**SOLUTION FOR HOMEWORK 10, STAT 5352**

Welcome to your homework devoted to ANOVA models.

As usual, try to find mistakes (and get extra points) in my solutions. Typically they are silly arithmetic mistakes (not methodological ones). They allow me to check that you did your HW on your own. Please do not e-mail me about your findings — just mention them on the first page of your solution and count extra points.

Now let us look at your problems.

Problem 1. First of all, let us calculate the corresponding totals and means. Set$Y_{ij}$ for the number of cases sold, here $i$ correspond to the package design (or treatment/level) and $j$ to $j$th store. Please note that a store here is not a block or second factor — all stores are different and they represent repeated observations (samples). This is why this is a single-factor design (ANOVA model).

Then a direct calculation yields $Y_{1\cdot} = \sum_{j=1}^{5} Y_{1j} = 73$, $Y_{2\cdot} = \sum_{j=1}^{5} Y_{2j} = 67$, $Y_{3\cdot} = \sum_{j=1}^{4} Y_{3j} = 78$, $Y_{4\cdot} = \sum_{j=1}^{5} Y_{4j} = 136$.

The corresponding mean numbers for each package-design are $\bar{Y}_{1\cdot} = 14.6$, $\bar{Y}_{2\cdot} = 13.4$, $\bar{Y}_{3\cdot} = 19.5$, $\bar{Y}_{4\cdot} = 27.2$

You may plot the mean numbers and then try to answer the raised question using your intuition. To solve the problem formally, we first calculate the grand mean

$$\bar{Y}_{\cdot\cdot} = Y_{\cdot\cdot}/[n_1 + n_2 + n_3 + n_4] = 354/[5 + 5 + 4 + 5] = 18.63.$$

Then we calculate the following sums of squares:

$$SSTR = 5(14.6 - 18.63)^2 + 5(13.4 - 18.63)^2 + 4(19.5 - 18.63)^2 + 5(27.2 - 18.63)^2 = 588.22,$$

$$SSE = (11 - 14.6)^2 + (17 - 14.6)^2 + (16 - 14.6)^2 + \ldots + (28 - 27.2)^2 = 158.2$$

Now note that SSTR has $4 - 1 = 3$ degrees of freedom, and SSE has $19 - 4 = 15$ degrees of freedom.

Now we can calculate the F statistic:

$$F = \frac{MSTR}{MSE} = \frac{SSTR/3}{SSE/15} = \frac{196.07}{10.55} = 18.6.$$

Recall that the hypothesis testing is always right tail, so we reject the hypothesis about no difference between package designs if $F > F_{\alpha,3,15} = 3.29$. In our case we obviously reject.