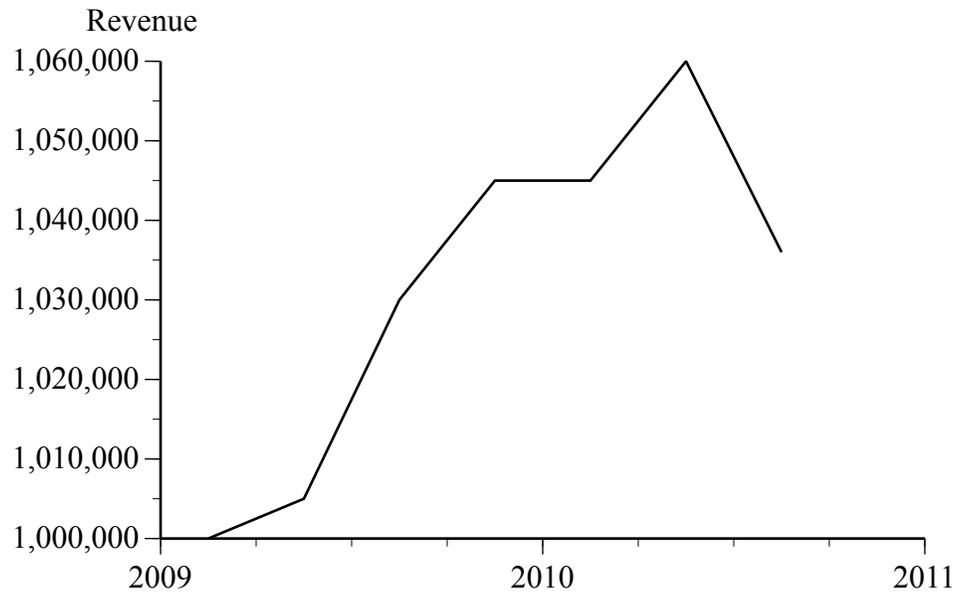


Final Examination (150 minutes)

No calculators allowed. Just set up your answers, for example, $P = 49/52$. BE SURE TO EXPLAIN YOUR REASONING. If you want extra time, you can buy time at a price of 1 point a minute; for example, if your test is handed in 10 minutes after the scheduled finish time, 10 points will be subtracted from the test score.

1. An Internet company's CEO gave her Board of Directors a graph prepared by the company's finance group that showed the company's revenue over the previous seven quarters. The Board grilled the CEO, asking her to explain why revenue was down so much. How would you have responded?



2. If you are dealt 5 cards from a standard 52-card deck, what is the probability that 4 of the 5 cards will be aces?
3. The Pizza Principle says that in New York City since the 1960s, the cost of a subway ride has been roughly equal to the cost of a slice of pizza. How, as a statistician, would you explain this relationship?

4. The equation $y = \alpha + \beta x + \varepsilon$, where y = unemployment and x = production, was estimated using monthly 2013 data, entering the months in a computer program in order: January, February, March, and so on. How would the estimates be affected if we enter the data backwards: December, November, October, and so on?
5. Nate Silver's book *The Signal and the Noise* looks at five mortgages, each of which has a 5% chance of defaulting. Assuming independence, he calculates that probability that at least one will default as

$$\binom{5}{1} 0.05^1 0.95^4 = 0.204$$

What is the correct probability?

6. Suppose that the damage award favored by individual potential jurors in a particular personal injury case can be described by a normal distribution with a mean of \$5,000,000 and a standard deviation of \$2,000,000. (This probability distribution is across randomly selected jurors.) What percentage of potential jurors favor an award of more than \$5,500,000?
7. Continuing the preceding exercise, assume that a jury is a random sample from this distribution and that the jury's damage award is the average of the awards favored by the individual jurors. Carefully explain the differences in the awards that can be anticipated with a 6-person jury versus a 12-person jury.
8. A medical study reported that Treatment A was more successful than Treatment B in treating small kidney stones (90% versus 80%) and in treating large kidney stones (70% versus 60%) but, overall, combining the data for large and small kidney stones, Treatment B was more successful. Is this possible or did they make a mistake? Explain your reasoning and use a numerical example to illustrate your argument. Be specific.

