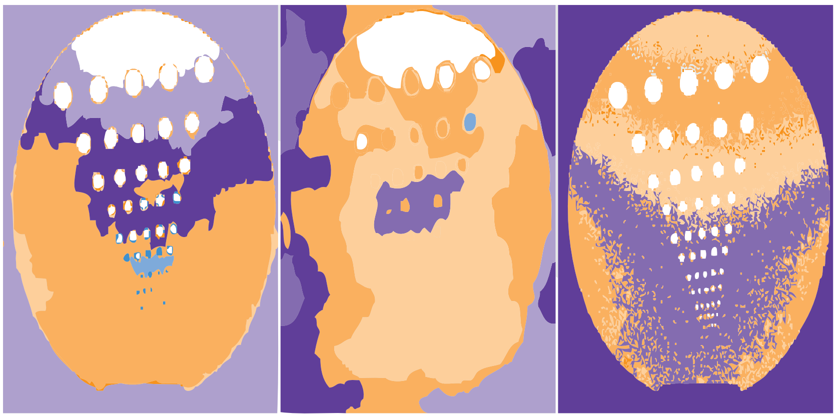
SIAM Conference on IMAGING SCIENCE
Program and Abstracts

May 12-14, 2014
Hong Kong Baptist University, Hong Kong



Tom Goldstein and Stanley Osher, SIAM J. Imaging Sciences, Vol.2, No. 2

This conference is the biennial activity of the SIAM Activity Group on Imaging Science. The SIAM Activity Group on Imaging Science brings together SIAM members and other scientists and engineers with an interest in the mathematical and computational aspects of imaging. The activity group organizes the biennial SIAM Conference on Imaging Science, awards the SIAG on Imaging Science Prize every two years to the authors of the best paper on mathematical and computational aspects of imaging, and maintains a website, a member directory, and an electronic mailing list.

Society for Industrial and Applied Mathematics

www.math.hkbu.edu.hk/SIAM-IS14/

Introduction

The interdisciplinary field of imaging science is experiencing tremendous growth. New devices capable of imaging objects and structures from nanoscale to the astronomical scale are continuously being developed and improved, and as result, the reach of science and medicine has been extended in exciting and unexpected ways. The impact of this technology has been to generate new challenges associated with the problems of formation, acquisition, compression, transmission, and analysis of images. By their very nature, these challenges cut across the disciplines of physics, engineering, mathematics, biology, medicine, and statistics. While the primary purpose of this conference is to focus on mathematical issues, the other facets of imaging, such as biomedical and engineering aspects, for example, will also play an important role.

SIAM-IS14 will exchange research results and address open issues in all aspects of imaging science and provide a forum for the presentation of work in imaging science.

Conference Themes

The reconstruction, enhancement, segmentation, analysis, registration, compression, representation, and tracking of two and three dimensional images are vital to many areas of science, medicine, and engineering. As a result, increasingly sophisticated mathematical, statistical, and computational methods are being employed in these research areas, which may be referred to as imaging science. These techniques include transform and orthogonal series methods, nonlinear optimization, numerical linear algebra, integral equations, partial differential equations, Bayesian and other statistical inverse estimation methods, operator theory, differential geometry, information theory, interpolation and approximation, inverse problems, computer graphics and vision, stochastic processes, and others.

Table of Contents

Conference Venue

Hong Kong Baptist University

Conference Sponsors

Centre for Mathematical Imaging and Vision, Hong Kong Baptist University

Croucher Foundation

Faculty of Science, Hong Kong Baptist University

Hong Kong Baptist University

Hong Kong Pei Hua Education Foundation

Scientific Committee

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University of Klagenfurt, Austria
Michael Ng
Hong Kong Baptist University, China
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University of Minnesota, USA

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Northwestern University, USA
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Technion, Israel
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ENS Cachan, France
Adrian Nachman
University of Toronto, Canada

Local Organization Committee

Members:

Thierry Blu
The Chinese University of Hong Kong, China
Xavier Bresson
The Center for Biomedical Imaging, Switzerland
Chris Chan
The Hong Kong Polytechnic University, China
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The Chinese University of Hong Kong, China
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Hong Kong University of Science and Technology, China
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The Chinese University of Hong Kong, China
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Hong Kong Baptist University, China
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City University of Hong Kong, China
Chin Ko Yau
Hong Kong Baptist University, China
Xiaoming Yuan
Hong Kong Baptist University, China
Tieyong Zeng
Hong Kong Baptist University, China
Lei Zhang
The Hong Kong Polytechnic University, China

SIAM IS14 At-a-Glance

Sunday May 11

5:00 PM - 8:00 PM
Registration
Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

Monday May 12

8:00 AM - 12:00 PM
1:30 PM - 5:00 PM
Registration
Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

9:25 AM - 9:30 AM
Conference Remarks
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

9:30 AM - 10:15 AM
IP1 Convex Representations for Imaging Problems
Antonin Chambolle, Ecole Polytechnique, France
(page 21)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

10:15 AM - 10:35 AM
The Vicent Caselles Student Award: Fine properties of the TVL1 and the TV-G models: Geometry Versus Oscillations
Vincent Duval, Ceremade, France
(page 21)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

10:35 AM - 11:05 AM
Coffee Break
3/F Podium, Academic and Administration Building

11:05 AM - 1:05 PM
Concurrent Sessions
(page 22)

MS07 Part I Modern Approaches for Dynamic Imaging
WLB206
MS08 Part I Mathematics for Imaging: the Legacy of Vicent Caselles
WLB103
MS10 Part I Asymptotics, Inverse Problems and Applications
WLB202
MS14 Part I Manifolds, Shapes and Topologies in Imaging
WLB204
MS25 Part I Mathematical Modeling and Related Inverse Problems in Medical Applications
DLB712
MS26 Recent Advances in Magnetic Resonance Imaging
WLB205
MS29 Part I Inverse Scattering Problems in Imaging Science
AAB201
MS31 Part I Geometry, Imaging and Computing
WLB104
MS32 Part I Variational Analysis in Image and Signal Processing: Theory and Algorithms
WLB211
MS37 Part I Recent Trends in Single Image Super-Resolution
WLB210
MS47 Part I Recent Advances in Optimization Techniques and Applications in Imaging Sciences
WLB208
MS51 Recently Developed Algorithms for Inverse Problems in Image Analysis
WLB207
MS57 Part I Modeling and Algorithms for Imaging Problems
AAB606
MS58 Novel Computational Methods for Electromagnetic Bioimaging Applications
WLB109
MS60 Part I Tensor Decompositions in Numerical Analysis, Optimization and Imaging
DLB719

1:05 PM - 1:50 PM
Lunch
Multi-purpose Hall, Level 2, Madam Kwok Chung Bo Fun Sports and Cultural Centre (SCC)

1:50 PM - 2:35 PM
IP2 Wavelet for Graphs and its Deployment to Image Processing
Michael Elad, Technion, Israel
(page 29)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

2:45 PM - 4:45 PM
Concurrent Sessions
(page 29)

MS05 Part I Keep the Edge? From Theory to Practice
WLB109
MS07 Part II Modern Approaches for Dynamic Imaging
WLB206
MS08 Part II Mathematics for Imaging: the Legacy of Vicent Caselles
WLB103
MS10 Part II Asymptotics, Inverse Problems and Applications
WLB202
MS11 Part I Modern Imaging Models, High Order Methods and Applications
WLB207
MS14 Part II Manifolds, Shapes and Topologies in Imaging
WLB204
MS20 Poisson Noise Removal
WLB209
MS25 Part II Mathematical Modeling and Related Inverse Problems in Medical Applications
DLB712
MS29 Part II Inverse Scattering Problems in Imaging Science
AAB201
MS31 Part II Geometry, Imaging and Computing
WLB104
MS32 Part II Variational Analysis in Image and Signal Processing: Theory and Algorithms
WLB211
MS37 Part II Recent Trends in Single Image Super-Resolution
WLB210
MS47 Part II Recent Advances in Optimization Techniques and Applications in Imaging Sciences
WLB208
MS57 Part II Modeling and Algorithms for Imaging Problems
AAB606
MS60 Part II Tensor Decompositions in Numerical Analysis, Optimization and Imaging
DLB719

4:45 PM - 5:15 PM
Coffee Break
3/F Podium, Academic and Administration Building

5:15 PM - 7:15 PM
Concurrent Sessions
(page 37)

MS03 Image Reconstruction Using Cross-Modality Priors
WLB210
MS05 Part II Keep the Edge? From Theory to Practice
WLB109
MS06 Variational Approaches for Image Sequence Analysis and Reconstruction"
DLB712
MS11 Part II Modern Imaging Models, High Order Methods and Applications
WLB207
MS13 Recent Developments in the Statistical Modelling of Brain Imaging Data
WLB202
MS16 High Precision Stereo Vision
WLB208
MS28 Image Denoising: Trends, Connections and Limitations
WLB103
MS29 Part III Inverse Scattering Problems in Imaging Science
AAB201
MS31 Part III Geometry, Imaging and Computing
WLB104
MS36
Geometry Processing with Functional Maps
WLB206
MS44 Reconstruction in Industrial X-ray Radiography
WLB203
MS48 Part I Computational Inversion Methods for Biomedical Imaging
WLB204
MS53 Part I Splitting Methods for Imaging Problems
AAB606
MS56 Directional Multiscale Representation Systems and Mathematical Imaging
WLB209

7:15 PM - 9:00 PM
Reception
Multi-purpose Hall, Level 2, Madam Kwok Chung Bo Fun Sports and Cultural Centre (SCC)

Tuesday May 13

8:00 AM - 12:00 PM
1:30 PM - 4:30 PM
Registration
Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

8:30 AM - 9:15 AM
IP3 Optimizing the Optimizers - What is the Right Image and Data Model?
Carola-Bibiane Schönlieb, University of Cambridge, UK
(page 44)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

9:15 AM - 10:00 AM
IP4 Personalized Blood Flow Simulation from an Image-Derived Model: Changing the Paradigm for Cardiovascular Diagnostics
Leo Grady, HeartFlow, USA
(page 45)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

10:00 AM - 10:30 AM
Coffee Break
3/F Podium, Academic and Administration Building

10:30 AM - 12:30 PM
Concurrent Sessions
(page 45)

MS02 Part I Photoacoustic Tomography
SCC2
MS04 Nonlinear Inverse Problems in Imaging
WLB204
MS11 Part III Modern Imaging Models, High Order Methods and Applications
WLB211
MS12 Part I Advances in Numerical Linear Algebra for Imaging
AAB201
MS17 Part I Detection and Analysis of Blood Vessels and Tree Shapes
WLB205
MS22 Part I Variational PDE and Multi-scale Multi-directional Sparse Representation in Imaging
WLB207
MS35 Part I Theoretical and Computational Aspects of Geometric Shape Analysis
WLB103
MS39 Part I Challenges in Inverse Problems for Imaging
WLB104
MS40 Part I A Fixed-Point Approach for Optimization Problems in Imaging
DLB712
MS45 Part I Multi-Frame Motion Estimation and Optical Flow Algorithms
SCC1
MS48 Part II Computational Inversion Methods for Biomedical Imaging
WLB206
MS52 Part I Non-Convex Models in Image Recovery and Segmentation
WLB208
MS54 Part I Optimization in Imaging: Algorithms, Applications and Theory
WLB210
MS55 Part I Advances and Trends of Modern Image Restoration
WLB109
MS57 Part III Modeling and Algorithms for Imaging Problems
DLB719

12:30 PM - 1:45 PM
Lunch
3/F Podium, Academic and Administration Building

12:50 PM - 1:35 PM
SIAG/IS Business Meeting
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

1:45 PM - 3:45 PM
Concurrent Sessions
(page 53)

MS02 Part II Photoacoustic Tomography
SCC2
MS12 Part II Advances in Numerical Linear Algebra for Imaging
AAB201
MS17 Part II Detection and Analysis of Blood Vessels and Tree Shapes
WLB205
MS21 New Frontiers in Inpainting
WLB206
MS22 Part II Variational PDE and Multi-scale Multi-directional Sparse Representation in Imaging
WLB207
MS35 Part II Theoretical and Computational Aspects of Geometric Shape Analysis
WLB103
MS39 Part II Challenges in Inverse Problems for Imaging
WLB104
MS40 Part II A Fixed-Point Approach for Optimization Problems in Imaging

DLB712
MS43 Tensor- and Manifold-Valued Data
WLB209
MS45 Part II Multi-Frame Motion Estimation and Optical Flow Algorithms
SCC1
MS46 Advances in Phase Retrieval for Diffractive Imaging
WLB211
MS52 Part II Non-Convex Models in Image Recovery and Segmentation
WLB208
MS53 Part II Splitting Methods for Imaging Problems
WLB210
MS55 Part II Advances and Trends of Modern Image Restoration
WLB109
MS57 Part IV Modeling and Algorithms for Imaging Problems
DLB719

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3:45 PM - 4:15 PM
Coffee Break
3/F Podium, Academic and Administration Building

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4:15 PM - 6:15 PM
MiniTutorial
Graph Cut, Convex Relaxation and Continuous Max-flow Problems
Egil Bae, University of California at Los Angeles, USA
Mila Nikolova, CNRS-ENS-Cachan, France
Xue-Cheng Tai, University of Bergen, Norway
(page 58)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

. . . .

4:15 PM - 6:15 PM
Concurrent Sessions
(page 59)

Contributed Talks
CT01–*WLB103*
CT02–*WLB104*
CT03–*WLB109*
CT04–*WLB205*
CT05–*WLB211*
CT06–*WLB209*
CT07–*WLB202*
CT08–*WLB206*
CT09–*WLB208*
CT10–*WLB207*
CT11–*WLB203*

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4:15 PM - 6:15 PM
Poster Presentation
(page 63)
Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

Wednesday May 14

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8:00 AM - 11:00 AM
Registration
Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

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8:30 AM - 9:15 AM
IP5 Pursuit of Low-dimensional Structures in High-dimensional Data
Yi Ma, ShanghaiTech University, China
(page 64)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

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9:15 AM - 10:00 AM
IP6 Emerging Methods in Photon-Limited Imaging
Rebecca Willett, University of Wisconsin-Madison, USA
(page 64)
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

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10:00 AM - 10:30 AM
Coffee Break
3/F Podium, Academic and Administration Building

. . . .

10:30 AM - 12:30 PM
Concurrent Sessions
(page 65)

MS01 Part I Beyond Single Shot Imaging: Academic and Industrial Points of View
WLB210
MS18 Part I Super-resolution: Theoretical and Numerical Aspects
WLB211
MS19 Part I Wave-based Imaging
WLB207
MS23 Sparse Reconstruction for Tomographic Imaging
WLB206
MS24 Part I Color Perception and Image Enhancement
WLB109
MS27 Part I High Frequency Wave Propagation and Related Imaging Problems
AAB606
MS30 Part I First-order Primal-dual Methods for Convex Optimization
WLB103
MS33 Models and Methods for Imaging Through Turbulence
WLB202
MS38 Part I Numerical Methods for

Large-scale Imaging Problems
WLB208
MS39 Part III Challenges in Inverse Problems for Imaging
WLB104
MS41 Part I Advances in Electrical Impedance Tomography
AAB201
MS49 Part I Methods, Computations, and Applications of Contemporary Dynamical Medical Imaging
WLB204
MS50 Part I Parallel and Distributed Computation in Imaging
WLB209
MS54 Part II Optimization in Imaging: Algorithms, Applications and Theory
DLB712
MS57 Part V Modeling and Algorithms for Imaging Problems
DLB719
MS59 Spectral Geometry in Manifold Analysis - Theory and Applications
WLB205

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12:30 PM - 1:30 PM
Lunch
Multi-purpose Hall, Level 2, Madam Kwok Chung Bo Fun Sports and Cultural Centre (SCC)

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1:30 PM - 2:15 PM
SIAG on Imaging Sciences Prize Lecture
Alfred M. Bruckstein, Technion, Israel
Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

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2:15 PM - 2:45 PM
Coffee Break
3/F Podium, Academic and Administration Building

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2:45 PM - 4:45 PM
Concurrent Sessions
(page 72)

MS01 Part II Beyond Single Shot Imaging: Academic and Industrial Points of View
WLB210
MS09 New Trends in Histogram Processing
WLB104
MS15 Applications of Splitting Methods to Nonconvex Problems in Imaging Science
WLB205
MS18 Part II Super-resolution: Theoretical and Numerical Aspects
WLB211
MS19 Part II Wave-based Imaging
WLB207
MS24 Part II Color Perception and Image Enhancement
WLB109
MS27 Part II High Frequency Wave Propagation and Related Imaging Problems
AAB606
MS30 Part II First-order Primal-dual Methods for Convex Optimization
WLB103
MS34 Imaging Through Strong Turbulence
WLB202
MS38 Part II Numerical Methods for Large-scale Imaging Problems
WLB208
MS41 Part II Advances in Electrical Impedance Tomography
AAB201
MS42 Statistical Techniques on Riemannian Manifolds for Analysis of Imaging Data
WLB206
MS49 Part II Methods, Computations, and Applications of Contemporary Dynamical Medical Imaging
WLB204
MS50 Part II Parallel and Distributed Computation in Imaging
WLB209
MS57 Part VI Modeling and Algorithms for Imaging Problems
DLB719

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6:00 PM - 9:30 PM
Conference Banquet
Central City Hall Maxim's Palace, 2/F, Low Block, City Hall, Central, Hong Kong

Conference Talk Arrangement

All plenary talks and SIAG prize lecture will be 45 minutes in duration, with 5 of the 45 minutes reserved for questions and discussion.

The Vicent Caselles student award talk will be 20 minutes in duration, with 5 of the 20 minutes reserved for questions and discussion.

The minitutorial will be 2 hours in duration.

All minisymposia talks will be 30 minutes in duration, with 5 of the 30 minutes reserved for questions and discussion.

All contributed talks will be 20 minutes in duration, with 5 of the 20 minutes reserved for questions and discussion.

In case you need to copy your presentation slides from your USB to a computer in lecture hall or meeting room, please do it in advance before the session starts.

Important Notice to Poster Presenters

The poster session is scheduled for Tuesday, May 13 at 4:15 PM. Poster presenters are requested to set up their poster material on the provided 4'x6' poster boards at the Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building between the hours of 1:15 PM and 4:15 PM. All materials must be posted by Tuesday, May 13 at 4:15 PM, the official start time of the session. Posters displays must be removed by 6:30 PM. Posters remaining after this time will be discarded. The conference is not responsible for discarded posters.

Registration Desk

The registration desk is located in Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Administration Building, and is open during the following times:

<u>Sunday, 11 May</u>

5:00 PM - 8:00 PM

<u>Monday, 12 May</u>

8:00 AM - 12:00 PM

1:30 PM - 5:00 PM

<u>Tuesday, 13 May</u>

8:00 AM - 12:00 PM

1:30 PM - 4:30 PM

<u>Wednesday, 14 May</u>

8:00 AM - 11:00 AM

Name Badges

Carry your name badge during the conference so that you can admit to all technical sessions, coffee breaks, lunches, reception and banquet

Registration Fee Includes

- Admission to all technical sessions
- Business Meeting (open to SIAG/IS members)
- Wi-Fi access at the conference
- Coffee breaks daily
- Lunches
- Reception and Banquet

Lunches

Simple lunches are provided on Monday and Wednesday at Multi-purpose Hall, Level 2, Madam Kwok Chung Bo Fun Sports and Cultural Centre (SCC), and on Tuesday at 3/F Podium, Academic and Administration Building.

Conference participants may also have a lunch at two canteens (AAB 5/F and Maxim Canteen at Baptist University Road) or a coffee shop (next to AAB Building) in the campus. Their locations can be found in the conference venue map (page 10).

Conference participants can also travel to nearby two shopping centers: Lok Fu Shopping Centre (at Lok Fu MTR station) and Festival Walk (at Kowloon Tong MTR station). Lok Fu has a more local flavour while Festival Walk is more modern and more expensive. It is a 15-minute walk from the University to either of these shopping centers (page 10).

Wi-Fi Access

The username and password of your account during the conference period (12-14 May) can be found in the name badge. Please make sure you have your own name badge so that you can access your device by your account. Your account is only allowed to be used by one device at any time.

Get-togethers

- Reception, Monday 12 7:15 PM - 9:00 PM
- Business Meeting (open to SIAG/IS members) Tuesday 13 12:50 PM - 1:35 PM
- Banquet, Wednesday 14 6:00 PM - 9:30 PM

Conference Banquet

Shuttle bus service is arranged to take conference participants to the banquet venue. The pickup point is at the entrance of Lam Woo Conference Center (see the conference venue map), and the pickup time is 5:15 P.M. Please wait there on time.

In case you plan to go the conference banquet venue directly, please check and refer to banquet venue map at page 15.

There will be no shuttle bus service after the conference banquet. Student helpers will guide conference participants to take the subway at Central Station or the ferry between Central and Tsim Sha Tsui. Please check your local hotel accommodation staff to figure out the way back from Central subway station or Tsim Sha Tsui ferry terminal.

Additional conference banquet tickets for the accompanying guests of conference participants are available. Please check and buy at the registration counter on or before 13 May 2014 afternoon. The price of a banquet ticket is HK$800 (or US$100, EURO$75, GBP$60, RMB$650).

Standard Visual Set-Up in Meeting Rooms

Computers and overhead projectors are provided in the meeting rooms. USB is not supplied. Please make sure you can copy your presentation slides to the computers in the meeting rooms. Speakers can also use their own computers. Cables or adaptors for Macbook computers are not supplied. Please bring your own cable/adaptor if using a Macbook computer. Also the conference is not responsible for the safety and security of speakers' computers.

Recording of Presentations

Audio and video recording of presentations at the conference is prohibited without the written permission of the presenter and the conference.

Please Note

Complimentary wireless Internet access in the conference venue and meeting rooms will be available for conference participants. The conference does not provide email stations for conference attendees.

The conference is not responsible for the safety and security of attendees' computers. Do not leave your laptop computers and personal things unattended. Please remember to turn off your cell phones, pagers, etc in all the sessions.

The conference cannot provide photocopying and dollar exchange service. The bank within campus can be found in the conference venue map.

SIAM Books and Journals

Display copies of books and complimentary copies of journals are available on site at Lam Woo Conference Center WLB201 (Mon. 10:30 AM - 5:30 PM, Tue. 9:30 AM - 5:30 PM, Wed. 9:30 AM - 2:00 PM). SIAM books are available at a discounted price during the conference. Completed order forms should be emailed or faxed to the SIAM office directly. It is not allowed to carry out on site transaction during the conference period.

Books Display

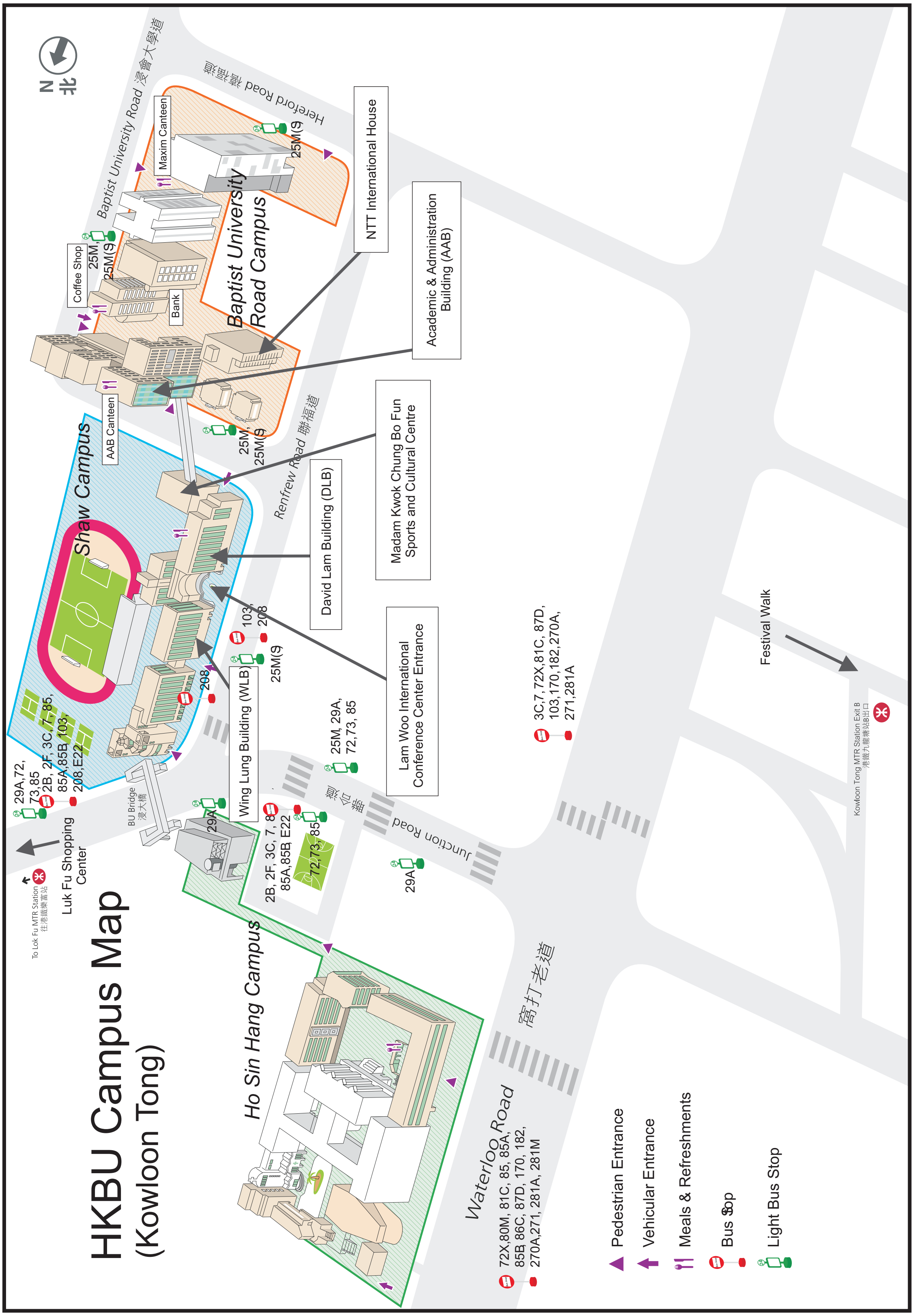
SIAM, Springer and IOP Publishing have books and journals display. They are displayed at Lam Woo Conference Center WLB201 (Mon. 10:30 AM - 5:30 PM, Tue. 9:30 AM - 5:30 PM, Wed. 9:30 AM - 2:00 PM). It is not allowed to carry out on site transaction during the conference period.

Twitter

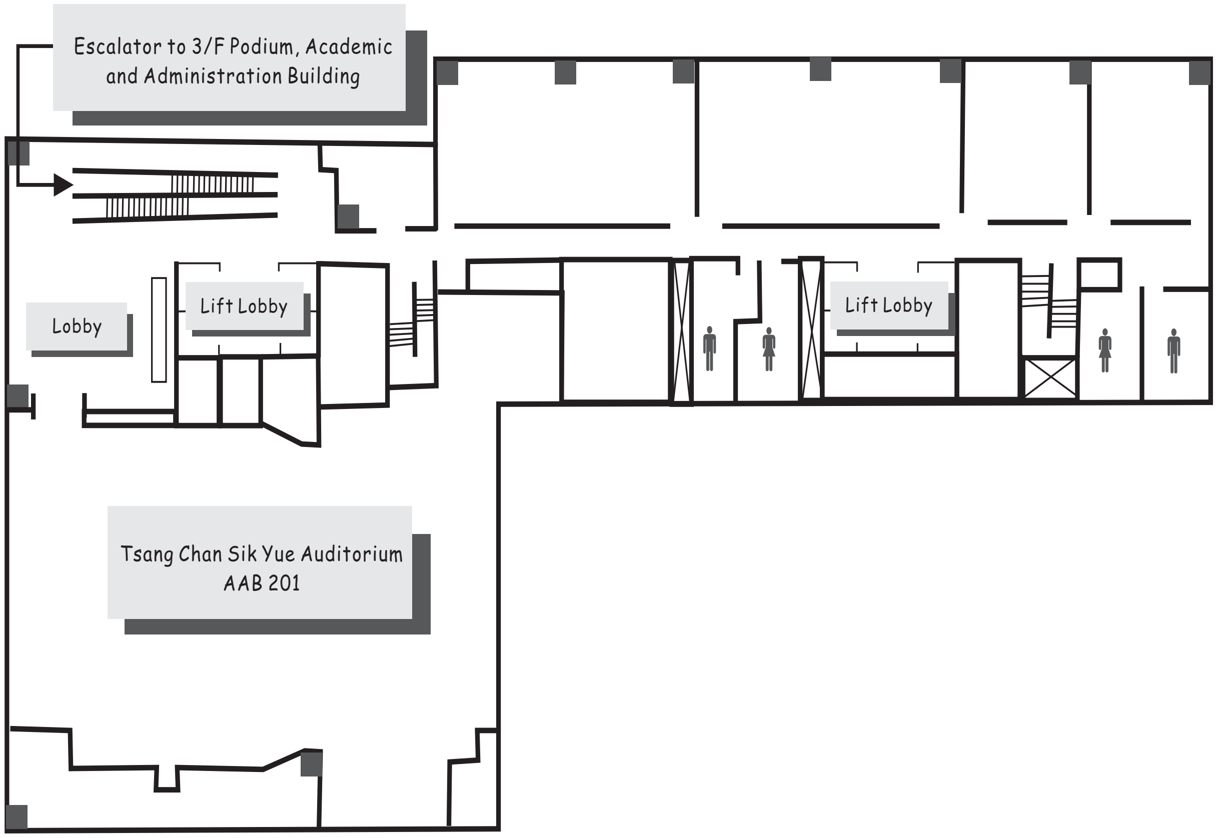
If you are tweeting about the conference, please use the designated hashtag to enable other attendees to keep up with the Twitter conversation and to allow better archiving of our conference discussions. The hashtag for this meeting is #SIAMIS14.

Comments

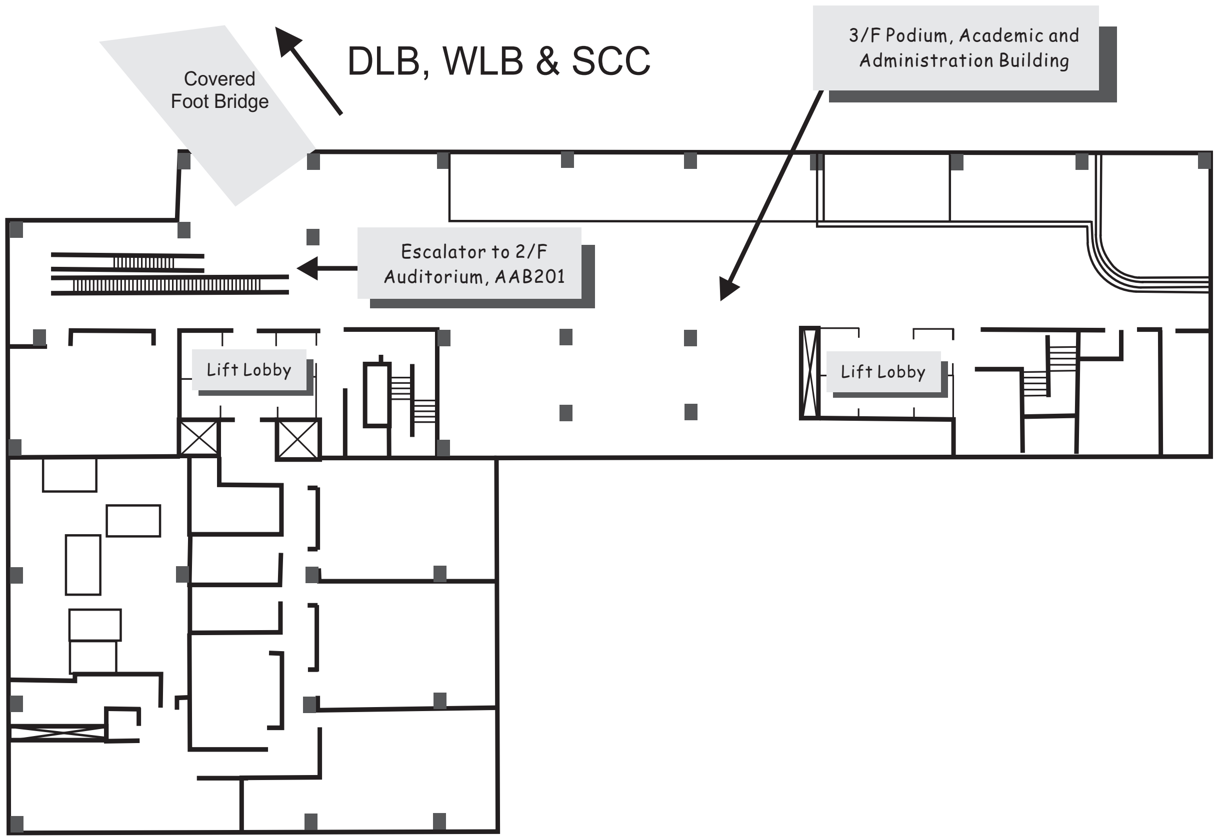
Comments about SIAM IS14 are encouraged ! Please send it to Cynthia Phillips, SIAM Vice President for Programs (vpp@siam.org)


HKBU Campus Map
(Kowloon Tong)
N 北
Baptist University Road 浸會大學道
Hereford Road
Renfrew Road 聯福道
Junction Road
Waterloo Road
窩打老道
Baptist University Road Campus
Shaw Campus
Ho Sin Hang Campus
Maxim Canteen
Coffee Shop
Bank
AAB Canteen
NTT International House
Academic & Administration Building (AAB)
Madam Kwok Chung Bo Fun Sports and Cultural Centre
David Lam Building (DLB)
Lam Woo International Conference Center Entrance
Wing Lung Building (WLB)
BU Bridge 浸大橋
Luk Fu Shopping Center
To Lok Fu MTR Station
Festival Walk
Kowloon Tong MTR Station Exit B
29A,72, 73,85
2B, 2F, 3C, 7, 85, 85A,85B 103, 208,E22
2B, 2F, 3C, 7, 8, 85A,85B, E22
72,73, 85
25M, 29A, 72,73, 85
29A
208
103, 208
3C,7,72X,81C, 87D, 103,170,182,270A, 271,281A
72X,80M, 81C, 85, 85A, 85B, 86C, 87D, 170, 182, 270A,271, 281A, 281M
Pedestrian Entrance
Vehicular Entrance
Meals & Refreshments
Bus Stop
Light Bus Stop

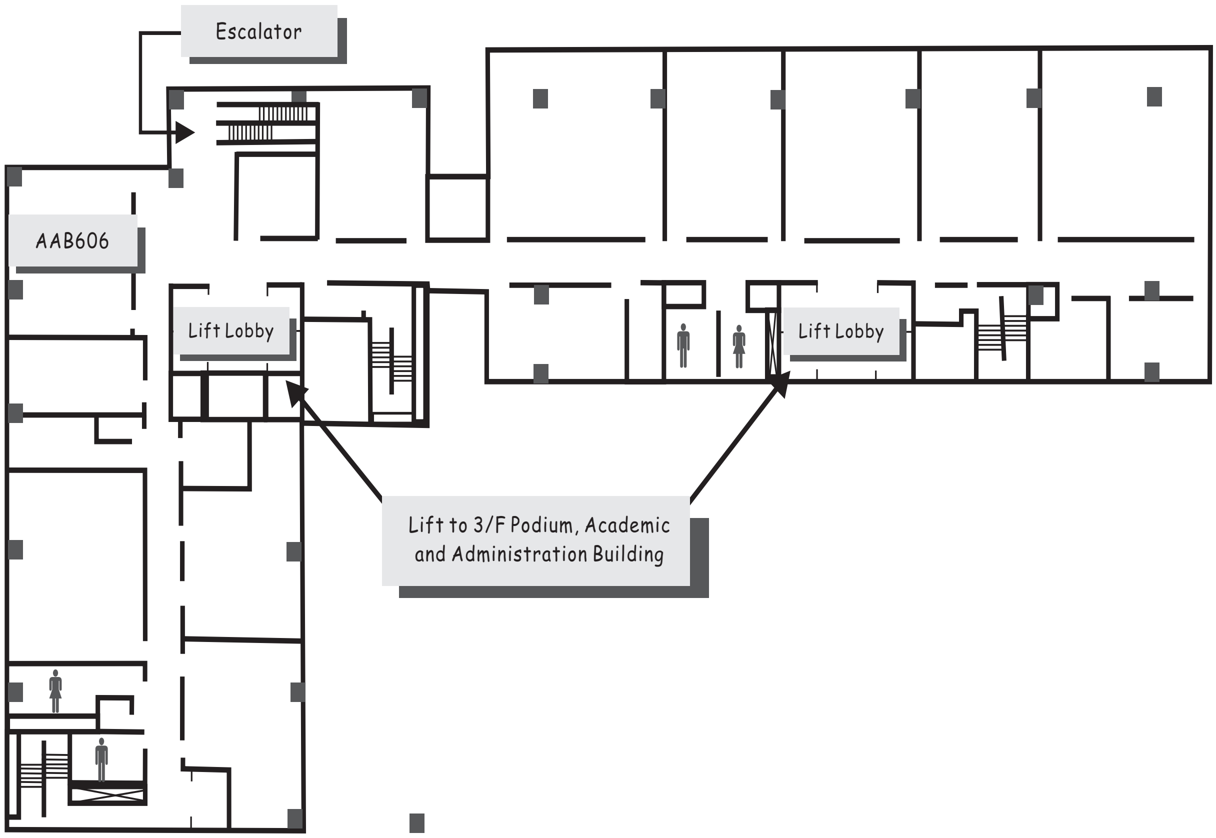
Academic and Administration Building (AAB) 2/F



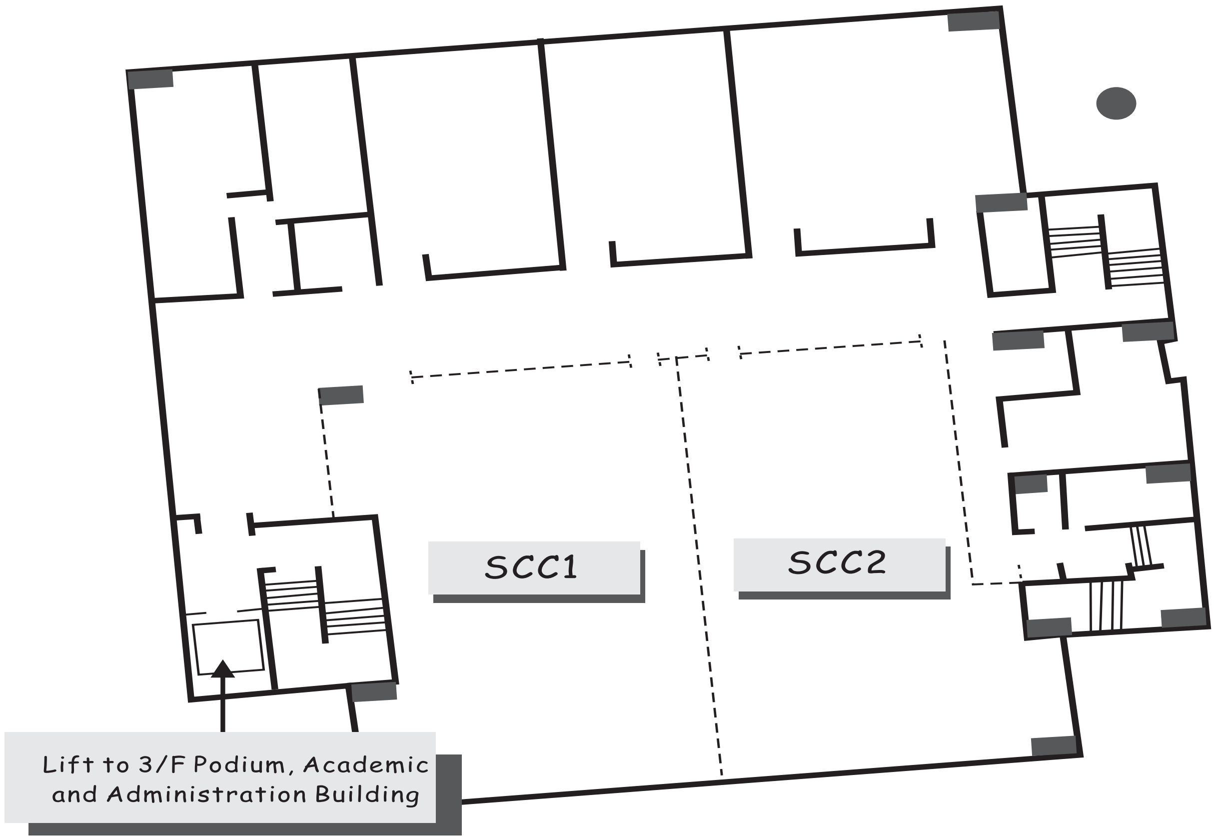
Academic and Administration Building (AAB) 3/F



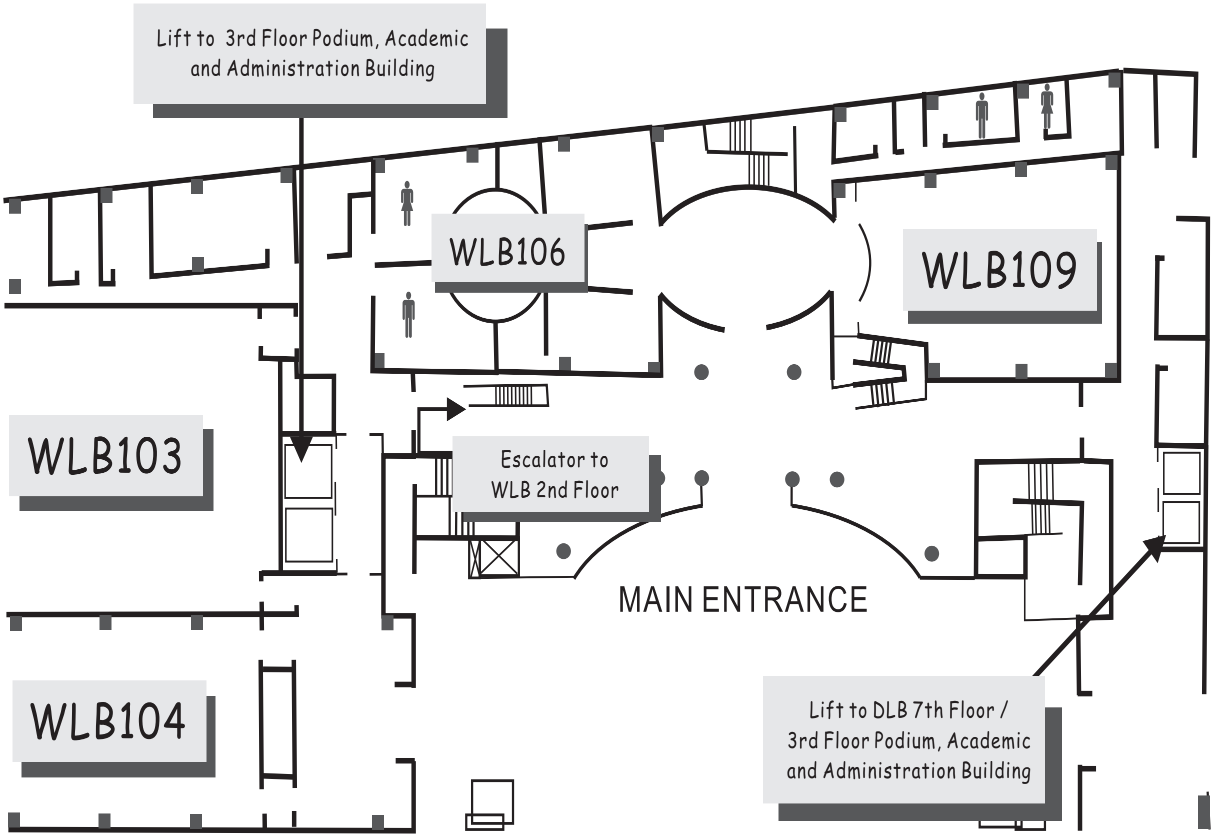
Academic and Administration Building (AAB) 6/F



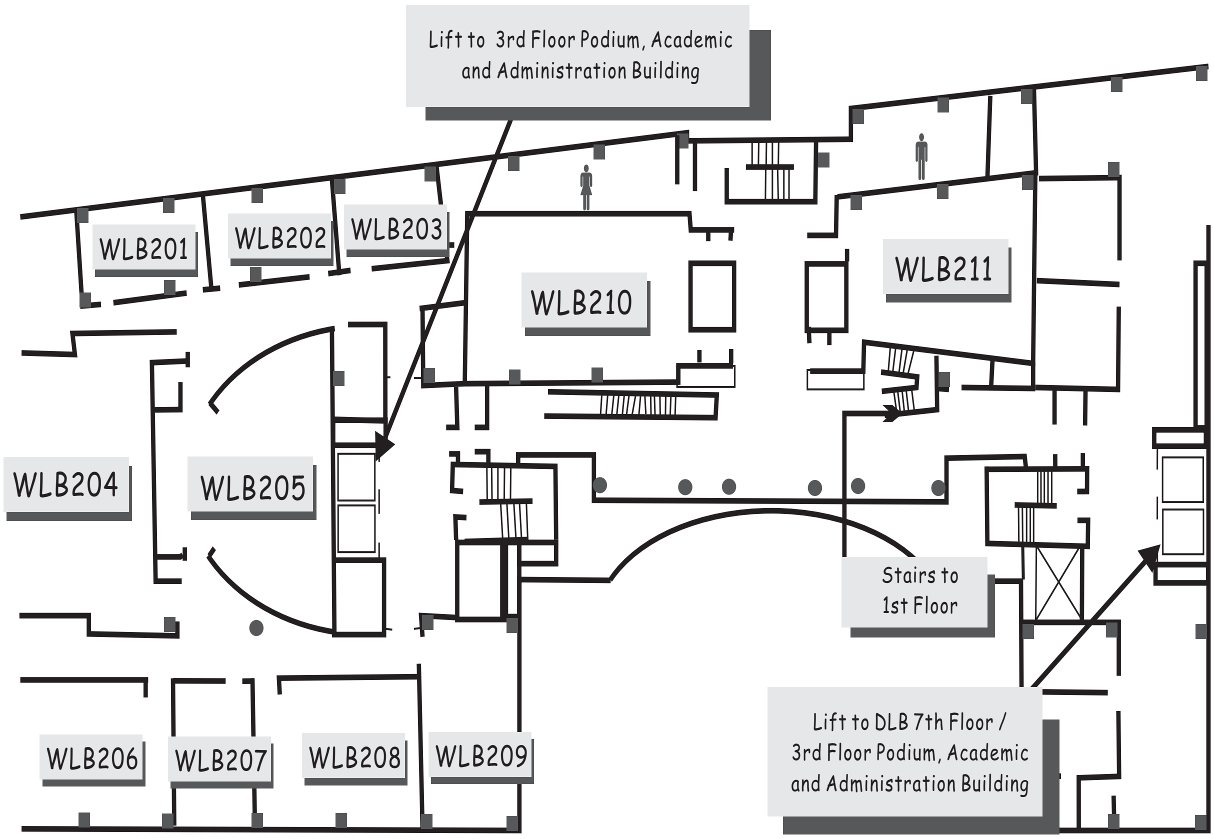
Madam Kwok Chung Bo Fun Sports and Cultural Centre (SCC)



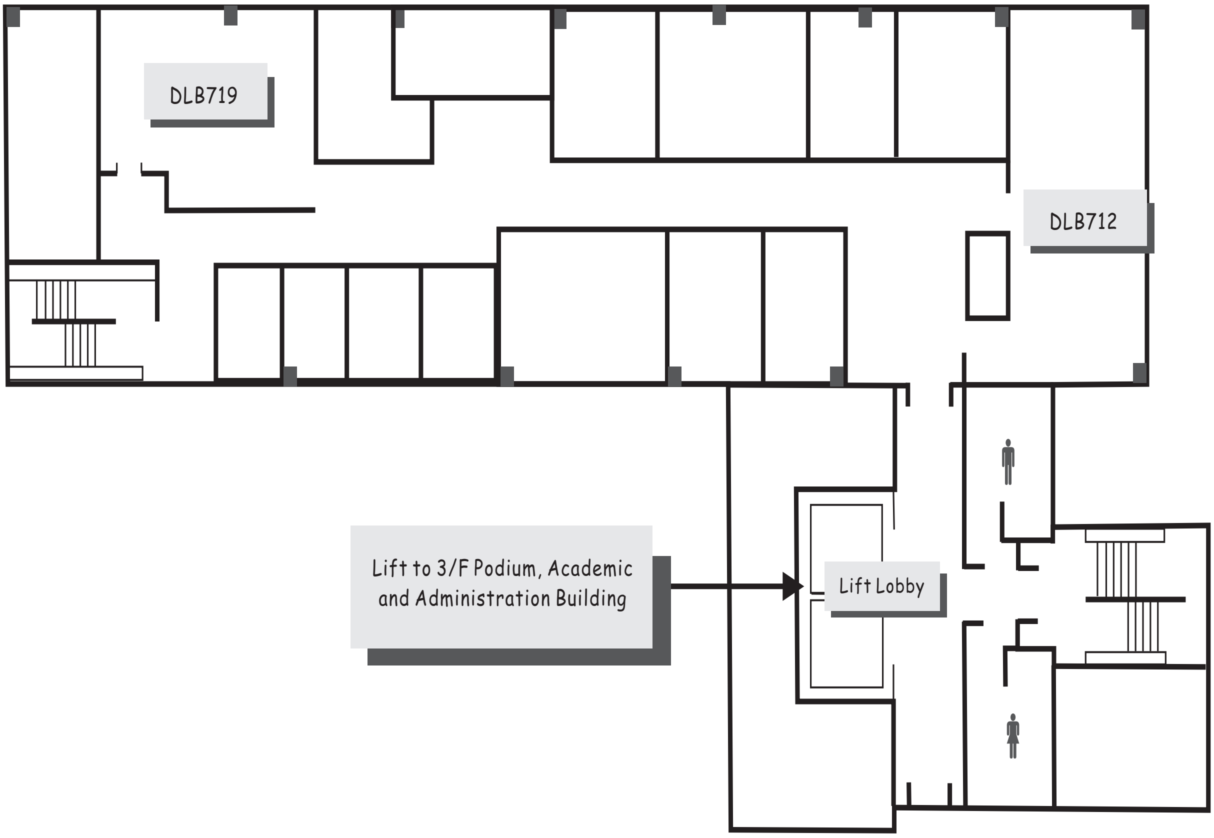
Wing Lung Building (WLB) 1/F



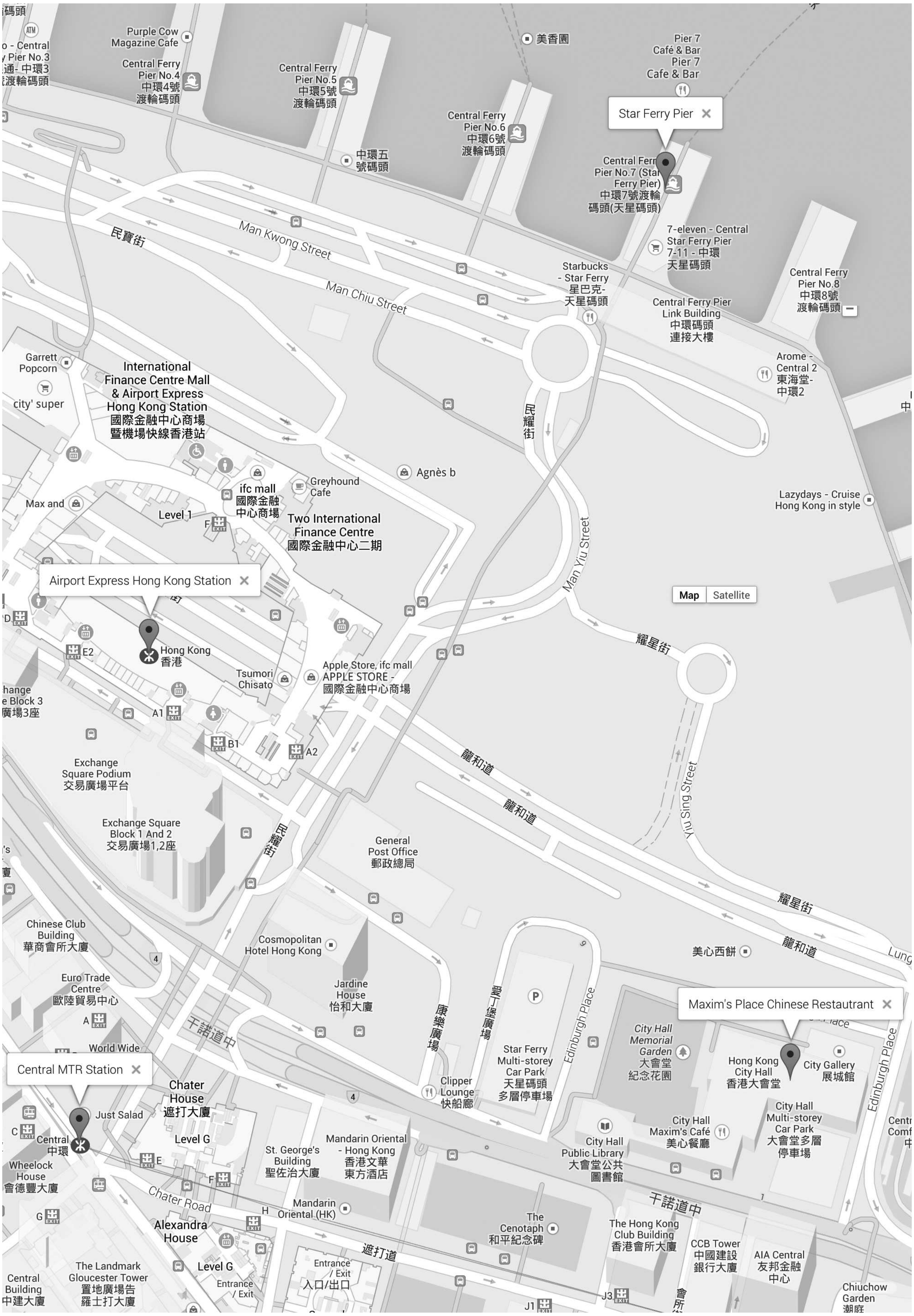
Wing Lung Building (WLB) 2/F



David Lam Building (DLB) 7/F



Conference Banquet Venue: Central City Hall Maxim's Palace, 2/F, Low Block, City Hall, Central, Hong Kong



Invited Plenary Speakers

All Invited Plenary Presentations will take place in Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building.

Monday, May 12, 9:30 AM - 10:15 AM

IP1 Convex Representations for Imaging Problems

Antonin Chambolle, Ecole Polytechnique, France

Monday, May 12, 1:50 PM - 2:35 PM

IP2 Wavelet for Graphs and its Deployment to Image Processing

Michael Elad, Technion, Israel

Tuesday, May 13, 8:30 AM - 9:15 AM

IP3 Optimizing the Optimizers - What is the Right Image and Data Model?

Carola-Bibiane Schönlieb, University of Cambridge, UK

Tuesday, May 13, 9:15 AM - 10:00 AM

IP4 Personalized Blood Flow Simulation from an Image-Derived Model: Changing the Paradigm for Cardiovascular Diagnostics

Leo Grady, HeartFlow, USA

Wednesday, May 14, 8:30 AM - 9:15 AM

IP5 Pursuit of Low-dimensional Structures in High-dimensional Data

Yi Ma, ShanghaiTech University, China

Wednesday, May 14, 9:15 AM - 10:00 AM

IP6 Emerging Methods in Photon-Limited Imaging

Rebecca Willett, University of Wisconsin-Madison, USA

SIAG on Imaging Sciences Prize Lecture

The Prize Lecture will take place in Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building.

Wednesday, May 14, 1:30 PM - 2:15 PM

Prize Paper: A. M. Bruckstein, D. L. Donoho, and M. Elad: "From Sparse Solutions of Systems of Equations to Sparse Modeling of Signals and Images", SIAM Review, Vol. 51, no. 1, pp. 34-81, 2009

presented by

Alfred M. Bruckstein, Technion, Israel

The Vicent Caselles Student Award[1]

The Vicent Caselles Student Award Talk will take place in Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building.

Awardee: Dr. Vincent Duval, CEREMADE, France

Monday, May 12, 10:15 AM - 10:35 AM

Talk – Fine properties of the TVL1 and the TV-G models: Geometry Versus Oscillations

[1]The 2014 SIAM Conference on Imaging Science will honor Professor Vicent Caselles (August 10, 1960 - August 14, 2013) `http://memorialwebsites.legacy.com/vicent-caselles/homepage.aspx`, who prematurely departed this world in August 2013, by awarding the Vicent Caselles Student Award.
Potential candidates should: Have a PhD awarded in the period January 2010 - January 2014 Work must be related to one of Professor Caselles contributions and areas of interest (e.g., image and video processing, variational formulations, PDEs, etc)
Candidates must submit a single journal quality paper representing their most significant work (paper can be already published, submitted, or a pre-print), together with a letter from their PhD advisor (or other senior researcher if not possible) explaining in detail how this work relates to Professor Caselles' contributions and areas of interest. The submission, including only those 2 documents, should be e-mailed to Professor Sapiro at guillermo.sapiro@duke.edu Candidate must be able to travel to SIAM IS 2014 to receive the award.
The awards committee is formed by Olivier Faugeras, Jean-Michel Morel, Stan Osher, Antonin Chambolle, Andres Almansa, and Guillermo Sapiro. Students and/or co-authors of the committee members in any publication, including pre-prints or submitted manuscripts, during the period 2010-2014, cannot be considered for the award. The award consists of: US$1000 dollars, Free registration to SIAM IS 2014, and A 20 minutes talk presenting their work during one of the SIAM IS plenary sessions.

MiniTutorial

The minitutorial will take place in Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building.

Tuesday, May 13, 4:15 PM - 6:15 PM

Graph Cut, Convex Relaxation and Continuous Max-flow Problems

Egil Bae, University of California at Los Angeles, USA

Mila Nikolova, CNRS-ENS-Cachan, France

Xue-Cheng Tai, University of Bergen, Norway

SIAM IS14 Program

Sunday May 11

Registration
5:00 PM - 8:00 PM

Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

Monday May 12

Registration
8:00 AM - 12:00 PM
1:30 PM - 5:00 PM

Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

Conference Remarks
9:25 AM - 9:30 AM

Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

IP1

9:30 AM - 10:15 AM
Chair: Michael Ng, Hong Kong Baptist University, China

Convex Representations for Imaging Problems

Antonin Chambolle, Ecole Polytechnique, France

This talk will address several results on convex representations for variational problems in imaging such as image partitioning, Mumford-Shah segmentation or matching problems. We will review recent results (obtained in collaboration with D. Cremers, T. Pock, E. Strekalovskiy) and discuss some difficulties and open problems.

Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

Monday May 12

The Vicent Caselles Student Award

10:15 AM - 10:35 AM
Chair: Antonin Chambolle, Ecole Polytechnique, France

Fine properties of the TVL1 and the TV-G models: Geometry Versus Oscillations

Vincent Duval, CEREMADE, France

In the past decade, the TVL1 and TV-G models have been used in many image processing applications, including denoising, geometry-texture decomposition, shape matching. Relying on results developed by V. Caselles and his collaborators for the study of the Rudin-Osher-Fatemi model, we analyze the fine properties of the minimizers of the TVL1 and the TV-G models. We describe the solutions of TVL1 by means of elementary morphological operations, and we exhibit some solutions of the TV-G model, highlighting a strong limitation on the produced decompositions.

Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

Coffee Break

10:35 AM - 11:05 AM

3/F Podium, Academic and Administration Building

Monday May 12

MS07 Part I
Modern Approaches for Dynamic Imaging
11:05 AM - 1:05 PM
WLB206

In recent years in biology, medicine, geo- or social sciences modern approaches for dynamic imaging got rapidly growing interest. This minisymposium brings together researchers contributing to dynamic imaging related to fluid or flow modeling on the one hand, or density-driven registration concepts on the other hand. Mathematical methodologies focus on variational methods with transport PDEs, sparsity as well as spatio-temporal, nonlocal or higher-order regularization. State-of-the-art research applications in 4D cell biology, tomography, microscopy and geosciences highlight the importance of flows and registration for dynamic imaging.

Organizer: Christoph Brune, University of Münster, Münster, Germany
Organizer: Andrea Bertozzi, UCLA, USA

11:05-11:35 Sparsity in Fluids - Vorticity Estimation via Compressive Sensing
Andrea Bertozzi, UCLA, USA

11:35-12:05 Improved Accuracy and Speed in Scanning Probe Microscopy by Image Reconstruction from Non-gridded Position Sensor Data
Travis Meyer, UCLA, USA

12:05-12:35 Image Interpolation with Optimal Transport
Nicolas Papadakis, Université Bordeaux, France

12:35-13:05 Spatio-temporal Optical Flow on Evolving Surfaces
Clemens Kirisits, University of Vienna, Austria

Monday May 12

MS08 Part I
Mathematics for Imaging: the Legacy of Vicent Caselles
11:05 AM - 1:05 PM
WLB103

This minisymposium, in memory of Professor Vicent Caselles Costa (1960-2013), will gather researchers who have worked closely, sometimes as collaborators, in the fields where Vicent was influential, in particular variational methods and mathematical analysis for image processing (inpainting, reconstruction, video editing, etc). We hope that Vicent would have appreciated this tribute to his impressive scientific influence.

Organizer: Antonin Chambolle, CMAP, Ecole Polytechnique, CNRS, France
Organizer: Andrés Almansa, LTCI, Telecom ParisTech, CNRS, France
Organizer: Mila Nikolova, CMLA, ENS Cachan, CNRS, France

11:05-11:35 Properties of the Solutions of the Total Variation Minimization Problem
Antonin Chambolle, CMAP, Ecole Polytechnique, CNRS, France

11:35-12:05 Metamorphosis and Discrete Geometry in the Space of Images
Martin Rumpf, Institute for Numerical Simulation, University of Bonn, Germany

12:05-12:35 Geodesic Active Contours : An Axiomatic Variational Geometric Approach
Ron Kimmel, Department of Computer Science, Technion - Israel Institute of Technology, Israel

12:35-13:05 Virtual Physiological Imaging: from Imaging to Computational Models and Back
Alejandro F. Frangi, Center for Computational Imaging & Simulation Technologies in Biomedicine, University of Sheffield, UK

Monday May 12

MS10 Part I
Asymptotics, Inverse Problems and Applications
11:05 AM - 1:05 PM
WLB202

This Minisymposium focuses on asymptotic methods and the crucial role they play in the solution of complex inverse problems. The study of the asymptotic behaviour of the underlying forward model with respect to a small (or a large) parameter gives rise to new imaging algorithm and to approximate models that are more suited for the analysis and the numerical solution of the inverse problem. The talks of the Minisymposium represent various applications of such approaches to solve inverse problems arising in non destructive testing and in electromagnetic imaging.

Organizer: Nicolas Chaulet, University College London, Department of Mathematics, UK
Organizer: Houssem Haddar, INRIA Saclay Ile de France / École Polytechnique, CMAP, France

11:05-11:35 Generalized Impedance Boundary Conditions and There use in the Inverse Electromagnetic Obstacle Problem
Nicolas Chaulet, University College London, Department of Mathematics, UK

11:35-12:05 Biosensing with Surface Plasmon Resonances
Faouzi Triki, Laboratoire Jean Kuntzmann, Université Grenoble-Alpes, France

12:05-12:35 Acoustic Inverse Scattering Using Topological Derivative of Far-field Measurements-based L^2 Cost Functionals
Cédric Bellis, Laboratory of Mechanics and Acoustics, CNRS, France

Monday May 12

MS14 Part I
Manifolds, Shapes and Topologies in Imaging
11:05 AM - 1:05 PM
WLB204

The detection, quantification or comparison of geometrical structures plays a central role in many imaging tasks. Particular examples are related to tomographic shape/topology reconstruction, shape recognition and statistics, based, e.g., on Riemannian geometry, or deformation analysis. In this minisymposium, recent analytical as well as computational approaches to aforementioned problems are addressed. In particular, techniques based on shape and topological sensitivity analysis, level set methods, adaptive geometric approximation, shape geodesics, and problems requiring efficient handling of Riemannian manifolds are emphasized.

Organizer: Günay Doğan, Theiss Research, National Institute of Standards and Technology, USA
Organizer: Michael Hintermüller, Institut für Mathematik, Humboldt-Universität zu Berlin, Germany

11:05-11:35 An Adaptive Shape Reconstruction Algorithm for Inverse Problems
Günay Doğan, Theiss Research, National Institute of Standards and Technology, USA

11:35-12:05 A Convex Approach to Sparse Shape Composition
Alireza Aghasi, School of Electrical and Computer Engineering, Georgia Institute of Technology, USA

12:05-12:35 Robust Principal Component Pursuit via Alternating Minimization on Matrix Manifolds
Tao Wu, Institute for Mathematics and Scientific Computing, University of Graz, Austria

12:35-13:05 A Discrete Geodesic Calculus for Shape Space Applications
Benedikt Wirth, Institute for Numerical and Applied Mathematics, University of Münster, Germany

Monday May 12

MS25 Part I
Mathematical Modeling and Related Inverse Problems in Medical Applications
11:05 AM - 1:05 PM
DLB712

Mathematical methods for modeling and signal analysis have become important tools in medical area. In particular, these require multidisciplinary collaboration accompanied with physics and bio-based modeling, imaging system design, signal image processing, high performance computing as well as experimental validation. In this mini-symposium, mathematical problems and challenges in biomedical problems will be discussed, and current research activities in modeling and inverse problems arising from such problems will be reviewed. Special emphasis will be given on blood flow modeling and signal recovery, sparse image reconstruction and convex optimization in MR, CT, and various imaging modalities. Audiences are expected to learn how sophisticated mathematics can be used for real world applications.

Organizer: Jong Chul Ye, Department of Bio and Brain Engineering, KAIST, Korea
Organizer: Yoon Mo Jung, Computational Science and Engineering, Yonsei University, Korea
Organizer: Kiwan Jeon, National Institute for Mathematical Sciences, Korea

11:05-11:35 A New Pre-reconstruction Iterative Algorithm for Dual-Energy Computed Tomography
Kiwan Jeon, National Institute for Mathematical Sciences, Korea

11:35-12:05 A Binary Metal Image Reconstruction Based on the Lambda Tomography in CT
Hyoung Suk Park, Department of Computational Science and Engineering, Yonsei University, Korea

12:05-12:35 Inverse Problem on

Quantitative Susceptibility Mapping (QSM)
Jae Kyu Choi, Department of Computational Science and Engineering, Yonsei University, Korea

Monday May 12

MS26
Recent Advances in Magnetic Resonance Imaging
11:05 AM - 1:05 PM
WLB205

Efficient data acquisition and image reconstruction schemes for Magnetic Resonance Imaging (MRI) have recently gained particular attention due to significant advances by random sampling strategies. A common data model in this area are Fourier measurements, which allows many of the developed schemes to also be transferable to a variety of other imaging procedures such as X-ray Computed Tomography which admit a similar model for data acquisition. This minisymposium will bring together leading researchers on sampling and reconstruction schemes for MRI and present the most recent developments in this area.

Organizer: Gitta Kutyniok, Department of Mathematics, Technische Universität Berlin, Germany
Organizer: Wang-Q Lim, Department of Mathematics, Technische Universität Berlin, Germany

11:05-11:35 A Shearlet Scheme for Optimal Magnetic Resonance Imaging
Gitta Kutyniok, Department of Mathematics, Technische Universität Berlin, Germany

11:35-12:05 Optimal Sampling Strategies for Compressed Sensing in MRI
Anders Hansen, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK

12:05-12:35 Stable and Robust Sampling Strategies for Compressive Imaging
Felix Krahmer, Institute for Numerical and Applied Mathematics, University of Göttingen, Germany

12:35-13:05 Video Compressive Sensing for Dynamic MRI
Wotao Yin, Department of Mathematics, UCLA, USA

Monday May 12

MS29 Part I
Inverse Scattering Problems in Imaging Science
11:05 AM - 1:05 PM
AAB201

The mini-symposium intends to bring together leading experts working in the field of inverse scattering theory for waves and particles propagation and related applications in imaging science to discuss recent developments and new challenges in this fascinating field.

Organizer: Hongyu Liu, University of North Carolina, USA
Organizer: Kui Ren, University of Texas, USA

11:05-11:35 A One-Step Reconstruction Algorithm for Quantitative Photoacoustic Imaging
Sarah Vallélian, Department of Mathematics, University of Texas at Austin, USA

11:35-12:05 Near-Field Imaging of Acoustic Obstacles with the Factorization Method
Bo Zhang, Institute of Applied Mathematics, AMSS, Chinese Academy of Sciences, China

12:05-12:35 Optical Tomography in Weakly Scattering Media
Simon Arridge, Department of Computer Science, University College London, UK

12:35-13:05 Reconstruction of Sources with Small Supports From a Single Cauchy Data and Application
Abdellatif EL Badia, Labo. Math. Appli. Compiegne, University of Technology of Compiegne, France

Monday May 12

MS31 Part I
Geometry, Imaging and Computing
11:05 AM - 1:05 PM
WLB104

Recent advances in differential geometry and its computational aspects provide useful tools for solving various imaging problems. The main theme of this mini-symposium is on the differential geometry based modeling/computation in 3D and higher with applications to imaging, visions and graphics. We will explore recent development in computational differential geometry, geometry processing, shape analysis, shape registration, image processing, image analysis, image understanding, computer graphics, visions and visualization; leading to applications in science, medicine, engineering, and other fields.

Organizer: Ronald Lok Ming Lui, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong
Organizer: David Xianfeng Gu, Department for Computer Sciences, State University of New York at Stony Brook, USA

11:05-11:35 Fundamental Geometry Processing
Gabriel Taubin, School of Engineering, Brown University, USA

11:35-12:05 Modeling Disease in the Human Brain with Geometry and Imaging
Monica K. Hurdal, Department of Mathematics, Florida State University, USA

12:05-12:35 Euler's Elastica For Image Restoration And Segmentation And Fast Algorithms
Xue-Cheng Tai, Department of Mathematics, University of Bergen, Norway

12:35-13:05 A New Iterative Algorithm for Mean Curvature-based Variational Image Denoising
Li Sun, School of Mathematics and Statistics, Lanzhou University, China

Monday May 12

MS32 Part I
Variational Analysis in Image and Signal Processing: Theory and Algorithms
11:05 AM - 1:05 PM
WLB211

The last eight years has seen a retooling of conventional computational strategies towards new ends ignited by the observation that in many cases the solution to a simple problem corresponds exactly to the solution to a much more complex – nonsmooth, nonconvex NP-complete – problem. This has opened the door to computationally feasible means for tackling problems that were previously considered out of reach. In this minisymposium we examine the mathematical foundations of convex and nonconvex optimization that inform leading numerical techniques in image and signal processing and provide a basis for new trends in computational strategies.

Organizer: D. Russell Luke, University of Göttingen, Germany
Organizer: Shoham Sabach, University of Göttingen, Germany

11:05-11:35 The Proximal Heterogeneous Block Implicit-Explicit Method: Application to Ptychogrpahy
Russell Luke, Institute for Numerical and Applied Mathematics, University of Göttingen, Germany

11:35-12:05 Possible Equivalence Between the Optimal Solutions of Least Squares Regularized by L0 Norm and Penalized by L0 Norm
Mila Nikolova, CMLA – CNRS, ENS-Cachan, France

12:05-12:35 Stable Recovery with Gauge Regularization
Jalal Fadili, GREYC CNRS, University of Caen, France

12:35-13:05 Composite Self-concordant Minimization
Quoc Tran Dinh, Laboratory for Information and Inference Systems, Ecole Polytechnique Federal de Lausanne, Switzerland

Monday May 12

MS37 Part I
Recent Trends in Single Image Super-Resolution
11:05 AM - 1:05 PM
WLB210

Image super-resolution techniques aim at resolution enhancement of images acquired by low-resolution sensors, while minimizing visual artifacts. Recently, the field of single image super-resolution has drawn considerable attention. In this setup, image recovery is cast as a severely underdetermined inverse problem, regularized by some image model or prior. The inverse problem is cast either as pure interpolation or zooming deblurring. Leading methods typically exploit sparsity of image patches in some domain and self-similarity of image patches within and across different scales of the image. The proposed minisymposium consists of two sessions, covering the leading methods in both problem setups.

Organizer: Tomer Peleg, Technion – Israel Institute of Technology, Israel
Organizer: Yaniv Romano, Technion – Israel Institute of Technology, Israel
Organizer: Michael Elad, Technion – Israel Institute of Technology, Israel

11:05-11:35 Single Image Interpolation via Adaptive Non-Local Sparsity-Based Modeling
Yaniv Romano, Department of Electrical Engineering, Technion - Israel Institute of Technology, Technion City, Israel

11:35-12:05 Sparse Image Super-resolution with Nonlocal Autoregressive Modeling
Weisheng Dong, School of Electronic Engineering, Xidian University, China

12:05-12:35 Image Super-resolution in the Sobolev Space
Lei Zhang, Dept. of Computing, The Hong Kong Polytechnic University, Hong Kong

12:35-13:05 Nonparametric Blind Super-Resolution

Tomer Michaeli, Department of Computer Science and Applied Mathematics, The Weizmann Institute of Science, Israel

Monday May 12

MS47 Part I

Recent Advances in Optimization Techniques and Applications in Imaging Sciences

11:05 AM - 1:05 PM

WLB208

In the past few years there has been an unprecedented growth in the volume of data collected in a variety of applications due to the fast advances of imaging and simulation technology. This poses high demands of sophisticated computation and optimization methods for efficient data analysis and processing. This mini-symposium is to discuss the recent developments in theory, techniques, and applications of optimization methods for imaging sciences in this field. Topics include but are not limited to advanced techniques in non-smooth and possibly non-convex optimization problems, and their applications in real-world imaging problems.

Organizer: Yunmei Chen, Department of Mathematics, University of Florida, USA
Organizer: Xiaojing Ye, Department of Mathematics and Statistics, Georgia State University, USA

11:05-11:35 Accelerated Primal Dual and ADMM Methods with Applications in Imaging

Yunmei Chen, Department of Mathematics, University of Florida, USA

11:35-12:05 Efficient Numerical Methods for Inverse Source Problems with Applications in Fluorescence Tomography

Haomin Zhou, School of Mathematics, Georgia Institute of Technology, USA

12:05-12:35 Sparse Subspace Clustering for Incomplete Face Images

Shiqian Ma, Department of Systems Engineering and Engineering Management, The Chinese University of Hong Kong, Hong Kong

12:35-13:05 Tomographic Reconstruction of Atmospheric Turbulence from Micro-lens Imagery

James G. Nagy, Mathematics and Computer Science Department, Emory University, USA

Monday May 12

MS51
Recently Developed Algorithms for Inverse Problems in Image Analysis
11:05 AM - 1:05 PM
WLB207

Many problems in image analysis, including image reconstruction, and quantitative and computed tomography, are eventually reduced to optimization problems. This minisymposium focuses on the recently developed efficient algorithms in this area.

Organizer: William W. Hager, Department of Mathematics, University of Florida, USA
Organizer: Maryam Yashtini, Department of Mathematics, University of Florida, USA

11:05-11:35 Adaptive Bregman Operator Splitting Method with Variable Stepsize for Parallel MR Imaging
Maryam Yashtini, Department of Mathematics, University of Florida, USA

11:35-12:05 Local Rigidity Constrained Diffeomorphic Deformations for Image Analysis
Yan Cao, Department of Mathematical Sciences, University of Texas at Dallas, USA

12:05-12:35 An Iterative Generalized l1 Greedy Algorithm for CT Image Reconstruction
Jiehua Zhu, Department of Mathematical Sciences, Georgia Southern University, USA

Monday May 12

MS57 Part I
Modeling and Algorithms for Imaging Problems
11:05 AM - 1:05 PM
AAB606

In recent years mainland China has many new developments in modeling and algorithms in imaging sciences. The objectives of this mini-symposium are to bring mainland China researchers in this field together to present their recent research work, to exchange ideas, and explore future collaborations. The topics of this mini-symposium were the latest development of modeling, algorithms and their applications in real-world imaging problems such as image denoising, deblurring, inpainting, decomposition, segmentation, and super-resolution reconstruction, etc. This minisymposium can provide a forum to stimulate discussions and establish collaborations between young Chinese researchers for further developments in this emerging imaging sciences research.

Organizer: Fang Li, Department of Mathematics, East China Normal University, China
Organizer: Huanfeng Shen, School of Resource and Environmental Science, Wuhan University, China
Organizer: Wei Wang, Department of Mathematics, Tongji University, China
Organizer: Xile Zhao, School of Mathematical Sciences, University of Electronic Science and Technology of China, China

11:05-11:35 A Weighted Dictionary Learning Model for Denoising Images Corrupted by Mixed Noise
Jun Liu, Beijing Normal University, China

11:35-12:05 Edge Detection Using A Modified Mumford-Shah Model
Yuying Shi, North China Electric Power University, China

12:05-12:35 Fast Algorithms for Structured Sparsity Based Brain Imaging
Yilun Wang, University of Electronic Science and Technology of China, China

12:35-13:05 A Level Set Formulation of Geodesic Curvature Flow on Simplicial Surfaces
Chulin Wu, Nankai University, China

Monday May 12

MS58
Novel Computational Methods for Electromagnetic Bioimaging Applications
11:05 AM - 1:05 PM
WLB109

This minisymposium is addressing bioimaging based on measurements of electric and magnetic fields outside the target of interest, including magnetoencephalography (MEG), electrical impedance tomography (EIT) and electroneurography (ENG). The mathematical problems that have to be solved in these modalities are characterized by a strong ill-posedness which inevitably results in low resolution in the solution unless the data are augmented by additional information about the target. The talks will present efficient and useful imaging algorithms designed so that the computed solutions obey constraints that may be quantitative in nature.

Organizer: Erkki Somersalo, Case Western Reserve University, USA
Organizer: Daniela Calvetti, Case Western Reserve University, USA

11:05-11:35 Imaging Focal Brain Activity from MEG Data
Erkki Somersalo, Case Western Reserve University, USA

11:35-12:05 Neuroelectric Source Localization by Random Spatial Sampling
Francesca Pitolli, Department of Basic and Applied Sciences for Engineering, University of Roma "La Sapienza", Italy

12:05-12:35 Handling Uncertainty in the Measurement Geometry in Practical EIT
Stratos Staboulis, Department of Mathematics and Systems Analysis, Aalto University, Finland

12:35-13:05 IAS Inversion of Electromagnetic Field Data
Sampsa Pursiainen, Aalto University, Finland

Monday May 12

MS60 Part I
Tensor Decompositions in Numerical Analysis, Optimization and Imaging
11:05 AM - 1:05 PM
DLB719

Tensor decompositions have a long history of application in data sciences, quantum physics, complexity theory in mathematics. Nowadays they actively penetrate many new fields such as approximation of multivariate functions, fast algorithms for new types of structured matrices, optimization problems, uncertainty quantification, efficient solvers for Fokker-Planck type equations, imaging sciences, analysis of probabilistic graphical models etc. It is essential that, besides classical tensor decompositions, new ways of representation and approximation of tensors are suggested and fastly becoming popular in different application fields. The aim of this minisymposium is to present new trends in numerical analysis, optimization and image processing methods based on tensor trains and related approaches for the representation of data and new recovery techniques in the case of incomplete data.

Organizer: Eugene Tyrtyshnikov, Institute of Numerical Mathematics of Russian Academy of Sciences, Lomonosov Moscow State University, Russia
Organizer: Ivan Oseledets, Skolkovo Institute of Science and Technology, Skolkovo, Moscow Region, Russia

11:05-11:35 Low-rank Structures in Numerical Analysis and Data Recovery Problems
Eugene Tyrtyshnikov, Institute of Numerical Mathematics of Russian Academy of Sciences, Lomonosov Moscow State University, Russia

11:35-12:05 Numerical Tensor Methods: Tools and Applications
Ivan Oseledets, Skolkovo Institute of Science and Technology, Russia

12:05-12:35 Tensor Recovery Methods and Nuclear Norms of Associated Matrices
Olga Lebedeva, Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University, Russia

12:35-13:05 Optimization of Measurements in k-spaces and Image Reconstruction Algorithms
Dmitry Zheltkov, Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University, Russian

Monday May 12

Lunch
1:05 PM - 1:50 PM

`Multi-purpose Hall, Level 2, Madam Kwok Chung Bo Fun Sports and Cul- tural Centre (SCC)`

IP2

1:50 PM - 2:35 PM
Chair: Yunmei Chen, University of Florida, USA

Wavelet for Graphs and its Deployment to Image Processing

Michael Elad, Technion, Israel

What if we take all the overlapping patches from a given image and organize them to create the shortest path by using their mutual Euclidean distances? This suggests a reordering of the image pixels in a way that creates a maximal 1D regularity. What could we do with such a construction? In this talk we consider a wider perspective of the above, and introduce a wavelet transform for graph-structured data. The proposed transform is based on a 1D wavelet decomposition coupled with a pre-reordering of the input so as to best sparsify the given data. We adopt this transform to image processing tasks by considering the image as a graph, where every patch is a node, and edges are obtained by Euclidean distances between corresponding patches. We show several ways to use the above ideas in practice, leading to state-of-the-art image denoising, deblurring, inpainting, and face-image compression results. (This is a joint work with Idan Ram and Israel Cohen.)

`Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building`

Monday May 12

MS05 Part I

Keep the Edge? From Theory to Practice

2:45 PM - 4:45 PM
`WLB109`

While many important theoretical and numerical advances have been made towards the understanding and numerical realization of structure-preserving methods there are still many open problems and unanswered questions. For instance, how to strike the right balance between structure-preservation and smoothness and how to model it? How can these reconstruction techniques be efficiently and accurately translated into practical applications to deal with corrupted and large-scale data? In this double minisymposium we will bring together researchers working on theory, algorithms and applications of structure-preserving methods to discuss the way forward on those important issues.

Organizer: Marta Betcke, Department of Computer Science, University College London, UK
Organizer: Carola-Bibiane Schönlieb, Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, UK

14:45-15:15 Ground States and Singular Values for TV and L1-type Models
Martin Burger, Institute for Computational and Applied Mathematics, Westfälische Wilhelms Universität (WWU) Münster, Germany

15:15-15:45 K-edge Imaging - X-ray CT Goes Functional
Alex Sawatzky, Department of Mathematics and Computer Science University of Münster, Germany

15:45-16:15 Optimization Methods for Total Generalized Variation Regularization
Kristian Bredies, Institute for Mathematics and Scientific Computing, University of Graz, Austria

16:15-16:45 Edge-Preserving Electrical Impedance Tomography
Samuli Siltanen, Department of Mathematics and Statistics, University of Helsinki, Finland

Monday May 12

MS07 Part II
Modern Approaches for Dynamic Imaging
2:45 PM - 4:45 PM
WLB206

In recent years in biology, medicine, geo- or social sciences modern approaches for dynamic imaging got rapidly growing interest. This minisymposium brings together researchers contributing to dynamic imaging related to fluid or flow modeling on the one hand, or density-driven registration concepts on the other hand. Mathematical methodologies focus on variational methods with transport PDEs, sparsity as well as spatio-temporal, nonlocal or higher-order regularization. State-of-the-art research applications in 4D cell biology, tomography, microscopy and geosciences highlight the importance of flows and registration for dynamic imaging.

Organizer: Christoph Brune, University of Münster, Münster, Germany
Organizer: Andrea Bertozzi, UCLA, USA

14:45-15:15 TGV-based Flow Estimation for 4D Cell Migration
Lena Frerking, Applied Mathematics, University of Münster, Germany

15:15-15:45 Nonlocal Crime Density Estimation Incorporating Housing Information
Joseph Woodworth, Department of Mathematics, UCLA, USA

15:45-16:15 A Nonlinear Variational Approach to Motion-corrected Reconstruction of Density Images
Sebastian Suhr, Institute of Mathematics and Image Computing, University of Lübeck, Germany

16:15-16:45 Joint Surface Reconstruction and 4-D Deformation Estimation from Sparse Data and Prior Knowledge for Marker-Less Respiratory Motion Tracking
Benjamin Berkels, AICES Graduate School, RWTH Aachen University, Germany

Monday May 12

MS08 Part II
Mathematics for Imaging: the Legacy of Vicent Caselles
2:45 PM - 4:45 PM
WLB103

This minisymposium, in memory of Professor Vicent Caselles Costa (1960-2013), will gather researchers who have worked closely, sometimes as collaborators, in the fields where Vicent was influential, in particular variational methods and mathematical analysis for image processing (inpainting, reconstruction, video editing, etc). We hope that Vicent would have appreciated this tribute to his impressive scientific influence.

Organizer: Antonin Chambolle, CMAP, Ecole Polytechnique, CNRS, France
Organizer: Andrés Almansa, LTCI, Telecom ParisTech, CNRS, France
Organizer: Mila Nikolova, CMLA, ENS Cachan, CNRS, France

14:45-15:15 Variational Methods for Virtual Soccer Game Replays
Nicolas Papadakis, Institut de Mathématiques de Bordeaux, University of Bordeaux, France

15:15-15:45 Multiscale Analyses of Images Defined on Riemannian Manifolds and of Similarities Between Images on Riemannian Manifolds
Felipe Calderero, Pompeu Fabra University, Spain

15:45-16:15 A Variational Perspective on Perceptually-inspired Color and Contrast Enhancement
Edoardo Provenzi, Signal and Image Processing Department, Institute Mines-Telecom ParisTech, France

16:15-16:45 A Variational Framework for Exemplar-Based Image Inpainting
Pablo Arias, University Pompeu Fabra, Spain

Monday May 12

MS10 Part II
Asymptotics, Inverse Problems and Applications
2:45 PM - 4:45 PM
WLB202

This Minisymposium focuses on asymptotic methods and the crucial role they play in the solution of complex inverse problems. The study of the asymptotic behaviour of the underlying forward model with respect to a small (or a large) parameter gives rise to new imaging algorithm and to approximate models that are more suited for the analysis and the numerical solution of the inverse problem. The talks of the Minisymposium represent various applications of such approaches to solve inverse problems arising in non destructive testing and in electromagnetic imaging.

Organizer: Nicolas Chaulet, Department of Mathematics, University College London, UK
Organizer: Houssem Haddar, INRIA Saclay Ile de France / École Polytechnique, CMAP, France

14:45-15:15 Non-destructive Eddy Current Inspection of Highly Conductive Thin Layer Deposits via Asymptotic Models
Zixian Jiang, Centre de Mathématiques Appliquées-INRIA Saclay, Ecole Polytechnique, France

15:15-15:45 The Vanishing Conductivity Limit in Eddy Current Imaging
Bastian Harrach, Department of Mathematics, University of Stuttgart, Germany

Monday May 12

MS11 Part I
Modern Imaging Models, High Order Methods And Applications
2:45 PM - 4:45 PM
WLB207

Various new and variational models beyond the ROF total variation work have been proposed recently to tackle emerging image restoration problems. Applications of some of the new emerging models will be discussed. Especially, higher order models will be presented. High order methods refer to solution techniques for minimizing energy functionals involving higher-order derivatives. They have become advantageous in many imaging applications where smooth features (with no artifacts such as staircasing) as well as sharp edges are equally important to preserve. High order regularisation is applicable to models for restoration, segmentation and registration. In contrast to the widely studied case of variational models based on first order derivatives where a large class of competing algorithms are developed, high order models lead to more challenging tasks in analysis and algorithms. There exist strong links to topics such as convex optimisation, convex relaxation, primal-dual methods and operator spitting methods. In this minisymposium we bring together experts from several leading groups to present and discuss their recent approaches and advances in image restoration modelling, analysis, high order methods and their applications

Organizer: Ke Chen, University of Liverpool, UK
Organizer: Xuecheng Tai, University of Bergen, Norway

14:45-15:15 Image Denoising Using LLT Model and Iterated Total Variation Refinement
Fenlin Yang, College of Mathematics and Statistics, Jishou University, China

15:15-15:45 Limiting Aspects of Non-convex Regularisation Models
Tuomo Valkonen, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK

15:45-16:15 Image Denoising Using the Gaussian Curvature of the Image Surface
Carlos Brito-Loeza, Universidad Autonoma de Yucatan, Mexico

16:15-16:45 Shape from Shading Using Mean Curvature
Wei Zhu, Department of Mathematics, University of Alabama, Tuscaloosa, USA

Monday May 12

MS14 Part II
Manifolds, Shapes and Topologies in Imaging
2:45 PM - 4:45 PM
WLB204

The detection, quantification or comparison of geometrical structures plays a central role in many imaging tasks. Particular examples are related to tomographic shape/topology reconstruction, shape recognition and statistics, based, e.g., on Riemannian geometry, or deformation analysis. In this minisymposium, recent analytical as well as computational approaches to aforementioned problems are addressed. In particular, techniques based on shape and topological sensitivity analysis, level set methods, adaptive geometric approximation, shape geodesics, and problems requiring efficient handling of Riemannian manifolds are emphasized.

Organizer: Günay Doğan, Theiss Research, National Institute of Standards and Technology, USA
Organizer: Michael Hintermüller, Institut für Mathematik, Humboldt-Universität zu Berlin, Germany

14:45-15:15 Computational Metric Geometry in the Natural Space
Ron Kimmel, Computer Science Department, Technion, Israel Institute of Technology, Israel

15:15-15:45 Affine-Invariant Shape Models for Contours and Their Discoveries in Images
Anuj Srivastava, Department of Statistics, Florida State University, USA

15:45-16:15 Smooth or Singular Metamorphoses for Images and Measures
Laurent Younes, Johns Hopkins University, USA

16:15-16:45 Shape and Topology Optimization Methods for Inverse Problems
Antoine Laurain, TU Berlin, Germany

Monday May 12

MS20
Poisson Noise Removal
2:45 PM - 4:45 PM
WLB209

Poisson noise appears in many imaging applications such as night vision, computed tomography (CT), fluorescence microscopy, astrophysics and spectral imaging. Several contributions from the recent years have moved from dealing with the "easy to treat" Gaussian noise model to the more realistic assumption that the noise is either Poisson distributed or a mixture of both Poisson and Gaussian noises. This context necessitates new perspective and tools for handling real life problems. This session gathers leading researchers in this field that will describe the current state-of-the-art

Organizer: Raja Giryes, Computer Science Department, Technion - Israel Institute of Technology, Israel
Organizer: Rebecca Willett, Electrical and Computer Engineering Department, University of Wisconsin-Madison, USA

14:45-15:15 Sparsity Based Poisson Denoising with Dictionary Learning
Raja Giryes, Computer Science Department, Technion - Israel Institute of Technology, Israel

15:15-15:45 Estimation of Mixed Poisson-Gaussian Noise Parameters via Variance Stabilization
Alessandro Foi, Department of Signal Processing, Tampere University of Technology, Finland

15:45-16:15 Adaptive Parameter Selection for Local and Non-local Poisson Noise Filtering
Charles Deledalle, IMB, CNRS-Université Bordeaux 1, France

16:15-16:45 First-Photon Imaging: Imaging by Estimation of Parametric Poisson Processes
Vivek K Goyal, Department of Electrical and Computer Engineering Boston University, USA

Monday May 12

MS25 Part II
Mathematical Modeling and Related Inverse Problems in Medical Applications
2:45 PM - 4:45 PM
DLB712

Mathematical methods for modeling and signal analysis have become important tools in medical area. In particular, these require multidisciplinary collaboration accompanied with physics and bio-based modeling, imaging system design, signal image processing, high performance computing as well as experimental validation. In this mini-symposium, mathematical problems and challenges in biomedical problems will be discussed, and current research activities in modeling and inverse problems arising from such problems will be reviewed. Special emphasis will be given on blood flow modeling and signal recovery, sparse image reconstruction and convex optimization in MR, CT, and various imaging modalities. Audiences are expected to learn how sophisticated mathematics can be used for real world applications.

Organizer: Jong Chul Ye, Department of Bio and Brain Engineering, KAIST, Korea
Organizer: Yoon Mo Jung, Computational Science and Engineering, Yonsei University, Korea
Organizer: Kiwan Jeon, National Institute for Mathematical Sciences, Korea

14:45-15:15 Vortex Flow Imaging Technique Using Echocardiography
Chi Young Ahn, National Institute for Mathematical Sciences, Korea

Monday May 12

MS29 Part II
Inverse Scattering Problems in Imaging Science
2:45 PM - 4:45 PM
AAB201

The mini-symposium intends to bring together leading experts working in the field of inverse scattering theory for waves and particles propagation and related applications in imaging science to discuss recent developments and new challenges in this fascinating field.

Organizer: Hongyu Liu, University of North Carolina, USA
Organizer: Kui Ren, University of Texas, USA

14:45-15:15 Detection and Classification From Electromagnetic Induction Data
Junqing Chen, Tsinghua University, China

15:15-15:45 One-shot Imaging Methods in Inverse Elastic Scattering
Jingzhi Li, Faculty of Science, South University of Science and Technology of China, China

15:45-16:15 Near-field Imaging of Rough Surfaces
Peijun Li, Department of Mathematics, Purdue University, West Lafayette, USA

16:15-16:45 On the Transmission Eigenvalue Problem Arising in Inverse Scattering Problem
Jijun Liu, Department of Mathematics, Southeast University, China

Monday May 12

MS31 Part II
Geometry, Imaging and Computing
2:45 PM - 4:45 PM
WLB104

Recent advances in differential geometry and its computational aspects provide useful tools for solving various imaging problems. The main theme of this mini-symposium is on the differential geometry based modeling /computation in 3D and higher with applications to imaging, visions and graphics. We will explore recent development in computational differential geometry, geometry processing, shape analysis, shape registration, image processing, image analysis, image understanding, computer graphics, visions and visualization; leading to applications in science, medicine, engineering, and other fields.

Organizer: Ronald Lok Ming Lui, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong
Organizer: David Xianfeng Gu, Department for Computer Sciences, State University of New York at Stony Brook, USA

14:45-15:15 New Developments in Levelset Based Image Segmentation and Art Pattern Synthesis
Yizhou Yu, Department of Computer Science, The Unviersity of Hong Kong, Hong Kong

15:15-15:45 A Discrete Uniformization Theorem for Polyhedral Surfaces
Jian Sun, Mathematical Sciences Center, Tsinghua University, China

15:45-16:15 Computing of Laplace-Beltrami Spectrum Via Conformal Deformation and Applications
Rongjie Lai, Department of Mathematics, University of California at Irvine, USA

16:15-16:45 Ricci Flow for Shape Analysis and Surface Registration
Wei Zeng, School of Computing and Information Sciences, Florida International University, USA

Monday May 12

MS32 Part II

Variational Analysis in Image and Signal Processing: Theory and Algorithms

2:45 PM - 4:45 PM

WLB211

The last eight years has seen a retooling of conventional computational strategies towards new ends ignited by the observation that in many cases the solution to a simple problem corresponds exactly to the solution to a much more complex – nonsmooth, nonconvex NP-complete – problem. This has opened the door to computationally feasible means for tackling problems that were previously considered out of reach. In this minisymposium we examine the mathematical foundations of convex and nonconvex optimization that inform leading numerical techniques in image and signal processing and provide a basis for new trends in computational strategies.

Organizer: D. Russell Luke, University of Göttingen, Göttingen, Germany
Organizer: Shoham Sabach, University of Göttingen, Göttingen, Germany

14:45-15:15 Proximal Alternating Linearized Minimization for Semi-algebraic Problems
Jérôme Bolte, University Toulouse Capitole & TSE, France

15:15-15:45 Solution of the Regularized Structured Total Least Squares Problem by an Alternating Proximal-Based Method with an Application to Blind Image Deblurring
Shoham Sabach, Institut fuer Numerische und Angewandte Mathematik, Universitaet Goettingen, Germany

15:45-16:15 A Sparse Kaczmarz Solver Based on the Linearized Bregman Method
Dirk Lorenz, Institute for Analysis and Algebra, TU Braunschweig, Germany

16:15-16:45 Local and Global Convergence Results for Affine Sparse Feasibility
Patrick Neumann, Institute for Numerical and Applied Mathematics, Georg-August-Universität Göttingen, Germany

Monday May 12

MS37 Part II

Recent Trends in Single Image Super-Resolution

2:45 PM - 4:45 PM

WLB210

Image super-resolution techniques aim at resolution enhancement of images acquired by low-resolution sensors, while minimizing visual artifacts. Recently, the field of single image super-resolution has drawn considerable attention. In this setup, image recovery is cast as a severely underdetermined inverse problem, regularized by some image model or prior. The inverse problem is cast either as pure interpolation or zooming deblurring. Leading methods typically exploit sparsity of image patches in some domain and self-similarity of image patches within and across different scales of the image. The proposed minisymposium consists of two sessions, covering the leading methods in both problem setups.

Organizer: Tomer Peleg, Technion – Israel Institute of Technology, Israel
Organizer: Yaniv Romano, Technion – Israel Institute of Technology, Israel
Organizer: Michael Elad, Technion – Israel Institute of Technology, Israel

14:45-15:15 A Statistical Prediction Model Based on Sparse Representations for Single Image Super-Resolution
Tomer Peleg, Department of Electrical Engineering, Technion – Israel Institute of Technology, Israel

15:15-15:45 Beta Process Joint Dictionary Learning for Coupled Feature Spaces and its Application to Single Image Super-Resolution
Hairong Qi, Department of Electrical Engineering and Computer Science, University of Tennessee, USA

15:45-16:15 The Analysis Model and Super-Resolution
Alex Bronstein, School of Electrical Engineering, Tel Aviv University, Israel

Monday May 12

MS47 Part II

Recent Advances in Optimization Techniques and Applications in Imaging Sciences

2:45 PM - 4:45 PM

WLB208

In the past few years there has been an unprecedented growth in the volume of data collected in a variety of applications due to the fast advances of imaging and simulation technology. This poses high demands of sophisticated computation and optimization methods for efficient data analysis and processing. This mini-symposium is to discuss the recent developments in theory, techniques, and applications of optimization methods for imaging sciences in this field. Topics include but are not limited to advanced techniques in non-smooth and possibly non-convex optimization problems, and their applications in real-world imaging problems.

Organizer: Yunmei Chen, Department of Mathematics, University of Florida, USA
Organizer: Xiaojing Ye, Department of Mathematics and Statistics, Georgia State University, USA

14:45-15:15 A Two-stage Image Segmentation Method Using a Convex Variant of the Mumford-Shah Model and Thresholding
Raymond Chan, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong

15:15-15:45 A New Convex Optimization Model for Multiplicative Noise and Blur Removal
Xile Zhao, School of Mathematical Sciences, University of Electronic Science and Technology of China, China

15:45-16:15 New Sparse Regularization Evolving ℓ_1 Subgradient
Wotao Yin, Department of Mathematics, UCLA, USA

16:15-16:45 Learning Sparsely Used Dictionaries via Convex Optimization
John Wright, Department of Electrical Engineering, Columbia University, USA

Monday May 12

MS57 Part II

Modeling and Algorithms for Imaging Problems

2:45 PM - 4:45 PM

AAB606

In recent years mainland China has many new developments in modeling and algorithms in imaging sciences. The objectives of this mini-symposium are to bring mainland China researchers in this field together to present their recent research work, to exchange ideas, and explore future collaborations. The topics of this mini-symposium were the latest development of modeling, algorithms and their applications in real-world imaging problems such as image denoising, deblurring, inpainting, decomposition, segmentation, and super-resolution reconstruction, etc. This minisymposium can provide a forum to stimulate discussions and establish collaborations between young Chinese researchers for further developments in this emerging imaging sciences research.

Organizer: Fang Li, Department of Mathematics, East China Normal University, China
Organizer: Huanfeng Shen, School of Resource and Environmental Science, Wuhan University, China
Organizer: Wei Wang, Department of Mathematics, Tongji University, China
Organizer: Xile Zhao, School of Mathematical Sciences, University of Electronic Science and Technology of China, China

14:45-15:15 Framelet Based Convex Optimization Model For Multiplicative Noise and Blur Removal
Fan Wang, Lan Zhou University, China

15:15-15:45 A Primal-Dual Method for Meyer's Model of Cartoon and Texture Decomposition
Youwei Wen, Kunming University of Science and Technology, China

15:45-16:15 Single Image Dehazing and Denoising: A Fast

Variational Approach
Faming Fang, East China Normal University, China

16:15-16:45 Total Variation Regularization Variational Method to Retrieval Phases from Partial Magnitude of 2D Images
Huibin Chang, Tianjin Normal University, China

Monday May 12

MS60 Part II
Tensor Decompositions in Numerical Analysis, Optimization and Imaging
2:45 PM - 4:45 PM
DLB719

Tensor decompositions have a long history of application in data sciences, quantum physics, complexity theory in mathematics. Nowadays they actively penetrate many new fields such as approximation of multivariate functions, fast algorithms for new types of structured matrices, optimization problems, uncertainty quantification, efficient solvers for Fokker-Planck type equations, imaging sciences, analysis of probabilistic graphical models etc. It is essential that, besides classical tensor decompositions, new ways of representation and approximation of tensors are suggested and fastly becoming popular in different application fields. The aim of this minisymposium is to present new trends in numerical analysis, optimization and image processing methods based on tensor trains and related approaches for the representation of data and new recovery techniques in the case of incomplete data.

Organizer: Eugene Tyrtyshnikov, Institute of Numerical Mathematics of Russian Academy of Sciences, Lomonosov Moscow State University, Russia
Organizer: Ivan Oseledets, Skolkovo Institute of Science and Technology, Russia

14:45-15:15 Wavelet Tensor Train Decomposition for the Compression of Image Sequences
Pavel Kharyuk, Faculty of Computational Mathematics and Cybernetics, Moscow State University, Russia

15:15-15:45 The Application of Tensor Calculus to the Probabilistic Graphical Models: Results and Open Problems
Dmitry Vetrov, Department of Computational Mathematics and Cybernetics, Moscow State University, Russia

15:45-16:15 Low-rank Approximation of Energies in Markov Random Fields and Their Representation in TT-format
Anton Rodomanov, Department of Computational Mathematics and Cybernetics, Lomonosov Moscow State University, Russia

16:15-16:45 Computationally Efficient Methods for MAP-inference and Partition Function Estimation in MRF in TT Format
Alexander Novikov, Department of Computational Mathematics and Cybernetics, Lomonosov Moscow State University, Russia

Monday May 12

Coffee Break

4:45 PM - 5:15 PM

3/F Podium, Academic and Administration Building

Monday May 12

MS03

Image Reconstruction Using Cross-Modality Priors

5:15 PM - 7:15 PM

WLB210

Multimodality techniques are increasingly used in tomography, where a subject is imaged with two or more modalities either sequentially or simultaneously. Regularisation is frequently imposed by proposing that one of the modalities is well-posed and should be used to guide reconstruction in the other modality, assumed to be ill-posed using, for example, local structural priors, non-local priors, and joint information theoretic priors. A more recent suggestion is to jointly solve the two inverse problems using a prior that reflects both within modality and cross-modality information. In this minisymposium we will present recent progress in these techniques.

Organizer: Simon Arridge, University College London, UK
Organizer: Ville Kolehmainen, University of Eastern Finland, Finland

17:15-17:45 Structural Priors for Multimodality Diffuse Optical Tomography
Ville Kolehmainen, Department of Applied Physics, University of Eastern Finland, Finland

17:45-18:15 Parallel Level Set Prior for Joint PET/MRI Reconstruction
Matthias Joachim Ehrhardt, Centre for Medical Image Computing, University College London, UK

18:15-18:45 Structural Priors for Emission Tomography Reconstruction: Benefits and Risks
Kathleen Vunckx, Medical Imaging Research Center, Dept. of Nuclear Medicine, University Hospitals Leuven & Dept. of Imaging & Pathology, KU Leuven, Belgium

18:45-19:15 Hidden States of Function and Anatomy
Stefano Pedemonte, Antinoula A. Martinos Center for Biomedical Imaging, Harvard University, USA

Monday May 12

MS05 Part II
Keep the Edge? From Theory to Practice
5:15 PM - 7:15 PM
WLB109

While many important theoretical and numerical advances have been made towards the understanding and numerical realization of structure-preserving methods there are still many open problems and unanswered questions. For instance, how to strike the right balance between structure-preservation and smoothness and how to model it? How can these reconstruction techniques be efficiently and accurately translated into practical applications to deal with corrupted and large-scale data? In this double minisymposium we will bring together researchers working on theory, algorithms and applications of structure-preserving methods to discuss the way forward on those important issues.

Organizer: Marta Betcke, Department of Computer Science, University College London, UK
Organizer: Carola-Bibiane Schönlieb, Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, UK

17:15-17:45 Exact Support Recovery for Sparse Spikes Deconvolution
Gabriel Peyré, Ceremade, University Paris-Dauphine, France

17:45-18:15 Aspects of the Total Generalised Variation (TGV) Minimisation Problem
Konstantinos Papafitsoros, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK

18:15-18:45 Fast Solvers for Non-convex Edge-preserving/Sparsifying TV^q-regularizations, $q \in (0, 1)$, and Issues with Variable Splitting Approaches in TV(=TV^1)-regularization
Michael Hintermüller, Department of Mathematics, Humboldt-University of Berlin, Germany

18:45-19:15 Image Reconstruction in Fluorescence Diffuse Optical Tomography Using Patch-based Anisotropic Diffusion Regularisation
Teresa Correia, University College London, UK

Monday May 12

MS06
Variational Approaches for Image Sequence Analysis and Reconstruction
5:15 PM - 7:15 PM
DLB712

In the recent years, the acquisition and processing of image sequences and videos has gained increasing attention in the imaging sciences. Compared to still images, videos are however of different nature and pose new challenges from the perspective of analysis and reconstruction: The corresponding data sets usually expose different characteristics with respect to the spatial directions and the time axis. Additionally, image sequences are often large scale so efficient algorithms are needed for their proper processing. This is a particular challenge for variational methods as these often aim at optimizing globally over the entire data set. The minisymposium brings together experts in variational modelling and optimization of image sequences to discuss recent developments and new approaches which specifically aim at exploiting the spatio-temporal structure of image sequences and videos.

Organizer: Kristian Bredies, Institute of Mathematics and Scientific Computing, University of Graz, Austria
Organizer: Martin Holler, Institute of Mathematics and Scientific Computing, University of Graz, Austria

17:15-17:45 Infimal-Convolution of Total-Variation-Type Functionals as Regularization for Video Reconstruction
Martin Holler, Institute for Mathematics and Scientific Computing, University of Graz, Austria

17:45-18:15 Robust Video Restoration by Joint Sparse and Low Rank Matrix Approximation
Hui Ji, Department of Mathematics, National University of Singapore, Singapore

18:15-18:45 Non-Local Total Generalized Variation for Motion and Stereo Estimation
René Ranftl, Institute for Computer Graphics and Vision, Graz University of Technology, Austria

18:45-19:15 Variational Approaches for Image Sequence Analysis and Reconstruction
Stephen Keeling, Institute for Mathematics and Scientific Computing, University of Graz, Austria

Monday May 12

MS11 Part II

Modern Imaging Models, High Order Methods And Applications
5:15 PM - 7:15 PM
WLB207

Various new and variational models beyond the ROF total variation work have been proposed recently to tackle emerging image restoration problems. Applications of some of the new emerging models will be discussed. Especially, higher order models will be presented. High order methods refer to solution techniques for minimizing energy functionals involving higher-order derivatives. They have become advantageous in many imaging applications where smooth features (with no artifacts such as staircasing) as well as sharp edges are equally important to preserve. High order regularisation is applicable to models for restoration, segmentation and registration. In contrast to the widely studied case of variational models based on first order derivatives where a large class of competing algorithms are developed, high order models lead to more challenging tasks in analysis and algorithms. There exist strong links to topics such as convex optimisation, convex relaxation, primal-dual methods and operator spitting methods. In this minisymposium we bring together experts from several leading groups to present and discuss their recent approaches and advances in image restoration modelling, analysis, high order methods and their applications

Organizer: Ke Chen, University of Liverpool, UK
Organizer: Xuecheng Tai, University of Bergen, Norway

17:15-17:45 Analysis and Design of Fast Graph Based Algorithms for High Dimensional Data
Andrea Bertozzi, Department of Mathematics, UCLA, USA

17:45-18:15 A Forward-backward Model for Image Restoration
Patrick Guidotti, University of California at Irvine, USA

18:15-18:45 High-order Geometrical Variational and PDE Methods for Noise Removal
Bibo Lu, School of Computer Science and Technology, Henan Polytechnic University, China

Monday May 12

MS13
Recent Developments in the Statistical Modelling of Brain Imaging Data
5:15 PM - 7:15 PM
WLB202

Traditionally, brain imaging studies have focused on locating brain regions showing task-related changes in neural activity. The voxel-wise general linear model has become the standard approach for analyzing such data. Recently however, there has been a surge in efforts to understand more complex aspects of brain function. This has encouraged the field to generate more sophisticated statistical methods. In this session, we will present new methodologies that seek to analyze brain signals in order to facilitate a better understanding of neurophysiological processes, provide more reliable inference tools, and hopefully result in developing new diagnostic and prognostic tools for brain disorders.

Organizer: Ivor Cribben, Department of Finance and Statistical Analysis, University of Alberta, Canada
Organizer: Linglong Kong, Department of Mathematical and Statistical Sciences, University of Alberta, Canada

17:15-17:45 Estimating Dynamic Graphical Models for fMRI Data
Ivor Cribben, Department of Finance and Statistical Analysis, Alberta School of Business, University of Alberta, Canada

17:45-18:15 Functional Magnetic Resonance Imaging Analysis in a Study of Alzheimer's Diseases
Jimin Ding, Department of Mathematics, Washington University in St. Louis, USA

18:15-18:45 Sparse Estimation in Partial Functional Linear Regression Model for Hyper-Acute Ischemic Stroke Study
Linglong Kong, Department of Mathematical and Statistical Sciences, University of Alberta, Canada

18:45-17:15 A Semi-parametric Nonlinear Model for Event-related fMRI
Tingting Zhang, Department of Statistics, University of Virginia, USA

Monday May 12

MS16
High Precision Stereo Vision
5:15 PM - 7:15 PM
WLB208

Stereo vision attempts to estimate depth from two images. For thirty years many techniques have been put forward to solve this problem, many of which have been and remain successful in certain cases. However, general purpose high precision reconstruction is still elusive. New approaches such as active sensing, multiple viewing, and video processing are now being looked at. Thus the time is ripe to organize the main ideas behind two-image stereo vision. In this mini-symposium we bring together leading researchers to shed light on the current thinking in this area and to discuss new developments and challenges.

Organizer: Gabriele Facciolo, Ecole normale suprieure de Cachan, Cachan, France
Organizer: Antoni Buades, Universitat de les Illes Balears, Palma de Mallorca, Spain

17:15-17:45 Observing the Earth in 3D with Pleiades-HR
Jean-Marc Delvit, Centre national d'Etudes Spatiales (CNES), France

17:45-18:15 Fusion of Kinect Depth with Trifocal Disparity Estimation for Fast High Quality Depth Maps
Neus Sabater, Technicolor Research and Innovation, France

18:15-18:45 How Much Further Can We Go in Two-frame Stereo?
Kuk-Jin Yoon, School of Information and Communications, Gwangju Institute of Science and Technology (GIST), Korea

18:45-19:15 On the Performance of Local Methods for Stereovision
Gabriele Facciolo, CMLA, Ecole normale supérieure de Cachan, France

Monday May 12

MS28
Image Denoising: Trends, Connections, and Limitations
5:15 PM - 7:15 PM
WLB103

Image denoising has undergone significant advances since the 80s. For example, local stencils have led to non-local patch based techniques, anisotropic diffusion has inspired a well developed line of research in the nonlinear PDE community, and statistics and kernel methods have provided tools for improving all of these techniques. The newest models appear to be closing in on an optimal state, yet new algorithms continue to demonstrate advances. This minisymposium addresses new denoising approaches, what improvements (if any) we can expect to achieve, and connections between these methods that give insight into their potential as well as their limitations.

Organizer: Marcelo Bertalmío, Universitat Pompeu Fabra, Spain
Organizer: Stacey Levine, Duquesne University, USA

17:15-17:45 Denoising an Image by Denoising its Curvature Image
Marcelo Bertalmío, Departamento de Tecnologías de la Información y las Comunicaciones, Universitat Pompeu Fabra, Spain

17:45-18:15 A Spatially Consistent Collaborative Filtering
Alessandro Foi, Department of Signal Processing, Tampere University of Technology, Finland

18:15-18:45 On the Internal vs. External Statistics of Image Patches, and its Implications on Image Denoising
Maria Zontak, Department of Computer Science and Applied Mathematics, Weizmann Institute, Israel

18:45-19:15 On Covariant Derivatives and Their Applications to Image Regularization
Thomas Batard, Department of Information and Communication Technologies, University Pompeu Fabra, Barcelona, Spain

Monday May 12

MS29 Part III
Inverse Scattering Problems in Imaging Science
5:15 PM - 7:15 PM
AAB201

The mini-symposium intends to bring together leading experts working in the field of inverse scattering theory for waves and particles propagation and related applications in imaging science to discuss recent developments and new challenges in this fascinating field.

Organizer: Hongyu Liu, University of North Carolina, USA
Organizer: Kui Ren, University of Texas, USA

17:15-17:45 Inverse Scattering Problems with Oblique Boundary Conditions
Haibing Wang, Department of Mathematics, Southeast University, China

17:45-18:15 Regularized Acoustic and Electromagnetic Cloaking
Hongyu Liu, Department of Mathematics and Statistics, University of North Carolina, USA

18:15-18:45 A Model Reduction Approach to Numerical Inversion for Parabolic Partial Differential Equations in One and Higher Dimensions
Alexander Mamonov, Schlumberger, USA

18:45-19:15 Multiscale Analysis for Ill-posed Problem with Support Vector Approach
Shuai Lu, School of Mathematical Sciences, Fudan University, China

Monday
May 12

MS31 Part III
Geometry, Imaging and Computing
5:15 PM - 7:15 PM
WLB104

Recent advances in differential geometry and its computational aspects provide useful tools for solving various imaging problems. The main theme of this mini-symposium is on the differential geometry based modeling /computation in 3D and higher with applications to imaging, visions and graphics. We will explore recent development in computational differential geometry, geometry processing, shape analysis, shape registration, image processing, image analysis, image understanding, computer graphics, visions and visualization; leading to applications in science, medicine, engineering, and other fields.

Organizer: Ronald Lok Ming Lui, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong
Organizer: David Xianfeng Gu, Department for Computer Sciences, State University of New York at Stony Brook, USA

17:15 - 17:45 Quasiconformal Surface Map Optimization for Uniformization with Arbitrary Topologies
Tsz Wai Wong, Department of Mathematics, University of California, Irvine, USA

17:45-18:15 Saddle Vertex Graph (SVG): A Novel Solution to the Discrete Geodesic Problem
Ying He, School of Computer Engineering, Nanyang Technological University, Singapore

Monday
May 12

MS36
Geometry Processing with Functional Maps
5:15 PM - 7:15 PM
WLB206

This minisymposium will be dedicated to exploring the theoretical and practical aspects of the recently proposed functional representation of mappings between geometric datasets. This representation, which treats 3d shapes and images as functional spaces and correspondences (mappings) between them as linear operators, has recently shown the potential to make a large impact on geometric data analysis by providing flexible and efficient tools for many challenging operations, including shape matching and exploration, vector field design and data clustering among many others. The talks will introduce the key notions and describe existing applications of functional maps to a wide audience.

Organizer: Maks Ovsjanikov, Ecole Polytechnique, France
Organizer: Frédéric Chazal, INRIA-Saclay, France

17:15-17:45 Functional Maps: A Flexible Representation of Maps Between Shapes
Maks Ovsjanikov, Ecole Polytechnique, France

17:45-18:15 Building and Using Functional Image Networks
Leonidas Guibas, Stanford University, USA

18:15-18:45 Joint Diagonalization and Closest Commuting Laplacians
Davide Eynard, Universita della Svizzera Italiana, Switzerland

18:45-19:15 An Operator Approach to Tangent Vector Field Processing
Mirela Ben-Chen, Technion University, Israel

Monday
May 12

MS44
Reconstruction in Industrial X-ray Radiography
5:15 PM - 7:15 PM
WLB203

X-ray radiography is an excellent tool for peering into the interior of an object. The goal is to recover the object function (an image) from line-integral measurements through the object. For industrial X-ray, the reconstruction accuracy has a paramount importance. Accuracy is related to many factors, e.g. the signal to noise ratio, the blur of the projection data, the conversion of measured data to attenuation units and the mathematical model. This minisymposium aims at bringing together experts in this area to exchange ideas on modeling, methodologies of improving reconstruction accuracy, efficient algorithms and applications in industries, nuclear physics and medicine.

Organizer: Mila Nikolova, CMLA, CNRS, ENS de Cachan, France
Organizer: Suhua Wei, Institute of Applied Physics and Computational Mathematics, China.

17:15-17:45 Sparsity in Fluids - Vorticity Estimation via Compressive Sensing
Romain Abraham, University d'Orleans, France

17:45-18:15 State Space Constrained Reconstruction for PET imaging
Huafeng Liu, Zhejiang University, China

18:15-18:45 Tailoring Advanced Image-reconstruction Algorithms to Real World Applications
Xiaochuan Pan, The University of Chicago, USA

18:45-19:15 High-order Total Variation Regularization Approach for Axially Symmetric Object Tomography from a Single Radiograph
Suhua Wei, Institute of Applied Physics and Computational Mathematics, China

Monday May 12

MS48 Part I
Computational Inversion Methods for Biomedical Imaging
5:15 PM - 7:15 PM
WLB204

The minisymposium focuses on regularization methods for computational inverse problems and their applications in biomedical images. There is a special focus on recent advances based on sparsity, multiresolution models, nonlocal approaches and level set methods. Theoretical, modeling, computational and application aspects will be considered in both discrete and continuous settings. The applications include few-data tomography, dynamic imaging, and diffusive modalities.

