BIA 654 Homework
Due on Mar. 8
Fall 2016

BIA 654 Homework 6

- Submit each homework at the beginning of each class.

1. This exercise was inspired by a real problem described in the article "Strategic Testing Stops Leaky Litter Cartons in Their Tracks" (*Packaging Digest*, August 2001, PLEASE FIND THIS PAPER IN CANVAS TO READ). The exercise resembles what the actual company did, but the data are not real.

   The makers of "Cats Love It" cat litter are facing a serious problem. Retail customers are reporting that cartons of the firm's premium brand cat litter are leaking the product onto store shelves. The company realizes that while cat lovers are used to cleaning stray sprays of litter tracked through the house, they are not willing to put up with cartons that leak on the way home.

   Management has determined that the problem is with the carton-sealing process. Cartons are filled and sealed on a production line run by 20 workers. The company decides to perform 3-factor factorial experiment. A run consists of filling and sealing 200 cartons. The factors to be tested and levels of each are shown below.

   Factor A is line speed with the minus level at 22 cartons per minute and the plus level at 30 cartons per minute. Factor B is the pressure applied by the gluing machine, with the minus level being lower pressure and the plus level being higher pressure. Factor C is the amount of glue used, with the plus level being the current amount and the minus level being 40% less glue.

   The response is the proportion(%) of cartons that leak, whose values are observed as 8, 45, 47, 10, 8, 40, 41, 8, listed in the *standard* order. For the questions below, you can do them either by hands (recommended) or computer.

   (a) Make the design matrix (with '+' and '–' symbols) that includes main effects and two- and three-factor interactions.

   (b) What are the estimated main effects of factor A and B? What is the estimated AC interaction?

   (c) Display the effects graphically through main effects of C and interaction plots for BC and AC.

2. (a) Suppose the three real estate appraisers independently examined each of five properties chosen at random from a particular neighborhood and gave appraised values. The manager of the appraisal service that employs them suspects that systematic differences among their methods of appraisal are causing undesirable inconsistencies in appraised values provided by her service. The issue is whether there are, in fact, systematic differences among the values reported by the three appraisers. The data, APPRAISED VALUES (In thousands of dollars), are shown below.

   Question: What kind of statistical analysis should you perform? Choose from: (Two sample t-test, pairwise t-test, One-way ANOVA, One-way ANOVA with block, Two-way ANOVA, Factorial design). If your answer is One-way ANOVA with block, which variable does play a role of block?

		Appraiser	
Property	A	B	C
1	90	93	92
2	94	96	88
3	91	92	84
4	85	88	83
5	88	90	87

(b) Suppose each of 4 Chardonnay wines of the same vintage was judged by 5 judges. Each wine was blinded and given to each judge in randomized order. The wines were scored on a 40-point scale, with higher scores meaning better wine. Based on those scores, we want to test whether there is a difference between the 4 Chardonnay wines in mean scores.

Question: What kind of statistical analysis should you perform? Choose: (Two sample t-test, pairwise t-test, One-way ANOVA, One-way ANOVA with block, Two-way ANOVA, Factorial design). If your answer is One-way ANOVA with block, which variable does play a role of block?

(c) A researcher was interested in whether an individual's interest in politics was influenced by their level of education and gender. Therefore, the dependent variable (response variable) was "interest in politics" and the two independent variables were "gender" and "level of education."

In particular, the researcher wanted to know whether there was an interaction between education level and gender. Put another way, was the effect of level of education on interest in politics different for males and females?

To answer this question, a random sample of 60 participants were recruited to take part in the study–30 males and 30 females–equally split by level of education: school, college and university (i.e., 10 participants in each group). Each participant in the study completed a questionnaire that scored their interest in politics on a scale of 0 to 100, with higher scores indicating a greater interest in politics.

Question: What kind of statistical analysis should you perform to answer for the original question? (Two sample t-test, pairwise t-test, One-way ANOVA, One-way ANOVA with block, Two-way ANOVA, Factorial design)

3. Recall the comparison between factorial design and one-factor-at-a-time (OFAT) approach considered in class: In the 2^2 factorial design (without replications), we conduct a total of 4 runs. The main effects of both factors (say A and B) are estimated by the difference between averages of *two* observations at the low and the high levels of each factor. Therefore, in order for the OFAT to achieve the same level of precision (that is, to obtain averages of *two*), one must have 2 runs at each experimental combination. Hence, for the 2 factor case, OFAT requires $2 \times 3 = 6$ total runs whereas 2^2 factorial design needs $2^2 = 4$ runs.

   Now, suppose there are 5 factors (A, B, C, D, E), each having two-levels. We know 2^5 factorial design (without replications), we conduct a total of 32 runs. How many total runs are required in order for the OFAT approach to achieve the same precision? Explain why.