Statistics for Engineering, 4C3/6C3

Assignment 6

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Question 1 [10]

Notes

- Use computer software for questions 1, 2 and 3, but make sure you can do the work by hand if this were a 3-factor system.
- Group hand-ins are allowed.

We are considering a bioreactor system, investigating four factors:

- **A** = feed rate: slow or medium
- **B** = initial inoculant size (300g or 700g)
- **C** = feed substrate concentration (40 g/L or 60 g/L)
- **D** = dissolved oxygen set-point (4mg/L or 6 mg/L)

The 16 experiments from a full factorial, 2^4, were randomly run, and the yields from the bioreactor, y, are reported here in standard order: y = [60, 59, 63, 61, 69, 61, 94, 93, 56, 63, 70, 65, 44, 45, 78, 77].

1. Calculate the 15 main effects and interactions and the intercept, using computer software.
2. Use a Pareto-plot to identify the significant effects. What would be your advice to your colleagues to improve the yield?
3. Refit the model using only the significant terms identified in the second question.
   - Explain why you don't actually have to recalculate the least squares model parameters (one way to answer this question is to fit the full model manually, then refit it with the terms dropped out; what do you notice while doing the calculations?).
   - Compute the standard error and confidence intervals and confirm that the effects are indeed significant at the 95% level.
4. Write down the exact settings for **A**, **B**, **C**, and **D** you would provide to the graduate student running a half-fraction in 8 runs for this system.
5. Before the half-fraction experiments are even run you can calculate which variables will be confounded (aliased) with each other. Report the confounding pattern for these main effects and for these two-factor interactions.
   - Generator =
   - Defining relationship =
   - Confounding pattern:
     - $\widehat{\beta}_{\mathbf{A}} \rightarrow$
     - $\widehat{\beta}_{\mathbf{B}} \rightarrow$
     - $\widehat{\beta}_{\mathbf{AB}} \rightarrow$
     - $\widehat{\beta}_{\mathbf{BC}} \rightarrow$
     - $\widehat{\beta}_{\mathbf{CD}} \rightarrow$

6. Now use the 8 yield values corresponding to your half fraction, and calculate as many parameters (intercept, main effects, interactions) as you can.
   - Report their numeric values.
   - Compare your parameters from this half-fraction (8 runs) to those from the full factorial (16 runs). Was much lost by running the half fraction?