Syllabus for Computational Physics

NYU Department of Physics - Fall, 2016
Prof. Haas <andy.haas@nyu.edu>
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This course provides an introduction for undergraduate physics students to computational physics. We will learn various techniques for solving physics problems numerically, using traditional programming, with the Python language. We will also peek at two other computing platforms, embedded computers (Arduinos) and FPGAs.

Topics (and tentative schedule):
Sep. 6: Chapter 1: Introduction and Python Tools
Sep. 13: Chapters 2+3: Software Basics and Errors/Uncertainties
Sep. 20: Chapter 4: Monte Carlo Techniques
Sep. 27: Chapter 5: Numerical Differentiation and Integration
Oct. 4: Chapter 6: Matrix Computation
Oct. 11: Chapter 7: Searching and Fitting
Oct. 18: Chapter 8: Differential Equations
Oct. 25: Chapter 9: ODE Applications
Nov. 1: Chapter 10: High-performance Computing
Nov. 8: Chapter 12: Fourier Transforms
Nov. 15: Chapter 15: Nonlinear Dynamics
Nov. 22: Start personal project (the basis for the presentation on Dec. 15th and final report)
Nov. 29: Embedded computing: Arduino
Dec. 6: Low-level computing: FPGA
Dec. 15: Presentations

Books:

- Computational Physics: Problem Solving with Python, 3rd Edition
  Rubin H. Landau, Manuel J Páez, Cristian C. Bordeianu
  http://www.wiley.com/WileyCDA/WileyTitle/productCd-3527413154.html
  https://www.amazon.com/Computational-Physics-Problem-Solving-Python/dp/3527413154
- Exploring Arduino: Tools and Techniques for Engineering Wizardry, 1st Edition
  Jeremy Blum, Wiley
  https://www.amazon.com/Exploring-Arduino-Techniques-Engineering-Wizardry/dp/1118549368
- Make: FPGAs: Turning Software into Hardware, 1st Edition
  David Romano, Maker Media, Inc
  https://www.amazon.com/Make-Turning-Software-Hardware-Projects/dp/145718785X

Videos (and slides):
These will be assigned to read/view outside of class:
http://physics.oregonstate.edu/~landaur/Books/CPbook/eBook/Lectures/

Sample codes: http://physics.oregonstate.edu/~landaur/Books/CPbook/Codes/

Class meets Tues. and Thurs, from 12:30pm - 1:45pm, in Meyer 425.
There is also a recitation session on Wednesdays.
Prof. Haas will have an open office hour on Tuesdays at 5pm, in Meyer 706.

Each week, on Tuesday, we'll introduce a "problem" (usually from the textbook). A report will then be worked on by each student, which solves that problem, including:
1. A restatement of the problem, and the equations you are to solve or simulate
2. A description of the numerical method being used
3. The code listing (in a separate electronic file), but place snippets of important code in the body of the report and explain how the program works
4. Results showing the solution: graphs, short tables, or something visual
5. Critical analysis: what did you learn, are you convinced, how could we do this better
6. For extra credit: explore some other application or extension of the program you find interesting!

Reports are due Tuesday at noon, electronically (PDF and code). They'll be returned in class the following Tuesday. Recitation sessions are a great time to discuss your returned reports with Alex. *Students may discuss the problems together and even help each other with their programs. In fact we encourage students to collaborate!* ***But each report must be written entirely by each student separately.***

Project/presentation:
Starting Nov. 22 each student will start work on a personal project, that he/she should discuss with Prof. Haas. It can be related to any methods we've discussed in class, or extend to some more advanced method. It should be of the same format as the other reports, but longer and more in depth. In addition to the written report, each student will also make a ~5 minute slide presentation to the class on Dec. 15, explaining the project and results.
There is no final exam.

Grading:
80% reports
20% project/presentation