Organizer: Samuli Siltanen, Department of Mathematics, University of Helsinki, Finland
Organizer: Xiaoqun Zhang, Department of Mathematics and Institute of Natural Sciences, Shanghai Jiao Tong University, China

17:15-17:45 Spatio-temporal TV Priors for Dynamic Inverse Problems in Biomedicine
Christoph Brune, Applied Mathematics, University of Münster, Germany

17:45-18:15 4D Computed Tomography Reconstruction from Few-projection Data via Temporal Non-local Regularization
Yifei Lou, Department of Mathematics, University of California Irvine, USA

18:15-18:45 Flow Driven Inpainting and Denoising
Hendrik Dirks, Institute for Applied Mathematics, University of Muenster, Germany

Monday May 12

MS53 Part I
Splitting Methods for Imaging Problems
5:15 PM - 7:15 PM
AAB606

Recently we have witnessed a rapid growth in the interaction of optimization technique and imaging science. In particular, there have been very impressive applications of operator splitting methods to various imaging problems, such as the alternating direction method of multipliers, forward-backward splitting methods, splitting versions of the proximal point algorithm, etc. This mini-symposium aims to bring together experts to exchange ideas and to discuss the most recent development in algorithmic design, theory and applications of operator splitting methods for imaging problems.

Organizer: Raymond H. Chan, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong, China
Organizer: Xiaoming Yuan, Department of Mathematics, Hong Kong Baptist University, Hong Kong, China

17:15-17:45 Fixed-Point Algorithms for Emission Computed Tomography Reconstruction
Yuesheng Xu, Sun Yat-sen University, China

17:45-18:15 Decentralized Optimization and its Splitting Methods
Wotao Yin, University of California at Los Angeles, USA

18:15-18:45 Accelerating Model-based X-ray CT Image Reconstruction Using Variable Splitting Methods with Ordered Subsets
Hung Nien, University of Michigan, USA

18:45-19:15 Primal-Dual Methods Revisited: New Schemes and Applications
Marc Teboulle, Tel Aviv University, Israel

Monday May 12

MS56
Directional Multiscale Representation
5:15 PM - 7:15 PM
WLB209

This minisymposium will provide an up to date and recent development on the design and applications of directional multiscale representation systems, including directional framelets, shearlets, ridgelets, etc.. It aims to provide a forum for the exchange of ideas among international researchers working in directional multiscale representation systems and their applications. We will have four speakers coming from four different countries (Canada, China, Germany, and Switzerland) to present their work on mathematical imaging using directional multiscale representation systems. We believe that the audience of this minisymposium would greatly benefit from their perspectives on this area.

Organizer: Xiaosheng Zhuang, City Univeristy of Hong Kong, Hong Kong, China

17:15-17:45 Image Denoising by Frequency-based Directional Multiscale Representation Systems
Xiaosheng Zhuang, City University of Hong Kong

17:45-18:15 Image Denoising by Directional Separable Complex Tight Framelets
Bin Han, Department of Mathematical and Statistical Sciences, University of Alberta Edmonton, Canada

18:15-18:45 Image Restoration Using Shearlet Based Sparsity Priors
Wang-Q Lim, Institut für Mathematik Technische, Universität Berlin, Germany

Monday May 12

Reception

7:15 PM - 9:00 PM

Multi-purpose Hall, Level 2, Madam Kwok Chung Bo Fun Sports and Cultural Centre (SCC)

Tuesday May 13

Registration

8:00 AM - 12:00 PM
1:30 PM - 4:30 PM

Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

Tuesday May 13

IP3

8:30 AM - 9:15 AM

Chair: Martin Burger, University of Münster, Germany

Optimizing the Optimizers - What is the Right Image and Data Model?

Carola-Bibiane Schönlieb, University of Cambridge, UK

When assigned with the task of reconstructing an image from given data the first challenge one faces is the derivation of a truthful image and data model. Such a model can be determined by the a-priori knowledge about the image, the data and their relation to each other. The source of this knowledge is either our understanding of the type of images we want to reconstruct and of the physics behind the acquisition of the data or we can thrive to learn parametric models from the data itself. The common question arises: how can we optimise our model choice? Starting from the first modelling strategy this talk will lead us from the total variation as the most successful image regularisation model today to non-smooth second- and third-order regularisers, with data models for Gaussian and Poisson distributed data as well as impulse noise. Applications for image denoising, inpainting and surface reconstruction are given. After a critical discussion of these different image and data models we will turn towards the second modelling strategy and propose to combine it with the first one using a bilevel optimization method. In particular, we will consider optimal parameter derivation for total variation denoising with multiple noise distributions and optimising total generalised variation regularisation for its application in photography.

Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

Tuesday May 13

IP4

9:15 AM - 10:00 AM
Chair: Gareth Funka-Lea, Siemens, USA

Personalized Blood Flow Simulation from an Image-Derived Model: Changing the Paradigm for Cardiovascular Diagnostics

Leo Grady, HeartFlow, USA

Coronary heart disease is the leading cause of mortality worldwide, accounting for 1/3 of all global deaths. Treatment of stable coronary heart disease is typically perfomed by medication/lifestyle for a lower disease burden or PCI (stenting) for a greater disease burden. The choice between these treatments is best determined by an invasive diagnostic test that measures blood flow through a diseased area. Unfortunately, this invasive diagnostic test is expensive, dangerous and usually finds a lower disease burden. We are working to change the diagnostics paradigm with a blood flow simulation on a personalized heart model that is derived from cardiac CT angiography images. This simulation-based diagnostic is much safer and more comfortable for the patient as well as less expensive. Our diagnostic depends on a hyperaccurate vessel tree image segmentation, physiological modeling and accurate computational fluid dynamics. In this talk I will discuss the mathematics that drive this technology and the successful clinical trials that have proven the simulation accuracy in patients.

`Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building`

Coffee Break

10:00 AM - 10:30 AM

`3/F Podium, Academic and Administration Building`

Tuesday May 13

MS02 Part I

Photoacoustic Tomography
10:30 AM - 12:30 PM
`SCC2`

Photoacoustic Tomography is the leading example of the new class of Imaging from Coupled Physics modalities. It presents challenging problems in both the modelling and reconstruction steps for both the acoustic and optical parts of the problem. In these minisymposia (parts I and II) we bring together leading researchers in both the theoretical and applied aspects of this exciting new imaging technique.

Organizer: Simon Arridge, Department of Computer Science, University College London, UK
Organizer: Ben T Cox, Department of Medical Physics, University College London, UK

10:30-11:00 Universal Inversion Formulas for Recovering a Function from Spherical Means
Markus Haltmeier, University of Innsbruck, Austria

11:00-11:30 Modelling Quantitative Photoacoustic Sectional Imaging
Peter Elbau, University of Vienna, Austria

11:30-12:00 Efficient Reconstruction Algorithms for Inverse Problems in Quantitative Photoacoustic Imaging
Kui Ren, University of Texas at Austin, USA

12:00-12:30 Bayesian Image Reconstruction in Quantitative Photoacoustic Tomography
Tanja Tarvainen, University of Eastern Finland, Finland

Tuesday May 13

MS04

Nonlinear Inverse Problems in Imaging
10:30 AM - 12:30 PM
`WLB204`

A vast majority of imaging applications are modeled as linear inverse problems and, consequently, profound literature exists on how to handle linear inverse problems mathematically and computationally. However, many interesting modern applications, ranging from tomographic reconstruction to computer vision problems, involve nonlinear phenomena, thus yielding nonlinear inverse problems. The solutions of these problems require novel mathematical and computational techniques. The goal of this minisymposium is to bring together experts in nonlinear imaging science to introduce new nonlinear imaging applications, discuss the accompanying challenges, and present novel approaches for their solution.

Organizer: Martin Benning, Magnetic Resonance Research Centre, Department of Chemical Engineering and Biotechnology, University of Cambridge, UK
Organizer: Michael Möller, Research and Development, Arnold & Richter Cine Technik GmbH & Co. Betriebs KG, Germany

10:30-11:00 Nonlinear Magnetic Resonance Velocity Imaging
Martin Benning, Magnetic Resonance Research Centre, Department of Chemical Engineering and Biotechnology, University of Cambridge, UK

11:00-11:30 Structural Health Monitoring in Anisotropic, Elastic Plates From Partial Boundary Measurements
Julia Piontkowski, Universitt des Saarlandes, Germany

11:30-12:00 Partially Blind Deblurring of Barcode From Out-of-focus Blur
Yifei Lou, Department of Mathematics, University of California, Irvine, USA

12:00-12:30 Depth From Defocus
Michael Möller, Research and Development, Arnold & Richter Cine Technik GmbH & Co. Betriebs KG, Germany

Tuesday May 13

MS11 Part III
Modern Imaging Models, High Order Methods And Applications
10:30 AM - 12:30 PM
WLB211

Various new and variational models beyond the ROF total variation work have been proposed recently to tackle emerging image restoration problems. Applications of some of the new emerging models will be discussed. Especially, higher order models will be presented. High order methods refer to solution techniques for minimizing energy functionals involving higher-order derivatives. They have become advantageous in many imaging applications where smooth features (with no artifacts such as staircasing) as well as sharp edges are equally important to preserve. High order regularisation is applicable to models for restoration, segmentation and registration. In contrast to the widely studied case of variational models based on first order derivatives where a large class of competing algorithms are developed, high order models lead to more challenging tasks in analysis and algorithms. There exist strong links to topics such as convex optimisation, convex relaxation, primal-dual methods and operator spitting methods. In this minisymposium we bring together experts from several leading groups to present and discuss their recent approaches and advances in image restoration modelling, analysis, high order methods and their applications

Organizer: Ke Chen, University of Liverpool, UK
Organizer: Xuecheng Tai, University of Bergen, Norway

10:30-11:00 A Non-Local Formulation for Higher-Order Total Variation-Based Regularization
Jan Lellmann, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK

11:00-11:30 Regularization Parameter Estimation in L2 and L1 Total Variation Color Image Deblurring
Elena Loli Piccolomini, Department of Mathematics, University of Bologna, Italy

11:30-12:00 Nonlinear Analysis of Population of Textured Manifolds with F-shape Spaces and Varifolds
Nicolas Charon, Center of Mathematics and Their Applications, Ecole Normale Suprieure Cachan, France

12:00-12:30 Surface Map Optimization Using Beltrami Holomorphic Flow
Ronald Lok Ming Lui, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong

Tuesday May 13

MS12 Part I
Advances in Numerical Linear Algebra for Imaging
10:30 AM - 12:30 PM
AAB201

Numerical linear algebra continues to play an integral role in the development of efficient and robust algorithms for image processing applications. This two-session minisymposium will highlight some of the latest advances in numerical linear algebra for imaging. Topics include iterative methods, variational methods, numerical optimization, and randomized algorithms for problems in applications such as image deblurring, remote sensing, compressed sensing, and adaptive optics.

Organizer: Julianne Chung, Department of Mathematics, Virginia Tech, USA
Organizer: Malena Ines Español, Department of Mathematics, The University of Akron, USA

10:30-11:00 Fast Nonstationary Preconditioned Iterative Methods for Ill-Posed Problems with, Application to Image Deblurring
Marco Donatelli, Department of Science and High Technology, University of Insubria, Italy

11:00-11:30 Semi-Convergence Properties of Kaczmarz's Method
Per Christian Hansen, Technical University of Denmark, Denmark

11:30-12:00 Dual-Scale Masks for Spatio-Temporal Compressive Imaging
Roummel Marcia, University of California, Merced, USA

12:00-12:30 Reduction Methods for Matrix Pairs with Application to Image Restoration
Lothar Reichel, Kent State University, USA

Tuesday May 13

MS17 Part I
Detection and Analysis of Blood Vessels and Tree Shapes
10:30 AM - 12:30 PM
WLB205

This minisymposium will highlight new mathematical approaches to the detection, segmentation and analysis of tree shaped objects or tubular structures such as blood vessels, airways, neural dendrites, and road networks as seen in 2D and 3D images. The last few years have seen the development of new formulations that allow for the application of more sophisticated algorithms and optimization schemes and developments in the underlying mathematics that allow tree and tube shaped objects to be handled in a more rigorous computational manner.

Organizer: Gareth Funka-Lea, Imaging and Computer Vision, Siemens Corporation, Corporate Technology Princeton, USA

10:30-11:00 An Overview of Mathematical Techniques for Blood Vessel Detection
Gareth Funka-Lea, Siemens Corporation, Corporate Technology, USA

11:00-11:30 Tubular Structure Detection for MR Angiographic Image Analysis
Albert C. S. Chung, The Hong Kong University of Science and Technolgy, Hong Kong, China

11:30-12:00 Automated Reconstruction of Curvilinear Networks from 2D and 3D Imagery
Engin Türetken, École Polytechnique Fédérale de Lausanne, Switzerland

12:00-12:30 Reproducible Interactive Correction of Blood Vessels
Leo Grady, HeartFlow, USA

Tuesday May 13

MS22 Part I
Variational PDE and Multi-scale Multi-directional Sparse Representation in Imaging
10:30 AM - 12:30 PM
WLB207

After decades of intensive studies, modern image analysis is still facing the challenges of recovering images from their noisy, blurry, and/or incomplete measurements. The precise recovery is especially valuable for images containing important details (including but not limited to medical images). High order regularity and multi-scale multi-directional sparse representation play important roles in these problems and have shown to be very successful. This mini-symposium brings together leading researchers to discuss the state-of-the-art theoretical developments in this two research directions as well as their applications in image denoising, image reconstruction, compressive sensing, image segmentation and compressive feature detection etc.

Organizer: Weihong Guo, Department of Mathematics, Case Western Reserve University, USA
Organizer: Julia Dobrosotskaya, Department of Mathematics, Case Western Reserve University, USA

10:30-11:00 A New Detail-preserving Regularity Scheme
Weihong Guo, Department of Mathematics, Case Western Reserve University, USA

11:00-11:30 Variational Approaches for Phase Image Processing with Applications in MRI
Kristian Bredies, Institute for Mathematics and Scientific Computing, University of Graz, Austria

11:30-12:00 Convex Image Segmentation with Generalized Partition Functions and Connections to Continuous Max-Flow

Egil Bae, Department of Mathematics, University of California, Los Angeles, USA

12:00-12:30 Joint Multi-Shot Multi-Channel Image Reconstruction in Compressive Diffusion Weighted MR Imaging

Hao Zhang, Department of Mathematics, University of Florida, USA

Tuesday May 13

MS35 Part I

Theoretical and Computational Aspects of Geometric Shape Analysis

10:30 AM - 12:30 PM

`WLB103`

The analysis, classification, and processing of geometric shapes is a timely and increasingly important problem in engineering, computer science, and mathematics. Modern strategies for shape analysis span several disciplines: statistical cliquing, differential geometry, data processing, and numerical optimization. The aim of this minisymposium is to present state-of-the-art methods for geometric shape analysis, and to discuss open problems, applications, and future directions for research of interest to the imaging science community. This minisymposium brings together researchers from diverse backgrounds to foster collaboration between the fields of computer vision, image processing, and mathematical shape analysis.

Organizer: Sergey Kushnarev, Singapore University of Technology and Design, Singapore
Organizer: Mario Micheli, Department of Mathematics, University of Washington, USA
Organizer: Akil Narayan, University of Massachusetts Dartmouth, USA

10:30-11:00 PCA on Manifolds Accounting for Curvature

Sergey Kushnarev, Engineering Systems Design, Singapore University of Technology and Design, Singapore

11:00-11:30 Surface Shape Matching and Analysis Using Intrinsic Coordinate Parameterizations

Shantanu H. Joshi, Ahmanson Lovelace Brain Mapping Center, Department of Neurology, UCLA, USA

11:30-12:00 Diffeomorphic Models and Centroid Algorithms for Computational Anatomy

Joan Alexis Glaunès, MAP5, Université Paris Descartes, Sorbonne Paris Cité, France

12:00-12:30 Numerical Computation of Geodesics on the Universal Teichmueller Space

Akil Narayan, University of Massachusetts Dartmouth, USA

Tuesday May 13

MS39 Part I

Challenges in Inverse Problems for Imaging

10:30 AM - 12:30 PM

WLB104

A key issue in imaging inverse problems is the correct choice of image priors (regularisation functionals) and data models (fidelity terms). Several strategies for conceiving optimization problems, combining prior and data information, have been considered. Let us evoke statistically grounded methods, adaptive regularization, dictionary learning, bilevel optimization, among others. All these approaches vary in their philosophy and mathematics. In spite of the achievements, there are more open questions than really satisfying answers. This minisymposium should constitute a platform for an exchange between researchers working on these problems from different points of view.

Organizer: Mila Nikolova, CNRS - ENS Cachan, France
Organizer: Carola-Bibiane Schönlieb, Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, UK

10:30-11:00 Constrained Image Restoration and Estimation of Regularization Parameters
Gabriele Steidl, University of Kaiserslautern, Germany

11:00-11:30 Toward Fast Transform Learning
Francois Malgouyres, Université Paul Sabatier, France

11:30-12:00 Bilevel Optimization for Learning Variational Models
Thomas Pock, Graz University of Technology, Austria

12:00-12:30 Model Selection with Piecewise Regular Gauges
Gabriel Peyré,University Paris-Dauphine, France

Tuesday May 13

MS40 Part I

A Fixed-Point Approach for Optimization Problems in Imaging

10:30 AM - 12:30 PM

DLB712

Optimization problems in image processing are ill-posed. Regularizations are commonly used to convert the ill-posed problems to well-posed ones. The resulting regularized models usually have non-differential objective functions which make mini- mizing the objective functional theoretically and numerically difficult. The problem of minimizing a regularized image model can be formulated as a problem of finding the fixed-point of a particular nonlinear operator. This mini-symposia addresses the mathematical challenges and computational difficulties brought by the use of fixed-point formulations and reports recent advances in this research direction.

Organizer: Lixin Shen, Syracuse University and Sun Yat-sen University
Organizer: Yuesheng Xu, Sun Yat-sen University and Syracuse University

10:30-11:00 Robust 1-Bit Compressive Sensing with One-Sided ℓ_0 Function
Lixin Shen, Syracuse University and Sun Yat-sen University

11:00-11:30 Preconditioned Alternating Projection Algorithms for Maximum a Posteriori ECT Reconstruction
Si Li, Sun Yat-sen University, China

11:30-12:00 Image Inpainting Using ℓ_0 Sparse Regularization in DCT-induced Wavelet Domain
Xueying Zeng, Ocean University of China, China

12:00-12:30 A Preconditioned Primal-dual Fixed Point Algorithm for Convex Separable Minimization With Applications to Image Restoration
Jianguo Huang, Shanghai Jiao Tong University, China

Tuesday May 13

MS45 Part I

Multi-Frame Motion Estimation and Optical Flow Algorithms

10:30 AM - 12:30 PM

SCC1

The rationale of the topic is that human vision massively uses information over time when it estimates velocities in movie sequences. Computer vision, though, does not reflect this in general: it often uses less information. Mostly, two-frame algorithms are used for dense pixel velocity estimation. This results in time-incoherent results. But recently, new methods evolved in treating the time-dependent problem. In particular, they model spatio-temporal coherence, adapt probabilistic and geometric tools, and use low-rank constraints in the variational problem. This minisymposium presents the most recent ideas for modeling and computational solutions of global-intime optical flow and registration.

Organizer: Thomas Widlak, University of Vienna, Austria

10:30-11:00 Dense Multi-Frame Optic Flow Using Subspace Constraints: Algorithms and Applications
Anastasios Roussos, University College London, UK

11:00-11:30 Novel Algorithms for Estimating Large-scale Optical Flow
Daniel Cremers, TU Muenchen, Germany

11:30-12:00 Optical Flow Decomposition with Time Regularization
Aniello Raffaele Patrone, University of Vienna, Austria

12:00-12:30 Modeling Temporal Coherence for Variational Optical Flow
Andres Bruhn, University of Stuttgart, Germany

Tuesday May 13

MS48 Part II
Computational Inversion Methods for Biomedical Imaging
10:30 AM - 12:30 PM
WLB206

The minisymposium focuses on regularization methods for computational inverse problems and their applications in biomedical images. There is a special focus on recent advances based on sparsity, multiresolution models, nonlocal approaches and level set methods. Theoretical, modeling, computational and application aspects will be considered in both discrete and continuous settings. The applications include few-data tomography, dynamic imaging, and diffusive modalities.

Organizer: Samuli Siltanen, Department of Mathematics, University of Helsinki, Finland
Organizer: Xiaoqun Zhang, Department of mathematics and Institute of Natural Sciences, Shanghai Jiao Tong University, China

10:30-11:00 Level Set Method for Dynamic Sparse-Data X-Ray Tomography
Samuli Siltanen, Department of Mathematics and Statistics, University of Helsinki, Finland

11:00-11:30 Empirical Phase Transitions in Sparsity-regularized Computed Tomography
Jakob Sauer Jørgensen, Department of Applied Mathematics and Computer Science, Technical University of Denmark, Denmark

12:00-12:30 Dynamic SPECT Reconstruction from Few Projections by Spatial-temporal Sparsity Constrained Matrix Factorization
Xiaoqun Zhang, Department of Mathematics and Institute of Natural Sciences, Shanghai Jiao Tong University, China

12:00-12:30 A Novel Method for Real-time Volumetric Imaging via Sparsity Learning
Xun Jia, Department of Radiation Medicine and Applied Sciences, University of California San Diego, USA

Tuesday May 13

MS52 Part I
Non-Convex Models in Image Recovery and Segmentation
10:30 AM - 12:30 PM
WLB208

In image recovery and segmentation, non-convex variational models are often closer to the real problems and turn out to perform better numerical results comparing the convex models. But at the same time, non-convexity poses significant challenges with respect to both the existence of solutions and the development of efficient algorithms. This minisymposium aims at bringing together experts in this area to present a series of talks on modeling, theoretical analysis, efficient numerical algorithms and applications.

Organizer: Yiqiu Dong, Technical University of Denmark, Denmark
Organizer: Tieyong Zeng, Hong Kong Baptist University, Hong Kong

10:30-11:00 Non-convex Multiple-objective Image Modeling
Alfred Hero, Dept. of Electrical Engineering and Computer Science, The University of Michigan, USA

11:00-11:30 Multiclass Segmentation by Iterated ROF Thresholding
Xiaohao Cai, Department of Mathematics, University of Kaiserslautern, Kaiserslautern, Germany

11:30-12:00 Restoration of Images Corrupted by Multiplicative Noise
Tieyong Zeng, Department of Mathematics, Hong Kong Baptist University, Hong Kong

Tuesday May 13

MS54 Part I
Optimization in Imaging: Algorithms, Applications and Theory
10:30 AM - 12:30 PM
WLB210

Optimization has been playing an important role in various imaging processing areas; and we have witnessed very active interaction between these two disciplines. This mini-symposium aims to bring together experts to exchange ideas and discuss the most recent advances in optimization techniques for image processing problems. Relevant progresses on algorithmic design, application and theory at the interface of optimization and imaging are all welcome.

Organizer: Xiaojun Chen, The Hong Kong Polytechnic University, Hong Kong
Organizer: Xiaoming Yuan, Hong Kong Baptist University, Hong Kong

10:30-11:00 Implicit Filtering
C. T. Kelley, North Carolina State University, USA

11:00-11:30 A Semismooth Newton-CG Augmented Lagrangian Algorithm for Convex Minimization Problems with Non-separable ℓ_1-regularization
Kim-Chuan Toh, National University of Singapore, Singapore

11:30-12:00 The Augmented-Lagrangian-Type Methods for Low Multilinear-Rank Tensor Recovery
Lei Yang, Tianjin University, China

12:00-12:30 An Algorithm for Variable Density Sampling with Block-constrained Acquisition
Pierre Weiss, University of Toulouse, France

Tuesday May 13

MS55 Part I
Advances and Trends of Modern Image Restoration
10:30 AM - 12:30 PM
WLB109

Image restoration is a critical component for vision applications, and provides an integral platform for research on statistical modeling of images. The past decade has witnessed the emerging and rapid development of modern image restoration methods, such as nonlocal regularization, sparse representation, dictionary learning, and low rank analysis, to name a few. Numerous machine learning approaches such as deep learning have also been adapted to image restoration, leading to interesting results. This mini-symposium provides a forum for colleagues in the community to share their recent research findings, and discuss the future trends of modern image restoration.

Organizer: Lei Zhang, Dept. of Computing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
Organizer: Ming-Hsuan Yang, Dept. of Electrical Engineering and Computer Science, University of California at Merced, USA

10:30-11:00 Weighted Nuclear Norm Minimization for Image Restoration
Lei Zhang, Dept. of Computing, The Hong Kong Polytechnic University, Hong Kong

11:00-11:30 Deblurring Face Images with Exemplars
Ming-Hsuan Yang, Dept. of Electrical Engineering and Computer Science, University of California at Merced, USA

11:30-12:00 The Noise Clinic
A. Buades, Universitat Illes Balears, Spain

Tuesday May 13

MS57 Part III
Modeling and Algorithms for Imaging Problems
10:30 AM - 12:30 PM
DLB719

In recent years mainland China has many new developments in modeling and algorithms in imaging sciences. The objectives of this mini-symposium are to bring mainland China researchers in this field together to present their recent research work, to exchange ideas, and explore future collaborations. The topics of this mini-symposium were the latest development of modeling, algorithms and their applications in real-world imaging problems such as image denoising, deblurring, inpainting, decomposition, segmentation, and super-resolution reconstruction, etc. This minisymposium can provide a forum to stimulate discussions and establish collaborations between young Chinese researchers for further developments in this emerging imaging sciences research.

Organizer: Fang Li, Department of Mathematics, East China Normal University, China
Organizer: Huanfeng Shen, School of Resource and Environmental Science, Wuhan University, China
Organizer: Wei Wang, Department of Mathematics, Tongji University, China
Organizer: Xile Zhao, School of Mathematical Sciences, University of Electronic Science and Technology of China, China

10:30-11:00 Spatially Adaptive Total Variation Model: From Pixel to Regional Perspective
Qiangqiang Yuan, School of Geodesy and Geomatics, Wuhan University, China

11:00-11:30 Separable Tensor Compressive Sensing and Application in Hyperspectral Imaging
Yongqiang Zhao, Northwestern Polytechnical University, China

11:30-12:00 An Online Coupled Dictionary Learning Approach

for Remote Sensing Image Fusion
Hongyan Zhang, Wuhan University, China

12:00-12:30 Joint Blind Unmixing and Sparse Representation for Anomaly Detection in Hyperspectral Image
Yuancheng Huang, Xi'an University of Science and Technology, China

Tuesday May 13

Lunch

12:30 PM - 1:45 PM

3/F Podium, Academic and Administration Building

SIAG/IS Business Meeting

12:50 PM - 1:35 PM

Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

Tuesday May 13

MS02 Part II

Photoacoustic Tomography
1:45 PM - 3:45 PM
SCC2

Photoacoustic Tomography is the leading example of the new class of Imaging from Coupled Physics modalities. It presents challenging problems in both the modelling and reconstruction steps for both the acoustic and optical parts of the problem. In these minisymposia (parts I and II) we bring together leading researchers in both the theoretical and applied aspects of this exciting new imaging technique.

Organizer: Simon Arridge, Department of Computer Science, University College London, UK
Organizer: Ben T Cox, Department of Medical Physics, University College London, UK

13:45-14:15 Algebraic Image Reconstruction in Combined Space for Photoacoustic Tomography
Amir Rosenthal, Helmholtz Zentrum Mnchen and Technische Universitt Mnchen, Germany

14:15-14:45 Compressed Sensing for High Resolution 3D Photoacoustic Tomography Using Data Sparsity
Marta Betcke, University College London, UK

14:45-15:15 Photoacoustic Tomography Image Reconstruction in Heterogeneous Media
Mark Anastasio, Washington University in St. Louis, USA

Tuesday May 13

MS12 Part II

Advances in Numerical Linear Algebra for Imaging

1:45 PM - 3:45 PM

AAB201

Numerical linear algebra continues to play an integral role in the development of efficient and robust algorithms for image processing applications. This two-session minisymposium will highlight some of the latest advances in numerical linear algebra for imaging. Topics include iterative methods, variational methods, numerical optimization, and randomized algorithms for problems in applications such as image deblurring, remote sensing, compressed sensing, and adaptive optics.

Organizer: Julianne Chung, Department of Mathematics, Virginia Tech, USA
Organizer: Malena Ines Español, Department of Mathematics, The University of Akron, USA

13:45-14:15 A Variational Method for Expanding the Bit-Depth of Low Contrast Images
Motong Qiao, Hong Kong Baptist University, Hong Kong, China

14:15-14:45 Variational Image Restoration with Auto-Correlation Whiteness Penalties
Fiorella Sgallari, University of Bologna, Italy

14:45-15:15 Iterative Reconstructors for Adaptive Optics
Mykhaylo Yudytskiy, Johann Radon Institute, Austria

15:15-15:45 Image Restoration with Poisson-Gaussian Mixed Noise
Alessandro Lanza, Department of Mathematics - CIRAM, University of Bologna, Italy

Tuesday May 13

MS17 Part II

Detection and Analysis of Blood Vessels and Tree Shapes

1:45 PM - 3:45 PM

WLB205

This minisymposium will highlight new mathematical approaches to the detection, segmentation and analysis of tree shaped objects or tubular structures such as blood vessels, airways, neural dendrites, and road networks as seen in 2D and 3D images. The last few years have seen the development of new formulations that allow for the application of more sophisticated algorithms and optimization schemes and developments in the underlying mathematics that allow tree and tube shaped objects to be handled in a more rigorous computational manner.

Organizer: Gareth Funka-Lea, Imaging and Computer Vision, Siemens Corporation, Corporate Technology, USA

13:45-14:15 Mathematical Morphology for Thin Object Detections
Laurent Najman, Université Paris-Est, France

14:15-14:45 Airway Tree-shape Modeling Through Large-Scale Tree-Space Statistics
Aasa Feragen, University of Copenhagen, Denmark

14:45-15:15 Discrete Optimization of Eulers Elastica with Application to Vessel Segmentation
Noha Youssry El-Zehiry, Siemens Corporation, Corporate Technology, USA

15:15:-15:45 Geodesic Methods for Blood Vessels and Tree Structure Segmentation
Laurent Cohen, CEREMADE, France

Tuesday May 13

MS21

New Frontiers in Inpainting

1:45 PM - 3:45 PM

WLB206

Image inpainting has witnessed tremendous progresses over the last 15 years. Drawing from applied mathematics as well as from computer sciences, many different approaches have proven their efficiency. Variational methods, PDE, copy-paste or patchbased approaches have yielded impressive results that are now routinely included in wide audience commercial softwares. Although many open problems remain, such as the restoration of large scale geometric structures or the simultaneous restoration of geometry and textures, image inpainting has reached some maturity. Building on these foundations, inpainting techniques have been applied to new modalities: video inpainting, high dynamic range imaging and more generally computational photography, or the inpainting of cosmological images, to name but a few. The aim of this symposium is to explore these new modalities and to account for recent works in these fields. In particular, the use of variational methods or sparse representations will be emphasized.

Organizer: Yann Gousseau, Telecom ParisTech - LTCI CNRS, France
Organizer: Simon Masnou, Université Lyon 1 - Institut Camille Jordan, France

13:45-14:15 Texture Aware Video Inpainting
Andrés Almansa, LTCI CNRS, Telecom ParisTech, France

14:15-14:45 Diminished Reality by Correction of Perspective and Color with Image Inpainting
Norihiko Kawai, Graduate School of Information Science, Nara Institute of Science and Technology, Japan

14:45-15:15 A Variational Model for Gradient-Based Video Editing
Rida Sadek, Department of

Information and Communication Technologies, University of Pompeu Fabra, Spain

15:15-15:45 The Controversial Story of Sparse Inpainting in Astronomy
Jean-Luc Starck, CEA/Saclay, France

Tuesday May 13

MS22 Part II
Variational PDE and Multi-scale Multi-directional Sparse Representation in Imaging
1:45 PM - 3:45 PM
WLB207

After decades of intensive studies, modern image analysis is still facing the challenges of recovering images from their noisy, blurry, and/or incomplete measurements. The precise recovery is especially valuable for images containing important details (including but not limited to medical images). High order regularity and multi-scale multi-directional sparse representation play important roles in these problems and have shown to be very successful. This mini-symposium brings together leading researchers to discuss the state-of-the-art theoretical developments in this two research directions as well as their applications in image denoising, image reconstruction, compressive sensing, image segmentation and compressive feature detection etc.

Organizer: Weihong Guo, Department of Mathematics, Case Western Reserve University, USA
Organizer: Julia Dobrosotskaya, Department of Mathematics, Case Western Reserve University, USA

13:45-14:15 Variational Image Reconstruction Using Composite Wavelets
Benjamin Manning, Department of Mathematics, University of Maryland, College Park, USA

14:15-14:45 α-Molecules: Wavelets, Shearlets, and Beyond
Gitta Kutyniok, Department of Mathematics, Technische Universität Berlin, Germany

14:45-15:15 Compressive Support Detection based on Multiple Hypothesis Testing
Yi (Grace) Wang, Department of Mathematics, Duke University and SAMSI, USA

Tuesday May 13

MS35 Part II
Theoretical and Computational Aspects of Geometric Shape Analysis
1:45 PM - 3:45 PM
WLB103

The analysis, classification, and processing of geometric shapes is a timely and increasingly important problem in engineering, computer science, and mathematics. Modern strategies for shape analysis span several disciplines: statistical cliquing, differential geometry, data processing, and numerical optimization. The aim of this minisymposium is to present state-of-the-art methods for geometric shape analysis, and to discuss open problems, applications, and future directions for research of interest to the imaging science community. This minisymposium brings together researchers from diverse backgrounds to foster collaboration between the fields of computer vision, image processing, and mathematical shape analysis.

Organizer: Sergey Kushnarev, Singapore University of Technology and Design, Singapore
Organizer: Mario Micheli, Department of Mathematics, University of Washington, USA
Organizer: Akil Narayan, University of Massachusetts Dartmouth, USA

13:45-14:15 Matrix-valued Kernels for Shape Deformation Analysis
Mario Micheli, Department of Mathematics, University of Washington, USA

14:15-14:45 Shape Analysis of Cardiac Images
Laurent Younes, Department of Applied Mathematics and Statistics, Center for Imaging Science, Johns Hopkins University, USA

14:45-15:15 Shape Analysis of Multiply-connected Objects Using Conformal Welding
Ronald Lok Ming Lui, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong

Tuesday May 13

MS39 Part II
Challenges in Inverse Problems for Imaging
1:45 PM - 3:45 PM
WLB104

A key issue in imaging inverse problems is the correct choice of image priors (regularisation functionals) and data models (fidelity terms). Several strategies for conceiving optimization problems, combining prior and data information, have been considered. Let us evoke statistically grounded methods, adaptive regularization, dictionary learning, bilevel optimization, among others. All these approaches vary in their philosophy and mathematics. In spite of the achievements, there are more open questions than really satisfying answers. This minisymposium should constitute a platform for an exchange between researchers working on these problems from different points of view.

Organizer: Mila Nikolova, CNRS - ENS Cachan, France
Organizer: Carola-Bibiane Schönlieb, Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, UK

13:45-14:15 Correlation Mining for Imaging Problems
Alfred Hero, The University of Michigan, USA

14:15-14:45 Blind Deblurring with Sharpness Metrics Based on Phase Coherence
Lionel Moisan, Université Paris Descartes, France

14:45-15:15 Non-Lipschitz L_p-Regularization and Box Constrained Model for Image Restoration
Xiaojun Chen, Hong Kong Polytechnic University, Hong Kong, China

15:15-15:45 Perturb-and-MAP Random Fields: Reducing Random Sampling to Optimization with Applications in Computer Vision
George Papandreou, Toyota Technological Institute at Chicago, USA

Tuesday May 13

MS40 Part II
A Fixed-Point Approach for Optimization Problems in Imaging
1:45 PM - 3:45 PM
DLB712

Optimization problems in image processing are ill-posed. Regularizations are commonly used to convert the ill-posed problems to well-posed ones. The resulting regularized models usually have non-differential objective functions which make mini- mizing the objective functional theoretically and numerically difficult. The problem of minimizing a regularized image model can be formulated as a problem of finding the fixed-point of a particular nonlinear operator. This mini-symposia addresses the mathematical challenges and computational difficulties brought by the use of fixed-point formulations and reports recent advances in this research direction.

Organizer: Lixin Shen, Syracuse University and Sun Yat-sen University
Organizer: Yuesheng Xu, Sun Yat-sen University and Syracuse University

13:45-14:15 Limited-Angle CT Reconstruction
Yao Lu, Sun Yat-sen University, China

14:15-14:45 Proximity Algorithms for Multiplicative noise Removal
Jian Lu, Shenzhen University, China

14:45-15:15 Fixed-point Proximity Algorithms for Optimization Problems in Image Restoration
Qia Li, Sun Yat-Sen University, China

Tuesday May 13

MS43
Tensor- and Manifold-Valued Data
1:45 PM - 3:45 PM
WLB209

Many image processing applications involve data that does not naturally have a scalar- or vector-valued representation. Instead, data such as angles, phases, orientations, or, in particular, covariance matrices, are more accurately represented by points or tensors on a manifold. Examples include the processing of phase data in time-of-flight cameras and velocity-encoded MRI, tensor fields in diffusion tensor imaging, and the denoising and generation of surface normals for 3D reconstruction and visualization. In this minisymposium we will address some of the unique challenges in the modelling, analysis, and numerical solution of problems with such non-standard range constraints.

Organizer: Jan Lellmann, Centre for Mathematical Sciences, University of Cambridge, UK
Organizer: Tuomo Valkonen, Centre for Mathematical Sciences, University of Cambridge, UK

13:45-14:15 First- and Higher-order Regularisation of Tensor Fields
Tuomo Valkonen, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK

14:15-14:45 Total Variation Regularization for Functions with Values in a Manifold
Daniel Cremers, Department of Computer Science, Technical University of Munich, Germany

14:45-15:15 Moment Tensors and High Angular Resolution Diffusion Imaging
Lek-Heng Lim, Department of Statistics, University of Chicago, USA

Tuesday May 13

MS45 Part II
Multi-Frame Motion Estimation and Optical Flow Algorithms
1:45 PM - 3:45 PM
SCC1

The rationale of the topic is that human vision massively uses information over time when it estimates velocities in movie sequences. Computer vision, though, does not reflect this in general: it often uses less information. Mostly, two-frame algorithms are used for dense pixel velocity estimation. This results in time-incoherent results. But recently, new methods evolved in treating the time-dependent problem. In particular, they model spatio-temporal coherence, adapt probabilistic and geometric tools, and use low-rank constraints in the variational problem. This minisymposium presents the most recent ideas for modeling and computational solutions of global-intime optical flow and registration.

Organizer: Thomas Widlak, University of Vienna, Austria

13:45-14:15 Recursive Joint Estimation of Dense Scene Structure and Camera Motion
Florian Becker, University of Heidelberg, Germany

14:15-14:45 Semicontinuity and Relaxation of a Variational Functional for Optical Flow
Janusz Ginster, University of Bonn, Germany

14:45-15:15 Real-Time Optical Flow Estimation Using High-Frame-Rate Videos
Idaku Ishii, Hiroshima University, Japan

15:15-15:45 Non-linear Spatio-Temporal Coherence Models for Optical Flow Estimation
Agustín Salgado, University of Las Palmas de Gran Canaria, Spain

Tuesday May 13

MS46
Advances in Phase Retrieval for Diffractive Imaging
1:45 PM - 3:45 PM
WLB211

Far-field diffraction patterns measured in the course of coherent X-ray diffractive imaging and other lensless techniques capture only the intensities of the diffracted waves; the phases must be recovered numerically. This mini-symposium will focus on recent developments in phase retrieval algorithms for solving this class of challenging large-scale, highly structured, and often ill-conditioned inverse problems.

Organizer: Stefan M. Wild, Argonne National Laboratory, USA
Organizer: Sven Leyffer, Argonne National Laboratory, USA
Organizer: Chao Yang, Lawrence Berkeley National Laboratory, USA

13:45-14:15 Benchmarking Optimization Algorithms for Phase Retrieval
Stefan M. Wild, Argonne National Laboratory, USA

14:15-14:45 Phase Retrieval in High Dimensional Data Space
Stefano Marchesini, Lawrence Berkeley National Laboratory, Germany

14:45-15:15 Toward Global Optimization for Phase Retrieval
Sven Leyffer, Argonne National Laboratory, USA

15:15-15:45 Fourier Phasing with Phase-uncertain Mask
Wenjing Liao, Duke University, USA

Tuesday May 13

MS52 Part II

Non-Convex Models in Image Recovery and Segmentation

1:45 PM - 3:45 PM

WLB208

In image recovery and segmentation, non-convex variational models are often closer to the real problems and turn out to perform better numerical results comparing the convex models. But at the same time, non-convexity poses significant challenges with respect to both the existence of solutions and the development of efficient algorithms. This minisymposium aims at bringing together experts in this area to present a series of talks on modeling, theoretical analysis, efficient numerical algorithms and applications.

Organizer: Yiqiu Dong, Technical University of Denmark, Denmark
Organizer: Tieyong Zeng, Hong Kong Baptist University, Hong Kong

13:45-14:15 Non-heuristic Graph Reduction for Graph Cut
François Malgouyres, Institut de Mathématiques de Toulouse, University of Toulouse, France

14:15-14:45 iPiano: Inertial Proximal Algorithm for Non-convex Optimization
Thomas Pock, Institute for Computer Graphics and Vision, Graz University of Technology, Austria

14:45-15:15 Four Color Theorem And Convex Relaxation For Image Segmentation With Any Number Of Regions
Xue-Cheng Tai, Department of Mathematics, University of Bergen, Norway

Tuesday May 13

MS53 Part II

Splitting Methods for Imaging Problems

1:45 PM - 3:45 PM

WLB210

Recently we have witnessed a rapid growth in the interaction of optimization technique and imaging science. In particular, there have been very impressive applications of operator splitting methods to various imaging problems, such as the alternating direction method of multipliers, forward-backward splitting methods, splitting versions of the proximal point algorithm, etc. This mini-symposium aims to bring together experts to exchange ideas and to discuss the most recent development in algorithmic design, theory and applications of operator splitting methods for imaging problems.

Organizer: Raymond H. Chan, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong, China
Organizer: Xiaoming Yuan, Department of Mathematics, Hong Kong Baptist University, Hong Kong, China

13:45-14:15 Splitting Strategies for Convex Problems with Complicated Block Structure
Ernie Esser, University of British Columbia, Canada

14:15-14:45 Revisiting the Quadratic Programming Formulation of Sparse Recovery
Mário Figueiredo, Instituto Superior Técnico, Portugal

14:45-15:15 On the Minimization of Quotient Functionals
Gabriele Steidl, University of Kaiserslautern, Germany

15:15-15:45 A Reweighted ℓ^2 Method for Image Restoration with Poisson and Mixed Poisson-Gaussian Noise
Xiaoqun Zhang, Shanghai Jiao Tong University, China

Tuesday May 13

MS55 Part II

Advances and Trends of Modern Image Restoration

1:45 PM - 3:45 PM

WLB109

Image restoration is a critical component for vision applications, and provides an integral platform for research on statistical modeling of images. The past decade has witnessed the emerging and rapid development of modern image restoration methods, such as nonlocal regularization, sparse representation, dictionary learning, and low rank analysis, to name a few. Numerous machine learning approaches such as deep learning have also been adapted to image restoration, leading to interesting results. This mini-symposium provides a forum for colleagues in the community to share their recent research findings, and discuss the future trends of modern image restoration.

Organizer: Lei Zhang, Dept. of Computing, The Hong Kong Polytechnic University, Hong Kong
Organizer: Ming-Hsuan Yang, Dept. of Electrical Engineering and Computer Science, University of California at Merced, USA

13:45-14:15 Joint Spatiotemporal Removal of Mixed Random and Fixed-pattern Noise From Video
Alessandro Foi, Department of Signal Processing, Tampere University of Technology, Finland

14:15-14:45 Structure-Texture Separation via Relative Total Variation
Jiaya Jia, Department of Computer Science and Engineering, The Chinese University of Hong Kong, Hong Kong

14:45-15:15 Super-resolution From Internet-scale Scene Matching
Libin Sun, Department of Computer Science, Brown University, USA

Tuesday May 13

MS57 Part IV
Modeling and Algorithms for Imaging Problems
1:45 PM - 3:45 PM
DLB719

In recent years mainland China has many new developments in modeling and algorithms in imaging sciences. The objectives of this mini-symposium are to bring mainland China researchers in this field together to present their recent research work, to exchange ideas, and explore future collaborations. The topics of this mini-symposium were the latest development of modeling, algorithms and their applications in real-world imaging problems such as image denoising, deblurring, inpainting, decomposition, segmentation, and super-resolution reconstruction, etc. This minisymposium can provide a forum to stimulate discussions and establish collaborations between young Chinese researchers for further developments in this emerging imaging sciences research.

Organizer: Fang Li, Department of Mathematics, East China Normal University, China
Organizer: Huanfeng Shen, School of Resource and Environmental Science, Wuhan University, China
Organizer: Wei Wang, Department of Mathematics, Tongji University, China
Organizer: Xile Zhao, School of Mathematical Sciences, University of Electronic Science and Technology of China, China

13:45-14:15 A Variational Approach for Image Stitching
Wei Wang, Tongji University, China

14:15-14:45 Screening Technique: Identifying Most Positions of Zeros in a Sparse Solution
Chaomin Shen, East China Normal University, China

14:45-15:15 Variational Approach for Color-to-Grayscale Image Conversion
Zhengmeng Jin, Nanjing University of Posts and Telecommunications, China

15:15-15:45 Total Generalized Variation Via Spectral Decomposition
Liang Xiao, Nanjing University of Science and Technology, China

Tuesday May 13

MiniTutorial
4:15 PM - 6:15 PM

Graph Cut, Convex Relaxation and Continuous Max-flow Problems
Egil Bae, University of California at Los Angeles, USA
Mila Nikolova, CNRS-ENS-Cachan, France
Xue-Cheng Tai, University of Bergen, Norway

Minimization methods and variational models are becoming fundamental for image processing and computer vision. Graph cut methods, which originated from combinatorial mathematics, have been widely used due to their fast speed and robustness with minimizations. Variational methods are also widely used and they often lead to some complex nonlinear partial differential equations. Fast numerical solvers and robust (global) minimization methods are needed and crucial. Recent research has revealed that graph cut methods (in the discrete setting) and some variational models (in the continuous setting) are solving the same numerical problems. The observation of these connections leads to interesting techniques to convexify some complicated variational models and also to produce fast numerical schemes thanks to some advanced techniques from convex programming. This tutorial will first introduce graph cut method for image processing and computer vision, then continues with some important variational models. Especially, we will present some recent continuous cut and continuous max-flow models and show their applications to image process- ing and computer vision. Connection between the discrete graph cut and continuous max-flow models will be revealed. Duality relationship between the different models will be discussed. Convex relaxation of more general variational models will be proposed following these discussions. Fast numerical algorithms becoming natural after convex relaxation and using convex programming techniques. In the end, we will present applications to image segmentation, image restoration, surface construction, machine learning, computer vision and graph theory. We also shall give some examples where convex relaxation fail.

Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building

Tuesday May 13

CT01

Contributed Talk I

4:15 PM - 6:15 PM

WLB103

16:15-16:35 Meteorological Data Analysis with Diffeomorphic Demons

Dominique Brunet, Cloud Physics and Severe Weather Research Section, Environment Canada, Government of Canada, Canada

16:35-16:55 Modelling and Analysing Oriented Fibrous Structures

Maaria Rantala, Department of Mathematics and Statistics, University of Helsinki, Finland

16:55-17:15 Fast Optimized Harmonic Registration of Genus-0 Closed Surfaces with Landmark Constraints

Pui Tung Choi, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong

17:15-17:35 Image Inpainting for 3D Conversion

Rob Hocking, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK

17:35-17:55 Surface Reconstruction from Parallel Contours with Exact Contour Constraints

Sangun Kim, Department of Mathematical Sciences, KAIST, Korea

17:55-18:15 A Convex Approach to Sparse Shape Composition

Alireza Aghasi, School of Electrical and Computer Engineering, Georgia Institute of Technology, GA, USA

Tuesday May 13

CT02

Contributed Talk 2

4:15 PM - 6:15 PM

WLB104

16:15-16:35 Simulation of Modified Keller-Segel Chemotaxis Model with Stochastic Parameters

Daniel Keegan, Hunter College CUNY, USA

16:35-16:55 Boundary Integral Strategy for Laplace Eigenvalue Problems

Eldar Akhmetgaliyev, Applied and Computational Mathematics, California Institute of Technology, USA

16:55-17:15 Optimal Filters for General-Form Tikhonov Regularization

Malena I. Español, Department of Mathematics, The University of Akron, USA

17:15-17:35 Drift-Diffusion Equations in Image Processing

Martin Schmidt, Department of Mathematics and Computer Science, Saarland University, Germany

17:35-17:55 Near Optimal Parameter Choice for General Spectral Filters

Viktoria Taroudaki, Applied Mathematics and Scientific Computation Program, University of Maryland, USA

Tuesday May 13

CT03

Contributed Talk 3
4:15 PM - 6:15 PM
WLB109

16:15-16:35 A General Framework of Piecewise-Polynomial Mumford-Shah Model for Image Segmentation
Chong Chen, Institute of Computational Mathematics and Scientific/Engineering Computing, Chinese Academy of Sciences, China

16:35-16:55 As-Killing-as-possible Image Registration for Tracking of Living Cells from Fluorescent Microscopy
Justin W.L. Wan, David R. Cheriton School of Computer Science, and Centre for Computational Mathematics in Industry and Commerce, University of Waterloo, Canada

16:55-17:15 Sign Regulator Based Color Image Segmentation Model
Haider Ali, Department of Mathematics, University of Peshawar, Pakistan

17:15-17:35 System of Methods for Iris Segmentation in Image
Ivan Matveev, Complex Systems Department, Computing Centre of Russian Academy of Sciences, Russia

17:35-17:55 A Method for C. Elegans Cell Lineage Tracking Based on Probabilistic Relaxation Labeling (PRL)
Long Chen, Department of Electronic Engineering, City University of Hong Kong, Hong Kong

17:55-18:15 Tracking of Cells in Zebrafish Embryogenesis by Finding Centered Paths Inside 4D Segmentations
Robert Spir, Department of Mathematics, Slovak University of Technology in Bratislava, Slovakia

Tuesday May 13

CT04

Contributed Talk 4
4:15 PM - 6:15 PM
WLB205

16:15-16:35 Inversion of Photoacoustic Tomography Using l_1-norm Regularization of Shearlet Coefficients
Christina Brandt, Institute of Mathematics, University of Osnabrück, Germany

16:35-16:55 Sparse Reconstruction for Tomographic Imaging: Bridging the Gap Between Theory and Practice Using the ASTRA Toolbox
Folkert Bleichrodt, Centrum Wiskunde & Informatica, Amsterdam, Netherlands

16:55-17:15 Breast Surface Reconstruction Based on Radon Transform for Microwave Breast Imaging Applications
Ahmet Hakan Tuncay, Department of Electronics and Communication, Istanbul Technical University, Turkey

17:15-17:35 Tomographic Reconstruction Using Learned Dictionaries
Sara Soltani, Department of Applied Mathematics and Computer Science, Technical University of Denmark, Denmark

17:35-17:55 Applications of Fast Fourier Transforms on Optimal Sampling Lattices in CT Image Reconstruction
Xiqiang Zheng, Voorhees College, USA

17:55-18:15 A Fast Denoising Approach of Medical Ultrasound Images Corrupted by Combined Additive and Multiplicative Noise on the MIC Architecture
Noppadol Chumchob, Department of Mathematics, Faculty of Science, Silpakorn University, Thailand

Tuesday May 13

CT05

Contributed Talk 5
4:15 PM - 6:15 PM
WLB211

16:15-16:35 An Overview of Kernel Methods for Tensor Based Classification
Boguslaw Cyganek, Department of Electronics, AGH University of Science and Technology, Krakow, Poland

16:35-16:55 Dynamical Estimation of Brain Activities from MEG Data
Lijun Yu, Department of Mathematics, Applied Mathematics and Statistics, Case Western Reserve University, USA

16:55-17:15 A Composition Model Combining Parametric Transformation and Non-parametric Deformation for Effective Image Registration
Mazlinda Ibrahim, Centre for Mathematical Imaging Techniques, Department of Mathematical Sciences, The University of Liverpool, UK

17:15-17:35 Computer Vision Applications in Characterizing Melanoma and Moles
Cheri Shakiban, Department of Mathematics, University of St. Thomas, USA

17:35-17:55 Artificial Intelligence and Traffic: Problems, Devices, Methods, Theorems
Marina Yashina, Mathematical Cybernetics and Information Technologies Department, Moscow Technical University of Communications and Informatics, Russia

Tuesday May 13

CT06
Contributed Talk 6
4:15 PM - 6:15 PM
WLB209

16:15-16:35 Creating and Utilising Prior Anatomical Information for Preclinical Brain Imaging with Fluorescence Molecular Tomography
Athanasios Zacharopoulos, Institute for Electronic Structure and Laser, Foundation for Research and Technology- Hellas, Greece

16:35-16:55 Detection of Bone Profiles in CT Images by Means of the Hough Transform
Cristina Campi, CNR-SPIN, Genova, Italy

16:55-17:15 Physiological Clustering: A noise-reduction approach in Quantitative Myocardial Perfusion PET
Hassan Mohy-ud-Din, Department of Electrical and Computer Engineering, Department of Applied Mathematics and Statistics, and Department of Radiology and Radiological Sciences, Johns Hopkins University, USA

17:15-17:35 Quantification of Glucose Metabolism with Nuclear Imaging PET Data
Sara Garbarino, Dipartimento di Matematica, Universitá degli Studi di Genova, Italy

17:35-17:55 Spontaneous Brain Activity Detection in Functional Magnetic Resonance Imaging Using Finite Rate of Innovation
Zafer Dogan, Institute of Bioengineering EPFL, Switzerland

17:55-18:15 Manifold Embedding Model of Image Patches and Its Application
Jianzhong Wang, Department of Mathematics and Statistics, Sam Houston State University, Texas, USA

Tuesday May 13

CT07
Contributed Talk 7
4:15 PM - 6:15 PM
WLB202

16:15-16:35 Imaging Strong Localized Scatterers
Anwei Chai, Stanford University, USA

16:35-16:55 Laplacian Colormaps: a Framework for Structure-preserving Color Transformations
Davide Eynard, Institute of Computational Science, Faculty of Informatics University of Lugano, Switzerland

16:55-17:15 On Best Basis Selection from Basis Dictionaries on Graphs
Naoki Saito, Department of Mathematics, University of California, Davis, USA

17:15-17:35 Real-time Compressed Imaging Of Scattering Volumes
Ohad Menashe, Department of Electrical Engineering, Tel Aviv University, Israel

17:35-17:55 Recovering Rank-One Matrices via Rank-r Matrices Relaxation
Pengwen Chen, National Chung Hsing University, Taiwan

17:55-18:15 Fourier-Bessel Rotational Invariant Eigenimages
Zhizhen Zhao, Courant Institute of Mathematical Sciences, New York University, USA

Tuesday May 13

CT08
Contributed Talk 8
4:15 PM - 6:15 PM
WLB206

16:15-16:35 Removing Simultaneous Gaussian and Salt-and-pepper Noise by Minimizing a Combined L^1-L^2-TV Functional
Andreas Langer, Institute of Mathematics and Scientific Computing, University of Graz, Austria

16:35-16:55 Efficient Smoothing Method for Image Restoration Using Nonsmoooth Regularization
Chao Zhang, Department of Applied Mathematics, Beijing Jiaotong University, China

16:55-17:15 Total Variation based Speckle Reduction Method
Hyenkyun Woo, School of Computational Sciences, Korea Institute for Advanced Study, Korea

17:15-17:35 Denoising Results Using Image Reconstruction Techniques Based on Legendre Polynomials Approximation of Continuous Prolate Spheroidal Functions (CPSF)
Maria C. Gonzalez, Department of Mathematics, University of California, Davis, USA

17:35-17:55 Exploiting Sparsity in Remote Sensing for Earth Observation
Xiaoxiang Zhu, Remote Sensing Technology, German Aerospace Center (DLR) & Technical University of Munich, Germany

17:55-18:15 Image De-noising Using Discrete Spectrum of a Schrödinger Operator
Zineb Kaisserli, Mathematical and Computer Science Division, University of Mostaganem Abdelhamid Ibn Badis University (UMAB), Algeria

Tuesday May 13

CT09
Contributed Talk 9
4:15 PM - 6:15 PM
WLB208

16:15-16:35 Improving D-bar Reconstructions for Electrical Impedance Tomography with Data-driven Post-processing
Andreas Hauptmann, Department of Mathematics and Statistics, University of Helsinki, Finland

16:35-16:55 Tomographic Reconstruction of 3-D Vector Fields Using a Discretized Integral Equations System
Chrysa D. Papadaniil, Department of Electrical and Computer Engineering, Aristotle University of Thessaloniki, Greece

16:55-17:15 Fast Approximation of Advanced Tomographic Reconstruction Methods
Daniël M. Pelt, Scientific Computing group, CWI, Amsterdam, Netherlands

17:15-17:35 Superiorization of EM Iteration and Applications in SPECT Image Reconstruction
Shousheng Luo, School of Mathematics and Information Sciences, University of Henan, China

17:35-17:55 Spectral Variational Method for Grid Removal in Digital Radiography
Yongjian Yu, Varian Medical Systems - X-Ray Products, Liverpool, NY USA

17:55-18:15 Comparison of Functional Formulations for Ultrasound Attenuation Compensation and Image Segmentation
Yongjian Yu, Varian Medical Systems - X-Ray Products, Liverpool, NY USA

Tuesday May 13

CT10
Contributed Talk 10
4:15 PM - 6:15 PM
WLB207

16:15-16:35 Convolutional Sparse Representations: Algorithms and Applications
Brendt Wohlberg, Theoretical Division, Los Alamos National Laboratory, USA

16:35-16:55 Synchrosqueezed Curvelet Transform for 2D Mode Decomposition
Haizhao Yang, Stanford University, USA

16:55-17:15 Tensor Nuclear Norm for High-Resolution Video Enhancement
Jiani Zhang, Department of Mathematics, Tufts University, USA

17:15-17:35 Sparse Approximations of Spatially Varying Blur Operators in the Wavelet Domain
Paul Escande, Département Mathématiques, Informatique, Automatique, Institut Supérieur de l'Aéronautique et de l'Espace, Toulouse, France

17:35-17:55 Regularized Sparse Representation Method for Image Interpolation
Meihua Xie, College of science, National University of Defense Technology, China

17:55-18:15 On the Restoration of Halftones of Green Noise Characteristics
Y H Fung, Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Hong Kong

Tuesday May 13

CT11
Contributed Talk 11
4:15 PM - 6:15 PM
WLB203

16:15-16:35 Nonoverlapping Domain Decomposition Methods for the Total Variation Minimization
Changmin Nam, Department of Mathematical Sciences, KAIST, Korea

16:35-16:55 Numerical Implementation of a New Class of Forward-backward Diffusion Equations for Image Restoration
James V. Lambers, Department of Mathematics, University of Southern Mississippi, USA

16:55-17:15 A Stable Scheme to Discretize Anisotropic Diffusion
Jerome Fehrenbac, Institut de Mathematiques de Toulouse, University of Toulouse III, France

17:15-17:35 Factional-order Derivative Regularization with Application to Two Imaging Models
Jianping Zhang, Department of Mathematical Sciences, University of Liverpool, UK

17:35-17:55 On the Convergence of a New Alternating Minimization Algorithm for Principal Component Pursuit
Paul Rodriguez, Department of Electrical Engineering, Pontifical Catholic University of Peru, Peru

17:55-18:15 Image Reconstructions with Improved 3D Block Matching
Robert Crandall, University of Arizona, USA

Tuesday May 13

Poster Presentation

4:15 PM - 6:15 PM

Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

1. Beyond the Grayscale Image: User-Aided Dimension Reduction of Color Images for Improved Edge Detection
Brianna Cash, University of Maryland, College Park, USA

2. A Python Toolbox for Energy Minimization of Shapes
Günay Doğan, Theiss Research, National Institute of Standards and Technology, USA

3. Sparsity Reconstruction in Partial Data Electrical Impedance Tomography
Henrik Garde, Department of Applied Mathematics and Computer Science, Technical University of Denmark, Denmark

4. Propagation of Singularities for Linearised Hybrid Inverse Problems
Kristoffer Hoffmann, Department of Applied Mathematics and Computer Science, Technical University of Denmark, Denmark

5. Recovery of the Camera Response Function from Few Images in High Dynamic Range Photography
Thomas Hoft, Department of Mathematics, University of St. Thomas, USA

6. Imaging of Complex Media with Elastic Wave Equations
Jérôme Luquel, INRIA Magique-3D, University of Pau, France

7. How to Avoid Smoothing a Histogram, and Why
Enric Meinhardt-Llopis, Ecole Normale Superieure de Cachan, France

8. Modeling Stereo Depth Perception with Coupled Nonlinear Elements
Atsushi Nomura, Faculty of Education, Yamaguchi University, Japan

9. Image Registration using Gradients Comparison and Non-Linear Elastic Regularization
Solène Ozeré, Laboratory of Mathematics, INSA Rouen, France

10. SIFT and a Bias in the Repeatability Criteria
Ives Rey-Otero, CMLA, Ecole Normale Superieure de Cachan, France

11. Simultaneous Reconstruction and Segmentation with Probabilistic Hidden Markov Model Regularization
Mikhail Romanov, Department of Applied Mathematics and Computer Science, Technical University of Denmark, Denmark

12. Creating and Utilising Prior Anatomical Information for Preclinical Brain Imaging with Fluorescence Molecular Tomography
Athanasios Zacharopoulos, Institute for Electronic Structure and Laser, Foundation for Research and Technology-Hellas, Greece

13. Analysis of Fuzzy Weighting Exponent in Fuzzy Active Contour Model
Jianzhou Zhang, College of Computer, Sichuan University, China

14. High Dynamic Range From a Single Image
Julie Delon, Université Paris Descartes, France

Wednesday May 14

Registration

8:00 AM - 11:00 AM

Tsang Chan Sik Yue Auditorium Lobby, 2/F Academic and Adminstration Building

Wednesday May 14

IP5

8:30 AM - 9:15 AM

Chair: Ron Kimmel, Technion, Israel

Pursuit of Low-dimensional Structures in High-dimensional Data

Yi Ma, ShanghaiTech University, China

In this talk, we will discuss a new class of models and techniques that can effectively model and extract rich low-dimensional structures in high-dimensional data such as images and videos, despite nonlinear transformation, gross corruption, or severely compressed measurements. This work leverages recent advancements in convex optimization for recovering low-rank or sparse signals that provide both strong theoretical guarantees and efficient and scalable algorithms for solving such high-dimensional combinatorial problems. These results and tools actually generalize to a large family of low-complexity structures whose associated regularizers are decomposable. We illustrate how these new mathematical models and tools could bring disruptive changes to solutions to many challenging tasks in computer vision, image processing, and pattern recognition. We will also illustrate some emerging applications of these tools to other data types such as web documents, image tags, microarray data, audio/music analysis, and graphical models. (This is joint work with John Wright of Columbia, Emmanuel Candes of Stanford, Zhouchen Lin of Peking University, and my students Zhengdong Zhang, Xiao Liang of Tsinghua University, Arvind Ganesh, Zihan Zhou, Kerui Min and Hossein Mobahi of UIUC.)

`Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building`

Wednesday May 14

IP6

9:15 AM - 10:00 AM

Chair: David Gu, State University of New York at Stony Brook, USA

Emerging Methods in Photon-Limited Imaging

Rebecca Willett, University of Wisconsin-Madison, USA

Many scientific and engineering applications rely upon the accurate reconstruction of spatially, spectrally, and temporally distributed phenomena from photon-limited data. When the number of observed events is very small, accurately extracting knowledge from this data requires the development of both new computational methods and novel theoretical analysis frameworks. This task is particularly challenging since sensing is often indirect in nature, such as in compressed sensing or with tomographic projections in medical imaging, resulting in complicated inverse problems. Furthermore, limited system resources, such as data acquisition time and sensor array size, lead to complex tradeoffs between sensing and processing. All of these issues combine to make accurate image reconstruction a complicated task, involving a myriad of system-level and algorithmic tradeoffs.
In this talk, I will describe novel algorithms and performance tradeoffs between reconstruction accuracy and system resources when the underlying intensity exhibits some low-dimensional structure. The theory supporting these methods facilitates characterization of fundamental performance limits. Examples include lower bounds on the best achievable error performance in photon-limited image reconstruction and upper bounds on the data acquisition time required to achieve a target reconstruction accuracy. The effectiveness of the theory and methods will be demonstrated for several important applications, including astronomy, night vision, and biological imaging.

`Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building`

Coffee Break

10:00 AM - 10:30 AM

`3/F Podium, Academic and Administration Building`

Wednesday May 14

MS01 Part I

Beyond Single Shot Imaging: Academic and Industrial Points of View
10:30 AM - 12:30 PM
WLB210

With the advent of computational imaging, the frontiers between optics, electronics and image processing are becoming thinner: in modern image acquisition devices, all three elements are viewed as a whole that should be optimized jointly. In particular modern cameras tend to take bursts of images that are jointly restored, thus allowing to go beyond the physical limitations of single-shot sensors (dynamic range, resolution, noise, blur, specularities, over-exposure). As a counterpart, multi-image restoration faces specific challenges (motion, outliers, illuminant modifications, etc.), that are being addressed by industry and academia using innovative tools from applied mathematics and image processing.

Organizer: Andrés Almansa, LTCI, Telecom ParisTech, CNRS, France
Organizer: Julie Delon, MAP5, Université Paris Descartes, CNRS, France
Organizer: Pablo Musé, IIE, Fac. de Ingeniería, Universidad de la República, Uruguay

10:30-11:00 Simultaneous HDR Image Reconstruction and Denoising for Dynamic Scenes
Pablo Musé, Universidad de la República, Uruguay

11:00-11:30 How to Trade Signal Sparsity for Outlier Resistance in Convex Reconstruction from Linear Measurements?
Saïd Ladjal, LTCI, Télécom ParisTech, France

11:30-12:00 Foreground and Background Reconstruction in High-Speed Photon-Limited Motion Imagery
Rebecca Willett, University of Wisconsin-Madison, USA

12:00-12:30 Color Transfer Between Close Views of the Same Scene
Stacey Levine, Duquesne University, USA

Wednesday May 14

MS18 Part I

Super-Resolution: Theoretical and Numerical Aspects
10:30 AM - 12:30 PM
WLB211

The goal of this mini-symposium (split into two parts) is to present state of the art results, on both theoretical guarantees and numerical algorithms, for inverse problems regularization using low complexity models (sparsity, bounded variation, low rank, etc.). These results attempt to bridge the gap between the surprising efficiency of recent regularization methods, and our theoretical understanding of their super-resolution effectiveness. While many theoretical guarantees rely on uniform analysis with with hypotheses requiring randomness or global incoherence of the measurements, real-life problems in imaging sciences (e.g. deconvolution, tomography, MRI, etc.) require more intricate theoretical tools and algorithms to capture the geometry of signals and images that can be stably recovered. This includes for instance variational methods over spaces of measures (e.g. sum of Dirac measures, bounded variation functions, etc.) and the development of novel recovery algorithms that can cope with the strong coherence of the measurement operator. The mini-symposium will gather talks by leading experts in the field.

Organizer: Jalal Fadili, CNRS-ENSICaen, Caen, France
Organizer: Gabriel Peyré, CNRS and Université Paris-Dauphine, France

10:30-11:00 Inverse Problems in Spaces of Measures
Kristian Bredies, University of Graz, Austria

11:00-11:30 Super-Resolution from Noisy Data
Carlos Fernandez-Granda, University of Stanford, USA

11:30-12:00 Exact Support Recovery for Sparse Spikes Deconvolution
Vincent Duval, University Paris-Dauphine, France

Wednesday May 14

MS19 Part I
Wave-based Imaging
10:30 AM - 12:30 PM
WLB207

Wave-based imaging is an interdisciplinary area in applied mathematics, with roots in hyperbolic partial differential equations, probability theory, statistics, optimization, and numerical analysis. This minisymposium will present some of the latest advances in this area including source and reflector imaging in random media with arrays, imaging with cross correlation techniques, imaging through the turbulent atmosphere, and imaging methods based on spectral decompositions of the scattering operator.

Organizer: Knut Sølna, University of California at Irvine, USA
Organizer: Josselin Garnier, Paris Diderot University, France

10:30-11:00 Medium Induced Resolution Enhancement for Broadband Imaging
Knut Sølna, University of California at Irvine, USA

11:00-11:30 Shape Identification and Classification in Echolocation
Han Wang, ENS Paris, France

11:30-12:00 Wave Luminescence Imaging
Kui Ren, Department of Mathematics, University of Texas at Austin, USA

Wednesday May 14

MS23
Sparse Reconstruction for Tomographic Imaging
10:30 AM - 12:30 PM
WLB206

Reconstruction methods based on exploiting sparsity in the image or a transform thereof have seen a tremendous development in recent years. In this minisymposium we focus on new ideas in the application to tomographic imaging including computed tomography (CT), positron emission tomography (PET), and other medical and non-medical settings. Aspects of interest include reconstruction with missing or reduced data, different sparse reconstruction methods including choice of prior or regularization, as well as implementation and application-specific aspects and related topics.

Organizer: Jakob Sauer Jørgensen, Technical University of Denmark, Denmark
Organizer: Per Christian Hansen, Technical University of Denmark, Denmark

10:30-11:00 Generalized Row-Action Methods for Tomographic Imaging
Martin S. Andersen, Technical University of Denmark, Denmark

11:00-11:30 Sparse X-ray Tomography Using a Besov Prior
Ville Kolehmainen, University of Eastern Finland, Finland

11:30-12:00 The Tradeoff Between Number of Projections and X-ray Intensity for Sparsity-exploiting Image Reconstruction in Computed Tomography
Emil Y. Sidky, University of Chicago, USA

12:00-12:30 PET Reconstruction From Short-time Data via GTV-Bregman
Martin Burger, Westfälische Wilhelms Universität (WWU) Münster, Germany

Wednesday May 14

MS24 Part I
Color Perception and Image Enhancement
10:30 AM - 12:30 PM
WLB109

Color perception is an important part of human vision. Color image research has advanced by using nonlinear color spaces such as HSV/HSI and chromaticity. This minisymposium focuses on color perception and enhancement. A common color enhancement strategy involves using a global or adaptive histogram specification and generalizing it to color channels. These processes are highly non-trivial and have to cope with the gamut problem. Other approaches are based, e.g., on variational methods with perceptually inspired energy functionals. The minisymposium aims to bring together scientists presenting different new approaches and discussing new research challenges.

Organizer: Sung Ha Kang, School of Mathematics, Georgia Institute of Technology, USA
Organizer: Gabriele Steidl, Technische Universität Kaiserslautern, Germany

10:30-11:00 Fast Hue and Range preserving Histogram Specification: New algorithms, Theory and Applications
Mila Nikolova, ENS-Cachan, France

11:00-11:30 White Balance in Cinema
Marcelo Bertalmío, Universitat Pompeu Fabra, Spain

11:30-12:00 Exemplar-Based Image Colorization Using RGB
Jean-Francois Aujol, Universite Bordeaux 1, France

12:00-12:30 Color Image Contrast Enhancement: 3-D Color Histogram Equalization Method
Sejung Yang, Ewha Womans University, Korea

Wednesday May 14

MS27 Part I
High Frequency Wave Propagation and Related Imaging Problems
10:30 AM - 12:30 PM
AAB606

Wave propagation and related inverse problems are essential for many different applications. Recently a variety of numerical methods and algorithms have been proposed for wave motion and related inverse problems. The related imaging problems include but not limited to traveltime tomography, boundary rigidity problems, seismic migration and inversion, and so on. This multi-session minisymposium will examine recent advances on the above fronts and related applications.

Organizer: Jianliang Qian, Department of Mathematics, Michigan State University, USA
Organizer: Shingyu Leung, The Hong Kong University of Science and Technology, Hong Kong
Organizer: Songting Luo, Iowa State University, USA

10:30-11:00 Adjoint State Method for the Recovery of Both the Source and the Attenuation in the Attenuated X-ray Transform
Songting Luo, Iowa State University, USA

11:00-11:30 Locating Multiscale Scatterers by A Single Far-field Pattern
Hongyu Liu, University of North Carolina, USA

11:30-12:00 Fast Matrix-free Direct Solution and Selected Inversion for Seismic Imaging Problems
Jianlin Xia, Purdue University, USA

12:00-12:30 Eulerian Methods for Schrodinger Equations in the Semi-Classical Regime
Shingyu Leung, The Hong Kong University of Science and Technology, Hong Kong

Wednesday May 14

MS30 Part I
First-Order Primal-Dual Methods for Convex Optimization
10:30 AM - 12:30 PM
WLB103

Many tasks in image processing can be treated by considering appropriate convex minimization problems. A common feature of these problems is that they often involve convex functionals for which the proximal operators are easily available and that the linear operators which are involved are not (stably) invertible but simple and fast to evaluate. The convex optimization problems can often be transformed into convex-concave saddle point problems with the advantage that the linear operators are "decoupled" from the convex functions. This reformulation allows to use primal-dual methods for the saddle point problems which do not assume any smoothness of the involved convex functionals. In this minisymposium, there will be talks about recent developments for primal-dual methods such as acceleration techniques, inexact evaluations and generalizations to non-linear operators.

Organizer: Dirk Lorenz, Institut für Analysis und Algebra, TU Braunschweig, Germany
Organizer: Thomas Pock, Institut for Computer Graphics and Vision, TU Graz, Austria

10:30-11:00 Rates of Convergence and Restarting Strategies
Antonin Chambolle, Ecole Polytechnique, CNRS, France

11:00-11:30 Adaptive Methods for Large Scale Optimization
Tom Goldstein, Rice University, USA

11:30-12:00 A Generalization of the Chambolle-Pock Algorithm to Banach Spaces with Application to Inverse Problems
Carolin Homann, University of Göettingen, Germany

12:00-12:30 The Linearized Bregman Method via Split Feasibility Problems
Dirk Lorenz, Institut für Analysis und Algebra, TU Braunschweig, Germany

Wednesday May 14

MS33
Models and Methods for Imaging through Turbulence
10:30 AM - 12:30 PM
WLB202

The focus of this minisymposium is the general problem of seeing through turbulent media of nonuniform density; for example the warm atmosphere or the oscillating surface of water. This is a wide field of research separated into a few sub-communities: astronomical seeing, underwater imaging, and long-distance surveillance over a hot terrain. Each of these problems has different challenges and constraints, but still there are many ideas that could be shared between them. The objective of this minisymposium is to bring together people of each of these backgrounds and discuss the differences and similarities between each turbulence model.

Organizer: Enric Meinhardt-Llopis, ENS Cachan, France

10:30-11:00 Atomic Models of Video Turbulence
Enric Meinhardt-Llopis, Ecole Normale Superieure de Cachan, France

11:00-11:30 Independent Components in Dynamic Refraction
Marina Alterman, Technion, Israel

11:30-12:00 Video Restoration of Turbulence Distortion
Yifei Lou, University of California Irvine, USA

12:00-12:30 A Geometric Method for Image Recovery Through Optical Turbulence
Mario Micheli, Department of Mathematics, University of Washington, USA

Wednesday May 14

MS38 Part I
Numerical Methods for Large-Scale Imaging Problems
10:30 AM - 12:30 PM
WLB208

The scope of this mini symposium is to show and discuss numerical methods for the solution of large-scale imaging problems based on, e.g., modern discretization schemes, splitting techniques, local adaptivity, and parallel computing.

Organizer: Eldad Haber, University of British Columbia Vancouver, Canada
Organizer: Lars Ruthotto, University of British Columbia, Vancouver, Canada

10:30-11:00 A Multigrid Solver for Hyperelastic Image Registration
Lars Ruthotto, University of British Columbia, Canada

11:00-11:30 Preconditioned Splitting for Large-Scale Biomedical Imaging
Christoph Brune, University of Münster, Germany

11:30-12:00 Large-Scale Image Reconstruction for Quantitative Susceptibility Mapping Applications
Julianne Chung, Virginia Tech, USA

12:00-12:30 Designing Optimal Regularized Inverse Matrices for Inverse Problems
Matthias Chung, Virginia Tech, USA

Wednesday May 14

MS39 Part III
Challenges in Inverse Problems for Imaging
10:30 AM - 12:30 PM
WLB104

A key issue in imaging inverse problems is the correct choice of image priors (regularisation functionals) and data models (fidelity terms). Several strategies for conceiving optimization problems, combining prior and data information, have been considered. Let us evoke statistically grounded methods, adaptive regularization, dictionary learning, bilevel optimization, among others. All these approaches vary in their philosophy and mathematics. In spite of the achievements, there are more open questions than really satisfying answers. This minisymposium should constitute a platform for an exchange between researchers working on these problems from different points of view.

Organizer: Mila Nikolova, CNRS - ENS Cachan, France
Organizer: Carola-Bibiane Schönlieb, Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, UK

10:30-11:00 Discrete Regularisation Approaches Related to Inverse Diffusion
Martin Welk, Private University for Medical Informatics and Technology (UMIT), Austria

11:00-11:30 Meta-learning for Parameter Choice in Image Denoising
Valeriya Naumova, Austrian Academy of Sciences, Austria

11:30-12:00 Fast and Sparse Noise Learning via Nonlinear PDE Constrained Optimization
Luca Calatroni, University of Cambridge, UK

12:00-12:30 Blind Denoising
Marc Lebrun, CNRS - ENS Cachan, France

Wednesday May 14

MS41 Part I
Advances in Electrical Impedance Tomography
10:30 AM - 12:30 PM
AAB201

Electrical Impedance Tomography (EIT) is an imaging modality based on probing an unknown body with electric currents and measuring the resulting voltages at the boundary of the body. EIT is attractive for many applications, including medical imaging, since the measurements can be made with cost-effective equipment and without harming living tissue. However, the image formation problem of EIT is a hard inverse problem because of its nonlinearity and extreme ill-posedness. This mini-symposium presents recent breakthroughs in theoretical, computational and practical aspects of EIT.

Organizer: Samuli Siltanen, University of Helsinki, Finland
Organizer: Jennifer L Mueller, Department of Mathematics, Colorado State University, USA
Organizer: Simon Arridge, University College London, UK

10:30-11:00 The Factorization Method for Three Dimensional EIT
Nicolas Chaulet, University College London, UK

11:00-11:30 Multifrequency EIT Using Spectral Information
Emma Malone, University College London, UK

11:30-12:00 Non-Destructive Testing of Concrete with EIT
Aku Seppänen, University of Eastern Finland, Kuopio, Finland

12:00-12:30 Combining Frequency-difference and Ultrasound-modulated EIT
Bastian Harrach, University of Stuttgart, Germany

Wednesday May 14

MS49 Part I
Methods, Computations, and Applications of Contemporary Dynamical Medical Imaging
10:30 AM - 12:30 PM
WLB204

Dynamic medical imaging such as 4D or real-time MRI/CT is of significant importance in current medical diagnosis and therapy. In this imaging modality, a sequence of images are acquired to continuously monitor the dynamic activities of human body, for instance, respiratory motion and metabolic process. However, insufficient measurements and large data size in this problem pose a lot of challenges. To improve image quality and processing efficiency, new methods and computational techniques need to be developed, particularly by exploring the spatial/temporal correlations between images due to amplitude variation and geometric deformation. This mini-symposium is to stimulate discussions on the methods, computations and applications in dynamic medical imaging, and facilitate research-clinic collaborations in this emerging field.

Organizer: Xun Jia, Department of Radiation Medicine and Applied Sciences, University of California San Diego, USA
Organizer: Xiaojing Ye, Department of Mathematics and Statistics, Georgia State University, USA

10:30-11:00 Dynamical CT Image Processing in Radiation Oncology
Xun Jia, University of California San Diego, USA

11:00-11:30 Patch-Based Low-Rank and Sparsity Penalty for Dynamic Imaging
Jong Chul Ye, KAIST, Korea

11:30-12:00 Dynamic Shape and Motion Estimation Under Inconsistent Contrast and Low SNR Conditions
Dan Ruan, UCLA, USA

12:00-12:30 Exploring Compressed Sensing Optimization for Total-Variation based Four-Dimensional Cone-Beam CT
Hua Zhang, Netherlands Cancer Institute, Netherlands

Wednesday May 14

MS50 Part I
Parallel and Distributed Computation in Imaging
10:30 AM - 12:30 PM
WLB209

Advantages in data sensing and collecting technology has led to a deluge of visual and multimedial data. However, the collecting and processing of these data types require an enormous computational effort, often too high for single processor architectures. The decentralized or distributed collection and storage of the data is desirable, and parallel and distributed algorithms are being developed on these distributed systems. This minisymposium collects together some of these exciting new directions with applications in imaging.

Organizer: Ming Yan, UCLA, USA
Organizer: Wotao Yin, UCLA, USA

10:30-11:00 Parallel and Distributed Sparse Optimization
Ming Yan, UCLA, USA

11:00-11:30 Hydra: Distributed Coordinate Descent for Big Data Problems
Peter Richtárik, University of Edinburgh, UK

11:30-12:00 Communication-Efficient Algorithms for Distributed Optimization
João Mota, University College London, UK

Wednesday May 14

MS54 Part II
Optimization in Imaging: Algorithms, Applications and Theory
10:30 AM - 12:30 PM
DLB712

Optimization has been playing an important role in various imaging processing areas; and we have witnessed very active interaction between these two disciplines. This mini-symposium aims to bring together experts to exchange ideas and discuss the most recent advances in optimization techniques for image processing problems. Relevant progresses on algorithmic design, application and theory at the interface of optimization and imaging are all welcome.

Organizer: Xiaojun Chen, The Hong Kong Polytechnic University, Hong Kong
Organizer: Xiaoming Yuan, Hong Kong Baptist University, Hong Kong

10:30-11:00 Functional-Analytic and Numerical Issues in Splitting Methods for Total Variation-based Image Reconstruction
Michael Hintermueller, Humboldt-Universität zu Berlin, Germany

11:00-11:30 Exact Recovery for Sparse Signal via Weighted L1 Minimization
Naihua Xiu, Department of Applied Mathematics, Beijing Jiaotong University, China

11:30-12:00 A Nonmonotone Approximate Sequence Algorithm for Unconstrained Nonlinear Optimization
Maryam Yashtini, Department of Mathematics, University of Florida, USA

12:00-12:30 Proximal Linearized Alternating Direction Method for Image Restoration
Sangwoon Yun, Sungkyunkwan University, Korea

Wednesday May 14

MS57 Part V
Modeling and Algorithms for Imaging Problems
10:30 AM - 12:30 PM
DLB719

In recent years mainland China has many new developments in modeling and algorithms in imaging sciences. The objectives of this mini-symposium are to bring mainland China researchers in this field together to present their recent research work, to exchange ideas, and explore future collaborations. The topics of this mini-symposium were the latest development of modeling, algorithms and their applications in real-world imaging problems such as image denoising, deblurring, inpainting, decomposition, segmentation, and super-resolution reconstruction, etc. This minisymposium can provide a forum to stimulate discussions and establish collaborations between young Chinese researchers for further developments in this emerging imaging sciences research.

Organizer: Fang Li, Department of Mathematics, East China Normal University, China
Organizer: Huanfeng Shen, School of Resource and Environmental Science, Wuhan University, China
Organizer: Wei Wang, Department of Mathematics, Tongji University, China
Organizer: Xile Zhao, School of Mathematical Sciences, University of Electronic Science and Technology of China, China

10:30-11:00 Study on Relationship Between System Matrix and Reconstructed Image Quality in Iterative Image Reconstruction
Jianfeng He, Kunming University of Science and Technology, China

11:00-11:30 A Universal Variational Framework for Sparsity Based Image Inpainting
Fang Li, East China Normal University, China

11:30-12:00 Image Restoration and Segmentation Based on a

Bilaterally Constrained Hybrid Total-Variation-Type Model
Zhi-Feng Pang, Henan University, China

12:00-12:30 A New Variational Model for Image Segmentation
Ling Pi, Shanghai Jiao Tong University, China

Wednesday May 14

MS59
Spectral Geometry in Manifold Analysis - Theory and Applications
10:30 AM - 12:30 PM
`WLB205`

Geometric computational tools serve in a wide range of applications in the fields of computer vision, graphics, machine learning and pattern recognition. In signal processing operating in the Fourier domain is a classic that can be generalized to Riemannian manifolds. The eigenfunctions set of the Laplace Beltrami operator is a non-Euclidean analog to the Fourier basis that allows us to analyze information on manifolds. In this mini-symposium we review the foundations of spectral analysis, explore the latest results in constructing invariant metrics, and construct invariant eigen-structures.

Organizer: Dan Raviv, MIT, USA

10:30-11:00 Scale, Equi-Affine and Affine Invariant Metrics
Dan Raviv, MIT, USA

11:00-11:30 Computational Metric Geometry in the Natural Space
Ron Kimmel, Technion-Israel Institute of Technology, Israel

11:30-12:00 Building Compatible Bases on Graphs, Images and Manifolds
Davide Eynard, Faculty of Informatics, Università della Svizzera italiana, Switzerland

12:00-12:30 Sparse Models in Shape Analysis
Alexander M. Bronstein, Tel Aviv university, Israel

Wednesday May 14

Lunch
12:30 PM - 1:30 PM

`Multi-purpose Hall, Level 2, Madam Kwok Chung Bo Fun Sports and Cultural Centre (SCC)`

SIAG on Imaging Sciences Prize Lecture
1:30 PM - 2:15 PM
Chair: Naoki Saito, Department of Mathematics, University of California, Davis, USA

Prize Paper: A. M. Bruckstein, D. L. Donoho, and M. Elad: From Sparse Solutions of Systems of Equations to Sparse Modeling of Signals and Images, SIAM Review, Vol. 51, no. 1, pp. 34-81, 2009
Alfred M. Bruckstein, Technion, Israel

`Tsang Chan Sik Yue Auditorium, 2/F Academic and Adminstration Building`

Coffee Break
2:15 PM - 2:45 PM
`3/F Podium, Academic and Administration Building`

Wednesday May 14

MS01 Part II

Beyond Single Shot Imaging: Academic and Industrial Points of View

2:45 PM - 4:45 PM

`WLB210`

With the advent of computational imaging, the frontiers between optics, electronics and image processing are becoming thinner: in modern image acquisition devices, all three elements are viewed as a whole that should be optimized jointly. In particular modern cameras tend to take bursts of images that are jointly restored, thus allowing to go beyond the physical limitations of single-shot sensors (dynamic range, resolution, noise, blur, specularities, over-exposure). As a counterpart, multi-image restoration faces specific challenges (motion, outliers, illuminant modifications, etc.), that are being addressed by industry and academia using innovative tools from applied mathematics and image processing.

Organizer: Andrés Almansa, LTCI, Telecom ParisTech, CNRS, France
Organizer: Julie Delon, MAP5, Université Paris Descartes, CNRS, France
Organizer: Pablo Musé, IIE, Fac. de Ingeniería, Universidad de la República, Uruguay

14:24-15:15 Disparity-Guided Demosaicing for Plenoptic Images
Neus Sabater, Technicolor Research and Innovation, France

15:15-15:45 Co-Design of a 3D Chromatic Camera
Pauline Trouvé, ONERA, France

15:45-16:15 Optical Matrix Probing for Photography and Videography
Kyros Kutulakos, University of Toronto, Canada

16:15-16:45 Adaptive Sensing and Reconstruction Techniques for CS-Video Applications
Patrick Llull, Duke University, USA

Wednesday May 14

MS09

New Trends in Histogram Processing

2:45 PM - 4:45 PM

`WLB104`

Histogram processing is one of the most important image processing tools with various applications such as contrast enhancement, segmentation, watermarking, texture synthesis and processing, pattern recognition, image retrieval, and so on. Even though a histogram is easy to compute, it gives rise to quite involved mathematical problems in the context of particular imaging tasks. This mini-symposium will be a platform for exchanges among the different applications by bringing together a selection of researchers working on this topic from very different points of views.

Organizer: Mila Nikolova, CMLA, CNRS and ENS de Cachan, France
Organizer: Raymond H. Chan, Department of Mathematics, The Chinese University of Hong Kong, Hong Kong, China

14:45-15:15 A Convex Formulation for Global Histogram Based Binary Segmentation
Jean-François Aujol, Université Bordeaux 1, France

15:15-15:45 Sliced Wasserstein Distance for Histograms Matching
Julien Rabin, CNRS-ENSICAEN-Université de Caen, France

15:45-16:15 Histogram Specification of Color Images Using a Variational Framework
Youwei Wen, Kunming University of Science and Technology, China

16:15-16:45 Two Stage Image Segmentation and Histogram Clustering
Tieyong Zeng, Hong Kong Baptist University, Hong Kong

Wednesday May 14

MS15

Applications of Splitting Methods to Nonconvex Problems in Imaging Science

2:45 PM - 4:45 PM

`WLB205`

Primal dual methods and operator splitting techniques are widely used in imaging science for solving convex nondifferentiable models. There are many recent examples of similar methods being successfully used to solve nonconvex problems, but they often have much weaker convergence guarantees. In this minisymposium we are interested in discussing some of these examples in order to develop better intuition for applying splitting methods to nonconvex problems.

Organizer: Ernie Esser, Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia Vancouver, Canada
Organizer: Xiaoqun Zhang, Department of Mathematics and Institute of Natural Sciences, Shanghai Jiao Tong University, China

14:45-15:15 Solving DC Programs that Promote Group 1-Sparsity
Ernie Esser, University of British Columbia Vancouver, Canada

15:15-15:45 Compressed Modes for Variational Problems in Math and Physics
Rongjie Lai, University of California, Irvine, USA

15:45-16:15 Alternating Direction Methods for Classical and Ptychographic Phase Retrieval
Zaiwen Wen, Peking University, China

16:15-16:45 Total Variation Structured Total Least Squares Method for Image Restoration
Xile Zhao, University of Electronic Science and Technology of China, China

Wednesday May 14

MS18 Part II

Super-Resolution: Theoretical and Numerical Aspects

2:45 PM - 4:45 PM

WLB211

The goal of this mini-symposium (split into two parts) is to present state of the art results, on both theoretical guarantees and numerical algorithms, for inverse problems regularization using low complexity models (sparsity, bounded variation, low rank, etc.). These results attempt to bridge the gap between the surprising efficiency of recent regularization methods, and our theoretical understanding of their super-resolution effectiveness. While many theoretical guarantees rely on uniform analysis with with hypotheses requiring randomness or global incoherence of the measurements, real-life problems in imaging sciences (e.g. deconvolution, tomography, MRI, etc.) require more intricate theoretical tools and algorithms to capture the geometry of signals and images that can be stably recovered. This includes for instance variational methods over spaces of measures (e.g. sum of Dirac measures, bounded variation functions, etc.) and the development of novel recovery algorithms that can cope with the strong coherence of the measurement operator. The mini-symposium will gather talks by leading experts in the field.

Organizer: Jalal Fadili, CNRS-ENSICaen, Caen, France
Organizer: Gabriel Peyré, CNRS and Université Paris-Dauphine, Paris, France

14:45-15:15 Beyond Incoherence and Beyond Sparsity: Compressed Sensing in the Real World
Ben Adcock, Purdue University, USA

15:15-15:45 The MUSIC Algorithm for Well-Separated Objects: A Sensitivity Analysis
Wenjing Liao, Duke University, USA

15:45-16:15 Sparse and Cosparse Tomographic Recovery from Few Projections
Stefania Petra, University of Heidelberg, Germany

Wednesday May 14

MS19 Part II

Wave-based Imaging

2:45 PM - 4:45 PM

WLB207

Wave-based imaging is an interdisciplinary area in applied mathematics, with roots in hyperbolic partial differential equations, probability theory, statistics, optimization, and numerical analysis. This minisymposium will present some of the latest advances in this area including source and reflector imaging in random media with arrays, imaging with cross correlation techniques, imaging through the turbulent atmosphere, and imaging methods based on spectral decompositions of the scattering operator.

Organizer: Knut Sølna, University of California at Irvine, USA
Organizer: Josselin Garnier, Paris Diderot University, France

14:45-15:15 Correlation-based Imaging in Random Media in the Paraxial Regime
Josselin Garnier, Paris Diderot University, France

15:15-15:45 Selective Imaging of Extended Reflectors in Waveguides
Chrysoula Tsogka, University of Crete, Greece

15:45-16:15 Elastic-wave Tomography and Inverse Scattering with Passive Sources
Maarten V. de Hoop, Purdue University, USA

Wednesday May 14

MS24 Part II
Color Perception and Image Enhancement
2:45 PM - 4:45 PM
WLB109

Color perception is an important part of human vision. Color image research has advanced by using nonlinear color spaces such as HSV/HSI and chromaticity. This minisymposium focuses on color perception and enhancement. A common color enhancement strategy involves using a global or adaptive histogram specification and generalizing it to color channels. These processes are highly non-trivial and have to cope with the gamut problem. Other approaches are based, e.g., on variational methods with perceptually inspired energy functionals. The minisymposium aims to bring together scientists presenting different new approaches and discussing new research challenges.

Organizer: Sung Ha Kang, School of Mathematics Georgia Institute of Technology, USA
Organizer: Gabriele Steidl, Technische Universität Kaiserslautern, Germany

14:45-15:15 A Wavelet-Based Framework for Perceptually-Inspired Color Enhancement
Edoardo Provenzi, Institute Mines Télécom ParisTech, France

15:15-15:45 Color Contrast Enhancement: Some Classical and Some New Methods
Ana Beln Petro Balaguer, University of the Balearic Islands, Spain

15:45-16:15 The Color of Texture - Analysis based on the Total-Variation Transform
Guy Gilboa, Technion - IIT, Israel

16:15-16:45 A Variational Histogram Equalization Method for Image Contrast Enhancement
Wei Wang, Tongji University, China

Wednesday May 14

MS27 Part II
High Frequency Wave Propagation and Related Imaging Problems
2:45 PM - 4:45 PM
AAB606

Wave propagation and related inverse problems are essential for many different applications. Recently a variety of numerical methods and algorithms have been proposed for wave motion and related inverse problems. The related imaging problems include but not limited to traveltime tomography, boundary rigidity problems, seismic migration and inversion, and so on. This multi-session minisymposium will examine recent advances on the above fronts and related applications.

Organizer: Jianliang Qian, Department of Mathematics, Michigan State University, USA
Organizer: Shingyu Leung, The Hong Kong University of Science and Technology, Hong Kong
Organizer: Songting Luo, Iowa State University, USA

14:45-15:15 Adaptive Phase Space Method for Traveltime Tomography
Eric Chung, The Chinese University of Hong Kong, Hong Kong

15:15-15:45 Long-time Stability and Convergence of the Uniaxial Perfectly Matched Layer Method for Time-domain Acoustic Scattering Problems
Xinming Wu, Fudan University, Shanghai, China

15:55-16:15 Joint Transmission and Reflection Traveltime Tomography for Reflector in Inhomogeneous Media Using First Arrivals
Wenbin Li, The Hong Kong University of Science and Technology, Hong Kong

16:45-16:45 Efficient Numerical Method for Helmholtz Equation with High Wave Number and its Application in Seismic Imaging Problem
Wenyuan Liao, University of Calgary, Canada

Wednesday May 14

MS30 Part II
First-Order Primal-Dual Methods for Convex Optimization
2:45 PM - 4:45 PM
WLB103

Many tasks in image processing can be treated by considering appropriate convex minimization problems. A common feature of these problems is that they often involve convex functionals for which the proximal operators are easily available and that the linear operators which are involved are not (stably) invertible but simple and fast to evaluate. The convex optimization problems can often be transformed into convex-concave saddle point problems with the advantage that the linear operators are "decoupled" from the convex functions. This reformulation allows to use primal-dual methods for the saddle point problems which do not assume any smoothness of the involved convex functionals. In this minisymposium, there will be talks about recent developments for primal-dual methods such as acceleration techniques, inexact evaluations and generalizations to non-linear operators.

Organizer: Dirk Lorenz, Institut für Analysis und Algebra, TU Braunschweig, Braunschweig, Germany
Organizer: Thomas Pock, Institut for Computer Graphics and Vision, TU Graz, Austria

14:45-15:15 A Primal-Dual Approach for Solving Optimization Problems Based on Information Measures
Mireille El Gheche, Université Paris-Est, France

15:15-15:45 An Inertial Forward-Backward Algorithm for Solving Monotone Inclusions
Thomas Pock, Graz University of Technology, Austria

15:45-16:15 Extending the Method of Chambolle and Pock to Non-Linear Operators
Tuomo Valkonen, University of

Cambridge, UK

16:15-16:45 Convergence Analysis of Accelerated Forward-Backward Algorithm with Errors
Silvia Villa, Istituto Italiano di Tecnologia, Italy

Wednesday May 14

MS34
Imaging Through Strong Turbulence
2:45 PM - 4:45 PM
WLB202

Obtaining full resolution performance of an imaging system when viewing through the Earth?s atmosphere requires careful mitigation of the turbulence-induced aberration in the observed wave front. This is typically achieved through the use of adaptive optics (AO) followed by computational post processing, such as multi-frame blind deconvolution (MFBD) methods. Although AO and MFBD techniques work well in low turbulence situations, they are much less effective in high turbulence, when the seeing conditions are very poor. The talks in this mini-symposium address recent developments in mathematical models and computational methods for imaging through strong atmospheric turbulence.

Organizer: James G. Nagy, Emory University, USA
Organizer: Stuart M. Jefferies, University of Hawaii, USA

14:45-15:15 A Phase Model for Point Spread Function Estimation in Ground-based Astronomy
Wenxing Zhang, University of Electronic Science and Technology of China, China

15:15-15:45 Uniqueness Results for Reconstruction of Imagery Degraded by Atmospheric Turbulence
Brandoch Calef, The Boeing Company, USA

Wednesday May 14

MS38 Part II
Numerical Methods for Large-Scale Imaging Problems
2:45 PM - 4:45 PM
WLB208

The scope of this minisymposium is to show and discuss numerical methods for the solution of large-scale imaging problems based on, e.g., modern discretization schemes, splitting techniques, local adaptivity, and parallel computing.

Organizer: Eldad Haber, University of British Columbia Vancouver, Canada
Organizer: Lars Ruthotto, University of British Columbia, Canada

14:45-15:15 Large-Scale Image Reconstruction with TV Priors
Martin Burger, Westfälische Wilhelms Universität (WWU) Münster, Germany

15:15-15:45 Brain Atlas Creation Using Image Registration and Restoration
Kanglin Chen, Fraunhofer MEVIS Lübeck, Germany

15:45-16:15 Nonlinear Image Registration with Sliding Motion Constraints
Alexander Derksen, Fraunhofer MEVIS Lübeck, Germany

16:15-16:45 Advances in 3D Electromagnetic Imaging
Eldad Haber, Department of Earth and Ocean Sciences University of British Columbia, Canada

Wednesday May 14

MS41 Part II
Advances in Electrical Impedance Tomography
2:45 PM - 4:45 PM
AAB201

Electrical Impedance Tomography (EIT) is an imaging modality based on probing an unknown body with electric currents and measuring the resulting voltages at the boundary of the body. EIT is attractive for many applications, including medical imaging, since the measurements can be made with cost-effective equipment and without harming living tissue. However, the image formation problem of EIT is a hard inverse problem because of its nonlinearity and extreme ill-posedness. This mini-symposium presents recent breakthroughs in theoretical, computational and practical aspects of EIT.

Organizer: Samuli Siltanen, University of Helsinki, Finland
Organizer: Jennifer L Mueller, Department of Mathematics, Colorado State University, USA
Organizer: Simon Arridge, University College London, UK

14:45-15:15 Anatomical and Physiological Priors for Absolute EIT Thorax Images
Erick León, University of São Paulo, Brazil

15:15-15:45 A Novel Data-Driven Edge Sharpening D-bar Reconstruction Algorithm for Electrical Impedance Tomography
Sarah J. Hamilton, University of Helsinki, Finland

15:45-16:15 Stochastic Galerkin Finite Element Method for Electrical Impedance Tomography
Nuutti Hyvönen, Aalto University, Finland

Wednesday May 14

MS42
Statistical Techniques on Riemannian Manifolds for Analysis of Imaging Data
2:45 PM - 4:45 PM
WLB206

Imaging data represents observations of objects and their structures in observed scenes. The tools for analyzing structures and their associated variability in different imaging contexts naturally come from a combination of geometry and statistics. These tools are especially important because despite high-dimensionality, imaging data usually represents low-dimensional underlying variability which, if harnessed properly, can lead to efficient image analysis procedures. In recent year, the emerging area of statistical inferences on nonlinear manifolds has helped advance ideas in image understanding and computer vision using concrete algorithms. This minisymposium will feature four presentations that will describe the latest advances in this area. The topics of these talks range from manifold regression and statistical peak detection in images to high- and ultra-high dimensional data analysis.

Organizer: Anuj Srivastava, Florida State University, USA

14:45-15:15 A Riemanian Framework for Parametric and Nonparametric Spherical Regression
Anuj Srivastava, Florida State University, USA

15:15-15:45 High-dimensional Manifold Valued Data Analysis
Ian Dryden, University of Nottingham, UK

15:45-16:15 SS-SPMs: Spatially Smoothing Statistical Parametric Maps for Ultra-High Dimensional Imaging Data
Hongtu Zhu, University of North Carolina, USA

16:15-16:45 Statistical Peak Detection in Images
Dan Cheng, North Carolina State University, USA

Wednesday May 14

MS49 Part II
Methods, Computations, and Applications of Contemporary Dynamical Medical Imaging
2:45 PM - 4:45 PM
WLB204

Dynamic medical imaging such as 4D or real-time MRI/CT is of significant importance in current medical diagnosis and therapy. In this imaging modality, a sequence of images are acquired to continuously monitor the dynamic activities of human body, for instance, respiratory motion and metabolic process. However, insufficient measurements and large data size in this problem pose a lot of challenges. To improve image quality and processing efficiency, new methods and computational techniques need to be developed, particularly by exploring the spatial/temporal correlations between images due to amplitude variation and geometric deformation. This mini-symposium is to stimulate discussions on the methods, computations and applications in dynamic medical imaging, and facilitate research-clinic collaborations in this emerging field.

Organizer: Xun Jia, Department of Radiation Medicine and Applied Sciences, University of California San Diego, USA
Organizer: Xiaojing Ye, Department of Mathematics and Statistics, Georgia State University, USA

14:45-15:15 A Hybrid 4D Cone Beam CT Reconstruction Algorithm for Highly Under-Sampled Projections from the 1-minute Cone Beam Scan
Xin Zhen, Southern Medical University, China

15:15-15:45 Motion-compensated Cone-Beam CT for Image-Guided Radiotherapy
Simon Rit, Université de Lyon, INSA-Lyon, Centre Léon Bérard, France

15:45-16:15 3D/4D Imaging Verification Using Digital

Tomosynthesis (DTS)
You Zhang, Department of Radiation Oncology, Duke University Medical Center, USA

Wednesday May 14

MS50 Part II
Parallel and Distributed Computation in Imaging
2:45 PM - 4:45 PM
`WLB209`

Advantages in data sensing and collecting technology has led to a deluge of visual and multimedial data. However, the collecting and processing of these data types require an enormous computational effort, often too high for single processor architectures. The decentralized or distributed collection and storage of the data is desirable, and parallel and distributed algorithms are being developed on these distributed systems. This minisymposium collects together some of these exciting new directions with applications in imaging.

Organizer: Ming Yan, UCLA, USA
Organizer: Wotao Yin, UCLA, USA

14:45-15:15 The Decentralized Gradient Descent Method for Multi-Agent Optimization
Qing Ling, University of Science and Technology of China, China

15:15-15:45 Consistency of Early Stopping Regularization in Linearized Bregman Algorithms
Yuan Yao, Peking University, China

Wednesday May 14

MS57 Part VI
Modeling and Algorithms for Imaging Problems
2:45 PM - 4:45 PM
`DLB719`

In recent years mainland China has many new developments in modeling and algorithms in imaging sciences. The objectives of this mini-symposium are to bring mainland China researchers in this field together to present their recent research work, to exchange ideas, and explore future collaborations. The topics of this mini-symposium were the latest development of modeling, algorithms and their applications in real-world imaging problems such as image denoising, deblurring, inpainting, decomposition, segmentation, and super-resolution reconstruction, etc. This minisymposium can provide a forum to stimulate discussions and establish collaborations between young Chinese researchers for further developments in this emerging imaging sciences research.

Organizer: Fang Li, Department of Mathematics, East China Normal University, China
Organizer: Huanfeng Shen, School of Resource and Environmental Science, Wuhan University, China
Organizer: Wei Wang, Department of Mathematics, Tongji University, China
Organizer: Xile Zhao, School of Mathematical Sciences, University of Electronic Science and Technology of China, China

14:45-15:15 Point Set Registration under Lie Group Framework
Yaxin Peng, Shanghai University, China

15:15-15:45 On Decomposition-Based Block Preconditioned Iterative Methods for Half-Quadratic Image Restoration
Yumei Huang, Lanzhou University, China

15:45-16:15 Digital Inpainting of Remote Sensing Images

Huanfeng Shen, Wuhan University, China

16:15-16:45 Ensemble Learning for Remote Sensing Image Processing

Peijun Du, Nanjing University, China

Wednesday May 14

Conference Banquet
6:00 PM - 9:30 PM

Central City Hall Maxim's Palace, 2/F, Low Block, City Hall, Central, Hong Kong

Abstracts of Minisymposia Talks

MS01 Part I
Simultaneous HDR Image Reconstruction and Denoising for Dynamic Scenes

High dynamic range (HDR) images are usually obtained from multiple photographs with different exposures. Irradiance is estimated combining, for each pixel, different exposure values at the same position; hence the scene must remain unchanged and images must be perfectly aligned. The proposed HDR generation method selects a reference image and estimates irradiance using a patch-based approach. This exploits image redundancy, generating HDR images that show higher PSNRs and are robust to misalignments and objects motion.

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MS01 Part I
How to Trade Signal Sparsity for Outlier Resistance in Convex Reconstruction from Linear Measurements?

We study a convex variational model for reconstructing a sparse solution from linear (noisy) measurements, which may be contaminated by sparse outlier noise. We show that (under certain hypothesis that use generalized RIP and NSP conditions) a perfect reconstruction happens whenever the sum of the signals sparsity and the number of outliers is less than a constant, which depends on the regularization parameter. An application to multi-image super-resolution is presented.

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MS01 Part I
Foreground and Background Reconstruction in High-Speed Photon-Limited Motion Imagery

Image foreground and background separation is an essential step in a variety of image processing, video analysis, and computer vision tasks. Typically, these methods accept streaming video data, compute an estimate of the background, and subtract this from the observed frames to generate a foreground scene. While such methods are very effective in high SNR regimes, they face serious limitations in low-light settings occurring in night vision surveillance and astronomy. Existing methods cannot be easily modified to yield good results. Therefore, new methods must be created to specifically deal with the low light setting. This work specifically addresses the problem of foreground and background separation and reconstruction in the case of Poisson distributed observations. The proposed approach builds upon recent advances in both the online learning community and sparse reconstruction methods for Poisson images. To aid in the reconstruction and separation tasks, the method learns and incorporates the dynamics of objects in both the background and foreground in real time. This is joint work with Eric Hall.

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MS01 Part I
Color Transfer Between Close Views of the Same Scene

In a number of situations, such as stereoscopic 3D cinema or exposure bracketing pictures, there is the need of matching the colors of an image to those of another, similar view that is taken as reference. In this talk we propose a general variational approach for solving this kind of problem. The variational formulation affords a mathematically sound model, the implementation is efficient, and the results show improvement over the state of the art.

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MS01 Part II
Disparity-Guided Demosaicing for Plenoptic Images

Plenoptic cameras capture the 4D light rays of a scene thanks to an array of microlenses placed between the sensor and the main lens. A new algorithm for view demosaicing that is performed after demultiplexing is proposed for plenoptic images. Our method estimates the disparity maps between the multiple views and use them to compute full RGB pixel values. Iterating this process (disparity estimation and demosaicing) leads to demosaiced views without cross-talk image artifacts.

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MS01 Part II
Co-Design of a 3D Chromatic Camera

We present the design of a 3D camera that produces a depth map from a color image using depth from defocus (DFD). We have shown that depth estimation performance could be improved using a chromatic lens and a dedicated DFD algorithm. Then we have developed an end-to-end performance model to predict depth estimation accuracy of any DFD camera and used it to optimize the optical and processing parameters of a chromatic camera.

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MS01 Part II
Optical Matrix Probing for Photography and Videography

I will discuss a new family of cameras that record just a fraction of the light coming from a controllable source, based on the actual 3D path it followed. Live video captured this way offers an unconventional view of everyday scenes in which scattering, refraction and other phenomena can be selectively blocked or enhanced, visual structures too subtle to notice with the naked eye become apparent, and object appearance can depend on depth.

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Matthew O'Toole Department of Computer Science, University of Toronto, Canada motoole@cs.toronto.edu

MS01 Part II
Adaptive Sensing and Reconstruction Techniques for CS-Video Applications

We build the coded aperture compressive temporal imaging (CACTI) system for video compressive sensing, by capturing the video at a low frame-rate ($\sim$ 30fps), to obtain high frame-rate videos ($>$ 300fps) via computation. Different reconstruction algorithms are investigated and here we show one optimization method, the generalized alternating projection (GAP) algorithm, and one dictionary learning method, the Gaussian mixture model(GMM) based algorithm. Furthermore, we develop a real-time adaptive temporal compressive sensing algorithm for video with CACTI as an example.

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MS02
Universal Inversion Formulas for Recovering a Function from Spherical Means

The problem of reconstruction a function from spherical means is at the heart of several modern imaging modalities and other applications. In this talk we derive universal back-projection type reconstruction formulas for recovering a function in arbitrary dimension from averages over spheres centered on the boundary an arbitrarily shaped bounded convex domain with smooth boundary. Provided that the unknown function is supported inside that domain, the derived formulas recover the unknown function up to an explicitly computed integral operator. For elliptical domains the integral operator is shown to vanish and hence we establish exact inversion formulas for recovering a function from spherical means centered on the boundary of elliptical domains in arbitrary dimension.

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MS02 Part I
Modelling Quantitative Photoacoustic Sectional Imaging

We study how photoacoustic imaging can be used to obtain sectional imaging data.
Hereby, the laser, which induces the photoacoustic effect, is focussed onto a single slice of the object, so that ideally only this slice produces an acoustic signal. However, since it is unavoidable that light scattering causes an extended illumination region, focussing detectors are used to measure the acoustic signal.
We present a mathematical model for this measurement setup and derive explicit reconstruction formulas for the absorption coefficient of the material.

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MS02 Part I
Efficient Reconstruction Algorithms for Inverse Problems in Quantitative Photoacoustic Imaging

Inverse problems in quantitative photoacoustic tomography (QPAT) aim at reconstructing physical parameters in the radiative transport equation or the diffusion equation from absorbed energy map inside the domain. We review here several efficient iterative and non-iterative reconstruction algorithms for QPAT in non-scattering media and highly scattering media that we have developed recently.

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MS02 Part I
Bayesian Image Reconstruction in Quantitative Photoacoustic Tomography

In quantitative photoacoustic tomography, distribution of optical parameters inside tissue are estimated from a photoacoustic image. This is an ill-posed problem and needs to be approached within the framework of inverse problems. In this work, the image reconstruction problem of quantitative photoacoustic tomography is considered in Bayesian framework. All variables are modelled as random variables and the posterior probability density of the parameters of primary interest is determined.

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MS02 Part II
Algebraic Image Reconstruction in Combined Space for Photoacoustic Tomography

In photoacoustic tomography, non-ideal tomographic data collection is common and often leads to image artifacts when closed-form reconstruction formulae are used. Algebraic reconstruction may be used to minimize such artifacts, but requires inverting extremely large model matrices when high resolution is sought. In this talk, a combined-space framework is presented under which the model matrix may be approximated by a set of smaller matrices that may be individually inverted, thus mitigating the computational burden of the inversion algorithm. The method is demonstrated on both numerically generated and experimental data.

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MS02 Part II
Compressed Sensing for High Resolution 3D Photoacoustic Tomography Using Data Sparsity

We present a new compressed sensing photoacoustic scanner based on optically addressed Fabry-Perot interferometer. Instead of slow raster acquisition the new scanner interrogates the whole sensor with a series of independent illumination patterns, each individual measurement being a scalar product of the illumination pattern and the acoustic field on the sensor. We discuss various aspects of compressed data acquisition and image reconstruction for this novel device on both simulated and real data.

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MS02 Part II
Photoacoustic Tomography Image Reconstruction in Heterogeneous Media

We review our recent advancements in image reconstruction approaches for PACT. Such advancements include physics-based models of the measurement process and associated inversion methods for reconstructing images from limited data sets in acoustically heterogeneous media. We also numerically investigate the problem of simultaneously reconstructing the optical and acoustic properties of an object from PACT measurement data. Applications of PACT to transcranial brain imaging and cancer detection will be presented.

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MS03
Structural Priors for Multimodality Diffuse Optical Tomography

We consider the incorporation of structural prior information into the regularization of diffuse optical tomography (DOT) problem. The approach is based on generalized Tikhonov regularization framework. Computational examples are given using simulated DOT data.

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MS03
Parallel Level Set Prior for Joint PET/MRI Reconstruction

Combined positron emission tomography and magnetic resonance imaging scanners allow us to simultaneously image structure and function of the human body. As function follows structure the two solutions of the two inverse problems are expected to show similar shapes. We will exploit this fact by modelling a joint prior which favours parallel level sets and hence similar structures. The results indicate that by utilizing the intrinsic shared structure both solutions can be significantly improved.

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MS03
Structural Priors for Emission Tomography Reconstruction: Benefits and Risks

High-resolution anatomical information from magnetic resonance imaging (MRI) or computed tomography (CT) can be used during image reconstruction of positron emission tomography (PET) or single photon emission computed tomography (SPECT) data to yield images with enhanced resolution and improved image quality. A large variety of structural priors for emission tomography have been proposed in literature. Pros and cons of different methods will be discussed, example applications will be shown and possible pitfalls will be highlighted.

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MS03
Hidden States of Function and Anatomy

Multi-modality medical imaging tools are enabling the acquisition of rich information related to the complex structural and functional properties of human tissue. Making sense of such information poses new computational challenges spanning from modeling the imaging devices to understanding the underlying physiological processes. We describe a unified probabilistic framework based on finite hidden discrete states for the integration of multi-modal imaging information and its application to perfusion PET-MR imaging.

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MS04
Nonlinear Magnetic Resonance Velocity Imaging

Magnetic Resonance (MR) velocity imaging is a powerful tool to study the rheology of complex fluids. In this context, MR acquisitions allow to measure differences of complex phases, which are proportional to the velocity of the studied fluid. Therefore, the task of recovering a velocity field from these measurements involves the solution of a nonlinear inverse problem. In this talk we will present a nonlinear Bregman iteration method and compare it to state-of-the-art methods.

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MS04
Structural Health Monitoring in Anisotropic, Elastic Plates from Partial Boundary Measurements

The detection and monitoring of damages in anisotropic materials such as carbon fibre reinforced composites is of great importance. We consider elasticity models of thin, anisotropic plates which serve as waveguides and explore their ability to build a monitoring system. For that purpose, the inverse identification of material parameters and inverse source detection from boundary measurements are analyzed. Finally, we answer questions regarding existence and uniqueness of solutions of the underlying direct and inverse problems.

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MS04
Partially Blind Deblurring of Barcode from Out-of-focus Blur

We propose a partially blind deblurring method for barcode when partial knowledge is available. We model the PSF for the out-of-focus blur from geometrical optics. With the known information, we can estimate a low-dimensional representation of the PSF using the Levenberg-Marquardt algorithm. Once the PSF is obtained, the image deblurring is followed by quadratic programming by replacing the binary constraint with $[0, 1]$.

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MS04
Depth from Defocus

Using the fact that the amount of blurriness contains clues about the distance of an image region to the focal plane, we investigate the problem of reconstructing a depth map from differently focused images. Modeling the dependence of the blur operator on the distance of an object to the focal plane yields a highly non-linear inverse problem which we approach by a variational formulation that jointly finds the depth map as well as an all-in-focus image.

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MS05 Part I
Ground States and Singular Values for TV and L1-type Models

We introduce singular vectors for nonlinear variational problems in imaging, consisting of a quadratic fidelity and regularization like ℓ^1 or TV. Those are a systematic way to exact solution for such methods, including basically all previously known ones. All singular vectors can be reconstructed up to a scalar factor even in the presence of (small) noise, respectively with correct scale by Bregman iterations. Moreover, we discuss the notion of scale and bias introduced by our theory.

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MS05 Part I
K-edge Imaging - X-ray CT Goes Functional

The development of energy-resolved X-ray CT using photon-counting detectors has enabled a new dimension of X-ray CT, in particular selective imaging of contrast agents loaded with K-edge materials. A practical issue is the high noise levels often present in material-decomposed sinogram data. In this talk, K-edge imaging is introduced and the reconstruction problem is formulated within a multi-channel framework in which statistical correlations between material pre-processed sinograms are exploited to improve image quality.

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MS05 Part I
Optimization Methods for Total Generalized Variation Regularization

The recently introduced concept of Total Generalized Variation (TGV) provides a convex penalty functional which is able to regularize on different scales of smoothness. In particular, one can observe edge preservation as well as recovery of smooth regions, leading to high-quality results for variational image reconstruction problems. We present strategies for the numerical solution of variational problems regularized with TGV. It will turn out that first-order primal-dual algorithms are well-suited for this purpose. Several applications are discussed including denoising, inverse problems and compressed sensing. Additionally, a new method which allows to incorporate preconditioners is proposed and its benefits are shown in numerical experiments.

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MS05 Part I
Edge-Preserving Electrical Impedance Tomography

Electrical impedance tomography (EIT) is an imaging modality where an unkown body is probed with electric currents. The internal conductivity distribution is to be recovered from the current-to-voltage boundary measurements. EIT is a nonlinear and severely ill-posed problem. The so-called D-bar method regularizes EIT using a nonlinear low-pass filter. However, the resulting images are blurred as high frequencies are discarded in the inversion. This talk describes a new way to incorporate a priori information into the D-bar reconstruction so that edges are preserved.

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MS05 Part II
Exact Support Recovery for Sparse Spikes Deconvolution

In this talk, I will study sparse spikes deconvolution over the space of measures. For non-degenerate sums of Diracs, we show that, when the signal-to-noise ratio is large enough, total variation regularization of measure recovers the exact same number of Diracs, and that both the locations and the heights of these Diracs converge toward those of the input measure when the noise drops to zero. This is joint work with V. Duval.

