OpenIntro Statistics

Chapter 5 Exercises

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Notes

Small sample hypothesis testing for a proportion

Online supplement.

- Clopper-Pearson interval

Ex. 6.1

Vegetarian college students. Suppose that 8% of college students are vegetarians. Determine if the following statements are true or false, and explain your reasoning.

- The distribution of the sample proportions of vegetarians in random samples of size 60 is approximately normal since $n \geq 30$.
  - False. The first condition fails. $0.08 * 30 = 2.4$
- The distribution of the sample proportions of vegetarian college students in random samples of size 50 is right skewed.
  - True. Due to CLT, when $np < 10$, there is skew, and the proportion is less than 0.5, in which case the skew is to the right.
- A random sample of 125 college students where 12% are vegetarians would be considered unusual.
  - True. The Z-score for 12% is: 1.6484512 That distance is right at the boundary for 95% of expected observations if the proportion of vegetarians is 8%. **ANSWER: False. The book considers this frequency not unusual.
- A random sample of 250 college students where 12% are vegetarians would be considered unusual.
  - Even more true. Increasing the samples reduces the error. Now The Z-score for 12% is: 2.331262 That distance is the boundary for 99% of expected observations if the proportion of vegetarians is 8%.
- The standard error would be reduced by one-half if we increased the sample size from 125 to 250.
  - False. The reduction is by the root of 2.

Ex. 6.2

Young Americans, Part I. About 77% of young adults think they can achieve the American dream. Determine if the following statements are true or false, and explain your reasoning.

- The distribution of sample proportions of young Americans who think they can achieve the American dream in samples of size 20 is left skewed.

  - True. Conditions fail and the proportion is greater than 0.5, so left skewed.
- The distribution of sample proportions of young Americans who think they can achieve the American dream in random samples of size 40 is approximately normal since $n \geq 30$.
  - False. The number of failures expected in that sample still amounts to less than 10.
- A random sample of 60 young Americans where 85% think they can achieve the American dream would be considered unusual. False. Z-score: 1.4725035
- A random sample of 120 young Americans where 85% think they can achieve the American dream would be considered unusual.
  - True. Z-score: 2.0824344

Ex. 6.3

Orange tabbies. Suppose that 90% of orange tabby cats are male. Determine if the following statements are true or false, and explain your reasoning.

- The distribution of sample proportions of random samples of size 30 is left skewed.
- Using a sample size that is 4 times as large will reduce the standard error of the sample proportion by one-half.
- The distribution of sample proportions of random samples of size 140 is approximately normal.
- The distribution of sample proportions of random samples of size 280 is approximately normal.

Ex. 6.4

Young Americans, Part II. About 25% of young Americans have delayed starting a family due to the continued economic slump. Determine if the following statements are true or false, and explain your reasoning.

- The distribution of sample proportions of young Americans who have delayed starting a family due to the continued economic slump in random samples of size 12 is right skewed.
- In order for the distribution of sample proportions of young Americans who have delayed starting a family due to the continued economic slump to be approximately normal, we need random samples where the sample size is at least 40.
- A random sample of 50 young Americans where 20% have delayed starting a family due to the continued economic slump would be considered unusual.
- A random sample of 150 young Americans where 20% have delayed starting a family due to the continued economic slump would be considered unusual.
- Tripling the sample size will reduce the standard error of the sample proportion by one-third.

Ex. 6.5

Gender equality. The General Social Survey asked a random sample of 1,390 Americans the following question: "On the whole, do you think it should or should not be the government's responsibility to promote equality between men and women?" 82% of the respondents said it"should be". At a 95% confidence level, this sample has 2% margin of error. Based on this information, determine if the following statements are true or false, and explain your reasoning.

- We are 95% confident that between 80% and 84% of Americans in this sample think it's the government's responsibility to promote equality between men and women.
- We are 95% confident that between 80% and 84% of all Americans think it's the government's responsibility to promote equality between men and women.

