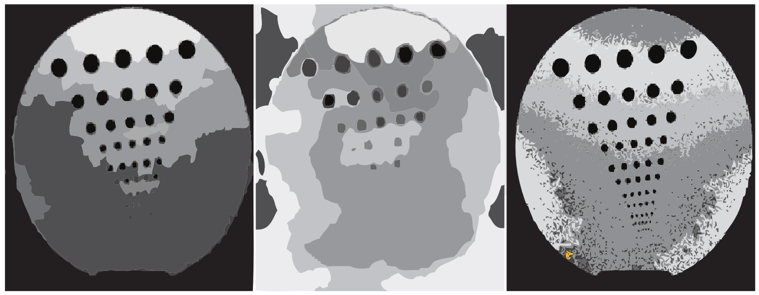
Final Program and Abstracts

SIAM Conference on

IMAGING SCIENCE



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

May 20 - 22, 2012

DoubleTree by Hilton Hotel Philadelphia Center City
Philadelphia, Pennsylvania, USA

This conference is sponsored by 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 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.

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.

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The SIAM registration desk is located in Overture - 3rd Floor, and is open during the following times:

Saturday, May 19
4:00 PM - 7:00 PM

Sunday, May 20
7:00 AM - 5:00 PM

Monday, May 21
7:45 AM - 5:00 PM

Tuesday, May 22
7:45 AM - 5:00 PM

Hotel Address

DoubleTree by Hilton Hotel
Philadelphia Center City

237 South Broad Street

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Hotel Telephone Number

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Hotel Check-in and Check-out Times

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**List current March 2012*

Funding Agency

SIAM and the Conference Organizing Committee wish to extend their thanks and appreciation to the U.S. National Science Foundation for its support of this conference.

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SIAM members save up to $130 on full registration for the SIAM Conference on Imaging Science (IS12)! Join your peers in supporting the premier professional society for applied mathematicians and computational scientists. SIAM members receive subscriptions to *SIAM Review* and *SIAM News* and enjoy substantial discounts on SIAM books, journal subscriptions, and conference registrations.

If you are not a SIAM member and paid the Non-Member or Non-Member Mini Speaker/Organizer rate to attend the conference, you can apply the difference between what you paid and what a member would have paid ($130 for a Non-Member and $65 for a Non-Member Mini Speaker/Organizer) towards a SIAM membership. Contact SIAM Customer Service for details or join at the conference registration desk.

If you are a SIAM member, it only costs $10 to join the SIAM Activity Group on Imaging Science (SIAG/IS). As a SIAG/IS member, you are eligible for an additional $10 discount on this conference, so if you paid the SIAM member rate to attend the conference, you might be eligible for a free SIAG/IS membership. Check at the registration desk.

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SIAM does not provide computers for any speaker. When giving an electronic presentation, speakers must provide their own computers. SIAM is not responsible for the safety and security of speakers' computers.

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All other concurrent/breakout rooms will have one (1) screen and one (1) data projector. Cables or adaptors for Apple computers are not supplied, as they vary for each model. Please bring your own cable/adaptor if using a Mac computer. Overhead projectors will be provided only when requested.

If you have questions regarding availability of equipment in the meeting room of your presentation, or to request an overhead projector for your session, please see a SIAM staff member at the registration desk.

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Complimentary wireless Internet access in the hotel lobby and restaurant will also be available. Additionally, wireless Internet access in the meeting rooms will be provided to SIAM attendees, the cost for which is incorporated into the conference registration fee.

SIAM will also provide a limited number of email stations for attendees during registration hours.

Registration Fee Includes

- Admission to all technical sessions
- Business Meeting (open to SIAG/IS members)
- Coffee breaks daily
- Room set-ups and audio/visual equipment
- Welcome Reception and Poster Session

Job Postings

Please check with the SIAM registration desk regarding the availability of job postings or visit *http://jobs.siam.org.*

Important Notice to Poster Presenters

The poster session is scheduled for Sunday, May 20 at 8:00 PM. Poster presenters are requested to set up their poster material on the provided 4' x 6' poster boards in the Ormandy West Room between the hours of 3:00 PM and 8:00 PM. All materials must be posted by Sunday, May 20 at 8:00 PM, the official start time of the session. Posters will remain on display until 10:00 PM. Poster displays must be removed by 10:00 PM. Posters remaining after this time will be discarded. SIAM is not responsible for discarded posters.

SIAM Books and Journals

Display copies of books and complimentary copies of journals are available on site. SIAM books are available at a discounted price during the conference. If a SIAM books representative is not available, completed order forms and payment (credit cards are preferred) may be taken to the SIAM registration desk. The books table will close at 1:00 PM on Tuesday, May 22.

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Comments?

Comments about SIAM meetings are encouraged! Please send to:

Sven Leyffer, SIAM Vice President for Programs (*vpp@siam.org*)

Get-togethers

- Welcome Reception and Poster Session

  Sunday, May 20
  8:00 PM – 10:00 PM

- Business Meeting
  (open to SIAG/IS members)

  Monday, May 21
  8:00 PM – 8:45 PM
  Complimentary beer and wine will be served.

Please Note

SIAM is not responsible for the safety and security of attendees' computers. Do not leave your laptop computers unattended. Please remember to turn off your cell phones, pagers, etc. during sessions.

Recording of Presentations

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

Social Media

SIAM is promoting the use of social media, such as Facebook and Twitter, in order to enhance scientific discussion at its meetings and enable attendees to connect with each other prior to, during and after conferences. If you are tweeting about a 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 #SIAMIS12.

SAVE THE DATE!

The 2014 SIAM Conference on Imaging Science will be held May 12-14, 2014, at Hong Kong Baptist University, Hong Kong.

Minitutorials

** All Minitutorials will take place in the Symphony Ballroom - 3rd Floor**

Sunday, May 20

MT1

Harry Potter’s Cloak via Transformation Optics

9:30 AM - 11:30 AM

We will explain, in a non-technical fashion, the basic ideas of what has been called transformation optics which has been used to make objects invisible to detection by electromagnetic waves, acoustic waves and other types of waves. Transformation optics uses the invariance properties under transformations of Maxwell’s equations in the case of electromagnetic waves. The medium parameters needed for perfect cloaking are singular at the interface of the region to the cloaked. We will also consider regularization procedures of perfect cloaking that lead to non-singular medium parameters and achieve approximate cloaking.

Organizer:

Gunther Uhlmann, University of California, Irvine, USA and University of Washington, USA

Speakers:

Gunther Uhlmann, University of California, Irvine, USA and University of Washington, USA

Ting Zhou, Massachusetts Institute of Technology, USA

Monday, May 21

MT2

Mathematics and Science of 3D Electron Microscope Imaging

9:30 AM - 11:30 AM

The two parts of this minitutorial deal with mathematics for Electron Tomography (ET) and Single Particle (SP). The one on ET surveys reconstruction methods for ET with emphasis on difficulties and their mathematical consequences. It also includes the model for image formation in electron microscopy, which is the same in SP. The minitutorial on SP focuses on presenting a novel reconstruction method, focusing on resolving the angular reconstitution problem. The method in question is based on a novel framework for non-linear optimization, which in turn is based on representation theoretic ideas - where the solution is an object of a category.

Organizers:

Ozan Öktem, KTH - Royal Institute of Technology, Sweden

Eric Todd Quinto, Tufts University, USA

Speakers:

Ronny Hadani, University of Texas at Austin, USA

Ozan Öktem, KTH - Royal Institute of Technology, Sweden

SIAM Activity Group on Imaging Science (SIAG/IS)

www.siam.org/activity/imaging

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SIAM Conference on

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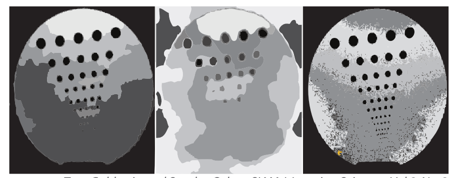

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ACTIVITES INCLUDE:

- Special sessions at SIAM Annual Meetings
- Biennial conference
- SIAG on Imaging Science Prize
- Website

BENEFITS OF SIAG/IS MEMBERSHIP:

- Listing in the SIAG's online-only membership directory
- Additional $10 discount on registration at the SIAM Conference on Imaging Science (excludes student)
- Electronic communications about recent developments in your specialty
- Eligibility for candidacy for SIAG/IS office
- Participation in the selection of SIAG/IS officers

ELIGIBILITY:

- Be a current SIAM member

COST:

- $10 per year
- Student SIAM members can join 2 activity groups for free!

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- Vice Chair: Naoki Saito, University of California
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Invited Plenary Speakers

** All Invited Plenary Presentations will take place in the Symphony Ballroom - 3rd Floor **

Sunday, May 20

8:15 AM - 9:00 AM

IP1 Magnetic Resonance Elastography

Richard L. Ehman, *Mayo Clinic, USA*

Monday, May 21

8:15 AM - 9:00 AM

IP2 Targeted Seismic Imaging

Alison Malcolm, *Massachusetts Institute of Technology, USA*

1:00 PM - 1:45 PM

IP3 Three Dimensional Structure Determination of Macromolecules by Cryo-electron Microscopy from the Applied Math Perspective

Amit Singer, *Princeton University, USA*

Tuesday, May 22

8:15 AM - 9:00 AM

IP4 Divide and Conquer: Using Spectral Methods on Partitioned Images

Dianne P. O'Leary, *University of Maryland, College Park, USA*

1:00 PM - 1:45 PM

IP5 Design in Imaging – From Compressive to Comprehensive Sensing

Lior Horesh, *IBM T.J. Watson Research Center, USA*

Prize Lecture

** The Prize Lecture will take place in the Symphony Ballroom - 3rd Floor **

Sunday, May 20

1:00 PM - 1:45 PM

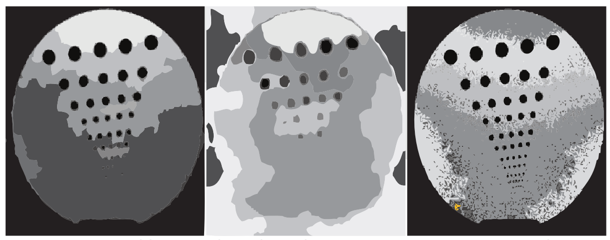
SIAG on Imaging Sciences Prize Lecture

Recipient Information and Title TBD

IS12 Program

SIAM Conference on

IMAGING SCIENCE



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Philadelphia, Pennsylvania, USA

SIAM BOOKS

Check out these and other books at the SIAM booth.

Conference attendees receive discounts on all displayed titles.

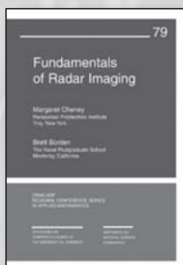
FAIR: *Flexible Algorithms for Image Registration*
Jan Modersitzki

This overview of state-of-the-art registration techniques from theory to practice includes numerous exercises designed to enhance readers' understanding of the principles and mechanisms of the described techniques. It also provides, via a supplementary Web page, free access to FAIR.m, a package that is based on the MATLAB® software environment, which enables readers to experiment with the proposed algorithms and explore the presented examples in more depth.

2009 · xxii + 189 pages · Softcover · ISBN 978-0-898716-90-0
List $69.00 · Attendee $55.20 · SIAM Member $48.30 · Order Code FA06

Fundamentals of Radar Imaging
Margaret Cheney and Brett Borden

This book includes a description of how a radar system works, together with the relevant mathematics; theory that guides the choice of radar waveforms; derivation of the fundamentals of scattering theory; derivation and discussion of the image formation process; and a long list of current open problems. Applied mathematicians will want this book because it explains the basics of radar imaging, provides a foundation for understanding the engineering literature, and gives references for many of the open problems.



2009 · xxiv + 140 pages · Softcover · ISBN 978-0-898716-77-1
List $59.00 · Attendee $47.20 · SIAM/CBMS $41.30 · Order Code CB79

Deblurring Images: *Matrices, Spectra, and Filtering*
Per Christian Hansen, James G. Nagy, and Dianne P. O'Leary

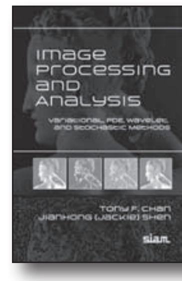
"At a very affordable and introductory level, the book has successfully integrated an emerging important application, mathematical analysis, efficient algorithms, and practical software implementation into a coherent and very appealing subject. …[there are] color plates for most figures, which further enhances the physical and informative appeal of the book."

— *Jackie Shen, Professor of Mathematics, University of Minnesota*

2006 · xiv+130 pages · Softcover · ISBN 978-0-898716-18-4
List $68.00 · Attendee $54.40 · SIAM Member $47.60 · Order Code FA03

Image Processing and Analysis: *Variational, PDE, Wavelet, and Stochastic Methods*
Tony F. Chan and Jianhong (Jackie) Shen

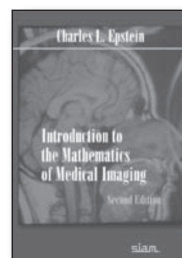
This book develops the mathematical foundation of modern image processing and low-level computer vision, and presents a general framework from the analysis of image structures and patterns to their processing. The core mathematical and computational ingredients of several important image processing tasks are investigated. The book bridges contemporary mathematics with state-of-the-art methodologies in modern image processing while organizing the vast contemporary literature into a coherent and logical structure.



2005 · xxii + 400 pages · Softcover · ISBN 978-0-898715-89-7
List $81.00 · Attendee $64.80 · SIAM Member $56.70 · Order Code OT94

Introduction to the Mathematics of Medical Imaging, *Second Edition*
Charles L. Epstein

This textbook provides a firm foundation in the mathematical tools used to model the measurements and derive the reconstruction algorithms used in most imaging modalities in current use. In the process, it also covers many important analytic concepts and techniques used in Fourier analysis, integral equations, sampling theory, and noise analysis. The book uses X-ray computed tomography as a "pedagogical machine" to illustrate important ideas and incorporates extensive discussions of background material making the more advanced mathematical topics accessible to readers with a less formal mathematical education. The mathematical concepts are illuminated with over 200 illustrations and numerous exercises.



2007 · xxxiv + 761 pages · Softcover · ISBN 978-0-898716-42-9
List $102.00 · Attendee $81.60 · SIAM Member $71.40 · Order Code OT102

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Nonmembers must use code "BKIS12" to get Special Conference Attendee Price. Expires 6-22-12.

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Saturday, May 19

Registration
4:00 PM-7:00 PM

Room:Overture - 3rd Floor

Sunday, May 20

Registration
7:00 AM-5:00 PM

Room:Overture - 3rd Floor

Welcoming Remarks
8:00 AM-8:15 AM

Room:Symphony Ballroom - 3rd Floor

IP1
Magnetic Resonance Elastography
8:15 AM-9:00 AM

Room:Symphony Ballroom - 3rd Floor

Chair: Peter Kuchment, Texas A&M University, USA

Many disease processes cause profound changes in the mechanical properties of tissues, yet none of the conventional medical imaging techniques such as CT, MRI, and ultrasound are capable of quantitatively delineating these properties. Magnetic Resonance Elastography (MRE) is an emerging diagnostic imaging technology that employs a novel MRI-based technique to visualize propagating acoustic shear waves in the body. Inversion algorithms are used to process these wave images to generate quantitative maps of tissue mechanical properties such as stiffness, viscosity, and anisotropy. The most important clinical application of MRE currently to evaluate chronic liver disease, where it can eliminate the need for an invasive biopsy. However, there are many other potential applications. This presentation will review the rationale and physical basis of MRE and the basic approaches used for data analysis. Areas of opportunity will be identified where more advanced inversion algorithms could create new applications or substantially contribute to the clinical value of the technology.

Richard L. Ehman
Mayo Clinic, USA

Sunday, May 20

Coffee Break
9:00 AM-9:30 AM

Room:Orchestra - 2nd Floor

MT1
Harry Potter's Cloak via Transformation Optics
9:30 AM-11:30 AM

Room:Symphony Ballroom - 3rd Floor

Chair: Gunther Uhlmann, University of California, Irvine, USA and University of Washington, USA

We will explain, in a non-technical fashion, the basic ideas of what has been called transformation optics which has been used to make objects invisible to detection by electromagnetic waves, acoustic waves and other types of waves. Transformation optics uses the invariance properties under transformations of Maxwell's equations in the case of electromagnetic waves. The medium parameters needed for perfect cloaking are singular at the interface of the region to the cloaked. We will also consider regularization procedures of perfect cloaking that lead to non-singular medium parameters and achieve approximate cloaking.

Speakers:

Gunther Uhlmann, University of California, Irvine, USA and University of Washington, USA

Ting Zhou, Massachusetts Institute of Technology, USA

Sunday, May 20

MS1

Analysis of Tomographic Images for Clinics: Recent Advances and Challenges - Part I of II

9:30 AM-11:30 AM

Room:Assembly C - 5th Floor

For Part 2 see MS11

Analysis of tomographic images is of central importance for diagnostic and therapeutic applications in various clinical contexts. Distinct characteristics between tissues, along with different image properties and qualities among imaging modalities, have posed great challenges to the analysis tasks. Therefore, new ideas, adaptive models, and special techniques are in high demand. This minisymposium aims to bring together mathematicians, medical physicists, radiologists, and engineers, especially young scientists, to exchange the most recent advances in tomographic image analysis. We hope this minisymposium can provide a forum to stimulate discussions and establish collaborations between mathematicians and clinic scientists for further developments in this emerging research field.

Organizer: Xiaojing Ye
Georgia Institute of Technology, USA

Organizer: Xun Jia
University of California, San Diego, USA

9:30-9:55 Applications of Tomographical Images in Cancer Radiotherapy and Cone Beam CT Image Enhancement Using Prior Nonlocal Means Method

Xun Jia, University of California, San Diego, USA

10:00-10:25 The Block DROP and CAV Algorithms for Compressed Sensing Based Tomography

Jiehua Zhu and Xiezhang Li, Georgia Southern University, USA

continued in next column

10:30-10:55 Trabecular Texture Analysis in Dental Cone Beam CT

Haibin Ling, Xiong Yang, Jie Yang, and Fangfang Xie, Temple University, USA; Yong Xu, South China University of Technology, China; Vasileios Megalooikonomou, Temple University, USA

11:00-11:25 Joint CT/CBCT Deformable Registration and Cone Beam CT Image Enhancement

Yifei Lou, Georgia Institute of Technology, USA; Xun Jia, University of California, San Diego, USA; Tianye Niu, Patricio Vela, and Lei Zhu, Georgia Institute of Technology, USA; Steve Jiang, University of California, San Diego, USA; Allen Tannenbaum, Boston University, USA

Sunday, May 20

MS2

Advances in Sparse Recovery Algorithms - Part I of II

9:30 AM-11:30 AM

Room:Assembly E - 5th Floor

For Part 2 see MS12

Nonsmooth optimization plays a central role in sparse recovery. The recent theory of compressed sensing has revitalized the interest in such optimization problems. Sparse recovery algorithms have an extensive literature, all of which can in essence be categorized into three main classes: convex (geometric), greedy (combinatorial), and probabilistic (variational/Belief Propagation) algorithms. The focus of this minisymposium is to give an overview of recent algorithmic advances in sparse recovery. We compare and contrast the advantages and limitations of these seemingly different approaches, and identify potential new research avenues for their interactions. Session will gather talks by leading experts in the field.

Organizer: Volkan Cevher
École Polytechnique Fédérale de Lausanne, Switzerland

Organizer: Jalal Fadili
Université de Caen, France

9:30-9:55 Graphical Models and Message Passing Algorithms to Solve Large Scale Regularized Regression Problems

Andrea Montanari, Stanford University, USA

10:00-10:25 Recovering Cosparse Vectors using Convex vs Greedy Algorithms

Remi Gribonval and Sangnam Nam, IRISA-INRIA, France; Mike Davies, University of Edinburgh, United Kingdom; Michael Elad, Technion, Israel

10:30-10:55 Simple and Practical Algorithm for Sparse Fourier Transform

Haitham Hassanieh, Massachusetts Institute of Technology, USA; *Piotr Indyk*, Massachusetts Institute of Technology, USA; Dina Katabi, Massachusetts Institute of Technology, USA

11:00-11:25 Hard Thresholding with Norm Constraints

Volkan Cevher, École Polytechnique Fédérale de Lausanne, Switzerland

Sunday, May 20

MS3

Novel Tomographic Imaging Techniques in Medicine

9:30 AM-11:30 AM

Room:Concerto A - 3rd Floor

Tomographic image restoration is a widely applied modality in medical imaging. Research in this area requires a multidisciplinary approach incorporating mathematical and numerical analysis, imaging processing methods, inverse problems, image reconstruction algorithms, and experimental techniques. A deep understanding of underlying physical phenomena and implementation details of reconstruction algorithms are prerequisites for recovering tomographic images with practical significance and value. In this minisymposium novel techniques in tomographic imaging are presented. These range from methods-based aspects such as sparse recovery techniques, topological sensitivities and advanced computational tools to modelling issues in medical imaging of electrical, optical, and mechanical properties of tissue.

Organizer: Michael Hintermueller
Humboldt University Berlin, Germany

9:30-9:55 Hybrid Techniques on Electrical Tissue Property Imaging
Jin Keun Seo, Yonsei University, South Korea

10:00-10:25 Conductivity Imaging from Minimal Current Density Data
Alexandru Tamasan, University of Central Florida, USA

10:30-10:55 Anisotropic Elastic Moduli Reconstruction of Transversely Isotropic Material in Magnetic Resonance Elastography
Ohin Kwon, Konkuk University, Korea

11:00-11:25 A Shape and Topology Optimization Method for the Resolution of Inverse Problems in Tomography
Antoine Laurain, Humboldt University Berlin, Germany

Sunday, May 20

MS4

Advances in 2D and 3D Hyperspectral Imaging - Part I of II

9:30 AM-10:30 AM

Room:Concerto B - 3rd Floor

For Part 2 see MS14

This symposium addresses methods for hyperspectral image data as smoothing, clustering, segmentation and registration. In this context we consider images with potentially arbitrarily many color channels. The challenges in this area are edge preserving denoising of this type of images and dealing with data which is not sampled on regular grids as is the case after registration. Especcially applications in mass spectrometrie imaging shall be focussed.

Organizer: Stefan Schiffler
University of Bremen, Germany

Organizer: Jan Strehlow
Fraunhofer MEVIS, Germany

9:30-9:55 TV-Minimization for Color Images on Non-regular Grids
Stefan Schiffler, University of Bremen, Germany

10:00-10:25 Efficient Algorithms for Photoacoustic Imaging
Stefan Kunis, University of Osnabrueck, Germany

Sunday, May 20

MS5

Current Developments and Challenges in Imaging Through Turbulence - Part I of II

9:30 AM-11:30 AM

Room:Aria A - 3rd Floor

For Part 2 see MS15

The video sequence captured in a long-range system, such as surveillance, is often corrupted by the atmospheric turbulence degradation. Each frame suffers from geometric distortion and focal blur. To process such data arises a large amount of challenges in image processing and computer vision, such as to real-time enhancement, object detection and recognition.
This minisymposium is intended to present the state-of-the-art methods in reconstructing a video or a latent image with higher resolution, which include non-rigid registration, image fusion and blind deconvolution. The richness of its applications would draw attention to many researchers working on imaging science.

Organizer: Yifei Lou
Georgia Institute of Technology, USA

Organizer: Sung Ha Kang
Georgia Institute of Technology, USA

9:30-9:55 The Past and Future of Imaging Through Turbulence
Arjuna Flenner, Naval Air Weapons Station, USA

10:00-10:25 Removing Atmospheric Turbulence
Xiang Zhu and Peyman Milanfar, University of California, Santa Cruz, USA

10:30-10:55 Turbulence Restoration: From Stabilization to Atmospheric Deblurring
Jerome Gilles, and Stanley J. Osher, University of California, Los Angeles, USA

11:00-11:25 A Dynamic Texture Model for Imaging Through Turbulence
Mario Micheli, Université Paris Descartes, France; Yifei Lou, Georgia Institute of Technology, USA; Stefano Soatto, and Andrea L. Bertozzi, University of California, Los Angeles, USA

Sunday, May 20

MS6

Advances in Nonsmooth and Nonconvex Minimization for Imaging - Part I of II

9:30 AM-11:30 AM

Room:Maestro A - 4th Floor

For Part 2 see MS16

Optimization plays a central role in modern image processing. While convex optimization has received considerable interest in the field, nonsmooth nonconvex optimization remains much less developed. Yet, there are many problems in image processing that involve nonconvex and nonsmooth functionals to minimize, e.g. in inverse problems. The minisymposium will give an overview of recent advances on both theoretical and algorithmic aspects of minimizing nonsmooth nonconvex objective functionals. Topics that will be covered range from well-posedness, to characterization of the minimizers and algorithms to reach them. The minisymposium will bring together recognized experts in optimization theory and imaging sciences.

Organizer: Mila Nikolova
ENS Cachan, France

Organizer: Jalal Fadili
Université de Caen, France

9:30-9:55 Nonconvex Nonsmooth Optimization via Gradient Sampling
Frank E. Curtis, and Xiaocun Que, Lehigh University, USA

10:00-10:25 On the Evaluation Complexity of Nonsmooth Composite Function Minimization with Applications to Nonconvex Nonlinear Programming
Coralia Cartis, University of Edinburgh, United Kingdom; Nicholas I.M. Gould, Rutherford Appleton Laboratory, United Kingdom; Philippe L. Toint, University of Namur, Belgium

10:30-10:55 High-Dimensional Covariance Estimation under Sparse Kronecker Product Structure
Alfred O. Hero, The University of Michigan, Ann Arbor, USA; Theodoris Tsiligkardis, University of Michigan, USA

11:00-11:25 Wasserstein Barycenter: Global Minimizers and Algorithm
Rabin Julien, University of Caen, France

Sunday, May 20

MS7

Mathematical Modeling of Textures - Part I of II

9:30 AM-11:30 AM

Room:Maestro B - 4th Floor

For Part 2 see MS17

Texture is a key component of natural images. Developing efficient models for textures is the key to go beyond the state of the art for several problems in image processing (compression, super-resolution), computer graphics (static and dynamic textures synthesis), computer vision (segmentation and retrieval) and psychophysics (visual perception). This requires to advance the research front in both statistical and deterministic models of natural images. This minisymposium features talks from world renown experts in the field of mathematical texture modeling.

Organizer: Gabriel Peyré
Université Paris Dauphine, France

Organizer: Jean-Francois Aujol
IMB, CNRS, Université Bordeaux 1, France

9:30-9:55 Denoising Textures with a Multiplicative Regularization Method
Xavier Bresson, City University of Hong Kong, Hong Kong

10:00-10:25 A Level-set Approach to Image-Texture Segmentation: Old and New
Jing Yuan, University of Western Ontario, Canada

10:30-10:55 Sparse Modeling of Random Phase Textures
Lionel Moisan, Universite Paris 5, France

11:00-11:25 Optimal Transport Mixing of Gaussian Texture Models
Gabriel Peyré, Université Paris Dauphine, France

Sunday, May 20

MS8

Generalized Radon Transform and Microlocal Analysis

9:30 AM-11:30 AM

Room:Minuet - 4th Floor

Generalized Radon transforms arise in a wide range of imaging aplications. This includes synthetic aperture radar, sonar, seismic imaging, X-Ray CT and electron microscopy to mention a few. This minisymposium will bring together researchers working on variety of imaging applications where the underlying imaging models are generalized Radon transforms and present the most recent results on the role of microlocal analysis in image formation.

Organizer: Birsen Yazici
Rensselaer Polytechnic Institute, USA

9:30-9:55 Synthetic Aperture Imaging of Moving Targets using Ultra-narrowband waveforms
Birsen Yazici and Ling Wang, Rensselaer Polytechnic Institute, USA

10:00-10:25 Microlocal Analysis of an Ultrasound Transform with Circular Source and Receiver Trajectories
Gaik Ambartsoumian, University of Texas at Arlington, USA; *Venky P. Krishnan*, Tata Institute of Fundamental Research, India; Todd Quinto, Tufts University, USA

10:30-10:55 Inversion of the V-Line Radon Transform in a Disc and Its Applications in Imaging
Gaik Ambartsoumian, University of Texas at Arlington, USA

11:00-11:25 Microlocal Analysis of Common Midpoint SAR Imaging
Raluca Felea, Rochester Institute of Technology, USA

Sunday, May 20

CP3

Contributed Session 3

9:30 AM-11:30 AM

Room:Rhapsody - 4th Floor

Chair: Carlos A. Ramirez, University of Texas, El Paso, USA

9:30-9:45 A New Variational Model for Removal of Both Additive and Multiplicative Noise and a Fast Algorithm for Its Numerical Approximation

Noppadol Chumchob, Silpakorn University, Thailand and Centre for Mathematical Imaging Techniques, United Kingdom

9:50-10:05 Solving Highly Ill-Conditioned Blind Deconvolution Problems

Paul Shearer and Anna Gilbert, University of Michigan, USA

10:10-10:25 An ℓ_1 Minimization Algorithm with Applications in Image Processing

Carlos A. Ramirez and Miguel Argaez, University of Texas, El Paso, USA

10:30-10:45 Corrected Diffusion Approximation in Layered Tissues

Shelley B. Rohde and Arnold D. Kim, University of California, Merced, USA

10:50-11:05 Iteratively Reweighted Least Squares for L1 Problems: Boring But Still Effective

Paul Rodriguez, Pontifical Catholic University of Peru, Peru; Brendt Wohlberg, Los Alamos National Laboratory, USA

11:10-11:25 An Adaptive Spectrally Weighted Structure Tensor for Hyperspectral Imagery Based on the Heat Operator

Maider J. Marin-Mcgee and Miguel Velez-Reyes, University of Puerto Rico, Mayaguez, Puerto Rico

Lunch Break

11:30 AM-1:00 PM

Attendees on their own

SIAG/IS Prize Lecture

1:00 PM-1:45 PM

Room:Symphony Ballroom - 3rd Floor

Sunday, May 20

Intermission

1:45 PM-2:00 PM

MS10

Inverse Problems and Image Analysis in Remote Sensing Science - Part I of IV

2:00 PM-4:00 PM

Room:Symphony Ballroom - 3rd Floor

For Part 2 see MS19

Remote sensing starts with the acquisition of information about an object or scene from a distance. These data can be spectral, multiangle, and polarimetric, and are generated using a variety of sensors, including optical, infrared, microwave, and radar. There is a broad range of remote sensing problems, solutions of which are immensely important for scientific understanding, and there has been a rapid development of robust computational approaches to address them. This interdisciplinary minisymposium will bring together researchers from different areas to represent the diversity of analytical and computational approaches for solving a variety of inverse problems in remote sensing science.

Organizer: Igor Yanovsky
Jet Propulsion Laboratory, California Institute of Technology, USA

Organizer: Anthony B. Davis
California Institute of Technology, USA

Organizer: Luminita A. Vese
University of California, Los Angeles, USA

2:00-2:25 Variational Methods for Remote Sensing Applications

Igor Yanovsky, Jet Propulsion Laboratory, California Institute of Technology, USA

2:30-2:55 Radar Imaging

Margaret Cheney, Rensselaer Polytechnic Institute and Naval Postgraduate School, USA

continued in next column

3:00-3:25 Edge-based Image Reconstruction, Hierarchical Feature Extraction, and Analysis - A Structural Approach

Lakshman Prasad, Los Alamos National Laboratory, USA

3:30-3:55 Contrast Invariant and Affine Sub-Pixel Optical-Flow for Remote Sensing Applications

Neus Sabater, California Institute of Technology, USA

Sunday, May 20

MS11

Analysis of Tomographic Images for Clinics: Recent Advances and Challenges - Part II of II

2:00 PM-4:00 PM

Room:Assembly C - 5th Floor

For Part 1 see MS1

Analysis of tomographic images is of central importance for diagnostic and therapeutic applications in various clinical contexts. Distinct characteristics between tissues, along with different image properties and qualities among imaging modalities, have posed great challenges to the analysis tasks. Therefore, new ideas, adaptive models, and special techniques are in high demand. This minisymposium aims to bring together mathematicians, medical physicists, radiologists, and engineers, especially young scientists, to exchange the most recent advances in tomographic image analysis. We hope this minisymposium can provide a forum to stimulate discussions and establish collaborations between mathematicians and clinic scientists for further developments in this emerging research field.

Organizer: Xiaojing Ye
Georgia Institute of Technology, USA

Organizer: Xun Jia
University of California, San Diego, USA

2:00-2:25 Temporally Consistent Segmentation of Longitudinal MRI Data and Related Issues
Chunming Li, Vanderbilt University, USA

2:30-2:55 Marginal Space Learning for Efficient Detection and Segmentation of Anatomical Structures in Medical Imaging
Yefeng Zheng, Siemens Corporation Research, Germany

continued in next column

3:00-3:25 An Efficient Algorithm for Multiphase Image Segmentation with Intensity Bias Correction
Haili Zhang and Yunmei Chen, University of Florida, USA; Xiaojing Ye, Georgia Institute of Technology, USA

3:30-3:55 A Geodesic Active Contour Based Model for Short Axis Cardiac-MR Image Segmentation
Sung Ha Kang, Georgia Institute of Technology, USA; W*ei Zhu*, University of Alabama, USA; George Biros, Georgia Institute of Technology, USA

Sunday, May 20

MS12

Advances in Sparse Recovery Algorithms - Part II of II

2:00 PM-3:30 PM

Room:Assembly E - 5th Floor

For Part 1 see MS2

Nonsmooth optimization plays a central role in sparse recovery. The recent theory of compressed sensing has revitalized the interest in such optimization problems. Sparse recovery algorithms have an extensive literature, all of which can in essence be categorized into three main classes: convex (geometric), greedy (combinatorial), and probabilistic (variational/Belief Propagation) algorithms. The focus of this minisymposium is to give an overview of recent algorithmic advances in sparse recovery. We compare and contrast the advantages and limitations of these seemingly different approaches, and identify potential new research avenues for their interactions. Session will gather talks by leading experts in the field.

Organizer: Volkan Cevher
École Polytechnique Fédérale de Lausanne, Switzerland

Organizer: Jalal Fadili
Université de Caen, France

2:00-2:25 Generalized Forward-Backward Splitting for Sparse Recovery
Jalal Fadili, Université de Caen, France; Gabriel Peyre, Université Paris Dauphine, France; Hugo Raguet, Universite Paris Dauphine and CNRS, France

2:30-2:55 General Purpose First-order Methods for Convex Minimization
Stephen Becker, California Institute of Technology, USA; Emmanuel Candes, Stanford University, USA; Michael C. Grant, California Institute of Technology, USA; Jalal Fadili, Université de Caen, France

3:00-3:25 Constructing Test Instances for Sparse Recovery Algorithms
Christian Kruschel, and Dirk Lorenz, Technische Universitaet Braunschweig, Germany

Sunday, May 20

MS13

Computational Photography

2:00 PM-3:30 PM

Room:Concerto A - 3rd Floor

Recent advances in digital imaging technology and in mathematical signal processing have created new possibilities for photography. Examples include massively detailed gigapixel images, improved scene understanding via finely time-resolved detection of photons, selective focusing of photographs after the images have been recorded, and capturing huge dynamical ranges of illumination by combining different exposures. This minisymposium collects together some of these exciting new directions of photographic imaging.

Organizer: Samuli Siltanen
University of Helsinki, Finland

2:00-2:25 Sensing Videos with the Single Pixel Camera
Richard G. Baraniuk, Rice University, USA

2:30-2:55 Infinite Photography
Tapio Helin, Matti Lassas, and Samuli Siltanen, University of Helsinki, Finland

3:00-3:25 Femto-Photography: Time Resolved Imaging for Looking Around Corners
Ramesh Raskar, Massachusetts Institute of Technology, USA

Sunday, May 20

MS14

Advances in 2D and 3D Hyperspectral Imaging - Part II of II

2:00 PM-4:00 PM

Room:Concerto B - 3rd Floor

For Part 1 see MS4

This symposium addresses methods for hyperspectral image data as smoothing, clustering, segmentation and registration. In this context we consider images with potentially arbitrarily many color channels. The challanges in this area are edge preserving denoising of this type of images and dealing with data which is not sampled on regular grids as is the case after registration. Especially applications in mass spectrometrie imaging shall be focussed.

Organizer: Stefan Schiffler
University of Bremen, Germany

Organizer: Jan Strehlow
Fraunhofer MEVIS, Germany

2:00-2:25 Registration of MALDI Imaging Data
Stefan Heldmann, Judith Berger, Jan Strehlow, and Stefan Wirtz, Fraunhofer MEVIS, Germany

2:30-2:55 Generating 3D MALDI Imaging Data
Jan Strehlow, Judith Berger, Stefan Heldmann, and Stefan Wirtz, Fraunhofer MEVIS, Germany

3:00-3:25 Including Spatial Similarities into Hierarchical Clustering of Hyperspectral Terahertz Images
Henrike Stephani, Fraunhofer Institute for Industrial Mathematics, Germany; Karin Wiesauer and Stefan Katletz, RECENDT, Linz, Austria; Daniel Molter, Fraunhofer Institute for Physical Measurement Techniques, Germany; Bettina Heise, Johannes Kepler University, Austria

3:30-3:55 Artifact-free Decompression of Transform-coded Multi-channel Images with TGV
Martin Holler and Kristian Bredies, University of Graz, Austria

Sunday, May 20

MS15

Current Developments and Challenges in Imaging Through Turbulence - Part II of II

2:00 PM-3:30 PM

Room:Aria A - 3rd Floor

For Part 1 see MS5

The video sequence captured in a long-range system, such as surveillance, is often corrupted by the atmospheric turbulence degradation. Each frame suffers from geometric distortion and focal blur. To process such data arises a large amount of challenges in image processing and computer vision, such as to real-time enhancement, object detection and recognition. This minisymposium is intended to present the state-of-the-art methods in reconstructing a video or a latent image with higher resolution, which include non-rigid registration, image fusion and blind deconvolution. The richness of its applications would draw attention to many researchers working on imaging science.

Organizer: Yifei Lou
Georgia Institute of Technology, USA

Organizer: Sung Ha Kang
Georgia Institute of Technology, USA

2:00-2:25 On-the-Fly Turbulence Effect Mitigation in Long-Range Surveillance Applications Based on Lucky Region Fusion
Mathieu Aubailly, University of Maryland, USA

2:30-2:55 Video Restoration of Turbulence Distortion
Yifei Lou and Sung Ha Kang, Georgia Institute of Technology, USA; Stefano Soatto, and Andrea L. Bertozzi, University of California, Los Angeles, USA

3:00-3:25 Non Rigid Geometric Distortions Correction -- Application to Atmospheric Turbulence Stabilization
Yu Mao, University of Minnesota, USA; Jerome Gilles, University of California, Los Angeles, USA

Sunday, May 20

MS16

Advances in Nonsmooth and Nonconvex Minimization for Imaging - Part II of II

2:00 PM-4:00 PM

Room:Maestro A - 4th Floor

For Part 1 see MS6

Optimization plays a central role in modern image processing. While convex optimization has received considerable interest in the field, nonsmooth nonconvex optimization remains much less developed. Yet, there are many problems in image processing that involve nonconvex and nonsmooth functionals to minimize, e.g. in inverse problems. The minisymposium will give an overview of recent advances on both theoretical and algorithmic aspects of minimizing nonsmooth nonconvex objective functionals. Topics that will be covered range from well-posedness, to characterization of the minimizers and algorithms to reach them. The minisymposium will bring together recognized experts in optimization theory and imaging sciences.

Organizer: Mila Nikolova
ENS Cachan, France

Organizer: Jalal Fadili
Université de Caen, France

2:00-2:25 On Local Linear Convergence of Elementary Algorithms with Sparsity Constraints
Russell Luke, University of Goettingen, Germany

2:30-2:55 $L^p(\Omega)$Optimization with $p\in(0,1)$
Karl Kunisch, Universität Graz, Austria; Kazufumi Ito, North Carolina State University, USA

3:00-3:25 Sparse Approximation via Penalty Decomposition Methods
Zhaosong Lu, Simon Fraser University, Canada

3:30-3:55 Symbology-based Algorithms for Robust Bar Code Recovery
Rachel Ward, University of Texas at Austin, USA

Sunday, May 20

MS17

Mathematical Modeling of Textures - Part II of II

2:00 PM-3:30 PM

Room:Maestro B - 4th Floor

For Part 1 see MS7

Texture is a key component of natural images. Developing efficient models for textures is the key to go beyond the state of the art for several problems in image processing (compression, super-resolution), computer graphics (static and dynamic textures synthesis), computer vision (segmentation and retrieval) and psychophysics (visual perception). This requires to advance the research front in both statistical and deterministic models of natural images. This minisymposium features talks from world renown experts in the field of mathematical texture modeling.

Organizer: Gabriel Peyré
Université Paris Dauphine, France

Organizer: Jean-Francois Aujol
IMB, CNRS, Université Bordeaux 1, France

2:00-2:25 Texture, Structure and Visual Matching
Stefano Soatto, University of California, Los Angeles, USA

2:30-2:55 Maximum Entropy Texture Modeling Based on a Physiological Front End
Eero P. Simoncelli, Courant Institute of Mathematical Sciences, New York University, USA

3:00-3:25 Linking a Texture Model to Visual Processing in Cortex
Jeremy Freeman, New York University, USA

Sunday, May 20

MS18

Mathematical Challenges in 4D Imaging - Part I of III

2:00 PM-4:00 PM

Room:Minuet - 4th Floor

For Part 2 see MS27

Modeling and understanding of complex systems in biology, medicine and geophysics require data that provide a solid resolution of spatial and temporal phenomena. Typically, the analysis of this data is memory consuming and computationally intense. With the increase of computing power and the invention of sophisticated numerical tools these large scale 3D and even 4D imaging problems are becoming tractable. In this minisymposium we aim to provide an overview on state-of-the-art imaging techniques from various fields which are mutually connected by similar technologies. The goal is to report on current computational approaches and challenges. Moreover, we aim to identify synergies between these fields.

Organizer: Jan Modersitzki
University of Lübeck, Germany

Organizer: Stefan Heldmann
Fraunhofer MEVIS, Germany

Organizer: Nathan D. Cahill
Rochester Institute of Technology, USA

2:00-2:25 4D Inverse Problems: Optimal Transport meets Sparsity and Low Rank
Christoph Brune, Hao Gao, and Stanley J. Osher, University of California, Los Angeles, USA

2:30-2:55 Which Geometric Structure for the Statistical Analysis of Longitudinal Deformations?
Xavier Pennec, INRIA, France

3:00-3:25 Motion Compensation for Dynamic Contrast Enhanced MRI
Stefan Heldmann, Fraunhofer MEVIS, Germany; Stephen Keeling, University of Graz, Austria; Jan Modersitzki, University of Lübeck, Germany; Lars Ruthotto, University of Muenster, Germany

3:30-3:55 A Spatio-temporal Motion Correction Scheme for Cardiac PET
Lars Ruthotto, University of Muenster, Germany; Jan Modersitzki, University of Lübeck, Germany

Sunday, May 20

CP1

Contributed Session 1

2:00 PM-4:00 PM

Room:Rhapsody - 4th Floor

Chair: Glenn Easley, System Planning Corporation, USA

2:00-2:15 Learning Sparsifying Transforms for Signal and Image Processing

Saiprasad Ravishankar and Yoram Bresler, University of Illinois, USA

2:20-2:35 A Compressive Sensing Synthetic Aperture Radar Method Incorporating Speckle

Glenn Easley, System Planning Corporation, USA; Vishal Patel, University of Maryland, USA; Rama Chellappa, University of Maryland, College Park, USA

2:40-2:55 Image Compression With Nearest-Neighbor Transforms

Aliaksei Sandryhaila, and Jose M.F. Moura, Carnegie Mellon University, USA

3:00-3:15 Robust High Frequency Information Guided Compressive Sensing Reconstruction

Weihong Guo and *Jing Qin*, Case Western Reserve University, USA

3:20-3:35 Adapted Curvelet Sparse Regularization in Limited Angle Tomography

Jürgen Frikel, Helmholtz Zentrum München, Germany

3:40-3:55 Sparse Shape Reconstruction

Alireza Aghasi and Eric Miller, Tufts University, USA; Justin Romberg, Georgia Institute of Technology, USA

Coffee Break

4:00 PM-4:30 PM

Room:Orchestra - 2nd Floor

Sunday, May 20

MS19

Inverse Problems and Image Analysis in Remote Sensing Science - Part II of IV

4:30 PM-6:30 PM

Room:Symphony Ballroom - 3rd Floor

For Part 1 see MS10
For Part 3 see MS32

Remote sensing starts with the acquisition of information about an object or scene from a distance. These data can be spectral, multiangle, and polarimetric, and are generated using a variety of sensors, including optical, infrared, microwave, and radar. There is a broad range of remote sensing problems, solutions of which are immensely important for scientific understanding, and there has been a rapid development of robust computational approaches to address them. This interdisciplinary minisymposium will bring together researchers from different areas to represent the diversity of analytical and computational approaches for solving a variety of inverse problems in remote sensing science.

