

Final Examination, Stat 1001, Fall, 2000

This is a closed book exam. However, you are permitted to have a three-page summary of notes (front and back OK). Each problem or each part of a problem is worth 10 points (maximum score is 230). Calculators are permitted. Put your answers directly on this exam.

1. A product advertisement claims: “People using *LoseWeight Fast* lost an average of 12 pounds!” Name three bits of information that would be needed to evaluate this claim, and why the information you specify is useful. (Don’t provide more than three reasons.)

There are many possible answers, including: the sample size matters, suppose only one person has used the product; the people matter, do they represent any meaningful population; the length of time of use matters, one week is different from 5 years; the standard deviation matters, if it is very large then the program may not be useful for everybody.

2. A large grocery store wants to know if its customers would be willing to bag their own groceries in exchange for a small reduction in prices. The store posted an interviewer at the door to the store each day from 1PM to 4PM on a Monday, Tuesday and a Wednesday, and the interviewer spoke with $n = 400$ customers.

- (a) What is the population of interest? Has the store achieved a random sample of the population of interest?

Either the store’s current customers, or all potential customers for the store. Unless people who shop on weekday afternoons are typical of all customers, the sample does not represent the population.

- (b) Suppose 100 of the 400 interviewed customers would be willing to bag groceries in exchange for a price decrease. Based on this information, what advice would you give to the store?

Since we don’t have a random sample of the population, this information seems of very little value.

3. A research study is proposed to determine if exercise reduces stress.

- (a) State the null and alternative hypothesis that will be examined by this study.

Null hypothesis: exercise does not reduce stress; Alternative hypothesis: exercise does reduce stress

- (b) The researcher wants to make the study large enough so that if it is true that exercise reduces stress, then the chance of finding no reduction in stress is small. Is the researcher concerned about type I error or type II error?

Type II.

4. True or false (and explain) The 95% confidence interval for the average weight of a box of bananas is from 38.5 pounds to 41.5 pounds. Therefore, assuming that weight of the boxes is normally distributed, 95% of all boxes of bananas must weigh between 38.5 pounds and 41.5 pounds.

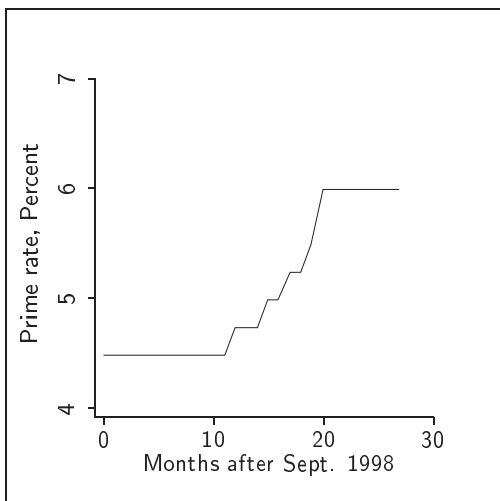
False. The confidence interval is the estimated mean plus or minus two times the standard deviation divided by the square root of the sample size, and is a statement about the average observed in the sample, not about future individual observations.

5. A new cream for dry skin is to be compared to a standard cream. Eighty volunteer subjects who meet the criterion of having dry skin are available. Forty of them are randomly assigned to use the new treatment and the remaining 40 are assigned to use the control treatment. The research goal is to see if the new cream is better than the old one.

- (a) Explain in the context of this experiment a *blind experiment*. Could this experiment be done as a blind experiment? If so, how? If not, why not?

An experiment is blind if the subjects don’t know which treatment they receive. This experiment could be blind if the subjects are not told which treatment they get and the creams are packed in identical containers.

