

Abstract

In their seminal work on homological sensor networks, de Silva and Ghrist (*Algebraic & Geometric Topology*, 7:339–358, 2007) showed the surprising fact that it’s possible to certify the coverage of a coordinate-free sensor network even with very minimal knowledge of the space to be covered. Here, coverage means that every point in the domain (except possibly those very near the boundary) has a nearby sensor. More generally, their algorithm takes a pair of nested neighborhood graphs along with a labeling of vertices as either boundary or interior and computes the relative homology of a simplicial complex induced by the graphs. This approach, called the Topological Coverage Criterion (TCC), requires some assumptions about the underlying geometric domain as well as some assumptions about the relationship of the input graphs to the domain. The goal of this paper is to generalize these assumptions and show how the TCC can be applied to both much more general domains as well as very weak assumptions on the input. We give a new, simpler proof of the de Silva-Ghrist Topological Coverage Criterion that eliminates any assumptions about the smoothness of the boundary of the underlying space, allowing the results to be applied to much more general problems. The new proof factors the geometric, topological, and combinatorial aspects, allowing us to provide a coverage condition that supports thick boundaries, k -coverage, and weighted coverage, in which sensors have varying radii.