

**CMPSC 580
Junior Seminar
Spring 2022**

**Assignment 8:
Experiment: Answering a Research Question using a Prototype**

Objectives

To design and conduct an experiment using developed prototype to collect preliminary data with a goal of answering at least one research question connected to the research project idea.



Figure 1: Is your idea feasible for the time and resources which are available to you?

Introduction

By this point, you should have a working and well-documented prototype that can run experiments, collect data, and analyze results. Additionally, you should have a well-defined research project accompanied by several research questions that can prove or disprove research hypotheses (expectations about how a certain phenomena or process works).

In a scientific process, an experiment typically refers to a process that tests a hypothesis but it can also try to answer “what if” questions without an expectation about what the results might be (ref: <https://en.wikipedia.org/wiki/Experiment>). Over the next week, you will design and carry out an experiment that will test your research hypothesis and will try to answer at least one of the research questions connected to your research idea.

- **Experiment Design:** You need to begin by planning your experiment. Experiment’s output is data so you can begin by thinking about anticipated findings (what research questions might you be able to answer) and decide what data you need to produce to get to those findings. Then, you can design your experiment with that output data in mind. In summary, try to answer the question “What experimental findings will answer my research question?” (ref: “Plan the Experiment” in Chapter 6, p. 92, of the *Published* textbook, [1]). Finally, you can identify the steps of the experiment, that is, “What are you going to do and exactly how will you do it?” It is helpful to conceptualize your experimental design by writing down your

ideas, making a flow diagram of the workflow of the experimental steps, and discussing them with a colleague.

- **Running the Experiment:** Now that you have carefully thought through your experiments and identified all of the steps necessary to complete it, you can finally begin your experiment (ref: “Run the Experiment” in Chapter 7, p. 104, of the *Published* textbook, [1]). As you run your experiment, remember to take notes, document your progress, and monitor your experiment consistently to be able to catch any mistakes early on. In particular, check the preliminary data that you are collecting to observe that it looks as expected. It is likely you will have to troubleshoot errors as you go through this process and it is common for a researcher to redo the experiment, sometimes multiple times!

Explore, but do not wander when completing your experimentation: *Exploration* implies preparation where-as *wandering* implies no clear destination (ref: chapter 7, page 5 of the *Published* textbook, [1]).

- **Analyzing Results:** Once you can confirm that your findings are meaningful and accurate, you have successfully completed an experiment. In order to do this, you will need to analyze output data (for example, run some statistical analysis on your output data) and visualize its findings (ref: “Visualize the Findings” in Chapter 8, p. 124, of the *Published* textbook, [1]). You will need to choose the right type of visualizations to display your findings.

Clone Your Assignment Repository

Today’s assignment repository can be found at the below link to a GitHub Classroom repository. Here you will work on the implementation of your prototype and then you must push your work to the GitHub cloud where the instructor will be able to view your work for grading. Often, there will be files in your assignment repositories which you are to edit before you submit them by using the below commands for `git`. **Please note that the instructor cannot view your submission and cannot grade your work unless you push your work to the GitHub cloud!**

<https://classroom.github.com/a/07-rHhPR>

To use this link, please follow the steps below.

- Click on the link and accept the assignment
- Once the importing task has completed, click on the created assignment link which will take you to your newly created GitHub repository for this lab,
- Clone this repository (bearing your name) and work locally
- As you are working on your lab, you are to commit and push regularly. The commands are the following.

```
– git add -A
– git commit -m ‘Your notes about commit here’
– git push
```

Part 1, Today Lab (Wednesday, April 20th): What To Do

Today you should complete the design of your experiment. Specifically, in your design, you should:

- Identify what research question related to your research project you will attempt to answer with an experiment.
- Identify what experimental findings that will answer your research question. What data will your experiment produce?
- Outline the detailed steps of your experiment. To help visualize these steps create a technical diagram of your experimental steps (workflow of what you will do in your experiment).
- Update your GitHub Project Board in your prototype implementation repository by adding the items to the TODO column corresponding to your experimentation steps.

Part 2, Class (Thursday, April 21st): What To Do

Begin class by pairing with a colleague and walking each other through your experimental design. Ask each other the following questions:

- What data are you trying to produce?
- How can your experiment generate that data?
- How can your prototype run that experiment?
- What additional functionality or input does your prototype need to run the experiment?
- How can this additional functionality or input be created?

Then, document your review of your colleague's experimental design in a GitHub issue in your colleague's "prototype" repository by commenting on the following prompts.

- Well-defined research question.
- Experiment that can attempt to answer the research question above.
- Clear output data to be derived from an experiment.
- Implemented prototype can clearly facilitate in running the experiment.
- Detailed steps outlining the workflow of the experiment.

If needed, before next class, please work on ensuring that your prototype is fully ready to run your experiment and, if any input information/data is needed that it is available for the experiment.

Part 3, Next Week Class (Tuesday, April 26th): What To Do

Now you need to run your experiment using your prototype. Be sure to carefully follow the steps you identified in your experimental design, document your progress, and check your results frequently.

All additional implementation you complete for the experiment must be put in your “prototype” repository and be clearly labeled and documented. Also, all of the output data produced by the experiment must be put into a clearly labeled directory in your “prototype” repository.

Part 4, Next Week Lab (Wednesday, April 27th): What To Do

During this lab you are to complete your experiment, and collect, analyze, and visualize results. Please consult the instructor on the methods of your data analysis and refer to “Visualize the Findings” chapter in the *Published* textbook [1] to learn of the techniques of producing effective visualizations.

Any code related to production of visualizations should be clearly labeled, documented, and located in your “prototype” repository.

Part 5, Next Week Class (Thursday, April 28th): What To Do

Lightening talk. Prepare a three min presentation / demonstration of your experiment and its results. Please be ready to discuss how this experiment is relevant to the research ideas which are at being studied in your project and how it attempts to answer at least one of your research questions.

Summary of deliverables

- **THIS week’s work**
 - **Part1; For lab (Wednesday):** Design an experiment. Respond to questions in File `writing/report.md`.
 - **Part2; For class (Thursday):** Peer review experimental plan. Respond to questions in File `writing/report.md`.
- **NEXT week’s work**
 - **Part 3; For class (Tuesday):** Run the experiment. Respond to questions in File `writing/report.md`.
 - **Part 4; For lab (Wednesday):** Continue the experiment, and collect, analyze, and visualize the results. Respond to questions in File `writing/report.md`.
 - **Part 5; For class (Thursday):** Lightening talk.
- **The software resources that you create for this work are to be submitted in the prototype/ repository**
- **Web notebook:** Please provide a cohesive blog post to summarize your experiment and its results on your website (min 200 words). Please title your posting, *Experiment*.

Help?

Please let the instructor know of any questions that you may have. Please use email or make office-hour appointment slots if you would like to discuss an issue.

References

- [1] T. Deetjen, “Published: A guide to literature review, outlining, experimenting, visualization, writing, editing, and peer review for your first scientific journal article,”