CHAPTER 22 Key

REJECTING CHANCE – TESTING HYPOTHESES IN RESEARCH

1. When researchers conduct a hypothesis test, what general question is being asked and answered regarding the sample versus the population?
   **ANSWER:** IS THE RELATIONSHIP OBSERVED IN THE SAMPLE LARGE ENOUGH TO BE CALLED STATISTICALLY SIGNIFICANT IN THE POPULATION?

Narrative: Cell phone survey
Suppose you suspect that most people are unhappy with their cell phone plans. You conduct a survey of 400 randomly selected cell phone owners ask them whether or not they are happy with their phone plans. Suppose 55% of the sample say no.

2. A majority of the sample are unhappy with their cell phone plans. Does this automatically mean that a majority of the population of all cell phone owners are too? Explain why or why not (no calculations, please!)
   **ANSWER:** NO; WE HAVE TO FIND OUT HOW LIKELY THESE RESULTS WOULD BE UNDER THE CONDITION THAT THERE IS NO CLEAR OPINION ONE WAY OR THE OTHER REGARDING CELL PHONE PLANS.

3. Suppose there is no clear opinion on how people perceive their cell phone plans (that is, 50% are happy with them, and 50% are not.) What is a reasonable range for the proportion of unhappy customers from numerous repeated samples of size 400 from this population?
   **ANSWER:** 95% OF THE SAMPLE PROPORTIONS SHOULD BE BETWEEN 45% AND 55%.

4. Suppose there is no clear opinion on how people perceive their cell phone plans (that is, 50% are happy with them, and 50% are not.) How likely would a value as large as .55 (or larger) be as the sample proportion in a sample of size 400?
   **ANSWER:** THE STANDARD SCORE IS +2. IF THERE IS TRULY NO PREFERENCE, THEN WE WOULD EXPECT RESULTS AS HIGH AS THIS, OR HIGHER, ABOUT 2.5% OF THE TIME.

5. What do you conclude, based on your survey results?
   **ANSWER:** IF THERE IS TRULY NO PREFERENCE, THEN WE WOULD EXPECT RESULTS AS HIGH AS THIS, OR HIGHER ABOUT 2.5% OF THE TIME. THIS IS LESS THAN 5%, SO WE WILL RULE OUT CHANCE AS THE EXPLANATION. DECISION: A MAJORITY OF CELL PHONE USERS ARE UNHAPPY WITH THEIR PLANS.

6. Suppose a confidence interval for the difference in mean weight loss for two different weight loss programs (Program 1 – Program 2) is entirely above zero. What does this mean?
   a. We can’t say with any confidence that there is a difference in mean weight loss for the populations of people on these two programs.
   b. We can say with confidence that there is a difference in mean weight loss for the populations of people on these two programs; further, we can say that the average weight loss on Program 1 is higher.
   c. We can say with confidence that there is a difference in mean weight loss for the populations of people on these two programs; further, we can say that the average weight loss on Program 2 is higher.
   d. None of the above.
   **ANSWER:** B
7. When a relationship or value from a sample is so strong that we decide to rule out chance as an explanation for its magnitude, what does this mean?
   a. The observed result is statistically significant.
   b. We conclude that the observed result carries over to the population, and cannot be explained away by chance.
   c. We could have been unlucky with our sample, and come to the wrong conclusion, but that chance is small.
   d. All of the above.
   ANSWER: D

8. When a relationship or value from a sample is so strong that we can effectively rule out chance as an explanation, we say that the result is __________________.
   ANSWER: STATISTICALLY SIGNIFICANT

9. If there is nothing new happening in the population, in the long run you should expect _________ of the sample means from samples of size n taken from this population to be at or below the population mean, regardless of the standard deviation or the sample size.
   ANSWER: 50% OR HALF

THE BASIC STEPS FOR TESTING HYPOTHESES
FREE RESPONSE QUESTIONS

10. In the American judicial system, you must presume that the defendant is innocent unless there is enough evidence to conclude that he/she is guilty. What are the null and alternative hypotheses in this situation? Be sure to label which one is which.
   ANSWER: NULL: THE DEFENDANT IS INNOCENT; ALTERNATIVE: THE DEFENDANT IS GUILTY.

11. Once the hypotheses are set up, and the data have been collected and summarized in a test statistic, what is the next step, that ultimately leads you to make your decision?
   ANSWER: YOU MUST DETERMINE HOW UNLIKELY THE TEST STATISTIC WOULD BE IF THE NULL HYPOTHESIS WERE TRUE.

