

Part I. (80 points) Do all calculations in Minitab. Use a word processor of your choice to write a report. Insert computer text output and graphics to support what you are saying, but you need to write something that looks like an academic paper — not a pile of computer output. Turn in a hard copy of your HW in class (i.e., don't email me your HW). Also:

1. Clearly define population parameters in each problem. That is, give a verbal description of what the population mean is in the context of the problem.
2. Clearly specify hypotheses when appropriate (not every problem involves a test of hypothesis).
3. Write a coherent conclusion based on each CI or test.

(80^{pts})

1. REM with ethanol treatment: An experiment was designed to investigate whether rapid eye movement (REM) sleep time depends on the amount of ethanol given in an injection. Four injection concentrations were considered: 0, 1, 2, and 4 grams per kilogram of body weight. Twenty rats were then chosen and randomly divided into four equal sized groups. Each group was given a different treatment (concentration of ethanol). The REM sleep time during the subsequent 24 hour period was recorded for each rat. The data are as follows:

80 pts

Treatment	REM sleep in minutes				
0 g/kg	88.6	73.2	91.4	68.0	75.2
1 g/kg	63.0	53.9	69.2	50.1	71.5
2 g/kg	44.9	59.5	40.2	56.3	38.7
4 g/kg	31.0	39.6	45.3	25.2	22.7

We are interested in comparing the typical amount of REM sleep across treatments.

(The data can be “reshaped” into columns in this way: Copy and paste the four data rows into Minitab, then Menu: Data/Stack/Rows, select the columns the data are in (e.g., C3–C7), store the stacked data in an empty column (e.g., C8), and select “Store row subscripts in” and select an empty column (e.g., C9). Finally, label the columns “REM” and “Treatment”, or other sensible names.)

Summarize all your results carefully in a report. Make certain you define all populations and parameters under consideration, and that you make clear with each step which parameter(s) you are analyzing. I am particularly concerned that you keep straight the distinction between sample and population means, and sample and population variances.

- (a) (10 pts) Make boxplots and dotplots of the data to compare the groups. Compute, in Minitab, the sample means and standard deviations for the 4 treatment groups.
- (b) (10 pts) Looking at the graphical and descriptive summaries from part (a), do there appear to be differences in the typical REM levels for the 4 groups? Describe the differences you see that appear to be most pronounced.
- (c) (10 pts) Do a one-way Analysis of Variance to compare the mean REM levels for the 4 groups. Are the groups significantly different at the 5% level?
- (d) (10 pts) Compare all possible pairs of groups using Fisher's LSD method, and summarize the results of the multiple comparison. Repeat for Tukey's HSD method, and using Bonferroni comparisons. Do the three methods find different groupings? If so, what accounts for that?
- (e) (10 pts) Are the results of the F -test in part (c), and the multiple comparisons in part (d) consistent with what you described in part (b)? Briefly discuss.
- (f) (10 pts) Looking at the numerical and graphical summaries does it appear that the distributions of REM levels are reasonably normal, and have constant variance across groups? Discuss.

80 pts

- (g) (10 pts) Comment on the Levene's and Bartlett's formal tests of equal variances in light of what you see when you look at the data.
- (h) (10 pts) Obtain the residuals (or centered values) and generate a normal probability plot based on them. This is an overall check on normality. Is the normality assumption reasonable here? Perform a formal test of normality on the residuals, report the p-value and comment. If the test says we did not sample from normally distributed populations, why does it appear to be saying that? Do you think there is a real difficulty here with applying the normal theory methods?