Response Surface Methodology, Stat 579 Homework 05 Name:
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Part I. (50 points) I recommend reading through all the parts of the HW (with my adjustments) before starting; this may save you some work.
MMA-RSM Chapter 5: 5.5, 5.7.

- For part 5.5(a), fit the first order model and use the results in parts (b) and (c). However, I think if you were doing this for real, fitting the first order model, or even the first order model with two-way interactions, is a bad idea. Do you agree with me? Back up your answer with some analysis.
- For part 5.5(b), use all main effects and make one unit steps.
- For part 5.5(c), the constraint makes no sense to me. Tell why. Instead of the given constraint, use this one: $x_1 + x_2 = -2.7$ (remember, these are coded units).

General: Try to do all calculations in R. All R code for the assignment should be included with the part of the problem it addresses (for code and output use a fixed-width font, such as Courier). Code is used to calculate result; text is used to report and interpret results – do not report or interpret results in the code.

(35 pts) **1. 5.5** In a metallurgy experiment it is desired to test the effect of four factors and their interactions on the concentration (percent by weight) of a particular phosphorus compound in costing material. The variables are: A, percent phosphorus in the refinement; B, percent remelted material; C, fluxing time, and D, holding time. The four factors are varied in a 24 factorial experiment with two castings taken at each factor combination. The 32 castings were made in random order, and the data are shown in Table E5.1.

Fit the first order model and use the results in parts (b) and (c). However, I think if you were doing this for real, fitting the first order model, or even the first order model with two-way interactions, is a bad idea. Do you agree with me? Back up your answer with some analysis.

(a) (15 pts) Build a first-order response function.

(b) (5 pts) Construct a table of the path of steepest ascent in the coded design variables.
Use all main effects and make one unit steps.

(c) (15 pts) It is important to constrain the percentage of phosphorus and the percentage of remelted material. In fact, in the metric of the coded variables we obtain $x_1 + x_2 = 2.7$, where x_1 is percent phosphorus and x_2 is percent remelted material. Recalculate the path of steepest ascent subject to the above constraint.
The constraint makes no sense to me. Tell why. Instead of the given constraint, use this one: $x_1 + x_2 = -2.7$ (remember, these are coded units).

(15 pts) **2. 5.7** It is stated in the text that the development of the path of steepest ascent makes use of the assumption that the model is truly first-order in nature. However, even if there is a modest amount of curvature or interaction in the system, the use of steepest ascent can be extremely useful in determining a future experimental region. Suppose that in a system involving x_1 and x_2 the actual model is given by $\mathrm{E}(y) = 14 + 5x_1 - 10x_2 + 3x_1x_2$. Assume that x_1 and x_2 are in coded form.

(a) (5 pts) Show a plot of the path of steepest ascent (based on actual parameters) if the interaction is ignored.

(b) (5 pts) Show a plot of the path of steepest ascent for the model with interaction. Note that this path is not linear.

(c) (5 pts) Comment on the difference in the two paths.