



# Homework 8

PSTAT 5A: Spring 2023, with Ethan P. Marzban

## Instructions

- Please submit your work to Gradescope by no later than **11:59pm on Wednesday, May 31**. As a reminder, late homework will not be accepted.
- Recall that you will be asked to upload a **single** PDF containing your work for *both* the programming and non-programming questions to Gradescope.
  - You can merge PDF files using either Adobe Acrobat, or using adobe's online PDF merger at [this link](#).

## Caution

Be aware that some parts may be easier (or, in fact, may *need* to be) computed using Python. If you do use Python for any part, please write down the code you used.

## Problem 1: Look at All Those Chickens!

The average weight of an adult male chicken is claimed to be 5.7 lbs. A representative sample of 36 adult male chickens is taken, and it is found that the weights of these sampled chickens have an average of 6.1 lbs and a standard deviation of 0.9 lbs. Suppose that we wish to test the original claims (that the true average weight of an adult male chicken is 5.7 lbs) against a two-sided alternative.

- Define the parameter of interest.
- State the null and alternative hypotheses in terms of the parameter you defined in part (a).
- What distribution do we use when performing our hypothesis test? Be sure to include any/all relevant parameter(s)!
- Compute the value of the test statistic.
- Compute the  $p$ -value of the test statistic.
- Conduct the test using the  $p$ -value value, and state the conclusions of the test in the context of the problem using an  $\alpha = 0.05$  level of significance.
- Compute the critical value of the test (again using an  $\alpha = 0.05$  level of significance).
- Conduct the test using critical value from part (g), and state the conclusions of the test in the context of the problem.
- Redo the test, now using an  $\alpha = 0.01$  level of significance. Do your conclusions change? If so, state the new conclusions in the context of the problem.

## Problem 2: Turn On the Light

*GaucheBrite*-brand lightbulbs are claimed to burn with an average wattage of 60 Watts. In actuality, the distribution of wattages across all *GaucheBrite*-brand lightbulbs is known to be roughly normal with a standard deviation of 27 Watts. A representative sample of 25 lightbulbs was taken; these 25 lightbulbs had a combined average wattage of 57 Watts. **Use a 5% level of significance.**

- a. Define the parameter of interest.
- b. State the null and alternative hypotheses in terms of the parameter you defined in part (a).
- c. What distribution do we use when performing our hypothesis test? Be sure to include any/all relevant parameter(s)!
- d. Compute the value of the test statistic.
- e. Compute the  $p$ -value of the test statistic.
- f. Conduct the test using the  $p$ -value value, and state the conclusions of the test in the context of the problem.
- g. Compute the critical value of the test.
- h. Conduct the test using critical value, and state the conclusions of the test in the context of the problem.

## Problem 3: Drinking Water

City officials of *Gauchonia* believe that 15% of households in *Gauchonia* have slightly elevated levels of fluoride in their drinking water. To test this claim, a representative sample of 375 households is taken. It is found that 13.6% of households in this sample have elevated levels of fluoride in their drinking water.

- a. Check that the success-failure conditions are met.
- b. Assuming the null is correct, what is the distribution of the test statistic?
- c. Suppose the city officials wish to test their claims against a two-sided alternative at an  $\alpha = 0.05$  level of significance. Compute the  $p$ -value of the test statistic, and use this to form a conclusion. Be sure to state your conclusion in the context of the problem.
- d. Now, suppose the city officials wish to test their claims against a lower-tailed alternative, still at an  $\alpha = 0.05$  level of significance. Compute the  $p$ -value of the test statistic, and use this to form a conclusion. Be sure to state your conclusion in the context of the problem.

## Problem 4: Programming

### Part (a): Recap of LaTeX Syntax

#### ! Task 1

First, add a second-level header that says Task 1. Then, typeset the following set of equations into a Markdown Cell. Pay very close attention to the alignment of equations, and make sure your parentheses display correctly. (Also, you may need to look up how to place a box around text in LaTeX)

$$\begin{aligned} \mathbb{P}(4 \leq X \leq 7) &= \mathbb{P}(X \leq 7) - \mathbb{P}(X \leq 4) \\ &= \mathbb{P}\left(\frac{X-3}{1.4} \leq \frac{7-3}{1.4}\right) - \mathbb{P}\left(\frac{X-3}{1.4} \leq \frac{4-3}{1.4}\right) \\ &= \mathbb{P}\left(\frac{X-3}{1.4} \leq 2.86\right) - \mathbb{P}\left(\frac{X-3}{1.4} \leq 0.71\right) \\ &= 0.9979 - 0.7611 = \boxed{0.2368} \end{aligned}$$

### Part (b): Numbered Equations

We have not yet talked about how to number equations in LaTeX. The syntax for creating a numbered equation is:

```
\begin{equation}{  
  <whatever equation you want>  
}\end{equation}
```

For example,

$$f_X(x) = x^2 \tag{1}$$

was created using the syntax

```
\begin{equation}  
  f_X(x) = x^2  
\end{equation}
```

#### ! Task 2

Create a labeled equation (you can use whatever equation you want) in a new Markdown Cell.

#### 🔥 Note

Your equation will not appear with a number in your .ipynb file; the equation number will only display in your final .pdf.

One of the benefits of labeling your equations is that you can reference them later! To create a labeled equation that is referable, use the syntax

```
\begin{equation}\{\label{eq:<name>}
  <your equation>
}\end{equation}
```

Then, to reference the equation later, use `\ref{eq:<name>}` where `<name>` is whatever you called your equation. For example:

$$a^2 + b^2 = c^2 \tag{2}$$

was created using

```
\begin{equation}\{\label{eq:pyth}}
  a^2 + b^2 = c^2
\end{equation}
```

meaning I can reference equation (2) using the code `\ref{eq:pyth}`.

### **! Task 3**

Create a labeled equation (you can use whatever equation you want) in a new Markdown Cell that is labeled, and then refer to the equation in a markdown cell underneath (just like we did above).

### **🔥 Note**

Again, neither the equation number nor the referenced equation number will appear in your `.ipynb` file; they will only appear in your final `.pdf`.