Organizer: Igor Yanovsky
Jet Propulsion Laboratory, California Institute of Technology, USA

Organizer: Anthony B. Davis
California Institute of Technology, USA

Organizer: Luminita A. Vese
University of California, Los Angeles, USA

4:30-4:55 Photon State Space and Radiative Transfer: The Physics of Imaging with Remote Sensors

Anthony B. Davis, California Institute of Technology, USA

5:00-5:25 Sensitivity Studies of Optical Scanning Polarimeter Retrievals of Aerosol and Cloud Optical Properties

Kirk Knobelspiesse, Brian Cairns, and Michael Mishchenko, NASA Goddard Space Flight Center, USA

5:30-5:55 Spectral Invariance in Atmospheric Radiation

Alexander Marshak, NASA Goddard Space Flight Center, USA; Yuri Knyazikhin, Boston University, USA

6:00-6:25 Atmospheric Radiative Effects and their Correction in Landsat Images

Alexei Lyapustin, NASA Goddard Space Flight Center, USA

Sunday, May 20

MS20

Hybrid Methods in Biomedical Imaging - Part I of II

4:30 PM-6:30 PM

Room:Assembly C - 5th Floor

For Part 2 see MS37

Many of classical tomography modalitites either have insufficient contrast with respect to certain features of medical interest (such as cancerous tumors lying within soft tissues), or are unstable and cannot deliver high resolution necessary to recover such features. In recent years several novel hybrid techniques were introduced; these modalities combine two (or even three) different types of physical fields to yield both high contrast and high resolution required by today's medicine. The present minisymposium brings together leading experts on photoacoustic, thermoacoustic, acousto-optic and acousto-electric tomographies.

Organizer: Leonid A. Kunyansky
University of Arizona, USA

4:30-4:55 Acousto-optic Imaging and Related Inverse Problems

John Schotland, University of Michigan, USA

5:00-5:25 Electro-Acoustic Imaging Methods

Yves Capdeboscq, Oxford University, United Kingdom

5:30-5:55 Stabilizing Inverse Problems by Internal Data

Dustin Steinhauer, Texas A&M University, USA

6:00-6:25 Joint Estimation of Wave Speed and Absorption Density Functions with Photoacoustic Measurement

Otmar Scherzer, University of Vienna, Austria; Andreas Kirsch, Karlsruhe Institute of Technology, Germany

Sunday, May 20

MS21

Seismic Imaging and Inversion - Part I of III

4:30 PM-6:30 PM

Room:Assembly E - 5th Floor

For Part 2 see MS29

Inferring Earth structure from seismic data is challenging because of the mult-scale, heterogeneous nature of the Earth. Further challenges lie in choosing how to acquire, represent and handle the large seismic data sets. The seismic inverse problem itself is generally non-convex and largely ill-posed, limiting the use of conventional optimization methods. As data are collected in regions of increasingly complicated geology, moving beyond linearized approximations is key to obtaining realistic, multi-scale models. To handle the large data sets intelligently, methods for sparse representation of wave fields are necessary to efficiently model and represent data, as well as to form images.

Organizer: Alison Malcolm
Massachusetts Institute of Technology, USA

Organizer: Laurent Demanet
Massachusetts Institute of Technology, USA

Organizer: Ivan Vasconcelos
Schlumberger Cambridge Research, United Kingdom

4:30-4:55 Do High Frequencies Contain Information about Low Frequencies?

Laurent Demanet, Massachusetts Institute of Technology, USA

5:00-5:25 Nonlinear Imaging and Inversion of Seismic Wavefields Using Interferometry

Ivan Vasconcelos, Schlumberger Cambridge Research, United Kingdom; Clement Fleury, Colorado School of Mines, USA; Daniel Macedo, University of Campinas, Brazil

5:30-5:55 Modeling and Inverting Seismic P-S mode Conversions from Anelastic Targets

Kris Innanen, University of Calgary, Canada

6:00-6:25 Interferometric Seismic Imaging by Sparse Inversion

Joost van der Neut, Delft University of Technology, Netherlands; Tristan van Leeuwen and *Felix J. Herrmann*, University of British Columbia, Canada; Kees Wapenaar, Delft University of Technology, Netherlands

Sunday, May 20

MS22

Functional Analysis and Accurate Numerical Methods in Image Processing

4:30 PM-6:30 PM

Room:Concerto A - 3rd Floor

In this minisymposium, methods in the calculus of variation and partial differential equations are used to understand mathematical properties in image denoising and colorization and to improve numerical simulations. In image colorization, existence of minimizers, reconstructibility, and faithfulness of color image restoration model are discussed. In image denoising, stability and consistency properties of various variational models are considered and fast, efficient, and accurate numerical methods for the Fenchel pre-dual in the total variation model are proposed. Comparison with well-known various efficient schemes for the Rudin-Osher-Fatemi model in terms of accuracy and efficiency will be undertaken.

Organizer: Jooyoung Hahn
University of Graz, Austria

4:30-4:55 Exact Reconstruction of Damaged Color Images using a Total Variation Model

Irene Fonseca and Giovanni Leoni, Carnegie Mellon University, USA; Francesco Maggi, University of Florence, Italy; Massimiliano Morini, Universita degli Studi di Parma, Italy

5:00-5:25 Variational Models for Denoising of Images and their Functional Analytic Properties

Barbara Zwicknagl, Carnegie Mellon University, USA; Rustum Choksi, McGill University, Canada; Irene Fonseca, Carnegie Mellon University, USA

5:30-5:55 Accurate Numerical Schemes in Image Denoising

Jooyoung Hahn and Carlos N. Rautenberg, University of Graz, Austria; Michael Hintermueller, Humboldt University Berlin, Germany

6:00-6:25 Fast Algorithms for Second Order TV and Fourth Order Mean Curvature Denoising

Ke Chen, University of Liverpool, United Kingdom; Carlos Brito, Universidad Autónoma de Yucatán, Mexico; Li Sun, Lanzhou University, China

Sunday, May 20

MS23

Efficient Optimization Algorithms and their Application to Image Analysis - Part I of II

4:30 PM-6:30 PM

Room:Concerto B - 3rd Floor

For Part 2 see MS31

Many problems in image analysis, including image denoising, image deblurring, image reconstruction, and compressed sensing, are eventually reduced to optimization problems. This minisymposium explores recently proposed optimization algorithms with application to image analysis.

Organizer: Yunmei Chen
University of Florida, USA

Organizer: William Hager
University of Florida, USA

Organizer: Maryam Yashtini
University of Florida, USA

4:30-4:55 Bregmanized Operator Splitting with Variable Stepsize: Convergence Analysis and MRI Application

Maryam Yashtini and William Hager, University of Florida, USA; Xiaojing Ye, Georgia Institute of Technology, USA; Yunmei Chen, University of Florida, USA

5:00-5:25 Title Not Available at Time of Publication

Stanley J. Osher, University of California, Los Angeles, USA

5:30-5:55 Smoothed Sparse Optimization

Ming-Jun Lai, University of Georgia, USA; *Wotao Yin*, Rice University, USA

6:00-6:25 Iterative Regularization of Inverse Problems by Efficient Inexact Uzawa Methods

Christoph Brune, University of California, Los Angeles, USA; Klaus Frick, University of Goettingen, Germany; Martin Burger, University of Muenster, Germany

Sunday, May 20

MS24

CANCELLED

4:30 PM-6:30 PM

Sunday, May 20

MS25

Advances in Operator Splitting Algorithms for Nonsmooth Optimization - Part I of II

4:30 PM-6:00 PM

Room:Maestro A - 4th Floor

For Part 2 see MS33

Nonsmooth optimization is at the heart of many problems in modern image processing. It turns out that many of these nonsmooth objective functionals have a structure that can be exploited to design fast, effective and provably convergent splitting algorithms. The goal of these algorithms is to achieve full splitting where each part in the objective is used separately. The minisymposium will give an overview of recent advances in operator splitting for nonsmooth optimization, both in the convex and nonconvex case. The minisymposium will bring together recognized experts in optimization theory and imaging sciences.

Organizer: Jalal Fadili
Université de Caen, France

Organizer: Gabriel Peyré
Université Paris Dauphine, France

Organizer: Laurent Condat
University of Caen, France

4:30-4:55 Smoothing and First Order Methods: A Unified Framework

Marc Teboulle, Tel Aviv University, Israel; Amir Beck, Technion - Israel Institute of Technology, Israel

5:00-5:25 Implementation of a Block Decomposition Algorithm for Solving Large-scale Conic Optimization Problems

Renato Monteiro and *Camilo Ortiz*, Georgia Institute of Technology, USA; Benar F. Svaiter, IMPA, Brazil

5:30-5:55 Primal-dual Splitting, Recent Improvements and Variants

Thomas Pock, Graz University of Technology, Austria; Chambolle Antonin, Ecole Polytechnique, France

Sunday, May 20

MS26

Recent Advances in Patch-based Image Processing - Part I of III

4:30 PM-6:30 PM

Room:Maestro B - 4th Floor

For Part 2 see MS34

The past few years have witnessed the emergence of a series of papers that tackle various image processing tasks in a locally adaptive, patch-based manner. These methods serve various applications, such as denoising, deblurring, inpainting, image decomposition, segmentation, super-resolution reconstruction, and more. As the name suggests, these techniques operate locally in the image, applying the same process for every pixel by manipulating small patches of pixels. In this minisymposium we intend to gather the leading researchers in this maturing arena to present a series of talks that will expose the current state of knowledge in this field.

Organizer: Gabriel Peyré
Université Paris Dauphine, France

Organizer: Michael Elad
Technion, Israel

Organizer: Peyman Milanfar
University of California, Santa Cruz, USA

4:30-4:55 The Pat(c)h Ahead: A Wide-Angle View of Image Filtering

Peyman Milanfar, University of California, Santa Cruz, USA

5:00-5:25 Poisson Noise Reduction with Non-local PCA

Joseph Salmon, Duke University, USA; Charles-Alban Deledalle, Université Paris Dauphine, France; Rebecca Willett and Zachary T. Harmany, Duke University, USA

5:30-5:55 Getting It Right: Parameter Selection For Non-Local Means Using Sure

Dimitri Van De Ville, and Michel Kocher, École Polytechnique Fédérale de Lausanne, Switzerland

6:00-6:25 Aggregation Methods for Optical Flow Computation

Charles Kervrann, INRIA, France

Sunday, May 20

MS27

Mathematical Challenges in 4D Imaging - Part II of III

4:30 PM-6:30 PM

Room:Minuet - 4th Floor

For Part 1 see MS18
For Part 3 see MS35

Modeling and understanding of complex systems in biology, medicine and geophysics require data that provide a solid resolution of spatial and temporal phenomena. Typically, the analysis of this data is memory consuming and computationally intense. With the increase of computing power and the invention of sophisticated numerical tools these large scale 3D and even 4D imaging problems are becoming tractable. In this minisymposium we aim to provide an overview on state-of-the-art imaging techniques from various fields which are mutually connected by similar technologies. The goal is to report on current computational approaches and challenges. Moreover, we aim to identify synergies between these fields.

Organizer: Jan Modersitzki
University of Lübeck, Germany

Organizer: Stefan Heldmann
Fraunhofer MEVIS, Germany

Organizer: Nathan D. Cahill
Rochester Institute of Technology, USA

4:30-4:55 Numerical Techniques for Structural and Joint Inversion
Eldad Haber, Emory University, USA; *Michal Holtzman Gazit*, University of British Columbia, Canada

5:00-5:25 Fast Algorithms for 4D Biophysically-constrained Image Registration
George Biros, University of Texas at Austin, USA

5:30-5:55 Large scale Imaging on Current Many-Core Platforms
Harald Koestler, University of Erlangen-Nuremberg, Germany

6:00-6:25 Image-Based Modelling of Brain Tumour Progression: From Individualization to Priors for Non-Rigid Image Registration
Andreas Mang and Thorsten M. Buzug, University of Luebeck, Germany

Sunday, May 20

MS67

Sparse and Redundant Representations for Image Reconstruction and Geometry Extraction

4:30 PM-6:30 PM

Room:Aria A - 3rd Floor

Sparse and redundant representations are powerful and popular mathematical tools for image denoising, reconstruction, sampling as well as feature extraction, classification etc. This minisymposium brings together researchers to discuss the recent advances in using wavelet frames, shearlets, and redundant dictionaries to reconstruct images and to extract geometrices.

Organizer: Weihong Guo
Case Western Reserve University, USA

4:30-4:55 Shearlets and Geometry Extraction
Gitta Kutyniok, Technische Universitaet Berlin, Germany; David L. Donoho, Stanford University, USA; Wang-Q Lim, Technische Universitaet Berlin, Germany

5:00-5:25 Box Spline Wavelet Frames for Image Edge Detection
Weihong Guo, Case Western Reserve University, USA; *Ming-Jun Lai*, University of Georgia, USA

5:30-5:55 The Analysis Co-Sparse Model: Pursuit, Dictionary Learning, and Beyond
Michael Elad, Ron Rubinstein, and Tomer Faktor, Technion, Israel

6:00-6:25 Sparse Approximation by Wavelet Frames with Applications to Image Restoration
Bin Dong, University of Arizona, USA

Sunday, May 20

CP2

Contributed Session 2

4:30 PM-6:30 PM

Room:Rhapsody - 4th Floor

Chair: To Be Determined

4:30-4:45 Reconstruction from Spherical Mean Data by Summability Methods
Frank Filbir, Helmholtz Zentrum München, Germany

4:50-5:05 3D Isar Image Reconstruction of Targets Through Filtered Back Projection
Zhijun Qiao, Jaime Lopez, and Tim Ray, University of Texas - Pan American, USA

5:10-5:25 Actin Filament Tracking in Electron Tomograms of negatively stained Lamellipodia using the Localized Radon Transform
Christoph Winkler, Johann Radon Institute for Computational and Applied Mathematics, Austria; Marlene Vinzenz and Victor Small, Austrian Academy of Sciences, Austria; Christian Schmeiser, University of Vienna, Austria

5:30-5:45 Attenuation Compensation in Ultrasound Imaging
Jue Wang, Union College, USA; Yongjian Yu, InfiMed Inc., USA

5:50-6:05 Automatic MRI Scan Positioning for Feeding Arteries of the Brain
Yan Cao, University of Texas, Dallas, USA; Peiying Liu and Hanzhang Lu, University of Texas Southwestern Medical Center at Dallas, USA

6:10-6:25 Restricted Convergence of Projected Landweber Iteration in Banach Spaces for Nonlinear Inverse Problems
Lingyun Qiu and Maarten V. de Hoop, Purdue University, USA; Otmar Scherzer, University of Vienna, Austria

Dinner Break

6:30 PM-8:00 PM

Attendees on their own

Sunday, May 20

PP1

Welcome Reception and Poster Session

8:00 PM-10:00 PM

Room:Ormandy West - Lobby Level

Automated Parameter Selection Tool for Solution to Ill-Posed Problems
Brianna Cash, University of Maryland, College Park, USA

Phase Retrieval with Random Illumination
Wenjing Liao and Albert Fannjiang, University of California, Davis, USA

A Generalized Simulated Annealing Approach to Image Reconstruction
Marc C. Robini, INSA Lyon, France

Image Reconstruction with Multiresolution Edge-Continuation and Non-Quadratic Data Fidelity
Marc C. Robini and Pierre-Jean Viverge, INSA Lyon, France

Direct Reconstruction from Spherical Mean Data
Ruben Seyfried, Helmholtz Zentrum München, Germany

A Nonconvex $\{TV\}^q$-Model in Image Restoration
Michael Hintermüller, Humboldt University Berlin, Germany; *Tao Wu*, University of Graz, Austria

Monday, May 21

Registration

7:45 AM-5:00 PM

Room:Overture - 3rd Floor

Remarks

8:10 AM-8:15 AM

Room:Symphony Ballroom - 3rd Floor

Monday, May 21

IP2

Targeted Seismic Imaging

8:15 AM-9:00 AM

Room:Symphony Ballroom - 3rd Floor

Chair: Samuli Siltanen, University of Helsinki, Finland

The seismic imaging problem, which is typically formulated as an inverse problem for the wavespeed in the acoustic wave equation, involves the estimation of both the smooth and oscillatory part of this wavespeed. For both of these problems, a large data set is typically recorded and subjected to extensive processing to estimate both parts of the wavespeed throughout the entire region the data are sensitive to. For many applications, however, only a part of this image is of interest. I will describe techniques for enhancing part of the image through appropriate data choices and regularization.

Alison Malcolm
Massachusetts Institute of Technology, USA

Coffee Break

9:00 AM-9:30 AM

Room:Orchestra - 2nd Floor

Monday, May 21

MT2

Mathematics and Science of 3D Electron Microscope Imaging

9:30 AM-11:30 AM

Room:Symphony Ballroom - 3rd Floor

Chair: Ozan Öktem, KTH Royal Institute of Technology, Sweden

Chair: Eric Todd Quinto, Tufts University, USA

The two parts of this minitutorial deal with mathematics for Electron Tomography (ET) and Single Particle (SP). The one on ET surveys reconstruction methods for ET with emphasis on difficulties and their mathematical consequences. It also includes the model for image formation in electron microscopy, which is the same in SP. The mini tutorial on SP focuses on presenting a novel reconstruction method, focusing on resolving the angular reconstitution problem. The method in question is based on a novel framework for non-linear optimization, which in turn is based on representation theoretic ideas - where the solution is an object of a category.

Speakers:

Ronny Hadani, University of Texas at Austin, USA

Ozan Öktem, KTH - Royal Institute of Technology, Sweden

Monday, May 21

MS28

Mathematics of Medical Imaging and Shape Analysis - Part I of III

9:30 AM-11:30 AM

Room:Assembly C - 5th Floor

For Part 2 see MS46

Medical imaging is the technique used to create images of human body seeking to reveal and examine diseases. The major challenge is to reconstruct high quality images using very limited data. Shape analysis, on the other hand, is a rapidly rising area whose aim is to provide intrinsic geometric descriptors of biological structures that can be used to detect and quantify diseases. Imaging is the process of acquiring data, while shape analysis is to analyze the acquired data. This minisymposium is to promote interactions between the two subjects that, we hope, can stimulate further developments of each subject.

Organizer: Bin Dong
University of Arizona, USA

Organizer: Rongjie Lai
University of Southern California, USA

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

Organizer: Ronald Lok Ming Lui
Chinese University of Hong Kong, Hong Kong

9:30-9:55 Laplace-Beltrami Eigen-Geometry and Applications to 3D Medical Imaging

Rongjie Lai, University of Southern California, USA

10:00-10:25 Respiratory Signal Extraction from X-ray Projection Images in 4D Cone Beam CT

Xun Jia, Hao Yan and Xiaoyu Wang, University of California, San Diego, USA; Wotao Yin, Rice University, USA; Steve Jiang, University of California, San Diego, USA

continued in next column

10:30-10:55 Rosian Noise Removal on HARDI Data in Medical Imaging

Melissa Tong, University of California, Los Angeles, USA; *Yunho Kim*, University of California, Irvine, USA; Luminita A. Vese, University of California, Los Angeles, USA

11:00-11:25 Real-Time Anatomy Tracking with Low-SNR MRI

Dan Ruan, University of California, Los Angeles, USA

Monday, May 21

MS29

Seismic Imaging and Inversion - Part II of III

9:30 AM-11:30 AM

Room:Assembly E - 5th Floor

For Part 1 see MS21
For Part 3 see MS38

Inferring Earth structure from seismic data is challenging because of the mult-scale, heterogeneous nature of the Earth. Further challenges lie in choosing how to acquire, represent and handle the large seismic data sets. The seismic inverse problem itself is generally non-convex and largely ill-posed, limiting the use of conventional optimization methods. As data are collected in regions of increasingly complicated geology, moving beyond linearized approximations is key to obtaining realistic, multi-scale models. To handle the large data sets intelligently, methods for sparse representation of wave fields are necessary to efficiently model and represent data, as well as to form images.

Organizer: Alison Malcolm
Massachusetts Institute of Technology, USA

Organizer: Laurent Demanet
Massachusetts Institute of Technology, USA

9:30-9:55 Velocity Continuation
Sergey Fomel, University of Texas at Austin, USA

10:00-10:25 Title Not Available at Time of Publication
Fons ten Kroode, Shell International Exploration & Production B.V., Netherlands

10:30-10:55 Applying Gauss-Newton and exact Newton methods to Full Waveform Inversion
Jean Virieux, ISTerre, University Joseph Fourier, France; Ludovic Metivier, Romain Brossier, and Stephane Operto, Grenoble Institut of Technology, France

11:00-11:25 Time-Lapse Image-Domain Wavefield Tomography
Jeffrey C. Shragge and David Lumley, University of Western Australia, Australia

Monday, May 21

MS30

Low Rank Modeling and its Applications to Imaging - Part I of II

9:30 AM-11:30 AM

Room:Concerto A - 3rd Floor

For Part 2 see MS52

Low rank modeling is arguably the most ubiquitous paradigm of data analysis and related fields. Despite the many existing standard techniques and their useful applications, there has been an overflow of recent developments with fundamentally novel viewpoints and new kinds of applications. These include the completion of missing values of low-rank matrices, robust low-rank models with sparse corruptions, mixtures of low-rank models, structured dictionary learning and selective sampling of hierarchically-structured high-rank matrices. The goal of this workshop is to present some of the recent theoretical progress of low rank modeling and its important applications to imaging and computer vision.

Organizer: Gilad Lerman
University of Minnesota, USA

9:30-9:55 PCA with Outliers and Missing Data
Sujay Sanghavi, University of Texas at Austin, USA

10:00-10:25 A Novel M-Estimator for Robust PCA
Teng Zhang, and Gilad Lerman, University of Minnesota, USA

10:30-10:55 Online Subspace Estimation and Tracking from Incomplete and Corrupted Data
Laura Balzano, University of Wisconsin, USA; Jun He, Nanjing University of Science & Technology, China; Arthur Szlam, New York University, USA; Brian Eriksson, Boston University, USA; Benjamin Recht and Robert Nowak, University of Wisconsin, USA

11:00-11:25 On the Use of Low-rank Regularization for Learning Graphical Models with Missing Data
Pradeep Ravikumar, University of Texas, Austin, USA

Monday, May 21

MS31

Efficient Optimization Algorithms and their Application to Image Analysis - Part II of II

9:30 AM-11:30 AM

Room:Concerto B - 3rd Floor

For Part 1 see MS23

Many problems in image analysis, including image denoising, image deblurring, image reconstruction, and compressed sensing, are eventually reduced to optimization problems. This minisymposium explores recently proposed optimization algorithms with application to image analysis.

Organizer: Yunmei Chen
University of Florida, USA

Organizer: William Hager
University of Florida, USA

Organizer: Maryam Yashtini
University of Florida, USA

9:30-9:55 A Primal Dual Method for Nonconvex Problems and Applications
Xiaoqun Zhang, Shanghai Jiaotong University, China; Ernie Esser, University of California, Irvine, USA

10:00-10:25 Nonsmooth Image Reconstruction Algorithms and Their Applications in Partially Parallel MR Imaging
Xiaojing Ye, Georgia Institute of Technology, USA; Yunmei Chen and William Hager, University of Florida, USA

10:30-10:55 A Primal Dual Method for Solving a Convex Model for DOAS Analysis
Ernie Esser and Jack Xin, University of California, Irvine, USA

11:00-11:25 Title Not Available at Time of Publication
Jing Yuan, University of Western Ontario, Canada

Monday, May 21

MS32

Inverse Problems and Image Analysis in Remote Sensing Science - Part III of IV

9:30 AM-11:30 AM

Room:Aria A - 3rd Floor

For Part 2 see MS19
For Part 4 see MS41

Remote sensing starts with the acquisition of information about an object or scene from a distance. These data can be spectral, multiangle, and polarimetric, and are generated using a variety of sensors, including optical, infrared, microwave, and radar. There is a broad range of remote sensing problems, solutions of which are immensely important for scientific understanding, and there has been a rapid development of robust computational approaches to address them. This interdisciplinary minisymposium will bring together researchers from different areas to represent the diversity of analytical and computational approaches for solving a variety of inverse problems in remote sensing science.

Organizer: Igor Yanovsky
Jet Propulsion Laboratory, California Institute of Technology, USA

Organizer: Anthony B. Davis
California Institute of Technology, USA

Organizer: Luminita A. Vese
University of California, Los Angeles, USA

9:30-9:55 Inverse Transport Problems in Remote Sensing Applications

Guillaume Bal, Columbia University, USA; Anthony B. Davis, California Institute of Technology, USA; Ian Langmore, Columbia University, USA; Youssef M. Marzouk, Massachusetts Institute of Technology, USA

10:00-10:25 Edge-preserving Super-resolution via Blind Deconvolution and Upsampling

Antonio Marquina, University of Valencia, Spain

continued in next column

10:30-10:55 Texture Adaptive Image Restoration Using Fractional Order Regularization

Fiorella Sgallari, University of Bologna, Italy; Raymond H. Chan, Chinese University of Hong Kong, Hong Kong; Alessandro Lanza and Serena Morigi, University of Bologna, Italy

11:00-11:25 Patch-based Locally Optimal Denoising

Peyman Milanfar and Priyam Chatterjee, University of California, Santa Cruz, USA

Monday, May 21

MS33

Advances in Operator Splitting Algorithms for Nonsmooth Optimization - Part II of II

9:30 AM-11:30 AM

Room:Maestro A - 4th Floor

For Part 1 see MS25

Nonsmooth optimization is at the heart of many problems in modern image processing. It turns out that many of these nonsmooth objective functionals have a structure that can be exploited to design fast, effective and provably convergent splitting algorithms. The goal of these algorithms is to achieve full splitting where each part in the objective is used separately. The minisymposium will give an overview of recent advances in operator splitting for nonsmooth optimization, both in the convex and nonconvex case. The minisymposium will bring together recognized experts in optimization theory and imaging sciences.

Organizer: Jalal Fadili
Université de Caen, France

Organizer: Gabriel Peyré
Université Paris Dauphine, France

Organizer: Laurent Condat
University of Caen, France

9:30-9:55 High-order Methods for Sparse Signal Recovery

Tom Goldstein, Stanford University, USA

10:00-10:25 Forward-backward Splitting and Proximal Alternating Methods for Nonconvex Nonsmooth Tame Problems

Jérôme Bolte, Université Toulouse I, France

10:30-10:55 A Memory Gradient Algorithm for Nonconvex Regularization with Applications to Image Restoration

Emilie Chouzenoux, Université Paris-Est Marne-la-Vallée, France

11:00-11:25 Combinatorial Selection and Least Absolute Shrinkage via the CLASH Algorithm

Volkan Cevher, École Polytechnique Fédérale de Lausanne, Switzerland

Monday, May 21

MS34

Recent Advances in Patch-based Image Processing - Part II of III

9:30 AM-11:30 AM

Room:Maestro B - 4th Floor

For Part 1 see MS26
For Part 3 see MS43

The past few years have witnessed the emergence of a series of papers that tackle various image processing tasks in a locally adaptive, patch-based manner. These methods serve various applications, such as denoising, deblurring, inpainting, image decomposition, segmentation, super-resolution reconstruction, and more. As the name suggests, these techniques operate locally in the image, applying the same process for every pixel by manipulating small patches of pixels. In this minisymposium we intend to gather the leading researchers in this maturing arena to present a series of talks that will expose the current state of knowledge in this field.

Organizer: Gabriel Peyré
Université Paris Dauphine, France

Organizer: Michael Elad
Technion, Israel

Organizer: Peyman Milanfar
University of California, Santa Cruz, USA

9:30-9:55 A Generalized Tree-Based Wavelet Transform and Its Application to Patch-Based Image Denoising
Michael Elad, Technion, Israel

10:00-10:25 Analysis of Image Patches: A Unified Geometric Perspective
Francois G. Meyer, University of Colorado, Boulder, USA

10:30-10:55 Patch Based Image Denoising With and Without Dictionary Learning
Lei Zhang, Hong Kong Polytechnic University, China

11:00-11:25 Matching By Tone Mapping
Yacov Hel-Or, The Interdisciplinary Center, Israel

Monday, May 21

MS35

Mathematical Challenges in 4D Imaging - Part III of III

9:30 AM-11:30 AM

Room:Minuet - 4th Floor

For Part 2 see MS27

Modeling and understanding of complex systems in biology, medicine and geophysics require data that provide a solid resolution of spatial and temporal phenomena. Typically, the analysis of this data is memory consuming and computationally intense. With the increase of computing power and the invention of sophisticated numerical tools these large scale 3D and even 4D imaging problems are becoming tractable. In this minisymposium we aim to provide an overview on state-of-the-art imaging techniques from various fields which are mutually connected by similar technologies. The goal is to report on current computational approaches and challenges. Moreover, we aim to identify synergies between these fields.

Organizer: Jan Modersitzki
University of Lübeck, Germany

Organizer: Stefan Heldmann
Fraunhofer MEVIS, Germany

Organizer: Nathan D. Cahill
Rochester Institute of Technology, USA

9:30-9:55 Matrix Factorization Techniques for Multivariate Imaging Analysis
James Gee, University of Pennsylvania, USA

10:00-10:25 Free Form Deformations with Dense Control Point Spacing for Image Registration
Nathan D. Cahill, Rochester Institute of Technology, USA

10:30-10:55 4D Image Based Parameter Estimation of Vascular Properties
Luca Bertagna, Emory University, USA; Mauro Perego, Florida State University, USA; *Alessandro Veneziani*, Emory University, USA

11:00-11:25 Image Processing with Stochastic PDEs
Tobias Preusser, University of Bremen, Germany; Torben Pätz, Fraunhofer MEVIS, Germany

Monday, May 21

MS44

Some Strategies to Improve Resolution in Electrical Impedance Tomography

9:30 AM-11:30 AM

Room:Rhapsody - 4th Floor

It is well known that absolute Electrical Impedance Tomography (EIT) medical images need improvement in terms of spatial resolution and accuracy of the electrical properties. This minisymposium is intended to make public some of the ideas that may improve spatial resolution and accuracy of absolute images. The Approximation Error Theory, anatomy-based priors, and the combination of ultrasound and EIT are examples of recently explored strategies.

Organizer: Raul G. Lima
University of Sao Paulo, Brazil

9:30-9:55 Electrical Impedance Tomography and Ultrasound: Some Experiences
Alex Hartov and Ryan Halter, Dartmouth College, USA

10:00-10:25 An Unscented Kalman Filter with an Approximation Error Model for Electrical Impedance Tomography
Jari Kaipio, Kuopio University, Finland; *Raul Lima*, University of Sao Paulo, Brazil

10:30-10:55 Prior Models of the Human Chest in Electrical Impedance Tomography
Fernando S. Moura, University of Sao Paulo, Brazil

11:00-11:25 Regional Lung Perfusion Estimated by Electrical Impedance Tomography
Marcelo Amato and *Eduardo Leite Costa*, University of Sao Paulo, Brazil

Lunch Break

11:30 AM-1:00 PM

Attendees on their own

Monday, May 21

PD1

Forward Looking Panel Discussion

12:00 PM-12:45 PM

Room:Symphony Ballroom - 3rd Floor

Chair: Gunther Uhlmann, University of California, Irvine, USA and University of Washington, USA

Panelists:

Guillaume Bal
Columbia University, USA

Margaret Cheney
Rensselaer Polytechnic Institute and Naval Postgraduate School, USA

Alison Malcolm
Massachusetts Institute of Technology, USA

Fadil Santosa
University of Minnesota, USA

Amit Singer
Princeton University, USA

Monday, May 21

IP3

Three Dimensional Structure Determination of Macromolecules by Cryo-electron Microscopy from the Applied Math Perspective

1:00 PM-1:45 PM

Room:Symphony Ballroom - 3rd Floor

Chair: Simon Arridge, University College London, United Kingdom

Cryo-electron microscopy is a technique by which biological macromolecules are imaged in an electron microscope. The molecules are rapidly frozen in a thin layer of vitreous ice, trapping them in a nearly-physiological state. Cryo-EM images, however, have very low contrast, due to the absence of heavy-metal stains or other contrast enhancements, and have very high noise due to the small electron doses that can be applied to the specimen. Thus, to obtain a reliable three-dimensional density map of a macromolecule, the information from thousands of images of identical molecules must be combined. When the molecules are arrayed in a crystal, the necessary signal-averaging of noisy images is straightforwardly performed. More challenging is the problem of single-particle reconstruction (SPR) where a three-dimensional density map is to be obtained from images of individual molecules present in random positions and orientations in the ice layer. Because it does not require the formation of crystalline arrays of macromolecules, SPR is a very powerful and general technique, which has been successfully used for 3D structure determination of many protein molecules and large complexes. I will introduce the main theoretical and computational (rather than experimental) challenges posed by SPR, and will focus on our (*) recent progress for obtaining three-dimensional structures, for image classification and for denoising. From the mathematical perspective, we combine ideas from different areas, such as, spectral graph theory, dimensionality reduction, representation theory and semidefinite programming. This conference also hosts a minisymposium on cryo-EM. (*) This is a joint project with Fred Sigworth (Yale), Yoel Shkolnisky (Tel Aviv), Ronny Hadani (UT Austin), and Shamgar Gurevich (Wisconsin-Madison).

Amit Singer
Princeton University, USA

Intermission

1:45 PM-2:00 PM

Monday, May 21

MS9

X-Ray CT Image Reconstruction

2:00 PM-4:00 PM

Room:Minuet - 4th Floor

With the emergence of compressive sensing theory, there is a renewed interest in exploring edge preserving, statistical and optimization based approaches in X-Ray CT image reconstruction. On the other hand, analytic image reconstruction methods are still the benchmark methods implemented in X-Ray CT machines due to their many advantages including computational efficiency and well understood predictable performance. This workshop will bring together researchers working on X-Ray CT image reconstruction and present the most recent advances in analytic and optimization based approaches thereby identify new directions and challenges in X-Ray CT image reconstruction.

Organizer: Birsen Yazici
Rensselaer Polytechnic Institute, USA

Organizer: Eric Miller
Tufts University, USA

2:00-2:25 Tensor-based Formulation for Spectral Computed Tomography
Oguz Semerci, Ning Hao, Misha E. Kilmer, and Eric Miller, Tufts University, USA

2:30-2:55 The Hilbert Transform in Analytic Cone-beam Image Reconstruction: A Visual Tour
Jed Pack, GE Global Research, USA

3:00-3:25 A Fourier Integral Operator Model for Conebeam X-ray CT and its Inversion
Birsen Yazici and Zhengmin Li, Rensselaer Polytechnic Institute, USA

3:30-3:55 Recent Advances in Image Reconstruction from Interior Data
Alexander Katsevich and Alexander Tovbis, University of Central Florida, USA

Monday, May 21

MS36

Three-Dimensional Macromolecular Structure Determination Using Cryo Electron Microscopy - Part I of II

2:00 PM-4:00 PM

Room:Symphony Ballroom - 3rd Floor

For Part 2 see MS45

The cryo-electron microscopy (EM) reconstruction problem is to find the three-dimensional structure of a macromolecule given noisy samples of its two-dimensional projection images at unknown random directions and positions. Cryo-EM images have very low contrast, due to the absence of heavy-metal stains or other contrast enhancements, and have very high noise due to the small electron doses that can be applied to the specimen. This minisymposium is concerned with algorithms, computational tools and mathematical theory necessary for solving the cryo-EM problem.

Organizer: Amit Singer
Princeton University, USA

Organizer: Ronny Hadani
University of Texas at Austin, USA

2:00-2:25 Progress with Classification of Cryo-EM Data by Manifold Embedding and Other Techniques
Joachim Frank, *Robert Langlois*, and Hstau Liao, Columbia University, USA; Chun Hong Yoon, University of Wisconsin, USA; Dimitris Giannakis, New York University, USA; Peter Schwander and Abbas Ourmazd, University of Wisconsin, USA

2:30-2:55 Resampling-based Assessment of Variability in 3D Reconstructions of Biological Molecules
Pawel A. Penczek, University of Texas, Houston, USA

3:00-3:25 Viewing Direction Estimation in cryo-EM Using Synchronization
Yoel Shkolnisky, Tel Aviv University, Israel; Amit Singer, Princeton University, USA

3:30-3:55 A Fourier-based Approach for Iterative 3D Reconstruction from Cryo-EM Images
Lanhui Wang, Princeton University, USA; Yoel Shkolnisky, Tel Aviv University, Israel; Amit Singer, Princeton University, USA

Monday, May 21

MS37

Hybrid Methods in Biomedical Imaging - Part II of II

2:00 PM-4:00 PM

Room:Assembly C - 5th Floor

For Part 1 see MS20

Many of classical tomography modalitites either have insufficient contrast with respect to certain features of medical interest (such as cancerous tumors lying within soft tissues), or are unstable and cannot deliver high resolution necessary to recover such features. In recent years several novel hybrid techniques were introduced; these modalities combine two (or even three) different types of physical fields to yield both high contrast and high resolution required by today's medicine. The present minisymposium brings together leading experts on photoacoustic, thermoacoustic, acousto-optic and acousto-electric tomographies.

Organizer: Leonid A. Kunyansky
University of Arizona, USA

2:00-2:25 Noise in Photoacoustic Tomography: From Point-like Detectors to Large integrating Detectors and its Influence on Spatial Resolution and Sensitivity
Peter Burgholzer, Research Center for Non Destructive Testing GmbH, Linz, Austria

2:30-2:55 Compressed Sensing and Photo-Acoustic Tomography
Simon Arridge, University College London, United Kingdom

3:00-3:25 Gradient-based Inversion for 3D Quantitative Photoacoustic Imaging
Teedah Saratoon and Ben Cox, University College London, United Kingdom; Tanja Tarvainen, University of Eastern Finland, Finland; Simon Arridge, University College London, United Kingdom

3:30-3:55 Experimental Translation of Image Reconstruction Methods for Three-Dimensional Optoacoustic Tomography
Mark Anastasio, and Kun Wang, Washington University in St. Louis, USA; Sergey Ermilov, Richard Su, and Alexander Oraevsky, TomoWave Laboratories, USA

Monday, May 21

MS38

Seismic Imaging and Inversion - Part III of III

2:00 PM-4:00 PM

Room:Assembly E - 5th Floor

For Part 2 see MS29

Inferring Earth structure from seismic data is challenging because of the mult-scale, heterogeneous nature of the Earth. Further challenges lie in choosing how to acquire, represent and handle the large seismic data sets. The seismic inverse problem itself is generally non-convex and largely ill-posed, limiting the use of conventional optimization methods. As data are collected in regions of increasingly complicated geology, moving beyond linearized approximations is key to obtaining realistic, multi-scale models. To handle the large data sets intelligently, methods for sparse representation of wave fields are necessary to efficiently model and represent data, as well as to form images.

Organizer: Alison Malcolm
Massachusetts Institute of Technology, USA

Organizer: Laurent Demanet
Massachusetts Institute of Technology, USA

2:00-2:25 Resolution Analysis in Full Waveform Inversion

Andreas Fichtner and Jeannot Trampert, Utrecht University, The Netherlands

2:30-2:55 Seismic Full Waveform Inversion, Recent Works and Research Directions

Henri Calandra, Total CSTGF, France; Changsoo Shin, Seoul National University, Korea; Christian Rivera, Total E&P, USA; Herve Chauris, Ecole des Mines de Paris, France; Alexander Aravkin, University of British Columbia, Canada

3:00-3:25 Dreamlet as a Physical Wavelet for Seismic Data Compression and Imaging

Ru-Shan Wu, University of California, Santa Cruz, USA

3:30-3:55 Migration Based on Two-way Depth Extrapolation

Gregory Beylkin, University of Colorado, USA

Monday, May 21

MS39

Models and Applications in Compressive Imaging - Part I of III

2:00 PM-4:00 PM

Room:Concerto A - 3rd Floor

For Part 2 see MS48

Compressive Sensing is a relatively new field in mathematics whereby one can collect far fewer samples of a signal than traditional sampling theory would imply while still capturing the essential information content in the underlying signal. In compressive imaging applications, this could result in dramatically new paradigms in image collection as well as algorithms for image exploitation. This minisymposium will address some of the latest research in the underlying sensing or measurement models, algorithms for image and video reconstruction, adaptation, and algorithms for image/video exploitation directly from the compressive measurements. We will tie the theory to practical applications of interest.

Organizer: Robert R. Muise
Lockheed-Martin, USA

Organizer: Justin Romberg
Georgia Institute of Technology, USA

2:00-2:25 Noval Measurements in Compressive Imaging

Mark Neifeld, DARPA/DSO, USA

2:30-2:55 Code Design for Target Tracking and Discrimination

Ronald Coifman, Yale University, USA

3:00-3:25 Stability and Robustness of Weak Orthogonal Matching Pursuits

Simon Foucart, Drexel University, USA

3:30-3:55 Adaptive Compressive Imaging Using Sparse Hierarchical Learned Dictionaries

Jarvis Haupt, University of Minnesota, USA

Monday, May 21

MS40

Higher-Order Models for Image Restoration - Part I of II

2:00 PM-4:00 PM

Room:Concerto B - 3rd Floor

For Part 2 see MS49

Non-smooth variational problems and PDEs based on higher-order models gain increasing attention in various image restoration tasks including image denoising, decomposition and image inpainting. Inspired by the famous ROF (Rudin, Osher and Fatemi) model for image denoising, non-smooth penalties are used in these approaches which are in particular aware of higher-order smoothness. While still aiming to preserve sharp features (like edges) in the image, higher regularity is imposed, where necessary, to eliminate the well-known staircasing artifact present in solutions of the ROF model. In this minisymposium we want to bring together different recent higher- order imaging approaches and discuss their analytic properties and their efficient numerical solution.

Organizer: Carola B. Schoenlieb
University of Cambridge, United Kingdom

Organizer: Kristian Bredies
University of Graz, Austria

2:00-2:25 Image Restoration with Total Generalised Variation

Kristian Bredies, University of Graz, Austria

2:30-2:55 A Variational Model for Functions of Bounded Hessian - Theory, Numerics and Applications

Kostas Papafitsoros, University of Cambridge, United Kingdom

3:00-3:25 Numerical Algorithms for Euler's Elastica Models in Image Processing

Jooyoung Hahn, University of Graz, Austria; Xue-cheng Tai, University of Bergen, Norway, and Nanyang Technological University, Singapore; Jason Ginmo Chung, Nanyang Technological University, Singapore; Yu Wang, Technion, Israel; Yuping Duan, Nanyang Technological University, Singapore

3:30-3:55 Infimal Convolution Regularizations with Discrete ℓ_1-type Functionals

Tanja Teuber, University of Kaiserslautern, Germany

Monday, May 21

MS41

Inverse Problems and Image Analysis in Remote Sensing Science - Part IV of IV

2:00 PM-4:00 PM

Room:Aria A - 3rd Floor

For Part 3 see MS32

Remote sensing starts with the acquisition of information about an object or scene from a distance. These data can be spectral, multiangle, and polarimetric, and are generated using a variety of sensors, including optical, infrared, microwave, and radar. There is a broad range of remote sensing problems, solutions of which are immensely important for scientific understanding, and there has been a rapid development of robust computational approaches to address them. This interdisciplinary minisymposium will bring together researchers from different areas to represent the diversity of analytical and computational approaches for solving a variety of inverse problems in remote sensing science.

Organizer: Igor Yanovsky
Jet Propulsion Laboratory, California Institute of Technology, USA

Organizer: Anthony B. Davis
California Institute of Technology, USA

Organizer: Luminita A. Vese
University of California, Los Angeles, USA

2:00-2:25 Structured Models for Inverse Problems
Guillermo Sapiro, University of Minnesota, Minneapolis, USA

2:30-2:55 L1 based Template Matching and its Application to Hyper Spectral Imaging
Stanley J. Osher, University of California, Los Angeles, USA

3:00-3:25 The Adaptive Inverse Scale Space Method for Hyperspectral Unmixing
Michael Moeller, Martin Burger, and Martin Benning, University of Muenster, Germany; Stanley J. Osher, University of California, Los Angeles, USA

3:30-3:55 Local Robust Principal Components for Nonlinear Datasets
James Theiler, Los Alamos National Laboratory, USA; Brendt Wohlberg and Rick Chartrand, Los Alamos National Laboratory, USA

Monday, May 21

MS42

Deterministic and Probabilistic Methods for Inverse Scattering and Impedance Tomography - Part I of II

2:00 PM-4:00 PM

Room:Maestro A - 4th Floor

For Part 2 see MS51

Inverse scattering and impedance tomography have been a very active field of applied mathematics in recent years. New trends have emerged that have allowed to obtain further insights and encouraging results for well established and fascinating inverse problems. The minisymposium focuses on recent developments and innovative contributions in this direction, considering theoretical results and numerical algorithms as well as their application to specific real world problems. Both deterministic and probabilistic formulations will be presented.