12. What numerical value do you calculate that gives you the answer to the question of how unlikely the test statistic would be if the null hypothesis were true?
   ANSWER: THE P-VALUE

13. In general, the decision in a hypothesis test is based on a single summary of the data. What is this summary called?
   a. The test score.
   b. The sample mean.
   c. The test statistic.
   d. None of the above.
   ANSWER: C

14. Which of the following is true about a p-value?
   a. It measures the probability that the null hypothesis is true.
   b. It measures the chance of observing your exact test statistic, assuming the null hypothesis were true.
   c. It measures how likely you would be to observe results at or beyond your test statistic, assuming the null hypothesis is true.
   d. All of the above.
   ANSWER: C
15. Which of the following conclusions do you draw if the p-value is not small enough to convincingly rule out chance?
   a. We cannot reject the null hypothesis.
   b. We accept the null hypothesis.
   c. We are convinced that chance alone produced the observed results.
   d. We accept the alternative hypothesis.
   ANSWER: A

16. Which of the following conclusions do you draw if the p-value is small enough to convincingly rule out chance?
   a. We reject the null hypothesis.
   b. We accept the alternative hypothesis.
   c. Our results are statistically significant.
   d. All of the above.
   ANSWER: D

17. The only way to conclude that the alternative hypothesis is the likely one is to have enough evidence to rule out ________, as presented in the ________ hypothesis.
    ANSWERS (RESPECTIVELY): CHANCE; NULL

18. The hypothesis that motivates most studies and is usually the reason the data are being collected in the first place is the ________ hypothesis.
    ANSWER: ALTERNATIVE OR RESEARCH

**TESTING HYPOTHESES FOR PROPORTIONS**

**Narrative: Coupons**
Suppose you think that the proportion of coupon users in grocery stores in your town has decreased from 10 years ago. You know from previous research that 10 years ago, 35% of grocery store customers in your town used coupons. Suppose you take a random sample of 100 customers from a variety of grocery stores in your town, and you find that 25 percent of them use coupons.

19. {Coupons narrative} Write down the null and alternative hypotheses.
    ANSWER: NULL: p=.35; ALTERNATIVE: p <.35, WHERE p REPRESENTS THE PROPORTION OF COUPON USERS AMONG ALL GROCERY STORE CUSTOMERS IN THIS TOWN.

20. {Coupons narrative} Explain whether this is a one-sided or a two-sided test, and why.
    ANSWER: ONE-SIDED; BEFORE LOOKING AT THE DATA, YOU THINK THE PROPORTION IS LESS THAN IT WAS BEFORE.

21. {Coupons narrative} What is the value of the test statistic for your observed results?
    ANSWER: -2.10

22. {Coupons narrative} Is the p-value for your observed results smaller than .05?
    ANSWER: YES, AREA TO THE LEFT OF -2.10 IS LESS THAN 2.5%
23. {Coupons narrative} What is your conclusion? Please use words that a non-statistics student would understand, and justify your answer. Assume a significance level of .05.

**ANSWER:** SINCE THE P-VALUE IS LESS THAN .05, REJECT THE NULL HYPOTHESIS. THIS MEANS THAT THE SAMPLE EVIDENCE IS STRONG ENOUGH TO CONCLUDE THAT A SMALLER PROPORTION OF PEOPLE IN YOUR TOWN ARE USING COUPONS THAN WERE 10 YEARS AGO.

24. What should you conclude if your p-value is greater than the level of significance?
   a. Do not reject the null hypothesis.
   b. Accept the null hypothesis.
   c. Conclude that chance alone produced the observed results.
   d. Accept the alternative hypothesis.

**ANSWER:** A

25. Which of the following conclusions do you draw if the p-value is smaller than the level of significance?
   a. Reject the null hypothesis.
   b. Accept the alternative hypothesis.
   c. The true population value is significantly different from the value in the null hypothesis.
   d. All of the above.

**ANSWER:** D

26. Suppose a two-sided hypothesis test for a population mean resulted in a p-value of 1. What would you conclude?
   a. The sample mean is exactly equal to the value stated in the null hypothesis.
   b. The test statistic is zero.
   c. You cannot reject the null hypothesis.
   d. All of the above.

**ANSWER:** D