Project Guidelines Handout

Physics 129 Summer 2024

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For the rest of the quarter, you will work to complete a course project. Your project must in a significant way involve mathematics, science, or technology. For example, a computer game might be a good project, but only if it involves ray tracing, physical modeling, or some other compelling topic. **You must write your own code for the project. It is not acceptable to simply copy a program or programs you find with a web search or generate with AI. The core function of the program must be implemented in code you wrote yourself. In other words, your effort must clearly involve more than just calling a series of library functions written by other people.**

Some project ideas are listed at the end of this handout. You may also come up with your own idea. **All project code and hardware must work when the code is run from the command line on a Raspberry Pi 5 (or 4 or 400) configured for Physics 129.** Project code must be written in Python, version 3. You may use additional software libraries if necessary, for example to support specialized hardware, but they must be freely available.

You may use only 7-bit ASCII text (unaltered English characters) in the code you turn in, in your program interfaces, and in your program output.

All projects must be preapproved by the instructor. By **Wednesday, July 17, at 11:55 P.M.**, you must email a brief (no more than **one paragraph**) description of your proposed project to the instructor for approval. Place the text in the body of your email message rather than an attachment. In particular, please *do not send Microsoft Word files.*

Your grade will depend on how challenging the project is, how well it is executed, and how interesting the final result is. As you make your decision about what to do, remember that you have limited time. **It is much better to finish a realistic project than to end the quarter with half of a really ambitious one.** The stages you will go through with your project are:

1. Design. **You must design your project. You may not simply copy and/or install someone else's code.**
2. Writing.
3. Debugging.
4. Aesthetic and functional refinement.

Make sure to leave time for all 4 of these tasks!!!

We have no budget for additional hardware, so if you decide you would like to do something involving hardware, you must buy it yourself (right away!).

Here is a guide to how projects will be graded, in points:

10: Planning. This grade will reflect the quality of your 1-paragraph project description (see above) and the **Project Specification** problem in Homework #4. Late submission will result in lost credit.

30: Selection and design. Is the project interesting? Your instructors are interested in math, science, and technology, so it should not be difficult to get full credit here. Avoid commonplace or mundane computing topics. Make sure to add something significantly new and interesting if your project overlaps with any of the homework problems.

Is the completed part of the project challenging? A project that can be finished in a couple of hours is probably too simple. Note that you will not get credit here for a challenging problem you don't solve, so choose wisely and **don't bite off more than you can chew!**

Is the interface well laid out, easy to use, and easy to understand? Is the code well structured and commented? Is the program elegant or crudely written? Note that a text-based interface can be done very well, and a graphical interface can be terrible. What is important is how well you design the interface you choose to build.

30: Function. Has the program been debugged? Does it handle all possible input gracefully? Does it always produce a correct answer?

Is the project complete? Does it appear to solve a problem in a satisfactory manner, or is it still lacking functionality? Is it finished, or did you run out of time?

Was the code implementing the core function of the program written solely by you? If not, no credit for this section, and possibly none at all.

30: Presentation. This score will reflect the quality of your presentation paper, as described in the **Final Project** problem in Homework #5.

Plagiarized projects will receive a score of 0. You may use freely available software modules and libraries for specific functions (for example, facial recognition), but you must be the sole author of the main project code.

Project possibilities:

- Interactive mouse-driven Mandelbrot Set or Julia Set explorer
- Set of 3-d ray-traced images of the Mandelbrot Set
- Ray tracer with several examples of rendered scenes
- Illustrations or animation of the 3-d vector field created by dipole radiation
- Illustrated or animated 2-d differential equation solver for heat with user-controlled boundary conditions
- Diffraction simulator

- Water wave simulation (propagation with boundaries or a breaking wave)
- Calculator for local sun and moon angles and rise and set times.
- Solar panel layout design tool and simulator
- Other non-trivial astronomical calculation or display
- Parallel Mandelbrot or Julia set calculator demonstrating performance improvement with multiple processors
- Parallel integer factoring program demonstrating performance improvement with multiple processors
- Other interesting use of parallel processing
- Hybrid image creator

Suggestions requiring additional hardware:

- Color vision demonstrator with LEDs
- Stepper motor-driven device
- Audible Morse code translator
- Something interesting with RPi audio
- Motion-detecting camera
- Network-controlled system to take and transmit a photograph
- USB microscope application
- Thermal imaging application
  https://www.adafruit.com/product/3538
  https://www.digikey.com/en/products/detail/adafruit-industries-llc/3538/7725296
  https://www.adafruit.com/product/4469
  https://www.digikey.com/en/products/detail/adafruit-industries-llc/4469/11497511
  https://www.sparkfun.com/search/results?term=thermal+camera
- Load cell application
  https://www.adafruit.com/product/4538
  https://www.digikey.com/en/products/detail/adafruit-industries-llc/4538/16584123
  https://learn.sparkfun.com/tutorials/getting-started-with-load-cells
- Automatic irrigation system
  https://www.adafruit.com/product/4026
  https://www.digikey.com/en/products/detail/adafruit-industries-llc/4026/9745252

- Sunrise simulator alarm clock
- Schlieren photography system

Forbidden topics:

- SIR or any other epidemiological modeling.
- AI. The Raspberry Pi typically does not have enough power to do useful AI. An exception might be made if you can present a very compelling argument for why your proposed project will work on a RPi.