Chapter 3 Scenarios

Asparagus grows up to 10" in a 24 hour period

Someone on the internet is claiming that asparagus shoots grow 10" in a 24 hour period. In order to test this theory, you go to your asparagus patch and measure each new shoot from each plant. You measure its length (in inches) at 8AM on the day it appeared and then again at 8AM the next day, subtracting to document the amount of growth.

As each plant produces multiple shoots, you end up with a sample of 85 measurements. The sample mean is 9.53 inches, with a sample standard deviation of 2.4 inches.

1. What is the research question?

2. What is the observational unit?

3. What type of variable is this? Categorical or Quantitative?

4. What are the appropriate symbols for the sample statistic, sample standard deviation, and population statistic for the variable type you chose above?

5. If you were conducting a hypothesis test, what would H_0 and H_A be using appropriate mathematical notation?

6. What is the standard error? Show your work, including the formula you used to get your answer.

7. What are the validity conditions for theory-based inference on this type of data?

8. Are the validity conditions met? Why or why not?

9. What formula should you use for the confidence interval? Provide the value of any constants you will use (e.g. multipliers).

10. Calculate the 2SD theory-based confidence interval for this data

11. What is your confidence level? What level of α corresponds to this confidence level?

12. Interpret your confidence interval

Cardiopulmonary Resuscitation (CPR)

On TV, CPR is seemingly more successful than it is in real life, where about 45% of people who receive CPR are at least temporarily resuscitated, and only 10% survive to discharge from the hospital. A group of doctors collected data on CPR survival rates in medical dramas, examining 88 episodes which aired between July 2008 and April 2009. They documented 70 CPR attempts; 32 succeeded in temporarily resuscitating the patient. Attempts to determine the percent successfully discharged from the hospital failed, as this is not a part of the plotline in most TV dramas.

1. What is the research question?

2. What is the observational unit?

3. What type of variable is this? Categorical or Quantitative?

4. What are the appropriate symbols for the sample statistic and population statistic for the variable type you chose above?

5. If you were conducting a hypothesis test, what would H_0 and H_A be using appropriate mathematical notation?

6. What is your sample statistic?

7. What is the standard error? Show your work, including the formula you used to get your answer.

8. What are the validity conditions for theory-based inference on this type of data?

9. Are the validity conditions met? Why or why not?

10. What formula should you use for the confidence interval? Provide the value of any constants you will use (e.g. multipliers).

11. Calculate an approximately 95% theory-based confidence interval for this data

12. What is your confidence level? What level of α corresponds to this confidence level?

13. Interpret your confidence interval

The Great Emu War

The Great Emu War occurred between November 2 and December 10, 1932 in the Campion district of western Australia. In the wake of WWI, veterans were given land to farm in the region with the goal of increasing the economic output of the region. Previously, this land was part of an Emu seasonal migration zone between the drier interior region and the coast. In 1932, the great depression had caused wheat prices to fall precipitously, so farmers were simultaneously trying to harvest wheat and bargain with the government over the price. Complicating the situation, some 20,000 emus arrived. Rather than appeal to the Minister of Agriculture, the farmer-soldiers appealed to the Minister of Defence, who promptly deployed machine guns, several army personnel, and 10,000 bullets to the “front". A cinematographer was also deployed to document the contingent's easy victory over the Emus.

There were several large-scale battles over the course of the war, but after the first few, the Emus appeared to work out the range of the guns[1], and stayed just out of reach. During one of these battles, about 1000 emus gathered and the soldiers attempted an ambush; there were approximately 12 casualties, as the machine gun jammed after the initial burst.

At the end of the Emu War, there were no reported human casualties, and only 986 of the 20,000 emus had been killed. 9860 bullets were used for the operation[2]. The Australian parliament debated whether to issue medals for this war, and one MP suggested that medals should be given to the Emus, who had won every round.

1. Suppose you want to establish the Emu casualty rate and compare it to the casualty rate of other Australian army operations. You decide to use the casualty rate from the entire war as your sample.

   (a) What is the observational unit?

   (b) What type of variable is this - Categorical or Quantitative?

   (c) What is the statistic of interest (proportion, mean, other quantity)?

   (d) What is your sample statistic?

[1] After a couple of days of skirmishes, the press reported that the Emus were organizing: “Each mob has its leader, always an enormous, black plumed bird standing fully 6-feet-high, who keeps watch while his fellows busy themselves with the wheat. At the first suspicious sign, he gives the signal, and dozens of heads stretch up out of the crop... starting a headlong stampede for the scrub". (https://doi.org/10.1080/14443050609388083)

[2] An emu who died later of other causes was found to have 5 bullets in him, suggesting that some of the bullets used actually found their targets, but that Emus are rather bullet-resistant.

(e) What is your standard error? Show your work, including the formula you used to get your answer.

(f) Calculate the 2SD theory-based confidence interval for your data

(g) What is your confidence level?

(h) Interpret your confidence interval in the context of the problem.

(i) What parts of the confidence interval equation would you expect to change if you had used the statistics from one of the first battles, where there were 12 casualties of around 1000 estimated birds?

(j) We might estimate a comparable casualty rate for Australian soldiers by using the rate from the most recent world war. In World War I, approximately 349,000 Australian men enlisted, with 61,966 casualties. How does the casualty rate for the Emus during the "Great War" compare to the casualty rate for the Australian soldiers during WWI? (Hint: Does the casualty rate for the army fall within the confidence interval? If it does not, what does that mean?)

2. The Emus were reported to understand the range of the machine guns. While learning in most animals takes place from repeated exposure, we might imagine instead that the Emus designed an observational study and have the ability to precisely measure the range of the machine guns[3]. Over 53 bursts of machine gun fire, the mean range of the machine gun was measured to be 1553 yd (SD = 204.74).

   (a) What is the observational unit?

   (b) What is the population? (Hint: What are you hoping to compare your sample statistic to?)

[3]Emus are said to be related to very intelligent dinosaurs such as Velociraptors. Jurassic Park demonstrated the intelligence of the species; we should not underestimate their descendants.

(c) What type of variable is this - Categorical or Quantitative?

(d) What is the statistic of interest (proportion, mean, other quantity)?

(e) What is your sample statistic? (Use correct mathematical notation)

(f) What is your standard error? Show your work, including the formula you used to get your answer.

(g) The Emus would like to have 95% confidence in the actual range of the machine guns used by the Australian military, so that the flock leaders can keep a safe distance (while maximizing the amount of wheat they can eat). Provide an interval containing the true range of the machine gun.

(h) Interpret your confidence interval in the context of the problem.

(i) Over the next several days, the Emus continue collecting data. Cumulatively, they have 92 measurements from bursts of machine gun fire, and the new mean range of the machine gun is 1550 yd (SD = 200). How do you expect your interval to change, now that you have more data? (The values are similar enough that you should not have to re-do the calculation.)