Organizer: Roland Griesmaier
University of Mainz, Germany

Organizer: Nuutti Hyvonen
Aalto University, Finland

2:00-2:25 Inverse Scattering Problem for Inhomogeneous Media Containing Obstacles
Fioralba Cakoni, University of Delaware, USA; Anne Cossonniere, CERFACS, France; Houssem Haddar, Ecole Polytechnique, France

2:30-2:55 A Mixed Formulation of the Quasi-reversibility Method to Solve Elliptic Cauchy Problems in 2d and 3d
Jeremi Darde, Antti Hannukainen, and Nuutti Hyvonen, Aalto University, Finland

3:00-3:25 Inverse Source Problems and the Windowed Fourier Transform
Roland Griesmaier, University of Mainz, Germany; Martin Hanke, Johannes Gutenberg-Universität, Mainz, Germany; Thorsten Raasch, University of Mainz, Germany

3:30-3:55 A Monotony Based Method for Electrical Impedance Tomography
Marcel Ullrich and Bastian Harrach, Universität Würzburg, Germany

Monday, May 21

MS43

Recent Advances in Patch-based Image Processing - Part III of III

2:00 PM-4:00 PM

Room:Maestro B - 4th Floor

For Part 2 see MS34

The past few years have witnessed the emergence of a series of papers that tackle various image processing tasks in a locally adaptive, patch-based manner. These methods serve various applications, such as denoising, deblurring, inpainting, image decomposition, segmentation, super-resolution reconstruction, and more. As the name suggests, these techniques operate locally in the image, applying the same process for every pixel by manipulating small patches of pixels. In this minisymposium we intend to gather the leading researchers in this maturing arena to present a series of talks that will expose the current state of knowledge in this field.

Organizer: Gabriel Peyré
Université Paris Dauphine, France

Organizer: Michael Elad
Technion, Israel

Organizer: Peyman Milanfar
University of California, Santa Cruz, USA

2:00-2:25 Optimal Transport Over the Space of Patches
Gabriel Peyré, Université Paris Dauphine, France

2:30-2:55 Learning to Sense GMMs
Guillermo Sapiro, University of Minnesota, Minneapolis, USA

3:00-3:25 Patch Foveation in Nonlocal Imaging
Alessandro Foi, Tampere University of Technology, Finland; Giacomo Boracchi, Politecnico di Milano, Italy

3:30-3:55 Analysis of a Variational Framework for Exemplar Based Image Inpainting
Gabriele Facciolo, ENS Cachan, France

Monday, May 21

CP4

Contributed Session 4

2:00 PM-4:00 PM

Room:Rhapsody - 4th Floor

Chair: Hayden Schaeffer, University of California, Los Angeles, USA

2:00-2:15 Image Recognition Via Moment Method

Shanshan Huang and Mireille Boutin, Purdue University, USA

2:20-2:35 An Algorithm for Shape Detection in Inverse Problems

Gunay Dogan, National Institute of Standards and Technology, USA

2:40-2:55 Segmentation Based on a Limiting Mumford and Shah Functional

Hayden Schaeffer, and Luminita A. Vese, University of California, Los Angeles, USA

3:00-3:15 Reconstruction of Images: Computation of Confidence Intervals

Viktoria Taroudaki, University of Maryland, USA; Dianne P. O'Leary, University of Maryland, College Park, USA

3:20-3:35 Restoration of Images Corrupted by Impulse Noise Using Blind Inpainting and ℓ_0 Norm

Ming Yan, University of California, Los Angeles, USA

3:40-3:55 Volterra Equations and Image Filtering and Processing

Eduardo Cuesta, University of Valladolid, Spain; Mokhtar Kirane and Salman Malik, Universitè de la Rochelle, France

Coffee Break

4:00 PM-4:30 PM

Room:Orchestra - 2nd Floor

Monday, May 21

MS45

Three-Dimensional Macromolecular Structure Determination Using Cryo Electron Microscopy - Part II of II

4:30 PM-6:30 PM

Room:Symphony Ballroom - 3rd Floor

For Part 1 see MS36

The cryo-electron microscopy (EM) reconstruction problem is to find the three-dimensional structure of a macromolecule given noisy samples of its two-dimensional projection images at unknown random directions and positions. Cryo-EM images have very low contrast, due to the absence of heavy-metal stains or other contrast enhancements, and have very high noise due to the small electron doses that can be applied to the specimen. This minisymposium is concerned with algorithms, computational tools and mathematical theory necessary for solving the cryo-EM problem.

Organizer: Amit Singer
Princeton University, USA

Organizer: Ronny Hadani
University of Texas at Austin, USA

4:30-4:55 Title Not Available at Time of Publication

Fred Sigworth, Yale University, USA

5:00-5:25 Spherically Constrained Reconstruction in Cryo-EM

Hemant Tagare, Andrew Barthel, and Fred Sigworth, Yale University, USA

5:30-5:55 New Rotationally Invariant Viewing Direction Classification Method for Cryo-EM Single Particle Reconstruction

Zhizhen Zhao, and Amit Singer, Princeton University, USA

6:00-6:25 Detecting Molecular Symmetry and Shape Using Cryo-electron Microscopy, Geometry, and Group Representation Theory

Shamgar Gurevich, University of Wisconsin, Madison, USA; Ronny Hadani, University of Texas at Austin, USA; Amit Singer, Princeton University, USA

Monday, May 21

MS46

Mathematics of Medical Imaging and Shape Analysis - Part II of III

4:30 PM-6:30 PM

Room:Assembly C - 5th Floor

For Part 1 see MS28
For Part 3 see MS55

Medical imaging is the technique used to create images of human body seeking to reveal and examine diseases. The major challenge is to reconstruct high quality images using very limited data. Shape analysis, on the other hand, is a rapidly rising area whose aim is to provide intrinsic geometric descriptors of biological structures that can be used to detect and quantify diseases. Imaging is the process of acquiring data, while shape analysis is to analyze the acquired data. This minisymposium is to promote interactions between the two subjects that, we hope, can stimulate further developments of each subject.

Organizer: Bin Dong
University of Arizona, USA

Organizer: Rongjie Lai
University of Southern California, USA

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

Organizer: Ronald Lok Ming Lui
Chinese University of Hong Kong, Hong Kong

4:30-4:55 Surface Ricci Flow and its Applications

David Gu, State University of New York, Stony Brook, USA

5:00-5:25 Robust Principal Component Analysis-based Four-dimensional Computed Tomography

Hao Gao, University of Los Angeles, USA; J*ianfeng Cai*, University of Iowa, USA; Zuowei Shen, University of Wisconsin, USA; Hongkai Zhao, University of California, Irvine, USA

continued on next page

5:30-5:55 Solving Pdes on Pont Clouds

Hongkai Zhao, University of California, Irvine, USA; Rongjie Lai, University of Southern California, USA; Jian Liang and Alvin Wong, University of California, Irvine, USA

6:00-6:25 Fast Multiscale Reconstruction of Images from Compressed Sensing Data

Tom Goldstein, Stanford University, USA; Judah Jacobson, University of California, Los Angeles, USA

Monday, May 21

MS47

Sparse Models for the Analysis and Exploitation of Imagery, Video and Geospatial Data

4:30 PM-6:30 PM

Room:Assembly E - 5th Floor

New developments in data acquisition systems are producing inexpensive sensors that can collect significant amounts of data at very high rates. Thus the storing, transmitting, exploiting and visualizing of these massive datasets are taxing computer memory and computational time. Novel theoretical advancements in mathematics and statistics such as Compressive Sensing, Sparse Representations and Matrix Completion have led to algorithms that can efficiently analyze and exploit these large datasets. This minisymposium explores new computational approaches employed for applications such as data reduction, noise reduction, segmentation, activity-based learning and real-time user assisted image analysis.

Organizer: Edward H. Bosch

National Geospatial-Intelligence Agency, USA

Organizer: John Greer

National Geospatial-Intelligence Agency, USA

4:30-4:55 Sparse Modeling for Human Activity Analysis in Motion Imagery

Alexey Castrodad, University of Minnesota, USA; Guillermo Sapiro, University of Minnesota, Minneapolis, USA

5:00-5:25 A Convex Non-Negative Matrix Factorization and Dimensionality Reduction on Physical Space

Stanley J. Osher, University of California, Los Angeles, USA

5:30-5:55 Evaluating Compressively Sensed Hyperspectral Imagery

John Greer, National Geospatial-Intelligence Agency, USA

6:00-6:15 Construction of Frames for Image Analysis and Representation

Edward H. Bosch, National Geospatial-Intelligence Agency, USA

6:15-6:30 Frame Theory and Sparse Deterministic Representations for Image Applications

Wojtek Czaja, University of Maryland, College Park, USA

Monday, May 21

MS48

Models and Applications in Compressive Imaging - Part II of III

4:30 PM-6:30 PM

Room:Concerto A - 3rd Floor

For Part 1 see MS39
For Part 3 see MS57

Compressive Sensing is a relatively new field in mathematics whereby one can collect far fewer samples of a signal than traditional sampling theory would imply while still capturing the essential information content in the underlying signal. In compressive imaging applications, this could result in dramatically new paradigms in image collection as well as algorithms for image exploitation. This minisymposium will address some of the latest research in the underlying sensing or measurement models, algorithms for image and video reconstruction, adaptation, and algorithms for image/video exploitation directly from the compressive measurements. We will tie the theory to practical applications of interest.

Organizer: Robert R. Muise

Lockheed-Martin, USA

Organizer: Justin Romberg

Georgia Institute of Technology, USA

4:30-4:55 Efficient 2-D Deconvolution for Filters Yielding Triangular Structure

Justin Romberg, Georgia Institute of Technology, USA

5:00-5:25 GMM for Audio Analysis

Guillermo Sapiro, University of Minnesota, Minneapolis, USA

5:30-5:55 Adaptive Compressive Imaging: Information-theoretic Design

Amit Ashok, University of Arizona, USA

6:00-6:25 Managing Model Complexity in High Frame Rate Compressive Video Sensing

Michael B. Wakin, Colorado School of Mines, USA

Monday, May 21

MS49

Higher-Order Models for Image Restoration - Part II of II

4:30 PM-6:30 PM

Room:Concerto B - 3rd Floor

For Part 1 see MS40

Non-smooth variational problems and PDEs based on higher-order models gain increasing attention in various image restoration tasks including image denoising, decomposition and image inpainting. Inspired by the famous ROF (Rudin, Osher and Fatemi) model for image denoising, non-smooth penalties are used in these approaches which are in particular aware of higher-order smoothness. While still aiming to preserve sharp features (like edges) in the image, higher regularity is imposed, where necessary, to eliminate the well-known staircasing artifact present in solutions of the ROF model. In this minisymposium we want to bring together different recent higher-order imaging approaches and discuss their analytic properties and their efficient numerical solution.

Organizer: Carola B. Schoenlieb
University of Cambridge, United Kingdom

Organizer: Kristian Bredies
University of Graz, Austria

4:30-4:55 A Convex, Lower Semi-continuous Approximation of the Euler-elastica Functional

Kristian Bredies, University of Graz, Austria; Thomas Pock, Graz University of Technology, Austria; *Benedikt K. Wirth*, Courant Institute of Mathematical Sciences, New York University, USA

5:00-5:25 The H^1 Norm of Tubular Neighborhoods of Curves and its Relation to the Elastica Energy

Yves van Gennip, University of California, Los Angeles, USA

5:30-5:55 Approximate Envelope Minimization for Higher-Order Models

Thomas Pock, Graz University of Technology, Austria

6:00-6:25 High Order Models and Fast Algorithms for Fairing Variational Implicit Surfaces

Carlos Brito, Universidad Autónoma de Yucatán, Mexico; Ke Chen, University of Liverpool, United Kingdom

Monday, May 21

MS50

Radar Imaging - Part I of II

4:30 PM-6:30 PM

Room:Aria A - 3rd Floor

For Part 2 see MS59

Radar imaging is a technology that has been developed, very successfully, within the engineering community during the last 50 years. Radar systems on satellites now make beautiful images of regions of our earth and of other planets such as Venus. One of the key components of this impressive technology is mathematics, and many of the open problems are mathematical ones. This minisymposium will address some recent mathematical advances in the field.

Organizer: Margaret Cheney
Rensselaer Polytechnic Institute and Naval Postgraduate School, USA

Organizer: Matthew Ferrara
Matrix Research, Inc., USA

4:30-4:55 Multiple-Input Multiple-Output Synthetic Aperture Radar Imaging

Jeffrey Krolik and Li Li, Duke University, USA

5:00-5:25 Polarimetric Synthetic-aperture Inversion for Extended Targets in Clutter

Kaitlyn Voccola, Air Force Research Laboratory, USA; Margaret Cheney, Rensselaer Polytechnic Institute and Naval Postgraduate School, USA; Birsen Yazici, Rensselaer Polytechnic Institute, USA

5:30-5:55 Reducing the Ionospheric Distortions of Spaceborne SAR Images with the Help of Dual Carrier Probing

Mikhail Gilman, Erick Smith, and Semyon V. Tsynkov, North Carolina State University, USA

6:00-6:25 Estimating Size, Shape, and Motion via Near-field Invariants of Radar Signals

Mark Stuff, Michigan Tech Research Institute, USA

Monday, May 21

MS51

Deterministic and Probabilistic Methods for Inverse Scattering and Impedance Tomography - Part II of II

4:30 PM-6:00 PM

Room:Maestro A - 4th Floor

For Part 1 see MS42

Inverse scattering and impedance tomography have been a very active field of applied mathematics in recent years. New trends have emerged that have allowed to obtain further insights and encouraging results for well established and fascinating inverse problems. The minisymposium focuses on recent developments and innovative contributions in this direction, considering theoretical results and numerical algorithms as well as their application to specific real world problems. Both deterministic and probabilistic formulations will be presented.

Organizer: Roland Griesmaier
University of Mainz, Germany

Organizer: Nuutti Hyvonen
Aalto University, Finland

4:30-4:55 Feasibility of Electrical Impedance Tomography Imaging for Non-destructive Testing of Concrete

Aku Seppanen and Kimmo Karhunen, University of Eastern Finland, Finland; Nuutti Hyvonen, Aalto University, Finland; Jari P Kaipio, University of Eastern Finland, Finland and University of Auckland, New Zealand

5:00-5:25 Simultaneous Reconstruction of Outer Boundary Shape and Conductivity Distribution in Electrical Impedance Tomography

Stratos Staboulis and Nuutti Hyvonen, Aalto University, Finland; Aku Seppanen, University of Eastern Finland, Finland; Jeremi Darde, Aalto University, Finland

5:30-5:55 A Feynman-Kac-type Formula for Impedance Tomography

Martin Simon and Martin Hanke, University of Mainz, Germany; Petteri Piiroinen, University of Helsinki, Finland

Monday, May 21

MS52

Low Rank Modeling and its Applications to Imaging - Part II of II

4:30 PM-6:30 PM

Room:Maestro B - 4th Floor

For Part 1 see MS30

Low rank modeling is arguably the most ubiquitous paradigm of data analysis and related fields. Despite the many existing standard techniques and their useful applications, there has been an overflow of recent developments with fundamentally novel viewpoints and new kinds of applications. These include the completion of missing values of low-rank matrices, robust low-rank models with sparse corruptions, mixtures of low-rank models, structured dictionary learning and selective sampling of hierarchically-structured high-rank matrices. The goal of this workshop is to present some of the recent theoretical progress of low rank modeling and its important applications to imaging and computer vision.

Organizer: Gilad Lerman
University of Minnesota, USA

4:30-4:55 Dictionary Learning by L1 Minimization
John Wright, Columbia University, USA

5:00-5:25 Robust Locally Linear Analysis with Applications to Image Denoising and Blind Inpainting
Yi Wang, University of Minnesota, USA; Arthur Szlam, New York University, USA; Gilad Lerman, University of Minnesota, USA

5:30-5:55 On Collective Matrix Factorization
Ming Yuan, Georgia Institute of Technology, USA

6:00-6:25 Efficient Spectral Clustering using Selective Similarities
Aarti Singh, Carnegie Mellon University, USA

Monday, May 21

MS53

Algorithms for Diffractive Imaging - Part I of II

4:30 PM-6:30 PM

Room:Minuet - 4th Floor

For Part 2 see MS62

The latest advances in X-ray science have made it possible to deduce three dimension (3D) structures of a variety of objects from a collection of 2D diffraction patterns. In order to perform such a reconstruction one must be able to assemble 2D diffraction images in 3D to obtain a 3D diffraction pattern. A phase retrieval algorithm must then be applied to recover the structure of the object in real space. This minisymposium highlights the recent progress in both areas and challenges that require further research effort.

Organizer: Chao Yang
Lawrence Berkeley National Laboratory, USA

4:30-4:55 Algorithms for Single Molecule Diffractive Imaging
Chao Yang, Lawrence Berkeley National Laboratory, USA

5:00-5:25 Comparison of Expectation-maximization and Graph-embedding Algorithms for Single Particle Imaging
Veit Elser, Cornell University, USA

5:30-5:55 Computational Challenges for Biological Structure Determination Using X-ray Diffraction
Nicholas Sauter, and *Ralf Grosse-Kunstleve*, Lawrence Berkeley National Laboratory, USA

6:00-6:25 Structure and Dynamics from Manifold Symmetries of Image Formation
Dimitris Giannakis, New York University, USA

Monday, May 21

CP5

Contributed Session 5

4:30 PM-6:10 PM

Room:Rhapsody - 4th Floor

Chair: Thomas Höft, Tufts University, USA

4:30-4:45 Reservoir Model Improvement by a Better Integration of 4D Seismic Data Using Image Processing Methods
Ratiba Derfoul and Sebastien Da Veiga, IFP Energies Nouvelles, France; Christian Gout and Carole Le Guyader, INSA Rouen, France

4:50-5:05 An Inverse Problem Approach to High Dynamic Range Photography
Thomas Höft, Tufts University, USA

5:10-5:25 Seismic Full-Waveform Inversion Using Sources and Receivers Compression Scheme
Aria Abubakar, Tarek Habashy, and Guangdong Pan, Schlumberger-Doll Research, USA

5:30-5:45 A One Dimensional Algorithm for Seismic Imaging and Inversion: Theoretical Development and Numerical Tests
Bogdan G. Nita, Montclair State University, USA; Ashley Ciesla, Brookedale Community College, USA; Christopher Smith, The College of New Jersey, USA

5:50-6:05 Compressing Aerial Images Using a Critical Representation of Laplacian Pyramid
Fang Zheng and Youngmi Hur, Johns Hopkins University, USA

Dinner Break

6:30 PM-8:00 PM

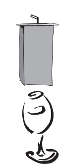
Attendees on their own

SIAG/IS Business Meeting

8:00 PM-8:45 PM

Room:Symphony Ballroom - 3rd Floor

Complimentary beer and wine will be served.



Tuesday, May 22

Registration

7:45 AM-5:00 PM

Room:Overture - 3rd Floor

Closing Remarks

8:10 AM-8:15 AM

Room:Symphony Ballroom - 3rd Floor

Tuesday, May 22

IP4

Divide and Conquer: Using Spectral Methods on Partitioned Images

8:15 AM-9:00 AM

Room:Symphony Ballroom - 3rd Floor

Chair: Peter Burgholzer, Research Center for Non Destructive Testing GmbH, Linz, Austria

Spectral filtering methods such as Tikhonov regularization are powerful tools in deblurring images, but their usefulness is limited by two factors: the expense of the computation and the lack of flexibility in the filter function. This talk focuses on overcoming these limitations by partitioning the data in order to better process each segment. The data division can take several forms: for example, partitioning by spectral frequency, by input channel, or by subimages. Benefits of a divide and conquer approach to imaging can include smaller error, better conditioning of subproblems, and faster computations. We give examples using various data partitionings.

Speaker:
Dianne P. O'Leary
University of Maryland, College Park, USA

Co-authors:
Glenn Easley
System Planning Corporation, USA
Julianne Chung
University of Texas at Arlington, USA

Coffee Break

9:00 AM-9:30 AM

Room:Orchestra - 2nd Floor

Tuesday, May 22

MS54

Electron Tomography: Mathematics and Science - Part I of II

9:30 AM-11:30 AM

Room:Symphony Ballroom - 3rd Floor

For Part 2 see MS65

Understanding the structural conformation of proteins and macromolecular assemblies is closely related to understanding their function within biological processes in the cell. Knowledge of these structures provides clues when developing therapeutic interventions for many diseases. Electron tomography is the only technique available to study structures of individual molecules in their natural environment. The reconstruction problem is however severely ill-posed and data are noisy, so advanced mathematics is needed. This workshop will bring together leaders at this interdisciplinary interface of image processing and stimulate new partnerships to address computational problems at this exciting frontier of cell biology.

Organizer: Eric Todd Quinto
Tufts University, USA

Organizer: Ozan Oktem
KTH Stockholm, Sweden

9:30-9:55 Local Algorithms in Electron Tomography

Eric Todd Quinto, Tufts University, USA; Ozan Oktem, KTH Stockholm, Sweden; Hans Rullgard, Stockholm University, Sweden

10:00-10:25 ET as an Inverse Problem with an Unbounded Operator

Holger Kohr, Universitaet des Saarlandes, Germany

10:30-10:55 Computational Methods in CryoEM

Hans Hebert, Karolinska Institutet, Sweden; Philip Koeck, Royal Institute of Technology, Sweden

11:00-11:25 Detection of Macromolecular Structures in Tomograms Using Reduced Representation Templates

Neils Volkmann, Burnham Medical Research Institute, USA

Tuesday, May 22

MS55

Mathematics of Medical Imaging and Shape Analysis - Part III of III

9:30 AM-11:30 AM

Room:Assembly C - 5th Floor

For Part 2 see MS46

Medical imaging is the technique used to create images of human body seeking to reveal and examine diseases. The major challenge is to reconstruct high quality images using very limited data. Shape analysis, on the other hand, is a rapidly rising area whose aim is to provide intrinsic geometric descriptors of biological structures that can be used to detect and quantify diseases. Imaging is the process of acquiring data, while shape analysis is to analyze the acquired data. This minisymposium is to promote interactions between the two subjects that, we hope, can stimulate further developments of each subject.

Organizer: Bin Dong
University of Arizona, USA

Organizer: Rongjie Lai
University of Southern California, USA

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

Organizer: Ronald Lok Ming Lui
Chinese University of Hong Kong, Hong Kong

9:30-9:55 Medical Morphometry and Computer Visions Using Quasi-Conformal Teichmuller Theory

Ronald Lok Ming Lui, Chinese University of Hong Kong, Hong Kong

10:00-10:25 Reconstruction of Binary Function from Incomplete Frequency Information

Yu Mao, University of Minnesota, USA

10:30-10:55 Edge Detection and Image Reconstruction Using Area Preserving Flows

Catherine M. Kublik, University of Texas, Austin, USA; Selim Esedoglu, University of Michigan, Ann Arbor, USA

11:00-11:25 Applications of Computational Quasiconformal Geometry on Medical Morphometry and Computer Graphics

Alvin Tsz Wai Wong, University of California, Irvine, USA

Tuesday, May 22

MS56

New Directions in X-ray CT Reconstruction: Limited, Subsampled, Dynamic Data - Part I of II

9:30 AM-11:30 AM

Room:Assembly E - 5th Floor

For Part 2 see MS66

Recently, limited data and subsampled X-ray CT received a lot of attention, in particular we mention breast tomosynthesis, dental CT and dynamic imaging. Somewhat parallel developments have been made in security applications, where cost-effectiveness and speed have been the major driving forces. This minisymposium addresses the image reconstruction problem for a wide range of limited data problems, the scope ranging from integration of prior information, non-linear methods, new cone beam geometries to sparsity enhanced image reconstruction as means to reduce the number of measurements and improving the quality of the reconstruction.

Organizer: Marta Betcke
University College London, United Kingdom

Organizer: Samuli Siltanen
University of Helsinki, Finland

9:30-9:55 Approximation Error Approach in Local Tomography

Ville P. Kolehmainen, University of Kuopio, Finland; Jari P Kaipio, University of Eastern Finland, Finland and University of Auckland, New Zealand

10:00-10:25 Adaptive Frequency-domain Regularization for Sparse-data Tomography

Martti Kalke, University of Helsinki, Finland

10:30-10:55 Polyenergetic X-Ray Reconstruction Algorithms for Breast Imaging

James G. Nagy, Ioannis Sechopoulos and Veronica M. Bustamante, Emory University, USA; Julianne Chung, University of Texas at Arlington, USA; Steve Feng, Emory University, USA

11:00-11:25 Multi-Sheet Rebinning Methods for Reconstruction from Asymmetrically Truncated Cone Beam Projections

Marta Betcke, University College London, United Kingdom; Bill Lionheart, University of Manchester, United Kingdom

Tuesday, May 22

MS57

Models and Applications in Compressive Imaging - Part III of III

9:30 AM-11:30 AM

Room:Concerto A - 3rd Floor

For Part 2 see MS48

Compressive Sensing is a relatively new field in mathematics whereby one can collect far fewer samples of a signal than traditional sampling theory would imply while still capturing the essential information content in the underlying signal. In compressive imaging applications, this could result in dramatically new paradigms in image collection as well as algorithms for image exploitation. This minisymposium will address some of the latest research in the underlying sensing or measurement models, algorithms for image and video reconstruction, adaptation, and algorithms for image/video exploitation directly from the compressive measurements. We will tie the theory to practical applications of interest.

Organizer: Robert R. Muise
Lockheed-Martin, USA

Organizer: Justin Romberg
Georgia Institute of Technology, USA

9:30-9:55 Recovering Sparse and Low Rank Matrices from Compressive Measurements

Richard G. Baraniuk and *Aswin Sankaranarayanan*, Rice University, USA

10:00-10:25 On the Power of Adaptivity in Sparse Recovery

Piotr Indyk, Massachusetts Institute of Technology, USA

10:30-10:55 Spectral Super-Resolution of Hypercritical Images

Chris Rozell, Georgia Institute of Technology, USA

11:00-11:25 Optimal Measurement Kernels for Dictionary Image Priors

Robert R. Muise, Lockheed-Martin, USA

Tuesday, May 22

MS58

Multi-frame Image and Video Processing - Part I of II

9:30 AM-11:30 AM

Room:Concerto B - 3rd Floor

For Part 2 see MS68

The output of a given image processing task is often improved when several image inputs are considered. These situations can be quite diverse in application, spanning high dynamic range imaging, pan sharpening, medical image fusion, and denoising or analyzing video data (to name a few). The common thread is that all of these techniques involve merging information from multiple frames, and often their mathematical approaches transfer across applications. This minisymposium addresses work that uses multiple image frames to enhance or analyze image or video data.

Organizer: Stacey E. Levine
Duquesne University, USA

Organizer: Marcelo Bertalmío
Universitat Pompeu Fabra, Spain

9:30-9:55 A Variational Approach for the Fusion of Exposure Bracketed Pairs

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

10:00-10:25 Optimal Estimators for HDR Reconstruction

Julie Delon, Aguerrebere Cecilia, and Gousseau Yann, Telecom Paris, France

10:30-10:55 Blind Subpixel Point Spread Function Estimation from Scaled Image Pairs

Mauricio Delbracio, CMLA, ENS de Cachan, France; *Andrés Almansa*, Telecom Paris, France; Pablo Muse, Universidad de la República, Uruguay; Jean Michel Morel, CMLA, ENS de Cachan, France

11:00-11:25 Burst Denoising

Toni Buades, Paris Descartes, France; Y*ifei Lou*, Georgia Institute of Technology, USA; Jean-Michel Morel, Universitat de les Illes Balears, Spain; Zhongwei Tang, Ecole Normale Superieur de Cachan, France

Tuesday, May 22

MS59

Radar Imaging - Part II of II

9:30 AM-11:30 AM

Room:Aria A - 3rd Floor

For Part 1 see MS50

Radar imaging is a technology that has been developed, very successfully, within the engineering community during the last 50 years. Radar systems on satellites now make beautiful images of regions of our earth and of other planets such as Venus. One of the key components of this impressive technology is mathematics, and many of the open problems are mathematical ones. This minisymposium will address some recent mathematical advances in the field.

Organizer: Margaret Cheney
Rensselaer Polytechnic Institute and Naval Postgraduate School, USA

Organizer: Matthew Ferrara
Matrix Research, Inc., USA

9:30-9:55 Overview of Multi-baseline Radar Interferometry and Tomography and Applications Potential

Scott Hensley, Jet Propulsion Laboratory, California Institute of Technology, USA`

10:00-10:25 Stochastic and Deterministic Methods for Analysis of Oscillatory Radar Signals

Masoud Farshchian, Naval Research Laboratory, USA

10:30-10:55 Mathematical Problems in Ultrawideband Radar

Eric Mokole, Naval Research Laboratory, USA

11:00-11:25 Clutter Effects in Imaging

Knut Solna, University of California, Irvine, USA

Tuesday, May 22

MS60

Electrical Impedance Tomography: Algorithms and Applications - Part I of II

9:30 AM-11:30 AM

Room:Maestro A - 4th Floor

For Part 2 see MS70

Electrical impedance tomography (EIT) is an imaging method where one probes an unknown conductive body using electric currents and aims to recover the inner conductivity distribution of the body from the data. The image formation task is an ill-posed and nonlinear inverse problem, requiring high-quality instrumentation and carefully regularized computational inversion algorithms. Applications of EIT include medical imaging, subsurface prospecting and non-destructive testing. This minisymposium presents recent progress of EIT imaging from the point of view of applications and computation.

Organizer: Jennifer L. Mueller
Colorado State University, USA

Organizer: Samuli Siltanen
University of Helsinki, Finland

9:30-9:55 Regularized D-bar Method for Electrical Impedance Tomography

Jennifer L. Mueller, Colorado State University, USA; Kim Knudsen, Technical University of Denmark, Denmark; Matti Lassas and Samuli Siltanen, University of Helsinki, Finland

10:00-10:25 Electrical Impedance Tomography and the Noise Subspace

Armin Lechleiter, University of Bremen, Germany

10:30-10:55 Direct Reconstruction in 3D Electrical Impedance Tomography Using a Nonlinear Fourier Transform

Kim Knudsen, Technical University of Denmark, Denmark

11:00-11:25 Direct Reconstructions in EIT and Heat Probing

Janne P. Tamminen, Tampere University of Technology, Finland

Tuesday, May 22

MS61

Unconventional Regularization Methods - Part I of II

9:30 AM-11:30 AM

Room:Maestro B - 4th Floor

For Part 2 see MS71

Though regularization theory already goes back to the work of Tikhonov in the sixties, it is still a very active field, since the vast amount of different inverse problems constantly requires or at least benefits from more involved and better adapted regularization methods. However, the desired features of the regularized solution often ask for more complicated structures in the regularization method such as e.g. non-smoothness, non-convexity, or non-locality of the regularization terms, which not only lead to theoretically, but also to practically challenging problems. We hope to cover at least some of the new developments in this area in this minisymposium.

Organizer: Thomas Fidler
University of Vienna, Austria

Organizer: Peter Elbau
RICAM, Austrian Academy of Sciences, Austria

9:30-9:55 Variations on Lasso Regularization
Christine De Mol, Université Libre de Bruxelles, Belgium

10:00-10:25 Linear Ill-posed Operator Equations with Poisson Data
Paul Eggermont and Vincent LaRiccia, University of Delaware, USA; Zuhair Nashed, University of Central Florida, USA

10:30-10:55 Source Identification from Line Integral Measurements and Simple Atmospheric Models
Selim Esedoglu, University of Michigan, Ann Arbor, USA

11:00-11:25 The Minimizers of Least Squares Regularized with ℓ_0 Norm: Uniqueness of the Global Minimizer
Mila Nikolova, ENS Cachan, France

Tuesday, May 22

MS62

Algorithms for Diffractive Imaging - Part II of II

9:30 AM-11:30 AM

Room:Minuet - 4th Floor

For Part 1 see MS53

The latest advances in imaging science have made it possible to deduce three dimension (3D) structures of a variety of objects from a collection of 2D diffraction patterns. In order to perform such a reconstruction one must be able to assemble 2D diffraction images in 3D to obtain a 3D diffraction pattern. A phase retrieval algorithm must then be applied to recover the structure of the object in real space. This minisymposium highlights the recent progress in both areas and challenges that require further research effort.

Organizer: Chao Yang
Lawrence Berkeley National Laboratory, USA

Organizer: Stefano Marchesini
Lawrence Berkeley National Laboratory, USA

9:30-9:55 Title Not Available at Time of Publication
Stefano Marchesini, Lawrence Berkeley National Laboratory, USA

10:00-10:25 Projection Methods for Low-count Diffractive Imaging in the Near and Far Fields
Russell Luke, University of Goettingen, Germany

10:30-10:55 Real-time Ptychographic X-ray Image Reconstruction
Filipe Maia, Lawrence Berkeley National Laboratory, USA

11:00-11:25 PhaseLift: Exact and Stable Phase Retrieval Via Convex Optimization
Vladislav Y. Voroninski, University of California, Berkeley, USA; Emmanuel Candes, Stanford University, USA; Thomas Strohmer, University of California, Davis, USA

Tuesday, May 22

MS63

Statistical Multiscale Methods in Imaging

9:30 AM-11:30 AM

Room:Rhapsody - 4th Floor

In statistical imaging two seemingly different fundamental approaches are well established. These are multiscale methods, such as thresholding in wavelet or curvelet frames, on the one hand and variational methods, where e.g. estimators are defined as solutions of suitable optimization problems, on the other hand. This minisymposium aims for highlighting the recent achievements in connecting these two paradigms which, amongst others, include fully data driven and spatially adaptive image reconstruction methods.

Organizer: Axel Munk
University of Goettingen, Germany

Organizer: Markus Haltmeier
Max Planck Institute for Biophysical Chemistry, Germany

9:30-9:55 Statistical Extreme Value Theory Meets Multiscale Imaging
Markus Haltmeier, Max Planck Institute for Biophysical Chemistry, Germany

10:00-10:25 Statistical Multiscale Methods for Biophotonic Imaging
Hannes Sieling, Klaus Frick, and Munk Axel, University of Goettingen, Germany

10:30-10:55 Spectral Density Estimation for Unevenly Spaced Time Series
Ivan Mizera, University of Alberta, Canada

11:00-11:25 Geometric Multiscale Analysis and Inpainting
Emily King, Universitaet Bonn, Germany; *Gitta Kutyniok*, Wang-Q Lim, and Xiaosheng Zhuang, Technische Universitaet Berlin, Germany

Lunch Break

11:30 AM-1:00 PM

Attendees on their own

Tuesday, May 22

IP5

Design in Imaging – From Compressive to Comprehensive Sensing

1:00 PM-1:45 PM

Room:Symphony Ballroom - 3rd Floor

Chair: Jin Keun Seo, Yonsei University, South Korea

In the quest for improving imaging fidelity, vast attention has been devoted to effective solution of ill-posed problems under various regularization configurations. Nevertheless, issues such as determining optimal configurations for data acquisition or more generally any other controllable parameters of the apparatus and process are frequently overlooked. While design for well-posed problems has been extensively studied in the past, insufficient consideration has been given to its ill-posed counterpart. This is markedly in contrast to the fact that many real-life problems are of such nature. In this talk I shall describe some of the intrinsic difficulties associated with design for ill-posed inverse problems, lay out a coherent formulation to address them and finally demonstrate the importance of such designs for various imaging problems.

Lior Horesh
IBM T.J. Watson Research Center, USA

Intermission

1:45 PM-2:00 PM

Tuesday, May 22

MS64

Stochastic Methods and Image Processing

2:00 PM-4:00 PM

Room:Assembly C - 5th Floor

Stochastic methods for image analysis is a rapidly growing field that provides a general framework for a large class of imaging problems. Furthermore, imaging problem formulation within a Bayesian framework has recently witnessed a dramatic increase in popularity and utility. Optimal estimators of these models, such as Maximum a Posteriori and Minimum Mean Square Errors estimators, are generally difficult to compute and several techniques, which generally rely on Monte Carlo Markov Chain methods, have recently come to the forefront of computational research. This workshop covers both the Bayesian modeling formulation as well as efficient computational techniques for the estimators.

Organizer: Arjuna Flenner
Naval Air Weapons Station, USA

2:00-2:25 Analysis of Bayesian Problems Using Non-Asyptotic Probability Tail Bounds
Gary Hewer, Naval Air Warfare Center, Weapons Division, USA; *Arjuna Flenner*, Naval Air Weapons Station, USA

2:30-2:55 Non-parametric Bayesian Modeling in Image Processing
Larry Carin, Duke University, USA

3:00-3:25 Total Variation Denoising Using Posterior Expectation
Cecile Louchet, University of Orléans, France

3:30-3:55 On Perfect Sampling of Some Markovian Energies
Jerome Darbon, ENS Cachan, France; Marc Sigelle, Télécom ParisTech, France

Tuesday, May 22

MS65

Electron Tomography: Mathematics and Science - Part II of II

2:00 PM-4:00 PM

Room:Symphony Ballroom - 3rd Floor

For Part 1 see MS54

Understanding the structural conformation of proteins and macromolecular assemblies is closely related to understanding their function within biological processes in the cell. Knowledge of these structures provides clues when developing therapeutic interventions for many diseases. Electron tomography is the only technique available to study structures of individual molecules in their natural environment. The reconstruction problem is however severely ill-posed and data are noisy, so advanced mathematics is needed. This workshop will bring together leaders at this interdisciplinary interface of image processing and stimulate new partnerships to address computational problems at this exciting frontier of cell biology.

Organizer: Eric Todd Quinto
Tufts University, USA

Organizer: Ozan Oktem
KTH Stockholm, Sweden

2:00-2:25 Making Electron Tomography and Template Matching Practical
Remco Schoenmakers, FEI Company, The Netherlands

2:30-2:55 Nonlinear Approximations as a Tool in Tomography
Matt Reynolds, Lucas Monzon, and *Gregory Beylkin*, University of Colorado at Boulder, USA

3:00-3:25 Mumford Shah Methods in Limited Data Tomography
Wolfgang Ring, University of Graz, Austria

3:30-3:55 Variational Methods in Molecular Electron Tomography
Chandrajit Bajaj, University of Texas at Austin, USA

Tuesday, May 22

MS66

New Directions in X-ray CT Reconstruction: Limited, Subsampled, Dynamic Data - Part II of II

2:00 PM-4:00 PM

Room:Assembly E - 5th Floor

For Part 1 see MS56

Recently, limited data and subsampled X-ray CT received a lot of attention, in particular we mention breast tomosynthesis, dental CT and dynamic imaging. Somewhat parallel developments have been made in security applications, where cost-effectiveness and speed have been the major driving forces. This minisymposium addresses the image reconstruction problem for a wide range of limited data problems, the scope ranging from integration of prior information, non-linear methods, new cone beam geometries to sparsity enhanced image reconstruction as means to reduce the number of measurements and improving the quality of the reconstruction.

Organizer: Marta Betcke
University College London, United Kingdom

Organizer: Samuli Siltanen
University of Helsinki, Finland

2:00-2:25 A Survey of CT Applications Enabled by Sparsity-exploiting Image Reconstruction

Emil Sidky, University of Chicago, USA; Jakob H. Joergensen, Technical University of Denmark, Denmark; Xiaochuan Pan, University of Chicago, USA

2:30-2:55 Connecting Object Sparsity and Number of Measurements in Total Variation-regularized X-ray CT

Jakob H. Joergensen, Technical University of Denmark, Denmark; Emil Y. Sidky, University of Chicago, USA; Per Christian Hansen, Technical University of Denmark, Denmark; Xiaochuan Pan, University of Chicago, USA

continued in next column

3:00-3:25 Proximal Algorithms and CT: New Results on 3D Real Datas and Color CT

Yannick Boursier, Mathieu Dupont, and Sandrine Anthoine, Aix-Marseille Université - CNRS, France; Jean-Francois Aujol, IMB, CNRS, Université Bordeaux 1, France; Clothilde Melot, Aix-Marseille Université - CNRS, France

3:30-3:55 Low Rank Matrix Decomposition/Factorization Methods for 4D Ct

Hongkai Zhao, University of California, Irvine, USA; Jianfeng Cai, University of Iowa, USA; Hao Gao, University of California, Los Angeles, USA; Xun Jia and Steve Jiang, University of California, San Diego, USA; Zuowei Shen, University of Wisconsin, USA

Tuesday, May 22

MS68

Multi-frame Image and Video Processing - Part II of II

2:00 PM-4:00 PM

Room:Concerto B - 3rd Floor

For Part 1 see MS58

The output of a given image processing task is often improved when several image inputs are considered. These situations can be quite diverse in application, spanning high dynamic range imaging, pan sharpening, medical image fusion, and denoising or analyzing video data (to name a few). The common thread is that all of these techniques involve merging information from multiple frames, and often their mathematical approaches transfer across applications. This minisymposium addresses work that uses multiple image frames to enhance or analyze image or video data.

Organizer: Stacey E. Levine
Duquesne University, USA

Organizer: Marcelo Bertalmío
Universitat Pompeu Fabra, Spain

2:00-2:25 Learning Human Activities and Interactions from Video

Guillermo Sapiro, University of Minnesota, Minneapolis, USA

2:30-2:55 Variational Imaging on Manifolds and Some Applications

Otmar Scherzer and Nicolas Thorstensen, University of Vienna, Austria

3:00-3:25 Exact Histogram Specifcation for Digital Images Using a Variational Approach

Mila Nikolova, ENS Cachan, France; Raymond H. Chan, Chinese University of Hong Kong, Hong Kong; You-Wei Wen, Kunming University of Science and Technology, China

3:30-3:55 Restoration of Photographies of Paintings

Toni Buades, Paris Descartes, France; Gloria Haro, Universitat Pompeu Fabra; Jean-Michel Morel, ENS Cachan, France

Tuesday, May 22

MS70

Electrical Impedance Tomography: Algorithms and Applications - Part II of II

2:00 PM-4:00 PM

Room:Maestro A - 4th Floor

For Part 1 see MS60

Electrical impedance tomography (EIT) is an imaging method where one probes an unknown conductive body using electric currents and aims to recover the inner conductivity distribution of the body from the data. The image formation task is an ill-posed and nonlinear inverse problem, requiring high-quality instrumentation and carefully regularized computational inversion algorithms. Applications of EIT include medical imaging, subsurface prospecting and non-destructive testing. This minisymposium presents recent progress of EIT imaging from the point of view of applications and computation.

Organizer: Jennifer L. Mueller
Colorado State University, USA

Organizer: Samuli Siltanen
University of Helsinki, Finland

2:00-2:25 Imaging of Non-stationary Flows in Industrial Process Tomography
Aku Seppanen and Antti Lipponen, University of Eastern Finland, Finland; Jari P Kaipio, University of Eastern Finland, Finland and University of Auckland, New Zealand

2:30-2:55 Problems in Electrical Impedance Tomography
David Isaacson, Rensselaer Polytechnic Institute, USA

3:00-3:25 Estimation of Spatial Resolution Improvement by the use of an Anatomy Based Prior of Pig Thoraxes in Electrical Impedance Tomography
Raul G. Lima, University of Sao Paulo, Brazil

3:30-3:55 A Direct D-bar Method for the Reconstruction of Complex Admittivities from EIT Data
Sarah Hamilton, Colorado State University, USA; Natalia Herrera, University of Sao Paulo, Brazil; Jennifer L. Mueller, Colorado State University, USA; Alan Von Herrmann, Colby College, USA

Tuesday, May 22

MS71

Unconventional Regularization Methods - Part II of II

2:00 PM-4:00 PM

Room:Maestro B - 4th Floor

For Part 1 see MS61

Though regularization theory already goes back to the work of Tikhonov in the sixties, it is still a very active field, since the vast amount of different inverse problems constantly requires or at least benefits from more involved and better adapted regularization methods. However, the desired features of the regularized solution often ask for more complicated structures in the regularization method such as e.g. non-smoothness, non-convexity, or non-locality of the regularization terms, which not only lead to theoretically, but also to practically challenging problems. We hope to cover at least some of the new developments in this area in this minisymposium.

