BIA 654 Homework 4

- Be sure to include statistical software outputs to show your work.

1. You are conducting a study to see if students do better when they study all at once or in intervals. One group of 12 participants took a test after studying for one hour continuously. The other group of 12 participants took a test after studying for three twenty minute sessions. The first group had a mean score of 75 and a variance of 120. The second group had a mean score of 86 and a variance of 100. Assuming the normal populations, independent samples, and equal population variances conditions hold, are the mean test scores of these two groups significantly different at the 0.05 level?

2. Find a file NHANES.dat. It contains a large data set related to patients profile and their health status. Suppose we are interested in whether BMI (Body Mass Index) is different between Male and Female groups. Is there an evidence of equal variance at significance level 0.05? Perform an appropriate two-sample t-test.

3. The female cuckoo lays her eggs into the nests of foster parents. The foster parents are usually deceived, probably because of the similarity in the sizes of the eggs. Lengths of cuckoo eggs (in millimeters) found in the nests of hedge sparrows, robins, and wrens are shown below:

   Hedge sparrow: 22.0, 23.9, 20.9, 23.8, 25.0, 24.0, 21.7, 23.8, 22.8, 23.1, 23.1, 23.5, 23.0, 23.0

   Robin: 21.8, 23.0, 23.3, 22.4, 23.0, 23.0, 23.0, 22.4, 23.9, 22.3, 22.0, 22.6, 22.0, 22.1, 21.1, 23.0

   Wren: 19.8, 22.1, 21.5, 20.9, 22.0, 21.0, 22.3, 21.0, 20.3, 20.9, 22.0, 20.0, 20.8, 21.2, 21.0

   It is believed that the size of the egg influences the female cuckoo in her selection of the foster parents. Do the data support this hypothesis? Test whether or not the mean lengths of cuckoo eggs found in the nests of the three foster-parent species are the same. (*Here, don't forget to check each of the underlying 'assumptions.'*)

4. Recall the class note example on three promotions and sales volume difference percentage data; see Lecture 4-2.pdf lecture slide, page 7. Perform one-way ANOVA procedure to test

   $$H_0 : \mu_1 = \mu_2 = \mu_3, \text{ vs. } H_1 : \text{ Not } H_0 .$$

   (a) Carry this out via hand calculations (it is worth doing this practice at least once!).

   (b) Now, do it again via statistical software package and compare with the result in (a).

   Remarks. We recall some logic behind ANOVA and also follow-up on the in-class questions.

   - A One-Way Analysis of Variance is a way to test the equality of three or more means *at one time* by using variances. There are the between group *variation* (SSB) (not *variance* yet) and the within group variation (SSW). The whole idea behind the ANOVA is to compare the ratio of between group variance (that is, variation/degrees of freedom, similar to sample variance formula s^2) to within group variance (SSW/degrees of freedom).
   - I agree to some extent that the term 'between-group' variation is a misnomer. This is because SSB does not measure something like $(\overline{X}_i - \overline{X}_j)^2$, which seems to be more consistent with the term 'between-group' variation. However, notice that *under the null* H_0, all means are the same ($\mu_1 = \mu_2 = \mu_3$). To test this equality of three (or more) means **simultaneously**, one wants to measure an *aggregated* variation caused by each group effect (that is, deviation from the overall mean); if this number is large enough, then it is an evidence that goes against H_0.
   - *If* the variance caused by the between group effect (that is, due to $\overline{X}_i - \overline{\overline{X}}$(overall mean), $i = 1, \ldots, c$) is much larger when compared to the variance that appears within each group, *then* it is likely because the means aren't the same.