STAT350 - Problem set 11

1. A student commented in a discussion group, "Random permutations are used to assign treatments to experimental units with a randomized complete block design just as with a completely randomized design. Hence there is no basic difference between these two designs." Comment.

2. **Hardware sales.** A manufacturer conducted a small pilot study of the effect of price of Bob the Builder Hammers on sales of this product in hardware stores. Since it might be confusing to customers if prices were switched repeatedly within a store, only one price was used for any one store during the six-month study period. Sixteen stores were employed in the study. To reduce experimental error variability, stores were chosen so that there would be one store for each sales volume-geographic location class. The four price levels (A: \$1.79, B: \$1.69, C: \$ 1.59, D: \$1.49) were assigned to the stores according to the latin square design shown below. Data on sales during the six-month period (in thousand dollars) follow and are provided on RamCT in the file called hammers.csv.

	Geographic Location class			
Sales volume class	Northeast	Northwest	Southeast	Southwest
1 (smallest)	1.2 (B)	1.5 (C)	1.0 (A)	1.7 (D)
2	1.4 (A)	1.9 (D)	1.6 (B)	1.5 (C)
3	2.8 (C)	2.1 (B)	2.7 (D)	2.0 (A)
4 (largest)	3.4 (D)	2.5 (A)	2.9 (C)	2.7 (B)

   (a) Obtain the residuals for a latin square model and plot them against the fitted values. Based on the plot, comment on the appropriateness of the model.

   (b) Create a QQ-plot of the residuals. Based on the plot, comment on the appropriateness of the model.

   (c) Write out a linear model for sales based on the study design. Identify the components in terms of the model and state any constraints and distributional assumptions on the parameters.

   (d) Test whether or not price level affects mean sales using a 0.05-level test. Provide all pieces of **RANT, DR. C** and the appropriate ANOVA table.

   (e) Calculate the relative efficiency for geographic location. Interpret the results.

   (f) Calculate the relative efficiency for sales volume class. Interpret the results.

   (g) Would a randomized complete block design have been adequate here? If so, which blocking variable would have been best?

3. An experiment is to be conducted on accelerated failure tests with small electric motors at five different temperatures. A maximum of five tests can be conducted in one day. There are 20 motors available for testing.

   (a) Design an experiment with a randomized assignment of temperatures to the motors. Show a sketch of the final set of tests that are to be conducted.

   (b) What are the treatment(s) in your study? Are they fixed or random?

   (c) Are there blocking factors in the study? If so, what are they? Are they fixed or random?

   (d) What is the name of your experimental design (e.g. factorial, CRD, RCBD, latin square)?

   (e) What method/model will you use to analyze the data (e.g. fixed effects ANOVA with interaction, mixed-effects ANOVA without interaction)?

4. You are designing a study to investigate soil-plant relationships in oak-pine mixed forests. The factor under study is the percent of oak in the forest mix. You have identified three suitable replicate sites for each of the following oak percentages in the forest mix: (1) 0%, (2) 20%-30%, (3) 45% - 55%, (4) 70% - 80%, and (5) 100%. You must collect soil and forest floor litter samples from each site and conduct laboratory chemical analyses of the samples. The labor is to be divided equally among three people because of the amount of work involved in the field and laboratory.

   (a) Design the study to control the experimental error variation with the 15 chosen sites during yourself and two other people as workers. Describe your study.

   (b) What are the treatment(s) in your study? Are they fixed or random?

   (c) Are there blocking factors in the study? If so, what are they? Are they fixed or random?

   (d) What is the name of your experimental design?

   (e) Sketch the analysis of variance for data from the study. Include the source of variation and degrees of freedom for each sum of squares partition.

   (f) Suppose you take two samples from each site. Repeat part (c).