THE UNIVERSITY OF CHICAGO

Departments of Computer Science, Mathematics, Statistics and the Computation Institute

SCIENTIFIC AND STATISTICAL COMPUTING SEMINAR

NILIMA NIGAM
Department of Mathematics
Simon Fraser University

How to effectively compute the spectrum of the Laplacian with mixed Dirichlet and Neumann data

THURSDAY, May 4, 2017 at 4:30 PM
226 Jones Laboratory, 5747 S. Ellis Avenue
Host: Lek-Heng Lim

ABSTRACT

Eigenfunctions of the Laplace operator with mixed Dirichet-Neumann boundary conditions may possess singularities, especially if the Dirichlet-Neumann junction occurs at angles $\geq \frac{\pi}{2}$. This suggests the use of boundary integral strategies to solve such eigenproblems. As with boundary value problems, integral-equation methods allow for a reduction of dimension, and the resolution of singular behaviour which may otherwise present challenges to volumetric methods. In this talk, we present a novel integral-equation algorithm for mixed Dirichlet-Neumann eigenproblems. This is based on joint work with Oscar Bruno and Eldar Akhmetgaliyev (Caltech). For domains with smooth boundary, the singular behaviour of the eigenfunctions at Dirichlet-Neumann junctions is incorporated as part of the discretization strategy for the integral operator. The discretization we use is based on the high-order Fourier Continuation method (FC). For non-smooth (Lipschitz) domains an alternative high-order discretization is presented which achieves high-order accuracy on the basis of graded meshes. In either case (smooth or Lipschitz boundary), eigenvalues are evaluated by examining the minimal singular values of a suitable discrete system. A naive implementation will not succeed even in simple situations. We implement a strategy inspired by one suggested by Trefethen and Betcke, who developed a modified method of particular solutions. The method is conceptually simple, and allows for highly accurate and efficient computation of eigenvalues and eigenfunctions, even in challenging geometries. If time permits, we shall also describe recent developments for the computation of the spectrum of sloshing problems.

Organizers:
Lek-Heng Lim, Department of Statistics, lekheng@galton.uchicago.edu
Ridgway Scott, Departments of Computer Science and Mathematics, ridg@cs.uchicago.edu
Jonathan Weare, Department of Statistics and The James Franck Institute, weare@uchicago.edu.

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