- If we considered many random samples of 1,390 Americans, and we calculated 95% confidence intervals for each, 95% of these intervals would include the true population proportion of Americans who think it's the government's responsibility to promote equality between men and women.
- In order to decrease the margin of error to 1%, we would need to quadruple (multiply by 4) the sample size.
- Based on this confidence interval, there is sufficient evidence to conclude that a majority of Americans think it's the government's responsibility to promote equality between men and women.

% n = 1390 % should be: 1142 % p = 1142/1390 = 0.82 % me = sqrt(.82.*08/1390)*1.96 = 0.02

Ex. 6.6

Elderly drivers. The Marist Poll published a report stating that 66% of adults nationally think licensed drivers should be required to retake their road test once they reach 65 years of age. It was also reported that interviews were conducted on 1,018 American adults, and that the margin of error was 3% using a 95% confidence level.

- Verify the margin of error reported by The Marist Poll.
- Based on a 95% confidence interval, does the poll provide convincing evidence that *more than* 70% of the population think that licensed drivers should be required to retake their road test once they turn 65?

Ex. 6.7

Fireworks on July 4^{th}. A local news outlet reported that 56% of 600 randomly sampled Kansas residents planned to set off fireworks on July 4^{th}. Determine the margin of error for the 56% point estimate using a 95% confidence level.

Ex. 6.8

Life rating in Greece. Greece has faced a severe economic crisis since the end of 2009. A Gallup poll surveyed 1,000 randomly sampled Greeks in 2011 and found that 25% of them said they would rate their lives poorly enough to be considered "suffering".

- Describe the population parameter of interest. What is the value of the point estimate of this parameter?
- Check if the conditions required for constructing a confidence interval based on these data are met.
- Construct a 95% confidence interval for the proportion of Greeks who are "suffering".
- Without doing any calculations, describe what would happen to the confidence interval if we decided to use a higher confidence level.
- Without doing any calculations, describe what would happen to the confidence interval if we used a larger sample.

Ex. 6.9

Study abroad. A survey on 1,509 high school seniors who took the SAT and who completed an optional web survey shows that 55% of high school seniors are fairly certain that they will participate in a study abroad program in college.

- Is this sample a representative sample from the population of all high school seniors in the US? Explain your reasoning.
- Let's suppose the conditions for inference are met. Even if your answer to part (a) indicated that this approach would not be reliable, this analysis may still be interesting to carry out (though not report). Construct a 90% confidence interval for the proportion of high school seniors (of those who took the SAT) who are fairly certain they will participate in a study abroad program in college, and interpret this interval in context.
- What does "90% confidence" mean?
- Based on this interval, would it be appropriate to claim that the majority of high school seniors are fairly certain that they will participate in a study abroad program in college?

Ex. 6.10

Legalization of marijuana, Part I. The General Social Survey asked 1,578 US residents: "Do you think the use of marijuana should be made legal, or not?" 61% of the respondents said it should be made legal.

- Is 61% a sample statistic or a population parameter? Explain.
- Construct a 95% confidence interval for the proportion of US residents who think marijuana should be made legal, and interpret it in the context of the data.
- A critic points out that this 95% confidence interval is only accurate if the statistic follows a normal distribution, or if the normal model is a good approximation. Is this true for these data? Explain.
- A news piece on this survey's findings states, "Majority of Americans think marijuana should be legalized." Based on your confidence interval, is this news piece's statement justified?

% 2348 surveyed % 770 not asked question % 2348 - 770 = 1578 asked question % 968 said legalize % 968 / 1578 = 0.61

Ex. 6.11

National Health Plan, Part I. A *Kaiser Family Foundation* poll for US adults in 2019 found that 79% of Democrats, 55% of Independents, and 24% of Republicans supported a generic "National Health Plan". There were 347 Democrats, 298 Republicans, and 617 Independents surveyed.

- A political pundit on TV claims that a majority of Independents support a National Health Plan. Do these data provide strong evidence to support this type of statement?
- Would you expect a confidence interval for the proportion of Independents who oppose the public option plan to include 0.5? Explain.

Ex. 6.12

Is college worth it? Part I. Among a simple random sample of 331 American adults who do not have a four-year college degree and are not currently enrolled in school, 48% said they decided not to go to college because they could not afford school.