Organizer: Thomas Fidler
University of Vienna, Austria

Organizer: Peter Elbau
RICAM, Austrian Academy of Sciences, Austria

2:00-2:25 Convergence of Variational Regularization Methods for Imaging on Riemannian Manifolds
Nicolas Thorstensen, University of Vienna, Austria

2:30-2:55 L-infinity Regularized Models for Segmentation, Cartoon-texture Decomposition, and Image Restoration
Luminita A. Vese, University of California, Los Angeles, USA

3:00-3:25 Morozov's Principle for the Augmented Lagrangian Method
Elena Resmerita, University Klagenfurt, Austria

3:30-3:55 Regularization Based on Integral Invariants
Thomas Fidler, University of Vienna, Austria

Tuesday, May 22

MS73

Splitting-Based L1 Minimization with Applications in Medical Imaging, Electrochemical Impedance Spectroscopy, and Seismic Imaging

2:00 PM-4:00 PM

Room:Aria A - 3rd Floor

L1 type of minimization such as total-variation regularization, sparse sensing play an important role in inverse problems. In this minisymposium, we want to bring together different large-scale computational applications, which employ L1 related regularization. In particular, we will cover applications including spiral MRI and ultrasound image reconstruction from medical imaging, estimation of polarization resistances of electrochemical impedance spectroscopy, and full-waveform inversion for seismic imaging. Computational issues such as operator splitting minimization methods, the selection of the regularization parameter, cost and performance analysis, and convergence will also be addressed and discussed.

Organizer: Youzuo Lin
Los Alamos National Laboratory, USA

Organizer: Wolfgang Stefan
University of Texas M. D. Anderson Cancer Center, USA

2:00-2:25 Solution of Ill-posed Inverse Problems Pertaining to Signal Restoration: Total Variation Parameter Estimation
Rosemary A. Renaut, Arizona State University, USA

2:30-2:55 L1/TV Models and Its Variants
Lixin Shen, Syracuse University, USA

continued on next page

Tuesday, May 22

MS73

Splitting-Based L1 Minimization with Applications in Medical Imaging, Electrochemical Impedance Spectroscopy, and Seismic Imaging

2:00 PM-4:00 PM

continued

3:00-3:25 A New Paradigm for Fast MRI Reconstruction with TV Regularization from Arbitrary Trajectories though K-Space

Wolfgang Stefan, University of Texas M. D. Anderson Cancer Center, USA; Ken-Pin Hwang, GE Healthcare, USA; R. Jason Stafford and John D Hazle, University of Texas M. D. Anderson Cancer Center, USA

3:30-3:55 Edge-Preserving Full-Waveform Inversion with a Modified Total-Variation Regularization Scheme

Youzuo Lin, Lianjie Huang, and Zhigang Zhang, Los Alamos National Laboratory, USA

Tuesday, May 22

CP6

Contributed Session 6

2:00 PM-3:40 PM

Room:Minuet - 4th Floor

Chair: Cheng Guan Koay, University of Wisconsin, Madison, USA

2:00-2:15 Optimal Acquisition Design for Diffusion MRI: A Case of Searching for a Needle in the Universe

Cheng Guan Koay, University of Wisconsin, Madison, USA; Evren Özarslan, National Institutes of Health, USA; M. Elizabeth Meyerand, University of Wisconsin, Madison, USA

2:20-2:35 Simultaneous Image Reconstruction and Sensitivity Map Estimation in Partially Parallel MR Imaging

Meng Liu and Yuyuan Ouyang, University of Florida, USA; Xiaojing Ye, Georgia Institute of Technology, USA; Yunmei Chen, University of Florida, USA; Feng Huang, Invivo Corporation, USA

2:40-2:55 Precision Limits for Source Parameter Estimation in Slitless Spectrometry

Figen S. Oktem and Farzad Kamalabadi, University of Illinois at Urbana-Champaign, USA; Joseph M. Davila, NASA Goddard Space Flight Center, USA

3:00-3:15 Sparse Reconstruction Applied to Tomographic SAR Inversion

Xiao Xiang Zhu, Technische Universitaet Muenchen, Germany; Richard Bamler, German Aerospace Center, Oberpfaffenhofen, Germany

3:20-3:35 Bandwidth-Efficient Remote Visualization on Mobile Devices

Sebastian Ritterbusch, Vincent Heuveline, Roman Reiner, and Andreas Helfrich-Schkarbanenko, Karlsruhe Institute of Technology, Germany

Tuesday, May 22

CP7

Contributed Session 7

2:00 PM-3:40 PM

Room:Rhapsody - 4th Floor

Chair: Julianne Chung, University of Texas at Arlington, USA

2:00-2:15 A Variational Infinite Perimeter Model for Image Selective Segmentation

Lavdie Rada and Ke Chen, University of Liverpool, United Kingdom

2:20-2:35 A Robust Approach to Detect Faces from Still Images

Qinghan Xiao, Defence R&D Canada, Canada; *Patrick Laytner* and Chrisford Ling, University of Waterloo, Canada

2:40-2:55 An Optimal Approach for Image Deblurring and Denoising with Data Acquisition Errors

Julianne Chung, University of Texas at Arlington, USA; Matthias Chung, Texas State University, USA; Dianne P. O'Leary, University of Maryland, College Park, USA

3:00-3:15 Image Segmentation and Inpainting Techniques for Reconstruction of Incomplete Cell Paths

Justin Wan, University of Waterloo, Canada

3:20-3:35 Pde Transforms and Non-Smooth Data: Singularity Detection, Segmentation and Denoising

Rishu Saxena, Arizona State University, USA; Siyang Yang, Michigan State University, USA

Tuesday, May 22

MS69

CANCELLED

2:00 PM-4:00 PM

Coffee Break

4:00 PM-4:30 PM

Room:Orchestra - 2nd Floor

Tuesday, May 22

MS72

Publishing Reproducible Science and Software

4:30 PM-6:30 PM

Room:Symphony Ballroom - 3rd Floor

Reproducibility, the ability of an experiment or study to be independently and accurately reproduced or replicated, is gaining momentum as a desirable principle of the scientific method for computational sciences. In order to become more common, this methodology needs so be implanted at the publication level with new contents, tools, criteria and journals. Software and data must become first-class scholarship, together with the traditional article content. The symposium gathers four speakers with an experience in publishing reproducible research and building and managing systems for publishing reproducible research. They will present their experience and the recent developments, current issues and future perspectives of their respective projects.

Organizer: Nicolas Limare
ENS Cachan, France

4:30-4:55 Image Processing On Line: Experiences in Reproducible Science and Software
Nicolas Limare, ENS Cachan, France; Toni Buades, Paris Descartes, France

5:00-5:25 Open Science: When Open Source Meets Open Access
Julien Jomier and Luis Ibanez, Kitware, Incorporated, USA

5:30-5:55 Open Research Computation: Supporting Reproducible Research Through Open Source Software
Cameron Neylon, Science and Technology Facilities Council, United Kingdom

6:00-6:25 Reproducible Research in Signal Processing: How to Increase Impact
Martin Vetterli, École Polytechnique Fédérale de Lausanne, Switzerland; *Patrick Vandewalle*, ReproducibleResearch.org, USA

Tuesday, May 22

MS74

Inverse Problems and Statistical Learning in Imaging Applications

4:30 PM-6:30 PM

Room:Concerto A - 3rd Floor

Computing reliable solutions to ill-posed inverse problems is important in many imaging applications (e.g., image deblurring, medical image reconstruction, computer vision, and geophysical imaging). In recent years, there has been significant progress in using statistical learning and modeling techniques for image processing and understanding. Speakers in this minisymposium will discuss novel methods, computational challenges, and recent results in the area of inverse problems and statistical learning techniques.

Organizer: Julianne Chung
University of Texas at Arlington, USA

Organizer: Matthias Chung
Texas State University, USA

4:30-4:55 Designing Optimal Spectral Filters for Inverse Problems
Matthias Chung, Texas State University, USA

5:00-5:25 Fast Composite Splitting Algorithm for Linear Composite Regularization
Junzhou Huang, University of Texas at Arlington, USA

5:30-5:55 Imaging the Earth's Conductivity and Changeability
Eldad Haber, Emory University, USA

6:00-6:25 Model-based Synthetic Aperture Radar Imaging
Vishal Patel, University of Maryland, USA

Tuesday, May 22

MS75

The Beltrami Framework and its Applications

4:30 PM-6:30 PM

Room:Concerto B - 3rd Floor

The Beltrami framework was introduced by Sochen, Kimmel and Malladi for image enhancement, 15 years ago. This is a pure geometric framework as images, shapes, vector fields are viewed as geodesics or harmonic maps in this approach. The Beltrami framework provides important properties, such as parametrization invariance and easy work on any Riemannian surfaces (e.g. brain cortical surface, multi-scale image, omni-directional image), so as to design efficient algorithms for geometric imaging problems. In this minisymposium, we will discuss recent advances of this framework and explore its potentialities towards a unifying variational method for geometric problems in imaging and related fields.

Organizer: Xavier Bresson
City University of Hong Kong, Hong Kong

Organizer: Dominique Zosso
École Polytechnique Fédérale de Lausanne, Switzerland

Organizer: Jean-Philippe Thiran
École Polytechnique Fédérale de Lausanne, Switzerland

4:30-4:55 Unifying Beltrami and Mumford-Shah Frameworks
Nir Sochen, Tel Aviv University, Israel

5:00-5:25 Invariant Beltrami-Operators - A Computational Study
Ron Kimmel, Technion Israel Institute of Technology, Israel

5:30-5:55 Diffusion Descriptors for 3D Shape Analysis
Michael M. Bronstein, Università della Svizzera Italiana, Switzerland

6:00-6:25 Geodesic Active Fields - A Geometric Framework for Image Registration
Dominique Zosso, École Polytechnique Fédérale de Lausanne, Switzerland; Xavier Bresson, City University of Hong Kong, Hong Kong; Jean-Philippe Thiran, École Polytechnique Fédérale de Lausanne, Switzerland

Tuesday, May 22

MS76

Radar Signal Processing

4:30 PM-6:30 PM

Room:Aria A - 3rd Floor

Radar signal processing is a rich source of interesting mathematical problems, which arise from a need to understand the structure and properties of the various abstract levels in the radar processing chain. The problems range from those associated with the sampling, detection, and reconstruction of electromagnetic signals to the high-order analyses required to fully extract and understand the underlying information content in the sensed signals. This minisymposium, which will feature some of the latest work in this area, aims to highlight the inter-relationships between the various aspects of radar signal processing.

Organizer: Margaret Cheney
Rensselaer Polytechnic Institute and Naval Postgraduate School, USA

Organizer: Raghu Raj
Naval Research Laboratory, USA

4:30-4:55 Information Theory in Radar Imaging, Detection and Classification
Raghu Raj, Naval Research Laboratory, USA

5:00-5:25 Radar Imaging and Feature Detection of Biological Media
Analee Miranda, Air Force Research Laboratory, USA

5:30-5:55 Compressive Illumination Waveforms for High Resolution Radar Sensing
Emre Ertin, Ohio State University, USA

6:00-6:25 A Butterfly Algorithm for SAR Imaging
Laurent Demanet, Massachusetts Institute of Technology, USA

Tuesday, May 22

MS77

Binary Constrained Variational Models and Algorithms in Image Processing

4:30 PM-6:30 PM

Room:Maestro A - 4th Floor

Binary constrained variational models are commonly used in several image processing areas, such as text restoration, image segmentation, multilabelling, and so on. Because of nonconvexity, it is also a big challenge to solve these models. This minisymposium aims at bringing together researchers in this area to present a series of talks on modeling, theoretical analysis, efficient numerical algorithms and applications.

Organizer: Yiqiu Dong
Helmholtz Zentrum München, Germany

4:30-4:55 A Convex Shape Prior and Shape Matching Based on the Gromov-Wasserstein Distance
Christoph Schnoerr, University of Heidelberg, Germany

5:00-5:25 A Binary Constrained General Model in Image Processing
Yiqiu Dong, Helmholtz Zentrum München, Germany

5:30-5:55 Flow-Maximizing joint with Message-Passing
Jing Yuan, University of Western Ontario, Canada

6:00-6:25 Optimality of Relaxations for Integer-Constrained Problems
Jan Lellmann, University of Cambridge, United Kingdom

Tuesday, May 22

CP8

Contributed Session 8

4:30 PM-6:10 PM

Room:Assembly C - 5th Floor

Chair: To Be Determined

4:30-4:45 Regularized Nonlinear Kaczmarz' Algorithm Applied on Inverse Scattering for the Full Maxwell Equations

Aref Lakhal, University of Saarland, Germany

4:50-5:05 Local Regularization for Inverse Problems in Imaging

Andreas Langer, University of Graz, Austria; Michael Hintermueller, Humboldt University Berlin, Germany

5:10-5:25 Noise-Robust Forward/ Backward Compressive Music in Joint Sparse Recovery Problems Using Subspace Fitting Criterion

Jong Min Kim, Ok Kyun Lee, and Jong Chul Ye, KAIST, Korea

5:30-5:45 Tracking Shape Deformations in Images: A Statistical Geometric Approach

Valentina Staneva and Laurent Younes, Johns Hopkins University, USA

5:50-6:05 Total Variation Based Multi-scale Analysis with Application on Fundus Image Analysis

Yan Wang and Triet Le, University of Pennsylvania, USA

Tuesday, May 22

CP9

Contributed Session 9

4:30 PM-6:30 PM

Room:Maestro B - 4th Floor

Chair: Peter Blomgren, San Diego State University, USA

4:30-4:45 Introduction of Non-Linear Elasticity Models for Characterization of Shape and Deformation Statistics: Application to Contractility Assessment of Isolated Adult Cardiocytes

Peter Blomgren, Carlos Bazan, Trevor Hawkins, David Torres, and Paul Paolini, San Diego State University, USA

4:50-5:05 Dynamic Multi-Channel MRI Reconstruction Via Low n-Rank Tensor Pursuit

Joshua D. Trzasko and Armando Manduca, Mayo Clinic, USA

5:10-5:25 Magnetic Resonance Elastography of Brain in Tbi

Corina Drapaca, Brian Johnson and Thomas Neuberger, Pennsylvania State University, USA

5:30-5:45 Computational Methods for Inverting the Soft X-Ray Transform

Joanna Klukowska and Gabor T. Herman, City University of New York, USA

5:50-6:05 Inverse Problems for Helical Objects: A Forward Model

Qiu Wang and Peter C. Doerschuk, Cornell University, USA

6:10-6:25 Fast Algorithm for Large-scale Linear Inversion with an Application in CO_2 Monitoring

Sivaram Ambikasaran, Stanford University, USA

Tuesday, May 22

CP10

Contributed Session 10

4:30 PM-6:10 PM

Room:Minuet - 4th Floor

Chair: Mi Wang, University of Leeds, United Kingdom

4:30-4:45 A 3D Model-Based Inversion Algorithm for Electromagnetic Data

Maokun Li, Aria Abubakar, and Tarek Habashy, Schlumberger-Doll Research, USA

4:50-5:05 Uniqueness of the Circular Area Invariant for Graphs of Periodic Functions

Jeff Calder, University of Michigan, USA; Selim Esedoglu, University of Michigan, Ann Arbor, USA

5:10-5:25 Non-Structural Imaging Methods for Characterisation of Nano-Particle Suspension

Mi Wang, University of Leeds, United Kingdom

5:30-5:45 Nonlocal Pdes-Based Morphology on Weighted Graphs for Image and Data Processing

Olivier Lezoray and Elmoataz Abderrahim, Université de Caen, France; Vinh Thong Ta, Universite de Bordeaux I, France

5:50-6:05 Tug of War game and Nonlocal Infinity Laplacian Equation with Application in Image Processing and Machine Learning

Abderrahim Elmoataz and *Olivier Lezoray*, Université de Caen, France

Tuesday, May 22

CP11

Contributed Session 11

4:30 PM-6:30 PM

Room:Rhapsody - 4th Floor

Chair: Ning Hao, Tufts University, USA

4:30-4:45 New Nonnegative Tensor Factorizations (NTF) with Anderson Acceleration

Ning Hao and Misha E. Kilmer, Tufts University, USA

4:50-5:05 Discrete Composite Wavelet Transforms

Glenn Easley, System Planning Corporation, USA; Demetrio Labate, University of Houston, USA; Vishal Patel, University of Maryland, USA

5:10-5:25 Anisotropic Triangulations for Image Approximations

Laurent Demaret, Helmholtz Zentrum München, Germany

5:30-5:45 Analysis and Comparative Evaluation of Methods for Phase Retrieval

Figen S. Oktem and Richard E. Blahut, University of Illinois at Urbana-Champaign, USA

5:50-6:05 Seismogram Registration and Application to Nonlinear Seismic Inversion

Hyoungsu Baek and Laurent Demanet, Massachusetts Institute of Technology, USA

6:10-6:25 Scattered Light in the Lunar Reconnaissance Orbiter Wide Angled Camera Images – A Preliminary Study

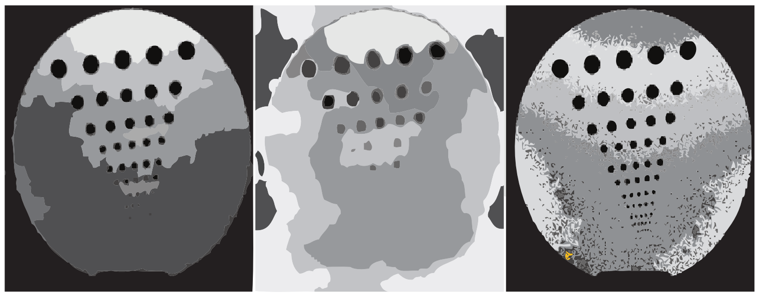
Prasun Mahanti, Mark Robinson, and David Humm, LROC Science Operations Center, USA

Notes

IS12 Abstracts

SIAM Conference on

IMAGING SCIENCE



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

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IP1

Magnetic Resonance Elastography

Many disease processes cause profound changes in the mechanical properties of tissues, yet none of the conventional medical imaging techniques such as CT, MRI, and ultrasound are capable of quantitatively delineating these properties. Magnetic Resonance Elastography (MRE) is an emerging diagnostic imaging technology that employs a novel MRI-based technique to visualize propagating acoustic shear waves in the body. Inversion algorithms are used to process these wave images to generate quantitative maps of tissue mechanical properties such as stiffness, viscosity, and anisotropy. The most important clinical application of MRE currently to evaluate chronic liver disease, where it can eliminate the need for an invasive biopsy. However, there are many other potential applications. This presentation will review the rationale and physical basis of MRE and the basic approaches used for data analysis. Areas of opportunity will be identified where more advanced inversion algorithms could create new applications or substantially contribute to the clinical value of the technology.

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IP2

Targeted Seismic Imaging

The seismic imaging problem, which is typically formulated as an inverse problem for the wavespeed in the acoustic wave equation, involves the estimation of both the smooth and oscillatory part of this wavespeed. For both of these problems, a large data set is typically recorded and subjected to extensive processing to estimate both parts of the wavespeed throughout the entire region the data are sensitive to. For many applications, however, only a part of this image is of interest. I will describe techniques for enhancing part of the image through appropriate data choices and regularization.

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IP3

Three Dimensional Structure Determination of Macromolecules by Cryo-electron Microscopy from the Applied Math Perspective

Cryo-electron microscopy is a technique by which biological macromolecules are imaged in an electron microscope. The molecules are rapidly frozen in a thin layer of vitreous ice, trapping them in a nearly-physiological state. Cryo-EM images, however, have very low contrast, due to the absence of heavy-metal stains or other contrast enhancements, and have very high noise due to the small electron doses that can be applied to the specimen. Thus, to obtain a reliable three-dimensional density map of a macromolecule, the information from thousands of images of identical molecules must be combined. When the molecules are arrayed in a crystal, the necessary signal-averaging of noisy images is straightforwardly performed. More challenging is the problem of single-particle reconstruction (SPR) where a three-dimensional density map is to be obtained from images of individual molecules present in random positions and orientations in the ice layer. Because it does not require the formation of crystalline arrays of macromolecules, SPR is a very powerful and general technique, which has been successfully used for 3D structure determination of many protein molecules and large complexes. I will introduce the main theoretical and computational (rather than experimental) challenges posed by SPR, and will focus on our (*) recent progress for obtaining three-dimensional structures, for image classification and for denoising. From the mathematical perspective, we combine ideas from different areas, such as, spectral graph theory, dimensionality reduction, representation theory and semidefinite programming. This conference also hosts a mini-symposium on cryo-EM. (*) This is a joint project with Fred Sigworth (Yale), Yoel Shkolnisky (Tel Aviv), Ronny Hadani (UT Austin), and Shamgar Gurevich (Wisconsin-Madison).

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IP4

Divide and Conquer: Using Spectral Methods on Partitioned Images

Spectral filtering methods such as Tikhonov regularization are powerful tools in deblurring images, but their usefulness is limited by two factors: the expense of the computation and the lack of flexibility in the filter function. This talk focuses on overcoming these limitations by partitioning the data in order to better process each segment. The data division can take several forms: for example, partitioning by spectral frequency, by input channel, or by subimages. Benefits of a divide and conquer approach to imaging can include smaller error, better conditioning of subproblems, and faster computations. We give examples using various data partitionings.

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IP5

Design in Imaging From Compressive to Comprehensive Sensing

In the quest for improving imaging fidelity, vast attention has been devoted to effective solution of ill-posed problems under various regularization configurations. Nevertheless, issues such as determining optimal configurations for data acquisition or more generally any other controllable parameters of the apparatus and process are frequently overlooked. While design for well-posed problems has been extensively studied in the past, insufficient consideration has been given to its ill-posed counterpart. This is markedly in contrast to the fact that many real-life problems are of such nature. In this talk I shall describe some of the intrinsic difficulties associated with design for ill-posed inverse problems, lay out a coherent formulation to address them and finally demonstrate the importance of such designs for various imaging problems.

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CP1

Sparse Shape Reconstruction

Given a collection (dictionary) of shapes, our problem of interest is choosing the right elements and "appropriately' combining them together to form a desired shape. A parametric level set approach is used to express an arbitrary shape as an interaction of various "sub-shapes'. The appropriate elements are chosen based on a sparsity constraint to use the least number of sub-shapes in the dictionary. The validity of the technique is tested through various examples.

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CP1

A Compressive Sensing Synthetic Aperture Radar Method Incorporating Speckle

Many techniques involving compressive sensing for Synthetic Aperture Radar (SAR) have been suggested, yet none of these adequately deal with the fact that SAR images contain a multiplicative component known as speckle. Speckle makes the compressibility and interpretation of SAR images difficult. In this work, we investigate a more complete formulation of the problem of reconstructing the piecewise smooth and texture component (speckle) directly from a set of compressed measurements.

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CP1

Adapted Curvelet Sparse Regularization in Limited Angle Tomography

We investigate the reconstruction problem of limited angle tomography which is known to be severely ill-posed. To stabilize the reconstruction we present an adapted curvelet sparse regularization method. This method is based on the characterization of curvelet coefficients, that can be stably reconstructed from a limited angular range data. We show that the dimension of the problem can be significantly reduced in the curvelet domain, leading to a considerable speedup of the reconstruction algorithm. In numerical experiments, we show the practical relevance of these results.

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CP1

Robust High Frequency Information Guided Compressive Sensing Reconstruction

In compressive sensing, accurate image reconstruction from very few noisy data is challenging. We extract high frequency sparse features directly from measurements and use them as a priori to guide further reconstruction. Various continuation strategies and non-negative Garotte shrinkage are applied to enhance the performance and the iterative approach suppresses the high frequency errors caused by insufficient data. The proposed model recovers images with rich geometrical information both efficiently and robustly using less data.

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CP1

Learning Sparsifying Transforms for Signal and Image Processing

We propose novel problem formulations and algorithms for learning sparsifying transforms from data. The algorithms are insensitive to initialization, and produce well-conditoned transforms that have much lower sparsification errors than analytical transforms such as wavelets. These transforms can also be used to construct equivalent synthesis dictionaries that provide similar/lower data fitting errors than the popular K-SVD algorithm, at 1/10th of the computational cost. Applied to image denoising the new sparsifying transforms perform better than overcomplete K-SVD dictionaries.

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CP1

Image Compression With Nearest-Neighbor Transforms

We propose a graph-based algorithm to image modeling and compression. Our approach constructs a nearest-neighbor graph representation of images by associating pixels with nodes and determining optimal edge weights from the structure of the images. The constructed graph then leads to the identification of an orthonormal basis for the expansion of the images and efficient image compression.

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CP2

Automatic MRI Scan Positioning for Feeding Arteries of the Brain

Blood supply is very important to the daily function of the brain. It is possible to monitor the cerebral blood flow (CBF) noninvasively using phase-contrast (PC) MRI. The PC scans need to be positioned perpendicular to feeding arteries at the entry point of skull. Given large variability in arterial trajectory across individuals, this task presents a major challenge to the operator and contributes significantly to measurement noise. In this project, we developed an automatic MRI scan positioning method for feeding arteries of the brain. The four major feeding arteries were first segmented out from the image and then the axial representations of the vertebral arteries were extracted. Optimal positioning for further MRI scans were then determined based on the geometric properties of the arteries. We compared the results to those obtained with manual positioning by an experienced operator. The findings suggest that the automatic PC positioning algorithm provides measures that are at least as accurate and precise as an experienced operator.

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CP2

Reconstruction from Spherical Mean Data by Summability Methods

The reconstruction from spherical mean data plays an important role in thermoacoustic and photoacoustic tomography. We consider a modification of a summability type approximative reconstruction. Among the consequences of this approach we present a inversion formula of the spherical mean Radon transform.

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CP2

3D Isar Image Reconstruction of Targets Through Filtered Back Projection

In this talk, an inversion scheme for near-field inverse synthetic aperture radar (ISAR) data is derived for both two and three dimensions from a scalar wave equation model. The proposed data inversion scheme motivates the use of a filtered back projection (FBP) imaging algorithm. The paper provides a derivation of the the general imaging filter needed for FBP, which will be shown to reduce to a familiar result for near-field ISAR imaging.

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CP2

Restricted Convergence of Projected Landweber Iteration in Banach Spaces for Nonlinear Inverse Problems

We consider a class of inverse problems defined by a nonlinear map from parameter or model functions to data. The parameter functions and data are contained in certain Banach spaces. We employ a projected Landweber iteration with posterior stepsize to give explicitly approximated sequences of the solution to the inverse problem. A restricted convergence result is established given a Lipschitz type stability condition on a closed, convex subset of the parameter function space.

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CP2

Attenuation Compensation in Ultrasound Imaging

Ultrasound B-scan exhibits shadowing and enhancement artifacts due to acoustic wave propagation and spatially varying attenuation across tissue layers. Estimation of local attenuation coefficients is important for clinical diagnosis and analysis. We present the mathematical framework of a novel joint estimation method for attenuation compensation and artifact reduction in pulse-echo ultrasound. Spatial resolution and speckle patterns are retained. Our results give higher quality attenuation compensation compared to several existing techniques using B-mode or RF images.

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CP2

Actin Filament Tracking in Electron Tomograms of negatively stained Lamellipodia using the Localized Radon Transform

The aim of this work was to develop a protocol for automated tracking of actin filaments in electron tomograms of lamellipodia embedded in negative stain. We show that a localized version of the Radon transform for the detection of filament directions enables three-dimensional visualizations of filament network architecture, facilitating extraction of statistical information including orientation profiles. We discuss the requirements for parameter selection set by the raw image data in the context of other, similar tracking protocols.

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CP3

A New Variational Model for Removal of Both Additive and Multiplicative Noise and a Fast Algorithm for Its Numerical Approximation

Variational image denoising models for additive and multiplicative noise removal from digital images are rarely encountered in the literature. To this end, this paper proposes a new variational model and its fast numerical algorithm. Numerical tests using both synthetic and realistic images not only confirm that our new model delivers quality results but also that the proposed numerical algorithm allows a very fast and accurate numerical solution of the proposed variational model.

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CP3

An Adaptive Spectrally Weighted Structure Tensor for Hyperspectral Imagery Based on the Heat Operator

A Tensor Nonlinear Anisotropic Diffusion (TAND) with a weighted Structure Tensor (ST) for Hyperspectral Images (HSI) is proposed. The weights are based on the heat operator. This is possible since neighboring spectral bands in HSI are highly correlated, as are the bands of its gradient. Comparisons with TAND using the classical ST show that the heat weighting helps TAND to better discriminate edges. Experiments with HSI of different spatial characteristics are presented.

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CP3

An ℓ_1 Minimization Algorithm with Applications in Image Processing

In this work, we consider a homotopic principle for solving large scale ℓ_1 unconstrained minimization problems. Our approach consists in solving a sequence of relaxed unconstrained problems depending on a positive regularization parameter that converges to zero. The optimality conditions of each sub-problem are characterized through a fixed point equation, where a preconditioned conjugate gradient algorithm is applied to solve a sequence of resulting linear systems. Numerical experiments are conducted showing that our algorithm compare favorably with state-of-the-art solvers. Moreover, we present a set of image processing applications including image denoising, image deblurring, image separation and image inpainting.

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CP3

Iteratively Reweighted Least Squares for L1 Problems: Boring But Still Effective

Split Bregman (SB) or Alternating Direction Method of Multipliers (ADMM) methods have become very popular for ℓ_1 norm optimization problems, including Total Variation and Basis Pursuit Denoising. It appears to be generally assumed that they deliver much better computational performance than older methods such as Iteratively Reweighted Least Squares (IRLS). We show, however, that IRLS type methods are computationally competitive with SB/ADMM methods for a variety of problems, and in some cases outperform them.

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CP3

Corrected Diffusion Approximation in Layered Tissues

I will present the corrected diffusion approximation for a thin beam incident on a layered medium. This model improves upon the diffusion approximation for small source detector separation distances without the long computation times of the radiative transport equation. It also provides a means to study oblique incidence and compute the full spatial and angular dependence of the radiance.

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CP3

Solving Highly Ill-Conditioned Blind Deconvolution Problems

Some blind deconvolution problems have high-quality an-

swers, but cannot be solved efficiently by popular optimization techniques such as alternating minimization, quasi-Newton, and conjugate gradients. We pose scientifically important model problems whose highly ill-conditioned Hessians grind these methods to a standstill. A new Schur complement technique to efficiently invert these Hessians is proposed, and we use this technique to power a large-scale trust region Newton method that can quickly solve highly ill-conditioned problems.

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CP4

Volterra Equations and Image Filtering and Processing

Fractional time derivatives allow to consider linear models intermediates between pure difussive (heat equation) and conservative (wave equation) models. These models enjoy intermediate properties which lead to formulate linear Volterra equations based models which can be understood as a generalization of classical fractional derivatives. The main contribution of our work is the model we propose allows to hadle the difussion by means of viscosity parameters in the context well posed linear PDEs. To make the high quality of results clear, practical experiments are shown.

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CP4

An Algorithm for Shape Detection in Inverse Problems

In this work, we propose a computational method to reconstruct shapes, i.e. regions or boundaries, in inverse problems. Our method is general in the sense that it can be used in conjunction with different inverse problems. However, it is designed to work for approximately piecewise constant functions. The method is based on a shape optimization formulation of the inverse problem. In contrast with recent work in this area, the geometry is modeled explicitly as a set of polygonal curves, not as a level set function. This approach allows flexibility in modeling and geometric regularization, and also results in computational efficiency, which will be illustrated with several examples.

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CP4

Image Recognition Via Moment Method

We will introduce the "shape dictionary", which is setted up by extracting a set of moment features from the moments we define. The shape features can help us recognizing letters and images.

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CP4

Segmentation Based on a Limiting Mumford and Shah Functional

We propose an energy minimization model for segmentation based on a limiting of the Mumford and Shah functional. Our proposed model is only depended on the edge set and is formulated using the level set framework with an extension for free endpoints/crack tips (open edges). The model is able to detect both open and closed edges. The algorithm is tested on both synthetic and real images, converging within a few iterations in some examples.

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CP4

Reconstruction of Images: Computation of Confidence Intervals

Computation of confidence intervals that bound the pixel values of an image is an important but not trivial problem. We use methods that reduce the computational cost for large images and parallelize them to reduce the running time. We experiment with different divisions of the image into sub-images and several boundary conditions. Ways to better use prior information for the boundary of the sub-images to improve the resulting intervals are also considered.

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CP4

Restoration of Images Corrupted by Impulse Noise Using Blind Inpainting and ℓ_0 Norm

We study the problem of image restoration of observed images corrupted by impulse noise and other types of noise (e.g. zero-mean Gaussian white noise). Since the pixels damaged by impulse noise contain no information about the true image, these damaged pixels can also be considered as missing information. If the pixels corrupted by impulse noise are known, then the image restoration problem becomes a standard image inpainting problem. However, the set of damaged pixels is usually unknown, thus how to find this set correctly is a very important problem. We proposed a method that can simultaneously find the damaged pixels and restore the image. This method can also be applied to situations where the damaged pixels are not randomly chosen, but follow some unknown procedure. By iteratively restoring the image and updating the set of damaged pixels, this method has better performance than other methods, as shown in the experiments.

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CP5

Seismic Full-Waveform Inversion Using Sources and Receivers Compression Scheme

We present a source-receiver compression approach for reducing the computational time and memory usage of the seismic full-waveform inversions. By detecting and quantifying the extent of redundancy in the data, we assemble a reduced set of simultaneous sources and receivers that are weighted sums of the physical sources and receivers employed in the survey. Because the number of these simultaneous sources and receivers can be significantly less than those of the physical sources and receivers, the computational time and memory usage of an inversion method can be tremendously reduced. The scheme is based on decomposing the data into their principal components using a singular-value decomposition approach and the data reduction is done through the elimination of the small eigenvalues. Consequently this will suppress the effect of noise in the data. Moreover, taking advantage of the redundancy in the data, this compression scheme effectively stacks the redundant data resulting in an increased signal-to-noise ratio. We present inversion results for well-known two-dimensional and three-dimensional models for surface seismic measurements. We show that this approach has the potential of significantly reducing both computational time and memory usage of the Gauss-Newton method by 1-2 orders of magnitude.

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CP5

Reservoir Model Improvement by a Better Integration of 4D Seismic Data Using Image Processing Methods

Calibrating reservoir models to flow data involves history matching processes. Model parameters are iteratively adjusted to minimize the misfit between the real data and the corresponding simulated responses. The current formulation used to quantify the seismic data mismatch is neither representative of the difference between two images, nor of matching quality. We describe an alternative formulation, using filtering, segmentation and image matching methods, to extract relevant information from seismic images and compute their dissimilarity.

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CP5

An Inverse Problem Approach to 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. The irradiance map (amount of light entering the input of the camera) of a natural scene spans up to 8–10 orders of magnitude but typical digital cameras record only two or three orders of magnitude. Recovering the response function of the camera allows one to combine low dynamic range images into a single image with the original dynamic range. We present preliminary results and analysis.

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CP5

A One Dimensional Algorithm for Seismic Imaging and Inversion: Theoretical Development and Numerical Tests

We present an inverse scattering method for geophysical imaging and amplitude correction from measured data. No knowledge about the medium under investigation is assumed. Analytic and numerical one dimensional examples show excellent results in finding both the location of interfaces and the amplitude of acoustic reflections. Our tests include different number of layers, high/low contrasts, velocity inversions and noisy data.

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CP5

Compressing Aerial Images Using a Critical Rep-

resentation of Laplacian Pyramid

An extremely simple scheme for transforming a Laplacian pyramid (LP) to be non-redundant is introduced recently. The resulting process provides a critical multiresolution representation of data, and its analysis/synthesis operators form a wavelet filter bank. In this talk, we briefly review the new scheme and then discuss the resulting system's very fast, LP-like, decomposition/reconstruction algorithms. We also present that the new system shows consistently more favorable results than other existing systems in compressing aerial images.

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CP6

Optimal Acquisition Design for Diffusion MRI: A Case of Searching for a Needle in the Universe

Diffusion MRI is a promising technique that allows scientists to investigate noninvasively the structural connectivity of the human brain. The focus of this work will be on sparse and optimal acquisition design for diffusion MRI. We propose a novel optimality criterion for sparse multiple-shell acquisition and quasi-multiple-shell designs in diffusion MRI and an effective semi-stochastic and moderately greedy search strategy to locate the optimum design configuration among more than 10^{27} to 10^{232} distinct configurations.

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CP6

Simultaneous Image Reconstruction and Sensitivity Map Estimation in Partially Parallel MR Imaging

We develop a variational model and numerical algorithm for simultaneous sensitivity map estimation and image reconstruction in partially parallel MR imaging with significantly undersampled data. The objective functional includes the data fidelity term and various regularizations on the underlying image and sensitivity maps. The algorithm decouples the problem into easier sub-problems involving variable splitting techniques and treats the TV term by PDHG scheme. Experimental results are presented to demonstrate the effectiveness of the proposed method.

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CP6

Precision Limits for Source Parameter Estimation in Slitless Spectrometry

Multi-order slitless imaging spectrometers have recently been proposed for observing dynamic events in the solar atmosphere. We analyze the problem of estimating the source parameters from such spectrometer measurements. We derive analytical lower bounds on the precision of estimates, via the application of Cramer-Rao bounds. We compare the derived bounds with numerically simulated errors. Furthermore, we explore the optimized instrument requirements including the resolution, signal-to-noise ratio, and measurement configuration.

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CP6

Bandwidth-Efficient Remote Visualization on Mobile Devices

Mobile devices, such as tablets, are well suited for mobile analysis of numerical simulations, but traditional remote visualization methods are not usable for high-latency low-bandwidth networks. We introduce a mathematical model for the visualization and interaction error based on the capabilities of current mobiles devices. We then derive theoretic upper and lower error-bounds for minimal bandwidth-consumption independent of 3D scene size and complexity. Finally, we propose a bandwidth-optimized remote visualization algorithm satisfying the error-bounds.

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CP6

Sparse Reconstruction Applied to Tomographic SAR Inversion

The highly anisotropic 3D resolution element of modern spaceborne multi-baseline SAR systems allow us to exploit sparsity for superresolution tomographic SAR inversion. This is particularly true for mapping of urban infrastructure. The proposed algorithm SL1MMER is shown to be efficient. Its superresolution power is derived by simulations and demonstrated with real TerraSAR-X data. 3D reconstructions of buildings are presented including their seasonal thermal deformations at resolution and coverage levels not possible so far.

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CP7

Mass Transport Problem and Its Application in Point Set Matching Problems

We study one point-set matching method based on Monge-Kantorvich mass transport problems and its application in matching two sets of pulmonary vascular tree branch points whose displacement is caused by the lung volume changes. Perfect match performances verdict the effectiveness. We provide theoretical analysis to explain these results: the curl-cardinality relation. It says that given point cardinality n, when the maximum curl does not exceed C/n, perfect matches can be obtained. (joint work with Ching-Long Lin and I-Liang Chern).

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CP7

An Optimal Approach for Image Deblurring and Denoising with Data Acquisition Errors

Data acquisition errors due to dead pixels or other hardware defects can cause undesirable artifacts in imaging applications. Compensating for these defects typically requires knowledge such as a defective pixel map, which can be difficult or costly to obtain and which is not necessarily static. However, recent calibration data is readily available in many applications. In this talk, we discuss an optimal combined approach for image deconvolution and denoising, which uses calibration data and minimizes the empirical Bayes risk. We show that our approach is able to reconstruct missing information better than standard filtering approaches and is robust even in the presence of a large number of defects.

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CP7

A Robust Approach to Detect Faces from Still Images

Haar-like features have been widely adopted for frontal face detection. However, the algorithm has challenges in detecting dark coloured faces or faces captured under poor illumination. To overcome these limitations, we present a new method of face detection in this paper. Experimental results from 9,883 positive images and 10,349 negative images show a considerable improvement in face detection hit rates without a significant change in false acceptance rates compared with the OpenCVs Haar detection algorithm.

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CP7

A Variational Infinite Perimeter Model for Image Selective Segmentation

In this talk we first present a dual level-set selective segmentation (DLSS) model with a combination of the edge detection and geometric distance functions, which can differentiate two objects having similar or identical intensities. The DLSS model uses a combination of two level-sets: a global level-set which segments all boundaries, and a local level-set which evolves and finds the boundary of the object closest to the geometric constraints (markers). For this model, a $\mathcal{H}^{\infty}$ Hausdorff measure (extending the classical notion of length) has been used as the penalization term. Then we show our new infinite perimeter dual level-set selective segmentation (IPDLSS) model which can select an object with oscillatory boundaries and cornering effect. For the IPDLSS model, the incorporation of the $\mathcal{L}^{\epsilon}$ Lebesgue measure of the ϵ-neighborhood of the contour as the penalization term is essential. Test results will show that IPDLSS leads to better results in cornering and with oscillatory boundaries than DLSS.

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CP7

Pde Transforms and Non-Smooth Data: Singular-

ity Detection, Segmentation and Denoising

The use of PDE Transforms for processing piecewise smooth data potentially contaminated with noise is explored. PDE transforms rely on coupled PDEs to decompose data into functional frequency modes useful for dual time-frequency analysis and data processing. Modes generated by the PDE transform provide a useful analysis tool for recovering various types of edges on different scales. High order PDEs help in resolving singularities of different degrees of severity as well as modes with adjacent frequencies in continuous regions.

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CP7

Image Segmentation and Inpainting Techniques for Reconstruction of Incomplete Cell Paths

One challenge of segmenting cells from fluorescence microscopy is that cells frequently disappear, resulting in broken cell paths in a 3D image volume. In this talk, we present a segmentation and an inpainting model that can reconstruct incomplete cell paths. The key idea of the segmentation model is to perform 2D segmentation in a 3D framework. We will also discuss the use of inpainting techniques which have the advantage of not just obtaining the cell contours but also the cell interiors. Numerical results of fluorescent live cell images will be given.

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CP8

Noise-Robust Forward/Backward Compressive Music in Joint Sparse Recovery Problems Using Subspace Fitting Criterion

We study a multiple measurement vector (MMV) problem where multiple signals share common sparse support set and are sampled by a common sensing matrix. Although we can expect that joint sparsity can improve the recovery performance over single measurement vector(SMV) problem, compressive sensing (CS) algorithms for MMV exhibit performance saturation as the number of multiple signals increases. Recently, to overcome this drawbacks of CS approaches, our group proposed so-called compressive MUSIC (CS-MUSIC) algorithm, which optimally combines CS with MUSIC using a generalized MUSIC criterion so that it outperforms all the conventional MMV algorithms. However, the existing CS-MUSIC does not fully exploit additional sampling more than necessary in terms of restricted isometry property condition. Hence, in this talk, we introduce a novel subspace fitting criterion that extends the generalized MUSIC criterion to deal with such situation so that it exhibits near-optimal behaviours. In addition, the subspace fitting criterion leads us two alternative forms of CS-MUSIC algorithm with forward and backward support selection, which significantly improves its noise robustness. Finally, we will illustrate several practical applications of the forward/backward CS-MUSIC such as dynamic tracking of time-varying signals and etc.

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CP8

Regularized Nonlinear Kaczmarz' Algorithm Applied on Inverse Scattering for the Full Maxwell Equations

We consider the inverse scattering problem for the full time-harmonic Maxwell equations using near field measurements. Based on a rigorous analysis, we recast the intertwined vector equations in the full Maxwell system into decoupled scalar inverse problems. To reconstruct the contrast function, we apply an adapted version of the Kaczmarz' algorithm to non-linear problems with thoroughly computed starting value. We regularize using the approximate inverse, where we apply analytically pre-computed reconstruction kernels at each iteration step. Numerical experiments in 3D using real data show the efficiency and stability of the algorithm.

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CP8

Local Regularization for Inverse Problems in Imaging

In applications in image processing the recovery of the unknown "ideal' image is often an ill-posed inverse problem. Thus regularization techniques are required to solve this problem. In order to enhance image details while preserving homogenous regions, the regularization parameter should be based on local image features. Therefore we discuss a model that utilizes a locally dependent regularization parameter for general inverse problems in image processing and we show convincing numerical examples in image restoration.

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CP8

Tracking Shape Deformations in Images: A Statistical Geometric Approach

We describe a statistical framework for tracking deformable objects in an image sequence under the constraint of preserving their topology. We represent the object's boundary by a manifold-valued random variable and we introduce a stochastic model for its evolution which ensures the induced deformations are smooth and invertible. We estimate the shape of the object from each image frame by restricting to low dimensional deformations which can be interpreted as random steps along geodesic paths in sub-

Riemannian geometry.

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CP8

Total Variation Based Multi-scale Analysis with Application on Fundus Image Analysis

Total variation minimization has been widely used in image analysis. Previous studies showed that this model is related to the local scale features in images. We will give a detailed comparison study of the local scale information revealed by different total variation models include TV-L2, TV-L1 and nonlinear diffusion. In addition, we will combine the advantages of different models, and show an application on fundus images analysis for blood vessels and drusen structures segmentation.

