ANOVA: Comparing More Than Two Means

10.2 Multiple Comparisons of Means

1. If a completely randomized design involves 9 means and we want to run a multiple comparison procedure to make pairwise comparisons, how many comparisons will need to be made?

2. A multiple comparison procedure for comparing four treatment means produced the confidence intervals shown below. Rank the means from smallest to largest. Indicate which means are significantly different?
   $\mu_A - \mu_B = (-12, -2)$
   $\mu_A - \mu_C = (-4, 6)$
   $\mu_A - \mu_D = (2, 12)$
   $\mu_B - \mu_C = (3, 13)$
   $\mu_B - \mu_D = (9, 19)$
   $\mu_C - \mu_D = (1, 11)$

3. A multiple comparison procedure is conducted and the results are given below. The means have been ranked from smallest to largest. Interpret the results and state the number of comparisons made: $\overline{A\ B}\ F\ \overline{C\ D}$

4. In a CRD experiment at a significance level of 2.5% with a balanced design (i.e.- all the treatment sample sizes are the same) the F statistic turns out to be 3.59 which has a p-value of 0.1069. What multiple comparison procedure should be used to make pairwise comparisons?

5. In a CRD experiment at a significance level of 1% with an unbalanced design (i.e.- all the treatment sample sizes are **not** the same) the F statistic turns out to be 9.97 which has a p-value of 0.0027. What multiple comparison procedure should be used to make pairwise comparisons?

Answers:

1. We will have 36 comparisons: ${}_9C_2 = \frac{9*8}{2} = 36$

2. $D\ \overline{\mathrm{C\ A}}\ B$

3. There are ${}_5C_2 = \frac{5*4}{2} = 10$ comparisons. $A \le B < F < C \le D$, Statistically A and B are tied for the smallest, while C and D are tied for the largest.

4. Since $p - value > \alpha$, we do not reject the null hypothesis. Thus we do not need a multiple comparison procedure to tell us which means are different from each other. We must assume they are all equal.

5. Since the sample sizes are unequal, we are dealing with an unbalanced design, so we will choose Bonferroni.