

Statistics 571 Midterm 2  
Hanlon/Larget, Fall 2011

Name: \_\_\_\_\_

Please circle the lecture section *in which you are registered*:                      Hanlon                      Larget

Please circle the lecture section *you attend*:    Hanlon                      Larget

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**Instructions:**

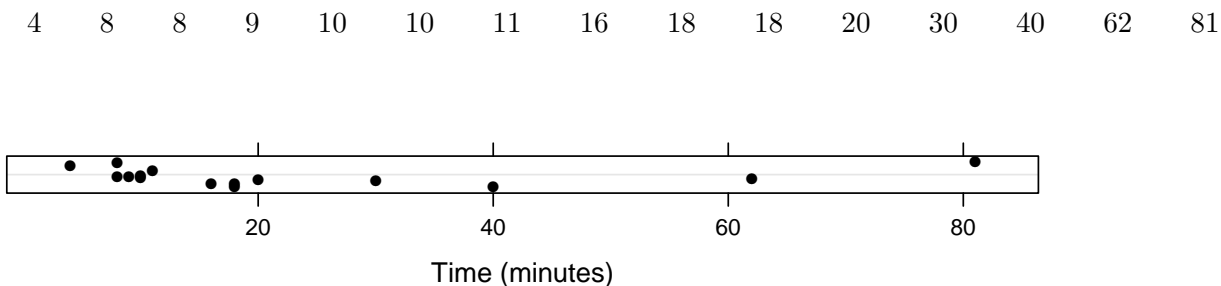
1. You may use a calculator, but you may not use a laptop computer or phone.
  2. The examination is open book, open notes, but not open neighbor. You may use any course handouts including lecture notes and homework solutions.
  3. Do all of your work in the space provided. Use the backs of pages if necessary, indicating clearly that you have done so (so the grader can easily find your complete answer).
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**For Graders' Use:**

Question	Possible Score	Score
1	25	
2	15	
3	20	
4	15	
5	25	
Total	100	

1. **(25 points)** In healthy adults, the peak serum cortisol level has a normal distribution with mean  $11.2 \mu\text{g/dL}$  and standard deviation  $2.5 \mu\text{g/dL}$ .
- (a) What is the 30th percentile of the distribution of peak cortisol levels in healthy adults?
  - (b) Calculate the proportion of healthy adults with peak cortisol level between 10.0 and 12.4  $\mu\text{g/dL}$ .
  - (c) A random sample of 4 healthy adults is chosen, and their peak cortisol level is measured. Let  $\bar{Y}$  be the sample mean of these observations. What is the mean and standard deviation of  $\bar{Y}$ ?
  - (d) (Continue Part c). Calculate  $P(10.0 \leq \bar{Y} \leq 12.4)$ .
  - (e) This time, 16 healthy adults are sampled.  $\bar{Y}$  is the sample mean of their peak cortisol levels. Consider  $P(10.0 \leq \bar{Y} \leq 12.4)$ . Without calculating this probability, do you expect it to be less than, equal to, or greater than the probability in (d)? Explain your answer very **briefly**.

2. (15 points) Many snake venoms contain large toxin molecules that cannot enter the bloodstream directly, but are absorbed and transported by lymphatic vessels before entering veins near the heart. In an experiment, researchers simulated snake bites by injecting 15 human volunteer subjects in the back of the foot with a sterile substance similar to snake venom and measured the time in minutes until the substance was transported to lymph nodes in the groin. The raw data, sorted and shown below, has a sample mean of 23.0 minutes and a standard deviation of 22.1 minutes and is displayed in the following dotplot (points are jittered vertically).



- (a) Treating this data as a random sample from the population of adults, use a  $t$ -distribution method to find a 95% confidence interval for the population mean time for the substance to move from the foot to the groin.
- (b) The bootstrap is an alternative approach for computing a confidence interval. Applying the bootstrap to this data results in a 95% confidence interval of  $13.4 < \mu < 34.9$  minutes. The bootstrap procedure was applied to obtain  $B = 10,000$  bootstrap means. Explain how the endpoints of the bootstrap confidence interval were determined from this sample.
- (c) Is the  $t$ -distribution or bootstrap confidence interval more reliable for this data? Explain **very briefly**.