- A newspaper article states that only a minority of the Americans who decide not to go to college do so because they cannot afford it and uses the point estimate from this survey as evidence. Conduct a hypothesis test to determine if these data provide strong evidence supporting this statement.
- Would you expect a confidence interval for the proportion of American adults who decide not to go to college because they cannot afford it to include 0.5? Explain.

Ex. 6.13

Taste test. Some people claim that they can tell the difference between a diet soda and a regular soda in the first sip. A researcher wanting to test this claim randomly sampled 80 such people. He then filled 80 plain white cups with soda, half diet and half regular through random assignment, and asked each person to take one sip from their cup and identify the soda as diet or regular. 53 participants correctly identified the soda.

- Do these data provide strong evidence that these people are any better or worse than random guessing at telling the difference between diet and regular soda?
- Interpret the p-value in this context.

Ex. 6.14

Is college worth it? Part II. Exercise 6.12 presents the results of a poll where 48% of 331 Americans who decide to not go to college do so because they cannot afford it.

- Calculate a 90% confidence interval for the proportion of Americans who decide to not go to college because they cannot afford it, and interpret the interval in context.
- Suppose we wanted the margin of error for the 90% confidence level to be about 1.5%. How large of a survey would you recommend?

Ex. 6.15

National Health Plan, Part II. Exercise 6.11 presents the results of a poll evaluating support for a generic "National Health Plan" in the US in 2019, reporting that 55% of Independents are supportive. If we wanted to estimate this number to within 1% with 90% confidence, what would be an appropriate sample size?

Ex. 6.16

Legalize Marijuana, Part II. As discussed in Exercise 6.10, the General Social Survey reported a sample where about 61% of US residents thought marijuana should be made legal. If we wanted to limit the margin of error of a 95% confidence interval to 2%, about how many Americans would we need to survey?

Ex. 6.17

Social experiment, Part I. A “social experiment” conducted by a TV program questioned what people do when they see a very obviously bruised woman getting picked on by her boyfriend. On two different occasions at the same restaurant, the same couple was depicted. In one scenario the woman was dressed “provocatively” and in the other scenario the woman was dressed”conservatively”. The table below shows how many restaurant diners were present under each scenario, and whether or not they intervened.

Explain why the sampling distribution of the difference between the proportions of interventions under provocative and conservative scenarios does not follow an approximately normal distribution.

Ex. 6.18

Heart transplant success. The Stanford University Heart Transplant Study was conducted to determine whether an experimental heart transplant program increased lifespan. Each patient entering the program was officially designated a heart transplant candidate, meaning that he was gravely ill and might benefit from a new heart. Patients were randomly assigned into treatment and control groups. Patients in the treatment

group received a transplant, and those in the control group did not. The table below displays how many patients survived and died in each group.

	control	treatment
alive	4	24
dead	30	45

Suppose we are interested in estimating the difference in survival rate between the control and treatment groups using a confidence interval. Explain why we cannot construct such an interval using the normal approximation. What might go wrong if we constructed the confidence interval despite this problem?

Ex. 6.19

Gender and color preference. A study asked 1,924 male and 3,666 female undergraduate college students their favorite color. A 95% confidence interval for the difference between the proportions of males and females whose favorite color is black ($p_{male} - p_{female}$) was calculated to be (0.02, 0.06). Based on this information, determine if the following statements are true or false, and explain your reasoning for each statement you identify as false.

- We are 95% confident that the true proportion of males whose favorite color is black is 2% lower to 6% higher than the true proportion of females whose favorite color is black.
- We are 95% confident that the true proportion of males whose favorite color is black is 2% to 6% higher than the true proportion of females whose favorite color is black.
- 95% of random samples will produce 95% confidence intervals that include the true difference between the population proportions of males and females whose favorite color is black.
- We can conclude that there is a significant difference between the proportions of males and females whose favorite color is black and that the difference between the two sample proportions is too large to plausibly be due to chance.
- The 95% confidence interval for ($p_{female} - p_{male}$) cannot be calculated with only the information given in this exercise.