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MS05 Part II
Aspects of the Total Generalised Variation (TGV) Minimisation Problem

Recently, there has been a lot of research regarding image reconstruction methods that preserve not only edges but smooth structures as well. Total Generalised Variation has produced remarkable results towards that direction. In this talk we examine properties of the analytical solutions of the one dimensional TGV denoising problem. We focus on the exact solutions for simple data functions and time permitting we will also discuss about ground states of the TGV functional.

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MS05 Part II
Fast Solvers for Non-convex Edge-preserving/Sparsifying $\mathbf{TV}^q$-regularizations, $q \in (0, 1)$, and Issues with Variable Splitting Approaches in $\mathbf{TV}(=\mathbf{TV}^1)$-regularization

Convex and non-convex total variation type regularization techniques and associated globally and locally superlinearly convergent solvers are presented. The TV^q-regularization results in a non-smooth and non locally Lipschitzian minimization task. Further, for the classical total variation problem issues with variable splitting techniques are addressed: In fact, it is demonstrated that while each step of a primal alternating minimization procedure may be well-defined, the overall target problem may not have a solution.

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MS05 Part II
Image Reconstruction in Fluorescence Diffuse Optical Tomography Using Patch-based Anisotropic Diffusion Regularisation

In [1] we introduced a split operator method to reconstruct fluorescence images fast and efficiently, using anisotropic diffusion regularisation and a priori anatomical information. We propose a modification, which consists in using patch-based anisotropic diffusion regularisation. We use compression methods to reduce the computational time. Results shown an improvement on the overall quality of the reconstructed images. ([1] T. Correia et al, Biomed. Opt. Exp. 2(9), 2632-2648 (2011).)

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MS06
Infimal-Convolution of Total-Variation-Type Functionals as Regularization for Video Reconstruction

A new regularization functional for image sequence reconstruction is proposed. In contrast to the still image setting, this is an open topic even for piecewise smooth image sequences. A main difficulty consists in treating the additional time dimension. Our approach is to consider image sequences as functions defined on a three-dimensional domain and to apply the infimal convolution of Total Variation type functionals (ICTV) with different gradient norms as regularization.

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MS06
Robust Video Restoration by Joint Sparse and Low Rank Matrix Approximation

In this talk, we presents a new video restoration scheme based on the joint sparse and low-rank matrix approximation. By grouping similar patches in the spatiotemporal domain, we formulate the video restoration problem as a joint sparse and low-rank matrix approximation problem. The resulted nuclear norm and ℓ_1 norm related minimization problem can also be efficiently solved by many recently developed numerical methods. The effectiveness of the proposed video restoration scheme is illustrated on two applications: video denoising in the presence of random-valued noise and video in-painting for archived films. The numerical experiments indicated the proposed video restoration method compares favorably against many existing algorithms.

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MS06
Non-Local Total Generalized Variation for Motion and Stereo Estimation

One of the most successful higher-order regularizers in the context of stereo and optical flow is Total Generalized Variation (TGV). In this work we propose a non-local extension for TGV models. We show that this new model can effectively combine segmentation cues with higher-order regularization. The proposed regularizer remains convex and hence it can be used as a replacement in existing motion and stereo models.

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MS06
Variational Approaches for Image Sequence Analysis and Reconstruction

Robust measures are introduced for methods to determine statistically uncorrelated or also statistically independent components spanning data which have been measured in a way that does not permit direct separation of these underlying components. Because of the nonlinear nature of the proposed methods, iterative methods are presented for the minimization of merit functions, and convergence of these methods is proved. Illustrative examples are presented to demonstrate the benefits of the robust approaches, and the benefits are presented for an application to the processing of dynamic medical imaging.

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MS07 Part I
Sparsity in Fluids - Vorticity Estimation via Compressive Sensing

This talk contributes to the fields of vortex methods for incompressible flows and compressive sensing for dynamic imaging. In recent years compressive sensing has been applied successfully to various imaging problems where sparsity in informative basis structures played a key role. In fluids, vortex methods (e.g. Rankine or Lamb-Oseen) were used to model the evolution of flows related to Navier-Stokes. The aim of this talk is to present a new model combining compressive sensing and vortex methods for fluid problems in imaging. Besides an analysis of approximations in the limiting case we will highlight numerical results for vorticity estimation in image sequences motivated by eddies in oceanic sciences.

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MS07 Part I
Improved Accuracy and Speed in Scanning Probe Microscopy by Image Reconstruction from Non-gridded Position Sensor Data

Scanning probe microscopy (SPM) has facilitated many scientific discoveries utilizing its strengths of spatial resolution, non-destructive characterization and realistic in situ environments. However, spacial accuracy is challenging for SPM at high frame rates. We present a new SPM technique, which we call sensor inpainting, that uses advanced image inpainting methods to render accurate images using position sensor data. This frees the scanning probe motion constraints and enables new techniques for high inertia nanopositioners of SPM.

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MS07 Part I
Image Interpolation with Optimal Transport

This talk is dedicated to the interpolation of images through optimal transport. We will present the use of first order convex optimization schemes to solve the discretized dynamic optimal transport problem, initially proposed by Benamou and Brenier in 2000. We show how proximal splitting schemes can deal with the L^2 optimal transport geodesic between distributions defined on a uniform spatial grid. We also show how more general cost functions can be taken into account and how to extend the method to perform optimal transport on a Riemannian manifold and deal with several image interpolation problems.

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MS07 Part I
Spatio-temporal Optical Flow on Evolving Surfaces

We extend the concept of optical flow with spatiotemporal regularisation to a dynamic non-Euclidean setting. Optical flow is traditionally computed from a sequence of flat images. In this talk we introduce variational motion estimation for images that are defined on an evolving surface. Volumetric microscopy images depicting a live zebrafish embryo serve as both biological motivation and test data.

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MS07 Part II
TGV-based Flow Estimation for 4D Cell Migration

Our aim is to track migrating leukocytes. Recent results have shown the advantages of the nonlinear and higher order terms of TGV-regularizers especially in static models for denoising and reconstruction. We present TGV-based models for flow estimation with the goal to get an exact recovery of simple flows and its implication on realistic tracking situations. To distinguish and quantify different pathways of migrating leukocytes, we use large scale 4D fluorescence live microscopy data in vivo.

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MS07 Part II
Nonlocal Crime Density Estimation Incorporating Housing Information

From discrete event locations, we model the relative probability of events in a spatial domain. Standard density estimation assigns positive probability to locations where events cannot realistically occur. When modeling residential burglaries this predicts burglaries occurring away from residences. To resolve this, we propose a nonlocal Maximum Penalized Likelihood Estimation that computes nonlocal weights from spatial data. We apply this method to residential burglary and housing data from San Fernando Valley.

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MS07 Part II
A Nonlinear Variational Approach to Motion-corrected Reconstruction of Density Images

We tackle the reconstruction problem of density images from indirect measurements with a novel variational approach: By implementing an appropriate modelling of the mass-conserving density transformation in the reconstruction process we obtain the first building block of our variational method. Suitable regularization for images with edges (total variation) and for reasonable deformations (hyperelastic) without self folding completes the functional. Detailed analytical results aswell as applications in cardiac PET are presented.

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MS07 Part II
Joint Surface Reconstruction and 4-D Deformation Estimation from Sparse Data and Prior Knowledge for Marker-Less Respiratory Motion Tracking

We present a sparse-to-dense registration approach capable of recovering an instantaneous body surface and estimating a dense 4D surface motion field from sparse sampling data and patient-specific prior shape knowledge. The system utilizes a marker-less active triangulation sensor delivering sparse but highly accurate 3D measurements in real-time. These are registered with a dense reference surface extracted from planning data. On 256 datasets from 16 subjects, the method achieves an accuracy of ± 0.23 mm (initial mismatch 5.66 mm).

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MS08 Part I
Properties of the solutions of the Total Variation Minimization Problem

I will review in this talk the latest results obtained in collaboration with Vicent Caselles and Matteo Novaga, and later on with students, on the qualitative properties of the minimizers of the total variation and the solutions of the total variation flow.

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MS08 Part I
Metamorphosis and Discrete Geometry in the Space of Images

The talk discusses the space of images as a manifold from the perspective of metamorphosis, a generalization of the flow of diffeomorphism approach with simultaneous transport and intensity variations both reflected by the underlying Riemannian metric. A variational time discretization of geodesics paths is proposed under minimal regularity requirements for the images. Γ-convergence of the underlying discrete path energy to the continuous path energy is shown. Relations to optical flow and video processing will be exploited. Computational results underline the efficiency of the proposed approach and demonstrate important qualitative properties. This is joint work with Alexander Effland.

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MS08 Part I
Geodesic Active Contours: An Axiomatic Variational

Geometric Approach

In this talk I will review basic operators in image analysis from a geometric-variational perspective while relating to the geodesic active contour model. These operators include classical edge detectors and image binarization. Finally, we will discuss a new model for multi-region image segmentation. This talk is based on joint papers with Anastasia Dubrovina and Alfred Bruckstein.

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MS08 Part I
Virtual Physiological Imaging: from Imaging to Computational Models and Back

We introduce the concept of Virtual Physiological Imaging (VPI), i.e. the ability to produce personalised and predictive imaging of unobservable variables by combining measurable cues from multimodal imaging and sensing systems as well as domain knowledge in the form of anatomical, physical and physiological models. VPI can be seen, in fact, as a hybrid imaging modality combining in vivo and in silico information. This lecture will therefore focus on the interplay between imaging and modelling methods as well as on illustrating it in cerebrovascular aneurysm management, one of the clinical translation domains that I have explored during the last decade.

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MS08 Part II
Variational Methods for Virtual Soccer Game Replays

In the past five years, Vicent Caselles has dedicated a lot of attention to the collaboration with the Spanish industry for the problem of synthesis of novel views for soccer TV applications. The final pipeline involves contributions in several fields of applied mathematics, image processing and computer vision: camera calibration, color equalization between images, depth and motion estimation, volumetric reconstruction, synthesis and video inpainting. In this talk, two variational tools that have been proposed within this project will be presented: a histogram equalization technique and a narrow band method for convexified multi-label problems.

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MS08 Part II
Multiscale Analyses of Images Defined on Riemannian Manifolds and of Similarities Between Images on Riemannian Manifolds

The goal of this talk is twofold: First, we present the multiscale analyses for images defined on Riemannian manifolds and extend the axiomatic approach proposed by Alvarez-Guichard-Lions-Morel to this general case. Second, we study the multiscale analysis of similarities between images on Riemannian manifolds, that is, the problem of comparing two patches belonging to the same image or to two different images defined on a Riemannian manifold, which can be defined by the image domain with a suitable metric depending on the image.

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MS08 Part II
A Variational Perspective on Perceptually-inspired Color and Contrast Enhancement

Human visual system properties are used to define energy functionals whose minimization leads to algorithms for color and constrast enhancement. It leads to perceptually-inspired modifications of the Sapiro-Caselles functional for histogram equalization, with a proper balance among a local and illumination-invariant contrast amplification and an entropy-like adjustment to the average luminance. A recent reformulation in the wavelet domain will be also presented. Marcelo Bertalmío, Vicent Caselles, Rodrigo Palma, Edoardo Provenzi, Alessandro Rizzi, Guillermo Sapiro collaborated to these results.

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MS08 Part II
A Variational Framework for Exemplar-Based Image Inpainting

Exemplar-based methods for image inpainting achieve impressive results on challenging textured images. In this work we propose a general variational framework for non-local image inpainting, from which important and representative previous inpainting schemes can be derived, in addition to leading to novel ones. We study some of these, and discuss some of their properties.

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MS09
A Convex Formulation for Global Histogram Based Binary Segmentation

We present a general convex formulation for global histogram-based binary segmentation. The model relies on a data term measuring the histograms of the regions to segment w.r.t. reference histograms as well as TV regularization allowing the penalization of the length of the interface between the two regions. The framework is based on some l^1 data term, and the obtained functional is minimized with an algorithm adapted to non smooth optimization. We present the functional and the related numerical algorithm and we then discuss the incorporation of color histograms, cumulative histograms or structure tensor histograms. Experiments show the interest of the method for a large range of data including both gray-scale and color images.

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MS09
Sliced Wasserstein Distance for Histograms Matching

In the last decade, various works have demonstrated that the optimal transport framework is well suited to address matching problems between features (such as histograms, point-clouds or signatures) for many applications in image processing and computer vision. The topic of this presentation is the approximation of the Wasserstein distance (aka EMD) and its derivative between histograms using 1-D projections. We will illustrate the interest of the proposed approach for image segmentation and color correction.

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MS09
Histogram Specification of Color Images Using a Variational Framework

Variational method for exact histogram specification has been successfully applied to gray images. The extension of this method to color images is not straight forward. Channel-to-channel approach in RGB color space will generalize false color in the specified image due to high correlation between RGB color components. In this talk, we introduce a new color histogram specification method. Numerical results show the performance of the proposed method.

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MS09
Two Stage Image Segmentation and Histogram Clustering

The Mumford-Shah model is one of the most important segmentation models in the last twenty years. In this talk, we propose a two-stage segmentation method based on it. The first stage of our method is to find a smooth solution g to a convex variant of the Mumford-Shah model. Once g is obtained, then in the second stage the segmentation is done by thresholding g into different phases. We prove that our method is convergent and that the solution g is always unique. In our method, there is no need to specify the number of segments $K(\geq 2)$ before finding g and there is no need to recompute g if the thresholds are changed. Experimental results show that our two-stage method performs better than many standard two-phase or multiphase segmentation methods for very general images, including antimass, tubular, MRI, noisy, and blurry image.

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MS10 Part I
Generalized Impedance Boundary Conditions and There use in the Inverse Electromagnetic Obstacle Problem

In this talk, we introduce the so called Generalized Impedance Boundary Conditions for electromagnetic scattering in the harmonic regime and provide a non linear optimisation method to solve the associated inverse obstacle problem. We will also show via numerical experiments that these approximate boundary conditions can be used to determine the shape of a perfectly conducting body covered by a thin layer of dielectric in a rather efficient way.

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MS10 Part I
Biosensing with Surface Plasmon Resonances

This talk is concerned with metal nano-optical sensors based on surface plasmon resonances. The sensing principle relies on spectral shifts caused by a surrounding dielectric perturbation of metallic structures such thin films or nano-particles. We first derive the asymptotic expansion of the resonances in terms of the size of the perturbation, then we study the spectral inverse problem related to the sensing technique.

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MS10 Part I
Acoustic Inverse Scattering Using Topological Derivative of Far-field Measurements-based L^2 Cost Functionals

The concept of topological sensitivity has proved effective for wave-based qualitative identification of finite-sized objects. As an effort towards a mathematical justification of the method, this study focuses on a topological derivative approach applied to the L^2-norm of the misfit between far-field measurements. Topological derivative based imaging functionals are analyzed for various cases, to characterize their behavior and their reconstruction abilities. Examples are discussed and this approach is compared to other well-known qualitative methods.

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MS10 Part II
Non-destructive Eddy Current Inspection of Highly Conductive Thin Layer Deposits via Asymptotic Models

Highly conductive thin layer deposits may blind the eddy current probes in non-destructive inspections. In this talk, we study several asymptoticmodels using different rescaling techniques to represent the thin layer by some transmission conditions on an interface. We choose a pertinent model from which we develop the inversion methods to reconstruct the layer thickness using eddy current signals. We give some numerical examples showing the modeling and the identification of thin layers.

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MS10 Part II
The Vanishing Conductivity Limit in Eddy Current Imaging

Transient excitation currents generate electromagnetic fields which in turn induce electric currents in proximal conductors. For slowly varying fields, this can be described by the eddy current equations, which are obtained by neglecting the dielectric displacement currents in Maxwell' equations. The eddy current equations are of parabolic-elliptic type: In insulating regions, the field instantaneously adapts to the excitation (elliptic behavior), while in conducting regions, this adaptation takes some time due to the induced eddy currents (parabolic behavior). For numerical calculations, it seems natural to regularize the parabolic-elliptic equation by replacing it with a full parabolic approximation in which the zero conductivity parameter has been set to a small positive value. Moreover, linearized reconstruction algorithms for eddy current imaging require to linearize the equation with respect to the conductivity, i.e. with respect to a change in type. In our talk we will present asymptotic results on the vanishing conductivity limit that justify parabolic regularization and characterize the derivative with respect to changing the equation from elliptic to parabolic type.

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MS11 Part I
Image Denoising Using LLT Model and Iterated Total Variation Refinement

Developing a variational model that is capable of restoring both smooth (no edges) and non-smooth (with edges) images is still a valid challenge at the image processing. In this presentation, we will present two methods for image denoising problems based on the use of the LLT model (by Lysaker, Lundervold and Tai) and iterated total variation refinement. The idea of our methods is, first make use of the LLT model to get a smooth primal sketch, and then get some meaningful signal by iterated total variation refinement from the removed noise image. Numerical experiments show our method is able to maintain some important information such as small details in the image, and at the same time to get a better visualization.

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MS11 Part I
Limiting Aspects of Non-convex Regularisation Models

Recently, non-convex regularisation models have been introduced for image processing in order to provide a better prior for gradient distributions in real images. These are based on using concave energies φ in the total variation type functional $\mathrm{TV}^q(u) := \int \|\nabla u(x)\|^q dx$. We demonstrate that functionals of this type pose many theoretical difficulties when extended from differentiable u to the entire space of functions of bounded variation. We then discuss remedies.

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MS11 Part I
Image Denoising Using the Gaussian Curvature of the Image Surface

We introduce a new high order variational model for image denoising. In this model, the L1-norm of the Gaussian curvature of the image surface is minimized. We will present evidence that this model restores both piece-wise constant and piece-wise smooth regions of an image without introducing the undesired staircase effect. We will present two fast iterative solvers for this model and will make comparisons against the mean curvature model [SIAM J. Imaging Sciences, Vol. 5, No. 1, pp. 1-2].

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MS11 Part I
Shape from Shading Using Mean Curvature

Shape from shading is a classic and fundamental problem in image processing. It aims to reconstruct a 3D scene from a given 2D irradiance image, which is a highly ill-posed problem. In this work, we will address a variational model that employs mean curvature of image surface as the regularizer and provide an analytical study of this model. Due to those specific features of the regularizer, the model can successfully restore smooth parts as well as parts with sharp transitions of objects reconstructed in the 3D scene. Moreover, we will discuss how the model is minimized by using augmented Lagrangian method. Numerical experiments will be presented to validate the model.

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MS11 Part II
Analysis and Design of Fast Graph Based Algorithms for High Dimensional Data

Geometric methods such as image snakes and total variation minimization are well-known in the image processing community. We discuss a class of new fast methods for large data clustering on graphs motivated by earlier work in the image processing community. The methods build on the connection between graph cuts, total variation on graphs, and diffuse interface approximations of these problems. Applications include multiclass semi-supervised learning and modularity optimization for community detection on social networks.

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MS11 Part II
A Forward-backward Model for Image Restoration

In this talk we shall consider a mild forward-backward regularization of the classical Perona-Malik model. Some analytical results will be presented as well as a series of numerical experiments to illustrate its main features.

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MS11 Part II
High-order Geometrical Variational and PDE Methods for Noise Removal

The goal of high-order methods for image denoising is to recovery a piecewise smoothing image and preserve edges while removing noise. In this presentation, we consider a gray scale image as a surface in 3-D and investigate the bendness change brought by the occurrence of noise. Inspirited by the second fundamental form, two high-order models, which we call total bending and relaxing bending, are proposed. Some experimental results will also be given.

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MS11 Part III
A Non-Local Formulation for Higher-Order Total Variation-Based Regularization

We review a non-local formulation of the classical total variation regularizer and propose a way to extend it to higher-order regularizers, such as TV2. We discuss several interesting applications, including deriving alternative discretizations for higher-order functionals, and show first numerical results.

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MS11 Part III
Regularization Parameter Estimation in L2 and L1 Total Variation Color Image Deblurring

In this talk we present an algorithm for the restoration of color images blurred by cross channel Point Spread Functions. The algorithm solves a regularization problem with the L2 or L1 data fitting term and the Total Variation regularization function It doesn't require any information on the noise present on the data and it estimates the value of the regularization parameter. Different blurring functions and kind of noise are considered in the numerical tests.

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MS11 Part III
Nonlinear Analysis of Population of Textured Manifolds with F-shape Spaces and Varifolds

The development of processing tools for the quantitative analysis of population of images defined on various deformable supports, that we name f-shapes, is a challenging and exciting task in particular for medical imaging. Most of the current tools require a fixed support to develop the full processing machinery and arbitrarily separate the geometrical content (coded in the supporting manifold) from the functional content (coded in the texture). We believe that such objects should be structured into f-shape spaces from which different tools should be derived. We will develop a framework articulating diffeomorphic transport and functional variations into a riemannian structure for f-shape spaces that, combined with varifold based discrepancy terms, looks a promising theoretical as well as numerical setting for such organising principle.

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MS11 Part III
Surface Map Optimization Using Beltrami Holomorphic Flow

Finding a meaningful 1-1 correspondence between surface data has important applications in various fields. It involves the optimization of certain energy functional over the space of all diffeomorphisms. This type of optimization problems is especially challenging, since the bijectivity of the mapping has to be ensured during the optimization process. Recently, a method, called the *Beltrami holomorphic flow(BHF)*, was proposed to solve the surface map optimization problem using quasi-conformal theories. The optimization problem is formulated to be defined over the space of Beltrami coefficients(BCs), instead of the space of diffeomorphisms. BCs effectively control the smoothness and bijectivity of the mapping, and hence make the optimization problem easier. However, the computation of BHF is slow since the variation of the BCs is obtained by integrations. In this paper, we propose an efficient splitting method to solve the surface map optimization problem over the space of BCs. The basic idea is to estimate the variation of the mapping under the variation of the BC using a sparse linear system, and ADMM-like splitting method is applied to solve the optimization problem. The proposed method significantly speed up the previous BHF approach. The proposed method also extend the BHF algorithm to general Riemann surfaces with arbitrarily topologies, such as multiply-connected domains. Experiments have been carried out on sythetic data together with real medical data. Results show that the proposed algorithm solves the surface map optimization problem efficiently.

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MS12 Part I
Fast Nonstationary Preconditioned Iterative Methods for Ill-Posed Problems with, Application to Image Deblurring

We introduce a new iterative scheme for solving linear ill-posed problems, similar to nonstationary iterated Tikhonov regularization, but with an approximation of the underlying operator to be used for the Tikhonov equations. For image deblurring problems such an approximation can be a discrete deconvolution that operates entirely in the Fourier domain. We provide a theoretical analysis of the new scheme, using regularization parameters that are chosen by a certain adaptive strategy. The numerical performance of this method turns out to be superior to state of the art iterative methods, including the conjugate gradient iteration for the normal equation, with and without additional preconditioning.

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MS12 Part I
Semi-Convergence Properties of Kaczmarz's Method

Kaczmarz's method has favorable semi-convergence properties: during the early iterations it converges very fast toward a good approximation to the exact solution, and thus produces a regularized solution. We present a rigorous analysis of the semi-convergence of Kaczmarz's method; to do this we study how the data errors propagate into the iteration vectors and we derive bounds for this noise propagation, thus providing a solid justification of their use as regularization methods.

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MS12 Part I
Dual-Scale Masks for Spatio-Temporal Compressive Imaging

We describe a coded aperture and keyed exposure approach to compressive video measurement. The proposed projections can be easily implemented using existing optical elements such as spatial light modulators. We extend these coded mask designs to novel dual-scale masks which enable the recovery of a coarse-resolution estimate of the scene with negligible computational cost. We develop numerical algorithms which utilize both temporal correlations and optical flow in the video sequence as well as the innovative structure of the projections.

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MS12 Part I
Reduction Methods for Matrix Pairs with Application to Image Restoration

We discuss several generalized Krylov subspace methods for reducing a pair of large matrices $\{A, B\}$ to a pair of small matrices $\{H, K\}$. Generalizations of Golub–Kahan bidiagonalization and the Arnoldi process are considered. Applications to Tikhonov regularization of large discrete ill-posed problems are described, in which A is a discretized blurring operator and B a discretized differential operator.

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MS12 Part II
A Variational Method for Expanding the Bit-Depth of Low Contrast Images

Traditionally, bit-depth expansion is an image processing technique to display a low bit-depth image on a high bit-depth monitor. In this paper, we study a variational method for expanding the bit-depth of low contrast images. Our idea is to develop a variational approach containing an energy functional to determine a local mapping function $f(r; x)$ for bit-depth expansion via a smoothing technique, such that each pixel can be adjusted locally to a high bit-depth value. In order to enhance low contrast images, we make use of the histogram equalization technique for such local mapping function. Both bit-depth expansion and equalization terms can be combined together into the resulting objective function. In order to minimize the differences among the local mapping function at the nearby pixel locations, the spatial regularization of the mapping is incorporated in the objective function. Experimental results are reported to show that the performance of the proposed method is competitive with the other compared methods for several testing low contrast images.

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MS12 Part II
Variational Image Restoration with Auto-Correlation Whiteness Penalties

Image restoration is an important task in image processing that arises in many modern imaging applications, including biomedical and astronomical ones. It consists in the inverse problem of recovering a clean sharp image from an observed image degraded by blur and some sort of noise. The main challenge comes from the fact that the problem is ill-posed so that some regularization is required. In this talk, we propose a constrained variational model for the restoration of blurred images corrupted by additive white noise. In particular, we propose to restore images by minimizing the total variation functional with whiteness constraints on the residue image. For the numerical solution of the problem, we propose an optimization algorithm based on the augmented- Lagrangian formulation and a very efficient variant of the alternating direction method of multipliers. This choice leads to optimization sub-problems that can be solved either in close-form or through the efficient solution of easy linear systems. Experimental results are presented that demonstrate the effectiveness of the proposed model.

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MS12 Part II
Iterative Reconstructors for Adaptive Optics

Large earthbound astronomical telescopes rely on adaptive optics systems in order to achieve a good image quality. The resolution of telescopes depends mainly on its diameter but it is further degraded by atmospheric turbulences. Adaptive optics systems correct for the influence of the atmosphere by measuring the incoming wavefront from bright guide stars. Based on the measurements, an optimal shape of deformable mirrors is computed such that the influence of the atmosphere is corrected after reflection on the deformable mirrors. The optimal mirror shape is computed as the solution to a large-scale inverse problem. Due to the fast changing atmosphere, the inverse problem has to be solved in real-time. We will present several iterative methods for the reconstruction, in particular a fast wavelet based hybrid solver, which computes a MAP-estimate for the solution of the underlying operator equation. In order to enhance the speed of reconstruction we introduce a frequency adapted preconditioner. Numerical results demonstrate the quality and speed of the method.

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MS12 Part II
Image Restoration with Poisson-Gaussian Mixed Noise

This talk will focus on the image denoising and deconvolution problem in case of mixed Gaussian-Poisson noise. By using a maximum a posteriori (MAP) estimation, we derive a new variational formulation whose minimization provides the desired restored image. The new functional is composed of the total variation (TV) regularization term, the Kullback-Leibler divergence term for Poisson noise and the L2-norm fidelity term for Gaussian noise. We consider a dual formulation for the TV term, thus changing the minimization into a min-max problem. A fast iterative algorithm is derived by using the proximal point method to compute the saddle point of the min-max problem. We show the capability of our model both on synthetic examples and on real images of low-count fluorescence microscopy. (Joint work with Serena Morigi and Fiorella Sgallari, University of Bologna, Italy, and You-Wei Wen, Kunming University of Science and Technology, Yunnan, China.)

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MS13
Estimating Dynamic Graphical Models for fMRI Data

Recently, the use of graphical models for estimating brain networks has become increasingly popular in the field of neuroscience. In this talk, we compare various graph estimation procedures on simulated and fMRI data and show how different the resulting graphs can be given certain choices made by the researcher. We also introduce a new method for analyzing brain networks in fMRI data using graphical models in longitudinal studies of brain imaging patients.

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MS13
Functional Magnetic Resonance Imaging Analysis in a Study of Alzheimer's Diseases

In this talk, I will explore resting-stage fMRI data from a Alzheimer's Disease (AD) study conducted in the ADRC at Washington University Medical School, using wavelet transformations and statistical signal extraction methods. Although fMRI data contain abundant information, only summary statistics, such as whole-brain volume and total intracranial volume, were used to differentiate AD with normal aging in the literature. We propose the functional mixed-effects model, which is an extension of linear mixed-effects model in the functional space, to model the resting-stage fMRI data. We further use the proposed model to facilitate the detection of the early onset of AD.

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MS13
Sparse Estimation in Partial Functional Linear Regression Model for Hyper-Acute Ischemic Stroke Study

In a hyper-acute ischemic stroke study, it is critical to assess tissue perfusion using certain MRI parameters (e.g., the mean transit time (MTT)). However, the time at which the MTT should be measured remains unclear. In this talk, we propose the use of the group adaptive LASSO to simultaneously estimate the sparse functional coefficients of MTT to find the best time of measurement. The results provide some new insights and confirm some previous findings.

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MS13
A Semi-parametric Nonlinear Model for Event-related fMRI

Nonlinearity in evoked hemodynamic responses is often present in event-related fMRI studies. Volterra series, a higher-order extension of linear convolution, has been used in the literature to construct a nonlinear characterization of hemodynamic responses. Estimation of the Volterra kernel coefficients is challenging due to the large number of parameters. We propose a semi-parametric model based on Volterra series for the hemodynamic responses that greatly reduces the number of parameters and enables information borrowing among subjects.

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MS14 Part I
An Adaptive Shape Reconstruction Algorithm for Inverse Problems

In many inverse problems, the objects of interest are the regions or shapes in the unknown media. This motivates algorithms that directly reconstruct shapes or region boundaries from the data, rather than solving for the medium density and then postprocessing. In this work, we formulate the task of shape reconstruction in inverse problems as a shape optimization problem and propose an adaptive algorithm that addresses the case of a piecewise constant medium. Key components to our method are the explicit representation of the geometry and discretization of the shape calculus using the finite element method. We demonstrate the effectiveness of our method with several examples.

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MS14 Part I
A Convex Approach to Sparse Shape Composition

We introduce "shape sparsity" as a novel approach in object-based modeling. For a given "shape dictionary", we define our problem as choosing a sparse set of elements and composing them via basic set operations to characterize desired regions in an image. Direct applications are object recovery and tracking, occluded shape recovery and optical character recognition. We propose a convex relaxation to this combinatorial problem and discuss the sufficient conditions under which the relaxation becomes exact.

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MS14 Part I
Robust Principal Component Pursuit via Alternating Minimization on Matrix Manifolds

Robust principal component pursuit (RPCP) refers to decomposition of a data matrix into low-rank and sparse components. In this work, instead of invoking a convex-relaxation model based on the nuclear norm and the ℓ^1-norm, RPCP is solved by considering a least-squares problem subject to rank and cardinality constraints. An alternating minimization scheme is employed to solve the resulting constrained minimization. In particular, the low-rank matrix subproblem is resolved by a tailored Riemannian optimization technique, and a q-linear convergence theory is established. The numerical experiments show that our method compares favorably with a popular convex-relaxation based approach.

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MS14 Part I
A Discrete Geodesic Calculus for Shape Space Applications

The notion of shapes can be useful in imaging for instance in the context of shape priors. Unfortunately, shapes are often difficult to deal with since the space of shapes usually has no linear structure. However, the space of shapes can frequently be equipped with a Riemannian metric, turning it into a Riemannian manifold, a structure that can be exploited computationally. We show how a corresponding set of computational tools on a (possibly infinite-dimensional) Riemannian manifold, a discrete geodesic calculus, can be developed just based on a computationally cheap approximate distance measure. It starts from an energy for discrete paths on the manifold, which gives rise to a notion of discrete geodesics as well as a discrete logarithmic map, a variational definition of a discrete exponential map, and a discrete parallel transport. We investigate the fundamental properties of those discrete operations and their convergence against their continuous counterparts, and we present applications in a space of viscous fluid-like shapes.

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MS14 Part II
Computational Metric Geometry in the Natural Space

Shapes can be treated and compared between as metric spaces. In the applied domain, one is confronted with the question of how to efficiently apply analysis tools like variations of the Gromov distance? We argue that the space spanned by the leading eigenfunctions of the Laplace Beltrami operator is natural for such operations. Examples of working in the spectral domain will support this argument.

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MS14 Part II
Affine-Invariant Shape Models for Contours and Their Discoveries in Images

Active contour, especially in conjunction with prior shape models, has become an important tool in image segmentation. However, most contour methods use shape priors based on similarity-shape analysis, i.e. analysis that is invariant to rotation, translation, and scale. In practice, the training shapes used for prior-shape models may be collected from viewing angles different from those for the test images and require invariance to a larger class of transformation. Using an elastic, affine-invariant shape modeling of planar curves, we propose an active contour algorithm in which the training and test shapes can be at arbitrary affine transformations, and the resulting segmentation is robust to perspective skews. We construct a shape space of affine standardized curves and derive a statistical model for capturing class-specific shape variability. The active contour is then driven by the gradient of a total energy composed of a data term, a smoothing term, and an affine-invariant shape-prior term. This framework is demonstrated using a number of examples involving the segmentation of occluded or noisy images of targets subject to perspective skew.

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MS14 Part II
Smooth or Singular Metamorphoses for Images and Measures

Based on the formalism of Metamorphosis, one can define Riemannian metrics on spaces of images or measures that are partially induced by the action of diffeomorphisms. We will review recent results applying this framework. The first one studies a metric defined on spaces of generalized functions, on which we make an explicit characterization of the geodesics that link discrete measures. The second one discusses a metric that is applicable to continuously differentiable images, within which the geodesic equation has solutions that are characterized by finite-dimensional dynamical systems. Using this property, we introduce an optimal control approach that optimizes solutions of such systems to compute geodesics between images. This is joint work with Casey Richardson.

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MS14 Part II
Shape and Topology Optimization Methods for Inverse Problems

In numerous image processing problems, the objects to be reconstructed have a nonsmooth structure. Typically, they may present piecewise constant or piecewise smooth features. Many well-established reconstruction algorithms rely on smooth functions for the approximation of the solution. In the past few years, reconstruction algorithms based on nonsmooth techniques to treat such cases have allowed to obtain more accurate reconstructions and therefore have drawn a considerable interest. In this talk, we propose a general shape optimization approach for the resolution of severely ill-posed inverse problems in tomography. For instance, in the case of Electrical Impedance Tomography, we reconstruct a piecewise constant electrical conductivity while in the case of Fluorescence Diffuse Optical Tomography, the unknown is a fluorophore concentration.

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MS15
Solving DC Programs that Promote Group 1-Sparsity

Many interesting applications require solving nonconvex problems that would be convex if not for a group 1-sparsity constraint. Splitting methods that are effective for convex problems can still work well in this setting. We propose several nonconvex penalties that can be used to promote group 1-sparsity in the framework of difference of convex or primal dual hybrid gradient (PDHG) methods. Applications to nonlocal inpainting, linear unmixing and phase unwrapping are demonstrated.

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MS15
Compressed Modes for Variational Problems in Math and Physics

Orthogonality constrained problems play important roles in many fields such as image science, computer graphics as well as mathematical physics. In this talk, i will discuss our recent work of L1 regularized variational Schrodinger equations for creating spatially localized modes and orthonormal basis, which can efficiently represent spatially localized functions and has promising potential to a variety of applications in many fields including signal processing, solid state physics, materials science, etc. Numerically, a splitting method is introduced to solve the proposed orthogonality constrained problem.

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MS15
Alternating Direction Methods for Classical and Ptychographic Phase Retrieval

In this talk, we show how augmented Lagrangian alternating direction method (ADM) can be used to solve both the classical and ptychographic phase retrieval problems. We present the connection between ADM and projection algorithms such as the hybrid input-output (HIO) algorithm, and compare its performance against standard algorithms for phase retrieval on a number of test images. Our computational experiments show that ADM appears to be less sensitive to the choice of relaxation parameters, and it usually outperforms the existing techniques for both the classical and ptychographic phase retrieval problems.

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MS15
Total Variation Structured Total Least Squares Method for Image Restoration

In this paper, we study the total variation structured total least squares method for image restoration. In the image restoration problem, the point spread function is corrupted by errors. In the model, we study the objective function by minimizing two variables: the restored image and the estimated error of the point spread function. The proposed objective function consists of the data-fitting term containing these two variables, the magnitude of error, and the total variation regularization of the restored image. By making use of the structure of the objective function, an efficient alternating minimization scheme is developed to solving the proposed model. Numerical examples are also presented to demonstrate the effectiveness of the proposed model and the efficiency of the numerical scheme.

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MS16
Observing the Earth in 3D with Pleiades-HR

The knowledge of ground elevation is essential in most remote sensing applications especially for very high resolution images. This ground elevation information can be retrieved from a pair of stereoscopic images, by correlation methods. The improving resolution of Earth observation systems like PleiadesHR (70 cm GSD) and their increasing stereoscopic capabilities open up new horizons for automatic Digital Elevation Model generation and allow to consider buildings reconstruction with an accuracy better than one meter RMS.

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MS16
Fusion of Kinect Depth with Trifocal Disparity Estimation for Fast High Quality Depth Maps

In order to generate depth maps for professional applications such as Cinema we have designed a rig consisting of a professional camera with two HD cameras and a Kinect. A novel fusion algorithm combining view matching and depth sensing is proposed, generating fast, high-quality depth maps (reliable in textured and uniform areas). Our implementation generates quarter pixel accurate depth maps for HD-720p at 15fps. The output is suitable for virtual view synthesis and 3D reconstruction.

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MS16
How Much Further Can We Go in Two-frame Stereo?

Even though a huge amount of researches have been done on two-frame stereo for last decades, we still have some questions about the two-frame stereo not clearly answered yet. Especially, when dealing with real-world images contaminated by several factors, the performance of the stereo methods is not acceptable. In this talk, I will discuss the fundamental limitations and difficulties of two-frame stereo in different aspects and discuss the possible research directions to overcome them.

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MS16
On the Performance of Local Methods for Stereovision

Motivated by photogrammetric applications we consider two issues of non-dense block-matching for stereovision. Correctly computing disparities at places where the pronto-parallel hypothesis is invalid (like discontinuities and slanted surfaces) and detecting invalid or ambiguous matches. We explore the use of oriented windows in order to deal with the first issue. While, to detect the mismatches we propose to use classic parameter-less techniques. Experiments show that incorporating these simple ingredients into a coarse-to-fine algorithm yield competitive results.

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MS17 Part I
An Overview of Mathematical Techniques for Blood Vessel Detection

This is a review of the state-of-the-art in techniques for blood vessel detection. The last few years have seen significant developments beyond the traditional approaches that included Dijkstras shortest path algorithm, Kalman filtering to track along the vessel, minimum spanning trees, and approaches developed for arbitrary object recovery such as level sets. New approaches draw from more sophisticated combinatorial optimization, image morphology, machine learning, linear programming and hybrid solutions.

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MS17 Part I
Tubular Structure Detection for MR Angiographic Image Analysis

The diagnosis and prognosis of vascular disease very often rely on three-dimensional angiography. Angiographic images allow physicians to better understand and quantify the disease pathology, and therefore an appropriate endovascular treatment can be planned. In this talk, I will introduce some of our newly developed image analysis techniques for tubular structure detection and vascular segmentation in angiograms. These new techniques are very useful for endovascular treatment planning using coils and stents.

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MS17 Part I
Automated Reconstruction of Curvilinear Networks from 2D and 3D Imagery

Although reconstructing curvilinear structures such as neural and vascular networks has received much attention over the years, robustness on noisy and complex data remains elusive. In this work, we formulate the delineation problem as a Quadratic Mixed Integer Program on a graph of potential paths, which can be solved optimally within a very small tolerance. We further propose a novel approach to weighting these paths, which results in a solution that closely matches the ground truth and outperforms state-of-the-art methods.

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MS17 Part I
Reproducible Interactive Correction of Blood Vessels

Personalized vessel modeling demands high fidelity and guaranteed results if the models will be used for biophysical simulation and guide treatment decisions. Although automated algorithms have progressed significantly, there is always a chance that the automated algorithm produces errors when modeling the vessel tree. These errors can have serious consequences for the patient if left uncorrected. Consequently, it is necessary for a user to visually validate the results and correct them if needed. I will describe a strategy for maximizing the reproducibility and correction of these models across users.

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MS17 Part II
Mathematical Morphology for Thin Object Detections

Curvilinear structures are common in medical imaging. In this talk, we present two novel tools to process these, which are based on path. Paths are thin and oriented elongated structuring elements that are not necessarily perfectly straight. A notable use of paths is for morphological filtering of images that depict thin objects of interest. We present robust tubular structure detectors based on such filtering. We also present a curvilinear structure enhancement based on optimal paths.

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MS17 Part II
Airway Tree-shape Modeling Through Large-Scale Tree-Space Statistics

Anatomical trees appear as transportation systems distributing blood, water or air. Due to their critical role, statistics on populations of trees is essential to understanding disease. This difficult due to anatomical variation in branching structure across subjects. I will present a geometric tree-space framework for leaf-labeled trees, and present applications to anatomical labeling of airway trees and large-scale statistics on the effect of Chronic Obstructive Pulmonary Disease on airway trees.

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MS17 Part II
Discrete Optimization of Eulers Elastica with Application to Vessel Segmentation

Vessel segmentation is much more challenging than blob-like objects due to the thin elongated anatomy of blood vessels, which can easily appear discontinuous in the acquired images due to noise or occlusion. In this talk, I will discuss a vessel segmentation approach that extracts the vessels by globally minimizing the surface curvature. The low curvature model enforces surface continuity and prevents leakages (false positive) and holes (false negatives).

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MS17 Part II
Geodesic Methods for Blood Vessels and Tree Structure Segmentation

Minimal paths have been used for long as an interactive tool to segment Tubular and tree structures as cost minimizing curves. The user usually provides start and end points on the image and gets the minimal path as output. These minimal paths correspond to minimal geodesics according to some adapted metric. They are a way to find a (set of) curve(s) globally minimizing the geodesic active contours energy. Finding a geodesic distance can be solved by the Eikonal equation using the fast and efficient Fast Marching method. In this talk we will focus on recent methods based on geodesics for segmentation of the whole vascular tree, either automatic or given just one seed point.

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MS18 Part I
Inverse Problems in Spaces of Measures

In the talk, the ill-posed problem of solving linear equations in the space of vector-valued finite Radon measures and Hilbert-space data is addressed. Well-posedness of Tikhonov-regularization with the Radon norm as well as further regularization properties and optimality conditions are discussed. Moreover, a flexible and convergent optimization algorithm in the space of measures is proposed. As an example, analysis and numerical experiments for the problem of sparse deconvolution are presented for which the space of Radon measures allows to model certain types of super-resolution problems.

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MS18 Part I
Super-Resolution from Noisy Data

Consider the problem of estimating a superposition of point sources from noisy bandlimited measurements. As long as the sources are not too clustered, a simple procedure based on convex programming is capable of super-resolving such a signal very effectively. In this talk, we provide non-asymptotic guarantees for this algorithm. On the one hand, we analyze the quality of the approximation when evaluated at a higher resolution. On the other, we characterize how accurately the method estimates the position of each source, showing that in a high SNR regime this does not depend on the dynamic range of the signal.

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MS18 Part I
Exact Support Recovery for Sparse Spikes Deconvolution

We focus on support recovery properties in ℓ^1-regularized sparse spikes deconvolution over the space of measures (i.e. the Beurling Lasso). For non-degenerate sums of Diracs, when the SNR is large enough, the model recovers the exact same number of Diracs. Those Diracs converge (in amplitude and location) toward those of the input measure as the noise tends to zero. We also study the impact of discretized grids on the support of the recovered solutions.

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MS18 Part II
Beyond Incoherence and Beyond Sparsity: Compressed Sensing in the Real World

Compressed sensing (CS) is based on three key concepts: sparsity, incoherence and uniform random subsampling. However, in many real-world problems in which CS is applied (e.g. medical imaging), these properties are lacking. In this talk we present a new theory, based on three new principles: asymptotic sparsity, asymptotic incoherence and multilevel random subsampling. We demonstrate that such concepts are more relevant in applications, and as a result, our theory explains the practical success of CS.

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MS18 Part II

The MUSIC Algorithm for Well-Separated Objects: A Sensitivity Analysis

The multiple signal classification (MUSIC) algorithm and its extension, recursively applied and projected MUSIC (RAP-MUSIC) are widely applied for source localizations in imaging. We will provide a rigorous sensitivity analysis of these algorithms to noise when the objects to be detected are well separated. A systematic numerical comparison between MUSIC, RAP-MUSIC and total variation minimization is performed.

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MS18 Part II
Sparse and Cosparse Tomographic Recovery from Few Projections

We study the sparsity and cosparsity model to theoretically investigate conditions for unique signal recovery from few tomographic measurements that involve structured matrices whose properties fall far short of common assumptions in compressed sensing. Numerical recovery through linear programming reveals a high accuracy of the theoretical predictions. The signal class covered by both models seems broad enough to cover relevant industrial applications of non-standard tomography, like particle image velocimetry and contactless quality inspection.

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MS19 Part I
Medium Induced Resolution Enhancement for Broadband Imaging

We discuss aspects of imaging with array data in a noisy environment. In particular we consider aspects of efficient processing of multioffset data and the role of clutter and noise. We focus on how a description of the statistics of the joint measurements can be used in the design of imaging schemes.

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MS19 Part I
Shape Identification and Classification in Echolocation

We propose a shape identification and classification algorithm for echolocation. The approach is based on first extracting geometric features from the reflected waves and then matching them with precomputed ones associated with a dictionary of targets. The construction of such frequency-dependent shape descriptors is based on some important properties of the scattering coefficients and new invariants. The stability and resolution of the proposed algorithm with respect to noise and the limited-view aspect are analytically and numerically quantified.

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MS19 Part I
Wave Luminescence Imaging

In wave-luminescence imaging (WLI), we use waves such as ultrasound and microwaves to generate luminescent light inside a scattering medium. We then measure on the surface of the medium outgoing photon density. From this measurement, we intend to image the distribution of the luminescence source inside the medium. We present here some recent theoretical and numerical results on WLI in various simplified settings. We show how to construct “good” probing waves for stable reconstructions.

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MS19 Part II
Correlation-Based Imaging in Random Media in the Paraxial Regime

Sensor array imaging in a randomly scattering medium is usually limited because coherent signals recorded by the array and coming from a reflector to be imaged are weak and dominated by incoherent signals coming from multiple scattering by the medium. We will see in this talk how correlation-based imaging techniques can mitigate or even sometimes benefit from the multiple scattering of waves, in particular when the source array has limited aperture.

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MS19 Part II
Selective Imaging of Extended Reflectors in Waveguides

We consider the problem of selective imaging extended reflectors in waveguides. To this end, we propose an imaging functional that uses projections on low rank subspaces of a weighted modal projection of the array response matrix, $\widehat{\mathbf{P}}(\omega)$. We carry out a detailed theoretical analysis of our selective imaging functional. Our numerical simulations are in very good agreement with the theory and illustrate the robustness of the proposed imaging method for reflectors of various shapes.

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MS19 Part II
Elastic-Wave Tomography and Inverse Scattering with Passive Sources

We present reverse-time continuation based procedures for inverse scattering and wave-equation reflection tomography including a free-surface boundary condition with data generated by unknown passive sources. We restrict our analysis to single scattered waves. Joint work with S. Burdick, X. Shang, J. Garnier, K. Sølna and R.D. van der Hilst.

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MS20 , WLB209
Sparsity Based Poisson Denoising with Dictionary Learning

The problem of Poisson denoising appears in various imaging applications, such as low-light photography and medical imaging. We propose to harness sparserepresentation modeling of image patches for this denoising task, handling severe SNR scenarios. We employ an exponential sparsity model, as recently proposed by Salmon et al., relying directly on the true noise statistics. Our scheme uses a greedy pursuit, with boot-strapping based stopping criterion, and dictionary learning within the denoising process, leading to state-of-the-art-results.

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MS20
Estimation of Mixed Poisson-Gaussian Noise Parameters via Variance Stabilization

Signal-dependent noise is often described through a parametric model that links the conditional variance to the conditional mean of the data. The model parameters typically have to be estimated, and are thus subject to errors. We investigate how a mismatch between estimated and true parameter values affects the accuracy of variance-stabilizing transforms (VST). As a practical application of general theoretical considerations, we devise a procedure for estimating Poisson-Gaussian noise parameters from a single image, combining VSTs and noise estimation for additive Gaussian noise. This unconventional application of variance stabilization yields a parameter-estimation accuracy competitive to that of conventional Poisson-Gaussian estimators.

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MS20
Adaptive Parameter Selection for Local and Non-local Poisson Noise Filtering

We propose a new approach to locally adapt the parameters of an image denoising algorithm. The proposed approach selects at each pixel one denoised version among several others obtained with different sets of parameters. The selection is driven by local statistics performed during the denoising of each version and by exploiting the specificity of the noise. The methodology is validated on local and non-local filtering of images corrupted by (approximately) Poisson noise.

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MS20
First-Photon Imaging: Imaging by Estimation of Parametric Poisson Processes

Mitigation of Poisson noise in active optical imaging conventionally requires hundreds of detected photons at each image pixel. In contrast, we have demonstrated simultaneous acquisition of range (with sub-pulse duration resolution) and reflectivity (with 4-bit resolution) using only one detected photon per pixel, even in the presence of high background noise. We achieve this through modeling the photon detection point process across illumination pulses and a novel method for censoring detection events caused by noise.

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MS21
Texture Aware Video Inpainting

We present a patch-based approach to inpaint videos, relying on a global, multi-scale optimization heuristic. Contrarily to previous approaches, the best patch candidates are selected using persistent multi-scale texture attributes. We show that this rationale prevents the usual wash-out of textured and cluttered parts of videos. The resulting approach is able to successfully and automatically inpaint complex situations, including high resolution sequences with dynamic textures and multiple moving objects.

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MS21
Diminished Reality by Correction of Perspective and Color with Image Inpainting

Diminished reality aims to remove real objects from video images in real time. This talk presents a diminished reality method for 3D scenes based on image inpainting. In this study, we improve the quality of image inpainting and preserve the temporal coherence of texture based on the approximation of the background structure by the combination of multiple planes. The photometric consistency is achieved by adjusting color of inpainted result in every frame.

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MS21
A Variational Model for Gradient-Based Video Editing

We present a gradient-based variational model for video editing, addressing the problem of propagating gradient-domain information along the optical flow of the video. The resulting propagation is temporally consistent and blends seamlessly with its spatial surroundings. In addition, the model we will present is able to cope with additive illumination changes and handles occlusions/dis-occlusions. In this presentation we consider the application where a user edits a frame by modifying the texture of an object's surface and wishes to propagate this editing throughout the video.

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MS21
The Controversial Story of Sparse Inpainting in Astronomy

Sparse inpainting is now a well known method in image processing, and it has been proposed for analyzing astronomical images with missing data. Despite the good experimental results, the astronomical community, especially in cosmology, has been very reluctant to this concept. We show in this talk astronomical applications where sparse inpainting is useful, and how it can be applied. Then we present and discuss the arguments raised by Bayesian cosmologists against sparse inpainting.

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MS22 Part I
A New Detail-Preserving Regularity Scheme

With the increasing complexity of images, image processing methods involving hybrid models have been proven to be more necessary and efficient. We pro- pose a novel regularization model integrating total generalized variation (TGV) and shearlet transform. The combination of multi-scale, multi-directional sparse representations and variational models works well in keeping edges and textures of various directions but suffers no oil painting effects. Applications in various tasks such as compressive sensing reconstruction, denoising and impainting show its advantages.

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MS22 Part I
Variational Approaches for Phase Image Processing with Applications in MRI

Phase data, for instance arising in magnetic resonance imaging (MRI), poses several challenges from the perspective of variational modeling and optimization: They are usually wrapped and forward models are often non-linear resulting in highly non-convex variational problems. In the talk, we discuss new variational models for applications in MRI in which the adequate consideration of the phase data is crucial. We show how the characteristics of phase data can be incorporated into the model leading to computationally tractable problems. Approaches and numerical results for two problems in MRI are presented: Fat-water separation and quantitative susceptibility mapping (QSM).

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MS22 Part I
Convex Image Segmentation with Generalized Partition Functions and Connections to Continuous Max-Flow

We present a generalized encoding framework for partitions in terms of functions instead of subsets and derive tight convex relaxations for variational image segmentation models that are formulated in the framework, containing significantly less unknowns than the number subregions. A set of conditions under which the convex models exactly represent the original variational models are derived. Finally, connections between the convex models and continuous max-flow problems are revealed and efficient optimization algorithms are derived.

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MS22 Part I
Joint Multi-Shot Multi-Channel Image Reconstruction in Compressive Diffusion Weighted MR Imaging

Multi-shot echo-planar imaging (EPI) based Diffusion weighted imaging (DWI) has the potential to provide higher spatial resolution results compared with the generally used Single-shot EPI method. However, there are motion-induced phase errors among different shots. We make use of the low-rank property of the magnitude of intensity matrices (I_n) of images from different shots and under-sampled data from multi-channel scans to jointly reconstruct images for each shot. Our proposed model is a combination of the data fitting, gradient weighted Total Variation regularization and low-rank decomposition of I_n, which is solved by an ADMM scheme.

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MS22 Part II
Variational Image Reconstruction Using Composite Wavelets

Many signal processing applications that involve image analysis, enhancement. and recovery require the design of numerically stable multiscale methods sensitive to the edge directions of the image content. We introduce a variational method for multipurpose image enhancement/recovery that is based on a class of multiscale multidirectional compactly supported tight frames built into an analogue of a diffuse interface model. This method is easily adaptable and the choice of the forcing term is determined by a priori known information, quality of the input data and the desired properties of the recovered image.

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MS22 Part II
α-Molecules: Wavelets, Shearlets, and Beyond

Applied harmonic analysis provides a variety of representation systems such as wavelets and shearlets, which are nowadays utilized for various imaging tasks. The main reason for their success is the fact that they deliver optimally sparse approximations for specific classes of functions. In this talk, we will introduce the novel concept of α-molecules which provides a unified framework encompassing various such multiscale systems and allows for a simplified construction of systems with prescribed sparse approximation properties.

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MS22 Part II
Compressive Support Detection Based on Multiple Hypothesis Testing

Objects of interests are usually defined on continuous domains. Almost all imaging approaches collect discrete data and very few work has been done in making references about the underlying images on continuous domain. This talk addresses how to make an inference about the support of the underlying images on a continuous domain from their incomplete compressive sensing data. We develop a compressive sensing imaging multiple comparison iMCP inferential procedure based on reproducible kernel Hilbert spaces.

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MS23
Generalized Row-Action Methods for Tomographic Imaging

We propose relaxed variants of Bertsekas' incremental proximal gradient methods. These methods generalize many existing row-action methods for tomographic imaging, and they provide a framework for deriving new incremental algorithms that incorporate different types of prior information via regularization. Despite their relatively poor global rate of convergence, these methods often exhibit fast initial convergence which is desirable in applications where low-accuracy solutions are acceptable. We demonstrate the efficiency of the approach with some numerical examples.

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MS23
Sparse X-ray Tomography Using a Besov Prior

We propose a sparsity-promoting reconstruction method to limited data x-ray tomography. The method is based on minimizing a sum of a data discrepancy term based on 2-norm and a regularizing term consisting of Besov 1-norm of the unknowns. The regularization parameter is selected by a technique called S-curve method, which can be used to incorporate prior information on the sparsity of the unknown target to the reconstruction process. Results are presented using experimental x-ray data.

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MS23
The Tradeoff Between Number of Projections and X-ray Intensity for Sparsity-exploiting Image Reconstruction in Computed Tomography

Much work on sparsity-exploiting CT image reconstruction has focused on reducing the number of projections required. One of the implications being that fewer views leads to less patient dose. In fact dose can be reduced by either using fewer views or reducing X-ray intensity per view. Use of sparsity-exploiting image reconstruction may tilt the balance between these factors toward fewer views. Here, we investigate this tradeoff in the context of a breast CT simulation.

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MS23
PET Reconstruction from Short-Time Data via GTV-Bregman

We discuss the solution of PET image reconstruction problems from short scan times by total variation type methods, which is challenging due to Poisson data. We discuss appropriate variational models and computational methods. The results demonstrate that TV regularization can reconstruct important structures even for bad statistics, improved results are obtained with generalized versions combining first and second order TV. A further step forward is made with Bregman iterations, also with respect to quantitative results.

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MS24 Part I
Fast Hue and Range preserving Histogram Specification: New algorithms, Theory and Applications

Color image enhancement is a complex and challenging task in digital imaging with abundant applications. Preserving the hue (the dominant color ingredient) of the input image is crucial in a wide range of situations. We propose a simple image enhancement methodology where the hue is conserved and the range (the gamut) of the R, G, B channels is optimally preserved. In our setup, the intensity of the input image is transformed into an intensity image whose histogram matches a specified, well-behaved target histogram, using our fast strict ordering algorithm. We derive a new color assignment approach that preserves the hue and the range in an optimal way. We analyze our algorithms in terms of their chromaticity improvement and compare them with the unique and quite popular histogram based hue and range preserving algorithm of Naik and Murthy. Numerical tests confirm our theoretical results and show that our algorithms performs much better than the Naik and Murthy algorithm. In spite of its simplicity, it gives quite often better results than the state-of-the art automatic color enhancement algorithm (ACE).

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MS24 Part I
White Balance in Cinema

In cinematography, performing white balance is a required operation whose aim is to emulate the color constancy property of the human visual system. Without white balance, pictures would appear off-color in most situations. In this talk we review basic concepts on colorimetry and color perception, explain the color correction pipeline in a digital cinema camera and how camera color calibration is performed at the movie shoot, and present the most relevant techniques for white balance, both for in-camera and off-line processing.

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MS24 Part I
Exemplar-Based Image Colorization Using RGB

This work deals with the problem of image colorization. A model including total variation regularization is proposed. Our approach colorizes directly the three RGB channels, while most existing methods were only focusing on the two chrominance channels. By using the three channels, our approach is able to better preserve color consistency. Our model is non convex, but we propose an efficient primal-dual like algorithm to compute a local minimizer. Numerical examples illustrate the good behavior of our algorithm with respect to state-of-the-art methods.

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MS24 Part I
A Variational Histogram Equalization Method for Image Contrast Enhancement

In this presentation, I will introduce a variational approach for histogram equalization, which contains an energy functional to determine a local transformation such that the histogram can be redistributed locally, and the brightness of the transformed image can be preserved. In order to minimize the differences among the local transformation at the nearby pixel locations, the spatial regularization of the transformation is also incorporated in the functional for the equalization process.

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MS24 Part II
A Wavelet-Based Framework for Perceptually-Inspired Color Enhancement

Variational principles in the spatial domain have been used to provide a general framework for perceptually-inspired color correction algorithms. They optimally balance a suitable local and non-linear contrast enhancement with an entropy-like adjustment of tone levels around the average per-channel intensity. Their main drawback is the high computational cost. In this contribution, it will be shown how to approach this problem in the wavelet domain, simplifying contrast enhancement formulae into implicit equations for the detail wavelet coefficients that can be quickly solved with Newton-Raphson's method.

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MS24 Part II
Color Contrast Enhancement: Some Classical and Some New Methods

The goal of color contrast enhancement is to provide a more appealing color image with vivid colors and clarity of details, thus permitting among other features, to "see in the shadows". In this presentation, we will carry out a little review to some classic algorithms in this field and we will present some recent algorithms. Finally, we will try to answer to the question: is it possible to find an objective method of comparison?

