Syllabus MATH 664:

Foundations of Adaptive Finite Element Methods and Their Implementations

Information on the class web page supersedes any information on this sheet:
http://www.math.tamu.edu/∼bonito/MTH664_2010_600.php

Instructor

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Textbooks

There is no textbook required for the course. Mainly, the following research papers are discussed:

1. *Quasi-optimal convergence rate for an adaptive finite element method.* Cascon et al. SIAM J. Numer. Anal. (2008).

2. *A goal-oriented adaptive finite element method with convergence rates.* Mommer et al. SIAM J. Numer. Anal. (2009).

3. *Convergence and optimality of adaptive mixed finite element methods.* Chen et al. Math. Comp (2009).

4. *A posteriori error estimators for the Stokes and Oseen equations.* Ainsworth et al. SIAM J. Numer. Anal. (1997).

Course Description

The finite element method is one of the most successful computational tools in dealing with partial differential equations arising in science and engineering (solid and fluid mechanics, electromagnetism, thermodynamics, etc). Adaptivity is a fundamental instrument in computational science and engineering which makes multiscale problems tractable. Its basic principle is to equidistribute the computational effort by increasing resolution near fine scale features (refinement) and removing degrees of freedom where the local scale is relatively large (coarsening).
The first part of the class is devoted to the study of the-state-of-the-art h-adaptive finite element methods on simplified elliptic problems. Several type of estimators are introduced with a special focus on residual type estimators and their extensions to goal oriented estimators. Their actual implementations are addressed as well.
The second part of the class discuss mixed formulations of the elliptic problems treated in the first part, thereby leading to saddle point problems. This is particularly relevant for instance in elasticity, where the quantity of interest is the stress tensor and not much the displacement.
The last part introduces fluid flows such as Stokes and Oseen systems characterized by saddle point structures as well. Different type of error estimators available and driving the adaptivity are considered.

Prerequisites

Some basic notions on finite element method will be reviewed. Therefore prior exposure to graduate level finite element methods will be useful but not mandatory. This course may be an excellent complement to the graduate finite element courses MATH 608, 609, 661, and the special topic course on approximation theory.

Grading System

The final grade is based on a take home project at the end of the semester. Each student has to chose right after the Q-drop date one of the two proposed projects. The first project is mainly constituted of theoretical problems but also includes basic practical problems (modification of a provided MATLAB code). The second project is more practical, can be tuned to the student interest, and requires more advanced implementation using the DEAL II library (www.dealII.org).

Office Hours

No special periods are blocked for office hours. You are welcome to schedule appointments by email.

Academic Integrity

The Aggie Honor Code *"An Aggie does not lie, cheat or steal, or tolerate those who do"* applies, see also the Honor Council Rules and Procedures at

$$http://aggiehonor.tamu.edu \quad .$$

Students are strongly encouraged to work together and discuss homework problems with each other. However, copying or stealing work done by others is an act of academic dishonesty and will be persecuted according to the University policy.

Disabilities

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit

$$http://disability.tamu.edu \quad .$$