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CP9

Fast Algorithm for Large-scale Linear Inversion with an Application in CO_2 Monitoring

Large scale inverse modeling is being widely used in subsurface problems, where direct measurements of parameters are expensive and sometimes impossible. Subsurface media are inherently heterogeneous in many ways. Furthermore, techniques such as hydraulic tomography and electric resistivity tomography allow the collection of more indirect measurements, and at the same time, there is an increased appreciation of the value of detailed characterization of the subsurface media. For instance in CO_2 sequestration projects, in-order to predict events like CO_2 leakage, it is imperative to model fine scale features. This results in solving for a large number of unknowns. Employing conventional numerical algorithms to find these unknowns is computationally expensive. The need for fast, efficient large scale inversion techniques is hence of much practical interest. In the current work, we use a Bayesian formulation to solve a large-scale tomography problem with an application to real-time monitoring at a CO_2 sequestration site. The Bayesian formulation has two significant steps to compute the unknowns. The first step involves forming a linear system and solving the linear system. The second step involves finding the unknowns from the solution obtained by solving the linear system. The fast novel algorithm, which exploits the underlying sparsity coupled with fast multipole method, accelerates both these steps. Using our new algorithm, we estimate 100 million unknowns in real-time at every time instant. This fast new algorithm, based on sparsity and the fast multipole method, has an asymptotic complexity of $\mathcal{O}(\sqrt{\Updownarrow})$ for the first step and $\mathcal{O}(\Updownarrow)$ for the second step, where m is the number of unknowns. This provides an enormous scale up compared to the conventional method which has a complexity of $\mathcal{O}(\Updownarrow^{\in})$ for both steps. The new algorithm is fairly general and can be extended to other similar tomography problems as well.

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CP9

Introduction of Non-Linear Elasticity Models for Characterization of Shape and Deformation Statistics: Application to Contractility Assessment of Isolated Adult Cardiocytes

We explore cardiocyte contractility assessment based on biomechanical properties, energy conservation, and information content. Contraction is defined by the energy-distance between the shapes of the contracting cell, obtained by warping one shape into another. Relevant results are obtained by employing a non-linear features fidelity, and a regularization term. The responses in isolated adult rat cardiocytes are computed and contrasted with previously established measures. Qualitative and quantitative agreement for frequency, pacing, and overall behavior is excellent.

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CP9

Magnetic Resonance Elastography of Brain in Tbi

Magnetic Resonance Elastography (MRE) is a non-invasive imaging technique that combines Magnetic Resonance Imaging and wave mechanics to estimate tissue stiffness in vivo. Recent studies show that MRE could aid in the diagnosis of diseases and tumor detection. In particular, MRE estimated decreased brain stiffness in multiple sclerosis, normal pressure hydrocephalus, and Alzheimers disease. We will use MRE and brain pulsations to estimate brain stiffness in TBI and possible correlations to loss of brain function.

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CP9

Computational Methods for Inverting the Soft X-Ray Transform

We present formulas for inverting the soft x-ray transform. This solves the inverse problem of reconstruction of 3D structures from 2D projections obtained by a soft x-ray microscope. This problem arose from experimental cellular biology. Previously-proposed approaches to solving it lacked mathematical rigour. We demonstrate, using biological data, why an exact mathematical inversion approach will result in more efficacious reconstructions.This work is supported by NSF grant DMS-1114901.

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CP9

Dynamic Multi-Channel MRI Reconstruction Via Low n-Rank Tensor Pursuit

In this work, we propose a low n-rank tensor pursuit strategy for accelerated dynamic multi-channel MRI reconstruction. We show that several contemporary low-rank matrix pursuit methods for MRI reconstruction arise as special instances of the proposed model, which is based on weighted tensor trace norm minimization. We generalize and compare these methods for dynamic multi-channel MRI reconstruction, investigate hybridization strategies for simultaneously exploiting redundancies in multiple dimensions, and demonstrate the different approaches for cardiac MRI.

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CP9

Inverse Problems for Helical Objects: A Forward Model

Many biological macromolecular complexes have helical symmetry. Cryo electron microscopy provides 2-D projection images with low SNR and unknown projection directions. By focusing on the axial and rotational shifts between adjacent motifs of the helix rather than on the period, number of motifs per period, and number of turns per period, a forward model is described which avoids integer programming and shortens computation time in inverse calculations. The method is demonstrated on Tobacco Mosaic Virus.

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CP10

Uniqueness of the Circular Area Invariant for Graphs of Periodic Functions

The representation of curves by integral invariants has become an important step in shape recognition and classification due primarily to their robustness with respect to noise. However, for many integral invariants, the question of uniqueness of representation has not been addressed. In this work, we study the case of the circular area invariant and show that the representation is unique for graphs of periodic functions and derive a stability estimate on the reconstruction map.

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CP10

Tug of War game and Nonlocal Infinity Laplacian Equation with Application in Image Processing and Machine Learning

Certain PDEs such as infinity Laplacian Equation can be obtained as limits of values of tug-of-war games when the parameter that controls the length of the possible movements goes to zero. In this presentation we consider a nonlocal version of the game on weighted Graphs, and we will show that the value function of this game correspond to a nonlocal infinity Laplacian on Graphs. We will provide applications for interpolation data on graphs in image processing and machine learning.

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CP10

Nonlocal Pdes-Based Morphology on Weighted Graphs for Image and Data Processing

Mathematical morphology (MM) offers a wide range of operators to address various image processing problems. These operators can be defined in terms of algebraic (discrete) sets or as partial differential equations (PDEs). We introduce a nonlocal PDEs-based morphological framework defined on weighted graphs. This formulation introduces nonlocal patch-based configurations for image processing and extends PDEs-based approach to the processing of arbitrary data such as nonuniform high dimensional data.

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CP10

A 3D Model-Based Inversion Algorithm for Electromagnetic Data

In this approach, the models are described by points in 3D and the radial basis functions are used as the interpolation functions for connecting these points. This renders the surface of the target intrinsically smooth. The multiplicative L2-norm and weighted L2-norm regularization schemes are employed in the inversion to constrain the curvature and to further smooth the surface. The inversion results demonstrate that both the shapes and material properties of the target are well reconstructed.

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CP10

Non-Structural Imaging Methods for Characterisation of Nano-Particle Suspension

Under an external alternating force on a colloid, e.g. pressure or electric field, a particle vibration potential will be generated, which forms the secondary current flow in addition to the ionic current flow. This paper addresses the linkage between the elementary analyses of colloids in kinetic model and the electric field solutions in static model for analysing nano-particle characteristics in a slab model and in spatial distribution, providing potential methods for non-structural imaging.

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CP11

Seismogram Registration and Application to Nonlinear Seismic Inversion

Seismograms from seismic surveys contain subsurface velocity and structure information. We show that optimal mapping between a seismogram and corresponding synthetic seismogram can be obtained and effectively used for full waveform inversion. Highly non-convex image registration problems due to the oscillatory wavelets are solved in a multiscale manner. Once found, mappings warp the seismogram so that the least square misfit optimization avoids local minima. Successful application to seismic inversion problems are demonstrated.

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CP11

Anisotropic Triangulations for Image Approximations

Adaptive triangulations offer a powerful framework for image approximation. In this talk, we deal with edge-preserving representations: this requires the design of anisotropic triangulations. We present a method based on Delaunay triangulations: related approximation theory, algorithmic issues, application to compression and connections with local metrics are discussed.

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CP11

Discrete Composite Wavelet Transforms

Composite wavelets provide a general framework for the construction of waveforms defined not only at various scales and locations, as traditional wavelets, but also at various orientations and with different scaling factors in each coordinate. In this work, we further investigate the constructions derived from this approach to develop critically sampled and nonsubsampled composite wavelets for the purpose of image coding and denoising. The demonstrations will show consistent improvements upon competing state-of-the-art methods.

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CP11

New Nonnegative Tensor Factorizations (NTF) with Anderson Acceleration

Traditionally, NTF represents a tensor as a sum of nonnegative outer products of vectors. Here we explore a novel tensor representation and approximate a nonnegative tensor as a sum of structured tensors named PCTs. This method allows the optimization to be achieved through a 2-way alternation instead of 3-way. Additionally, we adopt the Anderson acceleration during the iteration. As an example, we test the NMF, traditional NTF and our novel

NTF on the CBCL dataset.

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CP11

Scattered Light in the Lunar Reconnaissance Orbiter Wide Angled Camera Images A Preliminary Study

The Wide Angle Camera (WAC) onboard the Lunar Reconnaissance Orbiter spacecraft is mapping the complete Moon nearly every month with images at a scale of 100 meters/pixel in seven color bands. The WAC has large field-of-view and this makes the analysis of the contribution of wavelength dependant scattered light towards imaged scene brightness extremely important to future quantitative studies. A preliminary analysis is performed in this work and results and future directions are discussed.

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CP11

Analysis and Comparative Evaluation of Methods for Phase Retrieval

Phase-retrieval is the recovery of signals from Fourier magnitude with wide applications in imaging. To date there are not many comparative studies of phase-retrieval algorithms. We analyze and evaluate Schulz-Snyder and Fienup algorithms, the only general-purpose phase-retrieval algorithms, both theoretically and numerically. We review their recent re-interpretations and perform an experimental evaluation in terms of reliability, convergence properties, and noise sensitivity. Additional comparison is done against algorithms for blind-deconvolution, which phase-retrieval is special case of.

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MS1

Applications of Tomographical Images in Cancer Radiotherapy and Cone Beam CT Image Enhancement Using Prior Nonlocal Means Method

Cone beam computed tomography (CBCT) plays an important role in for cancer radiotherapy. In this talk, I will first discuss the applications of CBCT in radiotherapy and present some challenging yet clinically important problems, including reconstruction and enhancement, CT/CBCT deformable registration, and segmentation. I will also present our recent work on CBCT image enhancement where a patient CT is utilized to enhance the CBCT quality using a prior non-local means method.

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MS1

Trabecular Texture Analysis in Dental Cone Beam CT

It is known that variation of trabecular texture patterns inside oral cavity is correlated to bone density loss, which can leads serious diseases such as osteoporosis. Automatic analysis of such texture patterns provides a potential solution toward osteoporosis screening, and at a low cost since the data can be obtained during routine dental examinations. We evaluate several modern texture descriptors on trabecular texture in three dimensional dental cone beam computational tomography (CBCT). The study is performed on a dataset containing CBCT volumes from 96 subjects, which are further divided into four gender-age subgroups. For each volume, eight regions-of-interest (ROIs) containing trabecular bone structures are cropped by a dentist. After that, five types of texture descriptors, including the icosahedron HOG, the standard fractal dimension (FD), the multi-fractal spectrum (MFS), the mean intensity, and the intensity histogram are extracted from these ROIs. Statistical analysis are then performed on all these features to determine whether they are significantly different between different age-gender groups. The results show that many features are significantly correlated with the age-gender separation with p-value$<$0.05. Furthermore, we feed the features with low p-values into the support vector machine and have observed significant improvement in classification accuracy.

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MS1

Joint CT/CBCT Deformable Registration and Cone Beam CT Image Enhancement

In this paper, we propose an algorithm that simultaneously performs the registration of CT and conebeam CT (CBCT) and image enhancement of CBCT. In particular, we adapt a viscous fluid model which naturally incorporates two ingredients, a similarity measure for registration and an intensity correction term for image enhancement. By adding this term back to CBCT, we can obtain an intensity corrected CBCT with better image quality. Furthermore, we find that including such intensity correction term can in turn help to improve the registration results. To reach the clinical goal of minimal processing time, the algorithm is implemented on a graphic processing unit (GPU) platform. The robustness of our algorithm is illustrated using two patient datasets of head-and-neck and pelvis respectively

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MS1

The Block DROP and CAV Algorithms for Compressed Sensing Based Tomography

In this talk, we will introduce a block diagonally-relaxed orthogonal projectionalgorithm and a block component averaging algorithm for computedtomography image reconstruction in the compressed sensing framework andderive the convergence. Numerical experiments are shown to illustrate the convergence of the new algorithms.

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MS2

Hard Thresholding with Norm Constraints

We introduce a new sparse recovery paradigm, where efficient algorithms from combinatorial and convex optimization interface for interpretable and model-based solutions. A highlight is the introduction of a new algorithmic definition of union-of-subspaces models, which we dub as the Polynomial time Modular Approximation Property (PMAP). PMAP rigorously identifies tractable models within the generic union-of-subspaces models, extending the reach of the model-based sparse recovery to a broader set of applications. Synthetic and real data experiments illustrate that our approach can significantly enhance the performance of both hard thresholding methods and convex solvers in sparse recovery.

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MS2

Recovering Cosparse Vectors using Convex vs Greedy Algorithms

Analysis cosparse models are an alternative to standard sparse models, where an analysis operator multiplies the signal to obtain sparse coefficients. In this model the good old (synthesis) dictionary is no longer exploited and is made redundant. After highlighting the main differences between the models, empirical and theoretical performance comparisons will be provided between convex cosparse reconstruction algorithms and a recently introduced cosparse analogue to greedy sparse approximation algorithms, called the Greedy Analysis Pursuit. Imaging and acoustic applications will be discussed.

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MS2

Simple and Practical Algorithm for Sparse Fourier Transform

The Fast Fourier Transform (FFT) is one of the most fundamental numerical algorithms. It computes the Discrete Fourier Transform (DFT) of an n-dimensional signal in O(n log n) time. The algorithm plays an important role in many areas. In many applications (e.g., audio, image or video compression), most of the Fourier coefficients of a signal are "small" or equal to zero, i.e., the output of the transform is (approximately) sparse. In this case, there are algorithms that enable computing the non-zero coefficients faster than the FFT. However, in practice, the exponents in the runtime of these algorithms and their complex structure have limited their applicability to only very sparse signals. In this talk, I will describe a new set of algorithms for sparse Fourier Transform. Their key feature is simplicity, which leads to efficient running time with low overhead, both in theory and in practice. In particular, we can achieve a runtime of O(k log n), where k is the number of non-zero Fourier coefficients of the signal. This improves over the runtime of the FFT for any k ¡¡n.

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MS2

Graphical Models and Message Passing Algorithms to Solve Large Scale Regularized Regression Problems

This work surveys recent work in applying ideas from graphical models and message passing algorithms to solve large scale regularized regression problems. In particular, the focus is on compressed sensing reconstruction via ℓ_1 penalized least-squares (known as LASSO or BPDN). We discuss how to derive fast approximate message passing algorithms to solve this problem. Surprisingly, the analysis of such algorithms allows to prove exact high-dimensional limit results for the LASSO risk.

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MS3

Anisotropic Elastic Moduli Reconstruction of Transversely Isotropic Material in Magnetic Resonance Elastography

Magnetic resonance elastography (MRE) is an elastic tissue property imaging modality in which phase-contrast based MRI imaging technique is used to measure internal displacement induced by a harmonically oscillating mechanical vibration. Since soft tissues like skeletal muscles show anisotropic behavior, we develop a new method for the anisotropic elastic property imaging. In this talk, we considers the reconstruction in a transversely isotropic model which is the simplest case of anisotropy, based on an explicit representation formula using the Newtonian potential of the measured displacement.

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MS3

A Shape and Topology Optimization Method for the Resolution of Inverse Problems in Tomography

We propose a shape optimization approach for the resolution of inverse problems in tomography, namely Electrical Impedance Tomography and Fluorescence Diffuse Optical Tomography. These problems are severely ill-posed, and we regularize them by assuming that the functions to be reconstructed are piecewise constants. Then the problem essentially boils down to determining the shapes of some hidden inclusions. The sensitivity of the objective with respect to small boundary and topological perturbations of the inclusions is analysed.

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MS3

Hybrid Techniques on Electrical Tissue Property Imaging

Noting that MRI scanner can noninvasively measure magnetic fields inside the human body in a form of cross-sectional image, impedance imaging methods using MRI have been lately proposed. MREIT performs conductivity imaging below 1 kHz, whereas MREPT produces both conductivity and permittivity images at the Larmor frequency based on B1-mapping techniques. In this talk, we review the latest techniques in MREIT and MREPT.

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MS3

Conductivity Imaging from Minimal Current Density Data

Recently has been shown that the magnitude of one current density field suffices to recover the electrical conductivity inside a body. This interior data can currently be obtained from Magnetic Resonance data in the presence of direct/very low frequency current applied at the boundary of the object. One of the methods reduces the problem to minimizing a weighted gradient in the space of functions of bounded variation. In this talk I will present recent progress on this minimization problem. The results have been obtained jointly with A. Nachman and A. Moradifam.

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MS4

Efficient Algorithms for Photoacoustic Imaging

Advances in photoacoustic imaging (PAI) come with the urgent need for fast reconstruction algorithms whose computational complexity scales up to logarithmic factors linear in the problem size. The well known fast Fourier transform (FFT) is such an algorithm and found its application as nonequispaced variant e.g. in magnetic resonance imaging. As part of an iterative reconstruction scheme, we discuss a specific four-dimensional sparse FFT for the necessary computation of spherical mean values in three-dimensional PAI.

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MS4

TV-Minimization for Color Images on Non-regular Grids

Registering slice images of a 3D object in order to reconstruct the object results in a reconstruction where the pixels are no longer on a regular grid. This is even worse with elastic registration. In applications as MALDI imaging it is not suitable to "resample" the reconstruction hence we need to adjust image processing algorithms to non-regular grids. This results in some problems e.g. for TV-based denoising methods. In this talk we will present our adaption

of the Chambolle method.

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MS5
The Past and Future of Imaging Through Turbulence

The normal state of the atmosphere is a turbulent state due to wind and thermal currents. The atmospheric effects are noticeable, but not a serious complication for many common imaging situations. For example, atmospheric turbulence effects are rarely seen in vacation photos. When visual aids such as zoom lenses are used, or when the ambient temperature gradient is large, the atmospheric turbulence problems are highlighted. Therefore, atmospheric turbulence was initially addressed for improving imaging from telescopes. These visual aids, however, are increasingly used in imaging sensors for persistent surveillance and artificial sight for unmanned vehicles. For this reason, there is a need to improve atmospheric turbulence corrections to aid other problems such as target recognition, autonomous navigation, and automated image understanding. We will discuss some of models of atmospheric turbulence as well as the inherent time and length scales. Furthermore, we will discuss the performance metrics that are necessary to enable target recognition, navigation and image understanding applications.

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MS5
Turbulence Restoration: From Stabilization to Atmospheric Deblurring

Atmospheric turbulence affects long range imaging systems and can be modeled as a composition of geometric distortions and blur. First, we propose to combine a deformation field estimation and some regularization schemes in order to retrieve a stabilized image. Secondly, we adress the deblurring problem and efficiently solve it by using an analytical atmospheric kernel. Many experiments on real images will illustrate the performances of our approach.

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MS5
A Dynamic Texture Model for Imaging Through Turbulence

We address the problem of recovering an image from a sequence of distorted versions of it, where the distortion is caused by what is commonly referred to as ground-level turbulence. In mathematical terms, such distortion can be seen as the cumulative effect of a time-dependent anisoplanatic (space-variant) blur and a time-dependent deformation of the image domain. We introduce a dynamic model that is statistical in nature, rather than physical, for the generation of turbulence based on the dynamic texture approach. We expand the model to include the unknown image as part of the unobserved state and apply Kalman filtering to estimate such state. This operation yields a blurry image where the blurring kernel is, in fact, close to being space-invariant. Applying blind nonlocal Total Variation (NL-TV) deconvolution yields a crisp final result.

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MS5
Removing Atmospheric Turbulence

A new approach is proposed, capable of restoring a single high-quality image from a given image sequence distorted by atmospheric turbulence. This approach reduces the space and time-varying deblurring problem to a shift invariant one. It first registers each frame to suppress geometric deformation through non-rigid registration. Next, a temporal regression process is carried out to produce an image from the registered frames, which can be viewed as being convolved with a space invariant near-diffraction-limited blur. Finally, a blind deconvolution algorithm is implemented to deblur the fused image, generating a high quality output. Experiments using real data illustrate that this approach can effectively alleviate blur and distortions, recover details of the scene, and significantly improve visual quality.

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MS6
On the Evaluation Complexity of Nonsmooth Composite Function Minimization with Applications to Nonconvex Nonlinear Programming

We estimate the worst-case complexity of minimizing an unconstrained, nonconvex composite objective with a structured nonsmooth term by means of some first-order methods. We find that it is unaffected by the nonsmoothness of the objective in that a first-order trust-region or quadratic regularization method applied to it takes at most

$\mathcal{O}(\epsilon^{-\in})$ function-evaluations to reduce the size of a first-order criticality measure below ϵ. These results allow us to analyze the evaluation complexity of nonlinear nonconvex constrained programming by means of a penalty method and a short-step target-tracking type algorithm. We find that the complexity of reaching within ϵ of a KKT point is at most $\mathcal{O}(\epsilon^{-\in})$ problem-evaluations, which is the same in order as the function-evaluation complexity of steepest-descent methods applied to unconstrained, nonconvex smooth optimization.

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MS6
Nonconvex Nonsmooth Optimization via Gradient Sampling

We present an algorithm for general-purpose nonconvex nonsmooth optimization. The methodology assumes that the problem functions are locally Lipschitz and continuously differentiable over dense subsets of $\mathbf{R^n}$. It is applicable in unconstrained and constrained environments, where in the latter setting the constraint functions can also be nonconvex and nonsmooth. The algorithm is based on a process of sampling gradients of the problem functions randomly in an epsilon-neighborhood of a given solution estimate, solving a quadratic optimization subproblem, and then performing a line search. Global convergence guarantees state that, with probability one, the algorithm converges to a stationary point of the optimization problem and numerical results indicate that the method is efficient on a wide range of problems. It is expected that the methodology can easily be tailored to specific applications.

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MS6
High-Dimensional Covariance Estimation under Sparse Kronecker Product Structure

We consider the problem of structured covariance matrix estimation when the covariance factors as a kronecker product of low dimensional matrices and the observations are Gaussian distributed. This constitutes a new approach to estimating sparse graphical models for imaging, bioinformatics, finance, and other applications. The problem is formulated as a variational optimization of a Gaussian log-likelihood function with additive l1 penalty on non-sparsity of the kronecker product matrices. The dual formulation of this problem motivates an iterative algorithm based on a block coordinate-descent approach. Although the variational problem is nonconvex and nonsmooth, we show that the proposed algorithm converges to a local maximum under relatively mild assumptions. We give a tight rate of Frobenius norm convergence as the dimensions of the covariance matrix go to infinity. This rate is an order of magnitude better than the state-of-the art unstructured graphical lasso (Glasso) algorithm for estimation of general unstructured covariance matrices.

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MS6
Wasserstein Barycenter: Global Minimizers and Algorithm

This paper proposes a new definition of the averaging of discrete probability distributions as a barycenter over the-Wasserstein space. Replacing the Wasserstein original metric by a sliced approximation over 1D distributions allows us to use a fast stochastic gradient descent algorithm. This new notion of barycenter of probabilities is likely to find applications in computer vision where one wants to average features defined as distributions.

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MS7
Denoising Textures with a Multiplicative Regularization Method

Many problems in scientific computing can be cast as inverse problems. Unfortunately, most inverse problems are ill-posed, leading to unstable solutions. The most common approach to have well-posed inverse problems is to use the Tikhonovs additive regularization method dated back to 1943, which adds a regularization function to the data function. In this talk, we will introduce an alternate regularization method for inverse problems, which basically considers a multiplicative approach between regularization functional and data-oriented functional. The main improvements of this approach compared to Tikhonov's regularization method are the geometric invariance (important for medical and modern imaging techniques s.a. omnidirectional imaging) and the data adaptive regularization (process that can locally adapt its strength to the data). Experiments show that the proposed denoising method provides promising results for piecewise smooth images and textures.

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MS7

Sparse Modeling of Random Phase Textures

Randomizing the Fourier phases of an image is a simple algorithm that permits to reproduce well several kinds of microtextures. This Random Phase Noise (RPN) model is also interesting from a mathematical viewpoint, in particular because of its link with stationnary Gaussian Random Fields. We describe a way to represent a RPN by a sparse image called "reduced texton", that solves an optimization problem, and show its usefulness both for texture analysis and the synthesis of arbitrary large texture samples. (joint work with A.Desolneux and S.Ronsin)

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MS7

Optimal Transport Mixing of Gaussian Texture Models

In this talk I will tackle the problem of mixing color texture models learned from an input dataset. I focus on stationary Gaussian texture models, also known as spot noises. I derive the barycenter and geodesic path between models according to optimal transport. This allows the user to navigate inside the set of texture models, and perform texture synthesis from the obtained interpolated models. Numerical examples on a library of exemplars show the ability of our method to generate arbitrary interpolations among unstructured natural textures. This is a joint work with Sira Ferradans, Gui-Song Xia and Jean-Francois Aujol.

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MS7

A Level-set Approach to Image-Texture Segmentation: Old and New

In this talk we present an 'old' and 'new' level-set method to image texture segmentation: the 'old' idea of level sets, the 'new' insight with helps of recent convex optimization developments in image processing. It leads to a fast and reliable approach to computing segments based on texture features: the inherent obstacles with the classical level-sets are solved under the new variational perspective.

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MS8

Inversion of the V-Line Radon Transform in a Disc and Its Applications in Imaging

Several novel imaging modalities proposed during the last couple of years are based on a mathematical model, which uses the V-line Radon transform (VRT). This transform, sometimes also called broken-ray Radon transform, integrates a function along V-shaped piecewise linear trajectories composed of two intervals in the plane with a common endpoint. Image reconstruction problems in all those modalities require inversion of the V-line Radon transform. While there are ample results about inversion of the regular Radon transform integrating along straight lines, very little is known for the case of VRT. In this talk we discuss an exact inversion formula for the V-line Radon transform of functions supported in a disc of arbitrary radius. Our method is based on the classical filtered back-projection inversion formula of the regular Radon transform, and has similar features in terms of stability, speed, and accuracy. We illustrate our results by presenting various numerical simulations. The talk also discusses the interior problem of VRT, and some other open problems.

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MS8

Microlocal Analysis of Common Midpoint SAR Imaging

In Synthetic Aperture Radar (SAR) imaging, a plane carrying an antenna moves along a path. The antenna emits electromagnetic waves which scatter off the ground and are detected back with the same antenna. The received signals are used to produce an image of the ground. In common midpoint SAR imaging, the source and receiver move along a line at equal speeds away from a common midpoint. We analyze the microlocal properties of the forward operator F which is a Fourier integral operator with singularities. To recover the image we study the normal operator F^*F and show that F^*F is a sum of four operators belonging to $I^{p,l}(\Delta, C_i)$, where C_i are canonical graphs representing the artifacts which appear by backprojecting the data. This is joint work with G. Ambartsoumian, V. Krishnan, C. Nolan and T. Quinto.

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MS8

Microlocal Analysis of an Ultrasound Transform with Circular Source and Receiver Trajectories

We consider a generalized Radon transform that comes up in ultrasound reflection tomography. In our model, the ultrasound emitter and receiver move at a constant distance apart along a circle. We analyze the microlocal properties of the transform $\mathcal{R}$ that arises from this model. As a consequence, we show that for distributions with support sufficiently inside the circle, the normal operator $\mathcal{R}^*\mathcal{R}$ ($\mathcal{R}^*$ is the L^2 adjoint of $\mathcal{R}$) is an elliptic pseudodifferential operator of order -1 and hence all the singularities of such distributions can be recovered.

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MS8

Synthetic Aperture Imaging of Moving Targets using Ultra-narrowband waveforms

We present a novel method of imaging multiple moving targets using a SAR system transmitting ultra-narrowband continuouswaveforms. Ourmethod comprises of a new forwardmodel that relates the velocity as well as reflectivity information at each location to a correlated received signal; and a novel image formation method based on filtered-backprojection and image-contrast optimization. The method results in well-focused reflectivity images of moving targets and their velocity estimates regardless of the target location, speed, and velocity direction.

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MS9

Recent Advances in Image Reconstruction from Interior Data

The interior problem of tomography does not have a unique solution. When additional information about the region of interest is available, the uniqueness and stability can be recovered. In this talk we will summarize recent progress in theoretical understanding of the interior problem and some new algorithms for its numerical solution. Our starting point is the Gelfand-Graev formula, which establishes a relation between the ray transform of a function and its Hilbert transform along lines.

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MS9

The Hilbert Transform in Analytic Cone-beam Image Reconstruction: A Visual Tour

Several of the advances that have occurred in the past 10 years in analytic cone-beam image reconstruction have centered around the Hilbert transform. These advances include Katsevich's theoretically exact image reconstruction framework, the derivative backprojection (also called backprojection-filtration) approach, and several others. I will present a visual framework that I find useful for designing reconstruction algorithms and show how each of these approaches can be understood in this framework. I will also touch briefly on some of the interesting tradeoffs that are made where theory meets practice in CT.

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MS9

Tensor-based Formulation for Spectral Computed Tomography

Utilizing photon counting detector technology spectral computed tomography (CT) provides energy-selective measurements and reconstructions. In this work, we interpret the spectral CT data as a multidimensional array (tensor) and apply decomposition techniques to reduce the dimensionality of the linear inverse problem. Furthermore, we investigate tensor-based formulation of the multi-spectral reconstruction of linear attenuation coefficient and regularization techniques such as spectral regularization based on low rank assumptions for the case of densely binned energy spectra. We compare our method filtered back projection (FBP) reconstructions for each energy bin to demonstrate the advantages of the proposed formulation.

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MS9

A Fourier Integral Operator Model for Conebeam X-ray CT and its Inversion

This talk presents an analytic model in the form of a Fourier integral operator and its inversion for X-ray CT image reconstruction. The model can accommodate system related parameters and arbitrary source trajectories. We present a comparison of the inversion formula with the existing ones and demonstrate its performance in numerical simulations.

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MS10

Radar Imaging

This talk will address current mathematical work in radar imaging.

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MS10

Edge-based Image Reconstruction, Hierarchical Feature Extraction, and Analysis - A Structural Approach

Remote sensing image analysis has largely focused on spectral analysis. Modern sensors reveal spatial detail that calls for exploitation of structural information. Moreover, todays volume of imagery requires faster exploitation that leverages pixel redundancy for data reduction. We present a perceptually motivated approach to feature extraction that that utilizes edge information to recast images in terms of polygonal features. This representation can be used for automating object, anomaly, and change detection in remote sensing imagery.

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MS10

Contrast Invariant and Affine Sub-Pixel Optical-Flow for Remote Sensing Applications

CIAO (Contrast Invariant and Affine Optical Flow) is a dense area-based subpixel image matching algorithm. CIAO does not force the estimated disparity field between two images to be smooth and allows for contrast and brightness changes. The proposed model considers local affine displacements and it is robust to drastic changes in the images' content. CIAO proves particularly useful to extract high quality, high accuracy, and high density disparity maps from pairs of stereoscopic images.

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MS10

Variational Methods for Remote Sensing Applications

The development of a variety of novel sensors for capturing remote sensing and atmospheric data gave rise to many new applications and an enormous need for solving new inverse problems arising in these fields. This talk will describe some of the applications and variational approaches for solving associated inverse problems. In particular, decomposition of different layers of clouds, reconstruction of hurricane images, and data fusion of satellite records acquired by multiple instruments will be discussed.

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MS11

Temporally Consistent Segmentation of Longitudinal MRI Data and Related Issues

Abstract not available at time of publication.

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MS11

An Efficient Algorithm for Multiphase Image Segmentation with Intensity Bias Correction

We present an efficient algorithm for multiphase image segmentation in the presence of strong noise and intensity inhomogeneity. The problem is formalized as a min-max optimization problem that consists both primal and dual variables. We use the primal dual hybrid gradient (PDHG) algorithm to alternately solve for the optimal solutions. The proposed algorithm is quite efficient in that all the subproblems have closed form solutions. Moreover, the computational complexity is shown to be linear with respect to the size of the image. Numerical experiments on various images demonstrated that our algorithm outperforms recently developed methods in terms of efficiency and accuracy.

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MS11

Marginal Space Learning for Efficient Detection and Segmentation of Anatomical Structures in Medical Imaging

Recently, we proposed marginal space learning (MSL) as a generic approach for automatic detection and segmentation of 2D/3D anatomical structures in many medical imaging modalities. To accurately localize a 3D object, we need to estimate nine pose parameters (three for position, three for orientation, and three for anisotropic scaling). Instead of exhaustively searching the original nine-dimensional pose parameter space, only low-dimensional marginal spaces are searched in MSL to improve the detection speed. In this talk, I will present MSL in detail, followed by some recent developments, e.g., constrained MSL, MSL for non-rigid shape detection, and hierarchical MSL. Live demos on various applications of MSL will be shown.

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MS11

A Geodesic Active Contour Based Model for Short Axis Cardiac-MR Image Segmentation

We propose a novel geodesic active contour based variational model that uses two level set functions to segment the right/left ventricles and the epicardium in short axis MR images respectively. To relax the restriction on the choice of initial contours, we develop a new edge function. We also propose an iterative method to minimize the energy of our model. Experimental results are presented to validate the effectiveness of the proposed model.

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MS12
General Purpose First-order Methods for Convex Minimization

Interior-point methods handle convex programs regardless of smoothness or constraints, but have difficulty with large problems. Researchers are turning to simpler methods such as (projected) gradient-descent, but this requires smoothness and the ability to efficiently project. To address these issues, we introduce a framework and software package called TFOCS (Becker,Grant,Candes), and compare with recent splitting methods (Chambolle,Pock). We also present work on improving convergence speed by using non-diagonal preconditioners (Becker,Fadili).

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MS12
Generalized Forward-Backward Splitting for Sparse Recovery

This work introduces the generalized forward-backward splitting algorithm for minimizing convex functions of the form $F + \sum_{i=1}^{n} G_i$, where F has a Lipschitz-continuous gradient and the G_i's are simple in the sense that their Moreau proximity operators are easy to compute. While the forward-backward algorithm cannot deal with more than $n = 1$ non-smooth function, our method generalizes it to the case of arbitrary n. Our method makes an explicit use of the regularity of F in the forward step, and the proximity operators of the G_i's are applied in parallel in the backward step. This allows the generalized forward backward to efficiently address an important class of convex problems. We prove its convergence in infinite dimension, and its robustness to errors on the computation of the proximity operators and of the gradient of F. Examples on sparse recovery and inverse problems demonstrate the advantage of the proposed method in comparison to other splitting algorithms.

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MS12
Constructing Test Instances for Sparse Recovery Algorithms

Since the number of available algorithms solving the Basis Pursuit Denoising problem rises, it is desirable to create test instances containing a matrix, a right side and a (given) solution, which can be recovered exactly. To guarantee the existence of such a solution, the so-called source condition is sufficient and necessary. In this talk, we present strategies to construct test instances with different additional properties (e.g. a favorable dual certificate).

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MS13
Sensing Videos with the Single Pixel Camera

Recent progress in compressive sensing (CS) has enabled the construction of computational imaging devices that sense parsimoniously at the information rate of the scene under view rather than its Nyquist rate. One such CS device is the single pixel camera that randomly multiplexes light spatio-temporally onto a single sensor, which enables it to operate efficiently in wavelength regimes (such as deep into the infrared) that require exotic detectors. In this talk, we report on recent work to efficiently sense and recover video from CS measurements. Our first approach relies on recovering foreground innovations from a video by performing background subtraction directly on compressive measurements. Our second approach addresses the compressive video sensing problem by regularizing the scene with a dynamical systems prior. The predictive/generative models associated with dynamical systems are employed to provide significant spatio-temporal tradeoffs at sensing. Finally, our third approach highlights some of the recent work on simultaneously sensing the scene as well as its motion as objects in the scene articulate in front of the camera. Together, these methods provide a wide range of tradeoffs on parsimony in sensing and accuracy of reconstructed signals. We demonstrate the effectiveness of our techniques on simulated and real single pixel camera data.

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MS13
Infinite Photography

We introduce a new mathematical image model using the photographic process as the starting point. Images are represented as infinite sequences of photons allowing analysis at arbitrarily high resolution. We show that the resulting space has a metric structure and is intimately connected with bounded Borel measures. Furthermore, novel computational image processing algorithms based on the model are illustrated. This is joint work with Matti Lassas and Samuli Siltanen.

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MS13

Femto-Photography: Time Resolved Imaging for Looking Around Corners

Can we look around corners beyond the line of sight? Our goal is to exploit the finite speed of light to improve image capture and scene understanding. New theoretical analysis coupled with emerging ultra-high-speed imaging techniques can lead to a new source of computational visual perception. We are developing the theoretical foundation for sensing and reasoning using Femto-photography and transient light transport, and experimenting with scenarios in which transient reasoning exposes scene properties that are beyond the reach of traditional computer vision. (Joint work with a large team, see http://raskar.info/femto)

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MS14

Registration of MALDI Imaging Data

Registration is central in lifting existing 2D MALDI imaging to a 3D image modality. In the talk we present an approached based on nonlinear image registration for the reconstruction of 3D MALDI images from a stack of 2D MALDI slices. Therefore we first apply elastic serial registration resulting a stack of aligned 2D images. Afterwards, we perform 3D co-registration with an initially acquired MR image to restore the object's shape.

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MS14

Artifact-free Decompression of Transform-coded Multi-channel Images with TGV

The problem of artifact-free decompression of transform-coded multi-channel images, such as JPEG compressed color images, is addressed. This is done by formulating a constrained optimization problem involving a convex indicator function as data fidelity- and the recently introduced Total Generalized Variation (TGV) functional as regularization term. After a discussion of the continuous model, the application to JPEG decompression is considered, including practical aspects such as numerical realization and fast implementation on the GPU.

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MS14

Including Spatial Similarities into Hierarchical Clustering of Hyperspectral Terahertz Images

Hierarchical clustering (HC) is well suited for data exploration. For computational feasibility and flexibility of methods we combine the phase I preclustering of Karypis' Chameleon with agglomerative HC. Spatial similarity is integrated by slicewise image processing or direct inclusion into the similarity matrix: Precluster members are assumed to be independent Gaussian distributed and their overlap is calculated. A high overlap increases the total similarity. Results on hyperspectral Terahertz images show improved coherence of segmented objects.

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MS14

Generating 3D MALDI Imaging Data

MALDI imaging is a technique which records mass spectrums of tissue in two dimensions. We set up a processing pipline for generating three-dimensional (3D) MALDI-data enabling for 3D-clustering. We present a fully-automatic pipeline, regarding detection and segmentation of tissue on the carrier, pre-alignment, rigid reconstruction and image fusion. The whole processes brings MALDI spectrum data and histologic images together.

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MS15

On-the-Fly Turbulence Effect Mitigation in Long-Range Surveillance Applications Based on Lucky Region Fusion

We present a technique and experimental results for mitigation of the turbulence effect in long-range imaging scenarios. Our approach is based on the selection and fusion of image lucky regions. Lucky region selection is performed based on the local image quality and allows fusion of a diversity of images including different distortions, exposures and spectral ranges.

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MS15

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 in a distance can look distorted in the video sequence. Blurring and diffeomorphism are couple of the main effect of atmospheric turbulence, and we propose methods to stabilize the video sequence and give a good reference latent image. We reconstruct a new video sequence using Sobolev gradient deblurring with the temporal smoothing, and one latent image is found further utilizing the lucky-region method. With these methods, without any prior knowledge, the video sequence is stabilized while keeping sharp details, and the latent image shows more consistent straight edges.

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MS15

Non Rigid Geometric Distortions Correction – Application to Atmospheric Turbulence Stabilization

A novel approach is presented to recover image degraded by atmospheric turbulence. Given a sequence of frames affected by turbulence, we construct a variational model to characterize the static image. The optimization problem is solved by the Bregman iteration and operator splitting method. Our algorithm is simple and efficient, and can be easily generalized for different scenarios.

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MS16

$\mathbf{L^p(\Omega)}$−Optimization with $\mathbf{p} \in [\mathbf{0},\mathbf{1})$

For $p \in [0, 1)$ we consider the problem

$$\inf \mathrm{J(u)} = \frac{1}{2}|\mathrm{Ku} - \mathrm{f}|_{\mathrm{Y}}^2 + \beta\, \mathrm{N_p(u)} \text{ over } \mathrm{u} \in \mathcal{C} \qquad \text{(P)}$$

where K is a bounded, possibly compact operator with values in a Hilbert space Y, $\mathcal{C}$ a closed convex set, and

$$N_p(f) = \int_S |f(x)|^p\, dx \text{ for p} \in (0, 1) \text{ and } \mathrm{N_0(f) = meas\{x \in \Omega : f(x) \neq 0\}}.$$

We show existence for an L^2-regularized version of (P) and derive optimality conditions. Further we propose a primal dual active set method and we analyse a monotone scheme for obtaining numerical solutions. Applications include mathematical imaging with sparsity constraints.

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MS16

Sparse Approximation via Penalty Decomposition Methods

In this talk we consider sparse approximation problems, that is, general l_0 minimization problems with the l_0-"norm' of a vector being a part of constraints or objective function. In particular, we first study the first-order optimality conditions for these problems. We then propose penalty decomposition (PD) methods for solving them in which a sequence of penalty subproblems are solved by a block coordinate descent (BCD) method. Under some suitable assumptions, we establish that any accumulation point of the sequence generated by the PD methods satisfies the first-order optimality conditions of the problems. Furthermore, for the problems in which the l_0 part is the only nonconvex part, we show that such an accumulation point is a local minimizer of the problems. In addition, we show that any accumulation point of the sequence generated by the BCD method is a saddle point of the penalty subproblem. Moreover, for the problems in which the l_0 part is the only nonconvex part, we establish that such an accumulation point is a local minimizer of the penalty subproblem. Finally, we test the performance of our PD methods by applying them to sparse logistic regression, sparse inverse covariance selection, and compressed sensing problems. The computational results demonstrate that our methods generally outperform the existing methods in terms of solution quality and/or speed.

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MS16

On Local Linear Convergence of Elementary Algorithms with Sparsity Constraints

In sparsity optimization it is usually the sparsity of the signal or matrix that is minimized subject to some (usually linear) constraint. The naive formulation of the problem involves the ℓ_0 function, and is avoided since the resulting optimization problem has no known polynomial-time algorithms for its solution. Most practical numerical techniques involve relaxations to convex or quasi-convex surrogates. Surprisingly, however, sets built upon the ℓ_0 function are much more regular than would be expected. This regularity allows us to prove local linear convergence of elementary algorithms even for nonlinear problems with sparsity constraints without resorting to convex relaxations or even to the usual mutual coherence or restricted isometry conditions.

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MS16

Symbology-based Algorithms for Robust Bar Code Recovery

UPC bar codes can be characterized as sparse representations with respect to a certain symbology basis. We exploit this low-dimensional structure and introduce a greedy bar code reconstruction algorithm which can recover UPC bar codes from very noisy measurements and inaccurate parameter information. Extensions to general bar codes, radio-frequency identification, and text denoising will be discussed.

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MS17

Linking a Texture Model to Visual Processing in Cortex

Many mathematical models of texture employ a hierarchy, with simpler elements at one stage combined into more complex features at later stages. It is also well known that the cortical areas of the human visual system are organized into such a cascade. I will describe work that combines texture synthesis and human perception to forge a link between these two forms of hierarchy. Our model uses a cascade of biologically-plausible computations to capture a rich variety of features found in naturalistic texture images. To link the model to perception, we exploit the fact that visual signals are not encoded uniformly across the visual field; rather, neurons pool signals locally, in regions that grow with distance from the center of gaze. We develop a synthesis algorithm to generate images that are matched to the locally-pooled textural features of an original image. Such synthetic images are increasingly distorted or jumbled as the regions grow large, but so long as the regions are matched to those of cortical neurons, these distortions are invisible – the images are "metamers". We use perceptual experiments to quantify these effects, link them to different stages of cortical processing, and explain a variety of perceptual deficits that arise in the periphery of the visual field.

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MS17

Maximum Entropy Texture Modeling Based on a Physiological Front End

I'll describe our work in developing implicit models for both visual and auditory textures based on cascades of local measurements. Specifically, input signals are decomposed through application of bandpass linear filterbanks, interdigitated with rectifying nonlinearities, roughly analogous to the processing found in biological visual and auditory systems. The representational capabilities of these measurements may be studied by synthesizing novel signals that yield identical sets of measurements. We find that they are remarkably powerful in capturing structural properties of complex real-world textures.

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MS17

Texture, Structure and Visual Matching

I will describe a notion of Information for the purpose of decision and control tasks, as opposed to data transmission and storage tasks implicit in Communication Theory. It is rooted in ideas of J. J. Gibson, and is specific to classes of tasks and nuisance factors affecting the data formation process. When such nuisances involve scaling and occlusion phenomena, as in most imaging modalities, the "Information Gap' between the maximal invariants and the minimal sufficient statistics can only be closed by exercising control on the sensing process. Thus, senging, control and information are inextricably tied. This has consequences in understanding the so-called "signal-to-symbol barrier' problem, as well as in the analysis and design of active sensing systems. I will show applications in vision-based control, navigation, 3-D reconstruction and rendering, as well as detection, localization, recognition and categorization of objects and scenes in live video.

