MA5233 Computational Mathematics

Recess Week Project

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Deadline: 3 October 2019, 7pm

Instructions

- Pick any topic covered in the lectures.
- Perform some independent investigation on this topic.
- Write up your findings.

Some example projects are provided on page 2.

Project requirements

- You may work alone or in pairs. If you work in pairs, submit a single report with both your names on it.
- You may use any programming language of your choice. Submit your code along with your report. I will most likely not look at your code, but having access to it may help me understand your project better.
- Your report should start with a brief overview of your project and some motivation of why the topic you chose is interesting.
- Your project must involve mathematical reasoning, programming and some numerical experiments. For example, you can satisfy this requirement by 1) discussing the theory behind some algorithm, 2) implementing it, and 3) presenting some numerical results obtained with your code.
- 25% of your grade will be based on the presentation of your results. Make sure your report has a clear structure, your arguments are well formulated and your notation is consistent. Typesetting using LaTeX is recommended but not required.
- You are encouraged to look for additional literature. If you do, cite your references as failing to do so is plagiarism.

Hints

- Implementations of Krylov subspace methods are available in the `IterativeSolvers.jl` package, see https://github.com/JuliaMath/IterativeSolvers.jl

Example projects

- Discuss and implement either conjugate gradients or BiCGSTAB.
- Derive and implement a version of MinRes which requires storage for only five vectors.
- Discuss and implement multigrid in two dimensions.
- Apply multigrid to the Poisson equation $-\nabla \cdot \big(D(x)\,\nabla u(x)\big) = f(x)$ with spatially varying diffusion coefficient $D(x)$. Hint: the performance of multigrid degrades for very nonsmooth $D(x)$, e.g. $D(x)$ with discontinuities.
- Study the convergence of Krylov subspace methods as a function of the eigenvalues. Try a few preconditioners and see how they perform.

Note: most of the above projects cover only some of the required components 1) mathematics, 2) programming, 3) numerical experiments. It is your responsibility to make sure your project covers all three components.