Discussion 13: ANOVA with Multiple Pairwise Comparisons

Consider an experiment on the dose-response rates between four antibiotics, W, X, Y, and Z applied randomly at the same concentration to cultured bacteria, and the percent reduction in bacterial population are given:

W: 13.3, 13.7, 11.6, 11.9, 12.0, 12.9, 12.3, 12.1, 12.3, 12.3

X: 12.5, 13.9, 12.4, 14.0, 12.8

Y: 16.8, 16.6, 17.1, 15.0, 18.0, 16.5

Z: 13.2, 14.2, 13.5, 13.2, 14.3, 12.7, 14.9, 13.3, 13.5

The researchers wish to test $H_0 : \mu_W = \mu_X = \mu_Y = \mu_Z$, where each μ is the population mean reduction for the corresponding antibiotic.

Use R for these questions. Hint: See the lecture notes for sample R code.

1. Make a 4-way dotplot of reduction vs. sample. From this plot, guess at what an ANOVA test will say about H_0.

2. Create an ANOVA table for this test.

3. Check assumptions by checking sample standard deviations (is the largest no more than twice the smallest?), making a graph of residuals vs. sample means (fitted values) (is there reasonably uniform spread across samples and no outliers?), and making a normal QQ plot of residuals (are the populations plausibly normal?). Is it reasonable to suppose the ANOVA assumptions are met?

4. Make a decision in the context of the problem.

5. Find Tukey-Kramer simultaneous confidence intervals for the differences between each pair of means, $\mu_X - \mu_W$ through $\mu_Z - \mu_Y$. Which pairs of means are significantly different at the $\alpha = 5\%$ level?