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MS18

4D Inverse Problems: Optimal Transport meets Sparsity and Low Rank

The aim of this talk is to study models and efficient algorithms for 4D reconstruction in biomedical imaging. Standard reconstruction methods do not incorporate time dependent information or kinetics. This can lead to deficient accuracy at object boundaries, e.g. at cardiac walls. We discuss constrained optimization models combining ideas of inverse problems, spatio-temporal regularization and optimal transport. The main emphasis lies on 4D image decomposition via sparsity and low rank. This allows for better reconstructions in difficult MRI imaging sequences or video analysis with undesired background motion.

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MS18

Motion Compensation for Dynamic Contrast Enhanced MRI

In this work we present a novel approach for motion correction for dynamic enhanced MRI sequences. The idea for our method is twofold. First, we build on image registration techniques for correcting motion artifacts from the data. Second, we jointly estimate contrast uptake under certain model assumptions. In a first approach, we make the generic assumption the contrast uptake is a smooth process over time. In a second approach, we explicitly model the uptake as gamma function.

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MS18

Which Geometric Structure for the Statistical Analysis of Longitudinal Deformations?

Longitudinal morphological deformations can be evaluated using non-rigid registration for each subject but require the parallel transport to a common reference for longitudinal group-wise analysis. We have recently proposed a discrete construction of parallel transport only based on geodesics, the Schild's Ladder procedure. It was shown to be implemented extremely efficiently with great stability in the framework of diffeomorphisms parameterized by stationary velocity fields (SVF). Along with the efficient image registration methods based on SVFs (DARTEL, log-demons, etc), this constitute an interesting practical alternative to Riemannian-based methods (LDDMM). We show that the theoretical bases of this SVF framework in finite dimension can be based on the canonical Cartan connections. This raises the question of the minimal geometric structure needed to define interesting statistics on manifolds: can we remove the metric to generalize (part of) the statistical setting from Riemannian manifolds to affine connection spaces?

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MS18

A Spatio-temporal Motion Correction Scheme for Cardiac PET

Positron Emission Tomography (PET) is a nuclear imaging technique of increasing importance e.g. in cardiovascular investigations. However, cardiac and respiratory motion of the patient degrade the image quality due to acquisition times in the order of minutes. Reconstructions without motion compensation are prone to spatial blurring and affected attenuation correction. These effects can be reduced by gating, motion correction and finally summation of the transformed images. Gating schemes that are based on a finer grouping into phases of the respiratory and cardiac cycle are desirable in this application as each individual image shows less motion artifacts. However, the gated images are also based on a smaller fraction of counts and thus regularization becomes essential. In this work, we present a spatial-temporal approach to cardiac and respiratory motion correction in gated 3D PET. It is based on a mass-preserving and hyperelastic image registration scheme, which acknowledges the density property of PET and guarantees diffeomor- phic solutions. To improve the robustness against noise, we introduce additional smoothing in time and jointly optimize over all transfor- mations.

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MS19

Photon State Space and Radiative Transfer: The Physics of Imaging with Remote Sensors

Overhead sensors ultimately count photons, thus sampling their few state-space dimensions: energy (wavelength), momentum (viewing direction), spin (polarization). Physics-based retrievals of geophysical quantities from remote-sensing data therefore use at best multi-spectral/multi-angle radio-polarimetric input. However, implicit here is that just one spatial sample (pixel) is processed at a time, and this is indeed how Earth-observation missions operate. Although much can be extracted at pixel-scales, new frontiers will be multi-pixel algorithms, and deeper exploitation of pulsed sources.

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MS19

Sensitivity Studies of Optical Scanning Polarimeter Retrievals of Aerosol and Cloud Optical Properties

Scanning polarimeters are capable of simultaneously retrieving optical properties of both aerosols and clouds in partially cloudy pixels. This has been shown previously for simulations with one dimensional radiative transfer models, whose speed is required for operational retrievals. However, neglecting the impacts of three dimensional scattering will degrade retrieval accuracy. We investigated the significance of this degradation on retrieval accuracy to select the ideal operational retrieval strategy for scanning polarimeters.

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MS19

Atmospheric Radiative Effects and their Correction in Landsat Images

The high resolution images of the Earth surface obtained from satellites contain distortions caused by atmospheric scattering and absorption of solar radiation. We will discuss the atmospheric radiative effects and an accurate method of atmospheric correction over non-Lambertian spatially variable surface in application to the Landsat imagery. The approach uses formalism of the atmospheric optical transfer function implemented in radiative transfer algorithm SHARM-3D.

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MS19

Spectral Invariance in Atmospheric Radiation

Certain algebraic combinations of single-scattering albedo and solar radiation reflected from, or transmitted through cloudy atmospheres do not vary with wavelength. These are called spectrally-invariant relationships; they are the consequence of the fact that in cloud-dominated atmospheres the total extinction and total scattering phase function are only weakly sensitive to wavelength. We will discuss the physics behind this phenomenon, its mathematical basis, and possible applications to remote sensing and climate.

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MS20

Electro-Acoustic Imaging Methods

In this talk, I will discuss recent progresses in electro-acoustic imaging, based on the idea of imaging by modification: a controlled modification of the internal physical properties, by an exterior stimulation, allows to extract localized internal information on the unperturbed medium. I will conclude by a remark on the benefits of many redundant measurements for a microwave imaging problem.

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MS20

Joint Estimation of Wave Speed and Absorption Density Functions with Photoacoustic Measurement

We present an approach for simultaneous identification of the absorption density and the speed of sound by photoacoustic measurements. Experimentally our approach can be realized with sectional photoacoustic experiments. The mathematical model for such an experiment is developed and exact reconstruction formulas for both parameters are presented.

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MS20

Acousto-optic Imaging and Related Inverse Problems

A tomographic method to reconstruct the optical properties of a highly-scattering medium from incoherent acousto-optic measurements will be discussed. The method is based on the solution to an inverse problem for the diffusion equation and makes use of the principle of interior control of boundary measurements by an external wave field.

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MS20

Stabilizing Inverse Problems by Internal Data

Several hybrid imaging methods (e.g. those combining electrical impedance or optical imaging with acoustics) enable one to obtain internal information. This information stabilizes the exponentially unstable modalities of optical and electrical impedance tomography. A number of manifestations of this effect have been studied previously. I will discuss a simple, general approach that shows when and why internal information stabilizes the reconstruction. (This talk presents joint work with Peter Kuchment.)

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MS21

Do High Frequencies Contain Information about

Low Frequencies?

Data usually come in a high frequency band in wave-based imaging, yet one often wishes to determine large-scale features of the model that predicted them. When is this possible? Both the specifics of wave propagation and signal structure matter in trying to deal with this multifaceted question. I report on some recent progress with Paul Hand and Hyoungsu Baek. The answers are not always pretty.

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MS21

Interferometric Seismic Imaging by Sparse Inversion

Seismic interferometry complements conventional imaging by using multidimensional cross-correlations of recorded wavefields. Unfortunately, its performance may be impacted by practicalities such as noise, limited aperture, and incomplete data. We adress these issues by combining interferometric deconvolution with transform-domain sparsity promotion and imaging. This leads to a formulation that deals with data imperfections. Our preliminary findings show that sparsity promotion can lead to a significant improvement of the image quality under a salt flank.

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MS21

Modeling and Inverting Seismic P-S mode Conversions from Anelastic Targets

Truncated series expansions of modified Knott-Zoeppritz equations accurately reproduce pre-critical seismic amplitudes associated with anelastic P-S mode conversions. The leading order contribution includes a correction for Q_S contrasts. Amplitude-variation-with-frequency data from such conversions can be used to directly determine target Q_S values. It may be established: (1) that a P-S mode conversion occurs at an interface across which Q_S only varies; (2) that a Q_P contrast causes a negligible conversion, but significantly influences those caused by Q_S; (3) that the reciprocal quality factors are proportional to the frequency rates of change of the anelastic R_{PP}, R_{PS} and R_{SS}; and (4) that in the elastic limit and for large contrasts a V_P/V_S ratio of 2 takes on special importance, decoupling density variations and velocity variations across the reflecting boundary.

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MS21

Nonlinear Imaging and Inversion of Seismic Wavefields Using Interferometry

Using recent advances in seismic interferometry and scattering reciprocity, extended images are described as fields that are reconstructed inside the subsurface where no real observations exist, using observed boundary data and an a priori model. This definition of a seismic image provides a few advantages over more conventional definitions based on linearized back-projections: they account for the full nonlinear nature of seismic data, and can thus handle multiple-scattered waves as well as nonlinear finite-frequency amplitude effects. Since the extended images are by definition subsurface fields, they allow the design of novel image-domain objective functions that use extended-image annihilators explicitly defined in terms of partial differential equations (PDEs) for scattered fields. These PDE-based annihilators provide a flexible and comprehensive description of the model-dependent behavior of extended images: this allows for several unique features, including the design of single-frequency annihilators that allow for multi-scale inversions using extended images. The extended-image framework allows for nonlinear, finite-frequency inversions where both the extended images as well as the annihilators themselves are model dependent. Finally, we propose an inversion metric that jointly uses data- and image-domain misfit, and show that extended images provide additional information and potentially reduce ambiguity in the computation of model gradients.

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MS22

Fast Algorithms for Second Order TV and Fourth Order Mean Curvature Denoising

Image denoising is a fundamental task, studied by various researchers with a large range of variational models. The most well-known are the ROF model of Rudin-Osher-Fatimi 1992 and the PM model by Perona-Malik 1990.. While the indirect method of a split-Bregman implementation for the total variation model is effective, we review the fast and direct methods for the primal and dual models. The mean curvature model provides a powerful alternative to the TV as it can both preserve both edges and smooth regions. But the corresponding fourth order PDE is more challenging to solve than the TV case. We discuss recent algorithmic developments in new fix-point methods and multigrid methods. Joint work with C Brito, L Sun, Y Q Dong, M Hintermuller, J Savage, F L Yang, B Yu.

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MS22
Exact Reconstruction of Damaged Color Images using a Total Variation Model

Variational methods based on the minimization of certain energy functionals have been successfully employed to treat a fairly general class of image restoration problems. The underlying theoretical challenges are common to the variational formulation of problems in other areas (e.g. materials science). Here first order RGB variational problems for recolorization will be analyzed.

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MS22
Accurate Numerical Schemes in Image Denoising

In this talk, we review well-known numerical schemes to solve the Rudin-Osher-Fatemi (ROF) model and discuss about difficulties to obtain accurate discretization for obtaining a piecewise constant image. Based on analytical view point of ROF model in an infinite dimension, we use the pre-dual formulation to accurately achieve a solution in BV space, which is very robust to rotational invariance. We also demonstrate comparison with various efficient schemes.

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MS22
Variational Models for Denoising of Images and their Functional Analytic Properties

Variational models have proven useful for the denoising of natural images. They usually consist of a fidelity term and a regularization term. The two terms are weighted by a regularization parameter. Examples include the Rudin-Osher-Fatemi model and higher-order models. We compare recovery and stability properties of various variational models. This includes the impact of noise in the data, consistency properties of the models and the numerical computability of approximate solutions.

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MS23
Iterative Regularization of Inverse Problems by Efficient Inexact Uzawa Methods

The aim of this talk is to study convergence properties of inexact Uzawa methods applied to linear ill-posed problems. Augmented Lagrangian and Uzawa-type methods have recently received increasing attention as algorithms for edge-preserving or sparsity-promoting regularizations in image analysis. The inversion of forward operators can be avoided in inexact Uzawa approaches. The efficiency in terms of iteration number and computation time is related to splitting and preconditioning techniques. We study potential applications of the algorithm in biomedical image analysis.

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MS23
Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS23

Bregmanized Operator Splitting with Variable Stepsize: Convergence Analysis and MRI Application

This paper develops a Bregman operator splitting algorithm with variable stepsize (BOSVS) for solving problems of the form $\min\{\phi(Bu) + 1/2\|Au - f\|_2^2\}$, where ϕ may be nonsmooth. The original Bregman Operator Splitting algorithm employed a fixed stepsize, while BOSVS uses a line search to achieve better efficiency. These schemes are applicable to total variation (TV)-based image reconstruction. The stepsize rule starts with a Barzilai-Borwein (BB) step, and increases the nominal step until a termination condition is satisfied. The stepsize rule is related to the scheme used in SpaRSA (Sparse Reconstruction by Separable Approximation). Global convergence of the proposed BOSVS algorithm to a solution of the optimization problem is established. BOSVS is compared with other operator splitting schemes using partially parallel magnetic resonance image reconstruction problems.

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MS23

Smoothed Sparse Optimization

It is well known that minimizing $\|x\|_1$ subject to $Ax = b$ tends to give a sparse solution while minimizing $\|x\|_2^2$ give a dense solution. We show that minimizing the augmented L1 objective $\|x\|_1 + \frac{1}{2\alpha}\|x\|_2^2$, where $\frac{1}{2\alpha}$ is an appropriately small weight, can efficiently recover sparse vectors with provable recovery guarantees that are similar to those known for pure L1 minimization. For compressive sensing, the above augmented L1 minimization has exact and stable recovery guarantees given in terms of the null-space property, restricted isometry property, spherical section property, and RIPless property of the sensing matrix A. Most of these properties also hold for minimizing $\|X\|_* + \frac{1}{2\alpha}\|X\|_F^2$, for recovering low-rank matrices. Moreover, we show that the dual problems of various augmented L1 minimization problems, after simplification, are convex, unconstrained, and differentiable; hence, they enjoy a rich set of classical techniques such as gradient descent, line search, Barzilai-Borwein steps, quasi-Newton methods, and Nesterovs acceleration, which do not directly apply to L1 minimization or its dual. We show that the gradient descent iteration is globally linearly convergent, and we give an explicit rate. This is the first global linear convergence result among the gradient-based algorithms for sparse optimization.

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MS25

Implementation of a Block Decomposition Algorithm for Solving Large-scale Conic Optimization Problems

A recent work by Monteiro and Svaiter studied the iteration complexity of block decomposition methods for solving monotone variational inequalities and convex optimization problems. In this talk we review these methods and their corresponding complexity bounds. We also report very encouraging computational results comparing our methods with the second order algorithm SDPNAL (X. Zhao, D. Sun, and K. Toh) and the boundary point method introduced by J. Povh, F. Rendl, and A. Wiegele. The results obtained on a varied collection of large-scale conic problems consisting of both nonnegative vector and/or positive semidefinite matrix variables are quite promising.

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MS25

Primal-dual Splitting, Recent Improvements and Variants

In this work, first-order primal-dual algorithms are studied to solve a certain class of convex optimization problems with known saddle-point structure.

$$\min_{x\in X}\max_{y\in Y}\langle Kx, y\rangle + G(x) - F^*(y),$$

where X and Y are finite-dimensional vector spaces equipped with standard inner products $\langle\cdot,\cdot\rangle$, $K : X \to Y$ is a bounded linear operator and G and F are lsc proper convex functions with known structure. We also discuss some variants of the basic algorithm, as well as recent improvements based on preconditioning techniques.

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MS25

Smoothing and First Order Methods: A Unified Framework

We propose a unifying framework that combines smoothing approximation with fast first order algorithms for solving nonsmooth convex minimization problems. We prove that independently of the structure of the convex nonsmooth function involved, and of the given fast first order iterative scheme, it is always possible to improve the complexity rate and reach an $O(\varepsilon^{-1})$ efficiency estimate for the original nonsmooth problem, by solving an adequately smoothed approximation counterpart. Our approach relies on the combination of the notion of smoothable functions that we introduce with a natural extension of the Moreau-infimal convolution technique along with its connection to the smoothing mechanism via asymptotic (recession) functions. This allows for clarification and unification of several issues on the design, analysis, and the potential applications of smoothing methods when combined with fast first order algorithms.

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MS26

Aggregation Methods for Optical Flow Computation

Global variational methods for optical flow estimation suffer from an over-smoothing effect due to the use of coarse-to-fine schemes. We propose a semi-local estimation framework designed to integrate and improve any variational method. The idea is to implicitly segment the minimization domain into coherently moving patches. First, semi-local variational estimations are performed in overlapping square patches. Then, a global discrete optimization, based on an aggregation scheme and not prone to over-smoothing, selects for each pixel the optimal motion vector from the ones estimated at the preceding stage. The overall computation framework is simple and can be straightforwardly parallelized. Experiments demonstrate that this novel approach yields better results than the baseline global variational method: more accurate registration is globally achieved and motion discontinuities are sharpened.

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MS26

The Pat(c)h Ahead: A Wide-Angle View of Image Filtering

Filtering 2- and 3-D data (i.e. images and video) is fundamental and common to many fields. From graphics, machine vision and imaging, to applied mathematics and statistics, important innovations have been introduced in the past decade which have advanced the state of the art in applications such as denoising and deblurring. While the impact of these contributions has been significant, little has been said to illuminate the relationship between the theoretical foundations, and the practical implementations. Furthermore, new algorithms and results continue to be produced, but generally without reference to fundamental statistical performance bounds. In this talk, I will present a wide-angle view of filtering, from the practical to the theoretical, and discuss performance analysis and bounds, indicating perhaps where the biggest (if any) improvements can be expected. Furthermore, I will describe various broadly applicable techniques for improving the performance of **any** given denoising algorithm in the mean-squared error sense, without assuming prior information, and based on the given noisy data alone.

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MS26

Poisson Noise Reduction with Non-local PCA

Photon limitations arise in spectral imaging, nuclear medicine, astronomy and night vision. The Poisson distribution used to model this noise has variance equal to its mean so blind application of standard noise removals methods yields significant artifacts. Recently, overcomplete dictionaries combined with sparse learning techniques have become extremely popular in image reconstruction. The aim of the present work is to demonstrate that for the task of image denoising, nearly state-of-the-art results can be achieved using small dictionaries only, provided that they are learned directly from the noisy image. To this end, we introduce patch-based denoising algorithms which performs an adaptation of PCA (Principal Component Analysis) for Poisson noise. We carry out a comprehensive empirical evaluation of the performance of our algorithms in terms of accuracy when the photon count is very low. The results reveal that, despite its simplicity, PCA-flavored denoising appears to be competitive with other state-of-the-art denoising algorithms. Joint work with C-A. Deledalle, R. Willet and Z. Harmany.

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MS26

Getting It Right: Parameter Selection ForNon-Local Means Using Sure

Non-local means (NLM) is an effective denoising method that applies adaptive averaging based on similarity between neighborhoods in the image. An attractive way to both improve and speed-up NLM is by first performing a linear projection of the neighborhood. One particular example is to use principal components analysis (PCA) to perform dimensionality reduction. However, tuning the various parameters of the algorithm is a difficult problem due to their data dependency; e.g., width of the smoothing kernel, size of the neighborhood, dimensionality of the subspace when using PCA. To tackle this problem, we have derived an explicit analytical expression for Stein's unbiased risk estimate (SURE) in the context of NLM with linear projection of the neighborhoods. The SURE-NLM allows to monitor the MSE for restoration of an image corrupted by additive white Gaussian noise without knowledge of the noise-free signal. Moreover, the SURE comes with low computational cost. The SURE-NLM can then be used to optimize the parameters by combining it with a search algorithm in the parameter space. We propose an alternative based on the principle of linear expansions of multiple NLMs, each with a fixed parameter set, for which the optimal weights can be found by solving a linear system of equations. The experimental results demonstrate the accuracy of the SURE and its successful application to tune the parameters for NLM.

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MS27

Fast Algorithms for 4D Biophysically-constrained Image Registration

In my talk, I will discuss constrained variational methods for image registration. Variational methods have been quite successful in medical imaging, in particular in registration and segmentation. Examples include snakes, deformable registration, and level set methods. Biophysically constrained variational methods are image processing techniques that use prior knowledge related to the physiology (mechanics, biochemistry, electrophysiology) of the imaged tissue. The target application I consider in this talk is an image registration problem of MR images of patients with brain tumors. The goal of the image analysis is the characterization of the tumor aggressiveness and the construction of statistical atlases. The biophysical constraints are related to conservation laws that model soft tissue deformations and tumor growth. I will describe the details of the algorithms used in the analysis and present results on synthetic and clinical datasets.

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MS27

Numerical Techniques for Structural and Joint Inversion

When recovering a model function from noisy incomplete data, the problem is typically ill-posed, i.e. the solution is not unique and discontinuous with respect to data perturbations. Here, we propose a novel method for incorporating structural information into the model. We assume that the structure $s(x)$ is aligned with the model $m(x)$, and discuss the incorporation of structure in inverse problems and joint inversion, while using stable and efficient numerical implementation of such algorithms.

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MS27

Large scale Imaging on Current Many-Core Platforms

Today it is possible to solve medium size 3D or 4D imaging problems on modern computer architectures like GPUs in a few seconds. For the class of variational methods that require often the solution of a global, nonlinear optimization problem we show efficient parallel solution strategies, where a core part are numerical solvers like multigrid. We have incorporated imaging applications like image registration in our WaLBerla framework and show results on 3D medical data sets.

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MS27

Image-Based Modelling of Brain Tumour Progression: From Individualization to Priors for Non-Rigid Image Registration

In the present talk we will discuss modelling brain tumour progression on a tissue level. Such models have not only been designed to enable prediction of growth patterns in individual patients but also have evolved to a powerful tool to assist non-rigid image registration. We will discuss different flavours of models against such an area of application. As for the plain modelling approaches we will in particular focus on challenges posed to model individualization.

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MS28

Respiratory Signal Extraction from X-ray Projection Images in 4D Cone Beam CT

Patient respiratory signal is useful for the reconstruction of 4D cone beam CT. This talk will present a method to extract this signal from x-ray projection images. We noticed that these projections correspond to points along a helical trajectory on a torus surface. Principle component analysis is utilized on projections close to each other to find a signal corresponds to these projections. Global signal is obtained by combining all local signals.

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MS28
Rosian Noise Removal on HARDI Data in Medical Imaging

High Angular Resolution Diffusion Imaging (HARDI) data of the brain contain noise that prevents us from accurately extracting fiber pathways in the brain. In this work, we present a variational denoising model to denoise HARDI data corrupted by Rician noise. Our proposed model considers the Rician distribution of noise explicitly suggested by the underlying structure. Existence of a minimizer is discussed and numerical experiments are performed on three types of data: 2D synthetic data, 3D diffusion-weighted Magnetic Resonance Imaging (DW-MRI) data of a hardware phantom containing synthetic fibers, and 3D real HARDI data. Experiments show that our model is effective for denoising HARDI-type data while preserving important aspects of the fiber pathways such as fractional anisotropy (FA) and the orientation distribution functions (ODF).

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MS28
Laplace-Beltrami Eigen-Geometry and Applications to 3D Medical Imaging

Rapid development of 3D data acquisition technologies stimulates researches on 3D surface analysis. Intrinsic descriptors of 3D surfaces are crucial to either process or analyze surfaces. In this talk, I will present our recent work on 3D surfaces analysis by using Laplace-Beltrami (LB) eigensystem. The intrinsically defined LB operator provides us a powerful tool to study surface geometry through its LB eigen-system. By combining with other variational PDEs on surfaces, I will show our results on skeleton construction, feature extraction, pattern identification and surface mapping in 3D brain imaging by using LB eigen-geometry. The nature of LB eigen-system guarantee that our methods are robust to surfaces rotation and translation variations.

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MS28
Conformal Metric Optimization on Surface (CMOS) for Deformation and Mapping in Laplace-Beltrami Embedding Space

In this work we develop a novel technique for surface deformation and mapping in the high-dimensional Laplace-Beltrami embedding space. The key idea of our work is to realize surface deformation in the embedding space via optimization of a conformal metric on the surface.

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MS29
Velocity Continuation

Seismic reflection imaging, also known as seismic migration, requires estimation of velocity parameters. Velocity continuation is a process of seismic image transformation with changes in migration velocity. In the simplest case of zero-offset continuation, the process can be described by a hyperbolic PDE, extended recently to the 3-D multiazimuth case. In more complex cases (prestack velocity continuation in common-offset, common-shot or common-angle domain), the process requires pseudo-differential operators. I will describe novel extensions of the velocity continuations theory to a number of important practical cases as well as novel numerical methods for implementing velocity continuation operators in practice. A lowrank approximation of the wave extrapolation symbol leads to efficient spectral and finite-difference methods for practical velocity continuation.

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MS29
Time-Lapse Image-Domain Wavefield Tomography

Time-lapse seismic analysis is very successful at capturing detailed reservoir changes (e.g., pressure, saturation, fluid flow). Conventional 4D analyses involve linearized inversion about constant baseline models. However, linearity is violated where reservoirs are significantly altered by production/injection that generate complex 4D coda. These situations necessitate more robust depth-based wave-equation imaging and velocity analyses. We demonstrate this approach in a synthetic CO2 geosequestration experiment by inverting for slowness perturbations introduced by injecting a thin CO2 layer.

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MS29
Applying Gauss-Newton and exact Newton methods to Full Waveform Inversion

In the past years, Full Waveform Inversion (FWI) has been mainly based upon preconditioned non-linear conjugate gradient methods. We investigate here the application of Gauss-Newton and exact Newton methods to FWI, in a Newton-Krylov matrix free framework. This is achieved through second order adjoint state method formula for the computation of Hessian-vector products. Then two questions are considered: How to find adaptive stopping crite-

rion for the inner Krylov solver? How to efficiently precondition the inner linear systems.

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MS29
Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS30
Online Subspace Estimation and Tracking from Incomplete and Corrupted Data

Low-dimensional linear subspace approximations to high-dimensional data are useful for handling problems of estimation, detection and prediction, with applications such as network monitoring, collaborative filtering, object tracking in computer vision, and environmental sensing. Corrupted and missing data are the norm in many high-dimensional situations, not only because of errors and failures, but because it may be impossible to collect all the interesting measurements or impractical to compute in real-time using all the data available. Recently developed algorithms for "Matrix Completion" and "Robust PCA" have offered tools to find low-dimensional approximations to data even when data are missing and corrupted. However, these algorithms operate on all the available data at once and assume that the underlying low-dimensional subspace remains constant. In this talk I will describe two alternatives, a subspace tracking algorithm called GROUSE (Grassmannian Rank-one Update Subspace Estimation) and its robust counterpart GRASTA (Grassmannian Robust Adaptive Subspace Tracking Algorithm). Both are incremental algorithms that process one incomplete and/or corrupted measurement vector at a time. Thus GROUSE and GRASTA operate with considerably less computation than the other algorithms, while at the same time allowing flexibility for real-time applications such as tracking and anomaly detection. I will present these algorithms, discuss their relationship to LMS subspace tracking algorithms familiar to those in signal processing, and show their application to matrix completion, robust PCA, and background and foreground separation in video surveillance.

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MS30
On the Use of Low-rank Regularization for Learning Graphical Models with Missing Data

Gaussian graphical models have been quite popular for modeling joint distributions over real-valued random variables, where the association structure among the random variables is also of interest. They are specified by an undirected graph, and represent the set of multivariate Gaussian distributions whose inverse covariance matrices have support matching the undirected graph. Recovering this underlying graph structure when given limited samples is thus an important task in many of the applications of Gaussian graphical models. In many settings however, and in biological settings in particular, the data is not fully observed: samples have incomplete and potentially differing sets of covariates. In this talk, we consider the task of recovering graphical model structure under such missing data settings. We propose a novel M-estimator with regularization corresponding to sums of structure-inducing functions, where each such function encourages heterogeneous structure corresponding to the sum of a low-rank and a sparse matrix. We provide strong statistical and empirical guarantees for the performance of this M-estimator.

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MS30
PCA with Outliers and Missing Data

In the standard form, PCA involves organizing data into a matrix where columns represent the points, and rows the features. We consider PCA in a challenging setting where there are outliers (i.e. some columns are completely arbitrary), and most data is missing (i.e. most elements of the matrix are not observed). We propose a recovery method based on convex optimization, and provide analytical guarantees on when it is able to both (a) recover the low-rank matrix, and (b) identify the outliers. These tasks are challenging for other methods, because they are coupled and have to be performed jointly.

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MS30

A Novel M-Estimator for Robust PCA

We formulate a convex minimization to robustly recover a subspace from a contaminated data set, partially sampled around it, and propose a fast iterative algorithm to achieve the corresponding minimum. We establish exact recovery by this minimizer, quantify the effect of noise and regularization, explain how to take advantage of a known intrinsic dimension and establish linear convergence of the iterative algorithm. Our minimizer is an M-estimator. We demonstrate its significance by adapting it to formulate a convex minimization equivalent to the non-convex total least squares (which is solved by PCA). We compare our method with many other algorithms for Robust PCA on synthetic and real data sets and demonstrate state-of-the-art speed and accuracy.

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MS31

A Primal Dual Method for Solving a Convex Model for DOAS Analysis

We propose a variational model for differential optical absorption spectroscopy (DOAS) analysis that differs from previous approaches in that it is a convex model which also couples the estimation of fitting coefficients, background subtraction, wavelength misalignment and noise. DOAS is a technique for using Beer's Law to estimate concentrations of gases by fitting a combination of their characteristic absorption spectra to light intensity measurements taken over a range of wavelengths. We show how to efficiently solve our model using primal dual methods. Additionally, we use this example to illustrate the importance of preconditioning for improving the rate of convergence.

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MS31

Nonsmooth Image Reconstruction Algorithms and Their Applications in Partially Parallel MR Imaging

Image reconstructions with nonsmooth regularization (e.g. total variation) are capable to recover intrinsic sparsity of images for well preserved edges etc. We introduce a series of numerical algorithms that can effectively solve these nonsmooth minimization problems, which may involve much general data fitting terms with arbitrary sensing matrices and non-Gaussian noises. Results on clinical partially parallel MRI are shown to demonstrate their effectiveness. Convergence analysis and extensions to non-convex regularization will be discussed.

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MS31

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MS31

A Primal Dual Method for Nonconvex Problems and Applications

We show the primal dual method studied in E. Esser, X. Zhang, and T. F. Chan, *A General Framework for a Class of First Order Primal- Dual Algorithms for Convex Optimization in Imaging Science*, SIAM J. Imaging Sci. Volume 3, Issue 4, pp. 1015-1046, 2010, which is an efficient method for minimizing large non-differentiable convex functions, can also be a practical method for minimizing certain large non-differentiable nonconvex functions for which the nonconvex component is smooth and can be made strongly convex by the addition of a quadratic. We focus on applications where we want to increase the sparsity of a variable that is constrained to be nonnegative and sum to one. Instead we choose to encourage sparsity by adding a concave quadratic function to an otherwise convex function. In particular, we show how to apply this strategy to multiphase segmentation and nonlocal patch-based inpainting problems.

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MS32

Inverse Transport Problems in Remote Sensing Applications

We consider the reconstruction of inclusions in a scattering atmosphere from remote measurements of light, whose propagation is modeled by a transport equation. This ill-posed problem is solved using a Bayesian framework to prescribe measurement errors and prior assumptions. The posterior distribution is sampled by using a novel Markov Chain Monte Carlo called MC^3. We use a Monte Carlo path recycling strategy to significantly speed up costly forward transport simulations. Numerical simulations are

presented.

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MS32

Edge-preserving Super-resolution via Blind Deconvolution and Upsampling

We consider the super-resolution model introduced by S.J. Osher and this author in J. Sci. Comput., 2008 consisting of the solution of a total-variation based variational problem that solves a linear degradation model involving a convolution operator and a down- sampling operator. In this research work we explore different edge preserving up/down-sampling operators with different orders of spatial accuracy and different convolution operators to remove motion blur from degraded low resolved images. Some numerical examples are provided to show the features of the proposed algorithm.

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MS32

Patch-based Locally Optimal Denoising

We formulate the fundamental limits of image denoising using a statistical framework. Next, we propose a practical algorithm with the explicit aim of achieving the bound. The proposed method is a patch-based Wiener filter that takes advantage of both geometrically and photometrically similar patches. The resultant approach has a solid statistical foundation while producing denoising results that are comparable to or exceeding the current state-of-the-art, both visually and quantitatively.

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MS32

Texture Adaptive Image Restoration Using Fractional Order Regularization

We present an adaptive strategy for the restoration of images contaminated by blur and noise that allows to preserve textures. Total Variation regularization has good performance in noise removal and edge preservation but lacks in texture restoration. According to a texture detection strategy, we apply fractional-integer order diffusion. This can be related to a weighted norm regularization. A fast algorithm based on the half-quadratic technique is used. Numerical results show the effectiveness of our strategy.

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MS33

Forward-backward Splitting and Proximal Alternating Methods for Nonconvex Nonsmooth Tame Problems

In view of the minimization of a nonsmooth nonconvex function f, we present an abstract convergence result for descent methods satisfying a sufficient-decrease assumption, and allowing a relative error tolerance. Our result guarantees the convergence of bounded sequences, under the assumption that the function f satisfies the Kurdyka-Lojasiewicz inequality. This general result allows to cover a wide range of problems, including nonsmooth semi-algebraic (i.e. polynomial-like) or tame minimization. The specialization of our result to different kinds of structured problems provides several new convergence results for inexact versions of the forward-backward splitting algorithm, gradient projection method, some proximal-like Gauss-Seidel methods, etc.. Our results are illustrated through feasibility problems, or iterative thresholding procedures for compressive sensing.

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MS33

Combinatorial Selection and Least Absolute Shrinkage via the CLASH Algorithm

The least absolute shrinkage and selection operator (Lasso) for linear regression exploits the geometric interplay of the ℓ_2-data error objective and the ℓ_1-norm constraint to arbitrarily select sparse models. Guiding this uninformed selection process with sparsity models has been precisely the center of attention over the last decade in order to improve learning performance. To this end, we alter the selection process of Lasso in this paper to explicitly leverage combinatorial sparsity models (CSMs) via the combinatorial selection and least absolute shrinkage (CLASH) algorithm. A highlight is the introduction of a new algorithmic definition of CSMs, which we dub as the Polynomial time Modular ϵ-Approximation Property (PMAPϵ). PMAPϵ enables us to determine the impact of approximate combinatorial projections within CLASH. We then provide concrete guidelines how to leverage sets with PMAPϵ within CLASH, and characterize CLASH's estimation guarantees as a function of ϵ as well as the set restricted isometry constants of the regression matrix. Finally, we present experimental results using both simulated and real world data to demonstrate the effectiveness of CLASH.

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MS33

A Memory Gradient Algorithm for Nonconvex Regularization with Applications to Image Restoration

A memory gradient algorithm for non-convex regularization with applications to image restoration. Abstract: In this work, we consider a class of non-convex differentiable penalty functions for image recovery problems. The regularization is applied to a linear transform of the target image. As special cases, it includes edge preserving measures or frame analysis potentials. We develop a new Majorize-Minimize memory gradient algorithm for solving the non-convex minimization problem. The use of proximal tools allows us to consider the case of non-differentiable terms arising in the objective function. The convergence of the algorithm is investigated by using recent results in non-convex optimization. The fast convergence properties of the proposed optimization algorithm are illustrated through image processing examples.

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MS33

High-order Methods for Sparse Signal Recovery

Forward-backward splitting is a common way of solving non-differentiable problems. In this talk, we introduce an acceleration step that can be added to forward-backward splitting which implicitly performs conjugate gradient acceleration. In most situations, this method finds the exact solution to an L1 regularized minimization in a finite number of steps. This is done by exploiting the fact that, when recovering a sparse signal, the basis pursuit problem is equivalent to a quadratic minimization problem involving a low-rank matrix. The novel method takes advantage of this property by applying a conjugate gradient partan scheme to the underlying low-rank problem. This new algorithm has several advantages over other basis-pursuit schemes. In particular, it requires no time-step parameters as input, and the speed of the algorithm is almost completely insensitive to the condition number of the problem. This allows for the fast solution of basis pursuit problems involving convolution, orthogonal, and random matrices.

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MS34

A Generalized Tree-Based Wavelet Transform and Its Application to Patch-Based Image Denoising

What if we take all the overlapping patches from a given image and organize them to create the shortest path by using their mutual distances? This suggests a reordering of the image pixels in a way that creates a maximal 1D regularity. Could we repeat this process in several 'scales'? What could we do with such a construction? In this talk we consider a wider perspective of the above line of questions: We introduce a wavelet transform that is meant for data organized as a connected-graph or as a cloud of high-dimensional points. The proposed transform constructs a tree that applies a 1D wavelet decomposition filters, 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 vertices are obtained by Euclidean distances between corresponding patches. State-of-the-art image denoising results are obtained with the proposed scheme. Joint work with Idan Ram and Israel Cohen, Electrical Engineering Department - Technion.

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MS34

Matching By Tone Mapping

A fast pattern matching scheme termed Matching by Tone Mapping (MTM) is introduced which allows matching under non-linear tone mappings. We exploit the recently introduced Slice Transform to implement a fast computational scheme requiring computational time similar to the fast implementation of Normalized Cross Correlation (NCC). In fact, the MTM measure can be viewed as a generalization of the NCC for non-linear mappings and actually reduces to NCC when mappings are restricted to be linear. The MTM is shown to be invariant to non-linear tone mappings, and is empirically shown to be highly discriminative and robust to noise.

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MS34

Analysis of Image Patches: A Unified Geometric Perspective

Recent work in computer vision and image processing indicates that the elusive quest for the "universal" transform has been replaced by a fresh perspective. Indeed, researchers have recently proposed to represent images as a "collage" of small patches. The patches can be shaped into square blocks or into optimized contours that mimic the parts of a jigsaw puzzle. These patch-based appearance models are generative statistical models that can be learned from an image or a set of images. All these patch-based methods implicitly take advantage of the following fact: the dataset of patches, whether it is aggregated from a single image, or a library of images, is a smooth and low dimensional structure. In this work, we propose a unifying geometric theory to explain the success of patch-based method in image processing. In addition, we explain how geometric information such as tangent plane and curvature in patch-space can be used to process images in an optimal manner. This is a joint work with D.N. Kaslovsky, and B. Wohlberg.

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MS34

Patch Based Image Denoising With and Without Dictionary Learning

Patch based image processing has proved to be very effective for denoising. By exploiting the image nonlocal redundancy, some representative patch based methods such as BM3D have achieved state-of-the-art denoising results. In this talk, we will discuss the role of dictionary learning in patch-based image denoising (PID), and compare the denoising performance with and without dictionary learning. In the case of PID with dictionary learning, the dictionary can be pre-learned from clean example images, or it can be learned online from the noisy image, while the dictionary can be orthogonal or non-orthogonal. In the case of PID without dictionary learning, an analytically pre-designed dictionary such as DCT bases and wavelet/curvelet bases can be used, or the noisy patches themselves are directly used as a dictionary. In this talk, we will present extensive experiments to compare the various schemes, analyze their pros and cons, and discuss the future development of PID.

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MS35

Free Form Deformations with Dense Control Point Spacing for Image Registration

B-spline free form deformations (FFDs) have long been used in image registration because they provide a naturally intuitive parameterization in terms of control point displacements. However, the typical formulation of image registration as an optimization problem limits the density with which contol points can be defined. In this talk, we show how formulating the image registration problem in terms of an approximate solution to the Euler-Lagrange equations over the B-spline basis enables FFD-based image registration that is computationally efficient when the control point spacing approaches the density of the voxel spacing.

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MS35

Matrix Factorization Techniques for Multivariate Imaging Analysis

Contemporary neuroscientists typically collect a wealth of measurements on relatively few subjects. Studies are therefore usually underpowered. There is a pressing need for automated tools that are able to identify a reduced set of multidimensional salient features that drive the neurobiological mechanisms of disease, behavior and development. This talk will discuss some multivariate methods for computing the statistical comparisons commonly needed by population studies in medical imaging.

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MS35

Image Processing with Stochastic PDEs

We discuss methods based on stochastic PDEs (SPDEs) for the processing of images and image sequences with uncertain gray values resulting from measurement errors and noise. Our approach yields a reliable precision estimate for the image processing results. The ansatz space for such 3D and 4D images identifies gray values with random variables. The generalization of classical PDE image processing in this context leads to SPDEs which we discretize with the generalized polynomial chaos expansion and the generalized spectral decomposition method.

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MS35

4D Image Based Parameter Estimation of Vascular Properties

Non-invasive estimation of some properties of arterial tissues such as compliance can be obtained by medical images, solving inverse fluid-structure interaction (FSI) problems. After the 4D registration of time snapshots providing the displacement field of the wall, the parameter of interest minimizes the misfit between data and simulation under the constraint of the FSI problem, whose effective numerical solution raises several challenges. We address in particular the model reduction for the FSI problem.

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MS36

Progress with Classification of Cryo-EM Data by Manifold Embedding and Other Techniques

Single-particle data acquired by low-dose cryo-EM of macromolecules often exhibit heterogeneity, due to the coexistence of different states. In our efforts to develop and apply techniques of unsupervised classification, we are following three paths: (i) the maximum-likelihood method, (ii) the bootstrap reconstructions method, and (iii) manifold embedding. For manifold embedding, encouraging results have been obtained with simulated data, but experimental cryo-EM data still face difficulties due to the large size of the parameter space and the need for its fine sampling.

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MS36

Resampling-based Assessment of Variability in 3D Reconstructions of Biological Molecules

In cryo-electron microscopy biological macromolecules are captured in their native environment and their structure is preserved. It is thus possible to study dynamical effects of different functional states. These effects can be quantitatively characterized by the variance/covariance matrix of the 3D mass distribution of the structure. Nevertheless, as the data is available as projections of the macromolecule formed in the electron microscope, we address the problem using a stratified resampling technique.

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MS36

Viewing Direction Estimation in cryo-EM Using Synchronization

We present a noise-robust synchronization-based algorithm for determining the unknown viewing directions of cryo-EM images. Information about the spatial relation between pairs of images is first extracted using common lines between triplets of images, and then encoded in a specially designed matrix. In the noise-free case, this matrix is shown to have rank 3, and its non-trivial eigenspace is shown to reveal the projection orientations of all images.

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MS36

A Fourier-based Approach for Iterative 3D Reconstruction from Cryo-EM Images

In this talk, we focus on the 3D reconstruction problem from cryo-EM images assuming an existing estimate for their orientations and positions. We propose a fast and accurate Fourier-based Iterative Reconstruction Method (FIRM) that exploits the Toeplitz structure of the composition of a forward-projector and its back-projector. FIRM is fast and accurate compared with current methods. Moreover, FIRM combines images from different defocus groups simultaneously.

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MS37

Experimental Translation of Image Reconstruction Methods for Three-Dimensional Optoacoustic Tomography

In this work we implement and investigate the use of mathematically exact and iterative image reconstruction methods in 3D optoacoustic tomography (OAT). Accurate image models that incorporate the transducer response are utilized and the reconstruction algorithms are implemented using graphics processing units (GPUs) to alleviate the computational burden involved. The algorithms are applied to experimentally measured data acquired by use of a 3D OAT scanner and are evaluated by use of task-specific image quality metrics.

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MS37

Compressed Sensing and Photo-Acoustic Tomography

Photo-Acoustic Tomography (PAT) with dense arrays of detectors allows the reconstruction of high-resolution three-dimensional images of acoustic pressure corresponding to absorption of light in tissue. Current systems are quite slow to acquire a full data set, so dynamic studies are limited. In this talk I will discuss a new approach for acquiring a compressed set of data and thus to allow feasible reconstruction of four-dimensional images.

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MS37

Noise in Photoacoustic Tomography: From Point-like Detectors to Large integrating Detectors and its Influence on Spatial Resolution and Sensitivity

For photoacoustic tomography point-like detectors are not ideal at all: because of the small detector volume the thermodynamic fluctuations (= noise) get high and the signal amplitude is low, which results in a bad signal-to-noise ratio. But for a bigger detector volume the signal is averaged over the whole detector volume, which results in blurring of the reconstructed image. To describe this trade-off between spatial resolution and sensitivity for a varying detector volume in a quantitative way the pressure is described by a stochastic process.

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MS37

Gradient-based Inversion for 3D Quantitative Photoacoustic Imaging

The main aim in quantitative photoacoustics is to recover accurate estimates of the chromophore concentration distributions from photoacoustic images, thereby broadening the range of clinical and preclinical applications of photoacoustic imaging. The images are dependent on the tissue optical properties and the distribution of light, both of which are dependent on the tissue chromophores, and the problem is generally nonlinear, ill-posed and large-scale. Here we discuss the recent progress on solving this optical inverse problem.

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MS38

Migration Based on Two-way Depth Extrapolation

We discuss a new family of methods for migration and velocity analysis based on two-way depth extrapolation of seismic data. By using spectral projectors to avo id ill-posedness of two-way depth extrapolation, we maintain quality of imaging of steep features in arbitrary complicated background medium. Our method allows us to downward continue temporal frequency bands independently, thus opening the door for effective velocity analysis.

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MS38

Seismic Full Waveform Inversion, Recent Works and Research Directions

Seismic Full Wave Inversion (FWI) is very promising for estimating subsurface structure for O&G industry, but many questions are still open such as how to handle features unexplained by the forward model, the domain of integration, the choice of the initial model, the lack of low frequencies in the data... In this presentation we will present some recent work done in FWI and some research directions we are exploring for solving these challenging problems.