- (b) At the end of the experiment, the p -value is 0.02. Explain what this means with regard to this particular experiment.
- If the null hypothesis of no difference were true, we would get an observed difference at least as large as observed 2% of the time. Using a 5% significance level, we reject the hypothesis of no difference in favor of the alternative that the new treatment is better.*
- (c) Can we conclude from this experiment that the new treatment *causes* any difference between treatment and the standard? Why or why not?
- Because this is a randomized experiment we can infer causation. However, the subjects were volunteers, so they may not be representative of any particular population.*
6. In the Florida election the rate of “undervotes” in counties with punch card-voting is 1.5%, while in counties with optical scan ballots, the rate of undervotes is 0.3%.
- (a) What is the observed relative risk of a ballot being an undervote in a punch-card county compared to a optical scan county?
- $1.5/.03 = 5.$
- (b) A test of the hypothesis that the rate of undervotes was the same in the two types of counties versus the alternative that it is higher in punch-card counties has a p -value less than 0.00001. Write a sentence that explains the meaning of this statistic.
- The tiny p -value means that the chance of observing such a big difference in the rates of the two counties when the population rates are really equal is tiny. From this we infer that the population rates are not the same, and that undervotes are more common in punch-card counties.*
- (c) Can we take this evidence to conclude that the punch card ballot *causes* undervotes? Why or why not?
- Voting method is not assigned at random to counties, so it is possible that there is some other confounding factor like average age or something else that can be responsible for the difference in rates.*
7. You have just opened a factory (congratulations) in which you plan to manufacture high-precision widgets. You hope to make the best and most consistent widget in the industry.
- (a) Making high precision widgets requires that you purchase ball bearings that are as close to the same size as possible. You are choosing between two suppliers, A and B, who both make ball bearings. Both are capable of making ball bearings that have the same average size. What statistic would you need to know to choose between the two manufacturers, and how would you use it?
- Choose the company with the smaller standard deviation.*
- (b) Suppose that your widgets have a weight that is normally distributed with mean 200 grams and standard deviation of 4 grams. If all widgets that weigh more than 206 grams or less than 194 grams must be discarded, what fraction of your production do you discard?
- $z_1 = (194 - 200)/4 = -1.5$ and $z_2 = (206 - 200)/4 = 1.5$. *You need to find the area under the standard normal curve to the left of -1.5 and to the right of 1.5 , which is about 0.14 or 14%. So, 14% of the production is discarded. You should try to change your manufacturing process to make the standard deviation smaller, or you are likely to go bankrupt.*
8. In a random sample of 64 widgets taken from production in your factory, 16 widgets were slightly off-color, and the remaining were the correct color.
- (a) Give a 95% confidence interval for the true rate of off-color widgets.
- $16/64 \pm 2 \times \sqrt{(.25 \times .75)/64} \approx .25 \pm 2 \times .054 = .14 \text{ to } .36.$
- (b) Provide one sentence that describes what the confidence interval means.
- 95% of the time, intervals constructed the way we did this one will include the true proportion.*
9. The graph below is of the US Federal Discount rate, the rate at which banks can borrow money from the Federal Reserve Bank, for the last 28 months. A similar graph appears in the December 18 2000 issue of *Newsweek*. Give two reasons why this graph might be misleading.



Two problems are: missing zero on the vertical axis make changes look bigger; and selection of the interval (starting in apparently the fourth quarter of 1998) may have been chosen to make differences look more dramatic.

10. Defining an index like the consumer price index for comparing prices between countries can be done in many ways. One approach is to use the Big Mac Hamburger as a commodity that is essentially the same throughout the world. The table below gives the “Big Mac Index”, the cost of a Big Mac and fries, as well as the average cost of a bottle of beer, for 4 countries (the beer prices are made-up but the Big Mac prices are accurate as of March 2000).

Country	Big Mac	Beer
U. S.	\$2.51	\$1.50
Argentina	\$2.50	\$1.25
Brazil	\$1.65	\$0.90
Chile	\$2.45	\$1.10

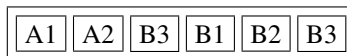
Adjusting for the cost of a Big Mac, where is beer more expensive, in Argentina or in Brazil?

Taking Argentina as the baseline for the index, adjusting for Big Mac, the adjusted cost of beer in Brazil is

$$\frac{2.50}{1.65} \times \$0.90 = \$1.36$$

so beer is more expensive in Brazil after adjusting for the cost of a BigMac.

11. A box contains 6 tickets. On each ticket, there is a number (either 1, 2, or 3) and a letter (either A or B). Here is a picture of the box:



In all the following questions, tickets are drawn at random, with replacement, from the box. For example, the first draw might be the ticket marked A2. It is then returned to the box and another draw is made.

- (a) **Fill in the blank:** The probability that a ticket drawn at random has the letter “A” on it= _____
 $2/6 = 1/3$.
- (b) Are the events {Ticket has a A} and {Ticket says 3} independent, mutually exclusive, or neither of these? How do you know?
Since none of the tickets are labelled A3, the two events are mutually exclusive.

12. If the probability of missing your bus to school is $1/10$, is the probability that you miss the bus at least once during the week (Monday to Friday) equal to $5/10$? Why or why not?

Assuming days are independent, probabilities will multiply, not add. The probability of missing at least once is 1 minus the probability of never missing = $1 - .9^5 = 0.41$.

13. You decide to lend a friend \$100 to start a (very) small business. If the business succeeds, the friend will repay your \$100 plus \$200 profit, but if the business fails you lose your \$100. If you judge that the probability that the business succeeds is $.75$, what is the expected value of your investment?

$.75 \times 200 + .25 \times -100 = 150 - 25 = 125$ or \$125. As long as your assessment that the probability of success is this high, this is a pretty good investment.

14. In the 1850s the physicist Forbes conducted several experiments to study the relationship between altitude and boiling point of water. He took his measurements at different altitudes both in the Scottish Highlands and in the Swiss Alps. He discovered that the correlation between altitude and boiling point is about -0.95 . Write one or two sentences that explains what this correlation means.

Boiling point and altitude are closely related. At higher altitudes boiling point is lower.