Math 104 Spring 2026 – Exploration 1.1: Can dogs understand human cues?

Dogs have been domesticated for about 14,000 years. In that time, have they been able to develop an understanding of human gestures? What about nonhuman cues? Researchers Udell, Giglio, and Wynne tested a small number of dogs in order to answer these questions.

The research question is: Can dogs understand human cues?

1. What are the observational units?

2. Identify the variable in this study (there is only one).

   What are the possible outcomes of this variable?

   Is it (circle one): Quantitative / Categorical

3. What is the sample size?

4. What is the observed statistic?

5. Is it possible Harley could have gotten 9 out of 10 correct, even if he didn't really understand the human gesture, and was just randomly guessing?
   Circle one: Yes / No

6. Do you think it is likely that Harley would have gotten 9 out of 10 correct if he was just guessing randomly?
   Circle one: Yes / No

To decide if Harley's 9/10 correct attempts could be due to chance alone, we'll use an analogy with coin-flipping to simulate the experiment many times. Dr. Roscoe will discuss the chance model. Fill in the following table indicating what parts of the real study correspond to the physical simulation.

Simulation	Actual Study
Coin flip	
Heads	
Tails	
Chance of heads	
One repetition of this simulation	

The best way to get an accurate estimate of probabilities is to repeat the experiment many times. We'll use technology to simulate the coin-flipping. *Flip the page!* ---------->

Open the One Proportion applet (← that's a clickable link; it's on Canvas too). Make sure the probability of heads has been set to 0.50 representing Harley's random guess between the two cups.

7. Set the **number of tosses** to 10 and press the **Draw Samples** button. What was the resulting number of heads?

Uncheck the **Show animation** button and press the **Draw Samples** button 9 more times, until "**Total Repetitions = 10"**. Is a pattern starting to emerge?

Now change **Number of repetitions** from 1 to 990 (so we can do a total of 1,000 repetitions) and press **Draw Samples**. The applet now shows the results for the number of heads in 1,000 different sets of 10 coin tosses. It's as if the Harley experiment has been repeated 1,000 times, *assuming Harley is guessing at random*.

8. Locate the result of getting 9 heads in the dotplot created by the applet. Would you consider this result unusual?
   Circle one: Yes / No
   Is it more towards the (*circle one)* center of the distribution or in the tail?

Use the following procedure to estimate the probability of getting 9 or 10 heads in a set of 10 attempts: Ensure the "**Number of heads**" radio button is selected. In the field labeled "**As extreme as**," type 9 and ensure the inequality button shows ≥. Click **Count**. The applet gives the *proportion of repetitions* in which 9 or 10 heads appeared. This is your *estimate of the probability* of getting 9 or 10 heads.

9. What is your estimate of the probability of getting 9 or more heads in 10 coin flips?

   Based on this probability, do the results of the study appear to be statistically significant?
   Circle one: Yes / No

Summary.

We will call the process of simulating "what could have been" statistics using a chance model the **3S strategy**. The three S's are: Statistic, Simulate, and Strength of evidence. The following questions summarize this process.

10. **Statistic.** What is the statistic in this study?

11. **Simulate.** (*Fill in the blanks)* We flipped a coin _____ times and kept track of how many times it came up heads. We repeated this process _____ more times, each time keeping track of how many heads were obtained in each of the _____ flips.
12. **Strength of evidence.** Because we rarely obtained a value of _____ heads when flipping the coin _____times, it is (*circle one*) believable / not likely that Harley is just guessing, because if Harley was just guessing, he (*circle one*) rarely / often would get a value like _____ correct out of _____ attempts.