9. In the traditional game Tong, two players, E and O, simultaneously reveal a hand showing one, two, or three fingers. If the sum of the fingers on the two players' hands is even, O pays \$1 to E. If the sum is odd, E pays \$1 to O. If each player is equally likely to show one, two, or three fingers and their choices are made independently, what is the expected value of this game for E? For O?

10. Explain why the proposed test is wrong and identify the correct test:

I will ask students from all five of the undergraduate Claremont Colleges: "Do you think your intelligence is above or below average compared to other students of your gender at your college?" I will analyze the data using an ANOVA F-test to test the null hypothesis that students are equally likely to answer above or below average, regardless of college or gender.

11. Explain why the proposed test is wrong and identify the correct test:

My question is "Does playing on home ice in the National Hockey League (NHL) give the home team a better chance to win?" I will choose six NHL teams and, for each team, use a Z single-sample categorical test of the null hypothesis that the chance of winning at home is equal to one half.

12. Explain why the proposed test is wrong and identify the correct test:

I used a chi-square test to look at the relationship between high school graduation rates in California counties and the per capita income in the past 12 months in these counties. Here are my results for the first four counties alphabetically in California:

	<i>Alameda</i>	<i>Alpine</i>	<i>Amador</i>	<i>Butte</i>
<i>Graduation rate</i>	86	91	88	87
<i>Per capita income</i>	\$35,434	27,135	26,969	23,556

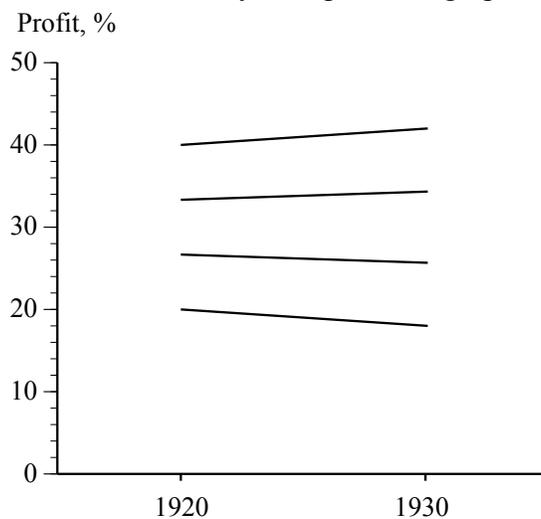
Graduation rate is the percent of persons age 25+ who graduated from high school and per capita income is annual income (in 2012 dollars) for the years 2008 through 2012, The chi-squared value is 8.58 and the p-value is 0.0353, which means we would reject the null at the 5% level, but not the 1% level.

13. A scientist visited the homes of Denver children who had died of cancer and found that many lived near power lines. A Swedish study analyzed data on cancer deaths and exposure to electro-magnetic fields (EMFs) from power lines. They did nearly 800 statistical tests and found that children diagnosed with leukemia had above-average exposure to EMFs. What statistical problems do you see with these two studies? Be specific.

14. A classic test lets a monkey choose M&Ms until the researcher identifies three colors (say blue, red, and green) that the monkey seems to prefer about equally. The monkey is then offered a choice between two M&M's—say, blue and red. If the monkey chooses blue, then the monkey is offered a choice between red and green. Two-thirds of the time, the monkey chooses green, apparently confirming the theory of choice rationalization: after we reject something, we devalue it.

Now suppose that the monkey is not perfectly indifferent between blue, red, and green M&Ms, but in fact prefers blue to red. What is the probability that the monkey also prefers green to red? (Assume that the monkey is randomly chosen from a group of monkeys that are equally likely to prefer one color to another.)

