AMS 595: Programming Languages and C++

Course Projects

Project Objectives

Practice, deepen, and expand skills in

- Programming
- Computation
- Tools and software
- (Collaboration)

Apply these skills to

- Your own science and research with support from peers and instructors
- Or to topics motivated by examples provided by us or online

Performing your Project

Time available for projects is short

- Roughly final 4 weeks of semester
- Bear this in mind while developing your project ideas

- Important note: if you choose C++ as your programming language, you might accomplish less, but create faster code
  - Taken into account in grading

Project Success

- A successful project need not have accomplished all of its original objectives, but perhaps instead you
  - Learned new skills, techniques, science along the way
  - Got major bits of code running
  - Developed some interim conclusions relevant to the original theme
- To communicate your outcomes you will surely need some tables, graphs or pictures

Project Grading

- Projects count for 40% of total course grade. It will be based on:
  - Your submitted code
  - Your final project slide
  - Your written report

- Submit software, data, report (PDF), and presentation slide

- Upload to Blackboard at end of semester
- We will post your slides

Getting Started: Project Proposal

1. Choose a topic
2. Prepare project proposal (ONE page or less)
   - Title
   - Your name and email
   - Brief summary (ca. 1/2 page) with rationale or background to topic, what outcomes you hope to achieve, and your plan for getting the work done.
   - State what software you will use.

- Upload by **11/6** as Word or pdf file with file name based on your name

Next Step: Project Slide

- Prepare a single slide to describe your project
- Title
- Your name
- Goal(s): One sentence summary
- What you plan to do
  - How you will reach your goals
  - What software you will use (C++, python, Matlab and anything else)
  - A relevant reference (if any)

Upload by **11/13** as ppt or pdf file with file name based on your name.
We will post the collection of slides on Blackboard.

Project Results Slide

- Prepare a single slide to describe your project
- Title
- Your name
- Original goal(s): One sentence summary
- Summary of what you have done
- What software you used from other sources and what you have created
- Experimental results, evaluations or findings

Upload by **11/30** as ppt or pdf file with file name based on your name.
We will post the collection of slides on Blackboard.

Final Step: Project Report

- Prepare a project report containing
  - Your software in C++, Python, and/or Matlab and associated data
    - If the data is huge, then provide links instead
    - All info needed to run code (e.g. compilers, options used etc.)
  - A PDF written document ~5 pages describing
    - ~1-page: the project objectives
    - ~2-pages: techniques and tools
    - ~2-pages: conclusions
      - Graphics and references in addition. They are not included in the 5 pages
      - **Don't forget references!!**
- **Upload to Blackboard. Due date 12/3**

Grading Criteria

- Well organized and clear description of goals, challenges and accomplishments
- Key components included? (e.g. Title, goals, approach, challenges, results)
- Appropriate level of information
- Convincing effort? Appropriate accomplishments?
- Clear identification of basis for work (references, starting point) as appropriate
- What you have learned
- Discussion of how you tested your code
- Anything special? (Use of tools, performance, creative approach,…??)
- References

Grading the Code

- Well thought out approach to solving stated problem (meeting your goals)
- Solution is efficient, effective, easy to understand
- Good standards of programming, including: organization and layout; modularity, use of suitable variable names
- Good documentation (concise but to the point, all major functions described)
- Program executes without errors and results correspond to information in report. Testing of program was adequate

Project Topics

- See our suggestions for some project topics
  - In Blackboard
- A variety of programming projects that have suitable size and scope
- Perhaps a starting point for some new ideas of your own
- Some other potential sources of project ideas in these slides

Project Topics

- There are plenty of examples of solved projects at:
- http://www.cppforschool.com/projects.html
- These come with C++ solutions, but they might give you ideas for another project
- Another collection of problems can be found at:
- http://www.projecteuler.net/about
- Mostly suited for single developer, might give you some ideas

Project Topics

- There are plenty of examples of solved projects using Matlab in Cleve Moler's book Experiments with MATLAB
- Could potentially be re-implemented in Python or C, expanded on or experimented with.
- They include
  Game of Life; Predtor-Prey Model; Sudoku
- Mandelbrot, Orbits, Shallow Water Equations
- Morse Code; Music

Project Topics

- You could look for efficient solutions in C++ to a problem requiring
  - Stencil operations, Linear algebra, Monte Carlo simulations, Genetic Algorithm, Molecular Dynamics
- Ex: Discover behavior of gas, liquid and solid starting from Newton's 2nd law and a simple model for the interaction between 2 atoms
  - Simulation: write your MD program
  - Data intensive: analyze data generated by an existing Python MD program
  - Graphics: write your own graphics or interface with package to visualize data generated by Mdcode

Project Topics

- Consider focusing on performance tuning
  - Getting a really fast code; experimenting with ideas for optimization and comparing performance of different versions
  - Potentially trying out, reporting on use of tools
- A very important real-world problem is the challenge of getting really fast matrix multiplication with double precision elements
- Can one version do (very) well on more than one computer?