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MS38

Resolution Analysis in Full Waveform Inversion

We propose a new method for the quantitative resolution analysis in full seismic waveform inversion that overcomes the limitations of synthetic inversions while being computationally more efficient and applicable to any misfit measure. The method rests on a parametrised Hessian of the misfit functional that allows to extract various resolution proxies, including direction-dependent resolution lengths and the posterior covariance. We illustrate our method with a full waveform inversion for Europe and western Asia.

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MS38

Dreamlet as a Physical Wavelet for Seismic Data Compression and Imaging

Seismic data are special data sets and they cannot fill the 4-D space-time in ar bitrary ways. The time-space distributions must observe causality which is roote d from the wave equation. Wave solutions can only exist on the light cone in the 4D Fourier space. Dreamlet is a type of physical wavelet defined on an observat ion plane (earth surface or a plane at depth z during extrapolation). Causality (or dispersion relation) built into the wavelet (dreamlet) and propagator is a d istinctive feature of dreamlet. We will discuss the dreamlet decomposition of se ismic data and dreamlet imaging in the compressed domain by survey sinking migra tion.

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MS39

Code Design for Target Tracking and Discrimination

Patch based de-noising algorithms and patch manifold smoothing have emerged as efficient de-noising methods. This talk provides a new insight on these methods, such as the Non Local Means or the Image Graph De-noising, by showing its use for filtering a selected pattern. Applications to target tracking in compressively sensed imagery is discussed.

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MS39

Stability and Robustness of Weak Orthogonal Matching Pursuits

A recent result establishing, under restricted isometry conditions, the success of sparse recovery via Orthogonal Matching Pursuit using a number of iterations proportional to the sparsity level is extended to Weak Orthogonal Matching Pursuits. The new result also applies to a Pure Orthogonal Matching Pursuit, where the index appended to the support at each iteration is chosen to maximize the subsequent decrease of the squared-norm of the residual vector.

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MS39

Adaptive Compressive Imaging Using Sparse Hierarchical Learned Dictionaries

Recent results in compressive sensing (CS) have established that many high dimensional objects can be accurately recovered from a relatively small number of linear projection observations, provided that the objects possess a sparse representation in some basis. Subsequent efforts have shown that the performance of CS can be improved by exploiting structure that may exist in the sparse representation of the object being acquired (structured sparsity), or by some form of online focusing of measurements throughout the sensing process (adaptivity). Here we discuss a powerful hybrid of these two ideas. We describe a simple adaptive sensing procedure for acquiring objects that exhibit structured sparsity characterized by low-degree graph-based coefficient dependencies, and we demonstrate that representations exhibiting this form of structured sparsity can be learned from collections of training data using recently developed techniques from sparse hierarchical dictionary learning. The combination of these ideas results in an effective and resource-efficient adaptive CS procedure, which we demonstrate in the context of compressive imaging.

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MS39

Noval Measurements in Compressive Imaging

Compressive measurement focuses on making relatively few information-rich measurements, rather than many information-poor measurements; exploiting the prior knowledge that natural images are nearly always sparse/compressible in some domain. Knowledge-Enhanced Compressive Measurements amplify the benefits of compressive measurement by incorporating into the measurement process additional prior knowledge concerning (a) signal classes, (b) task requirements, and (c) adaptation. Incorporation of signal priors can be used to ensure that measurements do not waste resources measuring something that we already know; whereas, the inclusion of task priors facilitates extraction of only that information most important to the exploitation task. Adaptation promotes an increasingly efficient measurement process, incorporating knowledge from earlier experience.

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MS40

Image Restoration with Total Generalised Variation

We study the recently introduced total generalised variation functional (TGV) of arbitrary order which constitutes a well-suited convex model for piecewise smooth images. After recalling basic properties, well-posedness of TGV-regularised ill-posed inverse problems is discussed, generalising the results already obtained for the second order case. In particular, we examine spaces of symmetric tensor fields of bounded deformation which play a crucial rule for deriving these existence results. Finally, some extensions of the TGV functional are proposed and illustrated by numerical examples.

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MS40

Numerical Algorithms for Eulers Elastica Models in Image Processing

We introduce recently developed fast and efficient numerical algorithms to solve Euler's elastica models with applications to variational image denoising, image inpainting, and image zooming. Minimization problems are reformulated as constrained problems by a variable splitting method and relaxation technique. The proposed constrained minimization problems are solved by using an augmented Lagrangian approach. Numerical tests are demonstrated to show an efficiency of proposed method.

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MS40

A Variational Model for Functions of Bounded Hes-

sian - Theory, Numerics and Applications

We formulate a minimisation problem in the space of functions of bounded Hessian. We prove existence and uniqueness of solutions through a relaxation process and we implement our method numerically using a split Bregman technique. Our results suggest improvement in comparison to total variation denoising and deblurring in terms of the staicasing effect and creation of artifacts in the restored image.

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MS40

Infimal Convolution Regularizations with Discrete l_1-type Functionals

As first demonstrated by Chambolle and Lions, the staircasing effect of the Rudin-Osher-Fatemi model can be reduced by using infimal convolutions of functionals containing higher order derivatives. In this talk, we examine a modification of such infimal convolutions in a general discrete setting. For the special case of finite difference matrices, we show the relation of our approach to the continuous total generalized variation recently developed by Bredies, Kunisch and Pock. Moreover, we present splitting methods to compute the minimizers of the l_2^2 – (modified) infimal convolution functionals, which are superior to previously applied second order cone programming methods. Finally, the differences between the ordinary and the modified infimal convolution approach are illustrated by numerical examples.
This is joint work with Simon Setzer (Saarland University) and Gabriele Steidl (University of Kaiserslautern).

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MS41

The Adaptive Inverse Scale Space Method for Hyperspectral Unmixing

Hyperspectral unmixing describes the technique of finding the abundances (fractions) of certain endmembers (spectral signatures of materials) in a hyperspectral image. We will show that the so called inverse scale space flow yields improved results for the recovery of sparse abundance maps in comparison to ℓ^1 regularization. With the means of convex analysis we will develop a very efficient and adaptive numerical method to compute the solution to this flow exactly without discretization.

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MS41

L1 based Template Matching and its Application to Hyper Spectral Imaging

Abstract not available at time of publication.

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MS41

Structured Models for Inverse Problems

In this work we will describe advances in the area of hyperspectral image analysis with sparse modeling tools. In particular, models for sub-pixel classification and unmixing from partial data are discussed, and results are presented both for urban and non-urban data. This is joint work with Alexey Castrodad, Zhengming Xing, John Greer, Edward Bosch, and Lawrence Carin.

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MS41

Local Robust Principal Components for Nonlinear Datasets

A robust variant of Principal Components Analysis decomposes a data matrix into low rank and sparse components, the former representing a low-dimensional linear model of the data, and the latter representing deviations from the model. This decomposition can be useful, but is not appropriate when the data are not well modeled by a single low-dimensional subspace. We construct a new decomposition corresponding to a more general underlying model consisting of a union of low-dimensional subspaces.

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MS42

Inverse Scattering Problem for Inhomogeneous Media Containing Obstacles

We consider the scattering problem for an inhomogeneous (possibly anisotropic) dielectric media containing obstacles inside. Such a problem arises in non-destructive testing of inhomogeneous materials using electromagnetic interrogation. The goal is to obtain estimates on the material properties of the inhomogeneity and/or the geometrical properties of embedded obstacles. More specifically, we will discuss associated eigenvalue problems and show that the corresponding eigenvalues can be computed from the scattering data and provide information on the inhomogeneity-obstacle structure.

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MS42

A Mixed Formulation of the Quasi-reversibility Method to Solve Elliptic Cauchy Problems in 2d and 3d

We propose a new mixed formulation of the quasi-reversibility method to solve bidimensional and tridimensional Cauchy problems. Unlike the standard formulation of quasi-reversibility, this new formulation can be discretized using standard finite element spaces, which eases its numerical implementation. We illustrate the functionality of the method with the help of numerical experiments.

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MS42

Inverse Source Problems and the Windowed Fourier Transform

The reconstruction of time-harmonic acoustic or electromagnetic sources from measurements of the far field of the corresponding radiated wave is an ill-posed inverse problem with fascinating applications. Based on the observation that the windowed Fourier transform of the radiated far field is related to an exponential Radon transform of a smoothed approximation of the source, we present a filtered backprojection algorithm to recover information on the unknown source. We discuss this algorithm and present numerical results.

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MS42

A Monotony Based Method for Electrical Impedance Tomography

The aim of Electrical Impedance Tomography is to reconstruct the spatially perturbed conductivity of an object from current-voltage measurements on its boundary. We consider the localization of inhomogeneous conducting areas surrounded by a constant background conductivity. The introduced reconstruction method bases on a well-known monotony relation combined with a concept of localized potentials. We specially concentrate on fast implementations that stem from the recent result that linearization does not lead to shape errors.

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MS43

Analysis of a Variational Framework for Exemplar Based Image Inpainting

We discuss a variational framework for exemplar based image inpainting, in which both the reconstructed image u and the non-local weights w are treated as variables and updated using the variational formulation. This approach permits to draw relations with some existing inpainting schemes, in addition to leading to novel ones. We carry out an analysis of two of these schemes providing existence of the solution, regularity of the minima and convergence of the alternating scheme for the variables (u,w).

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MS43

Patch Foveation in Nonlocal Imaging

Patch-based nonlocal imaging methods rely on the assumption that natural images contain a large number of mutually similar patches at different locations within the image. Patch similarity is typically assessed through the Euclidean distance of the pixel intensities and therefore depends on the patch size: while large patches guarantee stability with respect to degradations such as noise, the mutual similarity that can be verified between pairs of patches tends to reduce as the patch size grows. Thus, a windowed Euclidean distance is commonly used to balance these two conflicting aspects, assigning lower weights to pixels far from the patch center. We propose patch foveation as an alternative to windowing in nonlocal imaging. Foveation is performed by a spatially variant blur operator, characterized by point-spread functions having bandwidth decreasing with the spatial distance from the patch center. Patch similarity is thus assessed by the Euclidean distance of foveated patches, leading to the concept of foveated self-similarity. In contrast with the conventional windowing, which is only spatially selective and attenuates sharp details and smooth areas in equal way, patch foveation is selective in both space and frequency. In particular, we present an explicit construction of a patch-foveation operator that, given an arbitrary windowing kernel, replaces the corresponding windowing operator providing equivalent at-

tenuation of i.i.d. Gaussian noise, yet giving full weights to flat regions. Examples of this special form of self-similarity are shown for a number of imaging applications, with particular emphasis on image filtering, for which we demonstrate that foveated self-similarity is a more effective regularity assumption than the windowed self-similarity in assessing the patch similarity in nonlocal means denoising.

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MS43

Optimal Transport Over the Space of Patches

In this talk, I will propose a new model for static and dynamic textures as a statistical distribution over the space of patches. This set of patches is described as a discretized manifold using a nearest neighbor graph. A library of textures defines a collection of high dimensional distributions. It is possible to navigate over the set of distributions using the machinery of optimal transport on the graph manifold. I will show several applications such as patch-based synthesis using optimal transport projection and texture mixing using geodesic transport interpolation.

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MS43

Learning to Sense GMMs

In this work we describe methodologies to design the sensing matrix for efficient coding and detection of signals that follow a Gaussian Mixture Model. We describe both off-line and on-line techniques, in particular, two-step approaches that first detect the correct model and then optimally sense for it. Joint work with J. Duarte-Carvajalino, G. Yu, and L. Carin.

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MS44

Regional Lung Perfusion Estimated by Electrical Impedance Tomography

In order to visualize blood perfusion from electrical impedance tomographic images, it is necessary to separate perfusion information from images that also contain ventilation and noise. Clinically, it must be done in real time. This separation is performed through real-time projection into a subspace of principal components of perfusion, recently estimated from the same individual. Some clinical examples are presented.

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MS44

Electrical Impedance Tomography and Ultrasound: Some Experiences

Abstract not available at time of publication.

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MS44

An Unscented Kalman Filter with an Approximation Error Model for Electrical Impedance Tomography

Kalman filters are suitable for Electrical impedance tomography dynamic imaging. Both evolution and observation models are required and Kalman filters performance depends on the quality of these models. In many applications, accurate models are unfeasible for the inverse problem and approximated models must be employed. To improve the accuracy of approximated models, the approximation error method can be used for estimating the statistics of the resulting errors. Once these statistics are estimated, the inverse problem can be solved leading to better performance.

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MS44

Prior Models of the Human Chest in Electrical Impedance Tomography

Prior information is important for solving inverse problems in many fields. Often, priors are available as subjective knowledge and translating these into classical regularization schemes can be cumbersome. Bayesian methods provide a statistical framework for inverse problems, stating the problem as finding the posterior probability density function conditioned to the acquired measurements. Under this framework, adding subjective prior information is often more straightforward. In this talk, prior models of the human chest for EIT are presented and included in a Bayesian algorithm.

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MS45

Detecting Molecular Symmetry and Shape Using Cryo-electron Microscopy, Geometry, and Group Representation Theory

I will explain an algorithm that analyzes the noisy Radon images of a molecule obtained using cryo-electron microscope. The output of the algorithm is the symmetry and shape of the molecule. This algorithm should be an alternative to existing algorithms that are not robust to noise, use some a priori assumptions on the shape of the molecule, or assume our ability to crystallize the molecule. The ideas behind the algorithm, use geometric and group representation theoretic tools.

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MS45

Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS45

Spherically Constrained Reconstruction in Cryo-EM

In this talk, I will consider the problem of reconstructing transmembrane proteins after they are embedded in a synthesized sphere. Such spherically constrained reconstruction offers the advantage of limiting the degrees of freedom in reconstruction and of reconstructing the embedded state of the protein.

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MS45

New Rotationally Invariant Viewing Direction Classification Method for Cryo-EM Single Particle Reconstruction

One of the challenges in Single Particle Reconstruction is to identify images of the same view and bring them into register without prior knowledge of the molecule. We propose a new rotationally invariant viewing direction classification method to deal with this problem. In this method, images of the same view are identified by direct cross-correlation of the bispectrum-like rotationally invariant features and the in-plane rotational alignment is done only among those of similar viewing direction.

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MS46

Robust Principal Component Analysis-based Four-dimensional Computed Tomography

The Robust Principle Component Analysis model to 4DCT. Instead of viewing 4D object as a temporal collection of three-dimensional (3D) images and looking for local coherence in time or space independently, we percept it as a mixture of low-rank matrix and sparse matrix and explore the maximum temporal coherence of spatial structure among phases. Here the low-rank matrix corresponds to the “stationary’ background or reference state in space over time, while the sparse matrix stands for the “moving’ or “changing’ components, (under some proper sparsifying transform,) e.g., tumors or organs in motion. Together with a dynamic data acquisition procedure, our method can potentially maintain the similar reconstruction accuracy while using fewer projections of the data, as this dynamic scheme can reduce the total number of measurements and hence the radiation dose by acquiring complementary data in different phases without redundant measurements of the common background structure.

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MS46

Fast Multiscale Reconstruction of Images from Compressed Sensing Data

In this paper, we introduce multi-scale methods for reconstruction of sparse signals and images from measurements in a transform domain (i.e. the signal is sampled in the Fourier, Hadamard, or wavelet domain). We will show how a decomposition can be used to form ”coarse-grid” versions of large-scale problems. These reduced formulations of the problem are then used to craft multi-scale solvers for signal reconstruction problems. These multi-scale solvers are unconditionally stable, and are much more efficient than conventional first-order methods.

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MS46

Surface Ricci Flow and its Applications

Hamilton’s Ricci flow deforms the Riemannian metric proprotional to the curvature, such that the curvature evolves like a heat diffusion process, and eventually curvature becomes constant everywhere. In this talk, the discrete theories and computational algorithms for surface Ricci flow will be explained in details. Its applications in medical imaging, computer vision, geometric modeling and wireless sensor networks will be briefly introduced.

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MS46

Solving Pdes on Pont Clouds

We present an efficient and accurate numerical method for solving PDEs on point clouds directly without a surface reconstruction. The method only need a local least square approximation of the surface in a local coordinate system to learn the local metric to discretize differential operators. We will show computation of eigenvalues and eigenfunctions of Laplace-Beltrami operator and other applications.

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MS47

Construction of Frames for Image Analysis and Representation

We propose a new method for constructing tight frames from a set of orthonormal vectors via upsampling and circular convolution. When the vectors satisfy an orthonormal wavelet condition the technique effectively characterizes variation information and removes polynomial trend in 1D and 2D data. We extend the applications of this new technique to image edge detection, image representation and reconstruction, and data reduction.

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MS47

Sparse Modeling for Human Activity Analysis in Motion Imagery

An efficient sparse modeling pipeline for the recognition of human actions for action-based summarization of video is here developed. Spatio-temporal features that characterize local changes in the image are first extracted. This is followed by the learning of a class-structured dictionary encoding the individual actions of interest. Recognition is then based on a tradeoff of sparsity and quality of reconstruction, where the labels assigned to localized video frames come from the optimal sparse linear combination of the learned basis vectors (action primitives) representing the actions. A low computational cost deep-layer model learning the interclass correlations of the data is added for increasing discriminative power. In spite of its simplicity, the method is capable of modeling complex human interactions, outperforming previously reported results.

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MS47

Frame Theory and Sparse Deterministic Representations for Image Applications

We show in this work novel Frame Theoretic techniques and algorithms that exploit geometric information for physical meaningful sparse deterministic representations of high dimensional hyperspectral data. The proposed theoretical developments are employed for the purposes of pixel classification.

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MS47

Evaluating Compressively Sensed Hyperspectral Imagery

We introduce a new family of algorithms for constructing HSI from CS measurements. These algorithms combine spatial Total Variation (TV) with smoothing in the spectral dimension. We examine models for three different CS sensors: the Coded Aperture Snapshot Spectral Imager-Single Disperser (CASSI-SD) [Wagadarikar et al.] and Dual Disperser (CASSI-DD) [Gehm et al.] cameras, and a random sensing model closer to CS theory, but not necessarily implementable with existing technology. We simulate the capture of remotely sensed images by applying the sensor forward models to well-known HSI scenes an AVIRIS image of Cuprite, Nevada and the HYMAP Urban image.

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MS47

A Convex Non-Negative Matrix Factorization and Dimensionality Reduction on Physical Space

A convex framework for factoring a data matrix X into a non-negative product AS, with a sparse coefficient matrix S is developed. The columns of the dictionary matrix coincide with certain columns of X, thereby guaranteeing a physically meaningful dictionary and dimensionality reduction. We focus on applications to hyperspectral and abundances identification.

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MS48

Adaptive Compressive Imaging: Information-theoretic Design

We describe an information-theoretic design framework for compressive measurement design that exploits the additional prior information beyond signal/image sparsity. The performance of information-optimal compressive measurements is compared with random projections based measurements for different system parameters (e.g. signal to noise ratio) and prior models. We also consider a mixture of Gaussian signal prior for adaptive compressive imaging design and quantify the performance improvement with respect to a static measurement scheme.

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MS48

Efficient 2-D Deconvolution for Filters Yielding Triangular Structure

In this work, we will show that certain type of 2D deconvolution operators can be inverted in $O(Nlog^2N)$ time. While such "superfast" solvers have been developed recently for Toeplitz matrices (1D convolution), it has proven difficult to date to extend these algorithms to multi-level Toeplitz structure (i.e. convolution in multiple dimensions). Our algorithms are fast and exact (requiring just a few FFTs if the kernel is known in advance), and work on 2-level Toeplitz matrices that are triangular on one or both of their levels.

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MS48

GMM for Audio Analysis

A framework for representing quasi-harmonic signals, and its application to score-informed single channel musical instruments separation, is introduced in this paper. In the proposed approach, the signals pitch and spectral envelope are modeled separately. The model combines parametric filters enforcing an harmonic structure in the representation, with Gaussian modeling for representing the spectral envelope. The estimation of the signals model is cast as an inverse problem efficiently solved via a maximum a posteriori expectation-maximization algorithm. The relation of the proposed framework with common non-negative factorization methods is also discussed. The algorithm is evaluated with both real and synthetic instruments mixtures, and comparisons with recently proposed techniques are presented. Extensions to speaker separation are presented as well.

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MS48

Managing Model Complexity in High Frame Rate Compressive Video Sensing

In compressive streaming measurement systems such as the "single-pixel" camera, video reconstruction can be particularly daunting, because one may record as little as one measurement per time instant. We describe a framework for managing the complexity of representing such high frame rate videos. We explain how this framework can be incorporated into compressive sensing reconstruction, and we discuss the implications and tradeoffs associated with spatial and temporal resolution and the speed of moving objects.

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MS49

High Order Models and Fast Algorithms for Fairing Variational Implicit Surfaces

We present two numerical algorithms to solve three related curvature-based high order models for surface fairing. The first, is a stabilized fixed-point algorithm already tested in image denoising and now adapted to solving 3D models. The second, is a modification of a two-step method used to solve one of the models and here generalised to solve the other two presenting the new algorithm in an unified numerical framework applicable to all three models. Details from http://www.liv.ac.uk/cmit

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MS49

Approximate Envelope Minimization for Higher-Order Models

We propose a general method for minimizing a non-convex function, that can be written as the sum of simple functions. The method minimizes a convex function that is obtained by constructing a local convex envelope of the original non-convex function. The obtained approximate convex envelope can be written as a linear program incorporating local polytopes. For numerical solution we adopt a recently proposed pre-conditioned first-order primal-dual algorithm. We show results on classical energy minimization problems including elastica minimization and stereo using a second order smoothness term.

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MS49

A Convex, Lower Semi-continuous Approximation of the Euler-elastica Functional

We propose a convex lower semi-continuous approximation of Euler's elastica energy to be used for regularization in image processing. The approximation is related to the convex relaxation, which however seems difficult to obtain (unless the total variation part of the elastica energy is neglected in which case the convex relaxation interestingly reduces to constantly zero). Our approximation arises via so-called functional lifting of the image gradient into a space which has the normal and curvature of the image level lines as additional coordinates, and it can be expressed as a linear program.

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MS49
The H^{-1} Norm of Tubular Neighborhoods of Curves and its Relation to the Elastica Energy

The H^{-1} norm appears frequently in variational models for pattern formation as well as in some models for image analysis. Because patterns and images often have structures that are localized around curves, it is of interest to know how the H^{-1} norm interacts with the geometry of the curve. With this goal in mind in this talk we will study

(a rescaled version of) the H^{-1} norm of the constant function 1 on tubular neighborhoods of curves. We prove two asymptotic expansions in the width of the neighborhood, that show that at lowest order the H^{-1} norm depends on the length of the curve, at the next order the open ends of the curve (which are absent for a closed curve) contribute, and the curvature squared appears in the third lowest order term. This last term implies a relation with the elastica functional. One of the asymptotic results is

a pointwise asymptotic expansion for a fixed smooth open or closed curve, the other result is a Gamma-convergence result where the (closed) curves along the sequence are allowed to vary. This is joint work with Mark A. Peletier

done while both authors were at Eindhoven University of Technology.

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MS50
Multiple-Input Multiple-Output Synthetic Aperture Radar Imaging

In this paper, multi-input multi-output (MIMO) forward looking synthetic aperture radar (FL-SAR) is developed for imaging from a moving ground vehicle in multipath environments. Synthetic aperture radar, commonly deployed on airborne platforms, is currently precluded on surface vehicles due to multipath imaging artifacts in complex terrain. In this paper, MIMO methods are used to improve SAR images by suppressing directions of departure which would otherwise be multipath scattered and added to direct path returns.

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MS50
Estimating Size, Shape, and Motion via Near-field Invariants of Radar Signals

Understanding range dependent signals (from radar, seismic, etc) leads to Euclidean geometry problems, which require the determination of geometric configurations from partial information. Methods of attack include coordinate based approaches, invariant equations, and matrix completions. The best methods with respect to computational complexity and sensitivity to noise, seem to be not yet discovered. Insights are being gained from experiments with algebraic solutions of invariant equations, numerical optimization methods, matrix completion methods, and fixed point iterations.

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MS50
Reducing the Ionospheric Distortions of Spaceborne SAR Images with the Help of Dual Carrier Probing

Spaceborne SAR images deteriorate because of the mismatch between the received signal (affected by the ionospheric dispersion) and the matched filter (taken as if the propagation was unobstructed). The filter can be adjusted by including the parameters of the ionosphere, which, in turn, can be obtained by probing the terrain on two carrier frequencies. We study robustness of this approach, and show that the quality of the images improves after the filter has been corrected.

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MS50
Polarimetric Synthetic-aperture Inversion for Extended Targets in Clutter

We present an analytic inversion scheme for polarimetric synthetic-aperture radar in the case of an extended target embedded in clutter. We use microlocal analysis in a statistical setting to develop filtered-backprojection-type reconstruction methods. We model scatterers as dipoles; a scattering matrix thus characterizes scatterers. We include directional scattering assumptions to distinguish an extended target from clutter. We choose the backprojection filter that minimizes the mean-square error between the image and the target scattering matrix.

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MS51

Approximate Marginalization Over Uncertainties in Electrical Impedance Tomography

Electrical impedance tomography, like other inverse problems, tolerates model uncertainties poorly. In biomedical problems, for example, the boundary of the domain is time-varying, and constructing the computational model using a nominal geometry typically results in meaningless conductivity estimates. Similarly, truncation of the computational domain usually has the same effect. We consider a Bayesian inversion approach which models the uncertainties as stochastic entities and uses a computationally efficient marginalization approach to recover from the uncertainties.

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MS51

Feasibility of Electrical Impedance Tomography Imaging for Non-destructive Testing of Concrete

Electrical Impedance Tomography (EIT) is an imaging modality in which the internal three-dimensional conductivity distribution of the target is reconstructed on the basis of electrical measurements acquired from the surface of the target. We have recently studied the feasibility of EIT for non-destructive testing of concrete. Especially we have considered the localization of reinforcing bars and the identification of cracks in concrete. The results indicate that EIT holds potential for the assessment of concrete structures.

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MS51

A Feynman-Kac-type Formula for Impedance Tomography

In this talk we consider current-to-voltage maps arising in the complete electrode model of impedance tomography. A generalization of the classical Feynman-Kac formula is established. Furthermore, we discuss the numerical computation of current-to-voltage maps by a Monte Carlo method derived from this representation formula. As an application we study the reconstruction problem in the Bayesian framework using a probabilistic forward model.

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MS51

Simultaneous Reconstruction of Outer Boundary Shape and Conductivity Distribution in Electrical Impedance Tomography

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 the object shape simultaneously. The functionality of the technique is demonstrated via numerical tests with experimental data.

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MS52

Efficient Spectral Clustering using Selective Similarities

Spectral clustering has been very successful at segmenting images based on non-local similarities between pixels. However in many applications, e.g. multi-scale clustering of fiber-tracks in the brain using high-resolution DSI images, computing similarities between all pixels can be very inefficient. We show that eigenvectors of hierarchically-structured high-rank similarity matrices can be recovered by selectively sampling only O(N log N) entries of the N x N matrix. This leads to very efficient hierarchical spectral clustering algorithms.

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MS52

Robust Locally Linear Analysis with Applications to Image Denoising and Blind Inpainting

I will talk about the problems of denoising images corrupted by impulsive noise and blind inpainting (i.e., inpainting when the deteriorated region is unknown). Our basic approach is to model the set of patches of pixels in an image as a union of low-dimensional subspaces, corrupted by sparse but perhaps large magnitude noise. For this purpose, we develop a robust and iterative method for single subspace modeling and extend it to an iterative algorithm for modeling multiple subspaces. I will also cover the convergence for the algorithm and demonstrate state of the art performance of our method for both imaging problems.

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MS52

Dictionary Learning by L1 Minimization

The idea that many important classes of signals can be well-represented by linear combinations of a small set of atoms selected from a given dictionary has had dramatic impact on the theory and practice of signal processing. For practical problems in which an appropriate sparsifying dictionary is not known ahead of time, a very popular and successful heuristic is to search for a dictionary that minimizes an appropriate sparsity surrogate over a given set of sample data. While this idea is appealing, the behavior of these algorithms is largely a mystery; although there is a body of empirical evidence suggesting they do learn very effective representations, there is little theory to guarantee when they will behave correctly, or when the learned dictionary can be expected to generalize. In this talk, we describe several steps toward such a theory. We show that under mild hypotheses, the dictionary learning problem is locally well-posed: the desired solution is indeed a local minimum of the L1 norm. Namely, if A is an incoherent (and possibly overcomplete) dictionary, and the coefficients X follow a random sparse model, then with high probability (A;X) is a local minimum of the L1 norm over the manifold of factorizations (A,X) satisfying $AX = Y$, provided the number of samples is sufficiently large. For overcomplete A, this is the first result showing that the dictionary learning problem is locally solvable. Our analysis draws on tools developed for the problem of completing a low-rank matrix from a small subset of its entries. We also discuss several restricted situations in which the problem can be solved globally by efficient algorithms. We motivate these problems with applications examples from image processing and computer vision, such as image super-resolution and hyperspectral image acquisition. We also draw connections to related problems in sparse vector and low-rank matrix recovery.

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MS52

On Collective Matrix Factorization

The problem of collective matrix factorization naturally arises in a number of situations such as relational learning and protein-protein interaction prediction. Motivated by these applications, we investigate trace norm type of penalization to simultaneously learn a collection of low rank matrices from noisy observations on a few entries. We develop efficient algorithms to compute and establish error bounds for the estimate. Numerical examples are also included to demonstrate its merits.

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MS53

Comparison of Expectation-maximization and Graph-embedding Algorithms for Single Particle Imaging

Single-particle imaging with pulsed x-ray sources is faced with two problems: low signal and missing (orientation) information. One proposed reconstruction algorithm, the expectation-maximization method, builds a model from scratch and incrementally refines it to increase the probability of its consistency with the data. The alternative graph-embedding method constructs a graph whose edges are defined by pairs of similar data, and then embeds the graph into the space of orientations using the low order eigenfunctions of the graph/space. In this talk I review these methods and contrast their performance in the limit of low signal.

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MS53

Structure and Dynamics from Manifold Symmetries of Image Formation

We present a technique to solve the orientation recovery problem in ultra-low signal image and diffraction applications based on the differential-geometric properties of the rotation group SO(3). The method employs the leading eigenfunctions of the Laplace-Beltrami operator on SO(3), evaluated via sparse graph-theoretic algorithms, to make a consistent orientation assignment to each snapshot in the data set. We demonstrate efficient reconstruction of molecular structure from single-molecule diffraction patterns and images, and dynamically-evolving objects.

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MS53

Computational Challenges for Biological Structure Determination Using X-ray Diffraction

Computational methods are a key success factor in the use of X-ray crystallography for discovering the structures of large biomolecular complexes. Routine steps, calculated on small workstations, include derivation of Fourier phases to map the electron density, and improvement of atomic models using stereochemical knowledge. Treatment of raw diffraction images requires multiprocessing approaches, particularly at modern femtosecond X-ray free-electron lasers, where data are acquired at rates exceeding 1 GB/s and whole datasets reach 100 TB.

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MS53

Algorithms for Single Molecule Diffractive Imaging

The recent advances in X-ray science have made it possible to elucidate the 3D structure of molecules using 2D diffraction patterns of isolated molecules of the same type. To accomplish this task, we must first obtain the 3D diffraction pattern of the molecule. The reconstruction problem can be formulated as a nonlinear least squares problem or a maximum likelihood estimation problem. I will review and compare a number of different algorithms for solving these problems.

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MS54

Computational Methods in CryoEM

Cryo electron microscopy (cryoEM) provides structural information spanning from the atomic to the cellular level and is valuable for insights into the chemistry, molecular biology, and sub-cellular context of macromolecules and larger assemblies. CryoEM methodology can be divided into electron crystallography, single particle cryoEM and electron tomography. Several recent computational developments are focused on obtaining reliable 3-D starting models and the fact that the complexes being investigated often show structural heterogeneity that reflects biological dynamics.

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MS54

ET as an Inverse Problem with an Unbounded Operator

We investigate the general setting of a linear operator

$$\mathcal{A} : \mathcal{D}(\mathcal{A}) \supset \mathcal{X} \longrightarrow \mathcal{Y} \tag{1}$$

mapping a dense subset of a Hilbert space $\mathcal{X}$ to a Hilbert space $\mathcal{Y}$. The concept of the *approximate inverse* (Louis / Maass 1990) is shown to be easily adapted to this situation, and a natural extension to *feature reconstruction* (Louis 2011) is presented.
This method is applied to electron tomography, resulting in a fast WBP-type algorithm and a convergence theorem characterizing the best possible reconstruction.

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MS54

Local Algorithms in Electron Tomography

The authors will present derivative backprojection algorithms for electron microscope tomography (ET). These algorithms are local in the sense they need only limited angle region of interest data. This is exactly the data given in ET. The first algorithm is joint work with Ozan Oktem and is for linear electron paths. The second is joint work with Hans Rullgard, and it is for curved electron paths, which occur in electron microscopes with larger fields.

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MS54

Detection of Macromolecular Structures in Tomograms Using Reduced Representation Templates

Electron Tomography (ET) is useful for elucidating the 3D-architecture of cellular and sub-cellular systems at resolution of about 5 nm. One difficulty in ET is to assign molecular components to densities within the reconstruction. We will discuss detection of structures in tomograms using reduced representation templates. These consist of small point sets capturing the characteristics of the underlying structure. This approach is computationally feasible and useful for structures with higher order such as filaments and bundles.

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MS55

Edge Detection and Image Reconstruction Using Area Preserving Flows

We present the application of area preserving curvature motion to certain inverse problems that arise in medical imaging, such as tomographic inversion. In particular, we compare the common choices of perimeter penalty as a regularization term, for example as in the Mumford-Shah functional, with area preserving flows, and show that the use of area preserving curvature motion abates some reconstruction artifacts such as shrinkage of object contours due to perimeter penalties. Numerical experiments also suggest that area preserving flows may be less sensitive to parameters than Mumford-Shah based flows.

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MS55

Medical Morphometry and Computer Visions Using Quasi-Conformal Teichmuller Theory

In medical imaging and computer visions, studying the geometry and the deformation of 2D/3D shapes are of utmost importance. For example, comparing shape differences between anatomical structures (such as human brains) is crucial for disease analysis. Quasi-conformal Teichmuller Theory, which studies geometric deformations between shapes, is an ideal tool for this purpose. In practice, 2D/3D shapes are usually represented discretely by triangulation meshes. We therefore need to have a discrete version of Quasi-conformal theory on discrete meshes. In this talk, I will firstly talk about how can develop a discrete analogue of QC geometry on meshes. I will then talk about how computational QC geometry can be applied to medical imaging and computer visions applications. This is a joint work with Tony F. Chan, Alvin Wong and S-T Yau

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MS55

Reconstruction of Binary Function from Incomplete Frequency Information

Binary function is a class of important function that appears in many applications e.g. image segmentation, bar code recognition, shape detection and so on. Most studies on reconstruction of binary function are based on the nonconvex double-well potential or total variation. In this research we proved that under certain conditions the binary function can be reconstructed from partial frequency information by using only simple linear programming, which is far more efficient.

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MS55

Applications of Computational Quasiconformal Geometry on Medical Morphometry and Computer Graphics

Conformal mappings have been widely applied in medical imaging and computer graphics, such as in brain registration and texture mapping, where the mappings are constructed to be as conformal as possible to reduce geometric distortions. A direct generalization of conformal mappings is quasiconformal mappings, where the mappings are allowed to have bounded conformality distortions. In this talk, we explore how the theories of quasiconformal mappings and their computations can be applied to areas where conformal mappings are used traditionally. These includes registration of biological surfaces, shape analysis, medical morphometry, compression and refinement of texture mappings, and the inpainting of surface diffeomorphisms.

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MS56

Multi-Sheet Rebinning Methods for Reconstruction from Asymmetrically Truncated Cone Beam Projections

We present a family of multi-sheet rebinning methods for reconstruction from axially asymmetrically truncated cone beam X-ray projections, as acquired by a new type of multi-source scanners. In the sense of integral geometry the data is severely limited, nonetheless, the proposed methods achieve a reconstruction of quality similar to that of the complete data, due to an optimal combination of analytical and numerical techniques.

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MS56

Adaptive Frequency-domain Regularization for Sparse-data Tomography

A novel reconstruction technique for sparse tomographic imaging is introduced. This method applies a spatially varying constrained least square filter with regularization method based on total variation. The WIRT reconstruction is implemented in the frequency domain, where the information based on measurements and regularization can be treated separately. This algorithm is selectively applying regularization in the frequency regions where the frequency component values cannot be defined by the measurements, which enables computationally more effective iteration procedure than the conventional iterative methods.

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MS56

Approximation Error Approach in Local Tomography

Recently, the approximation error approach has been proposed for handling uncertainty and model reduction related errors in inverse problems. In this approach, approximate marginalization of these errors is carried out before the estimation of the interesting variables. In this talk, we describe the adaptation of the approximation error approach to the marginalization of the local tomography problem with respect the unknown x-ray attenuation density outside the region-of-interest.

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MS56

Polyenergetic X-Ray Reconstruction Algorithms for Breast Imaging

The U.S. Food and Drug Administration recently approved the first 3-D tomosynthesis breast imaging system. The technique uses standard mammography hardware to obtain limited angle tomography data. To reduce beam-hardening artifacts, and to obtain quantitative information about materials in the breast, we use an image reconstruction approach that incorporates the polyenergetic nature of the x-ray beam. In this talk we describe efficient computational approaches to solve the resulting large-scale nonlinear inverse problem.

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MS57

Recovering Sparse and Low Rank Matrices from Compressive Measurements

We consider the problem of recovering a matrix M that is the sum of a low-rank matrix L and a sparse matrix S from a small set of linear measurements of the form y=A(M) = A(L+S). This model subsumes three important classes of signal recovery problems: compressive sensing, affine rank minimization, and robust principal component analysis. We propose a natural optimization problem for signal recovery under this model and develop a new greedy algorithm called SpaRCS to solve it. SpaRCS inherits a number of desirable properties from the state-of-the-art CoSaMP and ADMiRA algorithms, including exponential convergence and efficient implementation. Simulation results with video compressive sensing, hyperspectral imaging, and robust matrix completion data sets demonstrate both the accuracy and efficacy of the algorithm.

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MS57

On the Power of Adaptivity in Sparse Recovery

We consider the problem of recovering the (approximately) best k-sparse approximation x* of an n-dimensional vector x from linear measurements of x. It is known that this task can be accomplished using m=O(k log (n/k)) non-adaptive measurements and that this bound is tight. In this talk we show that if one is allowed to perform measurements that are *adaptive*, then the number of measurements can be considerably (sometimes exponentially) reduced compared to the non-adaptive case. We discuss implications of our results to compressive sensing and data stream computing.

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MS57

Optimal Measurement Kernels for Dictionary Image Priors

We assume a dictionary which represents the canonical directions which represent image patches and wish to reconstruct imagery from compressive measurements. We derive a measurement criteria based upon optimizing the separation of these canonical image patch directions such that any reconstruction algorithm has better performance. We also adapt the measurement paradigm to the constraints of real hardware.

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MS57

Spectral Super-Resolution of Hypercritical Images

Hyperspectral imagery (HSI) is a remote sensing modality that yields highly detailed spectral descriptions of the terrain, often measuring 100+ spectral bands. HSI imagers, however, are relatively expensive and slow compared to more common multi-spectral imagers (MSI) measuring 8 spectral bands. In this work we propose recovering HSI-level spectral resolution from MSI-level imagery via sparse encoding in a learned spectral dictionary of spectral signatures. Learning a HSI dictionary under a sparsity model captures the rich higher-order statistics in HSI, and this information can be leveraged in a linear inverse problem to super-resolve HSI-level resolution from MSI-level imagery. We show that the per-pixel spectra can be recovered to high accuracy even when the scene has changed substantially due to seasonal variations, indicating that this procedure can be used to reduce the cost of obtaining high-resolution spectral imagery.

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MS58

Blind Subpixel Point Spread Function Estimation from Scaled Image Pairs

We introduce a blind algorithm for subpixel estimation of the PSF of a digital camera from aliased photographs (necessary assumption, since most cameras sample each color channel far below the Nyquist critical rate). The numerical procedure simply uses two fronto-parallel photographs of any planar textured scene at different distances. Hence knowledge of a known calibration grid (common in single-image-based methods) becomes unnecessary. An experimental evaluation shows that the proposed algorithm reaches the accuracy levels of the best non-blind state-of-the-art methods.

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MS58

A Variational Approach for the Fusion of Exposure Bracketed Pairs

We propose a variational method for automatically recombining an exposure bracketed pair of images into a single picture that reflects the best properties of each one: in general, good brightness and colour information are retained from longer exposure settings while sharp details are obtained from the shorter ones. The method is able to handle camera and subject motion as well as noise, and results compare favourably with the state of the art.

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MS58

Optimal Estimators for HDR Reconstruction

There are physical limitations on the maximal variations of luminosity that a camera sensor can measure. These limitations are due to the fact that each sensor has a finite capacity : above a given quantity of incident photons, the sensor saturates. This phenomenon is well known by photographers and is the reason of backlighting in images. In order to get details simultaneously in shadows and highlights, a possibility is to mix several images of the same scene taken with different exposure times. This can be done directly on RAW images, to avoid information loss due to quantization and gamma correction. Assume images have been perfectly registered. For each sensor cell of the camera, we aim at recovering the irradiance reaching the cell from the input measurements obtained with different exposure times. Knowing the physical model of the sensor, this can be seen as a statistical estimation problem. Several solutions have been proposed in the literature, using for instance heuristics [Debevec, Malik, 97], or a fine stochastic modeling of the camera noise [Granados et al, 2010]. In this work, we follow this last trend and investigate the optimality of different statistical estimators of the irradiance reaching the sensor. This question can be treated independently on each sensor cell, or more globally on the image, for instance by only considering linear estimators.

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MS58

Burst Denoising

Taking photographs under low light conditions with a hand-held camera is problematic. A long exposure time can cause motion blur due to the camera shaking and a short exposure time gives a noisy image. We consider the new technical possibility offered by cameras that take image bursts. Each image of the burst is sharp but noisy. In this preliminary investigation, we explore a strategy to efficiently denoise multi-images or video. The proposed algorithm is a complex image processing chain involving accurate registration, video equalization, noise estimation and the use of state-of-the-art denoising methods. Yet, we show that this complex chain may become risk free thanks to a key feature: the noise model can be estimated accurately from the image burst. Preliminary tests will be presented. On the technical side, the method can already be used to estimate a non parametric camera noise model from any image burst.

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MS59

Stochastic and Deterministic Methods for Analysis

of Oscillatory Radar Signals

We examine two different paradigms to analyze the fluctuation rates and oscillatory behavior of radar signals. The first method, which was recently proposed by us, is a stochastic method that relies on the level crossing rate (LCR), average out duration (AOD) and average surge duration (ASD). This method requires the joint distribution of a stochastic process and its time derivative, the general solution of which is an open problem and unknown. After defining the concept of this approach and relating it to radar terminology, we derive some new analytical results for a specific stochastic process. The accuracy of our derived equations are demonstrated vis--vis real radar signals. The second approach which we describe is the tunable Q-factor wavelet transform (TQWT) which is well suited to fast algorithms for sparsity-based inverse problems due to being a Parseval frame, easily invertible and efficiently implementable via radix-2 FFTs. The TQWT, which depends on the two main parameters of the Q-factor and asymptotic redundancy, when tuned, matches the oscillatory behavior of the wavelet transform. We demonstrate how this approach, which differs from the Fourier and Wavelet transform, decomposes a signal into a high-resonance and low-resonance component, and how it can be used to distinguish two radar signals. Application of this approach to real radar signals is also demonstrated.

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MS59

Overview of Multi-baseline Radar Interferometry and Tomography and Applications Potential

Abstract not available at time of publication.

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MS59

Mathematical Problems in Ultrawideband Radar

The very broad instantaneous bandwidth of ultrawideband (UWB) short-pulse radar permits more highly resolved imaging than traditional radar. Some mathematical problems and issues associated with the underlying electromagnetic theory and signal processing of an UWB radar are discussed: the fundamental notion of where an antenna radiates; what constitutes a reasonable representation of an UWB waveform; the appropriateness of the far-field approximation; and the concept of sub-wavelength resolution.

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MS59

Clutter Effects in Imaging

Abstract not available at time of publication.

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MS60

Direct Reconstruction in 3D Electrical Impedance Tomography Using a Nonlinear Fourier Transform

The Calderón problem is the mathematical formulation of Electrical Impedance Tomography. In 3D the problem was solved in the mid 1980's using a non-linear Fourier transform, and only recently a numerical implementation of the reconstruction algorithm has been obtained. In this talk the algorithm and its complete implementation and regularization will be presented. The implementation will be evaluated on several examples and the results will be compared to the results of a simpler linearization algorithm.