Ex. 6.20

Government shutdown. The United States federal government shutdown of 2018–2019 occurred from December 22, 2018 until January 25, 2019, a span of 35 days. A Survey USA poll of 614 randomly sampled Americans during this time period reported that 48% of those who make less than $40,000 per year and 55% of those who make $40,000 or more per year said the government shutdown has not at all affected them personally. A 95% confidence interval for ($p_{<40\text{K}} - p_{\geq 40\text{K}}$), where p is the proportion of those who said the government shutdown has not at all affected them personally, is (-0.16, 0.02). Based on this information, determine if the following statements are true or false, and explain your reasoning if you identify the statement as false.

- At the 5% significance level, the data provide convincing evidence of a real difference in the proportion who are not affected personally between Americans who make less than $40,000 annually and Americans who make $40,000 annually.
- We are 95% confident that 16% more to 2% fewer Americans who make less than $40,000 per year are not at all personally affected by the government shutdown compared to those who make $40,000 or more per year.
- A 90% confidence interval for ($p_{<40\text{K}} - p_{\geq 40\text{K}}$) would be wider than the $(-0.16, 0.02)$ interval.
- A 95% confidence interval for ($p_{\geq 40\text{K}} - p_{<40\text{K}}$) is (-0.02, 0.16).

% p1 = 0.48 % p2 = 0.55 % n1 = 162 % n2 = 452 % ((p1 - p2) + c(-1,1) * 1.96 * sqrt((p1*(1-p1)/n1) + (p2*(1-p2)/n2))) %>% round(2) % (-0.16, 0.02)

Ex. 6.21

National Health Plan, Part III. Exercise 6.11 presents the results of a poll evaluating support for a generically branded "National Health Plan" in the United States. 79% of 347 Democrats and 55% of 617 Independents support a National Health Plan.

- Calculate a 95% confidence interval for the difference between the proportion of Democrats and Independents who support a National Health Plan ($p_D - p_I$), and interpret it in this context. We have already checked conditions for you.
- True or false: If we had picked a random Democrat and a random Independent at the time of this poll, it is more likely that the Democrat would support the National Health Plan than the Independent.

Ex. 6.22

Sleep deprivation, CA vs. OR, Part I. According to a report on sleep deprivation by the Centers for Disease Control and Prevention, the proportion of California residents who reported insufficient rest or sleep during each of the preceding 30 days is 8.0%, while this proportion is 8.8% for Oregon residents. These data are based on simple random samples of 11,545 California and 4,691 Oregon residents. Calculate a 95% confidence interval for the difference between the proportions of Californians and Oregonians who are sleep deprived and interpret it in context of the data.

Ex. 6.23

Offshore drilling, Part I. A survey asked 827 randomly sampled registered voters in California "Do you support? Or do you oppose? Drilling for oil and natural gas off the Coast of California? Or do you not know enough to say?" Below is the distribution of responses, separated based on whether or not the respondent graduated from college.

- What percent of college graduates and what percent of the non-college graduates in this sample do not know enough to have an opinion on drilling for oil and natural gas off the Coast of California? - Conduct a hypothesis test to determine if the data provide strong evidence that the proportion of college graduates who do not have an opinion on this issue is different than that of non-college graduates.

	College Grad	
	Yes	No
Support	154	132
Oppose	180	126
Do not know	104	131
Total	438	389

Ex. 6.24

Sleep deprivation, CA vs. OR, Part II. Exercise 6.22 provides data on sleep deprivation rates of Californians and Oregonians. The proportion of California residents who reported insufficient rest or sleep during each of the preceding 30 days is 8.0%, while this proportion is 8.8% for Oregon residents. These data are based on simple random samples of 11,545 California and 4,691 Oregon residents.

- Conduct a hypothesis test to determine if these data provide strong evidence the rate of sleep deprivation is different for the two states. (Reminder: Check conditions)
- It is possible the conclusion of the test in part (a) is incorrect. If this is the case, what type of error was made?

Ex. 6.25

Offshore drilling, Part II. Results of a poll evaluating support for drilling for oil and natural gas off the coast of California were introduced in Exercise 6.23.

