# MA256 Lesson 3 - Significance - Strength of Evidence (1.1-1.2)

**Defintions review**

**Statistical Significance**

**What is the 3S Strategy?**

What is the difference between a **parameter** and a **statistic**?

**Define:**

$H_0$ :

$H_a$ :

$\pi$ :

$\hat{p}$ :

**n** :

**p-value** :

**Classify the strength of evidence for each range of p-values.**

| | | | |
|---|---|---|---|
| 0.1 | $< p$ | | \| |
| 0.05 | $< p \leq$ | 0.1 | \| |
| 0.01 | $< p \leq$ | 0.05 | \| |
| | $p \leq$ | 0.01 | \| |

## Chips Ahoy vs Keebler Original Chocolate Chip Cookies

Chips Ahoy! conducted a blind taste-test experiment with 50 randomly selected consumers and recorded whether they preferred Chips Ahoy! over Keebler's original chocolate chip cookies. Of those 50 consumers, 45 (90%) of them preferred Chips Ahoy! Chips Ahoy! now claims that 90% of consumers prefer their cookies over Keebler's.

**Step 1: Ask a Research Question:**

Q1) Restate from the given information.

**Step 2: Design a Study & Collect Data:**

Q3) Explain what type of study was conducted.

**Step 3: Explore the Data:** Q4) What could we do with the data to help us understand it better?

**Step 4:** Draw Inferences: Significance (today's lesson!)

*To draw inferences for this or any other research question, we must set the framework by answering the following questions. Do this at boards in teams of 2-3:*

Q5) What are the observational units?

Q6) What is the sample size and number of samples?

Q7) Identify & classify the variable collected.

Q8) What is the symbol, definition & value of the sample statistic?

Q9) What is the symbol, definition, & value of the population parameter?

Q10) What are the null & alternate hypotheses in words and symbol notation?

Q11) With the framework established, we can use the 3S strategy and *One Proportion* applet (http://www.isi-stats.com/isi2nd/ISIapplets2021.html) to estimate the likelihood that Chips Ahoy got the result they did if consumers could not taste a difference and were randomly choosing one of the two cookies.

**1. Statistic:** Write out the statistic: $\hat{p} = 45/50 = 90\%$ *or* 0.9

**2. Simulate:** Run the simulation using the *One Proportion* applet.

Probability of choosing Chips Ahoy! (success/heads) = $\pi$ (Parameter) =

Number of tosses = n (Sample size) =

Number of repetitions =

Select "Draw Samples" button.

**3. Strength of Evidence:**

Q12) How common/uncommon is our observation? Report the p-value. Select the "Count samples" "Count" button to calculate the P-value for this simulation. (What number should you use for the *As extreme as* value?) Did we prove the alternative hypothesis?

**2. Simulate (REDUX):** Run the simulation using R. For help with a `for` loop, see https://www.rdocumentation.org/packages/openintro/versions/2.4.0/topics/loop or type `?Control` in the console.

```
# set.seed(XXXXX)
#
# M <- XXXXX          # number of replications
# mypi <- XXXXX        # population parameter (under the null hypothesis)
# n <- XXXXX           # sample size
# n.succ <- XXXXX      # number of successes
# myphat <- XXXXX   # observed statistic (proportion of "successes")
#
# RES <- data.frame(res = XXXXX)  # create a data frame to hold the results of the simulation
#
# for(XXXXX){
#   myobs <- rbinom(XXXXX)
#   RES$res[rep] <- XXXXX
# }
#
# # plot a histogram of the results
# RES %>% ggplot(aes(x = XXXXX)) + geom_XXXXX() +
#   geom_vline(xintercept = XXXXX, color = "red")
#
# # estimate p-value
# sum(XXXXX)
```

Q13) What can you conclude from this study?

**Step 5: Formulate Conclusions:**

Q14) Can you generalize to other brands? Can you identify any bias in the study?

**Step 6: Look Back and Ahead:**

Q15) Identify limitations & suggest ways to overcome in new studies.

**A third competitor.**

Q16) How would the analysis above change if we introduced a third cookie competitor and conducted the experiment in our classroom?

Q17)Is it possible for the observed proportion to match the null hypothesis if the null hypothesis is false? If the null is true?

## Extra Problems:

**1.1.10** Kevin Durant of the Golden State Warriors hit 721 of his 1,383 field goal attempts in the 2018/2019 season for a shooting percentage of 52.1%. Over the lifetime of Kevin's career, can we say that Kevin is more likely than not to make a field goal?

a. Is the long-run proportion of Kevin making a field goal a parameter or a statistic?

b. Is 52.1% a parameter or a statistic?

c. When simulating possible outcomes assuming the chance model, how many times would you flip a coin for one repetition of the 2018/2019 season?

d. With each repetition, what would you keep track of?

e. What would be a typical value from a repetition of 1,383 coin flips? Justify your answer.

**1.1.11** If Kevin Durant of the Golden State Warriors hits 52 out of his first 100 field goals in the 2018/2019 season, let's see how we might investigate if he is more likely than not to make a field goal?

a. Based on these first 100 field goals, we want to find out what Kevin's long-run proportion of making a field goal is. Will this value be a statistic or a parameter?

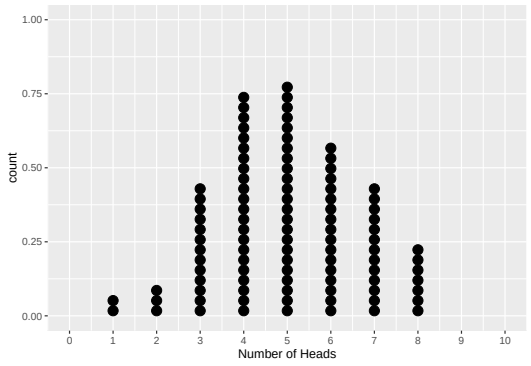
b. Is 52 out of 100 a statistic or a parameter?

c. We can use the **One Proportion applet** (or use R to simulate) to generate 1,000 possible values of Kevin's last 100 field goals under the chance model that he has a long-run proportion of 0.50 of making a field goal. Match the aspects of the simulation in Column A to their equivalent aspects in the actual study listed in Column B.

| Column A | Column B |
|---|---|
| Coin flip | Kevin misses his field goal |
| Heads | Long-run proportion of field goals Kevin makes |
| Tails | One set of 100 field goal shots by Kevin |
| Chance of heads | Kevin shoots a field goal |
| One repetition | Kevin makes his field goal |

**1.1.14. Buttered Toast** If you drop a piece of buttered toast on the floor, is it just as likely to land buttered side up as buttered side down? It sure seems like mine always lands buttered side down! Suppose that 7 of the last 10 times I dropped toast it landed buttered side down. In order to carry out a statistical analysis, the One Proportion applet was used to see whether my toast fell buttered side down a majority (more than 50%) of the time. Use the dotplot generated by the applet to answer (a)–(e).

```
## Bin width defaults to 1/30 of the range of the data. Pick better value with
## 'binwidth'.
```




a. How many dots are in the dotplot?

b. What does each dot represent in terms of dropped toast and buttered side down?

c. At what number is the dotplot centered? Could you have determined that before running the applet simulation? Why or why not?

d. Based on 7 of the last 10 slices of toast landing buttered side down and the dotplot, are you convinced that the long-run proportion of times my toast lands buttered side down is greater than 0.50? Explain how you are deciding.

e. Does this prove that my long-run proportion of dropping toast buttered side down is 0.50?