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MS60

Electrical Impedance Tomography and the Noise Subspace

Noise subspace approaches like the MUSIC algorithm are popular approaches to inverse problems in scattering theory. We show that an analysis of the MUSIC algorithm originating from inverse scattering can be carried over to the impedance tomography problem to detect (small or extended) inclusions.

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MS60

Regularized D-bar Method for Electrical Impedance Tomography

Imaging via electrical impedance tomography (EIT) is a nonlinear ill-posed inverse problem. A non-iterative EIT imaging algorithm is presented based on the use of a nonlinear Fourier transform. Regularization of the method is provided by nonlinear low-pass filtering, where the cutoff frequency is explicitly determined from the noise amplitude in the measured data. Results from numerical and experimental data are presented, suggesting that the method is useful for imaging the heart and lungs of a living patient.

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MS60
Direct Reconstructions in EIT and Heat Probing

Complex Geometric Optics solutions are used in direct reconstructions methods in EIT and heat probing. Numerical examples are presented using a boundary correcting procedure in the D-bar method, and a novelle heat probing method in 1D, 2D and with moving inclusion of heat conductivity. The results show that the theory involved can improve reconstructions in the case of EIT and can be numerically implemented in heat probing.

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MS61
Variations on Lasso Regularization

We will provide an overview of sparsity-based regularization methods for inverse imaging problems and of iterative algorithms allowing to compute the corresponding solutions. The emphasis will be put on some recent developments such as the use of mixed penalties, the quest for accelerating strategies and the solution of blind (or myopic) inverse problems where the operator to be inverted is also unknown (or partially known). Some open challenging questions will also be discussed.

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MS61
Linear Ill-posed Operator Equations with Poisson Data

We consider moment discretization for ill-posed problems with discrete Poisson data by means of penalized maximum likelihood estimation. Several computational approaches are discussed. Simplest of all is to just consider the plain least-squares problem and use "optimally' stopped conjugate gradients type methods. Next is the plain Expectation-Maximization (EM) algorithm for the unpenalized maximum likelihood problem (which has to "optimally' stopped as well, although it is not so clear how). There is also a nonlinearly smoothed EM algorithm for a specific penalized version of the maximum likelihood problem, depending on a smoothing (regularization) parameter. This smoothed version of the EM algorithms may be run until convergence, but the smoothing parameter needs to be chosen "optimally'. However, these EM algorithm are computationally very expensive. A final approach is to approximate the Poisson data with Gaussian data with the means equal to the variances. This is asymptotically equivalent to an iteratively reweighted least-squares problem, so conjugate gradient type methods can then be brought to bear on its solution.

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MS61
Source Identification from Line Integral Measurements and Simple Atmospheric Models

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MS61
The Minimizers of Least Squares Regularized with ℓ_0 norm: Uniqueness of the Global Minimizer

Data d are generated using an $M \times N$ real-valued arbitrary matrix A (e.g. a dictionary) with $M < N$. We provide an in-depth analysis of the (local and global) minimizers of an objective function $\mathcal{F}_\lceil$ combining a quadratic data-fidelity term and an ℓ_0 penalty applied to each entry of the sought after solution, weighted by a regularization parameter $\beta > 0$. For several decades, this objective focuses a ceaseless effort to conceive algorithms approaching a good minimizer. Our theoretical contributions, summarized below, shed new light on the existing algorithms and can help the conception of innovative numerical schemes. To solve the normal equation associated with any M-row submatrix of A is equivalent to compute a local minimizer $\hat{u}$ of $\mathcal{F}_\lceil$. (Local) minimizers $\hat{u}$ of $\mathcal{F}_\lceil$ are strict if and only if the submatrix, composed of those columns of A whose indexes form the support of $\hat{u}$, has full column rank. An outcome is that strict local minimizers of $\mathcal{F}_\lceil$ are easily computed without knowing the value of β. Each strict local minimizer is linear in data. The global minimizers of $\mathcal{F}_\lceil$ are always strict. They are studied in more details under the (standard) assumption that $\mathrm{rank(A) = M < N}$. The global minimizers with M-length support are seen to be impractical. Given d, critical values β_K for any $K \leq M - 1$ are exhibited such that if $\beta > \beta_K$, all global minimizers of $\mathcal{F}_\lceil$ are K-sparse. An assumption on A is adopted and proven to be generically true. Then for generically all data d, the objective $\mathcal{F}_\lceil$ has a unique global minimizer and the latter is K-sparse for $K \leq M - 1$. Instructive small-size (5×10) numerical illustrations confirm the main theoretical results.

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MS62
Projection Methods for Low-count Diffractive Imaging in the Near and Far Fields

With few exceptions, the most prevalent practical methods for solving phase retrieval problems arising in imaging are projection methods. Surprisingly, convergence of even the simplest algorithms has never been proved in settings appropriate for phase retrieval. We prove convergence of a very elementary algorithm for some (not all) phase retrieval problems and outline the extension of these results to more sophisticated algorithms and settings, in particular for low-count data where Poisson noise is significant and unavoidable. We demonstrate the theory and algorithms on experimental data from low-count photonic imaging experiments in the near and far-fields.

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MS62

Real-time Ptychographic X-ray Image Reconstruction

Ptychography is a recent imaging technique which combines the ease of use of a scanning transmission X-ray microscope with the high resolution of coherent diffractive imaging methods. Its robustness, when compared to single particle diffractive imaging, make it ideally suited to become a routine experimental method. We present the first real-time soft X-ray ptychography framework. Its ease of use and immediate feedback are finally turning diffraction imaging into a useable routine technique.

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MS62

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MS62

PhaseLift: Exact and Stable Phase Retrieval Via Convex Optimization

PhaseLift is a novel methodology for phase retrieval, combining structured illuminations with convex programming to recover phase from intensity measurements. Along with empirical demonstration that any complex-valued object can be recovered from the magnitude of few diffracted patterns by solving a convex optimization problem, stably with respect to noise, we exhibit masks which yield the signal uniquely and under further assumptions show that recovery via convex optimization is exact and stable with very high probability.

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MS63

Statistical Extreme Value Theory Meets Multiscale Imaging

Abstract not available at time of publication.

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MS63

Geometric Multiscale Analysis and Inpainting

One possible model for images is the cartoon model assuming that images are governed by edges. Shearlets have been introduced as an image processing methodology designed to sparsely approximate cartoon-like images, while ensuring a unified treatment of the continuum and digital world. In this talk, we will first discuss novel results on compactly supported shearlets. Then we will focus on the application of shearlets to the task of inpainting, providing theoretical and numerical results.

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MS63

Spectral Density Estimation for Unevenly Spaced Time Series

Regularization approaches for the estimation of the spectral density of unevenly spaced time series are proposed and studied; both L2 and L1 options are considered, in the penalty as well as in the infidelity term. The feasibility of the methods depends on the modern algorithms of convex optimization.

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MS63

Statistical Multiscale Methods for Biophotonic Imaging.

We present a locally adaptive estimation method of a one or two-dimensional regression function for Poisson data. Our approach is built on a multiresolution likelihood statistic which is not a Gaussian approximation but taylor suited for Poisson data and consequently particularly suited for low count observations, as in photonic spectroscopy. We further provide asymptotic results and illustrate the capability of the proposed method by various examples from imaging and signal detection.

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MS64

Non-parametric Bayesian Modeling in Image Processing

A new nonparametric Bayesian model is developed to integrate dictionary learning and topic model into a unified framework. The model is employed to analyze partially annotated images, with the dictionary learning performed directly on image patches or on associated extracted features. A hierarchical representation of the image patches and of the text is manifested via a generalization of the nested Chinese restaurant process. Efficient inference is performed with a Gibbs-slice sampler, and encouraging results are reported on widely used datasets.

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MS64

On Perfect Sampling of Some Markovian Energies

In this talk, we consider the sampling of Markov Random Fields using coupled Markov Chain to draw samples from the stationary distribution. We propose an algorithm that performs perfect sampling, i.e., after a finite number of steps the sample is exactly generated according to the target distribution. We give a sufficient condition (that is essentially of combinatorial nature) for the applicability of the method.

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MS64

Analysis of Bayesian Problems Using Non-Asyptotic Probability Tail Bounds

An approach to determine if a learned Bayesian dictionary is appropriate for images not used during the training stage is demonstrated, i.e. the concepts in the new images have drifted. The procedure relies on probability tail bounds, and a new result on obtaining probability tail bounds is proven. In particular, tail bounds for the exponential family of distributions are demonstrated. The tail bounds are applied to SIFT learned dictionaries to discover when concept drift occurs.

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MS64

Total Variation Denoising Using Posterior Expectation

Total variation image denoising can be interpreted as a Maximum A Posteriori estimate. This maximization aspect is partly responsible for the staircasing effect, i.e. the outbreak of quasi-constant regions separated by sharp edges. In this talk we transpose this denoising method into an estimation based on the posterior expectation. We demonstrate that the denoised images do not suffer from the staircasing effect. Practical computation of TV-LSE, and a proposed MCMC algorithm is analyzed.

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MS65

Variational Methods in Molecular Electron Tomography

I shall present a variational approach for reconstructing a three dimensional density function from a tilt series of two dimensional electron microscopy (EM) images. By minimizing an energy functional consisting of a data fidelity term and a choice of regularization terms, an L2-gradient flow is derived and efficiently solved. An iterative solution for the flow is constructed using tensor product B-spline finite elements in the spatial direction and an explicit Euler scheme in the temporal direction. Experimental tests show this variational method is efficient and effective and provides higher resolution 3D EM reconstructions, compared to several existing methods.

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MS65

Nonlinear Approximations as a Tool in Tomography

Rapid changes in the medium (e.g. boundaries) are the key features of interest in tomographic images. However, they are difficult to reconstruct accurately since the measured data are bandlimited and contaminated by noise. We use near optimal rational approximations in order to capture rapid changes in measured quantities. Effectively, we make use of the fact that such nonlinear approximations are not subject to the usual (Nyquist) sampling requirements. We show that, when used within our tomographic reconstruction algorithm, the approach results in improved resolution and noise reduction.

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MS65

Mumford Shah Methods in Limited Data Tomography

We introduce Mumford-Shah energy functionals for the retrieval of geometric and physical information from highly noise-corrupted EMT data. The introduction of appropriate homogeneity measures reduces ill-posedness of the inverse problem an — at the same time — reconstructs geometric information of shape and location of the probe directly from the data. The issue of regularization of the contour variable by area penalization in the Mumford-Shah approach is addressed both theoretically and numerically via a semi-implicit numerical approach for the iterative update of the shape variable. Numerical experiments comparing the Mumford-Shah method with other techniques are presented.

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MS65

Making Electron Tomography and Template Matching Practical

Acquisition of electron tomographic data sets has become almost fully automated nowadays. The bottleneck in the throughput chain is now clearly in the data analysis part of the tomography workflow, both in preprosessing (alignment of the tilt series) and in the further analysis using e.g. template matching of the acquired tomograms. In this presentation we present how high performance computing can be used to take over the role of the human operator in these areas.

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MS66

Proximal Algorithms and CT: New Results on 3D Real Datas and Color CT

The CPPM in Marseille developed recently a new demonstrator of small animal CT-scan PIXSCAN2 and an hybrid PET/CT Scan ClearPET/XPAD. The last one is designed to record images for both modalities CT and PET simultaneously. Moreover the use of a new generation of detectors which are not affected by dark noise leads to model the measurements with pure Poisson noise. Proximal algorithms can be used to solve the inverse problem in CT and they demonstrate on real data very good reconstruction properties at low radiation dose in 2D as well as in the context of CT spectral acquisitions. In this talk we will study their properties in the 3D case.

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MS66

Connecting Object Sparsity and Number of Measurements in Total Variation-regularized X-ray CT

In X-ray computed tomography (CT), total variation (TV)-regularized image reconstruction shows potential for low-dose imaging from few-view projection data. However, it remains unclear precisely for which images TV-regularized reconstruction can be expected to be accurate. We discuss approaches for determining sampling conditions ensuring recovery of the original image using TV-regularized reconstruction, including empirical phantom reconstruction studies, in an attempt to link object sparsity and the sufficient number of samples.

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MS66

A Survey of CT Applications Enabled by Sparsity-exploiting Image Reconstruction

Since 2005, when Candes, Romberg, and Tao launched the subject dubbed "Compressive Sensing" (CS), we have been studying the optimization problems and sparsity-exploiting ideas of this field for the purpose of application to image reconstruction in Computed Tomography (CT). From the applications perspective, the importance of the various CS concepts take on a different weighting than the theoretical investigations. This talk will survey the various applications of exploiting sparsity in X-ray based image reconstruction. We will cover, specifically, sparse-view sampling, limited-angular range scanning, digital breast tomosynthesis, and low-intensity X-ray illumination. In keeping with the theme of explaining the difference between practice and theory, we will discuss the role of convergence of the various CS optimization problems and suitability of the CT-model system matrices for sparsity-exploiting image reconstruc-

tion algorithms.

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MS66

Low Rank Matrix Decomposition/Factorization Methods for 4D Ct

We propose to use matrix decomposition/factorization method to reconstruct 4D CT images. The key point is to utilize redundancy in different projections for the common background and global time correlation such as periodicity to improve the image reconstruction and reduce the dose needed. I will discuss two low rank matrix models, one based on matrix decomposition and the other one on matrix factorization for 4D CT image reconstruction.

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MS67

Sparse Approximation by Wavelet Frames with Applications to Image Restoration

Wavelet frames are known to be able to sparsely approximate piecewise smooth functions, which has recently been used for image restoration problems including image deblurring, inpainting and medical imaging. In the first half of this talk, I will start with a brief review of some wavelet frame based models and their connections to variational models. Then I will present a model (as well as some fast algorithms) that penalizes the ℓ_0-norm of the frame coefficients, instead of the commonly used ℓ_1-norm. Numerical experiments show that using the ℓ_0-norm has advantages for some specific type of images. The second half of the talk is focused on the applications of wavelet frame based models to x-ray based conventional CT image reconstruction, as well as spectral CT image reconstruction.

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MS67

The Analysis Co-Sparse Model: Pursuit, Dictionary Learning, and Beyond

The synthesis-based sparse representation model for signals has drawn a considerable interest in the past decade. Such a model assumes that the signal of interest can be de- composed as a linear combination of a few atoms from a given dictionary. In this talk we concentrate on an alternative, analysis-based model, where an analysis operator (hereafter referred to as the Analysis Dictionary) multiplies the signal, leading to a sparse outcome. Our goal is to learn the analysis dictionary from a set of signal examples, and the approach taken is parallel and similar to the one adopted by the K-SVD algorithm that serves the corresponding problem in the synthesis model. We present the development of the algorithm steps, which include a tailored pursuit algorithm termed Backward Greedy algorithm and a penalty function for the dictionary update stage. We demonstrate its effectiveness in several experiments, treating synthetic data and real images, showing a successful and meaningful recovery of the analysis dictionary.

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MS67

Shearlets and Geometry Extraction

One main problem in imaging science is the extraction of geometrically distinct features from a mixture of those; an example being the extraction of spikes (pointlike features) and dendrites (curvelike features) from neurobiological images. For this, we will exploit sparsity methodologies by using a combined dictionary of wavelets and shearlets. We will present a theoretical analysis, an efficient algorithm as well as numerical experiments for the extraction of general point- and curvilinear features.

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MS67

Box Spline Wavelet Frames for Image Edge Detection

We will explain a bivariate box spline based on 8 directions (1,0), (0,1), (1,1), (1,-1), (2,1),(1,2), (-2,1),(-1,2) and construction of tight wavelet frames. These frame framelets are used for image edge detection. Comparison with other box spline wavelet frames will be shown to demonstrate that this wavelet frame works very well. Effectiveness on edge detection is also compared with standard wavelets, shearlets, classic Canny and segmentation based methods.

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MS68

Restoration of Photographies of Paintings

In this talk, we will review the main limitations of photography in terms of image quality as low signal noise ratio, blur, compression artifacts. Other limitations are introduced specifically for photographies of paintings as no controlled illumination, no flash, highlights from the varnish, medium, or glass in front of the painting. We will discuss how to remove or reduce these limitations when we dispose of a series of photographies of the same painting.

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MS68

Exact Histogram Specifcation for Digital Images Using a Variational Approach

Histogram specification refers to the problem of transforming an input quantized (digital) image to an output (also digital) image that follows a prescribed histogram. This is an ill-posed problem for digital images since there can be numerous pixels with the same intensity level, and there can be numerous ways of assigning them new intensity level according to the prescribed histogram. Classical histogram modification methods being designed for real-valued images, map these pixels into the same intensity level: then the output image deviates arbitrarily from the prescribed histogram. So as to satisfy the prescribed histogram, all pixels of the input image must be rearranged in a strictly ordered way, using some auxiliary attributes, while preserving the specific features of the input image. This is a crucial challenge in exact histogram specification for digital images. We propose a new method that efficiently provides a strict ordering for all pixel values. It is based on a well designed variational approach. Noticing that the input digital image contains quantization noise, we minimize an objective function whose solution is a real-valued image with reduced quantization noise. We show that all the pixels of this real-valued can be ordered in a strict way. Then transforming the latter image into another digital image satisfying a specified histogram is an easy task. This provides a new tool to restore image sequences corrupted by flicker (unnatural temporal fluctuations of intensity, due to variations in exposure time or inhomogeneous ageing or degradation of the film support).

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MS68

Learning Human Activities and Interactions from Video

In this talk, joint work with Alexey Castrodad, we will describe our advances in human activity recognition from video. We will illustrate how very simple models achieve state-of-the-art results. Such models are based on dictionary learning and sparse coding, embedded in a hierarchical structure.

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MS68

Variational Imaging on Manifolds and Some Applications

In this talk we consider the problem of optical flow on manifolds. We model appropriate equations describing the movements on manifold. Moreover, we show some partial differential equations for zooming of data on manifolds.

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MS70

A Direct D-bar Method for the Reconstruction of Complex Admittivities from EIT Data

A direct reconstruction algorithm for complex conductivities in $W^{2,\infty}()$, where is a bounded, simply connected Lipschitz domain in ^{2}, is presented. The algorithm constitutes the first D-bar method for the reconstruction of conductivities and permittivities in two dimensions. Reconstructions of numerically simulated chest phantoms with discontinuities at the organ boundaries are presented.

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MS70

Problems in Electrical Impedance Tomography

In electrical impedance tomography one tries to reconstruct and display the electrical properties of the interior of a body from measurements made on the surface or outside of the body. One of the reasons that EIT may be useful in diagnosing diseases is that tissues have differing conductivity depending on their state. For example lungs filled with air have a lower conductivity than lungs depleted of air. For this reason imaging the lungs conductivity may help to diagnose problems with ventilation , or lung function. Similarly hearts filled with blood have a higher conductivity than when emptied so that impedance imaging of the heart may help diagnose heart disease. Some breast cancers seem to have different impedance properties from benign lesions. This suggests that impedance imaging might be helpful in diagnosing breast cancer. In this talk it will be explained how impedance imaging can be seen as an inverse boundary value problem for Maxwell's equations. Problems arising in the design and application of EIT systems for medical imaging will be described. Movies and images from our EIT systems will be shown.

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MS70

Estimation of Spatial Resolution Improvement by the use of an Anatomy Based Prior of Pig Thoraxes in Electrical Impedance Tomography

The inverse problem associated to the Electrical Impedance Tomography (EIT) requires regularization, which can be interpreted as prior information. Anatomy based priors for medical and veterinary images generated by EIT are expected to improve spatial resolution. In the present work, the improvement of the spatial resolution is estimated. The anatomy based prior is based on in vivo tissue impeditivity measurements and CT-Scan images of pig thoraxes. These in vivo measurements were necessary to capture variations caused by perfusion of blood, muscle contraction and, sometimes, ventilation. A detailed numerical model of a pig thorax was developed. Objects of simple geometry were inserted in the numerical thorax model and the resulting EIT images were used to approximately quantify the spatial resolution.

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MS70

Imaging of Non-stationary Flows in Industrial Process Tomography

In this paper, we consider the problem of imaging fluids under non-stationary flow fields. As the imaging modality, we use the Electrical Impedance Tomography (EIT). We model the evolutions of targets with the Navier-Stokes equations and the convection-diffusion equation, and estimate the concentration distribution and the velocity field based on EIT data using the state-estimation. Numerical results suggest that tracking of complex flow fields is possible when suitable flow models are utilized in state estimation.

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MS71

Regularization Based on Integral Invariants

We investigate the applicability of integral invariants as geometrical shape descriptors in the context of ill-posed inverse problems. We propose the use of a Tikhonov functional, where the penalty term is based on the diffference of integral invariants. As a case example, we consider the prob- lem of inverting the Radon transform of an object with only limited data available.

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MS71

Morozov's Principle for the Augmented Lagrangian Method

The Augmented Lagragian Method received much attention recently (also under the name Bregman iteration), as an approach for regularizing inverse problems. This work shows convergence and convergence rates for this method when a special a posteriori rule, namely Morozov's discrepancy principle, is chosen as a stopping criterion. As potential fields of application we study implications of these results for particular examples in imaging, that is total variation regularization as well as ℓ^q penalties with $q \in [1, 2]$.

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MS71

Convergence of Variational Regularization Methods for Imaging on Riemannian Manifolds

We consider abstract operator equations $Fu = y$, where F is a compact linear operator between Hilbert spaces U and V, which are function spaces on *closed, fin te dimensional Riemannian manifolds*, respectively. This setting is of interest in numerous applications such as Computer Vision and non-destructive evaluation. In this work, we study the approximation of the solution of the ill-posed operator equation with Tikhonov type regularization methods. We state well-posedness, stability, convergence, and convergence rates of the regularization methods. Moreover, we study in detail the numerical analysis and the numerical implementation. Finally, we provide for three different inverse problems numerical experiments.

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MS71

L-infinity Regularized Models for Segmentation, Cartoon-texture Decomposition, and Image Restoration

We propose a cartoon-texture separation using the pre-dual to the space of Lipschitz functions. Specifically, we decompose an image into the sum of a cartoon part, in BV, and a texture component in the pre-dual of $W^{1,\infty}$. This decomposition is used to analyze the various features in the image, remove noise from cartoon images, and also to help better reconstruct the texture when degraded by (known and semi-blind) blur. The algorithm is tested on both synthetic and real images, with various implementations based on duality and on projectors.

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MS72

Open Science: When Open Source Meets Open Access

In the past decade, Open Source software has become more and more prominent and pervasive in the domain of scientific research. In parallel, scientific communities have come to the conclusion that open-access is essential to the future of science. The Insight Journal is an open-access infrastructure for collecting, validating and disseminating open source code, data and knowledge to the scientific community; founded on the principle of enabling reproducibility verification as a routine scientific practice.

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MS72

Image Processing On Line: Experiences in Reproducible Science and Software

Image Processing On Line (IPOL) publishes image algorithms with an attention to reproducibility: the description and the implementation are peer-reviewed and published under free licenses, the software must be reusable, and a web test and archive interface allows extensive exploration of the algorithm. With different publication procedures and tools, new constraints, and new benefits for researchers, the notions of quality and usefulness of a research article are reevaluated. Image Processing On Line. http://www.ipol.im/. ISSN:2105-1232

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MS72

Open Research Computation: Supporting Reproducible Research Through Open Source Software

The communication of research in a fashion which makes it reproducible remains a significant challenge. While computational research is an area where high standards of reproducibility are in principle possible adherence to best practice is rare. There is no real incentive for producing and sharing high quality software products related to research. Open Research Computation aims to develop incentives for researchers first to publish the software products of their research in a way that maximises the potential for their use and re-use through providing a traditional journal format that will develop a high profile.

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MS72

Reproducible Research in Signal Processing: How to Increase Impact

Worries about the reproducibility of research results date back to Descartes' work Discourse on (Scientific) Method. However, in computational sciences, new approaches to reproducibility are required. We give an overview of our personal experiences with reproducible research in the field of signal and image processing, and issues we ran into. We also present results from our reproducibility study on image processing papers. Finally, we give indications of increased impact for papers with reproducible results.

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MS73

Edge-Preserving Full-Waveform Inversion with a

Modified Total-Variation Regularization Scheme

Full-waveform inversion using acoustic or elastic waves has become more and more feasible with increasing computing power. The full-waveform inversion is usually ill-posed and requires computational methodologies to stabilize the inversion. We develop a full-waveform inversion method with a modified total-variation regularization scheme to preserve edges in tomography reconstructions. We apply the new method to acoustic/elastic reflection data for geophysical imaging and demonstrate the improved tomography capability of the method.

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MS73

Solution of Ill-posed Inverse Problems Pertaining to Signal Restoration: Total Variation Parameter Estimation

Spectral decomposition assists understanding the solution of ill-posed inverse problems. In the talk I consider application of standard approaches from Tikhonov regularization for finding appropriate regularization parameters in the total variation augmented Lagrangian implementations. The analysis of the solution uses the SVD and GSVD, and assists with understanding how to pick relevant regularization parameters for the total variation implementation. Application to solid oxide fuel cells will also be discussed.

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MS73

L1/TV Models and Its Variants

A proximity operator framework for studying the L1/TV image denoising model will be presented. The solutions of the L1/TV model are identified as fixed points of a nonlinear mapping expressed in terms of the proximity operator of the L1-norm or L2-norm. This formulation naturally leads to fixed-point algorithms for the numerical treatment of the model.

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MS73

A New Paradigm for Fast MRI Reconstruction with TV Regularization from Arbitrary Trajectories though K-Space

A novel, fast generalized non-Cartesian MRI reconstruction technique is presented. The approach computes an uncorrected non-uniform Fourier Transform from the k-space samples and generates a convolution kernel to correct trajectory induced errors. An iterative total variation regularized deconvolution is then performed on a Cartesian grid using fast Fourier Transforms to remove artifacts and blurring. The technique is demonstrated on synthesized MRI data for comparison to Cartesian sampling for several k-space trajectories, including spiral and rosette.

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MS74

Designing Optimal Spectral Filters for Inverse Problems

Filtering suppresses the amplification of errors when computing solutions to ill-posed inverse problems; however, selecting good regularization parameters is often expensive. In many applications, data are available from calibration experiments. Here, we describe how to use such data to pre-compute optimal filters. We formulate the problem in an empirical Bayes risk minimization framework. Numerical examples from image deconvolution illustrate that our proposed filters perform consistently better than well-established filtering methods.

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MS74

Imaging the Earths Conductivity and Changeability

Conductivity and chargeability of earth's materials are good proxies to mineralization and to hydrocarbons. Imaging these properties is therefore important in detecting and managing natural resources. In this talk we discuss the imaging of these properties under various conditions. We will show cases that traditional techniques fail and discuss a new technique we have develop to overcome many of the existing imaging roadblocks

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MS74

Fast Composite Splitting Algorithm for Linear Composite Regularization

In this talk, we consider the minimization of a smooth convex function regularized by the composite prior models. This problem is generally difficult to solve even if each subproblem regularized by one prior model is convex and simple. In this paper, we present two algorithms to effectively solve it. First, the original problem is decomposed into multiple simpler subproblems. Then, these subproblems are efficiently solved by existing techniques in parallel. Finally, the result of the original problem is obtained by averaging solutions of subproblems in an iterative framework. The proposed composite splitting algorithms are applied to the compressed MR image reconstruction and low-rank tensor completion. Numerous experiments demonstrate the superior performance of the proposed algorithms in terms of both accuracy and computation complexity.

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MS74

Model-based Synthetic Aperture Radar Imaging

There are many significant advantages such as reducing the required antenna size and reducing the needed number of measurements that are possible when Compressive Sensing (CS) techniques are used for imaging using Synthetic Aperture Radar (SAR). CS deals with reconstructing images that are sampled below the Nyquist rate provided certain conditions are met. These suggested techniques while powerful have, however, not adequately dealt with the fact that SAR images contain a multiplicative component known as speckle. Speckle makes the compressibility and interpretation of SAR images difficult. In this talk, I will present a more complete formulation of the problem of reconstructing the piecewise smooth and texture component (speckle) directly from a set of compressive measurements.

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MS75

Diffusion Descriptors for 3D Shape Analysis

Large databases of 3D models available in public domain have created the demand for shape search and retrieval algorithms capable of finding similar shapes in the same way a search engine responds to text quires. Since many shapes manifest rich variability, shape retrieval is often required to be invariant to different classes of transformations and shape variations. One of the most challenging settings in the case of non-rigid shapes, in which the class of transformations may be very wide due to the capability of such shapes to bend and assume different forms. In this talk, we will explore approaches to 3D shape retrieval analogous to feature-based representations popular in the computer vision community. We will show how to construct invariant local feature descriptors based on heat diffusion and compute them efficiently using the Laplace-Beltrami operator in order to represent 3D shapes as collections of geometric "words" and "expressions" and how to adopt methods employed in search engines for efficient indexing and search of shapes.

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MS75

Invariant Beltrami-Operators - A Computational Study

In this talk we modify the metric in the Laplace-Beltrami operator so that it captures the task at hand. We show how various classical solutions in image processing and analysis could be formulated as equations in which the laplace-Beltrami, where the metric is carefully selected, plays a major role. The next step is extending the Beltrami framework to surface processing and analysis. We deal with various groups of invariants from which the right metric is extracted, plugged into the operator, and demonstrate the robustness and efficiency of the resulting numerical solvers.

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MS75

Unifying Beltrami and Mumford-Shah Frameworks

We present a unifying generalization of the Mumford-Shah functional, in the Ambrosio-Tortorelli set up, and the Beltrami framework. The generalization of the Ambrosio-Tortorelli is in using a diffusion tensor as an indicator of the edge set instead of a function. The generalization of the Beltrami framework is in adding a penalty term on the metric such that it is defined dynamically from minimization of the functional. We show that we are able, in this way, to have the benefits of true anisotropic diffusion together with a dynamically tuned metric/diffusion tensor. The functional is naturally defined in terms of the vielbein-the metrics square root. Preliminary results show improvement on both the Beltrami flow and the Mumford-Shah flow.

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MS75

Geodesic Active Fields - A Geometric Framework for Image Registration

Image registration is an ill-posed inverse problem where one looks for the underlying deformation field that best maps one image onto another. Here, we propose to embed the deformation field in a weighted minimal surface problem. The energy of the deformation field is measured with the Beltrami energy, weighted by local image mismatch. Minimizing this energy drives the deformation field toward a minimal surface, while being attracted by the solution of the registration problem.

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MS76

A Butterfly Algorithm for SAR Imaging

SAR image formation involves computing an oscillatory integral which looks like a distortion of a Fourier transform. FFT-based algorithms exist and are fast, but they tend to be inaccurate. I present an algorithmic alternative to the FFT, called the butterfly algorithm, to compute the SAR imaging integral to within prescribed accuracy, in complexity O(N log N) where N is the number of pixels. Joint work with Matthew Ferrara, Nicholas Maxwell, Jack Poulson, and Lexing Ying.

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MS76

Compressive Illumination Waveforms for High Resolution Radar Sensing

Compressive sensing algorithms guarantee stable recovery of sparse signals from sub-Nyquist samples provided that mutual coherence between the columns of the sensing operator is low. For standard radar sensors with match filtering on receive the mutual coherence of the sensing matrix can be linked to the maximum side lobe level of the Woodward ambiguity function. In this talk we introduce of a novel radar sensor with wideband illumination and sub-Nyquist sampling on receive. We show that for this system the mutual coherence of the sensing operator can be controlled through random wideband illumination to enable high resolution range imaging from sub-Nyquist samples. Experimental results for this compressive sensing strategy will be given based on low-rate sampling of staggered multifrequency linear FM signals.

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MS76

Radar Imaging and Feature Detection of Biological Media

In this paper we derive a method to reconstruct an image and detect features from far field scattering data of human beings. We utilize physics and math-based theory to determine an appropriate model for the scattering data. We subsequently use this data model to find the appropriate algorithm that will reconstruct an image of the human being and detect features such as head size, arm, and leg length.

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MS76

Information Theory in Radar Imaging, Detection and Classification

We discuss some of our recent results in radar signal processing ranging from waveform design for radar imaging, discovery of a novel statistical characterization of sea-clutter with implications to detection theoretic algorithms, and recent results in ATR (automatic target recognition) based on novel feature selection methodologies coupled with probabilistic graphical approaches to classification. We attempt to place this in context of the larger panorama of activities taking place within radar signal processing.

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MS77

A Binary Constrained General Model in Image Processing

In this talk, we consider a class of problems given by a binary constrained model. The model covers several applications in image processing, such as the total variation model for binary image restoration, Mumford-Shah model for image segmentation, multilabelling problem, etc. In order to solve this model, we introduce its exact relaxation and give an efficient algorithm based on the Fenchel duality technique. Numerical results are presented in the end of the talk.

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MS77

Optimality of Relaxations for Integer-Constrained Problems

Variational convex relaxations can be used to compute approximate minimizers of optimal partitioning and multiclass labeling problems on continuous domains. We present recent developments on proving a priori upper bounds for the objective of the relaxed problem, and on the numerical solution of such problems.

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MS77

A Convex Shape Prior and Shape Matching Based on the Gromov-Wasserstein Distance

We present a novel convex shape prior functional with potential for application in variational image segmentation. Based on the Gromov-Wasserstein distance an approximation is derived that takes the form of an optimal transport problem with relaxed constraints. The approach inherits the ability to incorporate vast classes of geometric invariances beyond rigid isometries and to process additional (non-geometric) feature information. The resulting functional can be minimized by standard linear programming methods and yields a unique assignment of a given shape template to a given image. Numerical experiments are reported that illustrate key aspects of the approach, and open problems are outlined.

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MS77

Flow-Maximizing joint with Message-Passing

Computing 'cuts' in the spatially continuous setting proposes a series of challenging binary constrained optimization problems in image processing. By exploring their primal-dual formulations and some specified Bregman divergence, a family of efficient and interesting algorithms can be discovered with potential connections to the existing two approaches: max-flow and message-passing.

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PP1
Automated Parameter Selection Tool for Solution to Ill-Posed Problems

In many ill-posed problems it can be assumed that the error in the data is dominated by noise which is independent identically normally distributed. Given this assumption the residual should also be normally distributed with similar mean and variance. This idea has been used to develop three statistical diagnostic tests to constrain the region of plausible solutions. This poster demonstrates a software package that aids in the generation of a range of plausible regularization parameters.

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PP1
A Short Time Existence/uniqueness Result for a Nonlocal Topology-Preserving Segmentation Model

Motivated by a prior applied work of Vese and Le Guyader dedicated to segmentation under topological constraints, we derive a slightly modified model phrased as a functional minimization problem, and propose to study it from a theoretical viewpoint. The mathematical model leads to a second order nonlinear PDE with a singularity at $Du = 0$ and containing a nonlocal term. A suitable setting is thus the one of the viscosity solution theory and, in this framework, we establish a short time existence/uniqueness result as well as a Lipschitz regularity result for the solution.

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PP1
Phase Retrieval with Random Illumination

Obtaining an image from the magnitude of its Fourier transform is an important problem in physical sciences. We will show that the reconstruction of phase retrieval is greatly enhanced by random illumination, which can be realized by random phase/magnitude modulators or random masks.

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PP1
A Generalized Simulated Annealing Approach to Image Reconstruction

It is common pratice to speed-up simulated annealing by allowing the cost function and/or the candidate-solution generation mechanism to vary with temperature. We derive simple sufficient conditions for the global convergence of such generalized simulated annealing algorithms. These conditions are surprisingly weak; in particular, they do not involve the variations of the cost function with temperature. We show that our results can be successfully applied to image reconstruction problems involving challenging optimization tasks.

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PP1
Image Reconstruction with Multiresolution Edge-Continuation and Non-Quadratic Data Fidelity

The standard approach to image reconstruction, which consists in minimizing a cost function combining data-fidelity with edge-preserving regularization, tends to produce noisy object boundaries and to create a staircase effect. We propose to incorporate the smoothness of the edge field via an additional penalty term defined in a multiresolution domain. We provide an efficient half-quadratic algorithm to solve the resulting optimization problem, including the case when the data-fidelity is non-quadratic and the cost function non-convex.

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PP1
Direct reconstruction from spherical mean data

Circular and spherical mean data arises in various models of thermoacoustic and photoacoustic tomography which are rapidly developing modalities for in vivo imaging. We describe how summability respectively kernel based methods can be applied in order to come up with new reconstruction techniques. We will show how suitable kernels can be constructed. A detailed description for the most important bivariate and trivariate case will be provided, leading to effective recovery of image and volume data from spherical mean values, respectively. Finally, we present our implementation and some numerical examples.

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PP1
A Nonconvex TV^q-Model in Image Restoration

A nonconvex variational model is introduced which contains ℓ^q-norm, $q \in (0, 1)$, of image gradient as regularization. Such a regularization is a nonconvex compromise between support minimization and convex total-variation model. In finite-dimensional setting, existence of minimizer is proven, a semismooth Newton solver is introduced, and its global and locally superlinear convergence is established. The potential indefiniteness of Hessian is handled by a trust-region-based regularization scheme. Finally, the

associated model in function space is discussed.

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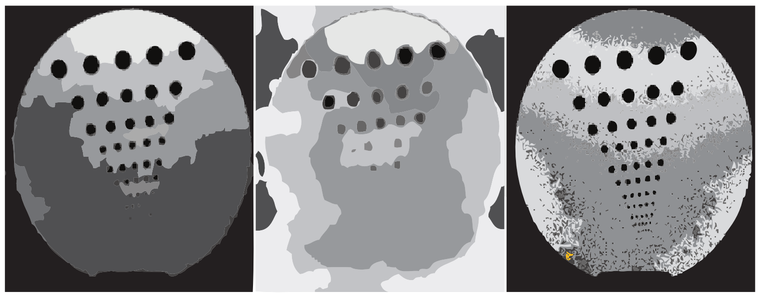
IS12 Speaker and Organizer Index

SIAM Conference on

IMAGING SCIENCE



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

May 20 - 22, 2012

DoubleTree by Hilton Hotel Philadelphia Center City

Philadelphia, Pennsylvania, USA

Italicized names indicate session organizers.

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IS12 Budget

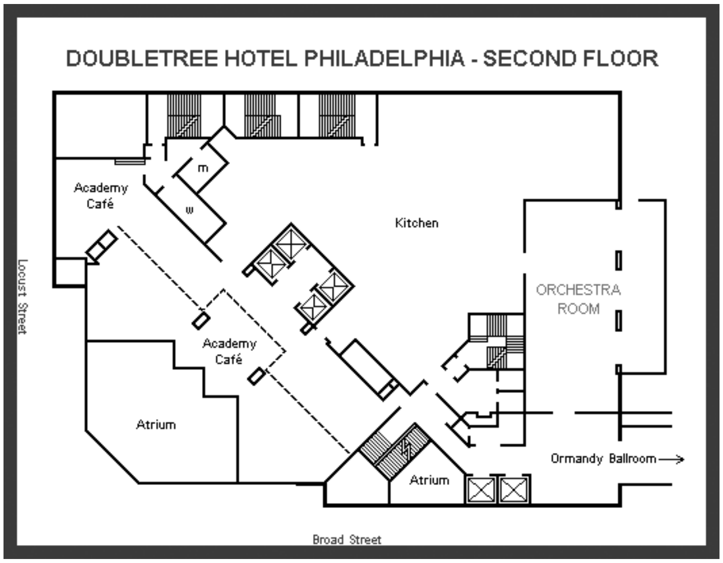
May 20-22, 2012
Philadelphia, PA

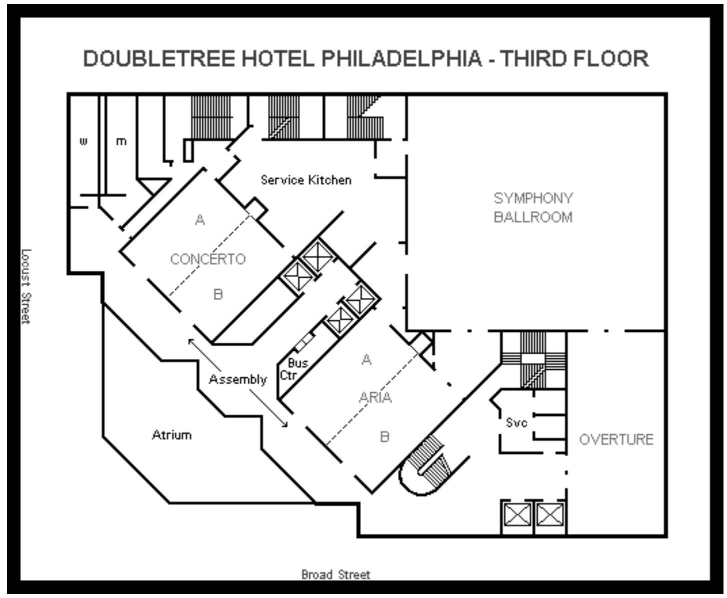
Expected Paid Attendance: 300

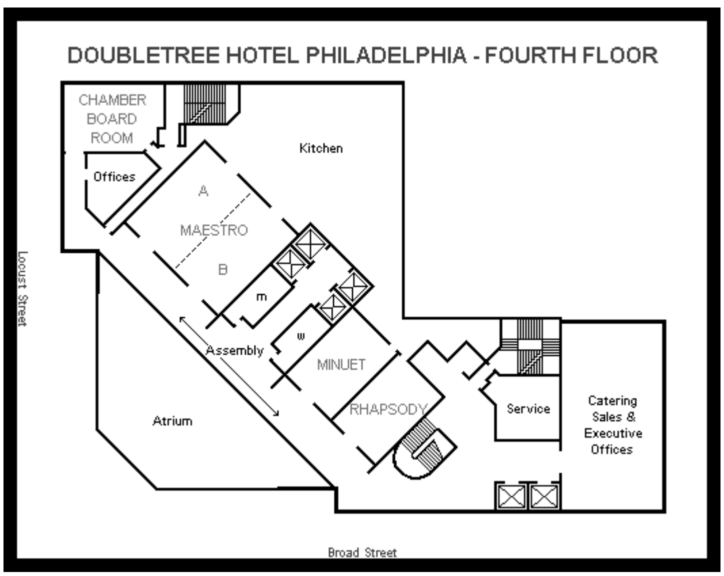
Revenue	
Registration	$102,135
Total	$102,135
Direct Expenses	
Printing	$2,400
Organizing Committee	$2,100
Invited Speaker	$12,750
Food and Beverage	$15,000
Telecomm	$4,300
AV and Equipment (rental)	$13,700
Room (rental)	$0
Advertising	$5,400
Conference Staff Labor	$23,600
Other (supplies, staff travel, freight, misc.)	$1,600
Total Direct Expenses:	$80,850
Support Services: *	
Services covered by Revenue	$21,285
Services covered by SIAM	$39,022
Total Support Services:	$60,307
Total Expenses:	$141,157

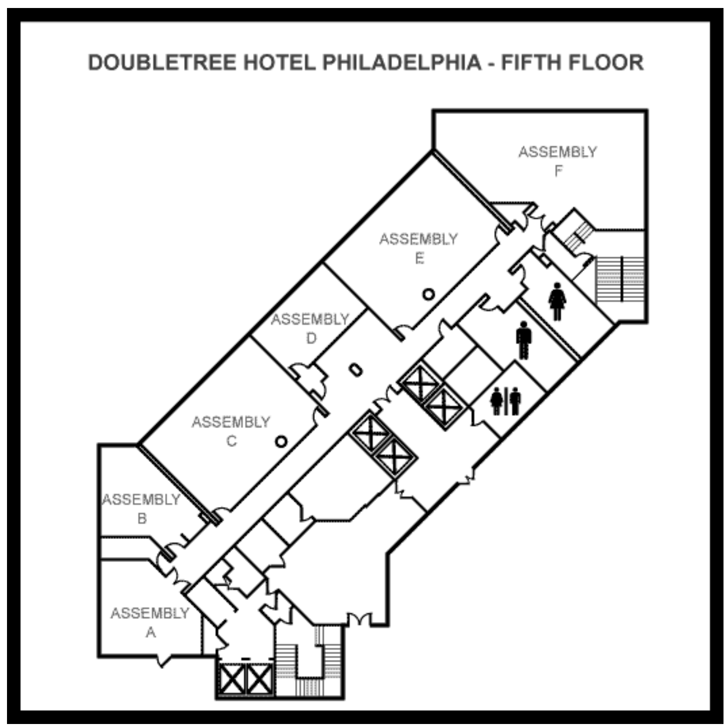
* Support services includes customer service, accounting, computer support, shipping, marketing and other SIAM support staff. It also includes a share of the computer systems and general items (building expenses in the SIAM HQ).

Doubletree by Hilton Hotel Philadelphia Center City Map









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