Lab Project: Developing a Hypothesis and Designing an Experiment

You received a blood pressure monitor (and a thermometer) with your lab kit. For your final lab project, you will design an experiment and use the blood pressure monitor (and/or thermometer) to test your hypothesis! The main steps are outlined below:

**By Nov. 23rd:**
- Pick A Group
- Develop A Hypothesis
- Design An Experiment
- Complete the “Project Check-In Survey” on Canvas

**By Dec. 4th:**
- Collect and Analyze Your Data
- Draw A Conclusion
- Present and Upload Your Finding

**By Dec. 6th:**
- Peer Review

**UPDATE (11/30/2020):** In the interest of time/reducing stress, we have removed the peer review component of the project, while you are still highly encouraged to watch and comment on your classmates’ presentations, this feedback will not be part of your final grade.

This whole project should only take you several hours, that is, around twice the time devoted to a lab, and therefore will count for the equivalent of two labs. Let’s break down the steps below:

**Detailed Instructions**

1. **Pick A Group:** You will be working in groups of 2-3 for this project. This can be your lab group, or a different group if you’d like to work with other students in the class.

2. **Develop A Hypothesis:** Once you have chosen your group, you should develop a hypothesis! This can be anything you can think of that you can easily investigate with your blood pressure monitor, thermometer, or other (see bullet point below). See the bottom of this document for examples. Your hypothesis should be based on a line of reasoning based on things you’ve learned (not necessarily from this class) and/or from some brief internet research.

   - NOTE: that if there is an interesting hypothesis your group is enthusiastic about testing, which does not use the blood pressure monitor or thermometer (e.g. COVID trends, polling statistics, or other pre-existing data sets) please reach out
to one of the members of the lab staff. Note also that if you do not collect the data used in your project, we will expect a more rigorous analysis.

3. Design An Experiment: Once you have a hypothesis in mind, you should come up with a systematic way to take data, and to compare this data to your hypothesis. You should be specific: More structure is usually better!

4. By Nov. 23rd (earlier is better though!) Complete The “Project Check-In Survey” on Canvas: Here you’ll tell us who is in your group, describe your hypothesis, your experimental design, and how you intend to analyze your data. A TF will review your descriptions, and get in touch if they have any advice or suggestions (or ideas!). The rubric the TFs will use to evaluate your proposed experiment is on the next page.

5. Collect and Analyze Your Data: After getting an okay from a Lab TF, go ahead and conduct your experiment! Take measurements and analyze your data using the Python techniques we learned in lab: You should incorporate your measurement uncertainties into your analysis. Depending on your hypothesis, you may need to fit your data to a model.

6. Draw A Conclusion: Given your analysis, can you draw a conclusion about your hypothesis? Were you correct, incorrect, or can you not tell? You should calculate a p-value, $\chi^2$ value, or another quantitative metric to evaluate your conclusion.

7. By Dec. 4th (earlier is better!) Present & Upload Your Findings: Once you have taken your data, analyzed your data, and have compared your data with your hypothesis and drawn conclusions, you should create a short (approximately 3-5 slides) presentation, and record an approximately 2-4 minute video of your presentation (e.g. on Zoom). Note that these times are suggestions: the presentations should only be as long as needed to carefully describe the following:

- Hypothesis
- Experimental Procedure
- Data, with appropriate plots
- Analysis
- Conclusions – both written describing confidence of confirmation/disconfirmation and numerical with error bars
- Self Reflection: How could you improve this analysis? (e.g. Is this the same conclusion you would draw if you had more data?)

Upload this presentation [instructions for how to do this will be here soon!]

NOTE: Each member of your group should be a part of the presentation (try to have everyone talk for about the same amount of time). Note that these presentations are meant to be casual - you will be evaluated on the clarity and content of your
presentation, not on how “slick” or “fancy” your slides are. Longer isn’t necessarily better. The rubric the TFs will use to grade your presentations is on the next page.

8. Peer Review: We will have an online posters session! You will post your videos to a class page, comment on other projects, and respond to feedback on your project. Note that both your evaluation of your peers’ work and your peers’ evaluation of your work will impact your grade. (More details on this step will be posted after Nov. 23rd)

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**RUBRIC 1**: For evaluating your proposed hypothesis and experimental design

- **Your hypothesis should be reasonable**: that is you should be able to make a reasonable argument that the quantities considered are causally linked (i.e., blood pressure vs, Zodiac sign). This may be stretchable if you make reasonable arguments about measurable quantities (i.e. "I'm scared of clowns, so my blood pressure may go up when there's one around! I will therefore measure my blood pressure before and after entering a haunted house with X number of clowns."), but we will not allow anything too crazy.
- **Quantities considered in the hypothesis should be measurable** (i.e. blood pressure vs. how tired I feel isn't measurable, whereas blood pressure vs. hours of sleep is)
- **Hypothesis should be testable with around a week (or two) of data collection**. (i.e., blood pressure now vs. blood pressure during finals week would take too long to complete)

**RUBRIC 2**: For evaluating presentations:

- Accuracy of analysis, given data: Do your conclusions follow from your data? Do your chosen analysis techniques make sense, given your hypothesis? **Note: this does NOT correspond to finding a “correct” or incorrect answer. Rather, we are checking if you have drawn conclusions that are supported by data. If a rigorous analysis results in an inconclusive result or a result that contradicts the literature, it is still correct.**
- Clarity of presentation: Can viewers/listeners understand what you did and why you did it? Are your hypothesis, experimental design, analysis, and conclusions clearly explained? Make sure your discussion is clearly understandable to anyone else who has taken PS2.
Example Hypotheses (to inspire you – you can come up with one that interests you):

- My systolic blood pressure, diastolic blood pressure, pulse, and/or temperature will [BE HIGHER/BE LOWER/BE THE SAME] after...
  - 5 deep breaths
  - Exercise
  - Urinating
  - Watching 5 minutes of kitten videos
  - Eating
  - Drinking tea or drinking coffee
  - A nap
  - Meditating
  - Doing work on homework
  - Evening vs. Morning
  - Standing vs. sitting vs. lying down

- Predicting a trend for how systolic blood pressure, diastolic blood pressure, pulse, and/or temperature change as a function of time spent exercising? (e.g. linear, quadratic, logistic curve, or other function)
  - Or over the course of a full day?

- One group from class this year came up with: “The more you disagree with [a particular politician], the more your blood pressure will rise after watching [that politician] speak.”

- Predicting a trend for how systolic blood pressure and/or diastolic blood pressure change as a function of where the cuff/arm is in relation to your heart?

- Predict how much greater/smaller ankle blood pressure (systolic or diastolic) is compared to arm blood pressure? (Look up “Ankle-Brachial Index”)

- Is blood pressure correlated/anti-correlated with pulse?

- Predicting the distribution systolic blood pressure, diastolic blood pressure, pulse, and/or temperature measurements follow?