	College Grad	
	Yes	No
Support	154	132
Oppose	180	126
Do not know	104	131
Total	438	389

- What percent of college graduates and what percent of the non-college graduates in this sample support drilling for oil and natural gas off the Coast of California?
- Conduct a hypothesis test to determine if the data provide strong evidence that the proportion of college graduates who support off-shore drilling in California is different than that of non-college graduates.

Ex. 6.26

Full body scan, Part I. A news article reports that "Americans have differing views on two potentially inconvenient and invasive practices that airports could implement to uncover potential terrorist attacks." This news piece was based on a survey conducted among a random sample of 1,137 adults nationwide, where one of the questions on the survey was "Some airports are now using 'full-body' digital x-ray machines to electronically screen passengers in airport security lines. Do you think these new x-ray machines should or should not be used at airports?" Below is a summary of responses based on party affiliation.

- Conduct an appropriate hypothesis test evaluating whether there is a difference in the proportion of Republicans and Democrats who think the full- body scans should be applied in airports. Assume that all relevant conditions are met.
- The conclusion of the test in part (a) may be incorrect, meaning a testing error was made. If an error was made, was it a Type 1 or a Type 2 Error? Explain.

Ex. 6.27

Sleep deprived transportation workers. The National Sleep Foundation conducted a survey on the sleep habits of randomly sampled transportation workers and a control sample of non-transportation workers. The results of the survey are shown below.

Conduct a hypothesis test to evaluate if these data provide evidence of a difference between the proportions of truck drivers and non-transportation workers (the control group) who get less than 6 hours of sleep per day, i.e. are considered sleep deprived.

Ex. 6.28

Prenatal vitamins and Autism. Researchers studying the link between prenatal vitamin use and autism surveyed the mothers of a random sample of children aged 24 - 60 months with autism and conducted another separate random sample for children with typical development. The table below shows the number of mothers in each group who did and did not use prenatal vitamins during the three months before pregnancy (periconceptional period).

- State appropriate hypotheses to test for independence of use of prenatal vitamins during the three months before pregnancy and autism.

- Complete the hypothesis test and state an appropriate conclusion. (Reminder: Verify any necessary conditions for the test.)
- A New York Times article reporting on this study was titled "Prenatal Vitamins May Ward Off Autism". Do you find the title of this article to be appropriate? Explain your answer. Additionally, propose an alternative title.

Ex. 6.29

HIV in sub-Saharan Africa. In July 2008 the US National Institutes of Health announced that it was stopping a clinical study early because of unexpected results. The study population consisted of HIV-infected women in sub-Saharan Africa who had been given single dose Nevaripine (a treatment for HIV) while giving birth, to prevent transmission of HIV to the infant. The study was a randomized comparison of continued treatment of a woman (after successful childbirth) with Nevaripine vs Lopinavir, a second drug used to treat HIV. 240 women participated in the study; 120 were randomized to each of the two treatments. Twenty-four weeks after starting the study treatment, each woman was tested to determine if the HIV infection was becoming worse (an outcome called *virologic failure*). Twenty-six of the 120 women treated with Nevaripine experienced virologic failure, while 10 of the 120 women treated with the other drug experienced virologic failure.

- Create a two-way table presenting the results of this study.
- State appropriate hypotheses to test for difference in virologic failure rates between treatment groups.
- Complete the hypothesis test and state an appropriate conclusion. (Reminder: Verify any necessary conditions for the test.)

Ex. 6.30

An apple a day keeps the doctor away. A physical education teacher at a high school wanting to increase awareness on issues of nutrition and health asked her students at the beginning of the semester whether they believed the expression "an apple a day keeps the doctor away", and 40% of the students responded yes. Throughout the semester she started each class with a brief discussion of a study highlighting positive effects of eating more fruits and vegetables. She conducted the same apple-a-day survey at the end of the semester, and this time 60% of the students responded yes. Can she used a two-proportion method from this section for this analysis? Explain your reasoning.

Ex. 6.31

True or false, Part I. Determine if the statements below are true or false. For each false statement, suggest an alternative wording to make it a true statement.

