

MATH 676 Project for Joshua Hanophy

Proposed project: The first part of your project consists of implementing an interface for the pAIR preconditioner found in Hypre. This will in particular consist of suggesting and testing out default parameters for the preconditioner that work for “out of the box” for a reasonable number of diffusion, convection, advection problems. The interface should be similar to the existing interface to Trilinos (and/or PETSc) found in the library. I would appreciate to see well-documented code on the implementation side as well (that can serve as a positive example how to document source code for future generations to understand). The stated goal is to make a pull request to get the interface into the library. A pull request should also be accompanied by a number of small tests that check basic functionality (for some dummy equation).

A second part of your project will be concerned with the implementation of an example step that demonstrates how to use the preconditioner. In order to have a strong example step (that is ready for inclusion) we will have to identify either some interesting equation (with a twist) that deserve a thorough discussion, and/or demonstrate and explain our interfaces for parallel linear algebra in more detail. I will help you identifying a suitable scope for the example step and will make sure to communicate our plan with my fellow deal.II developers.

Note: This project is subject to modification by mutual agreement between you and me. The goal is to have a project that fits your research interests. If you would like to deviate from the path outlined here, talk to me!

Relevant tutorial programs: For your project, you will want to read through tutorial programs **32, 42, 55** . You should consider starting the program you will write for your project as a variation of one of these. (Links to all tutorial programs can be found at <https://www.dealii.org/developer/doxygen/deal.II/Tutorial.html>.)

Relevant video lectures: In addition to the resources already posted on the course website (Google Drive), you should watch lectures **41.5, 41.75** for background material necessary for your project. Links to all videos can be found at <http://www.math.colostate.edu/~bangerth/videos.html>.

Keep notes on these resources and all background reads in your journal as on all other external resources you consult!

Project tasks: As part of your project, you will need to meet the following milestones:

- *Milestone 1 (March 18, 2019 – the week after spring break):*
 - Implement and document an interface for the pAIR preconditioner in Hypre. Write a number of (unit) tests for the interface that ensure that the preconditioner interface is properly working. (Make a pull request.) Identify the precise topic of the example step and start working on it.
 - You will need to prepare and give a 10 minute presentation in class on your progress so far.
 - You will also need to prepare a 1–2 page reflection essay outlining things you have learned so far. Guidance for the content is provided in the first day handout. This essay should be part of (and be clearly marked in the table of contents in) your online journal.
- *Milestone 2 (April 29, 2018):*
 - Finish the example step and accompanying documentation. When you are good to go (i. e. pending publication is accepted) make a pull request for inclusion of the example step.
 - You will need to prepare and give a 15 minute presentation in class or during the final exam time on the results of your project.

- You will also need to prepare a report on your project in the style of the tutorial program – i.e., including an introduction, a results section, and commented code that contains everything to run a simulation you show in your result.

Deliverables: Your deliverables at the end of semester include the following items:

- Your final report (as discussed above in Milestone 2) as a PDF file, emailed to me or checked into a github repository to which you give me access.
- Your finished, documented code and all input files necessary to run it, checked into a github repository to which you give me access.
- Your second 1–2 page reflection essay, as outlined in the first day hand out. This essay should be part of (and be clearly marked in the table of contents in) your online journal.

Grading: I will determine your grade in this class based on the following criteria:

- Sophistication of the code beyond the program from which it was started.
- Extent of documentation in the code.
- Extent of the documentation surrounding the program, i.e., description of the equation and its properties, description of the principles used in the implementation, and documentation of worked-out examples computed with the program.
- Sophistication and realism of the testcases to which you apply your numerical scheme.

As an example of how these reports should look like (though maybe not quite as extensive), take a look at the deal.II tutorial programs.

If you are interested, good projects may be published as part of the library and distributed with future versions (see for example the step-21, step-24, and step-25 tutorial programs that were created by students of a prior class), or as part of the code gallery (see <http://dealii.org/code-gallery.html>). Of course, you will then also be credited publicly for your work.