15. Data on the profits (return on assets) of 100 firms were grouped into quartiles based on their 1930 profits: the top 25, second 25, third 25, and bottom 25. The average profits in 1930 and 1920 were then calculated for the firms in these 1930 quartiles. How would you explain the graph?



16. A researcher used 2011 data for 30 developing countries to estimate a model of real per capita GDP, in U.S. dollars. The education variables are the percent of people of the appropriate age enrolled in school; for example, the total number of females enrolled in primary schools divided by the number of females of primary school age. The adolescent fertility rate is births per 1,000 women ages 15-19.

The researcher initially estimated Model 1. After noting the high multicollinearity among the explanatory variables, the researcher estimated Model 2.

	Model 1		Model 2	
	Coefficient	t-value	Coefficient	t-value
Intercept	92,229	1.17	16,380	0.72
Female primary education	1,154	0.64	726	1.53
Male primary education	-2,219	0.96	-899	1.68
Female secondary education	-1,771	1.57	-1,081	2.21
Male secondary education	1,901	1.80	1,113	2.16
Female tertiary education	265	0.47	263	0.71
Male tertiary education	-84	0.10	192	0.37
Volume of exports	429	0.11		
Unemployment rate	-290	0.17		
Adolescent fertility rate	-89	0.43		
R-squared	0.804		0.684	

The author concluded that, “The R-squared value decreased from 0.804 to 0.684. However, this model provides more precise estimates of the coefficients of the explanatory variables. The standard errors fall by almost half and the t-values for almost all variables, specifically secondary education for both genders, are statistically significant, unlike in the previous model.” What do you think?

17. A study of CO2 emissions estimated this model using 2010 data for 161 countries:

$$Y = -807,815 + 14,370X_1 + 3,655X_2 + 9,134X_3$$

where Y = CO2 emissions (kilotons), X_1 = industrial percentage of GDP, X_2 = agricultural percentage of GDP, and X_3 = services percentage of GDP, with $X_1 + X_2 + X_3 = 100$. The author reported that,

The standard errors were quite large: 16,418,125 for Y , 163,877 for X_1 , 164,871 for X_2 , and 164,305 for X_3 . The t value for Y was 0.0492, and its p value was 0.4804. X_1 had a t value of 0.0877 and a p value of 0.4652 while X_2 had a t value of 0.0222 and a p value of 0.4912 and, finally, X_3 had a t value of 0.0556 and a p value of 0.4779.

- a. What problems do you see with this model specification?

- b. How would you respecify the model?

- b. What problems do you see with the reported results?

18. A student played 100 games of Roshambo (rock, scissors, paper) against a computer software program, winning 32 games, losing 38, and drawing 30. The computer tried to figure out the player's strategy. The following table separates the results into the first 50 games and the last 50 games:

	Player Won	Computer Won	Draw
First 50 games	19	16	15
Second 50 games	13	22	15
Total	32	38	30

- a. Is the difference in the win-loss percentages between the first half and second half statistically persuasive?
- b. The computer noticed that this player seldom repeated moves (like rock after rock). In 99 opportunities to repeat a move, the player only repeated a 7 times. Is this a statistically persuasive pattern?

19. A study reported that among Major League Baseball players born between 1875 and 1930, players whose first names began with the letter D died, on average, 1.7 years younger than did players whose first names began with the letters E through Z. What statistical reasons make you skeptical?

20. In order to see whether women are more successful at single-sex or coeducational colleges, samples of women attending a women's college and a coeducational college were asked, "Do you feel you are successful at your college?" The results were as follows:

	Women's College	Coeducational College
Yes	37	30
No	15	13

The researcher explained that, "A chi-square test was used to see if the results are statistically significant. We assume that a positive answer is a valid determinate of true success, so that the null hypothesis is that the probability equals 0.5, because there is a 50-percent chance of agreeing that either yes, one is successful or no, one is not successful." The observed values were compared to these expected values:

	Women's College	Coeducational College
Yes	26	21.5
No	26	21.5

Explain why this procedure is not persuasive, and then make an appropriate statistical test.