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MS24 Part II
The Color of Texture - Analysis based on the Total-Variation Transform

A new total variation (TV) transform and inverse-transform, related to nonlinear spectral theory, is presented. Through this transform we obtain a TV spectrum and a generalized framework of structure-texture decomposition at all scales. We apply the transform to natural color images and analyze some statistics regarding the scale and color characteristics of textures of natural images.

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MS24 Part II
Color Image Contrast Enhancement: 3-D Color Histogram Equalization Method

The usage of digital images has rapidly increased with growing public consumption of entertainment and communication appliances, such as digital TVs, digital cameras, mobile phone cameras, and personal media players. Histogram equalization has been one of the most widely used techniques due to its effectiveness and simplicity in contrast enhancement. This talk introduces a recent trend of color histogram equalization methods. The majority of color histogram equalization methods do not yield uniform histogram in gray scale. After converting a color histogram equalized image into gray scale, the contrast of the converted image is worse than that of an 1-D gray scale histogram equalized image. Therefore, I will present a 3-D color histogram equalization method that produces uniform distribution in gray scale histogram by defining a new cumulative probability density function in 3-D color space. In addition, an effective hue preserving gamut mapping method with high saturation for color image enhancement will be described. Test results with natural and synthetic images will be provided to compare and analyze various color histogram equalization algorithms.

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MS25 Part I
A New Pre-reconstruction Iterative Algorithm for Dual-Energy Computed Tomography

Dual-energy computed tomography (DECT) refers to various CT imaging methods which use attenuation values at two different X-ray spectra. Compare to conventional single-energy CT, extra projection can potentially increase the accuracy to distinguish different material properties. In this presentation, we provide a new iterative method to obtain the attenuation coefficients by solving the system of non-linear equations coming from different X-ray spectra. The proposed method can be improve the accuracy without any extra system calibration.

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MS25 Part I
A Binary Metal Image Reconstruction Based on the Lambda Tomography in CT

In the field of dental and medical radiography, the advantage of computed tomography (CT) is partly limited by the metallic objects-related artifacts images. These metal artifacts, which appear as dark and bright streaks, seriously degrade the image of CT and information about teeth. The aim of the present study is to introduce the new method of recovering metal shape in the reconstructed CT image based on the local property of Lambda tomography.

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MS25 Part I
Inverse Problem on Quantitative Susceptibility Mapping (QSM)

The inverse problem of QSM is to recover the susceptibility distribution of the human body from the measured local field that is expressed by the convolution of the susceptibility distribution with the magnetic field generated by a unit dipole. However, it is ill-posed due to the presence of zeros at a cone in the Fourier representation of the unit dipole kernel. In this presentation, we will provide mathematical analysis for the inverse problem of QSM.

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MS25 Part II
Vortex Flow Imaging Technique Using Echocardiography

Recently, vortex flow imaging has been proposed as a new methodology to clinically evaluate the cardiac function. It commonly uses echo particle image velocimetry(E-PIV) to characterize intra-ventricular flow fields non-invasively. However, E-PIV has some limitations such as the injection of contrast agent and the fast motion of blood flow. To cope with them, we proposed a new vortex flow imaging technique using 2D echocardiography data. In our study, 2D echo image sequences of apical four-, three- and two-chamber views are acquired over the entire cardiac cycle for the same phase, respectively. We extract the LV boundaries in the three different views and reconstruct 3D LV boundaries for the entire cardiac cycle from the the extracted LV boundary sequences. By solving the Navier-Stokes equation with the moving boundary condition of the extracted LV boundaries, we estimate the 3D velocity fields of blood flow and compute the vortex flow by taking the curl of the velocities.

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MS26
A Shearlet Scheme for Optimal Magnetic Resonance Imaging

Images, in particular those arising from MRI, are typically governed by anisotropic features. A common model for this situation are cartoon-like functions. In this talk, we will present a sparse subsampling strategy of Fourier samples which can be shown to perform in fact optimally for this class of functions. One main ingredient of our methodology is a scale-direction dependent random sampling strategy combined with a novel frame of dualizable shearlets.

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MS26
Optimal Sampling Strategies for Compressed Sensing in MRI

When compressed sensing techniques are applied in MRI there are two intriguing phenomena that are observed: Firstly, the optimal sampling strategy depends on the structure of the image one wants to recover, and secondly, the success of compressed sensing depends on the resolution (higher resolution allows for better subsampling). In this talk we will mathematically explain these phenomena and provide a theoretical framework for how to choose the optimal sampling strategy for the particular problems of interest.

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MS26
Stable and Robust Sampling Strategies for Compressive Imaging

Until recently, rigorous theory for sampling with compressive frequency measurements, had only been developed for bases incoherent to the Fourier basis. Most bases known to allow for sparse image representations, such as wavelet bases, however, do not have this property. Empirical studies have shown that variable density sampling strategies overcome this obstacle. We introduce a theory which reveals suitable variable density sampling strategies and provides theoretical reconstruction results for compressive imaging via frequency measurements.

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MS26
Video Compressive Sensing for Dynamic MRI

We present a video compressive sensing framework to accelerate the image acquisition process of dynamic MRI. The key idea is to construct a compact representation of the spatio-temporal data and perform computation within the motion manifold, in our case, linear dynamical systems. Given compressive measurements, the state sequence can be first estimated using system identification. We then reconstruct the video using a joint structured sparsity assumption. We also investigate the impact of various sampling strategies.

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MS27 Part I
Adjoint State Method for the Recovery of Both the Source and the Attenuation in the Attenuated X-Ray Transform

Motivated by recent theoretical results for the identification problem arising in single-photon emission computerized tomography (SPECT), we propose an adjoint state method for recovering both the source and the attenuation in the attenuated X-ray transform. Our starting point is the transport-equation characterization of the attenuated X-ray transform, and we apply efficient fast sweeping methods to solve static transport equations and adjoint state equations. Numerous examples are presented to demonstrate various features of the identification problem.

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MS27 Part I
Locating Multiscale Scatterers by A Single Far-Field Pattern

In this talk, I shall present our recent study on locating multiple multiscale scatterers by a single far-field pattern. The imaging schemes developed could be applied to acoustic, electromagnetic and elastic scattering, and could work in extremely general and practical scenarios.

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MS27 Part I
Fast Matrix-Free Direct Solution and Selected Inversion for Seismic Imaging Problems

Rank structured methods have been previously shown very effective in solving large discretized Helmholtz equations. In this talk, we show our recent development of matrix-free direct solvers for large dense or spare matrices based on rank structures and randomized sampling. Unlike existing direct or iterative methods, these new solvers can quickly provide direct solutions with controllable accuracies, using only a small number of matrix-vector multiplications. This is especially attractive for problems which are ill-conditioned, where it is too expensive to form the matrix, or where there are too many right-hand sides. The solvers are also useful for problems with varying parameters (e.g., frequency). We then discuss the application of the methods to the extraction of selected entries of the inverse of large sparse matrices. For discretized Helmholtz equations, we can quickly compute the diagonal blocks or any off-diagonal entries of the inverse. Such information is useful for the preconditioning of the problem. These methods can significantly improve the efficiency of the solution/inversion of the Hessian matrix in Gauss-Newton iterations for FWI.

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MS27 Part I
Eulerian Methods for Schrodinger Equations in the Semi-Classical Regime

We discuss Eulerian approaches to compute semi-classical solutions of the Schrodinger equations including the Eulerian Gaussian beam method and a recently developed method which incorporating short-time WKBJ propagators into Huygens principle. These Eulerian are shown to be computationally very efficient and can yield accurate semi-classical solutions even at caustics.

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MS27 Part II
Adaptive Phase Space Method for Traveltime Tomography

In this talk, we present an adaptive strategy for the phase space method for traveltime tomography. The method first uses those geodesics/rays that produce smaller mismatch with the measurements and continues on in the spirit of layer stripping without defining the layers explicitly. The adaptive approach improves stability, efficiency and accuracy. We then extend our method to reflection traveltime tomography by incorporating broken geodesics/rays, for which a jump condition has to be imposed at the broken point for the geodesic flow. In particular we show that our method can distinguish non-broken and broken geodesics in the measurement and utilize them accordingly in reflection traveltime tomography. We demonstrate that our method can recover the convex hull (with respect to the underlying metric) of unknown obstacles as well as the metric outside the convex hull.

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MS27 Part II

Long-time Stability and Convergence of the Uniaxial Perfectly Matched Layer Method for Time-domain Acoustic Scattering Problems

The uniaxial perfectly matched layer (PML) method uses rectangular domain to define the PML problem and thus provides greater flexibility and efficiency in dealing with problems involving anisotropic scatterers. In this paper we first derive the uniaxial PML method for solving the time-domain scattering problem based on the Laplace transform and the complex coordinate stretching in the frequency domain. We prove the long-time stability of the initial-boundary value problem of the uniaxial PML system for piecewise constant medium property and show the exponential convergence of the time-domain uniaxial PML method. Our analysis shows that for fixed PML absorbing medium property, any error of the time-domain PML method can be achieved by enlarging the thickness of the PML layer as ln T for large $T > 0$. Numerical experiments are included to illustrate the efficiency of the PML method.

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MS27 Part II

Joint Transmission and Reflection Traveltime Tomography for Reflector in Inhomogeneous Media Using First Arrivals

We propose a level set based adjoint state method for solving the joint transmission and reflection traveltime tomography problems, where both the underlying slowness and the location of reflector are unknown. The level set based adjoint state method is present in our previous work to study the transmission traveltime tomography with discontinuous slowness. In this work, we use the level set method to visualize the location of reflector and incorporate it into the slowness inversion. we define the mismatch functional including both the transmission part and the reflection part, and the adjoint state method is used to obtain the gradient of such functional. The treatment of the transmission part is the same as the case in our previous work. While to minimize the reflection part of the mismatch functional we need to solve a new system of adjoint equations also delicate boundary conditions are incorporated; we provide a detailed derivation on this subject. Finally numerical results are given to demonstrate our algorithm.

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MS27 Part II

Efficient Numerical Method for Helmholtz Equation with High Wave Number and Its Application in Seismic Imaging Problem

Numerical solution of multi-dimensional Helmholtz equation with high wave number is a challenging task. On one hand, the direct method is very inefficient while on the other hand the classical iterative method usually fails to converge as the large linear system resulted from spatial discretization of the Helmholtz equation is indefinite. These difficulties make it very challenging to solve full waveform inversion problem in frequency domain for the high frequency part. In this work we applied the compact higher-order Pade approximation to obtain higher-order accuracy. The resultant large linear system is preconditioned and then solved by iterative method. We then derive the adjoint Helmholtz equation and solve it using the developed method to compute the adjoint variable. Finally the results are used to solve the full waveform inversion in frequency domain. Numerical examples are presented to demonstrate the efficiency and effectiveness of the presented method.

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MS28

Denoising an Image by Denoising Its Curvature Image

In this work we argue that when an image is corrupted by additive noise, its curvature image is less affected, i.e. the PSNR of the curvature image is larger. We speculate that, given a denoising method, we may obtain better results by applying it to the curvature image and then reconstructing from it a clean image, rather than denoising the original image directly. Numerical experiments confirm this for several PDE-based and patch-based denoising algorithms.

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MS28

A Spatially Consistent Collaborative Filtering

The BM3D filter is based on a special nonlocal image modelling implemented through the *grouping* and *collaborative filtering* procedures. First, grouping finds mutually similar 2-D image blocks and stacks them together in 3-D arrays, called *groups*. Then, collaborative filtering produces individual estimates of the grouped blocks via shrinkage of the 3-D transform spectra of such groups. Following a position-driven design of the 3-D transform, we introduce a collaborative filtering that is adaptive to the spatial configuration of the grouped blocks. The potential of this supplementary adaptivity is illustrated for image denoising and enhancement.

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MS28

On the Internal vs. External Statistics of Image Patches, and Its Implications on Image Denoising

Surprisingly, “Internal-Denosing” (using internal noisy patches) usually outperforms “External-Denoising” (using external clean patches), especially in high noiselevels. We analyze and explain this phenomenon. We further show how the “fractal” property of natural images (cross-scale patch recurrence) promotes a new powerful internal search-space. Since noise drops dramatically at coarser scales of the noisy image, for almost any noisy patch, its unknown clean version naturally emerges in a coarser scale, at the same relative image coordinates.

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MS28
On Covariant Derivatives and Their Applications to Image Regularization

We present a generalization of the Euclidean and Riemannian gradient operators to a vector bundle, a geometric structure generalizing the concept of manifold. One of the key ideas is to replace the standard differentiation of a function by the covariant differentiation of a section. Dealing with covariant derivatives satisfying the property of compatibility with vector bundle metrics, we construct generalizations of existing mathematical models for image regularization that involve the Euclidean gradient operator, namely the linear scale-space and the Rudin-Osher-Fatemi denoising model. For well-chosen covariant derivatives, we show that our denoising model outperforms state-of-the-art (local) variational denoising methods both in terms of PSNR and Q-index.

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MS29 Part I
A One-Step Reconstruction Algorithm for Quantitative Photoacoustic Imaging

Photoacoustic tomography (PAT) is a recent multi-physics biomedical imaging modality that aims at achieving simultaneously high resolution and high contrast. The goal is to reconstruct the optical diffusion and absorption properties of the biological tissue from time-dependent acoustic pressure data measured on the tissue surface. In the past, a two-step image reconstruction process for PAT was done in the setting where the acoustic wave speed within the tissue is known. However, this method is not feasible if the speed is unknown. We present a one step reconstruction algorithm for PAT image reconstruction that will eliminate this problem.

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MS29 Part I
Near-Field Imaging of Acoustic Obstacles with the Factorization Method

The factorization method of Kirsch is a simple and fast non-iterative method for imaging obstacles from far-field scattering data. However, it is an open problem how to develop a factorization method with the near-field data which is efficient in computation. In this talk, we will propose such a factorization method by using the near-field data. Numerical results are also provided to illustrate the validity of the inversion algorithm. This is a joint work with Guanghui Hu, Jiaqing Yang and Haiwen Zhang.

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MS29 Part I
Optical Tomography in Weakly Scattering Media

Tomography based on attenuation without scattering is well studied and forms the basis of several imaging systems. In the presence of strong scattering, photon propogation modelled as diffusion forms the basis of diffuse optical tomography (DOT) which is nonlinear and stongly ill-posed. In between these limits, the weakly scattering regime, also known as the mesocopic regime, presents an interesting problem both for the forward and inverse models. In this talk I will discuss recent progress in this area.

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MS29 Part I
Reconstruction of Sources with Small Supports From a Single Cauchy Data and Application

This work focuses on an algebraic reconstruction method allowing to solve an inverse source problem in the elliptic equation $\Delta u + \mu u = F$ from a single Cauchy data. The source term F is a distributed function having compact support within a finite number of small subdomains. Two applications of the inverse problem we consider here can be the Helmholtz equation in an interior domain (corresponding to μ positive) and the bioluminescence tomography (corresponding to μ negative), but they are not the only ones.

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MS29 Part II
Detection and Classification From Electromagnetic Induction Data

In this talk, we introduce an efficient algorithm for identifying conductive objects using induction data derived from eddy currents. Our method consists of first extracting geometric features from the induction data and then matching them to precomputed data for known objects from a given dictionary. The matching step relies on fundamental properties of conductive polarization tensors and new invariants introduced in this paper. A new shape identification scheme is introduced and studied. We test it numerically in the presence of measurement noise. Stability and resolution capabilities of the proposed identification algorithm are quantified in numerical simulations. The talk is based on the joint work with H. Ammari, Z. Chen, D. Volkov, J. Garnier and H. Wang.

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MS29 Part II
One-Shot Imaging Methods in Inverse Elastic Scattering

In this talk, we shall present some recent development on one-shot imaging methods in inverse elastic scattering. The methods could work in an extremely general setting. The underlying scatterer could consist of multiple components, and the number of the components and the physical property of each component are not required to be known in advance. Moreover, the scatterer may include, at the same time, components of small size and regular size compared to the detecting elastic wavelength. For regular-sized components, we need impose a certain generic condition. The methods are based on a series of novel indicator functions and could be generalized to detecting objects in radar applications.

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MS29 Part II
Near-Field Imaging of Rough Surfaces

This talk is concerned with a class of inverse rough surface scattering problems in near-field imaging, which are to reconstruct the scattering surfaces with resolution beyond the diffraction limit, roughly half of the wavelength. A novel approach is developed to solving the inverse problems. The method requires only a single incident field with one frequency and one incident direction, and is realized efficiently by using the fast Fourier transform. Numerical results show that the method is simple, stable, and effective in reconstructing surfaces with super-resolved resolution.

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MS29 Part II
On the Transmission Eigenvalue Problem Arising in Inverse Scattering Problem

Consider the efficient computations of interior transmission problems. By converting this non-self adjoint problem into a quadric eigenvalue problem, we propose an efficient numerical scheme to catch the small real eigenvalues which is the key factors in inverse scattering problems. Finally, the efficiency of the proposed scheme for solving the transmission eigenvalue problems are tested by solving the scattering problems of inhomogeneous medium problem with real eigenvalue as the wave number. This is a joint work with Dr. T. X. Li and Prof. W. W. Lin.

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MS29 Part III
Inverse Scattering Problems with Oblique Boundary Conditions

We consider the scattering problems with oblique boundary conditions. Instead of standard boundary conditions, a linear combination of the normal and tangential derivatives is prescribed on the boundary of the scatterer. This kind of boundary conditions are of great importance in scattering theory of electromagnetic waves and ocean waves. Both the forward and inverse problems for the oblique derivative problem are considered. The forward problem is treated using layer potentials, generalizing the usual approach for the standard exterior boundary value problems. As for the inverse problem, we are concerned with the uniqueness and numerical scheme for the reconstruction of the unknown scatterer from far-field data.

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MS29 Part III
Regularized Acoustic and Electromagnetic Cloaking

In this talk, I will describe the recent theoretical and computational progress of our work on regularized transformation-optics cloaking. Ideal cloak makes use of singular metamaterials, posing great challenges for both theoretical analysis and practical fabrication. Regularizations are incorporated into the construction to avoid the singular structures.

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MS29 Part III
A Model Reduction Approach to Numerical Inversion for Parabolic Partial Differential Equations in One and Higher Dimensions

We propose a novel numerical inversion algorithm for parabolic partial differential equations, based on model reduction. The reduced model is obtained with rational interpolation in the frequency (Laplace) domain and a rational Krylov subspace projection method. It amounts to a nonlinear mapping from the function space of the unknown resistivity to the low-dimensional space of the parameters of the reduced model. We use this mapping as a nonlinear preconditioner for the Gauss-Newton iterative solution of the inverse problem. For the sake of clarity of the exposition, the theoretical details of the method are presented for a 1D problem. However, the method can be generalized to higher dimensions, so we provide the numerical resistivity reconstructions in both the 1D and 2D cases. The 2D approach can be applied in 3D without any modifications.

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MS29 Part III
Multiscale Analysis for Ill-posed Problem with Support Vector Approach

Based on the use of compactly supported radial basis functions, we extend in this paper the support vector approach (SVA) to a multiscale scheme for approximating the solution of a moderately ill-posed problem on bounded domains. In order to reduce the error induced by noisy data, regularization technique is performed by using the Vapnik's ϵ-intensive function to replace the standard l^2 loss function. Convergence proof for noise-free data is then derived under an appropriate choice of the Vapnik's cut-off parameter and the regularization parameter. Numerical examples are constructed to verify the efficiency of the proposed SVA approach and the effectiveness of the parameter choices.

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MS30 Part I
Rates of Convergence and Restarting Strategies

We will discuss several strategies for obtaining optimal first order gradient or primal-dual descent schemes in various nonsmooth cases, using smoothing and restarting methods. We will show that such approaches can work in theory, but do not practically improve on standard acceleration.

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MS30 Part I
Adaptive Methods for Large Scale Optimization

Splitting methods (or first-order methods) are a common tool for solving large-scale problems in image processing and machine learning. One of the primary difficulties of splitting methods is the need to choose stepsize parameters. These parameters are problem dependent and have a dramatic effect on the efficiency of the methods. Unfortunately there is little theory available to guide this choice, making it difficultly to choose efficient parameters without hand tuning. In this talk, we present adaptive splitting methods that automatically tune parameters for optimal performance without user inputs.

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MS30 Part I
A Generalization of the Chambolle-Pock Algorithm to Banach Spaces with Application to Inverse Problems

For a Hilbert space setting, Chambolle and Pock introduced an attractive first-order primal-dual algorithm which solves a convex optimization problem and its Fenchel dual simultaneously. We present a nonlinear generalization of this algorithm to Banach spaces. Moreover, under certain conditions we prove strong convergence as well as convergence rates. Due to our generalization, the method becomes applicable for a wider class of problems. This fact make it particularly interesting for solving ill-posed inverse problems on Banach spaces by Tikhonov regularization or the iteratively regularized Newton-type method, respectively. This will be illustrated by numerical examples.

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MS30 Part I
The Linearized Bregman Method via Split Feasibility Problems

The linearized Bregman method is a method to compute sparse solutions of linear systems. The method has been proven to converge to a solution which has a minimal quadratically regularized ℓ^1-norm and the proof have been simplified by interpreting it as a gradient method for the dual problem. In this talk we show that the method can be seen as an instance of a general algorithm for split feasibility problems. This gives a new proof for the convergence of the linearized Bregman method and also yields a new step-size which sometimes even outperforms the "kicking" of the linearized Bregman method. Moreover, one can derive numerous other algorithms in the same framework: A block-linearized Bregman method where each iteration only uses a part of the linear equation, a sprase Kaczmarz method where each iteration only uses a single linear equation and also an "online version" which can be used when the measurements are not taken all at once but incrementally.

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MS30 Part II
A Primal-Dual Approach for Solving Optimization Problems Based on Information Measures

φ-divergences introduced by Csiszár in 1963 constitutes a useful class of similarity measures, especially in information theory. These divergences correspond to multivariate functions, which are not separable sums of functions of one real variable. We investigate their use as cost functions in possibly nonsmooth large dimensional convex optimization problems like those encountered in imaging and machine learning. After showing how to compute the corresponding proximity operators in a simple manner, we propose novel primal-dual methods, derived from the theory of monotone operators, leading to efficient proximal algorithms. The flexibility of the proposed approaches stems from the fact that the divergences may be composed with arbitrary linear operators.

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MS30 Part II
An Inertial Forward-Backward Algorithm for Solving Monotone Inclusions

We propose a new inertial forward backward splitting algorithm to minimize the sum of two monotone operators, with one of the two operators being co-coercive. We prove convergence of the algorithm in a Hilbert space setting and show that several recently proposed first-order methods can be obtained as special cases of the general algorithm. Numerical results show that the proposed algorithm converges faster than existing methods, while keeping the computational cost of each iteration basically unchanged.

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MS30 Part I
Extending the Method of Chambolle and Pock to Non-Linear Operators

Many applications inherently involve non-linear forward operators. Particular examples include modelling of the Stejskal-Tanner equation in diffusion tensor imaging, and direct regularisation of the phase of a complex image in MR velocity imaging. The algorithm of Chambolle and Pock being advantageous for total variation type regularised problems, we extended it to non-linear operators. In this talk, we will sketch the ingredients for obtaining local convergence, and demonstrate very promising numerical performance especially in comparison to the Gauss-Newton method.

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MS30 Part II
Convergence Analysis of Accelerated Forward-Backward Algorithm with Errors

We present a convergence analysis of accelerated forward-backward split- ting methods for minimizing the sum of a smooth convex function and a nonsmooth convex function, when the proximity operator is not available in closed form, and can only be computed up to a certain precision. We prove that the inexact implementation achieves the same convergence rate as in the error-free case, provided that the admissible errors are of a certain type and satisfy a sufficiently fast decay condition. Furthermore, we give a global complexity analysis, taking into account the cost of computing ad- missible approximations of the proximal point. An experimental analysis is also presented.

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MS31 Part I
Fundamental Geometry Processing

The first fundamental form measures distances and angles on a smooth surface, and the second fundamental form measures how the surface normal varies along curves, i.e., curvature. The two fundamental forms are invariant to rigid body transformations of the surface, and satisfy the Gauss-Codazzi-Mainardi (CDM) equations. Conversely, given two second order symmetric tensor fields satisfying together the CDM equations, the Fundamental Theorem of Surface Theory asserts that: 1) there exists a surface immersed in three-dimensional Euclidean space with these fields as its first and second fundamental forms; and 2) the surface is unique modulo rigid body transformations. We formulate and prove the analog theorem for polygon meshes, including extensions to manifold meshes of arbitrary topology, meshes with border, and even non-manifold mehes. We present a new pose-independent algorithm for interactive shape design based on 3D-painting the fundamental forms directly on the mesh, and then integrating these forms in the variational sense.

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MS31 Part I
Modeling Disease in the Human Brain with Geometry and Imaging

The highly folded surface of the human brain is difficult to visualize and analyze. The development of these folding patterns is not fully understood and there is debate in the biological and neuroscientific communities as to why folds develop in a particular location. Additionally, there are many diseases involving the folding the patterns of the brain that occur in early development and causes of these diseases are not understood. I will discuss some mathematical and computational models we have developed using a prolate spheroid domain to gain insight into cortical folding pattern formation. I will also discuss how conformal mapping can assist with the study and analysis of diseases in the human brain.

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MS31 Part I
Euler's Elastica For Image Restoration And Segmentation And Fast Algorithms

Minimization of functionals related to Euler's elastica energy has a wide range of applications in computer vision and image processing. An issue is that a high order nonlinear partial differential equation (PDE) needs to be solved and the conventional algorithm usually takes high computational cost. In this paper, we propose a fast and efficient numerical algorithm to solve minimization problems related to the Euler's elastica energy and show applications to variational image denoising, image inpainting, and image zooming. We reformulate the minimization problem as a constrained minimization problem, followed by an operator splitting method and relaxation. The proposed constrained minimization problem is solved by using an augmented Lagrangian approach. Numerical tests on real and synthetic cases are supplied to demonstrate the efficiency of our method. In this talk, we will also extend these algorithms for models with minimization of the mean curvature of the image surfaces and show applications of these fast algorithms for image segmentation where we only need to regularize the "curvature" of a curves or surface. This talk is based on joint works with: Tony Chan, Jooyong Hahn, Ginma Chung, Wei Zhu.

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MS31 Part I
A New Iterative Algorithm for Mean Curvature-Based Variational Image Denoising

The mean curvature-based model is one model which is known to be effective for restoring both smooth and nonsmooth images. It is, however, extremely challenging to solve efficiently. We propose a new and general numerical algorithm for solving the mean curvature model which is based on an augmented Lagrangian formulation with a special linearised fixed point iteration and a nonlinear multigrid method. Numerical experiments are conducted to illustrate the advantages by comparing with other related algorithms and to test the effectiveness of the proposed algorithms.

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MS31 Part II
New Developments in Levelset Based Image Segmentation and Art Pattern Synthesis

I present new developments in levelset based interactive image segmentation and art pattern synthesis. The level set method is clearly advantageous for image objects with a complex topology and fragmented appearance. Our levelset based image segmentation integrates discriminative classification models with the level set method to better avoid local minima. Our level set function approximates a posterior probabilistic mask of a foreground object. We further apply expectation-maximization (EM) to improve the performance of both the probabilistic classifier and the level set method over multiple passes. On the other hand, art patterns, such as line drawings and digital arts appear everywhere, from simple icons to cartoons, maps and illustrations. We apply the level set method to synthesizing art patterns with curvilinear features from exemplars, which we cast as a global optimization problem. Our energy function for this problem measures both the appearance similarity of color patterns and shape similarity of curvilinear features. We further generalize our energy function and optimization algorithm so that they can effectively synthesize art patterns that consist of multiple layers. Experiments and comparisons demonstrate the superior performance of our methods.

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MS31 Part II
A Discrete Uniformization Theorem for Polyhedral Surfaces

A discrete conformality forpolyhedral metrics on surfaces is introduced in this paper which generalizes earlier work on the subject.It is shown that each polyhedral metric on a surface is discrete conformal to a constant curvature polyhedral metric which is unique up to scaling. Furthermore, the constant curvature metric can be found using a discrete Yamabe flow with surgery.

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MS31 Part II
Computing of Laplace-Beltrami Spectrum via Conformal Deformation and Applications

The spectrum of Laplace-Beltrami (LB) Operator plays an important role in surface analysis and has been made successful applications in many fields such as computer graphics and medical image analysis. This talk will discuss our recent work about variation of LB spectrum via conformal deformation and its applications in shape analysis.

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MS31 Part II
Ricci Flow for Shape Analysis and Surface Registration

Ricci flow has been successfully applied in the proof of Poincaré's conjecture, which deforms the Riemannian metric proportionally to the curvature, such that the curvature evolves according to a heat diffusion process. Ricci flow offers a powerful tool for shape analysis and surface registration, and has been used to tackle the fundamental problems in engineering and biomedicine: conformal brain mapping and virtual colonoscopy in medical imaging; 3D human face registration and deformable surface tracking in computer vision; global surface parameterization in computer graphics; homotopy detection in computational topology; delivery guaranteed greedy routing and load balancing in wireless sensor network, and so on.

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MS31 Part III
Quasiconformal Surface Map Optimization for Uniformization with Arbitrary Topologies

We present a novel algorithm for computing surface uniformizations for surfaces with arbitrary topology. By minimizing a user-defined quasiconformal energy functional, surface maps onto arbitrary domains are adjusted to be as conformal as possible. The novelty in our method lies in the iterative adjustment of generators on the uniformization domain, which changes until the algorithm converges. We demonstrate the efficiency and accuracy of our method and compare it with other state of the art algorithms.

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MS31 Part III
Saddle Vertex Graph (SVG): A Novel Solution to the Discrete Geodesic Problem

This paper presents the Saddle Vertex Graph (SVG), a novel solution to the discrete geodesic problem. The SVG is a sparse undirected graph that encodes complete geodesic distance information: a geodesic path on the mesh is equivalent to a shortest path on the SVG, which can be solved efficiently using the shortest path algorithm (e.g., Dijkstra algorithm). The SVG method solves the discrete geodesic problem from a local perspective. We have observed that the polyhedral surface has some interesting and unique properties, such as the fact that the discrete geodesic exhibits a strong local structure, which is not available on the smooth surfaces. The richer the details and complicated geometry of the mesh, the stronger such local structure will be. Taking advantage of the local nature, the SVG algorithm breaks down the discrete geodesic problem into significantly smaller sub-problems, and elegantly enables information reuse. It does not require any numerical solver, and is numerically stable and insensitive to the mesh resolution and tessellation. Users can intuitively specify a model-independent parameter K, which effectively balances the SVG complexity and the accuracy of the computed geodesic distance. More importantly, the computed distance is guaranteed to be a metric. The experimental results on real-world models demonstrate significant improvement to the existing approximate geodesic methods in terms of both performance and accuracy.

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MS32 Part I
The Proximal Heterogeneous Block Implicit-Explicit Method: Application to Ptychogrpahy

We propose an alternating minimization algorithm for minimizing separably convex functions over separable nonconvex feasible sets. The method converges to a critical point from any feasible initial guess for semi-algebraic functions and sets. In the presence of additional structure the method can be parallelized. We apply our algorithm to the problem of simultaneous deconvolution-phase retreival in ptychographic imaging. Our framework recovers the state of the art as limiting cases of our basic algorithm and improves upon existing techniques.

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MS32 Part I
Possible Equivalence Between the Optimal Solutions of Least Squares Regularized by L0 Norm and Penalized by L0 Norm

When looking for a sparse solution of an under-determined linear system, two popular options are to find the optimal solution of squares regularized by L0 pseudo-norm or penalized by L0 (known also as K-sparsity problem). Even though non convex, these problems are often considered as somehow "equivalent". We analyse in depth the relationship between the optimal solutions of these models. We prove that equivalence can occur under specific (fully described) conditions. An important conclusion is that in terms of optimal solution, the K-sparsity problem offers wider possibilities.

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MS32 Part I
Stable Recovery with Gauge Regularization

Regularization plays a pivotal role when facing the challenge of solving ill-posed inverse problems, where the number of observations is smaller than the ambient dimension of the object to be estimated. A line of recent work has studied regularization models with various types of low-dimensional structures. In such settings, the general approach is to solve a regularized optimization problem, which combines a data fidelity term and some regularization penalty that promotes the assumed low-dimensional/simple structure. This paper provides a general framework to capture this low-dimensional structure through what we coin piecewise regular gauges. These are convex, non-negative, closed, bounded and positively homogenous functions that will promote objects living on low-dimensional subspaces. This class of regularizers encompasses many popular examples such as the ℓ_1 norm, $\ell_1 - \ell_2$ norm (group sparsity), nuclear norm, as well as several others including the ℓ_∞ norm. We will show that the set of piecewise regular gauges is closed under addition and pre-composition by a linear operator, which allows to cover mixed regularization, and analysis-type priors (e.g. total variation, etc.). Our main results provide a unified sharp analysis of exact and robust recovery guarantees from partial measurements.

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MS32 Part I
Composite Self-Concordant Minimization

We propose a variable metric framework for minimizing the sum of a self-concordant function and a possibly non-smooth convex function endowed with a computable proximal operator. We theoretically establish the convergence of our framework without relying on the usual Lipschitz gradient assumption on the smooth part. An important highlight of our work is a new set of analytic step-size selection and correction procedures based on the structure of the problem. We describe concrete algorithmic instances of our framework for several interesting large-scale applications and demonstrate them numerically on both synthetic and real data.

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MS32 Part II
Proximal Alternating Linearized Minimization for Semi-Algebraic Problems

We introduce a proximal alternating linearized minimization (PALM) algorithm for solving a broad class of nonconvex and nonsmooth minimization problems. Building on the powerful Kurdyka-Łojasiewicz property, we derive a self-contained convergence analysis framework and establish that each bounded sequence generated by PALM globally converges to a critical point. Our approach allows to analyze various classes of nonconvex-nonsmooth problems and related nonconvex proximal forward-backward algorithms with semi-algebraic problem's data, the later property being shared by many functions arising in wide variety of fundamental applications. A by-product of our framework also shows that our results are new even in the convex setting. As an illustration of the results, we derive a new and simple globally convergent algorithm for solving the sparse nonnegative matrix factorization problem.

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MS32 Part II
Solution of the Regularized Structured Total Least Squares Problem by an Alternating Proximal-Based Method with an Application to Blind Image Deblurring

We consider a broad class of regularized structured total-least squares problem (RTLS) encompassing many scenarios in image processing. This class of problem results in a nonconvex model and thus finding a global solution is in general a difficult task. We introduce a new algorithm for solving this class of problems which blends proximal and alternating schemes by exploiting data information and structures. The resulting algorithm is proven to globally converge to a critical point and is amenable to efficient and simple computational steps. We illustrate our theoretical findings by presenting numerical experiments on deblurring large scale images which demonstrate the effectiveness of our algorithm.

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MS32 Part II
A Sparse Kaczmarz Solver Based on the Linearized Bregman Method

In this talk we generalize the linearized Bregman method for sparse solutions of linear systems to a method which computes sparse solutions of so-called split feasibility problems. Besides a new convergence proof and a new stepsize criterion for the linearized Bregman method we also obtain a generalization of the Kaczmarz method that computes sparse solutions. This gives rise to new methods for compressed sensing problems in which the measurements are too costly to use “batch processing” (i.e. waiting for all measurements to arrive) and one uses “online processing” (i.e. each row of the measurement matrix is processed on its own).

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MS32 Part II
Local and Global Convergence Results for Affine Sparse Feasibility

Finding a vector with the fewest nonzero elements that satisfies an underdetermined system of linear equations is an NP-complete problem that is typically solved numerically via convex heuristics or nonconvex relaxations. We present elementary methods based on projections for solving a sparse feasibility problem without employing convex heuristics. We present analytical tools that allow us to show global linear convergence of AP and a relaxation thereof under familiar constraint qualifications. These analytical tools can also be applied to other algorithms such as the Douglas–Rachford algorithm where we achieve local linear convergence of this method applied to the sparse affine feasibility problem.

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MS33
Atomic Models of Video Turbulence

We recall some simple methods to simulate turbulent videos of static objects. Each method is motivated by a physical model, but we describe them as image processing operators acting on the latent image. The latent image can be recovered easily from each simulation. Thus, we claim that the main difficulty in the correction of turbulence must come from a combination of different effects. Indeed, we find several of these individual effects appearing in real examples.

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MS33
Independent Components in Dynamic Refraction

Refraction causes random dynamic distortions in atmospheric turbulence and in views across a water interface. The latter scenario is experienced by submerged animals seeking to detect prey or avoid predators, which may be airborne or on land. Man encounters this when surveying a scene by a submarine or divers while wishing to avoid the use of an attention-drawing periscope. The problem of inverting random refracted dynamic distortions is difficult, particularly when some of the objects in the field of view are moving. On the other hand, in many cases, just those moving objects are of interest, as they reveal animal, human, or machine activity. Furthermore, detecting and tracking these objects does not necessitate handling the difficult task of complete recovery of the scene. We show that moving objects can be detected very simply, with low false-positive rates, even when the distortions are very strong and dominate the object motion. Localizing objects in three dimensions (3D) despite this random distortion is also important to some predators and also to submariners avoiding the salient use of periscopes. Refracted distortion statistics induce a probabilistic relation between any pixel location and a line of the salient use of periscopes. Refracted distortion statistics induce a probabilistic relation between any pixel location and a line of sight in space. Measurements of an objects random projection from multiple views and times lead to a likelihood function of the objects 3D location. The likelihood leads to estimates of the 3D location and its uncertainty. sight in space. Measurements of an objects random projection from multiple views and times lead to a likelihood function of the objects 3D location. The likelihood leads to estimates of the 3D location and its uncertainty.

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MS33
Video Restoration of Turbulence Distortion

When the video is taken from a long range system, atmospheric turbulence can corrupt the video sequence and an object can look distorted. Blurring and diffeomorphism are couple of the main effects of atmospheric turbulence. We propose methods to stabilize the video sequence and give a good reference image. We reconstruct a new video sequence using Sobolev gradient sharpening with temporal smoothing, and one latent image is found further utilizing the lucky-region method.

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MS33
A Geometric Method for Image Recovery Through Optical Turbulence

The phenomenon that is commonly referred to as optical "turbulence" in imaging is caused by the time and space-varying refraction index of the air which is due, among other factors, to temperature, air pressure, humidity, and wind conditions between the acquired scene and the image-capturing device. The resulting image sequence is also affected by the different and changing lighting conditions within the scene, by the actual distance between the observed objects and the camera, and by other artifacts introduced by the device itself. The above described distortion may be modeled, at least to a first approximation, as the combined effect of (i) a blur with an anisoplanatic point spread function and (ii) a time-dependent deformation of the image domain. In this talk I will describe an algorithm that, starting from this observation, first employs a geometric method for restoring the structure of the scene, and then uses variational deconvolution techniques to yields a crisp, final result. The algorithm may be viewed as an alternate minimization procedure of a functional that includes a data matching term, a regularization term for the deformations, and a regularization term for the recovered image. The algorithm has proven very effective for the the recovery of images affected by both ground-level atmospheric blur, and by underwater turbulence caused by temperature gradients.

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MS34
A Phase Model for Point Spread Function Estimation in Ground-Based Astronomy

In ground-based astronomy, the imaging system of telescope is generally interfered by atmospheric turbulence and hence images so acquired are blurred with unknown point spread function (PSF). To restore the observed images, aberration of the wavefront at the telescope's aperture, i.e., the phase, is utilized to derive the PSF. We develop a model to reconstruct the phase directly, aided by total variation regularizer and SCPRS method. Numerical results illustrate the efficiency of the new model.

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MS34
Uniqueness Results for Reconstruction of Imagery Degraded By Atmospheric Turbulence

Reconstruction of imagery degraded by atmospheric turbulence is a problem of great practical importance. We discuss conditions for uniqueness in several inverse problems, including phase retrieval, multiframe blind deconvolution, and phase-diverse speckle. In each case, the setting considered is incoherent imaging through Kolmogorov turbulence. We show that this model yields strong probabilistic results.

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MS35 Part I
PCA on Manifolds Accounting for Curvature

Principal Component Analysis (PCA) is a widely used tool to reduce the dimensionality of the data. In many applications data lies on a manifold, but PCA cannot be applied directly to this non-linear space. The traditional approach is to linearize the data via the tangent space representation. In this talk I will show how to take into the account the curvature of the manifold to have a better estimate of the principal components, and better capture the variance of the data.

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MS35 Part I
Surface Shape Matching and Analysis Using Intrinsic Coordinate Parameterizations

We present a geometric method for parameterization, matching, and analysis of surface shapes. Surfaces are parameterized and represented by intrinsic coordinate maps derived from the conformal structure of the shape. This parameterization is invariant to rigid transformations of the shape, as well as angle-preserving parameterizations of the surface. Shape matching between coordinate maps of two surfaces is achieved by i) deforming the isothermal curves of the intrinsic parameterization under a nonlinear transformation, and ii) locally reparameterizing the isothermal curves to yield invariant diffeomorphic matchings. We show experimental results for open surfaces such as facial geometries, as well as closed surfaces representing neuroanatomical shapes such as the hippocampus and the cortex. Lastly, we show significant statistical effects of age on the morphology of the hippocampus for a population of healthy individuals.

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MS35 Part I
Diffeomorphic Models and Centroid Algorithms for Computational Anatomy

This talk will discuss several techniques for the estimation of a template shape within a population in the diffeomorphic framework. This has important applications in computational anatomy, to study the shape variability of human organs. It is also closely related to centroid computation methods on Riemannian manifolds. A new method, called Iterative Centroid, will be presented, which can be considered as a template estimation method in itself, or as a good initialization for other algorithms.

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MS35 Part I
Numerical Computation of Geodesics on the Universal Teichmueller Space

We propose and investigate a numerical shooting algorithm for computing the distance between welding map representatives (i.e. shapes) on the universal Teichmueller space. Geodesics are determined by the Euler-Poincare equation on the group of S^1 diffeomorphisms, and the algorithm seeks to solve the associated boundary-value problem connecting the welding maps. The solution is computed as a sum of self-similar "teichon" solutions, and a matching term employing cross-ratios and a Delaunay triangulation is minimized via nonlinear iterative methods. We show that the algorithm works well for computing the geodesic between non-crowded shapes.

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MS35 Part II
Matrix-valued Kernels for Shape Deformation Analysis

In recent years the rapid development of precise acquisition techniques for medical data has prompted applied mathematical work on the quantification of geometric deformation, for the ultimate purpose of performing statistics (e.g. template estimation, classification, regression analysis, and so on) on shape spaces; examples of shapes are curves in two or three dimensions, surfaces, images, tensor fields, or sets of feature points. In particular, the action of groups of diffeomorphisms induces Riemannian metrics on shape spaces; such approach is known as Large Deformation Diffeomorphic Metric Mapping (LDDMM). One may choose different metrics (inner products of vector fields) on the tangent space of the diffeomorphisms group, and these will induce different metrics and geometries on the shape spaces. In this talk we shall characterize the class of translation- and rotation-invariant metrics on group of diffeomorphisms in n-dimensional Euclidean space, through the analysis of the respective matrix-valued kernels in the spatial and Fourier domains. We shall also provide examples of metrics whose geodesics in the group are generated by curl-free or divergence-free vector fields. The latter may prove especially useful in medical applications where deformations are known to preserve volume (for example, for deformations of the tissues of the heart).

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MS35 Part II
Shape Analysis of Cardiac Images

Diffeomorphic mapping methods based on optimal control, such as the LDDMM (large deformation diffeomorphic metric mapping) algorithm, have provided powerful tools for the analysis of brain images and have been used for image registration and comparison, statistical analyses of datasets of brain subvolumes, like the hippocampus, amygdala and other regions intervening in neurodegenerative diseases like Alzheimer's or Huntington's. While these methods can be applied to cardiac data as such, specific features of heart imagery, including their dynamic nature, require new approaches. We will describe extensions of LDDMM designed for mapping high-resolution triangulated surfaces, representing, for example, the left ventricle, to MR images that are sparsely sampled along the long axis, allowing for atlas computation and population-based shape analysis. We will also explain how similar ideas can be used to design new 3D-consistent tracking methods adapted tagged MRI imaging.

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MS35 Part II
Shape Analysis of Multiply-Connected Objects Using Conformal Welding

Shape analysis is a central problem in the field of computer vision. In 2D shape analysis, classification and recognition of objects from their observed silhouettes are extremely crucial but difficult. It usually involves an efficient representation of 2D shape space with a metric, so that its mathematical structure can be used for further analysis. Although the study of 2D simply-connected shapes has been subject to a corpus of literatures, the analysis of *multiply-connected* shapes is comparatively less studied. In this work, we propose a representation for general 2D multiply-connected domains with arbitrary topologies using *conformal welding*. A metric can be defined on the proposed representation space, which gives a metric to measure dissimilarities between objects. The main idea is to map the exterior and interior of the domain conformally to unit disks and circle domains (unit disk with several inner disks removed), using holomorphic 1-forms. A set of diffeomorphisms of the unit circle can be obtained, which together with the conformal modules are used to define the shape signature. The proposed shape signature uniquely determines the multiply-connected objects under suitable normalization. We also introduce a reconstruction algorithm to obtain shapes from their signatures. Experiments have been carried out on shapes extracted from real images. Results demonstrate the efficacy of our proposed algorithm as a stable shape representation scheme.

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MS36
Functional Maps: A Flexible Representation of Maps Between Shapes

This talk will discuss a representation of maps between pairs of geometric objects (3D shapes, images, etc.) that generalizes the standard notion of a point-to-point correspondence and instead considers linear mappings between function spaces. The resulting representation is compact, and yet allows for very efficient inference (shape matching) and enables a number of map-processing applications, including algebraic map manipulation, optimization and visualization among others.

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MS36
Building and Using Functional Image Networks

Functional maps between images can be defined via the preservation of various image features. Networks of such maps can be used not only to transport information around the network but also to extract information from the network. We show how to use cycle-consistency of function transportation as a regularizer for obtaining better pair-wise image maps, and then how to exploit the resulting map network for a number of tasks, such as image co-segmentation.

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MS36
Joint Diagonalization and Closest Commuting Laplacians

We construct multimodal spectral geometry by finding a pair of closest commuting operators (CCO) to a given pair of Laplacians. The CCOs are jointly diagonalizable and hence have the same eigenbasis. Our construction extends classical data analysis tools based on spectral geometry, including diffusion maps and spectral clustering. We provide synthetic and real examples of applications in dimensionality reduction, shape analysis, and clustering, demonstrating that our method better captures the inherent structure of multi-modal data.

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MS36
An Operator Approach to Tangent Vector Field Processing

We introduce a novel coordinate-free method for manipulating and analyzing vector fields on discrete surfaces. Unlike the commonly used representations (e.g. as vectors on faces of a mesh), we argue that vector fields can be naturally viewed as linear operators acting on functions defined on the mesh. We show that composition of vector fields with other functional operators is natural in this setup and demonstrate several applications, including joint vector field design on multiple surfaces.

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MS37 Part I
Single Image Interpolation via Adaptive Non-Local Sparsity-Based Modeling

A common approach towards the treatment of image restoration in recent years is to divide the given image into overlapping patches and process each of them based on a model for natural image patches. In this paper we propose a novel image interpolation method which combines the non-local self-similarities of natural image patches and adaptive sparse representation modeling. The proposed method is contrasted with competitive and related algorithms, and demonstrated to achieve state-of-the-art results.

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MS37 Part I
Sparse Image Super-Resolution with Nonlocal Autoregressive Modeling

Sparsity-based image super-resolution has been proven to be a promising approach to reconstruct a high-resolution image from one low-resolution image. However, such method becomes less effective when the sampling operator is coherent with the sparsifying dictionary. In this talk, I will introduce the nonlocal autoregressive model for sparsity-based image super-resolution. By incorporating the local and nonlocal constraints, the sparse reconstruction will become much more stable and effective for single image super-resolution.

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MS37 Part I
Image Super-Resolution in the Sobolev Space

Super-resolution models usually involve a fidelity term and several regularization terms. Although numerous image priors have been proposed as regularizers, the fidelity term generally is defined in the image space, e.g., by the L2-norm. In this talk, we suggest to replace the L2-norm by the Sobolev metric which is more suitable for modeling detailed textures. We investigate the optimization algorithms in the Sobolev space, and discuss the convergence and the optimum of the proposed method.

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MS37 Part I
Nonparametric Blind Super-Resolution

Super-Resolution (SR) algorithms assume a known blur kernel (the camera PSF, a Gaussian, etc.) However, SR performance deteriorates when the kernel deviates from the correct one. We propose a 'Blind SR' framework. We show that: (i) The PSF is the *wrong* blur kernel to use. (ii) The correct kernel can be recovered from the low-res image using the patch-recurrence property of natural images (internally across scales, or externally in an image collection).

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MS37 Part II
A Statistical Prediction Model Based on Sparse Representations for Single Image Super-Resolution

We address single image super-resolution using a statistical prediction model based on sparse representations of low and high resolution patches. This model allows us to avoid any invariance assumption, commonly practiced in sparsity-based approaches treating this task. Prediction of high resolution patches is obtained via MMSE estimation and the resulting scheme has the useful interpretation of a feedforward neural network. We suggest a training algorithm for this network and show its advantages over existing methods.

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MS37 Part II
Beta Process Joint Dictionary Learning for Coupled Feature Spaces and Its Application to Single Image Super-Resolution

This talk discusses a new Bayesian approach to formulate the coupled feature spaces dictionary learning problem and its application to single image super-resolution. Due to the unique property of the Beta Process model, the proposed algorithm is able to learn sparse representations that correspond to the same dictionary atoms with the same sparsity but different values in coupled feature spaces, thus bringing consistent and accurate mapping between coupled feature spaces.

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MS37 Part II
The Analysis Model and Super-Resolution

We present a unified framework for supervised learning of sparse models, which contains as particular cases models promoting sparse synthesis and analysis type of priors, and mixtures thereof. We apply these ideas to single image super resolution, where the operators are learned in a supervised fashion from ground-truth examples as a bilevel optimization problem. Leveraging ideas on fast trainable regressors, we propose a way of constructing feed-forward networks capable of efficiently approximating the learned models.

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MS38 Part I
A Multigrid Solver for Hyperelastic Image Registration

Regularization functionals based on hyperelasticity are powerful for applications of non-linear image registration. Key features of hyperelastic schemes are their capability of modelling large deformations while guaranteeing their invertibility. One limiting factor for large-scale registration problems is the severe computational cost. In particular, approximately inverting the discretized Hessian in Gauss-Newton optimization schemes becomes prohibitively expensive. We present local Fourier analysis results, propose a Galerkin multigrid scheme, and demonstrate its effectiveness on real world applications.

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MS38 Part I
Preconditioned Splitting for Large-Scale Biomedical Imaging

This talk contributes to numerical convex splitting methods for large-scale imaging problems. Recently, primal-dual augmented Lagrangian methods have received increasing attention especially for saddle-point problems of decoupled sparsity-promoting variational methods in image processing. The aim of this talk is to present convergence properties of a preconditioned splitting method for moderately and severely ill-posed imaging problems. We will highlight advantages in terms of usefulness (splitting), stability (preconditioning) and speed (parallelization) for large-scale biomedical imaging.

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MS38 Part I
Large-Scale Image Reconstruction for Quantitative Susceptibility Mapping Applications

In many applications such as image deconvolution and quantitative susceptibility mapping (QSM), being able to efficiently and accurately solve a large-scale inverse problem is a crucial and challenging task. In QSM applications, given a blurred and noisy image of measured field shifts, the goal is to reconstruct tissue susceptibilities. In this talk, we describe efficient numerical methods for regularization of large-scale problems and provide numerical results from QSM applications.

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MS38 Part I
Designing Optimal Regularized Inverse Matrices for Inverse Problems

In this talk we present a new framework for solving ill-posed inverse problems by compute an optimal regularized inverse matrix. An optimal regularized inverse matrix is obtained by incorporating probabilistic information and solving a Bayes risk minimization problem. We present theoretical results for the Bayes problem and discuss efficient approaches for solving the empirical Bayes risk minimization problem. Our approach is illustrated on examples from image processing. Once computed, the optimal regularized inverse matrix can be used to solve inverse problems very efficiently.

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MS38 Part II
Large-Scale Image Reconstruction with TV Priors

We discuss computational methods for image reconstruction with TV priors and their application to real life data. In particular we focus on primal-dual Newton methods including a dual interior point approach. We also comment on the efficient sampling of posterior densities in Bayesian approaches with TV priors used to quantify uncertainties in reconstructions.

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MS38 Part II
Brain Atlas Creation Using Image Registration and Restoration

We present a variational framework to create a comprehensive brain atlas based on image registration and image restoration. Particularly, the brain atlas is created by elastic registration and characterized by a sharp average shape. The L1-TV or L2-TV image restoration for the brain atlas is used to average individual structures without losing prominent common edges. With variant tests we give promising results in DBS therapy planning applications.

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MS38 Part II
Nonlinear Image Registration with Sliding Motion Constraints

Common medical image registration approaches are enforcing a global continuity of the deformation field. However, a sliding behavior along adjacent organ borders (e.g. lung and ribcage) yields a non-continuous deformation field in reality. Therefore we present in this talk a registration framework that allows discontinuities in the deformation field along predefined organ borders given by arbitrary orientable submanifolds. The incorporated methods involve constrained nonlinear registration in the Lagrange frame and a finite element discretization.

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MS38 Part II
Advances in 3D Electromagnetic Imaging

Electromagnetic imaging (EM) is often used for geophysical application such as finding minerals, hydrocarbons and water. In this talk we review recent advances in 3D EM methods. In particular we discuss the use of multiscale techniques for efficient modeling and stochastic optimization algorithms for the inversion. We will show how EM methods work on synthetic as well as field data sets.

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MS39 Part I
Constrained Image Restoration and Estimation of Regularization Parameters

We deal with the minimization of seminorms under certain constraints as Kullback-Leibler divergence or Anscombe transform constraints. Our minimization technique rests upon primal-dual methods and relations between constrained and penalized convex problems which resemble the idea of Morozov's discrepancy principle. Behind a sequence of vectors converging to a minimizer it produces also a sequence of parameters converging to a regularization parameter so that the penalized problem has the same solution as our constrained one.

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MS39 Part I
Toward Fast Transform Learning

The usual dictionary learning strategies alternate a code update stage and a dictionary update stage. In this talk, we study the possibility to compute a dictionary update stage, when the matrix-vector multiplications with the dictionary are computed with a fast transform. With that in mind, we investigate the possibility to approximate an atom by a composition of K convolutions with sparse kernels. Despite the nonconvexity of the optimization problem, we are able, when K is large (say $K = 10$), to approximate with a very high accuracy many atoms such as modified DCT, curvelets, sinc functions or cosines.

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MS39 Part I
Bilevel Optimization for Learning Variational Models

Variational models are particularly well suited to solve inverse problems in image processing. In this talk, we consider bilevel optimization for learning optimized regularization terms. We will consider the simple case of just learning the regularization parameters of fixed regularizers but also the case where we learn the regularizer itself. We show that we can obtain simple and computationally efficient variational models that lead to state-of-the-art results.

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MS39 Part I
Model Selection with Piecewise Regular Gauges

In this talk, we investigate in a unified way the structural properties of a large class of convex regularizers for linear inverse problems. We consider regularizations with convex positively 1-homogenous functionals (so-called gauges) which are piecewise smooth. Singularities of such functionals are crucial to force the solution to the regularization to belong to an union of linear space of low dimension. These spaces (the so-called "models") allows one to encode many priors on the data to be recovered, conforming to some notion of simplicity/low complexity. This family of priors encompasses many special instances routinely used in regularized inverse problems such as ℓ^1, $\ell^1 - \ell^2$ (group sparsity), nuclear norm, or the ℓ^∞ norm. The piecewise-regular requirement is flexible enough to cope with analysis-type priors that include a pre-composition with a linear operator, such as for instance the total variation and polyhedral gauges. This notion is also stable under summation of regularizers, thus enabling to handle mixed regularizations. Our main set of contributions provide sufficient conditions that allow to provably controlling the deviation of the recovered solution from the true underlying object, as a function of the noise level. More precisely we establish two main results. The first one ensures that the solution to the inverse problem is unique and lives on the same low dimensional sub-space as the true vector to recover, with the proviso that the minimal signal to noise ratio is large enough. This extends previous results well-known for the ℓ^1 norm, analysis ℓ^1 semi-norm, and the nuclear norm to the general class of piecewise smooth gauges. In the second result, we establish ℓ^2 stability by showing that the ℓ^2 distance between the recovered and true vectors is within a factor of the noise level, thus extending results that hold for coercive convex positively 1-homogenous functionals. This is a joint work with S. Vaiter, C. Deledalle, M. Golbabaee and J. Fadili.

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MS39 Part II
Correlation Mining for Imaging Problems

Correlation mining is a class of methods for extracting complex patterns from massive multivariate datasets, such as spatio-temporal data and images. Correlation mining has many applications in imaging and multidimensional signal processing including pattern discovery and anomaly detection in imaging and video, materials science, optical astronomy, and computational biology. In this talk I will present emerging methods of correlation mining for massive datasets, present mathematical theory, and illustrate with imaging applications.

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MS39 Part II
Blind Deblurring with Sharpness Metrics Based on Phase Coherence

Lately, new image sharpness metrics have been proposed that indirectly exploit the information contained in the phase component of the Fourier Transform of an image. Using such metrics for blind image deconvolution is appealing, in particular because they are able to distinguish between true sharpness and unwanted ringing artifacts resulting from erroneous deblurring kernels. We here propose some variational models for sharpness-based blind deconvolution, and discuss strategies to try to minimize the associated non-convex functionals.

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MS39 Part II
Non-Lipschitz l_p-Regularization and Box Constrained

Model for Image Restoration

In this paper, we study regularized nonsmooth nonconvex minimization with box constraints for image restoration. We present a computable positive constant for using nonconvex nonsmooth regularization, and show that the difference between each pixel and its four adjacent neighbors is either 0 or larger than θ in the recovered image. Moreover, we give an explicit form of θ for the box-constrained image restoration model with the non-Lipschitz nonconvex $\updownarrow_p$-norm $(0 < p < 1)$ regularization. Our theoretical results show that any local minimizer of this imaging restoration problem is composed of constant regions surrounded by closed contours and edges. Numerical examples are presented to validate the theoretical results, and show that the proposed model can recover image restoration results very well.

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MS39 Part II
Perturb-and-MAP Random Fields: Reducing Random Sampling to Optimization with Applications in Computer Vision

We will present an overview of the recently developed “Perturb-and-MAP” method which attempts to reduce probabilistic inference to a randomized energy minimization problem, thus establishing a close link between the probabilistic inference and optimization approaches to energy-based modeling. The Perturb-and-MAP approach makes Bayesian inference practically tractable for large-scale problems involving continuous or discrete variables, as illustrated in challenging computer vision applications such as image inpainting and deblurring, image segmentation, and scene labeling.

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MS39 Part III
Discrete Regularisation Approaches Related to Inverse Diffusion

Discontinuity-enhancing image regularisers related to nonlinear diffusion PDEs are well established in image processing. Some interesting PDEs of this kind, however, involve negative diffusivities that pose challenges for their analysis and numerical treatment. The talk focusses on approximations of such PDEs by spatially discrete filters which offer interesting alternatives to standard discretisations. Recent results in this area will be presented.