- The chi-square distribution, just like the normal distribution, has two parameters, mean and standard deviation.
- The chi-square distribution is always right skewed, regardless of the value of the degrees of freedom parameter.
- The chi-square statistic is always positive.
- As the degrees of freedom increases, the shape of the chi-square distribution becomes more skewed.

Ex. 6.32

True or false, Part II. Determine if the statements below are true or false. For each false statement, suggest an alternative wording to make it a true statement.

- As the degrees of freedom increases, the mean of the chi-square distribution increases.
- If you found $\chi^2 = 10$ with $df = 5$ you would fail to reject H_0 at the 5% significance level.
- When finding the p-value of a chi-square test, we always shade the tail areas in both tails.
- As the degrees of freedom increases, the variability of the chi-square distribution decreases.

Ex. 6.33

Open source textbook. A professor using an open source introductory statistics book predicts that 60% of the students will purchase a hard copy of the book, 25% will print it out from the web, and 15% will read it online. At the end of the semester he asks his students to complete a survey where they indicate what format of the book they used. Of the 126 students, 71 said they bought a hard copy of the book, 30 said they printed it out from the web, and 25 said they read it online.

- State the hypotheses for testing if the professor's predictions were inaccurate.
- How many students did the professor expect to buy the book, print the book, and read the book exclusively online?
- This is an appropriate setting for a chi-square test. List the conditions required for a test and verify they are satisfied.
- Calculate the chi-squared statistic, the degrees of freedom associated with it, and the p-value.
- Based on the p-value calculated in part (d), what is the conclusion of the hypothesis test? Interpret your conclusion in this context.

Ex. 6.34

Barking deer. Microhabitat factors associated with forage and bed sites of barking deer in Hainan Island, China were examined. In this region woods make up 4.8% of the land, cultivated grass plot makes up 14.7%, and deciduous forests make up 39.6%. Of the 426 sites where the deer forage, 4 were categorized as woods, 16 as cultivated grassplot, and 61 as deciduous forests. The table below summarizes these data.

- Write the hypotheses for testing if barking deer prefer to forage in certain habitats over others.
- What type of test can we use to answer this research question?
- Check if the assumptions and conditions required for this test are satisfied.
- Do these data provide convincing evidence that barking deer prefer to forage in certain habitats over others? Conduct an appropriate hypothesis test to answer this research question.

Ex. 6.35

Quitters. Does being part of a support group affect the ability of people to quit smoking? A county health department enrolled 300 smokers in a randomized experiment. 150 participants were assigned to a group that used a nicotine patch and met weekly with a support group; the other 150 received the patch and did not meet with a support group. At the end of the study, 40 of the participants in the patch plus support group had quit smoking while only 30 smokers had quit in the other group.

- Create a two-way table presenting the results of this study.
- Answer each of the following questions under the null hypothesis that being part of a support group does not affect the ability of people to quit smoking, and indicate whether the expected values are higher or lower than the observed values.
- How many subjects in the "patch + support" group would you expect to quit?
- How many subjects in the "patch only" group would you expect to not quit?

Ex. 6.36

Full body scan, Part II. The table below summarizes a data set we first encountered in Exercise 6.26 regarding views on full-body scans and political affiliation. The differences in each political group may be due to chance. Complete the following computations under the null hypothesis of independence between an individual's party affiliation and his support of full-body scans. It may be useful to first add on an extra column for row totals before proceeding with the computations.

- How many Republicans would you expect to not support the use of full-body scans?
- How many Democrats would you expect to support the use of full- body scans?
- How many Independents would you expect to not know or not answer?

Ex. 6.37

Offshore drilling, Part III. The table below summarizes a data set we first encountered in Exercise 6.23 that examines the responses of a random sample of college graduates and non-graduates on the topic of oil drilling. Complete a chi-square test for these data to check whether there is a statistically significant difference in responses from college graduates and non-graduates.

