THE GRADUATE SCHOOL
of
**THE UNIVERSITY OF COLORADO
AT BOULDER**

DISSERTATION DEFENSE
of

Tobias Matthew Jones

FOR THE DEGREE

DOCTOR OF PHILOSOPHY

Date/Time: November 8, 2013 from 2:00 PM MST

Bldg./Rm: Grandview Conference Room at 1320 Grandview Ave

Examining Committee Members:
Stephen McCormick
Thomas Manteuffel
John Ruge
Robert Falgout
and Geoffrey Sanders

OUTLINE OF STUDIES

Major Field: Applied Mathematics - Multigrid Methods

BIOGRAPHICAL NOTES

Toby was born in Cambridge, England, but grew up in Greenwich, Connecticut. After attending the University of Colorado at Boulder from 1997-2001 Toby left academia to pursue a career making video games. Having never left the area, he returned to pursue a graduate degree at CU. Toby has had the opportunity to spend the last three years working with the computational group at grandview and several researchers at LLNL. Due to this, he has little free time, but any spare time he has is spent skiing, biking, or trying to convince his daughter not to jump off high objects.

THESIS

Algebraic Multigrid Methods For Parallel Computing, Systems, and Graphs

Faculty Advisor Stephen McCormick

ABSTRACT

In modern large-scale supercomputing applications, Algebraic MultiGrid (AMG) is a leading choice for solving linear systems. However, on the newest architectures, the relatively high cost of communication versus computation is a concern for the scalability of traditional implementations. Introduced here are Algebraic MultiGrid Domain Decomposition (AMG-DD) and Algebraic MultiGrid Range Decomposition (AMG-RD) which trade communication for computation by forming composite levels that replace many stages of multilevel communication with local computation using redundant information.

Another open topic in the application of AMG is in the context of solving systems of equations. Adaptive Smoothed Aggregation was developed as a method to address the potential difficulties with not only generating the aggregates in this setting, but also to generate the kernel components required to efficiently solve these problems. New variants on this approach are introduced that aim to more effectively identify the local and global near null spaces as well as form more robust multilevel solvers.

Historically, AMG has been used to solve linear systems that arise from the discretization of differential equations. However, due to the $\mathcal{O}(N)$ scalability of the method, it seems natural to investigate it in other contexts that generate large sparse linear systems. Data mining in graph theory applications generate very large, but extremely sparse, linear systems, called Graph Laplacians. As a step in the process of targeting AMG for these problems, eigenvectors of matrices formed from graphs are investigated.