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MS39 Part III
Meta-Learning for Parameter Choice in Image Denoising

In many real-life applications, one encounters the situation where an image of interest has to be restored from mixed or multiplicative noise. Several effective algorithms to achieve reasonable denoising have been proposed. However, they presuppose some a priori knowledge on the noise nature to set their parameters. We propose here a novel approach based on the meta-learning concept that by employing the previous experience adaptively adjusts unknown parameters to each previously unseen image.

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MS39 Part III
Fast and Sparse Noise Learning via Nonlinear PDE Constrained Optimization

We consider a nonlinear PDE constrained optimization approach to learn the optimal weights for a generic TV-denoising model featuring different noise distributions possibly present in the data from a training set of images. To overcome the high computational costs needed to compute the numerical solution, we use dynamical sampling schemes. We will consider also spatially dependent weights combined with a sparse regularisation on the parameter vector.

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MS39 Part III
Blind Denoising

We address the problem of joint noise estimation and image denoising by a fully automatic procedure. This leads us to model the remnant noise after compression and other nonlinear transforms usually applied to raw images which have adultered the initial raw Poisson white noise. Thus, we attempt to estimate an image/frequency/signal dependent noise from the image itself and we shall show how to combine it with a state-of-the-art image denoiser.

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MS40 Part I
Robust 1-Bit Compressive Sensing with One-Sided ℓ_0 Function

We introduce an optimization model for reconstruction of sparse signals from noisy 1-bit measurements. The model is derived based on maximum a posterior. The data fidelity term of the objective function of the model uses the one-sided ℓ_0 function to impose the consistency restriction of the one-bit compressive sensing problem. Unlike existing algorithms, our proposed model does not require prior knowledge for noise level of the 1-bit measurements. A fixed-point proximity algorithm is developed for this model and the convergence analysis of the algorithm is provided. The numerical results show that the proposed model is suitable for reconstruction of sparse signals from noisy 1-bit measurements.

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MS40 Part I
Preconditioned Alternating Projection Algorithms for Maximum *a Posteriori* ECT Reconstruction

We propose a preconditioned alternating projection algorithm (PAPA) for solving the maximum *a posteriori* (MAP) emission computed tomography (ECT) reconstruction problem. Specifically, we formulate the reconstruction problem as a constrained convex optimization problem with the total variation (TV) regularization. We then characterize the solution of the constrained convex optimization problem and show that it satisfies a system of fixed-point equations defined in terms of two proximity operators raised from the convex functions that define the TV-norm and the constrain involved in the problem. The characterization (of the solution) via the proximity operators that define two projection operators naturally leads to an alternating projection algorithm for finding the solution. For efficient numerical computation, we introduce to the alternating projection algorithm a preconditioning matrix (the EM-preconditioner) for the dense system matrix involved in the optimization problem. We prove theoretically convergence of the preconditioned alternating projection algorithm. In numerical experiments, performance of our algorithms, with an appropriately selected preconditioning matrix, is compared with performance of the conventional MAP expectation-maximization (MAP-EM) algorithm with TV regularizer (EM-TV) and that of the recently developed nested EM-TV algorithm for ECT reconstruction. Based on the numerical experiments performed in this work, we observe that the alternating projection algorithm with the EM-preconditioner outperforms significantly the EM-TV in all aspects including the convergence speed, the noise in the reconstructed images and the image quality. It also outperforms the nested EM-TV in the convergence speed while providing comparable image quality.

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MS40 Part I
Image Inpainting Using ℓ_0 Sparse Regularization in DCT-induced Wavelet Domain

We propose a constrained inpainting model to recover an image from its incomplete and/or inaccurate wavelet coefficients. The objective functional of the proposed model use the ℓ_0 norm to promote the sparsity of the image in a special redundant system which is generated from the discrete cosine transform matrix. To overcome the algorithmic difficulty caused by ℓ_0 norm, we propose to approximate it with its Moreau envelope. An alternating minimization algorithm solving the new approximation optimization model is developed, and the convergence analysis of the algorithm is provided. The proposed algorithm can be accelerated by FISTA technique and we also propose an adaptive way to determine the approximation parameter to speed up the algorithm further. Our numerical experiments show that the proposed model and minimization algorithm can recover images with much better quality than the models based on ℓ_1 norm and total variation in terms of the PSNR values and visual quality of the restored images.

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MS40 Part I
A Preconditioned Primal-dual Fixed Point Algorithm for Convex Separable Minimization with Applications to Image Restoration

In the area of image science, many problems or models involve minimization of a sum of two convex separable functions. In this talk, we intend to develop a general algorithmic framework for solving such a problem from the point of view of fixed point algorithms based on proximity operators. Motivated from proximal forward-backward splitting (PFBS) and fixed point algorithms based on the proximity operator for image denoising, we design a primal-dual fixed point algorithm based on proximity operator (PDFP^{2}O$_\kappa$ for $\kappa \in [0, 1)$) and obtain a scheme with close form for each iteration. We establish the convergence of the proposed PDFP^{2}O$_\kappa$ algorithm, and under some stronger assumptions, we can further prove the global linear convergence of the proposed algorithm. We illustrate the efficiency of PDFP^{2}O$_\kappa$ through some numerical examples on image supperresolution and computerized tomographic reconstruction. Finally, we are going to show our recent work on how to precondition the previous algorithm. This is a joint work with Peijun Chen and Xiaoqun Zhang.

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MS40 Part II
Limited-Angle CT Reconstruction

Limited-angle CT reconstruction has inferior image quality because a few number of projects from limited angular range. The incomplete acquisition of projects provides insufficient frequency information for analytical image reconstruction and causes artifacts. To obtain satisfied reconstruction, regularization method has to be performed to suppress the noise and artifacts from missed frequency bands. In this work, we studied the application of regularized algebraic reconstruction method for limited-angle CT reconstruction.

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MS40 Part II
Proximity Algorithms for Multiplicative noise Removal

This paper proposes a new variational model for denoising images corrupted by multiplicative noise. We first analyzes the constraint condition for obtaining the strictly convexity of the model. Then, for solving the new convex variational model, an alternating minimization algorithm with the proximity operator is established to find the minimizer of the objective functional efficiently. In numerical experiments, performance of our algorithms is compared with that of the tow state-of-the-art methods available in the literature.

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MS40 Part II
Fixed-Point Proximity Algorithms for Optimization Problems in Image Restoration

We proposes a general fixed-point proximity algorithm framework for convex optimization problems in imaging science. We prove the convergence of the fixed-point proximity algorithms under certain conditions. Moreover, we point out that some existing popular algorithms, such as forward-backward splitting, alternating direction minimization, primal-dual algorithm with over relaxation, can be identified as special cases of our framework. Therefore, we are able to understand these algorithms from a unified perspective and prove the convergence of them in a unified way. Finally, we present a fixed-point proximity algorithm for a specific nonconvex image restoration model.

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MS41 Part I
The Factorization Method for Three Dimensional EIT

The use of the Factorization method for Electrical Impedance Tomography has been proved to be a very promising tool for recovering inhomogeneous inclusions in a known background. In this talk we demonstrate the capability of this method to locate inclusions in realistic inhomogeneous three dimensional background media from both simulated data and experimental data collected in plastic head shaped tank.

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MS41 Part I
Multifrequency EIT Using Spectral Information

Multifrequency Electrical Impedance Tomography exploits the dependence of tissue impedance on frequency to recover an image of conductivity. Recent results suggest that the use of explicit spectral constraints can significantly improve image quality. A method is researched for estimating the spectra of individual tissues, whilst simultaneously reconstructing the conductivity. The advantage of this method is that a priori knowledge of the spectral constraints is not required to be exact in that the constraints are updated at each step of the reconstruction.

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MS41 Part I
Non-Destructive Testing of Concrete with EIT

In this work, we apply electrical impedance tomography (EIT) imaging to non-destructive testing (NDT) of concrete structures. A special focus is in detection of cracking, which is one of the most significant factors contributing the premature deterioration of concrete and shortening service lives of structures. New computational methods for the crack detection are developed in Bayesian inversion framework. The feasibility of EIT for NDT of concrete is tested with various experiments.

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MS41 Part I
Combining Frequency-Difference and Ultrasound-Modulated EIT

We propose a new inclusion detection method for electrical impedance tomography (EIT) that is completely unaffected by geometrical modelling errors as it does not require knowledge of the electrode position or the shape of the imaging domain. The idea is to combine ultrasound-modulated EIT with frequency-difference EIT measurements. We use an ultrasound wave to alter the conductivity in a small focussing region inside the imaging domain. The resulting effect on the EIT measurements is then compared to the effect of a change in the electric current frequency. This shows whether the focussing region lies inside a conductivity anomaly or not.

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MS41 Part II
Anatomical and Physiological Priors for Absolute EIT Thorax Images

The use of physiological and anatomical priors of tissue resistivity distribution within the thorax, also known as anatomical atlas, in conjunction with the Gaussian filter as regularization methods are discussed. The proposed methodology employs the finite element method and the Gauss-Newton algorithm in order to obtain three-dimensional resistivity images. In vivo EIT images obtained during pulmonary physiological changes collected from a swine are compared to X-ray tomographic images.

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MS41 Part II
A Novel Data-Driven Edge Sharpening D-bar Reconstruction Algorithm for Electrical Impedance Tomography

EIT is an imaging modality that recovers the internal conductivity of a body via surface current and voltage measurements. The reconstruction task is a noise-sensitive ill-posed nonlinear inverse problem. The D-bar method, based on a tailor made scattering transform, regularizes EIT through a nonlinear low-pass filter. In medical applications it is known a priori that the conductivity contains high-frequency features (organ boundaries), often blurred in D-bar images due to the low-pass filter. In this talk, a novel approach of coupling a priori knowledge with the D-bar method is introduced and sharpened reconstructions from noisy simulated EIT data are presented, suggesting this as an exciting new avenue for EIT.

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MS41 Part II
Stochastic Galerkin Finite Element Method for Electrical Impedance Tomography

Electrical impedance tomography aims at reconstructing the conductivity of a body from boundary measurements of current and voltage. In this work, the conductivity is modeled as a log-normal random field with a known prior distribution. Using a stochastic Galerkin finite element method, a parametrized approximation is written for the posterior distribution, which enables efficient computation of point estimators. The feasibility of this approach is demonstrated by numerical examples based on the complete electrode model.

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MS42
A Riemanian Framework for Parametric and Nonparametric Spherical Regression

We discuss the problem of modeling relationship between manifold-valued random variables, with a focus on spherical or directional variables. We will present an example each from the parametric and the nonparametric approaches to regression. We model the response variable with a von Mises-Fisher distribution with the mean given by a transformation of the predictor variable. In the parametric approach this transformation is given by a rigid rotation, a mobius transformation, or a projective linear map, while in the nonparametric case the transformation is a full diffeomorphism between spheres. For the projective linear map, we have developed a Newton-Raphson algorithm on special linear group for finding maximum likelihood estimates of the regression parameter and established asymptotic properties of these estimators using large sample-size analysis. Through examples, we demonstrates improvements in the prediction and modeling performance of the proposed framework over previously used models.

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MS42
High-Dimensional Manifold Valued Data Analysis

Images are usual highly structured and high dimensional. Constraints imposed on the images, such as normalization or registation, lead to representations of the data objects as points on high-dimensional manifolds. Statistical analysis of manifold valued data provides a framework for investigating variability, group differences and general regression relationships. Tangent spaces, parallel transport and Gaussian approximations are key ingredients in the methodology, which will be illustrated in a range of applications in biomedical image analysis.

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MS42
SS-SPMs: Spatially Smoothing Statistical Parametric Maps for Ultra-High Dimensional Imaging Data

The aim of this paper is to develop a novel statistical framework for spatially smoothing statistical parametric maps (SS-SPMs) to carry out group analysis of neuroimaging data. SS-SPMs is proposed to optimally apply a large class of parametric and semiparametric statistical models to analyzing massive imaging data in various complex studies (e.g., longitudinal or familial), while accounting for the functional nature of neuorimaging data. SS-SPMs includes a measurement model at each voxel, a latent factor model for score equation maps, and a jumping surface model for each parameter image. We develop a three-stage estimation procedure to simultaneously smooth the maps of parameter estimates, to approximate the corresponding standard deviation maps, and to test hypothesis of interest. Our estimation procedure can preserve possible jumps and edges among different piecewise-smooth regions in each parameter map. We systematically investigate the asymptotic properties (e.g., consistency and asymptotic normality) of the multiscale adaptive parameter estimates. Our Monte Carlo simulation and real data analysis have confirmed the excellent performance of SS-SPMs.

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MS42
Statistical Peak Detection in Images

Suppose an image is composed of a set of unimodal peaks observed under smooth Gaussian noise. A common approach to peak detection in such setting is to perform matched filtering and then threshold the height of the local maxima of the ob- served random field. In this work, this approach is formalized as a topological multiple testing problem, enabling a statistical determination of the detection threshold. Assuming unimodal true peaks with nite support and Gaussian stationary ergodic noise, it is shown that the algorithm with Bonferroni or Benjamini-Hochberg multiple testing correction provides asymptotic strong control of the family wise error rate and false discovery rate, and is power consistent, as the search space and the signal strength get large, where the search space may grow exponentially faster than the signal strength. Simulations show that error levels are maintained for non-asymptotic conditions, and that power is maximized when the smoothing kernel is close in shape and bandwidth to the signal peaks, akin to the matched lter theorem in signal processing. The methods are illustrated in the detection of molecules in fluorescence nanoscopy.

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MS43
First- and Higher-order Regularisation of Tensor Fields

Many image processing applications involve data that does not naturally have a scalar- or vector-valued representation. Instead, data such as angles, phases, orientations, or, in particular, covariance matrices, are more accurately represented by points or tensors on a manifold. Examples include the processing of phase data in time-of-flight cameras and velocity-encoded MRI, tensor fields in diffusion tensor imaging, and the denoising and generation of surface normals for 3D reconstruction and visualization. In this minisymposium we will address some of the unique challenges in the modelling, analysis, and numerical solution of problems with such non-standard range constraints.

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MS43

Total Variation Regularization for Functions with Values in a Manifold

While total variation is among the most popular regularizers for variational problems, its extension to functions with values in a manifold is an open problem. We propose an algorithm to solve such problems which applies to arbitrary Riemannian manifolds. The framework can be easily adapted to different manifolds including spheres and three-dimensional rotation data, and allows to obtain accurate solutions even with a relatively coarse discretization.

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MS43

Moment Tensors and High Angular Resolution Diffusion Imaging

A moment tensor has the form $E(x \otimes x \otimes \ldots \otimes x)$ for some random vector x. A symmetric tensor is a moment tensor if and only if it can be written as a positive linear combination of symmetric rank-1 tensors. Such tensors have many nice properties. We will provide the mathematical foundations for the Schultz–Seidel construction of 3D images of neural fibers from dMRI measurements via decompositions and approximations of moment tensors.

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MS44

Sparsity in Fluids - Vorticity Estimation via Compressive Sensing

In order to validate the simulation of a material that undergoes a shock, an X-ray experiment is performed where a tomographic reconstruction is needed. As the theoretical object is radially symmetric, a single radiograph is enough to perform the reconstruction. The goal of this paper is to study 3D-deformations using very few views (about three) by introducing an optimal transport formulation in order to reconstruct an object close to the simulation that fits the data.

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MS44

State Space Constrained Reconstruction for PET imaging

A state space strategy offers an alternative to achieve robust and optimal image reconstructions. Compared to earlier statistical works, our efforts have three novel aspects. First, this paradigm undertakes the uncertainties on both the imaging system model and the measurement data. Secondly, it is capable of unifying the dynamic/static reconstruction problems into a general framework. Finally, Since the H_infinity principle makes no assumptions on the measurement statistics, it is suited for PET imaging.

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MS44

Tailoring Advanced Image-Reconstruction Algorithms to Real World Applications

Realization of the potential of recent algorithm advances for X-ray-based tomographic imaging in real-world applications is a challenging task. In the presentation, insights and guidance will be illustrated for tailoring the algorithms to imaging applications, with real-data examples in NDI, security scan, and medicine. Also, clarifications will be made for a number of confusing issues concerning data sampling and imaging models. Finally, if time allows, the significant issue of meaningful image-quality evaluation will be discussed.

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MS44

High-order Total Variation Regularization Approach for Axially Symmetric Object Tomography from a Single Radiograph

We consider Abel transform based density reconstruction for axially symmetric objects from a single radiograph by fan-beam X-rays. All contemporary methods assume that the density is piecewise constant or linear. This is quite a restrictive approximation. Our proposed model is based on high-order total variation regularization. Its main advantage is to reduce the staircase effect and enable the recovery of smoothly varying regions. We compare our model with other potential methods by giving numerical tests.

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MS45 Part I

Dense Multi-Frame Optic Flow Using Subspace Constraints: Algorithms and Applications

My research in 3D Computer Vision focuses on the inference of 3D dynamic models from video. While most 3D Vision techniques aim to recover the structure of static scenes, in fact natural scenes are dynamic in nature and contain multiple independently moving or non-rigid objects, such as human bodies. How far can we go in acquiring 3D models of such moving scenes automatically and only from the stream of images from a single conventional camera? While multiple-camera setups, specialised sensors (such as depth cameras), prior knowledge about the objects to be reconstructed or training data might make this task easier, here we take a purely data-driven approach which has the widest possible applicability in fields including cinema post-production, sports science, robotics, and laparoscopy. In this talk I will present the recent solutions that we have proposed to the most challenging aspects of dynamic, non-rigid and articulated inference from images: modelling highly deformable surfaces, such as flexible cloth; 2D deformable tracking; dense optical flow estimation and non-rigid video registration. In particular I will address the problem of non-rigid video registration, or the computation of optical flow from a reference frame to each of the subsequent images in a sequence, when the camera views deformable objects. We exploit the high correlation between 2D trajectories of different points on the same non-rigid surface by assuming that the displacement of any point throughout the sequence can be expressed in a compact way as a linear combination of a low-rank motion basis. This subspace constraint effectively acts as a trajectory regularization term leading to temporally consistent optical flow. We formulate it as a robust soft constraint within a variational framework by penalizing flow fields that lie outside the low-rank manifold.

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MS45 Part I
Novel Algorithms for Estimating Large-Scale Optical Flow

Multilabel problems are of fundamental importance in computer vision and image analysis. Yet, finding global minima of the associated energies is typically a hard computational challenge. Recently, progress has been made by reverting to spatially continuous formulations of respective problems and solving the arising convex relaxation globally. In practice this leads to solutions which are either optimal or within an a posteriori bound of the optimum. Unfortunately, in previous methods, both run time and memory requirements scale linearly in the total number of labels, making these methods very inefficient and often not applicable to problems with higher dimensional label spaces. In this paper, we propose a reduction technique for the case that the label space is a continuous product space and the regularizer is separable, i.e., a sum of regularizers for each dimension of the label space. In typical real-world labeling problems, the resulting convex relaxation requires orders of magnitude less memory and computation time than previous methods. This enables us to apply it to large-scale problems like optic flow, stereo with occlusion detection, segmentation into a very large number of regions, and joint denoising and local noise estimation. Experiments show that despite the drastic gain in performance, we do not arrive at less accurate solutions than the original relaxation. Using the novel method, we can for the first time efficiently compute solutions to the optic flow functional which are within provable bounds (typically 5%) of the global optimum.

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MS45 Part I
Optical Flow Decomposition with Time Regularization

In this paper we present a variational method for determining cartoon and texture components of the optical flow of a noisy image sequence. The method is realized by applying decomposition methods and then by using spatio-temporal regularizers. We study a decomposition for the optical flow into bounded variation and oscillating component in greater detail. Numerical examples demonstrate the capabilities of the proposed approach.

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MS45 Part I
Modeling Temporal Coherence for Variational Optical Flow

In this paper, we will present a novel parametrization for multi-frame optical flow computation that naturally enables us to embed the assumption of a temporally coherent spatial flow structure, as well as the assumption that the optical flow is smooth along motion trajectories. Experiments show the clear superiority of our approach when compared to existing strategies for imposing temporal coherence. Moreover, we demonstrate the state-of-the-art performance of our method at the widely used Middlebury benchmark.

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MS45 Part II
Recursive Joint Estimation of Dense Scene Structure and Camera Motion

In this talk, we present nonlinear variational models for the coherent estimation of motion fields. We propose several contributions that efficiently relate flow fields at different time instants. These contributions translate into new assumptions that are useful for modeling coherent flows in time, especially in the presence of large displacements. These can be easily combined with traditional spatial models, consistently linking the flow information in the spatial and temporal dimensions. This general scheme deals with continuous and non-continuous velocities.

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MS45 Part II
Semicontinuity and Relaxation of a Variational Functional for Optical Flow

A fundamental task in image processing is the simultaneous denoising and estimation of motion in an image sequence. The brightness constancy assumption gives a pointwise differential condition on the motion field. At object edges, where usually intensity and motion velocity jump simultaneously, this condition fails. The talk presents a joint total variation functional. Its relaxation - which ensures lower semicontinuity - comes along with a microscopic variational problem on edges as generalized brightness constancy assumption. Thereby, bounds for the relaxed energy allow to rule out microstructure formation under reasonable assumptions on the application and thus demonstrate the appropriateness of the joint model.

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MS45 Part II
Real-Time Optical Flow Estimation Using High-Frame-Rate Videos

This talk concerns an optical flow method for both high- and low-speed objects based on high-frame-rate videos. A frame-straddling function can improve the measurable range of optical flows without heavy computation by selecting a small frame interval for high-speed objects and a large frame interval for low-speed objects. Optical flows are accurately estimated in real time at hundreds of fps, and the effectiveness of the frame-straddling optical flow is verified with several real-time experimental results.

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MS45 Part II
Non-linear Spatio-Temporal Coherence Models for Optical Flow Estimation

In this talk, we present nonlinear variational models for the coherent estimation of motion fields. We propose several contributions that efficiently relate flow fields at different time instants. These contributions translate into new assumptions that are useful for modeling coherent flows in time, especially in the presence of large displacements. These can be easily combined with traditional spatial models, consistently linking the flow information in the spatial and temporal dimensions. This general scheme deals with continuous and non-continuous velocities.

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MS46
Benchmarking Optimization Algorithms for Phase Retrieval

We provide an overview of optimization algorithms for phase retrieval and develop metrics for testing the effectiveness and performance of these algorithms. Using these metrics, we revisit Fienup's (Appl. Optics, 1982) comparative study of projection-based algorithms and examine more recent algorithms. We also describe our initial efforts in creating standardized test sets for CDI and ptychography in order to perform systematic benchmarking and inform future algorithmic developments.

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MS46
Phase Retrieval in High Dimensional Data Space

With high speed detectors and ever brighter light sources, imaging by diffraction is becoming increasingly popular. Detectors producing several TB/h diffraction measurements are now operational at every synchrotron in the world. Diffraction measurements contain short-spatial Fourier frequency information about an object, enabling wavelength resolution. The phase retrieval problem is made tractable by recording multiple diffraction patterns from the same region of the object. In ptychography, by using a small step sizerelative to the size of the illuminating beam when scanning the sample. Diffraction measurements from neighboring regions are related to each other by the illumination geometry. This motivates us to consider synchronization methods aiming to organize local information in a global way.

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MS46
Toward Global Optimization for Phase Retrieval

We discuss various formulations of the phase retrieval problem in coherent X-ray diffraction imaging (CDI) as a structured *nonconvex* optimization problems. We review matrix-lifting techniques that provide convex semi-definite programming relaxations of the nonconvex CDI inverse problem. Unfortunately, the resulting SDP formulations square the size of the problem and are computationally intractable for realistic applications. We suggest a new hybrid local-global optimization technique that provides good solution at reasonable computational cost.

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MS46
Fourier Phasing with Phase-uncertain Mask

Fourier phase retrieval is studied with the introduction of a random phase mask. Solution of the phasing problem was proved to be unique with exact knowledge of the mask. Recently uniqueness has been extended to the case where only rough information about the mask's phases is assumed. New phasing algorithms alternating between the object update and the mask update are demonstrated to have the capability of recovering both the object and the mask (within the object support) simultaneously.

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MS47 Part I
Accelerated Primal Dual and ADMM Methods with Applications in Imaging

We present accelerated primal dual (APD) method and accelerated alternating direction method of multipliers (AADMM) for solving a class of non-smooth convex minimization. By incorporating a multi-step accelerated gradient method into the primal dual algorithm and ADMM scheme, respectively, the APD and AADMM methods can achieve the same optimal rate of convergence as Nesterov's smoothing technique. Both APD and AADMM do not smooth the objective function. They can deal with the situation, where the feasible region is unbounded with modified termination criterion. The experimental results on image reconstruction from partially parallel MR imaging, and comparisons of the performance of APD, AADMM, Nesterov?s smoothing technique, and several existing methods will be presented.

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MS47 Part I
Efficient Numerical Methods for Inverse Source Problems with Applications in Fluorescence Tomography

I will present a new approach to solve the inverse source problems arising in Fluorescence Tomography (FT). It computes the solution using a two-step strategy: find a particular solution to match the boundary measurements, then correct the solution in the kernel space. It dramatically improves the computation speed and image resolution over the existing methods.

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MS47 Part I
Sparse Subspace Clustering for Incomplete Face Images

In this talk, we present a novel approach to cluster face images with missing pixels based on sparse subspace clustering. We propose a nonconvex optimization model for this purpose. An efficient first-order optimization algorithm is proposed to solve this structured optimization model. Preliminary experiments on face images from Extended Yale B dataset shows than our method can cluster the incomplete images very well when 30% pixels of the images are missing.

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MS47 Part I
Tomographic Reconstruction of Atmospheric Turbulence from Micro-lens Imagery

Data acquired using a micro-lens array to form multiple images of the full field-of-view of an astronomical target can be used to reconstruct the 3-D wave front for the observations. The reconstruction problem can be modeled as a large-scale inverse problem, and solved using iterative optimization techniques. We show that there is substantial structure in the mathematical model that can be exploited for computational efficiency.

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MS47 Part II
A Two-Stage Image Segmentation Method Using a Convex Variant of the Mumford-Shah Model and Thresholding

The Mumford-Shah model is one of the most important image segmentation models, and has been studied extensively in the last twenty years. In this talk, we propose a two-stage segmentation method based on the Mumford-Shah model. The first stage of our method is to find a smooth solution g to a convex variant of the Mumford-Shah model. Once g is obtained, then in the second stage, the segmentation is done by thresholding g into different phases. The thresholds can be given by the users or can be obtained automatically using any clustering methods. Because of the convexity of the model, g can be solved efficiently by techniques like the split-Bregman algorithm or the Chambolle-Pock method. We prove that our method is convergent and the solution g is always unique. In our method, there is no need to specify the number of segments K ($K \geq 2$) before finding g. We can obtain any K-phase segmentations by choosing $(K-1)$ thresholds after g is found in the first stage; and in the second stage there is no need to recompute g if the thresholds are changed to reveal different segmentation features in the image. Experimental results show that our two-stage method performs better than many standard two-phase or multi-phase segmentation methods for very general images, including anti-mass, tubular, MRI, noisy, and blurry images.

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MS47 Part II
A New Convex Optimization Model for Multiplicative Noise and Blur Removal

The main contribution of this paper is to propose a new convex optimization model for multiplicative noise and blur removal. The main idea is to rewrite a blur and multiplicative noise equation such that both image variable and noise variable are decoupled. The resulting objective function involves the total variation regularization term, the term of variance of the inverse of noise, the ℓ_1-norm of the data fitting term among the observed image, and noise and image variables. Such convex minimization model can be solved efficiently by using many numerical methods in the literature. Numerical examples are presented to demonstrate the effectiveness of the proposed model. Experimental results show that the proposed model can handle blur and multiplicative noise (Gamma, Gaussian or Rayleigh distribution) removal quite well.

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MS47 Part II

New Sparse Regularization Evolving ℓ_1 Subgradient

We introduce new spare regularization approaches based on evolving the ℓ_1 subgradient p. It is closely related to LASSO, inverse scale space, Bregman regularization, and linearized Bregman. We show that the new approaches give better solutions than LASSO. The solutions are sparser and fit data better. Both theoretical guarantees and computational results will be given. This is joint work with Ming Yan, Yuan Yao, and Stanley Osher.

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MS47 Part II
Learning Sparsely Used Dictionaries via Convex Optimization

The ability to learn sparsifying dictionaries for sample data is important for many practical applications of sparse modeling in the imaging sciences. We describe heuristics for learning complete dictionaries and orthonormal bases in various settings. We show that if the data are generated according to a sufficiently sparse random model, the true underlying dictionary and coefficients can be recovered (upto an inevitable ambiguity) with high probability. This talk describes joint work with Dan Spielman (Yale), Huan Wang (Yahoo), Ju Sun (Columbia) and Cun Mu (Columbia).

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MS48 Part I
Spatio-Temporal TV Priors for Dynamic Inverse Problems in Biomedicine

In dynamic biomedical imaging mathematical inversion and tracking methods play a fundamental role. Particularly in the context of cell biology, tomography and live microscopy, innovative spatio-temporal imaging models are of strongly growing interest. The aim of this talk is to highlight recent modeling and computations of joint density reconstruction and flow quantification for 4D image sequences. With the success of TV and TGV regularization for static imaging we focus on properties of spatio-temporal TV priors within optimal transportation.

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MS48 Part I
4D Computed Tomography Reconstruction from Few-projection Data via Temporal Non-local Regularization

4D computed tomography is an important modality in medical imaging due to its ability to resolve patient anatomy motion in each respiratory phase. We propose a new 4D-CT reconstruction algorithm that explicitly takes into account the temporal regularization in a non-local fashion. By imposing a regularization of a temporal non-local means (TNLM) form, 4D-CT images at all phases can be reconstructed simultaneously using extremely under-sampled x-ray projections.

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MS48 Part I
Flow Driven Inpainting and Denoising

Modern microscopes are able to visualize even the smallest biological processes within cells. One example is intracellular flows where the flow dynamics within a single cell are visualised by a sequence of microscopic images over time. Extracting accurate information on very short timescales, however, comes with a lack of spatial quality of the images in terms of resolution and noise. One possibility to counteract this and enhance the image sequence is to use the fact that the recorded images are connected by motion of objects over time. In this talk we present a model that couples flow information into an image inpainting/denoising problem and simultaneously calculates the flow pattern between timesteps.

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MS48 Part II
Level Set Method for Dynamic Sparse-Data X-Ray Tomography

A novel time-dependent tomographic imaging modality with multiple source-detector pairs in fixed positions is discussed. All detectors record simultaneously time-dependent radiographic data ("X-ray videos") of a moving object, such as a beating heart. The dynamic two- or three-dimensional structure is reconstructed from projection data using a new computational method. Time is considered as an additional dimension in the problem, and a generalized level set method [Kolehmainen, Lassas, Siltanen, SIAM J Scientific Computation 30 (2008)] is applied in the space-time. In this approach, the X-ray attenuation coefficient is modeled by the continuous level set function itself (instead of a constant) inside the domain defined by the level set, and by zero outside. Numerical example with both simulated and measured data suggest that the method enforces suitable continuity both spatially and temporally.

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MS48 Part II
Empirical Phase Transitions in Sparsity-regularized Computed Tomography

Sparsity-exploiting reconstruction has proven useful for dose reduction in computed tomography, even though theoretical recovery guarantees from compressed sensing do not apply. Instead we aim to empirically establish quantitative understanding of the role of sparsity in computed tomography. Through computational studies we provide empirical evidence of sharp average-case phase transitions from no to full recovery across different image classes, sparsity in the image itself and in its gradient (total variation) and noise-free and noisy data.

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MS48 Part II
Dynamic SPECT Reconstruction from Few Projections by Spatial-temporal Sparsity constrained Matrix Factorization

Dynamic Single-Photon Emission Computed Tomography (SPECT) allows 3D visualization and monitoring of biological processes in human body. Due to fast decay of radioisotope by time, very few projection data can be collected at each time interval. Thus the reconstruction of dynamic images is a very challenge problem, especially when noise is present. In this work, we consider low rank matrix factorization of unknown images and explore spatial-temporal sparsity structures of both representation coefficients and basis. The proposed variational model can be efficiently solved by well-known sparse optimization algorithms. Numerical experiments and comparison with other methods on 2D and 3D data show the advantages of our proposed method for the reconstruction and regularization from very few projection data with noise.

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MS48 Part II
A Novel Method for Real-Time Volumetric Imaging via Sparsity Learning

Real-time volumetric imaging is desirable for image guidance and treatment monitoring in radiation therapy. We have developed a framework to generate patient image based on real-time measurement data of different types. A respiratory motion model is constructed using patient-specific 4D-CT. The motion is then correlated with measurements, where relevant data components are automatically selected to predict the motion, yielding the real-time images. Experiments on phantom and patient cases show satisfactory results.

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MS49 Part I
Dynamical CT Image Processing in Radiation Oncology

Radiation therapy aims at delivering a prescribed amount of radiation dose to the cancer target, while minimizing doses to surrounding critical organs. Dynamic medical imaging such as 4D-CT plays an important role when treating tumors in lung or upper abdomen, where respiration-induced motions may compromise treatment plan and dose delivery quality. This talk will give an overview on the needs of dynamic imaging in radiation oncology and current techniques, particularly on 4D-CT and 4D-cone beam CT.

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MS49 Part I
Patch-Based Low-Rank and Sparsity Penalty for Dynamic Imaging

Dynamic imaging is widely used in MRI, CT, and PET. However, to retain sufficient temporal resolution, the number of samples or its signal to noise ratio are often not sufficient enough, so conventional reconstruction algorithms produce images with artifacts. To address this problem, many advanced reconstruction algorithms have been developed using various spatio-temporal regularizations. The main goal of this work is to develop a novel spatio-temporal regularization approach that exploits inherent similarities within and across frames. One of the main contributions of this paper is to demonstrate that such correlations can be exploited using a low rank constraint of spatio-temporal patches that is less sensitive to global intensity variations. Using simulation results and real in vivo experiments with MRI, CT, and PET, we confirm that the proposed algorithm can improve image quality and extract high quality parameters.

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MS49 Part I
Dynamic Shape and Motion Estimation Under Inconsistent Contrast and Low SNR Conditions

The study of pharmacokinetic behavior requires precise knowledge of voxel trajectory. Spatially heterogeneous variations in the image sequence, as in the presence of dynamic contrast, violate the conventionally assumed intensity and/or statistical consistency and invalidate the use of L2 or mutual information as matching objectives. We propose to utilize shape geometry in a holistic manner and use this new “consistency” for dynamic registration. Further improvement of robustness and efficiency are achieved by incorporating shape priors.

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MS49 Part I
Exploring Compressed Sensing Optimization for Total-Variation Based Four-Dimensional Cone-Beam CT

Compressed sensing based cone-beam (CB) computed tomography (CT) reconstruction is an unconstrained multi-criteria optimization problem, which simultaneously minimize the image sparsity as well as the error. We propose a framework with Pareto frontier analysis to explore the possible regularization weights for four dimensional (4D) CBCT, extend the sparsity extraction by spatial-temporal total-variation, and utilize Nesterov’s descent method to achieve convergence speed. Experiments of both phantom and clinical data demonstrated the feasibility of our framework.

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MS49 Part II
A Hybrid 4D Cone Beam CT Reconstruction Algorithm for Highly Under-Sampled Projections from the 1-Minute Cone Beam Scan

Respiratory motion is the main problem in lung/upper-abdominal radiotherapy. An iteratively performed forward-backward splitting (FBS) method is invented to split the original reconstruction problem into separated reconstruction and deformable registration problems. By performing FBS, it achieves a fusion of both the right geometrical information from measured CBCT projections and correct intensity values from the planning CT, and hence yields a high quality 4D-CBCT image, even with highly sparse projections from a 1-min CBCT scan.

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MS49 Part II
Motion-compensated Cone-Beam CT for Image-Guided Radiotherapy

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MS49 Part II
3D/4D Imaging Verification Using Digital Tomosynthesis (DTS)

Digital tomosynthesis (DTS) was developed recently for image guided radiation therapy (IGRT). Unlike cone-beam CT (CBCT), DTS only acquires projections within a limited scan angle to reconstruct quasi-3D/4D images. Therefore, DTS has much lower imaging dose and shorter scanning time than CBCT. New image reconstruction techniques have been developed to use patient prior knowledge and deformation models to recover full volumetric information in DTS. This talk will review the current developments of DTS for IGRT.

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MS50 Part I
Parallel and Distributed Sparse Optimization

Modern datasets have a large number of features or training samples stored in distributed manners. Motivated by the need of solving sparse optimization problems with large datasets, we propose two approaches (i) distributed implementations of prox-linear algorithms and (ii) GRock, a parallel greedy coordinate-block descent method. We establish the convergence of GRock and explain why it often performs exceptionally well. Numerical results on a computer cluster and Amazon EC2 demonstrate the efficiency of our algorithms.

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MS50 Part I
Hydra: Distributed Coordinate Descent for Big Data Problems

We propose Hydra: distributed coordinate descent for big data optimization. Hydra partitions the coordinates to the nodes of a cluster. At every iteration, each node picks a random subset of the coordinates from those it owns, and in parallel updates them based on a simple closed-form formula. We give bounds on the number of iterations sufficient to approximately solve the problem with high probability, and show how it depends on the data and partitioning.

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MS50 Part I
Communication-Efficient Algorithms for Distributed Optimization

We propose a distributed algorithm for minimizing a sum of functions where each function is known only at one node of a given network. We assume each function depends on an arbitrary set of components of the optimization variable and not necessarily on all of them, as usually assumed. Although very general, our algorithm requires less communications to converge than prior distributed algorithms, even ones that were designed for a particular application.

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MS50 Part II
The Decentralized Gradient Descent Method for Multi-Agent Optimization

This talk focuses on the decentralized gradient descent method that solves the multi-agent optimization problem. At each iteration, each agent mixes its local solution with its neighbors', and descends in the negative gradient direction of its local cost function. We show that if the local objective functions are restricted strongly convex and have Lipschitz continuous gradients, the decentralized gradient descent method converges linearly to a neighborhood of the optimal solution.

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MS50 Part II
Consistency of Early Stopping Regularization in Linearized Bregman Algorithms

Linearized Bregman iterations can be regarded as an iterative procedure to follow the regularization path with early stopping rules. In this talk we will establish statistical consistency of early stopping regularization for a limit dynamics of Linearized Bregman iterations. Under similar conditions for LASSO, sign-consistency of such Bregman dynamics can be established. Bregman dynamics has an additional advantage over LASSO in that it is bias-free when sign-consistency is reached, which is however inevitable for all convex penalized likelihood methods due to Fan-Li's result. This explains the experimental observation that Bregman regularization path is often better than LASSO path, due to such an effect of nonconvex penalization.

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MS51
Adaptive Bregman Operator Splitting Method with Variable Stepsize for Parallel MR Imaging

This paper proposes an new adaptive Bregman operator splitting algorithm with variable stepsize (Adaptive BOSVS) for solving problems of the form $\min_u \phi(Bu) + 1/2\|Au - f\|^2$, where $\phi(Bu)$ may be nonsmooth. The original BOSVS algorithm uses a line search to achieve efficiency, while a proximal parameter is adjusted to ensure global convergence whenever a monotonicity condition is violated. The new Adaptive BOSVS uses a simpler line search than that used by BOSVS, and the monotonicity test can be skipped. Numerical experiments based on partially parallel image reconstruction compare the performance of BOSVS and Adaptive BOSVS scheme.

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MS51
Local Rigidity Constrained Diffeomorphic Deformations for Image Analysis

We developed a new diffeomorphic deformation framework for image analysis in which the deformation was constrained by local rigidity. The deformation is driven by a set of control points, which are chosen from the image pixels based on the local properties. Less control points are chosen in the regions which are more homogeneous and the local rigidity constraints are the main driving force in those areas. This model has good shape conservation properties, the deformation is reasonable even for a small number of control points.

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MS51
An Iterative Generalized l1 Greedy Algorithm for CT Image Reconstruction

In this talk, we will introduce a a generalized l_1 greedy algorithm via total variation minimization for CT image reconstruction. Numerical experiments are shown to illustrate the convergence of the new algorithm and demonstrate the superiority of the algorithm over the reweighted l_1 minimization and l_1 greedy algorithm.

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MS52 Part I
Non-Convex Multiple-Objective Image Modeling

In many imaging applications there exist multiple measures of goodness-of-fit of a model to an observed image. For example, image reconstruction, outlier detection, and segmentation are often evaluated on the basis of image approximation error, anomaly detection error, and region classification error, respectively. A single model generally does not simultaneously optimize these multiple objective functions. Convex approaches to optimization over model space is to scalarize by replacing the multiple objective functions with a linearly weighted combination. Non-convex approaches to this optimization problem take a direct approach and search for non-dominated solutions, called Pareto sets, of the multiple objective optimization problem. We discuss this problem in the context of image retrieval and show how continuum limit theory can be used to characterize the nature of these non-dominated solutions.

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MS52 Part I
Multiclass Segmentation by Iterated ROF Thresholding

Variational models as the Mumford-Shah model and the active contour model have many applications in image segmentation. In this paper, we propose a new multiclass segmentation model by combining the Rudin-Osher-Fatemi model with an iterative thresholding procedure. We show that our new model for two classes is indeed equivalent to the Chan-Vese model but with an adapted regularization parameter which allows to segment classes with similar gray values. We propose an efficient algorithm and discuss its convergence under certain conditions. Experiments on cartoon, texture and medical images demonstrate that our algorithm is not only fast but provides very good segmentation results in comparison with other state-of-the-art segmentation models in particular for images containing classes of similar gray values.

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MS52 Part I

Restoration of Images Corrupted by Multiplicative Noise

In this talk, a new variational model for restoring blurred images with multiplicative noise is proposed. Based on the statistical property of the noise, a quadratic penalty function technique is utilized in order to obtain a strictly convex model under a mild condition, which guarantees the uniqueness of the solution and the stabilization of the algorithm. For solving the new convex variational model, a primal-dual algorithm is proposed, and its convergence is studied. The talk ends with a report on numerical tests for the simultaneous deblurring and denoising of images subject to multiplicative noise. A comparison with other methods is provided as well.

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MS52 Part II
Non-heuristic Graph Reduction for Graph Cut

After some reminders on graph cuts, we present a simple local test which permits to quickly assign some nodes to a label. We give a theorem stating that the assignment is correct and give the sketch of its prove. Experimentally we find that in many cases the test permits to limit the construction of the graph and the computation of the max flow in a thin band surrounding the boundary of the object.

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MS52 Part II
iPiano: Inertial Proximal Algorithm for Non-Convex Optimization

We study an algorithm for solving a minimization problem composed of a differentiable (possibly non-convex) and a convex (possibly non-differentiable) function. The algorithm combines forward-backward splitting with an inertial term. A rigorous analysis of the algorithm for the proposed class of problems yields global convergence of the function values and the arguments. We demonstrate iPiano on several vision problems, among them learned priors in denoising and optical flow estimation, and image compression.

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MS52 Part II
Four Color Theorem and Convex Relaxation for Image Segmentation with Any Number of Regions

Image segmentation is an essential problem in imaging science. One of the most successful segmentation models is the piecewise constant Mumford-Shah minimization model. This minimization problem is however difficult to carry out, mainly due to the non-convexity of the energy. Recent advances based on convex relaxation methods allow to estimate almost perfectly the geometry of the regions to be segmented when the mean intensity and the number of segmented regions are known a priori. The next important challenge is to provide a tight approximation of the optimal geometry, mean intensity and the number of regions simultaneously while keeping the computational time and memory usage reasonable. In this work, we propose a new algorithm that combines convex relaxation methods with the four color theorem to deal with the unsupervised segmentation problem. More precisely, the proposed algorithm can segment any a priori unknown number of regions with only four intensity functions and four indicator ("labeling") functions. The number of regions in our segmentation model is decided by one parameter that controls the regularization strength of the geometry, i.e. the total length of the boundary of all the regions. The segmented image function can take as many constant values as are needed. This talk is based on joint works with T. F. Chan, X. Bresson and R. Zhang.

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MS53 Part I
Fixed-Point Algorithms for Emission Computed Tomography Reconstruction

Emission computed tomography (ECT) is a noninvasive molecular imaging method that finds wide clinical applications. It provides estimates of the radiotracer distribution inside a patient's body through tomographic reconstruction from the detected emission events. In this talk, we propose a fixed-point algorithm - preconditioned alternating projection algorithm (PAPA) for solving the maximum a posteriori (MAP) ECT reconstruction problem. Specifically, we formulate the reconstruction problem as a constrained convex optimization problem with the total variation (TV) regularization via the Bayes law. We then characterize the solution of the optimization problem and show that it satisfies a system of fixed-point equations defined in terms of two proximity operators of the convex functions that define the TV-norm and the constraint involved in the problem. This characterization naturally leads to an alternating projection algorithm (APA) for finding the solution. For efficient numerical computation, we introduce to the APA a preconditioning matrix (the EM-preconditioner) for the large-scale and dense system matrix. We prove theoretically convergence of the PAPA. In numerical experiments, performance of our algorithms, with an appropriately selected preconditioning matrix, is compared with performance of the conventional expectation-maximization (EM) algorithm with TV regularization (EM-TV) and that of the recently developed nested EM-TV algorithm for ECT reconstruction. Based on the numerical experiments performed in our work, we observe that the APA with the EM-preconditioner outperforms significantly the conventional EM-TV in all aspects including the convergence speed and the reconstruction quality. It also outperforms the nested EM-TV in the convergence speed while providing comparable reconstruction quality.

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MS53 Part I
Decentralized Optimization and Its Splitting Methods

Decentralized optimization meets the future needs arising from mobile computing, self-driving cars, cognitive radios, and collaborative data mining, just to name a few. It allows optimization problems in a self-organizing network to be solved without a central computer. Compared to standard distributed computing with a fusion data, a decentralized approach is safer and more reliable since it tolerates certain failed nodes or links, has better load balance, and allows each node to keep its data private during the computation. This talk introduces new methods for decentralized optimization include a few based on operator/variable splitting methods. We provide convergence analysis and numerical examples. This talk covers different join work with Qing Ling, We Shi, and Kun Yuan at USTC.

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MS53 Part I
Accelerating Model-Based X-Ray CT Image Reconstruction Using Variable Splitting Methods with Ordered Subsets

The augmented Lagrangian (AL) optimization method has drawn more attention recently in imaging applications due to its decomposable structure for composite cost functions and empirical fast convergence rate under weak conditions. However, for problems such as the X-ray computed tomography (CT) image reconstruction, where there is no efficient way to solve the inner least-squares problem, the AL method can be slow due to the iterative inner updates. To solve this problem, we consider a linearized variant of the AL method, that replaces the quadratic AL penalty term by a separable quadratic surrogate, thus leading to a much simpler image update. The presentation will describe the convergence properties of the linearized AL method and a recently proposed order-subsets (also known as the incremental gradient) accelerable splitting-based algorithm for fast model-based X-ray CT image reconstruction using the linearized AL framework.

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MS53 Part I
Primal-Dual Methods Revisited: New Schemes and Applications

Classical primal-dual based methods have recently attracted a revived interest for solving structured convex minimization problems arising in signal/image processing and machine learning. In this talk, we focus on the interplay between optimization problems, their saddle point representation, and global rate of convergence analysis of these methods. In particular, we introduce a new algorithm for a class of saddle point problems which allows to efficiently address an important class of convex models. We prove its global rate of convergence and illustrate its relevance and performance through numerical examples.

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MS53 Part II
Splitting Strategies for Convex Problems with Complicated Block Structure

The Alternating Direction Method of Multipliers (ADMM) and its variants can be applied to very general convex problems. There has been a lot of interesting recent work on accelerating the rate of convergence by dynamically and adaptively updating algorithm parameters. However, the formulation of the problem can also have a significant effect on practical performance. We will discuss splitting and preconditioning strategies for applying these methods to convex problems with complicated block structure.

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MS53 Part II
Revisiting the Quadratic Programming Formulationof Sparse Recovery

One of the first successful algorithms to handle the famous $\ell_2 + \ell_1$ optimization problem of sparse recovery (a.k.a. the LASSO) was based on reformulating it as a bound-constrained quadratic program (BCQP), solved using projected gradient descent with spectral (Barzilai-Borwein) step choice. We revisit the BCQP formulation, considering two different algorithmic approaches: the alternating direction method of multipliers and a quasi-Newton-type algorithm. Although both involve a matrix inverse in each iteration, in several relevant problems this inversion can be efficiently computed and these methods achieve state-of-the-art speed.

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MS53 Part II
On the Minimization of Quotient Functionals

In various applications it seems to be more useful to involve quotients like max(b/x,x/b) into the data term of the energy functional than differences abs(x-b). In this talk we deal with the minimization of quotient functionals, in particular with the approximation related to quotient functionals. The results were applied for estimating the selectivities of predicates for a query optimizer in a relational database management system. This is joint work with G. Moerkotte (University of Mannheim, Germany) and A. Repetti (Université Paris Est, France).

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MS53 Part II
Reweighted ℓ^2 Method for Image Restoration with Poisson and Mixed Poisson-Gaussian Noise

We study weighted ℓ^2 fidelity in variational models for Poisson noise related image restoration problems. Gaussian approximation to Poisson noise statistic is adopted to deduce weighted ℓ^2 fidelity. Different from usual weighted ℓ^2 approximation, we propose a reweighted ℓ^2 fidelity with sparse regularization by framelets. Based on Split Bregman algorithm, the proposed numerical scheme is composed of three easy subproblems that involve quadratic minimization, soft shrinkage and matrix vector multiplications. Unlike usual least square approximation of Poisson noise, we dynamically update the underlying noise variance from previous estimate. The solution of the proposed algorithm is shown to be the same as the one obtained by minimizing Kullback-Leibler divergence fidelity with the same regularization. This reweighted ℓ^2 formulation can be easily extended to mixed Poisson-Gaussian noise case. Finally, the efficiency and quality of the proposed algorithm compared to other Poisson noise removal methods are demonstrated through denoising and deblurring examples. Moreover, mixed Poisson-Gaussian noise tests are performed on both simulated and real digital images for further illustration of the performance of the proposed method.

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MS54 Part I
Implicit Filtering

In this talk we will describe the implicit filtering algorithm, a derivative-free optimization method for functions which may be non-smooth, discontinuous, not everywhere defined, and/or random. The algorithm combines a direct search method with a quasi-Newton quadratic model. We will discuss the essential idea of the method, the latest theoretical results, and an application to imaging from a paper by Cornello, Piccolomini, and Nagy (Numer Alg, 2013).

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MS54 Part I
A Semismooth Newton-CG Augmented Lagrangian Algorithm for Convex Minimization Problems with Non-Separable ℓ_1-Regularization

We consider the minimization of the sum of a convex function and a non-separable ℓ_1-regularization term. Such problems appear in various high-dimensional sparse feature learning problems in statistics, as well as in image processing. We propose an inexact semismooth Newton augmented Lagrangian (SSNAL) algorithm to solve an equivalent reformulation of the problem. Comprehensive results on the global and local convergence of the algorithm are established, including the characterization of the positive definiteness of the generalized Hessian in each subproblem of the algorithm. Numerical experiments show that the SSNAL algorithm performs favourably in comparison to several state-of-the-art first-order algorithms for solving fused lasso problems, and outperforms the best available algorithms for clustered lasso problems.

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MS54 Part I
The Augmented-Lagrangian-Type Methods for Low Multilinear-Rank Tensor Recovery

Low multilinear-rank tensor recovery is a recovery task of finding a low multilinear-rank tensor that fulfills some linear constraints. Combining variable splitting and convex relaxation, we develop a Splitting Augmented Lagrangian Method (SALM) to solve the problem and prove its convergence under some conditions. Inspired by Gauss-Seidel method, we further propose two improved frames of SALM, which have promising numerical performance though their convergences are still missing.

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MS54 Part I
An Algorithm for Variable Density Sampling with Block-Constrained Acquisition

We propose an original algorithm to perform variable density sampling when using blocks of measurements. The basic idea is to minimize a tailored dissimilarity measure between a probability distribution defined on a set of isolated measurements and a probability distribution defined on a set of blocks of measurements. This problem is convex and we define an efficient mini

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MS54 Part II
Functional-Analytic and Numerical Issues in Splitting Methods for Total Variation-Based Image Reconstruction

Variable splitting schemes for the function space TV-model in its primal and pre-dual formulations are considered. In the primal splitting formulation, while existence of a solution cannot be guaranteed, it is shown that quasi-minimizers of the penalized problem are asymptotically related to the solution of the original TV-model. On the other hand, for the pre-dual formulation a family of parametrized problems is introduced and a parameter dependent contraction of an associated fixed point iteration is established. Moreover, the theory is validated by numerical tests. Additionally, the augmented Lagrangian approach is studied, details on an implementation on a staggered grid are provided and numerical tests are shown.

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MS54 Part II
Exact Recovery for Sparse Signal via Weighted L1 Minimization

Numerical experiments have indicated that the reweighted L1 minimization perform exceptionally well in recovering sparse signal. In this talk, we want to develop new exact recovery conditions and algorithm for sparse signal via weighted L1 minimization. We first introduce the concept of WNSP (weighted null space property) and reveal that it is a necessary and sufficient condition for weighted L1 exact recovery. We then show that the RIC (restricted isometry constant) bound by weighted L1 minimization trends to 1 under some situations which is greater than the existing RIC bound 0.4343. Finally, we propose a modified iterative reweighted L1 minimization (MIRL1) algorithm based on our selection principle of weight, and the numerical experiments demonstrate that our algorithm MIRL1 behaves much better than the existing weighted L1 minimization algorithms.

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MS54 Part II
A Nonmonotone Approximate Sequence Algorithm for Unconstrained Nonlinear Optimization

A new nonmonotone algorithm will be presented for unconstrained nonlinear optimization. Under proper searching direction assumptions, this algorithm has global convergence for minimizing general nonlinear objective function with Lipschitz continuous derivatives. For convex objective function, this algorithm would maintain the optimal convergence rate of convex optimization. Some preliminary numerical results will be also presented.

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MS54 Part II
Proximal Linearized Alternating Direction Method for Image Restoration

Recently, the augmented Lagrangian-based alternating direction method has been proposed to solve total variation regularized variational models and frame-based models for image restoration with multiplicative noise or Poisson noise. But algorithms based on the augmented Lagrangian require inner iterations or an inverse involving the Laplacian operator at each iteration. In this talk, we propose a proximal linearized alternating direction (PLAD) method for solving those models. The proposed PLAD method does not require any inner iterations or inverses due to the linearization scheme. We establish global convergence under mild conditions.

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MS55 Part I
Weighted Nuclear Norm Minimization for Image Restoration

We study the weighted nuclear norm minimization (WNNM) problem with F-norm data fidelity, where the singular values are assigned different weights. The solutions of the WNNM problem are analyzed under different weighting conditions. We then apply the proposed WNNM algorithm to image restoration by exploiting the image nonlocal self-similarity. Experimental results clearly show that the proposed WNNM algorithm outperforms many state-of-the-art image restoration algorithms in term of both quantitative measure and visual perception quality.

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MS55 Part I
Deblurring Face Images with Exemplars

The success of the state-of-the-art image deblurring methods mainly stems from implicit or explicit restoration of salient edges for kernel estimation. However, existing methods are less effective when blurred images do not contain rich textures (e.g., blurred face images), as only a few sharp edges can be predicted by generic priors for kernel estimation. In this paper, we address the problem of deblurring face images by exploiting good exemplar structures. We determine the kind and number of edges of a face image for effective kernel estimation, and form a set of exemplar structures. Given a blurred face image, the most similar exemplar structure is determined. We propose a maximum a posterior (MAP) deblurring algorithm based on a predicted exemplar structure without using coarse-to-fine strategies or ad-hoc edge selections. Extensive evaluations against state-of-the-art methods demonstrate that the effectiveness of the proposed algorithm for deblurring face images.

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MS55 Part I
The Noise Clinic

Demosaicking and compression stages in the camera imaging chain correlate and color initial white noise at the sensor. This makes traditional image denoising algorithms useless for denoising most part of image photographs. We present a new multiscale algorithm estimating and removing noise from any digital image.

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MS55 Part II
Joint Spatiotemporal Removal of Mixed Random and Fixed-Pattern Noise from Video

We propose a framework for denoising videos corrupted by spatially correlated random and fixed-pattern noise (FPN). Our approach is based on motion-compensated 3-D spatiotemporal volumes, i.e. sequences of 2-D patches along the motion trajectories. The spatial and temporal redundancy within each volume are leveraged to attain sparsity in a separable 3-D spatiotemporal transform domain, leading to effective separation of signal from noise through shrinkage. Specifically, our shrinkage utilizes an adaptive 3-D threshold array calculated from the particular motion trajectory and from the individual power spectral densities of random noise and FPN. The proposed framework enables high-quality imaging for various challenging applications and particularly for thermography.

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MS55 Part II
Structure-Texture Separation via Relative Total Variation

It is ubiquitous that meaningful structures are formed by or appear over textured surfaces. Extracting them under the complication of texture patterns is very challenging, but of great practical importance. We propose new inherent variation and relative total variation measures, which capture the essential difference of these two types of visual forms, and develop an efficient optimization system to extract main structures. Our approach finds a number of new applications.

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MS55 Part II
Super-Resolution from Internet-Scale Scene Matching

We present a highly data-driven approach to the task of single image super-resolution. Our key observation is that global scene descriptors and Internet-scale image databases enable us to find similar scenes even at extremely low-resolution. We quantitatively show that the statistics of scene matches are more predictive than internal image statistics for the super-resolution. Finally, we build on recent patch-based texture transfer techniques to hallucinate texture detail and compare our super-resolution with other recent methods.

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MS56
Image Denoising by Frequency-based Directional Multiscale Representation Systems

In this talk, we shall mainly discuss the digitization and applications of a directional multiscale representation system: frequency-based smooth affine shear tight frames. The MRA structure of such tight frames and their connections to directional wavelet frames allow the realization of frequency-based smooth affine shear tight frames through their underlying filter bank systems via subsampling. Applications in image denoising and comparison to other systems like curvelets, shearlets, wavelets, etc., shall be presented.

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MS56
Directional Multiscale Representation Systems and Mathematical Imaging

Real-valued separable wavelets can only capture edge singularities along horizontal and vertical directions. In this talk, we present a theory and construction of directional separable complex tight framelets. Our approach has the advantages of improved directionality and uses finitely supported filter banks. We propose a family of directional separable complex tight framelets with increasing directions, which have superior performance in image denoising over many known wavelet-based image denoising methods.

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MS56
Image Restoration Using Shearlet Based Sparsity Priors

Over the past decades, various data models have been proposed and image processing has relied heavily on those models. Among them, sparse and redundant representation model has recently received extensive attention and shown to be quite effective in various applications. The key idea of this model is to search for data which can be sparsely represented by some given representation system under certain constraint depending on problems. Therefore, it is essential to use a representation system that can provide a sparse representation for true data we want to approximate in this model.
In this talk, we will discuss various image restoration tasks using shearlets which can be shown to provide nearly optimal sparse representations for data governed by anisotropic features and mathematical guarantees for our restoration schemes for such data.

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MS57 Part I
A Weighted Dictionary Learning Model for Denoising Images Corrupted by Mixed Noise

We propose a general weighted l^2-l^0 norms energy minimization model to remove mixed noise from the images. The approach is built upon maximum likelihood estimation (MLE) framework and sparse representations over a trained dictionary. Instead of optimizing the likelihood functional derived from a mixture distribution, we present a new weighting data fidelity function which has the same minimizer as the original likelihood functional but is much easier to optimize. The weighting function in the model can be determined by the algorithm itself and it plays a role of noise detection in terms of the different estimated noise parameters. In addition, we also extend our method to nonlocal version. Experimental results demonstrate its better performance compared with some existing methods.

