

Exam 2 – Practice

Exploding Batteries

The following info is from a made up study.

A group of engineers is trying to figure out how to make better, longer-lasting batteries for electrical vehicles. They have run into a bit of a problem recently, in that a rather large proportion of the two types of batteries they've developed seem to sometimes *just explode* when being used. They are unhappy with this result and so have been testing many of their batteries to figure out what's going on.

The engineers tested 300 different batteries and gathered data into the following table.

Exploding Battery Results

Battery	Exploded	Unexploded	Sum
Type 1	41	103	144
Type 2	14	142	156
Sum	55	245	300

Question 1

Part A: What is the probability of a battery exploding?

Part B: What is the probability of Exploding given that a battery is Type 1?

Part C: What is the probability of Exploding given that a battery is Type 2?

Part D: Are the battery type and whether a battery explodes independent? Justify your answer using appropriate probabilities from A, B, or C.

Part E: Are the events “Type 2” and “Unexploded” disjoint? Explain.

Part F: Compute the odds-ratio for this table. (Show work)

Part G: Use the odds-ratio value to explain whether or not there is an association between battery type and whether a battery explodes. (use a value of 2 if you didn't get part E)

Part H: Do your answers to D and G agree? Explain.

Dragon Actuaries

A fictitious pre-industrial kingdom has been having a string of bad luck recently: their villages and farmland keep getting attacked by fire-breathing dragons.

The ruler of this kingdom is trying to figure out if it is worth the money to hire mercenaries to guard the villages from dragons.

Damage assessors and actuaries have been running the data and they have come up with the following info to figure out how much damage to expect when a dragon attacks with or without mercenaries defending a village.

- The probability of a dragon burning down the village is 0.4
- The probability of mercenaries defend the village is 0.34
- The probability of mercenaries defending the village AND it burns down is 0.11
- The probability of the village burning down *given* there were no mercenaries to defend it is 0.44

Question 2

Answer the following, providing values for probabilities. Show work using probability formulas to receive credit.

Part A: What is $P(\text{village not burning down})$?

Part B: What is $P(\text{village burns AND no mercenaries defend})$

Part C: What is $P(\text{village burns} \mid \text{mercenaries defend})$

Part D: What is $P(\text{village burns down OR mercenaries defend the village})$

Part E: According to the data are the events ‘mercenaries defend the town’ and ‘village burns down’ independent? Justify answer using appropriate probabilities.

Part F: Suppose you are a resident of a village in this kingdom. According to the data, would you want mercenaries to defend the village or not?

Alien Abductions

Many people believe that there are alien lifeforms that exist in places other than Earth throughout the universe. A potentially smaller subset of these people believe that alien life has visited earth, and an even smaller subset believe that aliens have abducted humans to study them.

In a survey that I just made up, 240 US adults were asked whether they had been abducted by aliens. 9 people in the sample said they had been, 231 said they had not been abducted by aliens.

Research Question: What proportion of US adults believe they have been abducted by aliens?

Question 3

Part A: Describe the parameter in context.

Part B: State the value of the statistic and the symbol we use to denote it.

Part C: Check the conditions for making a confidence interval using the Normal distribution. (We will proceed regardless)

Part D: Make a 90% confidence interval for the parameter

Part E: Interpret the confidence interval in context. (leave values blank if you don't get part D)

Alien Abductions Pt 2.

Turns out aliens are real and they've been abducting people to learn about us. They want to eat us, but are concerned that humans may contain too many microplastics.

An alien scientist abducted a random sample of 37 humans from all over the world and measured the concentration of micro-plastics in their blood. In the sample the mean micro-plastic concentration was 14 parts-per-million (ppm) with a standard deviation of 3.1 ppm.

The appropriate t^* value is one of the following:

```
# qt(.95, df=37) = 1.687094
# qt(.95, df=36) = 1.688298
# qt(.90, df=37) = 1.304854
# qt(.90, df=36) = 1.305514
# qt(.975, df=37) = 2.026192
# qt(.975, df=36) = 2.028094
```

Question 4

Part A: Describe the parameter the alien scientist is trying to estimate.

Part B: Are the conditions met to construct a 95% CI using a t-distribution?

Part C: State the correct value for t^* we want to use for a 95% CI to 6 decimal places.

Part D: Make a 95% CI for the parameter (show work)

Part E: Interpret this confidence interval in context. (leave values blank if you don't get part D)

CI Conceptual Questions

I am going to put a selection of these on the exam. Know your answers ahead of time.

- What is the purpose of a confidence interval?
- What does “confidence” actually mean?
- What type of variability do CIs account for?
- Explain the relationship between confidence level and interval width
- Explain the relationship between sample size and interval width
- How do width of CIs using the normal distribution compare to t-distribution CIs for the same confidence level
- Why do we use the t-distribution when the σ is not known?
- When do we use t- vs. Normal distribution for CIs?
- Explain the 68-95-99.7% Rule
- What is a sampling distribution?
- What is the Margin of Error?
- Briefly explain what the CLT tells us