Ex. 6.38

Parasitic worm. Lymphatic filariasis is a disease caused by a parasitic worm. Complications of the disease can lead to extreme swelling and other complications. Here we consider results from a randomized experiment that compared three different drug treatment options to clear people of the this parasite, which people are working to eliminate entirely. The results for the second year of the study are given below:

- Set up hypotheses for evaluating whether there is any difference in the performance of the treatments, and also check conditions.
- Statistical software was used to run a chi-square test, which output:

  Use these results to evaluate the hypotheses from part (a), and provide a conclusion in the context of the problem.

Ex. 6.39

Active learning. A teacher wanting to increase the active learning component of her course is concerned about student reactions to changes she is planning to make. She conducts a survey in her class, asking students whether they believe more active learning in the classroom (hands on exercises) instead of traditional lecture will helps improve their learning. She does this at the beginning and end of the semester and wants to evaluate whether students' opinions have changed over the semester. Can she used the methods we learned in this chapter for this analysis? Explain your reasoning.

Ex. 6.40

Website experiment. The OpenIntro website occasionally experiments with design and link placement. We conducted one experiment testing three different placements of a download link for this textbook on the book's main page to see which location, if any, led to the most downloads. The number of site visitors included in the experiment was 701 and is captured in one of the response combinations in the following table:

- Calculate the actual number of site visitors in each of the six response categories.
- Each individual in the experiment had an equal chance of being in any of the three experiment groups. However, we see that there are slightly different totals for the groups. Is there any evidence that the groups were actually imbalanced? Make sure to clearly state hypotheses, check conditions, calculate the appropriate test statistic and the p-value, and make your conclusion in context of the data.
- Complete an appropriate hypothesis test to check whether there is evidence that there is a higher rate of site visitors clicking on the textbook link in any of the three groups.

Ex. 6.41

Shipping holiday gifts. A local news survey asked 500 randomly sampled Los Angeles residents which shipping carrier they prefer to use for shipping holiday gifts. The table below shows the distribution of responses by age group as well as the expected counts for each cell (shown in parentheses).

- State the null and alternative hypotheses for testing for independence of age and preferred shipping method for holiday gifts among Los Angeles residents.
- Are the conditions for inference using a chi-square test satisfied?

Ex. 6.42

The Civil War. A national survey conducted among a simple random sample of 1,507 adults shows that 56% of Americans think the Civil War is still relevant to American politics and political life.

- Conduct a hypothesis test to determine if these data provide strong evidence that the majority of the Americans think the Civil War is still relevant.
- Interpret the p-value in this context.
- Calculate a 90% confidence interval for the proportion of Americans who think the Civil War is still relevant. Interpret the interval in this context, and comment on whether or not the confidence interval agrees with the conclusion of the hypothesis test.

Ex. 6.43

College smokers. We are interested in estimating the proportion of students at a university who smoke. Out of a random sample of 200 students from this university, 40 students smoke.

- Calculate a 95% confidence interval for the proportion of students at this university who smoke, and interpret this interval in context. (Reminder: Check conditions.)
- If we wanted the margin of error to be no larger than 2% at a 95% confidence level for the proportion of students who smoke, how big of a sample would we need?

Ex. 6.44

Acetaminophen and liver damage. It is believed that large doses of acetaminophen (the active ingredient in over the counter pain relievers like Tylenol) may cause damage to the liver. A researcher wants to conduct a study to estimate the proportion of acetaminophen users who have liver damage. For participating in this study, he will pay each subject $20 and provide a free medical consultation if the patient has liver damage.

- If he wants to limit the margin of error of his 98% confidence interval to 2%, what is the minimum amount of money he needs to set aside to pay his subjects?
- The amount you calculated in part (a) is substantially over his budget so he decides to use fewer subjects. How will this affect the width of his confidence interval?

Ex. 6.45

Life after college. We are interested in estimating the proportion of graduates at a mid-sized university who found a job within one year of completing their undergraduate degree. Suppose we conduct a survey and find out that 348 of the 400 randomly sampled graduates found jobs. The graduating class under consideration included over 4500 students.

