

Please show any work you do by hand/calculator. These are due on Wednesday, October 4 at the beginning of class.

- 1) Exercise 5.1 in the textbook, to put you through the paces of using the standard normal distribution table.
- 2) For parts a, b, and d below, assume a normally-distributed population with  $\mu = 50$  and  $\sigma = 10$ .
  - a. If 4 scores are sampled from this population, what is the probability that the mean of the scores is between 48 & 52? (If you need help using the unit normal table to do this or part b, please ask.)
  - b. If 16 scores are sampled from this population, what is the probability that the mean of the scores is between 48 & 52?
  - c. Explain why the probabilities in parts b and c are different, and why the lower probability is lower. Try to do this in the plainest, least-statistical-sounding language you can.
  - d. Assume that a sample of  $n = 25$  individuals is selected from this population and given a treatment that is supposed to raise their score. The mean score in this sample is 55. Assuming that the population standard deviation is unchanged by the treatment, what is the 95% confidence interval for the mean of the treatment population (i.e., the population represented by the sample that received the treatment)?
- 3) Suppose that 238 students from a state in the USA took the verbal portion of the SAT and had a mean score of 525. Assume further that these 238 students are a random sample of students from this state, and that the SAT verbal section in general (i.e., across all students who take it) is supposed to have a mean of 500 with a standard deviation of 100.
  - a. Compute a 95% confidence interval for the mean SAT verbal score for all students in this state. (Assume that the SD stays at 100 for students in this state. The CI should be centered at 525, not 500.)
  - b. Does it seem likely that the students in this state are performing better than the general population? Please answer more than just "yes" or "no"; use the CI (and its interpretation) to argue for your answer.
- 4) The questions below are designed to force you to think through the logic of confidence intervals and hypothesis testing as well as the errors that can arise. GRE verbal scores are supposed to<sup>1</sup> have a mean of 500 and a standard deviation of 100, and are normally distributed. Imagine that someone invents a drug that allegedly increases verbal ability. To test this drug, a random sample of GRE-takers is recruited to take the drug and then take the GRE. The research question here is: "Is the drug effective at increasing verbal ability?"
  - a. What is the null hypothesis in plain English?
  - b. What is the null hypothesis in parameters? (This should be about what  $\mu_{\text{drug}}$  is for the GRE verbal section.)
  - c. If the null is true, what (approximately) should the mean GRE verbal score of the drug-taking GRE-takers be?
  - d. If the null is true, what is unlikely to occur with the mean GRE verbal score of the drug-taking GRE-takers?
  - e. Imagine that the null hypothesis is in fact true. Imagine further that the sample of drug-taking GRE-takers have a mean GRE verbal score of 550. What might cause a result like this to occur?
  - f. Imagine now that you have no idea whether the null hypothesis is in fact true (just like real life!). Imagine further that you have a good-sized sample ( $n = \text{hundreds or more}$ ) and that the sample has a mean GRE verbal score of 550 after taking the drug. Argue how this observed score could lead one to doubt the truth of the null hypothesis. Your argument should take into account your answer to parts c and d.
  - g. Now imagine that the null hypothesis is true. Imagine further that a sample of 16 subjects is recruited to take the drug and then take the GRE. Then another sample of 16 does this. And another sample. And on and on until every possible sample of 16 subjects has participated. What are the 95% most-likely means for these samples of 16? How wide is this interval? What is the center of this interval?
  - h. Now imagine that you don't know if the null is true or false and that a single sample of 16 subjects takes the drug and gets a mean of 530 on the GRE. What should the center of the interval be now? What should the width of the interval be? What changed from part g, and what stayed the same?

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<sup>1</sup> Or at least it used to.