



The University of Chicago  
Departments of Computer Science,  
Mathematics, and Statistics

## Scientific and Statistical Computing Seminar

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### Hodge Decomposition: Applications and Numerics

**FRIDAY, February 3, 2012, at 3:30 PM**

133 Eckhart Hall, 5734 S. University Avenue (unless announced otherwise).

### ABSTRACT

A vector field on a compact domain decomposes uniquely into divergence-free, curl-free, and harmonic parts. This is an old and well-known tool in engineering known as Helmholtz decomposition. This idea generalizes to Hodge decomposition on manifolds, graphs, meshes, and other types of domains. I'll first recall Hodge decomposition in finite-dimensional spaces using the most elementary tools from linear algebra. We will then see it concretely manifested as a tool to solve vector Poisson's equation as well as a tool to rank alternatives on a graph. This is one demonstration of the unifying power of Hodge decomposition in modern computational mathematics. Then I will describe and compare numerical methods for Hodge decomposition on meshes and graphs. Even in such simple preliminary experiments some surprises are evident pointing to the need for new developments in numerical methods for graphs.

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