

Final Project

Overview

The final project will give you an opportunity to take a physical question of your choice and explore it with the help of your Compass colleagues. The goal here is to create scientific models which can sufficiently explain and reproduce data which you gather from either experiments or physical simulations.

You will break up into research groups of 2 to 3 students, each of which will pick a question in the physical sciences that you can gain traction on and explore with the support of a graduate student research advisor. This will mean building conceptual and mathematical models and applying them to answer some specific facet of your original question. We will work on the final projects for around two months, starting on October 9 and concluding with a written report and poster due on December 7 and December 4, respectively. This process is designed to model the actual research process, so that you can get a feel for what real science research is like. And above all, it's meant to be a fun opportunity to explore a novel concept worth wondering about.

The Process

On October 2, we will provide you with a list of about a dozen possible research questions. Part of your homework that week will be to look over this list and rank your top choices. You are encouraged to propose your own ideas, but be aware that they are subject to approval based on being appropriate for a research project of this length and scope. This approval process will likely involve some back-and-forth between you, us, and the rest of the class.

On October 9, the first half of class will be devoted to sorting everyone into research groups and assigning each group to a question and research advisor. We strongly encourage you get a sense of who is interested in what before class by talking either in person or on Piazza. We want the actual sorting process be as free-form as possible, so that we can create groups that will take both your preference of topic and preference of group mates into account. The graduate student research advisors will also sort themselves into your groups as part of this process.

From October 16 through November 6, the first hour of each class will be devoted to meeting in your research groups with your advisors to make progress on your projects. You should be prepared to give a 5-minute update on what you worked on in the past week. This will allow you to work with each other, your advisor, and us to address any questions or difficulties you may be having. By the end of the period, you and your group should have chosen concrete individual and group goals to accomplish over the next week. You will need to meet with your group outside of class when it becomes necessary.

The Products

While we know that the scope and content of your project will change as you learn more about it (and you will almost inevitably learn less than you hoped for — welcome to research!), you will be expected to produce work at the end of the semester that communicates your results to your classmates, the other advisors, and us. This will take the form of (1) a **written research report** and (2) a **poster** to be presented at a poster session. Additionally, you will each submit (3) a comprehensive **personal reflection** on your progress as a student over the course of the fall semester.

Written Research Report

Each group will submit a written paper summarizing your findings. This will include a complete description of any models you use, predictions you make, and other resources you use to come to your findings. Papers should be about five pages long, but feel free take the amount of space you need to explain your work well. A **draft** of this paper is due in class on **Tuesday, November 27**. The **final version** of the paper is **due on Friday, December 7 by 5PM** as a PDF in your bSpace dropbox.

Please include the following in your paper:

1. Abstract

This is a paragraph that should appear at the beginning of your paper summarizing everything that you have written, including about a sentence of each of the following: the reason your project is interesting, your approach, and your findings. This is not a mystery novel, it's a research paper! A person unfamiliar with your work should be able to understand the main points of your paper and decide whether or not they want to read the details based on your abstract alone.

2. Introduction

This is the first part of your paper and it should include two main things: a rigorous statement of your question and relevant background material. You should explain what the question you are trying to address is and comment on why this question is interesting to you. Then, you should provide the information that your reader will need to know in order to understand both your question and the results you will present. This is also the place to present anything else that you think would be useful for your reader to have as context while reading the rest of your paper.

3. **Model & Results**

This is the section of your paper where you guide the reader through your model and results. The way you present the material here should **not** be in the order that you learned it, but in the order in which it will make the most sense to the reader (always remember your audience!). This is also **not** a record of everything you did (that's what your lab notebook is for). Instead, it should contain only the information necessary to guide the reader through understanding what you've come to understand. It should be a clear story about what you discovered that anyone who has read your Introduction should understand. More specifically, you should include the following:

a) **The model**

You should discuss what physical situations you considered and the physical model(s) you used to describe them. You should also include all the assumptions you made as a part of your model.

b) **Quantitative predictions**

Your report should contain at least one quantitative prediction about the system you are considering. That can be in the form of a number that you calculate or a mathematical equation expressing a relationship that you derived.

c) **Experimental results**

In some cases, you may want to measure a quantity that your model can predict. If you have conducted an experiment, this is the place to describe exactly how you conducted your experiment and what you measured. Then you should compare your experimental results to your quantitative predictions. Even if you don't perform an experiment, experimental data about your phenomenon may be available; you could compare your predictions with this.

4. **Discussion**

This is the conclusion to your report, where you take your work and connect it with your original question. What did you learn that helped answer your original question? What questions do you still have? Are there questions that you discovered in the course of doing your research? If you had another semester to work on the project, what would you look at next? How would you proceed?

5. **Statement of Work Distribution**

Include a statement at the end of your paper that describes who in your group contributed what fraction of the work towards completing your project. This can be as detailed as you like, but a statement as simple as "Alice contributed 60% and Bob contributed 40%" is fine.

Scientific Poster

Your group will also create a poster summarizing your project to be presented at a Compass Poster Session and Holiday Party on **Tuesday, December 4 at 6:30PM in 375 LeConte**. All of Compass will be invited to this event, and some part of the time will be set aside for attendees to visit each group's poster and talk to the group members about their work. Therefore, the poster's content should essentially be a summary of your paper, with an emphasis on conveying important information visually while you talk with people interested in your poster.

The poster should be black-and-white with dimensions 36" x 30" (width x height). A **draft** of your poster will be due in class on **Tuesday, November 20**. You may make it using whatever software you like (for example, Microsoft PowerPoint, Adobe Illustrator, or Adobe InDesign, which are all available for free from software.berkeley.edu), but you must submit your **final version** as a PDF to your bSpace dropbox by **Friday, November 30 at 5PM** so that we have time to print them before the poster session.

Personal Reflection

We also would like you to take some time to consider your process while working on this project. This reflection should be about 2-4 pages long and is due on **Friday, December 7 at 5PM** in your bSpace dropbox. Note that while you will only submit one paper and one poster per group, you will each complete your own personal reflection.

The reflection should have three parts:

1. Reflection on model building

You have gone through the process of building a model twice: once with light and once with your final project. You've also thought about models of intelligence. Here are some questions to start your reflection: How has this experience both reinforced and challenged whatever you thought a model was before this fall? Does your model match up well with the criteria of "what is a model" that we came to consensus on at the beginning of the course? Did you deliberately make your model incorporate these criteria, or did it just happen, and is that good or bad? What thoughts do you have about the process of answering a question by building a model?

2. General reflection on the research process

What was it like conducting your research? Did anything surprise you about the process? Was there anything that was particularly challenging?

3. Specific reflection on a piece of your research process

Pick a specific moment in the course of your research where you got stuck or had trouble proceeding. What happened? Why were you stuck? What did you attempt to do to get unstuck? What worked? What didn't work? What was the outcome and why?