- Describe the population parameter of interest. What is the value of the point estimate of this parameter?
- Check if the conditions for constructing a confidence interval based on these data are met.
- Calculate a 95% confidence interval for the proportion of graduates who found a job within one year of completing their undergraduate degree at this university, and interpret it in the context of the data.
- What does "95% confidence" mean?
- Now calculate a 99% confidence interval for the same parameter and interpret it in the context of the data.
- Compare the widths of the 95% and 99% confidence intervals. Which one is wider? Explain.

Ex. 6.46

Diabetes and unemployment. A Gallup poll surveyed Americans about their employment status and whether or not they have diabetes. The survey results indicate that 1.5% of the 47,774 employed (full or part time) and 2.5% of the 5,855 unemployed 18-29 year olds have diabetes.

- Create a two-way table presenting the results of this study.
- State appropriate hypotheses to test for difference in proportions of diabetes between employed and unemployed Americans.
- The sample difference is about 1%. If we completed the hypothesis test, we would find that the p-value is very small (about 0), meaning the difference is statistically significant. Use this result to explain the difference between statistically significant and practically significant findings.

Ex. 6.47

Rock-paper-scissors. Rock-paper-scissors is a hand game played by two or more people where players choose to sign either rock, paper, or scissors with their hands. For your statistics class project, you want to evaluate whether players choose between these three options randomly, or if certain options are favored above others. You ask two friends to play rock-paper-scissors and count the times each option is played. The following table summarizes the data:

Use these data to evaluate whether players choose between these three options randomly, or if certain options are favored above others. Make sure to clearly outline each step of your analysis, and interpret your results in context of the data and the research question.

Ex. 6.48

2010 Healthcare Law. On June 28, 2012 the U.S. Supreme Court upheld the much debated 2010 healthcare law, declaring it constitutional. A Gallup poll released the day after this decision indicates that 46% of 1,012 Americans agree with this decision. At a 95% confidence level, this sample has a 3% margin of error. Based on this information, determine if the following statements are true or false, and explain your reasoning.

- We are 95% confident that between 43% and 49% of Americans in this sample support the decision of the U.S. Supreme Court on the 2010 healthcare law.

- We are 95% confident that between 43% and 49% of Americans support the decision of the U.S. Supreme Court on the 2010 healthcare law.
- If we considered many random samples of 1,012 Americans, and we calculated the sample proportions of those who support the decision of the U.S. Supreme Court, 95% of those sample proportions will be between 43% and 49%.
- The margin of error at a 90% confidence level would be higher than 3%.

Ex. 6.49

Browsing on the mobile device. A survey of 2,254 American adults indicates that 17% of cell phone owners browse the internet exclusively on their phone rather than a computer or other device.

- According to an online article, a report from a mobile research company indicates that 38 percent of Chinese mobile web users only access the internet through their cell phones. Conduct a hypothesis test to determine if these data provide strong evidence that the proportion of Americans who only use their cell phones to access the internet is different than the Chinese proportion of 38%.
- Interpret the p-value in this context.
- Calculate a 95% confidence interval for the proportion of Americans who access the internet on their cell phones, and interpret the interval in this context.

Ex. 6.50

Coffee and Depression. Researchers conducted a study investigating the relationship between caffeinated coffee consumption and risk of depression in women. They collected data on 50,739 women free of depression symptoms at the start of the study in the year 1996, and these women were followed through 2006. The researchers used questionnaires to collect data on caffeinated coffee consumption, asked each individual about physician- diagnosed depression, and also asked about the use of antidepressants. The table below shows the distribution of incidences of depression by amount of caffeinated coffee consumption.

- What type of test is appropriate for evaluating if there is an association between coffee intake and depression?
- Write the hypotheses for the test you identified in part (a).
- Calculate the overall proportion of women who do and do not suffer from depression.
- Identify the expected count for the highlighted cell, and calculate the contribution of this cell to the test statistic, i.e. $(Observed - Expected)^2/Expected$.
- The test statistic is $\chi^2 = 20.93$. What is the p-value?
- What is the conclusion of the hypothesis test?
- One of the authors of this study was quoted on the NYTimes as saying it was "too early to recommend that women load up on extra coffee" based on just this study. Do you agree with this statement? Explain your reasoning.