3. (20 points) In a study of soybean aphids a total of ten (10) soybean plants are sampled at random from a population. For each plant, the number of aphids found at the top and at the bottom of the plant are recorded. Here is a data summary.

	Top	Bottom	Difference
n	10	10	
mean	10.6	8.1	
SD	2.01	1.60	2.92

Use an appropriate  $t$  test to address the question of whether or not the mean number of aphids per plant is the same between top and bottom.

- State hypotheses in words and symbols.
- Compute the test statistic.
- Compute the degrees of freedom.
- Find a range for the p-value from the  $t$ -table.
- Interpret the results in the context of the problem.

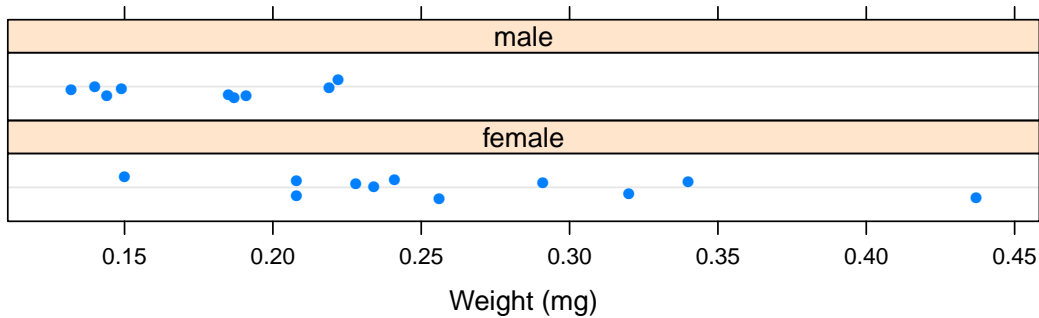
4. **(15 points)** The following experiment was run to determine whether or not different flavors of ice cream melt at different speeds. Two flavors (A and B) of ice cream were stored in the same freezer in similar-sized containers. For each observation, one teaspoonful of ice cream was taken from the freezer, transferred to a plate, and the melting time at room temperature was observed to the nearest second. Nine observations were taken on each flavor. Here is a data summary.

	Flavor A	Flavor B	Difference
n	9	9	
mean	1012	944.9	
SD	20.7	78.2	50.92

- (a) Compute a 95% confidence interval for the difference in mean melting times between Flavor A and Flavor B.
- (b) Interpret this confidence interval in the context of the study.
- (c) Another student computes a 95% confidence interval based on Welch's method. Is there any reason to prefer this confidence interval compared to the one computed in (a)? Briefly explain.

5. (25 points) Female and male mosquitos have potentially different sizes by weight. A researcher captured 11 female and 9 male mosquitos and measured their weights in milligrams. Is there evidence in the data below that the mean weight of female mosquitos is larger than the mean weight of males?

Group	$n$	mean	sd
Female	11	0.2648	0.0785
Male	9	0.1743	0.0342



- (a) State hypotheses in symbols. Define each symbol that you introduce.
- (b) Using a  $t$ -distribution method that assumes equal population variances, calculate the test statistic (female minus male).
- (c) Circle one option in each underlined portion of the following statement to make it correct.  
 The p-value for the hypothesis test is 1 | 2 times the area to the LEFT | RIGHT of the correct test statistic calculated in part (b) beneath a  $t$  density with 8 | 10 | 18 | 19 | 20 degrees of freedom.
- (d) One of the following numerical values is the correct p-value. Use your  $t$ -table to identify which one it is and circle it.  
 0.0002448                  0.002448                  0.02448                  0.2448
- (e) Name an assumption of the hypothesis test from part (b) that may be questionable in light of the dotplot of the data.
- (f) The p-value from a permutation test of the hypothesis using this data is estimated to be 0.0018, based on 10,000 permutations of the data. Briefly explain how this value was obtained.