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MS57 Part I
Edge Detection Using a Modified Mumford-Shah Model

The purpose of this paper is to introduce a new model for edge detection. In order to treat the constraint of the level-set function and the involved total variation (TV)-term effectively, we propose the proximity algorithm and the split Bregman method to resolve the binary level-set function, and the fixed-point iterative scheme to solve the second unknown, i.e., the expected piecewise smooth approximation to the given image. Furthermore, we proposed coupled pretreatments to speed up the computation. The efficiency of the proposed minimization algorithms is shown by comparing it with the existing methods.

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MS57 Part I
Fast Algorithms for Structured Sparsity Based Brain Imaging

Structured sparsity is playing an important role in high dimensional multi-variate data analysis. In this talk, we are focusing on developing new efficient algorithms for sparse optimization problems, arising from brain imaging and related pattern recognition problems.

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MS57 Part I
A Level Set Formulation of Geodesic Curvature Flow on Simplicial Surfaces

Curvature flow (planar geometric heat flow) has been extensively applied to image processing, computer vision, and material science. To extend the numerical schemes and algorithms of this flow on surfaces is significant for corresponding motions of curves and images defined on surfaces. In this talk, we are interested in the geodesic curvature flow over triangulated surfaces using a level set formulation. After presenting the geodesic curvature flow equation on general smooth manifolds based on an energy minimization of curves, we discretize the equation by a semi-implicit finite volume method (FVM). For convenience of description, we call the discretized geodesic curvature flow as dGCF. The existence and uniqueness, as well as the regularization behavior, of dGCF are discussed. Finally, we present several applications of dGCF to three problems: the closed-curve evolution on manifolds; the edge detection of images painted on triangulated surfaces; interactive surface mesh segmentation.

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MS57 Part II
Framelet Based Convex Optimization Model for Multiplicative Noise and Blur Removal

The main idea is to rewrite a blur and multiplicative noise equation such that both image variable and noise variable are decoupled. The resulting objective function involves the weighted l_1 norm of the tight frame coefficients term, the term of variance of the inverse of noise, the 1-norm of the data fitting term among the observed image, and noise and image variables. Such convex minimization model can be solved efficiently by using many numerical methods in the literature. Numerical examples are presented to demonstrate the effectiveness of the proposed model. Experimental results show that the proposed model can handle some distributions of multiplicative noises quite well.

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MS57 Part II
A Primal-Dual Method for Meyer's Model of Cartoon and Texture Decomposition

In this talk, we study Meyer's model of cartoon and texture decomposition in image processing. This model, which is indeed a minimization problem, contains an l_1-based TV-norm and an l_∞ based G-norm and hence it is difficult to implement in practice. Using dual formulation to represent both TV-norm and G-norm, the minimization problem of Meyer's model is transferred into a minimax problem, where a saddle point needs to seek. A first-order primal-dual algorithm is proposed to compute the saddle point of the minimax problem. The convergence of the proposed algorithm is theoretically proved. Numerical results are presented to show the well performance of the proposed method.

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MS57 Part I
Single Image Dehazing and Denoising: A Fast Variational Approach

In this presentation, we propose a new fast variational approach to dehaze and denoise simultaneously. The proposed method first estimates a transmission map using windows adaptive method based on a simple but effective image prior-dark channel prior. This transmission map can avoid the block effect and thus enhance the precision of the estimation. The transmission map is then converted to a depth map, with which the new variational model can be built to find the final haze-free and noise-free image. The existence and uniqueness of minimizer of the proposed variational model is further discussed. A numerical procedure based on the Chambolle-Pock algorithm is given, and the convergence of the algorithm is ensured. Extensive experimental results on real scenes demonstrate that our method can restore vivid and contrastive haze-free and noise-free images effectively.

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MS57 Part II
Total Variation Regularization Variational Method to Retrieval Phases from Partial Magnitude of 2D Images

In many applications, the magnitude measurements of objects Fourier transform are recorded; However, people can not measure the corresponding phase information at all. Phase retrieval is that by using such magnitude information to reconstruct the phase or the object, which is generally an ill-posed inverse problem. It has attracted much attention of researchers to study more than one half century. In this paper, we focus on the phase retrieval from partial magnitude of Fourier transformation(FT) of 2D images. Both the exact partial magnitude information and the noisy data are considered. Total variation regularization model is proposed, and an efficient alterative directional multiplier method (ADMM) is adopted to solve the proposed model. Various numerical tests are made to demonstrate the proposed model outperforms the phase retrieval model without total variation regularization, since the reconstructed images preserve the structure and edges, and own less visible artifacts as well.

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MS57 Part III
Spatially Adaptive Total Variation Model: From Pixel to Regional Perspective

Total variation is a popular and effective image prior model. However, as it favors a piecewise constant solution, the result under high noise intensity is often poor. Therefore, we develop a regional adaptive total variation (RATV) model, in which the spatial information weight is constructed and classified with k-means clustering, and the regularization strength in each is controlled regionally. Experimental results, on both image denoising and super-resolution, verified its effectiveness.

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MS57 Part III
Separable Tensor Compressive Sensing and Application in Hyperspectral Imaging

Traditional compressive sensing for multidimensional data is based on vectorization which will lead to the loss of structure information. To overcome this limitation, we propose a tensor compressive sensing strategy for multidimensional data. Based on Tucker decomposition model, an overcomplete separable dictionary learning method is proposed for every mode. Simultaneously, to make the sensing matrix and dictionary be incoherent, we also propose a method to learn separable sensing matrix for every mode instead of using random matrix. In multidimensional case, large number of training samples will be involved. To make the tensor compressive sensing algorithm more efficient, we also proposed an online learning method which requires less computer memory.

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MS57 Part III
An Online Coupled Dictionary Learning Approach for Remote Sensing Image Fusion

Most earth observation satellitesprovide a high spatial resolution (HR) panchromatic (Pan) image and a multispectral (MS) image at a lower spatial resolution (LR). Image fusion is an effective way to acquire the high spatial resolution multispectral images that are widely used in various applications. This presentation proposes an online coupled dictionary learning approach for image fusion. Fusion results suggests the effectiveness of the proposed fusion method.

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MS57 Part III
Joint Blind Unmixing and Sparse Representation for Anomaly Detection in Hyperspectral Image

The objective of this work is to bring a new robust anomaly detection algorithm which is able to find sub-pixel targets, and a new background representation model. The background is modeled by a dictionary, which is constructed by blind unmixing algorithm and is composed with relatively pure endmember bundles. Then each pixel in hyperspectral image is sparse represented by the dictionary. Those pixels that have large reconstruction errors are the potential anomaly targets. Compared with the classical global RX algorithm, the proposed algorithm performed very well in sub-pixel anomaly detection even in noisy image.

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MS57 Part IV
A Variational Approach for Image Stitching

In this presentation, I will introduce an algorithm for image stitching. The idea is to propose a variational approach containing an energy functional to determine both a weighting mask function and a stitched image together. The existence of solution of the proposed energy functional is shown. An alternating minimizing algorithm is introduced to solve the proposed model numerically.

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MS57 Part IV
Screening Technique: Identifying Most Positions of Zeros in a Sparse Solution

Screening technique refers to algorithms that identify most positions of zeros in a sparse solution of certain problems with a convex loss function and a l_1-norm penalty, such as least absolute shrinkage and selection operator (LASSO). We first introduce one type of screening method: SAfe Feature Elimination (SAFE), then present our improvement on the SAFE method, which mainly make use of the optimal dual solution. We also demonstrate our experimental results to show the efficiency of the algorithm.

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MS57 Part IV
Variational Approach for Color-to-Grayscale Image Conversion

Color-to-grayscale conversion is the process to convert a color image to a grayscale one. The main aim of this talk is to give a variational approach for contrast preserving decolorization. The existence and uniqueness of the minimizer of the variational model can be shown. We also present an effective algorithm to solve the variational model numerically, and show the convergence of the algorithm. Experimental results are reported to demonstrate the effectiveness of the proposed method, and its performance is better than those of the other testing methods for a set of benchmark color images.

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MS57 Part IV
Total Generalized Variation via Spectral Decomposition

We present a new unified framework of total generalized variation involving higher degree partial image derivatives. In spectral decomposition framework, we derive an equivalent representation of the total generalized variation, which is formulated as weighted L1-L2 mixed norms of the image derivatives. A novel projected gradient algorithm is designed to solve the resulting optimization problems. Comparisons of the proposed model with state-of-the-art higher-order approaches in image recovery demonstrated the significant improvement in performance.

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MS57 Part V
Study on Relationship Between System Matrix and Reconstructed Image Quality in Iterative Image Reconstruction

A simple length weighted algorithm was proposed for PET imaging system matrix. Compared with the traditional length weighted algorithm the proposed algorithm reduced situations of the intercepted photon rays with the grid and the grid index by the proposed approach was determined in the two dimensional coordinate. The image reconstructed with the system matrix was constructed through the new process and the quality of the reconstructed image was assessed. The experimental results show that the operation speed of the proposed algorithm is more than three times faster than Siddon algorithm.

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MS57 Part V
A Universal Variational Framework for Sparsity Based Image Inpainting

Image inpainting is an important topic in the field of computer vision and image processing, which aims to filling-in the missing information in an observed incomplete image. We study a universal variational framework to solve image inpainting problem in which many popular regularization techniques can be utilized. Efficient numerical scheme is designed and convergence of the algorithm is also studied. Experimental results demonstrate that the proposed method is promising in various image inpainting tasks such as scratch and text removal, randomly missing pixel filling and small size missing block completion.

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MS57 Part V
Image Restoration and Segmentation Based on a Bilaterally Constrained Hybrid Total-Variation-Type Model

This report studies the image restoration and segmentation problems based on a bilateral constraint by convexly combining two classes of total-variation-type functionals. The proposed model including two L^1-norm terms leads to some numerical difficulties, so we employ the alternating split Bregman method (ASB) to solve it which can be reinterpreted as Douglas-Rachford splitting applied to the dual problem. We also prove that the ASB owns the convergence rate $O(\frac{1}{\mathcal{M}})$ for the iteration $\mathcal{M}$. Experimental results demonstrate the viability and efficiency of the proposed model and algorithm to restore blurring and noisy images.

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MS57 Part V
A New Variational Model for Image Segmentation

In this paper, we present a variational formulation for image segmentation based on local Laplacian distribution. We assume that the local image data within each pixels neighborhood satisfy the Laplacian distribution. Meanwhile, we propose a new spatial regularization term on membership functions. Alternating minimization method is used to derive the numerical algorithm in which each subproblem has closed form solution. Experimental results demonstrate that the proposed model is effective for various image segmentation.

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MS57 Part VI
Point Set Registration under Lie Group Framework

Point set registration is the process of finding an optimal spatial transformation that aligns two point sets. Given two point sets (with outliers), We propose a trimmed strategy for affine registration of point sets using Lie group parametrization. This is conducted by sequentially finding the closest correspondence of two point sets, estimating the overlap rate of two sets, and finding the optimal affine transformation via the exponential map of the affine group.

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MS57 Part VI
On Decomposition-Based Block Preconditioned Iterative Methods for Half-Quadratic Image Restoration

Half-quadratic regularization can effectively preserve image edges and a fixed-point iteration method can be employed to solve the minimization problem. In this talk, Newton method is applied to solve the half-quadratic regularization image restoration problem. We designed decomposition-based block preconditioning matrices and the preconditioned conjugate gradient method is applied to solve the linear system arising from the Newton iterations. Both theoretical and experimental results show that the proposed preconditioners are very efficient.

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MS57 Part IV
Digital Inpainting of Remote Sensing Images

Because of the malfunction of sensors and the cloud occlusions, the dead pixels are common in the remote sensing images. In order to recover the missing information, we propose extract the auxiliary information from the image itself, from other spectral bands, from other temporal images, or from their combinations in the variational and/or compressed sensing frameworks. This presentation also gives an in-depth investigation and comparison of the state-of-the-art inpainting methods for the remote sensing images.

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MS57 Part VI
Ensemble Learning for Remote Sensing Image Processing

This paper intends to give a review to the uses of ensemble learning to remote sensing image processing by selecting image classification and change detection as two case tasks. The framework of ensemble learning for remote sensing image processing is designed, and different application schemes are discussed. Secondly, some benchmark ensemble learning algorithms are applied to improve the performance of some popular remote sensing image classifiers.

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MS58
Imaging Focal Brain Activity from MEG Data

In this talk, we discuss Bayesian methods for imaging focal electric activity in brain from induced magnetic fields measured outside the head. The signal corresponding to focal activity is occluded by brain noise, and a significant challenge is to separate data coming from activity of different spatial and temporal statistical characteristics. We discuss Bayesian methods of source separation, based on the use of appropriately designed mixture prior models and priorconditioned iterative solvers.

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MS58
Neuroelectric Source Localization by Random Spatial Sampling

Fast neural source localization is essential for both neuroscience studies and effective clinical applications. We propose an efficient inversion method for the localization of neuroelectric sources from electromagnetic data recorder outside the head. We will show several numerical tests on both synthetic and real data and will prove that the proposed method is fast, spatially accurate and has a low computational load.

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MS58
Handling Uncertainty in the Measurement Geometry in Practical EIT

The aim of electrical impedance tomography (EIT) is to reconstruct the admittance distribution inside a body from boundary measurements of current and voltage. In this work, the need for prior geometric information on the measurement setting of EIT is relaxed by introducing a Newton-type output least squares algorithm that reconstructs the admittance distribution and geometric parameters simultaneously. The functionality of the technique is demonstrated via numerical tests with experimental data.

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MS58
IAS Inversion of Electromagnetic Field Data

Electromagnetic applications lead to high dimensional parameter spaces limiting the applicable palette of inversion methods. This talk concentrates on the iterative alternating sequential (IAS) algorithm providing a fast and stable option for many such occasions. Inverse problems of electro/magnetoencephalography and sparse source ultrasound/radio-wave/microwave tomography will be covered. The former one is linear and involves quasi-static electromagnetic field data to be inverted for a sequence of time frames. The latter is non-linear with the data following from a hyperbolic forward model which can be approached, for instance, via the finite-difference time-domain method or with a simple ray tracing technique.

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MS59
Scale, Equi-Affine and Affine Invariant Metrics

Shape recognition deals with the study geometric structures. Modern surface processing methods can cope with non-rigidity - by measuring the lack of isometry, deal with similarity or scaling - by multiplying the Euclidean arc-length by the Gaussian curvature, and manage equi-affine transformations - by resorting to the special affine arc-length definition in classical equi-affine differential geometry. Here, we propose a computational framework that is invariant to the full affine group of transformations (similarity and equi-affine). Thus, by construction, it can handle non-rigid shapes. Technically, we add the similarity invariant property to an equi-affine invariant one and establish an affine invariant pseudo-metric. As an example, we show how diffusion geometry can encapsulate the proposed measure to provide robust signatures and other analysis tools for affine invariant surface matching and comparison.

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MS59
Computational Metric Geometry in the Natural Space

Shapes can be treated and compared between as metric spaces. In the applied domain, one is confronted with the question of how to efficiently apply analysis tools like variations of the Gromov distance? We argue that the space spanned by the leading eigenfunctions of the Laplace Beltrami operator is natural for such operations. Examples of working in the spectral domain will support this argument.

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MS59
Building Compatible Bases on Graphs, Images, and Manifolds

Spectral methods are used in computer graphics, machine learning, and computer vision, where many important problems boil down to constructing a Laplacian operator and finding its eigenvalues and eigenfunctions. We show how to generalize spectral geometry to multiple data spaces. Our construction is based on the idea of simultaneous diagonalization of Laplacian operators. We show how this problem is related to the problem of finding closest commuting operators, and discuss numerical methods for its solution.

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MS59
Sparse Models in Shape Analysis

In this talk, we will present a novel sparse modeling approach to non-rigid shape matching using only the ability to detect repeatable regions. As the input to our algorithm, we are given only two sets of regions in two shapes; no descriptors are provided so the correspondence between the regions is not know, nor we know how many regions correspond in the two shapes. We show that even with such scarce information, it is possible to establish very accurate correspondence between the shapes by using methods from the field of sparse modeling, being this, the first non-trivial use of sparse models in shape correspondence. We formulate the problem of permuted sparse coding, in which we solve simultaneously for an unknown permutation ordering the regions on two shapes and for an unknown correspondence in functional representation. We also propose a robust variant capable of handling incomplete matches. Numerically, the problem is solved efficiently by alternating the solution of a linear assignment and a sparse coding problem. We show that the proposed methods achieve state-of-the-art performance on standard benchmarks containing both synthetic and scanned objects.

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MS60 Part I
Low-Rank Structures in Numerical Analysis and Data Recovery Problems

We consider a variety of low-rank structures expressed through tensor decompositions of multi-index arrays, including the TT and HT decompositions, and learning strategies as generalizations of the cross interpolation algorithm in the case of matrices. We show how these strategies can be used in numerical integration of multivariate functions, fast summation algorithms for series, solution of Smoluchowski equation. Using them as well we construct a new heuristic method for global optimization problems and demonstrate its performance for solving the docking problem for a sample of ligand-protein complexes.

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MS60 Part I
Numerical Tensor Methods: Tools and Applications

Tensors and their compact representations play crucial role in different applications. To break the curse of dimensionality (i.e., the exponential complexity growth with respect to the dimension of the tensor) low-parametric representations are required. We will discuss basic tensor decompositions (canonical format, Tucker format) and their disadvantages which lead to the development of novel tensor format (Tensor Train and Hierarchical Tucker formats). Good news is that these formats come with robust and effective algorithm for numerous tasks of approximation, interpolation, approximate solution of linear system and eigenvalue problems. These tools are implemented in an open-source software package TT-Toolbox. Efficient methods for different applications can be obtained my using these building blocks. Applications include biology, chemistry, data mining and compression.

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MS60 Part I
Tensor Recovery Methods and Nuclear Norms of Associated Matrices

We propose several algorithms to estimate missing values in visual data based on tensor decompositions. Tensor recovery has two principal cases: a tensor is given in all positions but some of the elements were corrupted (tensor pursuit), and the case of given corruption mask (tensor completion). We deal with tensor ranks defined by ranks of unfolding matrices such as Tucker ranks, TT-ranks (but not canonical rank). In image recovery we usually have 2 or 3 dimensional data, but it is useful to consider given data as a multidimensional tensor. We compare several splitting techniques and matrix and tensor recovery methods for MRI data.

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MS60 Part I
Optimization of Measurements in k-spaces and Image Reconstruction Algorithms

Reducing MRI scan time is an important problem, because it reduce scan cost. Also it may even improve image quality, as the less scan time the less patient moves. Common idea is to measure not all k-space values, but only values on some mask, approximating others through image reconstructions. This work is about different approaches of such masks construction, including adaptive mask construction during the scan that is better in many cases than precomputed masks. Also different ways of image reconstructions, including one based on WTT (Wavelet Tensor Train transform), will be discussed.

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MS60 Part II
Wavelet Tensor Train Decomposition for the Compression of Image Sequences

This work is devoted to a Wavelet Tensor Train decomposition for the compression of array's families at the example of monochrome image sequences. Wavelet tensor train decomposition is an algebraic technique for the construction of adaptive wavelet transforms. Its main disadvantage is that it requires to store filters for each image. We propose a new approach that is based on the construction of one filter for a sequence of images.

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MS60 Part II
The Application of Tensor Calculus to the Probabilistic Graphical Models: Results and Open Problems

Discrete probabilistic graphical models (e.g. Bayesian and Markov nets) is a state-of-the-art framework for modeling highly-interdependent multi-dimensional data such as images, video, social networks, texts, etc. They possess attractive factorization properties which make approximate inference tractable. But even more problems are still open. On the other hand they can be treated as tensors of high dimension. Their TT-representation offers completely new approach to the analysis of graphical models making many inference problems easier to solve. We derive several formulations and show how they can be approximated via TT-formulation of graphical models.

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MS60 Part II
Low-Rank Approximation of Energies in Markov Random Fields and Their Representation in TT-format

Our goal is to approximate Markov Random Field (MRF) energy using Tensor-Train (TT) format. A standard way to construct TT-approximation of a generic function is to use TT-interpolation techniques. However, MRF energy functions possess a specific structure which can be exploited. We decompose MRF energy into a sum of relatively small terms, construct TT-approximation for each individual term and then take their sum. The proposed method is faster and more accurate than direct energy TT-interpolation.

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MS60 Part II
Computationally Efficient Methods for MAP-Inference and Partition Function Estimation in MRF in TT Format

We deal with Markov Random Field (MRF) energy represented in Tensor-Train (TT) format. We exploit both the TT structure and properties of MRF energy to build efficient methods for solving MRF problems. First problem of interest is the maximum a posteriori (MAP) inference, which corresponds to finding the minimal element in the tensor. The second problem is computing MRF partition function, which corresponds to taking the sum of tensor elements under a nonlinear transformation.

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Abstracts of Contributed Talks

CT01

Meteorological Data Analysis with Diffeomorphic Demons

The goal of this presentation will be to demonstrate that advanced mathematical algorithms found in medical imaging could also benefit meteorological data analysis. In particular, we are interested in using diffeomorphic image registration for time-interpolation, analogue finding and verification of a variety of meteorological data fields. The usefulness of the developed algorithms will be demonstrated by comparing a precipitation assimilation analysis (CaPA) with forecasts from the Canadian numerical weather model (GEM) during a severe rain event.

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CT01

Modelling and Analysing Oriented Fibrous Structures

A mathematical model for fibrous structures using a direction dependent scaling law is presented. The orientation of fibrous nets (e.g. paper) is analysed with a method based on the curvelet transform. The curvelet-based orientation analysis has been tested successfully on real data from paper samples: the major directions of fibre orientation can apparently be recovered. Similar results are achieved in tests on data simulated by the new model, allowing a comparison with ground truth.

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CT01

Fast Optimized Harmonic Registration of Genus-0 Closed Surfaces with Landmark Constraints

Harmonic registration between genus-0 closed surfaces with landmark constraints is crucial in medical imaging and computer visions. The computation is slow and usually the bijectivity of the registration cannot be guaranteed under large deformations. In this talk, we introduce an algorithm that significantly accelerates the optimized harmonic registration and guarantees the bijectivity of the registration. Experimental results on human cortical surfaces are presented to demonstrate the effectiveness of the proposed algorithm.

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CT01

Image Inpainting for 3D Conversion

Despite the explosion in popularity of 3D movies over the past five years, many directors prefer to shoot in 2D and convert after the fact. “Conversion” means the construction of the right eye view given the left (or vice versa), and involves inpainting the background behind occluding objects. This inpainting problem is unique in that one boundary of the inpainting domain must be handled differently, necessitating the development of specialized algorithms.

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CT01

Surface Reconstruction from Parallel Contours with Exact Contour Constraints

In medical imaging or computational biology, it is required to reconstruct a surface from contours for visualization and further processing. We propose a method to generate a surface which is smooth enough and exactly passes through each contour by solving an energy minimization problem with constraints. We use the gradient of normal vector as the surface energy and level set function to impose the exact contour constraints.

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CT01

A Convex Approach to Sparse Shape Composition

We introduce “shape sparsity” as a novel approach in object-based modeling. For a given “shape dictionary”, we define our problem as choosing a sparse set of elements and composing them via basic set operations to characterize desired regions in an image. Direct applications are object recovery and tracking, occluded shape recovery and optical character recognition. We propose a convex relaxation to this combinatorial problem and discuss the sufficient conditions under which the relaxation becomes exact.

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CT02

Simulation of Modified Keller-Segel Chemotaxis Model with Stochastic Parameters

We consider a modified Keller-Segel model for chemotaxis previously studied by Murray and others. We introduce techniques that allow simulations over general domains. For this presentation we simulate this equation pair on a disk using a combination of FEM, stochastic collocation and Euler time stepping. Besides Stochastic parameters we consider perturbed regular partitions and stochastic initial conditions. Work with Prof. John Loustau, Hunter College CUNY.

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CT02

Boundary Integral Strategy for Laplace Eigenvalue Problems

The problem of evaluation of eigenvalues of the Laplace operator plays an important role in imaging applications. Use of integral equation methods allows dimension reduction; however it results in nonlinear problem. For the cases of mixed boundary value problem and domains with corners, an additional complexity is low regularity of corresponding eigenfunctions. We present a novel approximation strategy for mixed eigenproblem and apply high-order collocation method for domains with corners. We also introduce new approach in the eigenvalue search, that resolves the nonlinear optimization problem. The resulting method can compute high- and low-frequency eigenfunctions with prescribed accuracy in short computing times.

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CT02
Optimal Filters for General-Form Tikhonov Regularization

In this work, we use training data in an empirical Bayes risk framework to estimate optimal regularization parameters for the general-form Tikhonov problem and the multi-parameter Tikhonov problem. We will show how estimates of the optimal regularization parameters can be efficiently obtained and present several numerical examples from signal and image deconvolution to demonstrate their performance.

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CT02
Drift-Diffusion Equations in Image Processing

The goal of this presentation is to rigorously show that properties of diffusion equations have corresponding counterparts for drift-diffusion equations. We will discuss, among others, existence and uniqueness of solutions, positivity preservation, Lyapunov functionals and convergence of the parabolic solution to the steady state elliptic solution. In addition to the theoretical results, we will present experiments revealing the powerfulness of drift-diffusion equations for tasks such as seemless image cloning, shadow removal and dithering.

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CT02
Near Optimal Parameter Parameter Choice for General Spectral Filters

Solutions involving spectral filters have been proposed for image restoration. O'Leary (2001) used statistical analysis and observed properties of the noise to estimate the near-optimal parameter for the Tikhonov filter. In this work, we use a similar approach for general filters and their combinations. The resulting restorations compare favorably to those using parameters estimated through generalized cross-validation (GCV) and the discrepancy principle. An automatic computation of the important Picard parameter is also formulated.

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CT03
A General Framework of Piecewise-Polynomial Mumford-Shah Model for Image Segmentation

Our model generalizes the well-known piecewise-constant case, and is almost the simplest framework to apply piecewise polynomials to appropriately approximate the original Mumford-Shah model. The proposed model is well suited to being efficiently solved by the split Bregman iteration algorithm. Experimental results demonstrate that our model has more desirable performance in terms of segmented accuracy, efficiency and robustness, comparing with other variational models in addressing a number of aforementioned challenging segmentation scenarios.

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CT03
As-Killing-As-Possible Image Registration for Tracking of Living Cells from Fluorescent Microscopy

One challenge of analyzing cell images obtained from fluorescent microscopy is that cells frequently disappear and reappear. In this talk, we present an image registration approach which can reconstruct the appearance and location of the missing cells from the image frames where the cells become invisible. In order to obtain natural cell movements such as translation and rotation, we propose a novel registration technique which is Killing energy minimizing, motivated by the fact that a vector field with zero Killing energy will generate an isometric deformation. We will present reconstruction results of C2C12 cells in fluorescent images.

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CT03
Sign Regulator Based Color Image Segmentation Model

Images are diverse in nature and this makes the image segmentation task very challenging. One model may work for one class of images but it may not work in other types of images. One of the deficiencies that seems responsible for the failure of active contours models is the choice of region descriptors. The region descriptors such as image gradients based edge detector function, variance, absolute deviation and coefficient of variation etc. are commonly used and work for particular images. In order to design a model which can handle many tough images we use a new generalized region descriptor. In contrast with the latest models for color image segmentation, the outstanding performance of our proposed model is guaranteed through mathematical proofs and experimental tests.

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CT03

System of Methods for Iris Segmentation in Image

A system of methods for iris location and segmentation in eye image is presented. Input data are images used by iris recognition systems, output contains coordinates of inner and outer iris borders and iris pixel mask or decision that image does not contain iris of acceptable quality. Processing starts with approximate detection of eye center position followed by approximate detection of iris inner and outer boundaries. Precise borders are detected at final steps of processing by specially designed methods. System functioning is verified with images from public domain databases and tested in IREX NIST international competition.

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CT03

A Method for *C. elegans* Cell Lineage Tracking Based on Probabilistic Relaxation Labeling (PRL)

The 3D time-lapse images of developing *C. elegans* embryos provide valuable information on *C. elegans* embryogenesis at the single cell level. In our work, a probabilistic relaxation labeling algorithm is used for *C. elegans* cell lineage tracking. In this method, cell positions from different images are matched according to a spatial compatibility measure. Our method can reduce the tracking error and enhances the accuracy of the developed *C. elegans* cell lineage significantly.

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CT03

Tracking of Cells in Zebrafish Embryogenesis by Finding Centered Paths Inside 4D Segmentations

We are dealing with the tracking of cell movement and division during the very early stages of Zebrafish embryogenesis development. Thanks to the advances in modern microscopy we can obtain long time series of 3D volume images and use them for the construction of 4D segmentation representing the cell movement as spatio-temporal structures. Using various mathematical algorithms we can construct a potential field inside this 4D segmentation and use it for the cell movement tracking and the cell lineage tree reconstruction.

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CT04

Inversion of Photoacoustic Tomography Using l_1-norm Regularization of Shearlet Coefficients

Recovery of image data from photoacoustic measurements asks for solving the inverse problem to a Cauchy problem for the three-dimensional wave equation. In this talk, we discuss a similar two-dimensional scenario and introduce an effective discretisation. The inversion of the spherical mean value operator is regularized by minimization of the Tikhonov-functional with l_1-penalty in order to promote sparse solutions. We assume that the object has a sparse representation in a shearlet frame and we explain how to incorporate the shearlet transformation in an appropriate way into our setting. Moreover, we will give several numerical reconstruction examples.

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CT04

Sparse Reconstruction for Tomographic Imaging: Bridging the Gap Between Theory and Practice Using the ASTRA Toolbox

Despite the demonstrated capabilities of sparse reconstruction algorithms, applying such methods to real experimental data remains difficult. Practical constraints, with respect to computational efficiency, memory usage and implementation complexity form a major obstacle. We show how the ASTRA toolbox for advanced tomography algorithm development bridges this gap, by combining a Matlab interface with an efficient GPU implementation of tomographic building blocks. It allows direct application of mathematical codes for sparse reconstruction to large experimental datasets.

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CT04

Breast Surface Reconstruction Based on Radon Transform for Microwave Breast Imaging Applications

Microwave breast imaging methods require the shape of the breast to be well known in order to image the breast accurately. In this study human breast surface is reconstructed using 2-D images obtained by a rotating optical camera mounted on the microwave imaging setup. After several image processing operations, parallel beam back-projection is applied to reconstruct the 3-D numerical breast surface model.

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CT04
Tomographic Reconstruction Using Learned Dictionaries

We examine the role of training images as prior information for the solution in tomographic image reconstruction problems. Training images are conceptual images that contain a set of desired visual features, and we use dictionary learning to construct a dictionary from these images. Using the dictionary as prior information, we solve a Lasso least-squares problem that yields a reconstruction that has a sparse representation with respect to the dictionary.

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CT04
Applications of Fast Fourier Transforms on Optimal Sampling Lattices in CT Image Reconstruction

Optimal sampling lattices, such as hexagonal and face (body) centered cubic lattices, provide more efficient sampling than Cartesian lattices. Advantages include their flexibility in handling higher packing density, more uniform distribution of the lattice points in representing geometric objects, and so on. Furthermore, regular hexagonal structures perform better than square structures in approximating circular regions; truncated octahedron shapes or rhombic dodecahedron shapes approximate spherical objects better than cubes. In this presentation, I will show how to utilize fast Fourier transforms on optimal lattices for CT image reconstruction.

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CT04
A Fast Denoising Approach of Medical Ultrasound Images Corrupted by Combined Additive and Multiplicative Noise on the MIC Architecture

This work deals with a fast denoising approach of medical ultrasound images corrupted by combined additive and multiplicative noise, which are difficult to be removed. To this end, we firstly develop a new variational model and then solve the Euler-Lagrange equation using an efficient multigrid algorithm implemented on the many integrated core architecture with OpenMP. Numerical tests confirm that our new removal method is fast and delivers good quality results.

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CT05
An Overview of Kernel Methods for Tensor Based Classification

We present an overview of the kernel methods for tensor based classification. Kernel functions are acting as similarity measures between tensors exploiting the intrinsic multilinear algebraic structure of input data. We compare three basic types of kernels: the factor kernel where each factor is responsible for similarity of a given flattening of the input tensors, the geodesic distance kernel, as well as the probabilistic kernel with each factor representing different generative models of tensors.

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CT05
Dynamical Estimation of Brain Activities from MEG Data

We investigate the mathematical model for dynamic imaging of brain activity from magnetic field measurements outside the head. The challenges lie in the ill-posedness of the inverse problem, limitations of available data, and a further obstruction comes from the complex structure and high amplitude of the noise. We discuss a novel time evolution model combined with Bayesian filtering techniques that allow sequential updating of the estimate from time series data.

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CT05
A Composition Model Combining Parametric Transformation and Non-parametric Deformation for Effective Image Registration

Transformation models in image registration can be placed into two categories: parametric and non-parametric. Models which fall into the first category are based on a small number of parameters and are effective for global alignment, while for models in the second category the transformation is based on a functional map with a regularization term, which is effective for localized alignment. Variational formulations for non-parametric based models demonstrate considerable potential in solving registration problems but are very expensive in terms of computational cost and thus relatively slow when compared to the parametric models. We therefore propose a composition model which combines both parametric and non-parametric transformations and hence possesses the advantages of the two categories. The transformation is decomposed into a parametric global component based on the B-splines regularized by the bending energy, and a smooth non-parametric local component governed by the linear curvature via regularization. Registration examples are shown to demonstrate the improved capabilities of the proposed model over the individual models.

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CT05
Computer Vision Applications in Characterizing Melanoma and Moles

In this research project, we focus on computer vision applications to detect and analysis border irregularity in skin lesions. In particular, we will utilize three different methods; fractal dimension, signature curves and cumulative distance histograms together with statistical methods to compare the borders of malignant melanoma samples to the border of common moles. We propose that melanoma possess distinguishable border differences from nevi, often undetectable to the human eye and we will show how these methods are used to detect and quantize their differences for diagnosis.

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CT05
Artificial Intelligence and Traffic: Problems, Devices, Methods, Theorems

We present problems and models discussed recently. Pattern recognition problems first of all are connected with necessity of model parameter identification and verification. Next problems include real-time methods for traffic. Main goal of these methods is to provide traffic safety. In this direction we define recognition methods of wide range of traffic violations, leading to road accidents or creating critical situations. Also problems of development of mobile monitoring system of urban road network in seasons (winter-summer), including pavement, traffic control signs, are considered.

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CT06
Creating and Utilising Prior Anatomical Information for Preclinical Brain Imaging with Fluorescence Molecular Tomography

Fluorescence Molecular Tomography (FMT) has become an important tool for preclinical imaging. Still mice brain imaging posses challenges that are usually overcame with the inclusion of prior structural information from a coexisting modality like CT or MRI, in the reconstruction. We present a method for the creation of the necessary structural information for the anatomy and the optical properties of the mouse head. Matching the surface of preconstructed atlases to the actual head imaged, with the help of elastic deformation we create matching anatomical maps to be used as priors in the inversion procedure and improve the image reconstruction of the fluorescence targets.

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CT06
Detection of Bone Profiles in CT Images by Means of the Hough Transform

The Hough Transform is a well-established pattern recognition algorithm for the detection of straight lines, circles and ellipses in images. A recent paper has shown that algebraic geometry arguments allow the generalization of this method to the recognition of irreducible curves. Here we use this technique to detect bone profiles in clinical X-ray computed tomography images and discuss the impact of the results on oncological applications.

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CT06
Physiological Clustering: A Noise-reduction Approach in Quantitative Myocardial Perfusion PET

A novel framework is presented for robust kinetic parameter estimation at the individual voxel level applied to absolute flow quantification in dynamic myocardial perfusion (MP) PET. Kinetic parameter estimation is formulated as nonlinear least squares with spatial constraints where the constraints are computed from physiologically driven clustering of dynamic images. The proposed framework improves quantitative accuracy, and has long-term potential to enhance capabilities of MP PET in the detection, staging and management of coronary artery disease.

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CT06
Quantification of Glucose Metabolism with Nuclear Imaging PET Data

PET is an imaging technique capable of detecting picomolar quantities of a labelled tracer with a good temporal resolution. FDG is a tracer mimiking the glucose behavior in tissues and here we focus on the kinetic analysis of this tracer in murine models. We provide preliminary results on the generalization of the classical graphical approaches of compartmental analysis: the uniqueness and the existence of the solution of the inverse problem of finding the transmission coefficients is proved in different cases. Results are shown for dynamic micro-PET imaging data for hepatic and renal metabolism.

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CT06

Spontaneous Brain Activity Detection in Functional Magnetic Resonance Imaging Using Finite Rate of Innovation

Conventional analysis of functional magnetic resonance imaging (fMRI) data is based on general linear model (GLM). However, spontaneous brain activity cannot be inferred from standard GLM approaches. Hence, we develop a method for the detection of spontaneous brain activity that is modelled as a finite rate innovation (FRI) signal, i.e., a stream of Diracs. Relaxing the Strang-Fix condition, we design an adequate FRI sampling kernel that allows us to retrieve the innovation instants in continuous domain.

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CT06

Manifold Embedding Model of Image Patches and Its Application

Recently, the patch ordering method has been introduced in image processing. In this method, the patches of an image are sorted to a sequence so that the relatively simple 1-D operators can be applied for image processing. In this talk, we introduce a 1-D manifold embedding model for the image patches. In the model, the patches of an image is considered to reside on a 1-D manifold in a high dimensional space. Then image procession can be realized by operators on the manifold. Since the metric relation among the patched is well established in the model, interpolation, filtering, and other operators will perform more accurately. Several examples in image inpainting are presented to show the validity of the model.

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CT07

Imaging Strong Localized Scatterers

We study active array imaging of small but strong scatterers in homogeneous media when multiple scattering is nonnegligible. Foldy-Lax equations are used to model the wave propagation. We show how to avoid the nonlinearity and form images non-iteratively through a two-step process using ℓ_1 norm minimization. We give a formulation using joint sparsity optimization when multiple and diverse illuminations are available. We will also show how optimal illuminations can be used to improve the images.

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CT07

Laplacian Colormaps: A Framework for Structure-preserving Color Transformations

When mapping between color spaces, one wishes to find image-specific transformations preserving as much as possible the structure of the original image. Using image Laplacians to capture structural information, we show that if color transformations between two images are structure-preserving the respective Laplacians are approximately jointly diagonalizable (i.e., they commute). Using Laplacians commutativity as a criterion of color mapping quality, we minimize it w.r.t. the parameters of a color transformation to achieve optimal structure preservation.

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CT07

On Best Basis Selection from Basis Dictionaries on Graphs

We describe our construction of two dictionaries of bases for handling data measured on a graph: the *Hierarchical Graph Laplacian Eigen Transform* and its special case *the Haar-Walsh dictionary on a graph*. Because these basis dictionaries contain numerous orthonormal bases, one can select the "best basis" from them for one's task at hand, e.g., image approximation, denoising, classification, etc. We demonstrate the effectiveness of the best basis selected from such basis dictionaries using real examples.

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CT07

Real-Time Compressed Imaging of Scattering Volumes

We propose a method and a prototype imaging system for real-time reconstruction of volumetric piecewise-smooth scattering media. The volume is illuminated by a sequence of structured binary patterns emitted from a fan beam projector, and the scattered light is collected by a two-dimensional sensor, thus creating an under-complete set of compressed measurements. We show a fixed complexity and latency reconstruction algorithm capable of estimating the scattering cross-section in real-time. We also show a simple greedy algorithm for learning the optimal illumination patterns. Our results demonstrate faithful reconstruction from only few projections. Furthermore, a method for compressed registration of the measured volume to a known template is presented, showing excellent alignment with a single projection. Though our prototype system operates in visible light, the presented methodology is suitable for fast x-ray scattering imaging, in particular in real-time vascular medical imaging.

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CT07
Recovering Rank-One Matrices via Rank-r Matrices Relaxation

PhaseLift, proposed by E.J. Candes et al is one convex relaxation approach for phase retrieval. The relaxation enlarges the solution set from rank one matrices to positive semidefinite matrices. In this talk, we study a novel relaxation applied to non convex minimization approaches, for instance, alternating minimization methods. A generic measurement matrix is standardized to consist of orthogonal columns. The standardized frames are employed to recover the rank-one matrix among the rank-r matrices, and the desired rank one matrix is the one with the maximal leading eigenvalue. Besides, with sufficient amount of nearly orthogonal sensing vectors, we show that the corresponding singular vector is close to the unknown signal and thus it can be a good initialization. Some empirical studies are conducted to illustrate the effectiveness of this relaxation approach.

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CT07
Fourier-Bessel Rotational Invariant Eigenimages

We present an efficient and accurate algorithm for principal component analysis (PCA) of a large set of 2D images, and, for each image, the set of its uniform rotations in the plane and its reflection. It is more robust to noise than traditional PCA. Each image is expanded in the Fourier-Bessel basis and the expansion is truncated using a sampling criterion such that the maximum amount of information is preserved without the effect of aliasing.

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CT08
Removing Simultaneous Gaussian and Salt-and-pepper Noise by Minimizing a Combined L^1-L^2-TV Functional

In real world applications often a mixture of different noise types occurs in images, for example the image registration procedure introduces Gaussian noise and then digital transmission errors produce impulsive noise. We tackle the problem of removing simultaneous Gaussian and salt-and-pepper noise by optimizing a convex functional with a total variation regularization and a combination of a quadratic L^2-term and a non-smooth L^1-term. We demonstrate that our approach well suits the restoration task.

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CT08
Efficient Smoothing Method for Image Restoration Using Nonsmoooth Regularization

There are a variety of successful applications of using nonsmooth regularization model in image restoration. The nonsmooth term, however, makes difficulty in designing efficient algorithms. In this paper, we suggest an efficient smoothing method with solid convergent result to overcome the difficulty, which is very easy to implement and flexible of adapting both unconstrained and constrained models. Numerical experiments show that the smoothing method is promising.

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CT08
Total Variation based Speckle Reduction Method

Speckle (multiplicative noise) naturally appear in various coherent imaging systems, such as synthetic aperture radar and ultrasound. Due to the strong interference phenomena in coherent imaging systems, it is hard to identify the valuable objects from the captured noisy data. In this talk, we introduce framework for total variation based speckle reduction problems. The framework is based on m-th root transformation and linearized proximal alternating minimization algorithm.

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CT08
Denoising Results Using Image Reconstruction Techniques Based on Legendre Polynomials Approximation of Continuous Prolate Spheroidal Functions (CPSF)

Performance of images denoising techniques varies depending on noise type. A general assumption is that the noise spectrum is uniformly distributed while image spectrum is not. Imaging filtering permits discards part of the noise localized at high frequencies. For images with transitions, this approach causes blurring, which can be information loss. Our work uses a set of CPSF to represent the image and evaluate the denoising capabilities for salt & pepper, Gaussian, speckle, and Rician noise.

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CT08
Exploiting Sparsity in Remote Sensing for Earth Observation

Sparse signals are commonly expected in Remote Sensing and Earth Observation, yet not fully exploited. We develop sparse reconstruction based algorithms for several problems that cover a wide range of fields including SAR and optical (multispectral and hyperspectral) remote sensing. The developed algorithms are evaluated with both simulated and real remote sensing data, e.g., acquired by spaceborne systems such as TerraSAR-X, TanDEM-X, and WorldView-2 and by airborne sensors such as HyMAp and HySpex.

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CT08
Image De-noising Using Discrete Sectrum of a Schrödinger Operator

A new image de-nosing method is presented in this study. The main idea is to decompose the image in an adaptive basis that consists of the squared L^2-normalized eigen-functions of a semi-classical Schrödinger operator. The operator's potential is given by the noisy image. An appropriate choice of the semi-classical parameter enables a good reconstruction of the de-noised image. Comparisons to Total variation and SVD methods have been done. The first results obtained are promising.

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CT09
Improving D-bar Reconstructions for Electrical Impedance Tomography with Data-Driven Post-Processing

Reconstructions of conductivities in electrical impedance tomography (EIT) obtained with the D-bar method are known to be smooth, even when the true conductivity is discontinuous. In this work, we reintroduce edges to the smoothed reconstruction by minimizing the Ambrosio-Tortorelli functional used in image segmentation. The minimization process is controlled by a fidelity term which encodes the geometry of the problem at hand. Reconstructions from noisy simulated EIT data are presented for discontinuous conductivities.

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CT09
Tomographic Reconstruction of 3-D Vector Fields Using a Discretized Integral Equations System

A method that efficiently deals with the ill-posed problem of recovering all three components of a vector field only from boundary line-integral data is described here. The method creates data redundancy by discretizing the scanning lines and reconstructing the field in finite grid points via a linear equations system. The solution is validated through simulations on electrostatic fields and the comparison with the corresponding solution that derives from the Laplace partial differential equation.

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CT09
Fast Approximation of Advanced Tomographic Reconstruction Methods

Recent advanced tomographic reconstruction methods that exploit image priors, such as sparsity with respect to some basis, are powerful, but also highly computationally intensive. This poses problems when reconstructing large practical datasets. We propose a novel class of reconstruction methods based on machine learning, which can automatically learn to approximate the results of such computationally demanding algorithms during a training phase. After training, reconstructions can be computed with the high speed of classical backprojection methods.

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CT09
Superiorization of EM Iteration and Applications in SPECT Image Reconstruction

The convergence of EM iteration in the presence of perturbation was investigated, and a superorized EM iteration was designed. The applications of the superorized EM iteration in SPECT image reconstruction was conducted to validate the performance of it.

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CT09
Spectral Variational Method for Grid Removal in Digital Radiography

We present a variational method in spectral domain to automatically suppress the artifacts caused by a stationary anti-scatter device in digital radiography for contrast enhancement. The raw radiographic image is modeled as a true image corrupted by a pseudo-periodic strip waveform with fixed period and small amplitude random variations. The amplitude spectrum of the underlying log-transformed image is reconstructed as the minimizer to a spectral objective functional. We demonstrate the improvements over conventional spectral notch filters.

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CT09
Comparison of Functional Formulations for Ultrasound Attenuation Compensation and Image Segmentation

A generic image processing method was developed to compensate for attenuation artifacts and automatically segment anatomic structures in medical ultrasound images. The method is based on the variational principle. We formulated and compared several different energy functionals hoping to find an optimal functional. For data fidelity, conventional L2-norm and a semi-norm dual were considered. For regularizations in backscatter and attenuation, a semi-norm in Sobolev space, total variation, and TVq-regularization were considered. In curve evolution, active contour and level set representation were compared. A fast Poisson solver was derived. The Split Bregman method and fast gradient descent re-projection were used to solve the optimization problem.

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CT10

Convolutional Sparse Representations: Algorithms and Applications

The usual patch-wise sparse coding of images has been very successful, but leads to a representation that is not optimal for the image as a whole. In contrast, the recently developed convolutional sparse coding computes a representation for an entire image, but broader use of this model has been hampered by the high computational cost. A new efficient algorithm will be presented, and some applications enabled by this algorithm will be discussed.

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CT10

Synchrosqueezed Curvelet Transform for 2D Mode Decomposition

We introduces the synchrosqueezed curvelet transform (SSCT) as an optimal tool for 2D mode decomposition of banded wave-like components. It consists of generalized curvelet transforms with application dependent scaling parameters, and a synchrosqueezing technique for sharpened phase space representations. In a superposition of banded wave-like components with well-separated wave-vectors, the SSCT can recognize each component and precisely estimate their local wave-vectors. A discrete analogue of the continuous transform are proposed with fast implementations.

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CT10

Tensor Nuclear Norm for High-Resolution Video Enhancement

Recently, a tensor nuclear norm based on the t-SVD of Kilmer and Martin [2011] has been proposed for regularization in multi-energy CT and color image deblurring applications. We discuss the extension of the use of the tensor nuclear norm to the problem of superresolution enhancement for video clips. Examples illustrate the potential of our approach.

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CT10

Sparse Approximations of Spatially Varying Blur Operators in the Wavelet Domain

Restoration of images blurred by spatially varying PSFs is a problem met increasingly. One of the main difficulties is the computational burden caused by the huge dimensions of blur matrices. It prevents the use of naive approaches to perform matrix-vector multiplications. We study an original approach which consists of approximating blurring operators by sparse matrices in the wavelet domain. We provide theoretical complexity results and compare this approach to standard approximations as piecewise convolutions.

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CT10

Regularized Sparse Representation Method for Image Interpolation

Image interpolation based on sparse representation is a new interpolation method, which is a reconstruction problem in compressed sensing in essence. But the performance of this new method is limited by the performance of the sampling matrix. To solve this problem, we studied a regularized sparse representation interpolation method. In this new method, we obtained a new observation equation by designing a regularized operator and multiplying it with the original observation equation, which can reduce the system's ill-posedness caused by under-sampling and improve the recovery performances of sparse and approximate sparse signals. Numerical results show that the regularized sparse representation method has higher Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index Measurement (SSIM) than the sparse representation method, and it can also process the interpolation problem with noise.

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CT10

On the Restoration of Halftones of Green Noise Characteristics

Images printed on paper are generally binary halftones. In some applications such as photocopying, it is required to restore the original image from a scanned halftone. Conventional inverse halftoning algorithms focus on storing halftones of blue noise characteristics. It has been found that printed halftones generally bear green noise characteristics to compensate for the dot gain. In this presentation, we will report the progress of our study on restoring halftones of green noise characteristics.

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CT11

Nonoverlapping Domain Decomposition Methods for the Total Variation Minimization

We propose nonoverlapping domain decomposition methods for solving total variation minimization problem. We decompose the domain into rectangular subdomains, where the local total variation problems are solved. The boundary values of the solution of local problems are sent to the adjacent subdomains so that the right hand sides of the adjacent local problems are changed. Sequential and parallel algorithms are presented. The convergence of both algorithms is analyzed and numerical results are presented.

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CT11

Numerical Implementation of a New Class of Forward-Backward-Forward Diffusion Equations for Image Restoration

In this talk, we present the implementation and numerical experiments demonstrating new forward-backward-forward nonlinear diffusion equations for noise reduction and deblurring, developed in collaboration with Patrick Guidotti and Yunho Kim. The new models preserve and enhance the most desirable aspects of the closely-related Perona-Malik equation without allowing staircasing. By using a Krylov subspace spectral (KSS) method for time-stepping, the properties of the new models are preserved without sacrificing efficiency.

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CT11

A Stable Scheme to Discretize Anisotropic Diffusion

We propose a scheme to discretize the anisotropic diffusion equation. This scheme is based on a choice of the stencil that ensures non-negativity whatever the anisotropy of the diffusion tensor. The stencil is composed of a fixed number of points (6 in 2D, 12 in 3D), it is locally adapted to the diffusion tensor, and its computation is based on lattice reduction methods. Examples in 2D and 3D image processing will be shown.

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CT11

Factional-Order Derivative Regularization with Application to Two Imaging Models

As new regularizer, a fractional-order derivatives based seminorm offers advantages over integer order derivatives (first order gradients and second order Laplacians), potentially useful for a large class of variational models in imaging and inverse problems. To address the solution challenges in non-sparse Toeplitz like operators resulting from discretization, we propose a new and iterative numerical method. We first study the method for image denoising and compare our approach with results from high order methods (mean curvature, TGV). Then we apply the new regularizer and solution methods to image registration models. Numerical experiments will be given to show excellent restoration results in terms of image quality and some advantages in modelling deformations in image registration.

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CT11

On the Convergence of a New Alternating Minimization Algorithm for Principal Component Pursuit

We have recently proposed an alternating minimization algorithm for solving a minor variation (min $\|D - L - S\|_F + \|S\|_1$ s.t. $rank(L) = r$) of the original Principal Component Pursuit (PCP) functional. Initial computational experiments in a video background modeling problem have shown this algorithm to be approximately 10 times faster than the current state of the art algorithm for PCP. Here we provide mathematical proofs for the convergence of the proposed algorithm, as well as for its equivalence to the original PCP problem.

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CT11

Image Reconstructions with Improved 3D Block Matching

Some recent state-of-the-art techniques for image processing involve sparse, nonlocal models, which take advantage of correlations between features in different regions of an image to allow for “collaborative filtering”. Such models are useful in denoising, deblurring, and other common image processing tasks; for example, they form the basis of the BM3D algorithm. I will introduce a modification to this model which allows for rotation-invariant feature matching, leading to improved image restorations.

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Abstracts of Contributed Posters

Poster 1
Beyond the Grayscale Image: User-Aided Dimension Reduction of Color Images for Improved Edge Detection

Popular edge detection methods use grayscale images because they are fast and easy to process. Grayscale images capture the light intensity of the continuous scene, losing color information. Implementing edge detection methods on a color images comes at a significant cost. This work develops a new color space by user aided transformation of the three coordinate color image into a single coordinate space where the color discontinuities of interest are captured.

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Poster 2
A Python Toolbox for Energy Minimization of Shapes

Many tasks in image processing, e.g., image segmentation, surface reconstruction, are naturally expressed as energy minimization problems, in which the free variables are shapes, such as curves in 2d or surfaces in 3d. This approach is very popular due to its intuitiveness and the flexibility to easily incorporate data fidelity, geometric regularization and statistical prior terms. However, carrying out the actual minimization in an efficient and reliable manner requires overcoming many technical challenges. In this work, we introduce a Python toolbox that implements a diverse collection of shape energies for image processing, and state-of-the-art optimization methods to compute their solutions.

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Poster 3
Sparsity Reconstruction in Partial Data Electrical Impedance Tomography

Electrical impedance tomography (EIT) is an imaging technique for which the electrical conductivity is reconstructed from electrical measurements at the surface of the body. The severe ill-posedness and non-linearity of the inverse problem implies that it is immensely difficult to make good reconstructions with sharp edges, especially when only partial data is available. By use of sparsity regularization with a distributed regularization parameter, it is possible to reconstruct small inclusions/inhomogenities, even from partial boundary data. By use of prior information as estimates of the support of the inclusions, it is possible to substantially improve the reconstructed shape and contrast.

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Poster 4
Propagation of Singularities for Linearised Hybrid Inverse Problems

Hybrid inverse problems are mathematical descriptions of novel tomographic methods that utilise coupled physical phenomena to obtain high contrast and high resolution images. For a class of linearised hybrid inverse problems, including mathematics models of Ultrasound Modulated Electrical Impedance Tomography and Current Density Impedance Imaging, the ellipticity and associated stability properties depend on the chosen boundary potentials. On the poster we explain and visualise exactly how singularities propagate when such linearised problems are non-elliptic.

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Poster 5
Recovery of the Camera Response Function from Few Images in High Dynamic Range Photography

We describe an inverse problem for determining the response function of a camera system from multiple photographs of a scene captured with different exposure times. Recovering the response function of the camera allows one to combine low dynamic range images into a single image with higher dynamic range. Parameterized, non-parameterized, and phenomenological models of the response function are considered, and corresponding regularization problems presented. We present preliminary results and analysis, emphasizing the case where one has a small number (3–5) of images.

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Poster 6
Imaging of Complex Media with Elastic Wave Equations

Reverse Time Migration is a numerical tool based on the solution of full wave equations providing seismic images of the subsurface. Using Elastodynamics equations returns most accurate information. But RTM is very computationally intensive and it is necessary to reduce the computational burden regarding both the memory occupancy and the number of required computations. We propose a new elastic imaging condition which requires a reduced number of computations and provides accurate images of heterogeneous media.

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Poster 7
How to Avoid Smoothing a Histogram, and Why

The histograms of small images are often smoothed using a kernel k. This operation corresponds to the addition of k-distributed noise in the images. We propose a more precise method to obtain a smooth density from an image: zoom-in the image by a very large factor and compute its histogram. This method is better when the goal is separating the modes of the histogram. There are efficient algorithms to compute and approximate these densities.

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Poster 8
Modeling Stereo Depth Perception with Coupled Nonlinear Elements

This poster presents a model of human stereo depth perception for a pair of stereo images. The model consists of coupled FitzHugh-Nagumo nonlinear elements, which are described with ordinary differential equations and are placed at grid points of a three-dimensionally connected network. By applying the model to several stereo image pairs, I explore its validity in comparison with psychological evidence of human depth perception, in particular, on anisotropy observed between horizontal and vertical depth gradients.

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Poster 9
Image Registration using Gradients Comparison and Non-Linear Elastic Regularization

We focus on the problem of image registration, that is to say how to align a Template image with a Reference image. Concerning the regularization of the problem, we have chosen a non-linear elastic regularizer to allow large deformations. In particular, we look more closely at the stored energy of Saint Venant-Kirchhoff and we add a penalty term to control the Jacobian determinant of the deformation. Since the stored energy function is not quasiconvex, we study a relaxed problem using the quasiconvex envelop. Then instead of comparing the grey levels, we are concerned with a fidelity term based on the gradients of the images.

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Poster 10
SIFT and a Bias in the Repeatability Criteria

Most image matching algorithms rely on the detection and comparison of local stable keypoints. A major challenge is the performance evaluation of keypoint detectors – typically based on the repeatability criterion. We show that this criterion is biased favoring algorithms producing redundant detections, and propose a simple variant that takes into account the descriptors overlap. Experimental evidence show that the hierarchy of popular feature transforms is overthrown by this amended comparator, and SIFT is still leading.

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Poster 11
Simultaneous Reconstruction and Segmentation with Probabilistic Hidden Markov Model Regularization

We formulate a general bayesian framework for the simultaneous reconstruction and segmentation to enhance the robustness of the reconstruction and segmentation for the noise and for the lack of data and to enhance the material separation on the tomogram. Chosen the optimization strategy, we do experimental validation of our technique by comparison with a Filtered Back Projection (FBP) and a Total Variation (TV) methods for a simple problem instance with a grey-scale segmentation.

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Poster 12
Creating and Utilising Prior Anatomical Information for Preclinical Brain Imaging with Fluorescence Molecular Tomography

Fluorescence Molecular Tomography (FMT) has become an important tool for preclinical imaging. Still mice brain imaging posses challenges that are usually overcame with the inclusion of prior structural information from a coexisting modality like CT or MRI, in the reconstruction. We present a method for the creation of the necessary structural information for the anatomy and the optical properties of the mouse head. Matching the surface of preconstructed atlases to the actual head imaged, with the help of elastic deformation we create matching anatomical maps to be used as priors in the inversion procedure and improve the image reconstruction of the fluorescence targets

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Poster 13
Analysis of Fuzzy Weighting Exponent in Fuzzy Active Contour Model

In image segmentation, fuzzy active contour model based on the minimization of a fuzzy energy is recently proposed. However, how to choose the fuzzy weighting exponent is not given. In this paper, it first shows that the fuzzy energy does not increase when the fuzzy weighting exponent increases. Second, the relationship between the fuzzy active contour energy and the Gamma approximate energy is discussed to understand the fuzzy weighting exponent.

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Poster 14
High Dynamic Range From a Single Image

High dynamic range (HDR) imaging from multiple images suffers from various drawbacks due to camera and object motion. We propose to create HDR images form a single shot, using a new sensor technology that enables different exposure levels per pixel. Through a thorough understanding of acquisition noise sources we model the problem as an statistical estimation problem with missing data, which can be solved using recent estimation methods with Gaussian mixture model priors for patches.

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