

# AM115 Section 1: Laptop Battery Lifespan Analysis

Name: \_\_\_\_\_

Section: \_\_\_\_\_

## AM115 Section 1: The Battery Replacement Decision

### Background

You need to replace your laptop battery and are comparing two brands based on lifespan data from online reviews.

**Brand A:** \$45 replacement battery

**Brand B:** \$65 replacement battery (claims “40% longer life”)

### Part A: Model Selection (Group Discussion - 10 min)

1. **Discuss:** Why can't we use a binomial model for battery lifespans?
2. Sketch what you think the distribution of battery lifespans looks like? Sketch it below.
3. **Discuss:** Can you think of a distribution(s) that might be appropriate for modeling battery lifespans?
4. What type of failures are you assuming? Random events that could happen anytime? Or gradual wear-and-tear that gets worse with age? How does this assumption affect your choice of model?

### Part B: Quick Analysis (5 min)

**Brand A lifespans (months):** 18.2, 24.5, 15.3, 22.1, 28.9, 19.7, 26.3, 21.4

1. Calculate the mean lifespan
2. If using exponential model, estimate the failure rate  $\lambda$  (failures/month)

3. What's the monthly cost of Brand A's battery?

### Part C: Maximum Likelihood (15 min)

1. Write down the general form of the likelihood of having observed lifespans  $\{t_1, t_2, \dots, t_n\}$  under the model  $f()$  which is parameterized by  $\theta$ .
2. Now, write the likelihood of the same observations under your specific model (i.e., the distribution you chose).
3. **Discuss:** Consider the PDF you are using and the likelihood for a single observation. How are they similar? How are they different?
4. Write the log-likelihood.
5. **Discuss:** Why do we use the logarithm of the likelihood instead of the likelihood itself?
6. Use calculus to find the maximum likelihood estimate (MLE)
7. **Discuss:** What is the interpretation of the MLE in general?
8. **Discuss:** What is the interpretation of your specific MLE parameter value for Brand A's data?

### Notes

We'll implement this analysis in Python next, where we can handle larger datasets and create visualizations to support our decision.