PROJECT DESCRIPTION

CEE 361-513: Introduction to Finite Element Methods

The objective of the project is to explore an application of finite elements to a problem of interest to you. The project can be of two kinds: (1) explore a modeling problem or (2) develop relevant technologies. Examples of (1) could be modeling of structural response to multi-pysics phenomena, the interaction of solids and structures with fluids or soils, the fluid flow in fractured materials, or the solution of an interesting PDE. Examples of (2) could be the creation of mesh adaptivity schemes, improved quadrature rules, or the design of new finite elements.

For modeling you will be using FEniCS to implement the finite element solver while for the development projects consult with us in regards to which tools are best to be used. While you have the freedom to choose a project of your interest you should highlight why what you are planning to do is new and relevant.

You may work in pairs, although the expectations for group projects are greater than for individual projects.

If you have any questions about the topic of your project please come to office hours or email me to set up a time to discuss it. If you would like to tackle a more challenging problem (perhaps aligned with your current research) but feel that you would need extra support, please consult with me as to discuss feasible goals and get addition direction.

The project consists of three milestones. Reports shall be compiled in LaTeX.

Milestone 1: Project Proposal

The project proposal should be emailed to chiaramonte@princeton.edu by November 7th, please turn in a short report (1-2 pages max) containing

i. the title of the project

ii. description of the physical problem being modeled or the finite element technology to be developed

iii. a statement of the mathematical model (partial differential equations and boundary conditions) in both strong and weak form, and

iv. questions you would like to answer through your project

Milestone 2: Midterm report

Project midterm project report will be due on December 12th. The report should follow the format of a research paper with the following suggested sections:

i. Introduction, including a description of the physical problem

ii. Mathematical Formulation and Finite Element Approximation, including strong and weak form and expressions for the discrete equations;

iii. FEniCS Implementation and Verification, describing briefly how it was implemented in FEniCS and including exact or manufactured solutions used to verify the code

iv. Numerical Result

v. Discussion or Conclusions; and

vi. References.

As this will be an interim report some of the work might be still a work in progress. Namely the implementation may not be completed and results may be incomplete (albeit you are expected to have some preliminary results to show for). Thus highlight the work completed thus far and the trajectory for the successful completion of the project.

Milestone 3: Final report

The final project report will be due on December 12th. The report should follow the format of a research paper with the following suggested sections:

i. Introduction, including a description of the physical problem

ii. Mathematical Formulation and Finite Element Approximation, including strong and weak form and expressions for the discrete equations (matrix form)

iii. FEniCS Implementation and Verification, describing briefly how it was implemented in FEniCS and including exact or manufactured solutions used to verify the code;

iv. Numerical Results;

v. Discussion or Conclusions; and

vi. References.