2024 Spring – SPC&O HW#14

1. Suppose the earning margin of a hotel is possibly affected by its located area's nearby total number hotel rooms, the nearest distance to other hotels, the nearby total office space, the nearby number of colleges, the nearby average household income, and the distance to downtown. 24pring-HW14.xls collects data from 100 hotels (inns).
   a) Are there any multicollinearity effects among the possible factors?
   b) Are there any nonlinear and/or interaction effects of the possible factors on the margin?
   c) Perform regression analysis (including effect significance tests and ANOVA) to build a best model to predict the hotel margin.
2. Consider an eight-variable, sixteen-run, two-level fractional factorial design.
   (a) Write down the defining relation for each of the following candidate designs:
      i. 5=234, 6=134, 7=123, 8=124
      ii. 5=234, 6=134, 7=123, 8=1234
   (b) Which of the above two designs is preferred? Why?

3. The following table provides the design matrix for a certain two-level fractional factorial experimental design.

Test	1	2	3	4	5
1	-	-	-	+	-
2	+	-	-	-	+
3	-	+	-	-	+
4	+	+	-	+	-
5	-	-	+	+	+
6	+	-	+	-	-
7	-	+	+	-	-
8	+	+	+	+	+

   (a) Write down the generators and the defining relation for this design.
   (b) What is the resolution of this design?
   (c) Write down all of the linear combinations of confounded effects that can be estimated from the result of this experiment. Assume that all interaction effects may be important.
   (d) Suppose that it was decided to run only a four-variable experiment using eight tests. What generator would you propose for this design? How would the

design resolution differ as compared with the original design?

4. For the "Glove Box Door" experiment, instead of a full-factorial experiment the following fractional factorial experiment was conducted:

Test	X1	X2	X3	X4	Response, y (mm)	
1	-1	-1	-1	-1	-1.44	-0.08
2	1	1	-1	-1	-0.5	-0.24
3	1	-1	1	-1	-0.79	-0.64
4	-1	1	1	-1	1.22	0.28
5	1	-1	-1	1	-0.63	-1.19
6	-1	1	-1	1	0.47	0.44
7	-1	-1	1	1	1.29	0.64
8	1	1	1	1	0.4	0.34

(a) Write down the generators and the defining relation for this design.

(b) What is the resolution of this design?

(c) Write down all the confounded effects that can be estimated from the result of this experiment. Assume that all interaction effects may be important.

(d) Calculate the 7 effects of the base design on the parallelisms and compare the results to the full-factorial results in SPCO3.2.

(e) Perform *t*-test to determine which factor effects (main and/or two-factor interaction effects) are statistically significant with the confidence level α=0.05 and compare the results to the full-factorial results in SPCO3.2.

(f) Plot Q-Q plot for the 7 effects of base design and compare the results to the full-factorial results in SPCO3.2.

(g) Use the "significant" effects to build a regression model and compare the results to the full-factorial results in SPCO3.2.

(h) Calculate, without excel, the sum of squares total (SST). What is the degree of freedom for SST.

(i) Calculate, without excel, the sum of squares for the main effects.

(j) Construct, without excel, an ANOVA table by assuming all interaction effects are insignificant and calculate each of the main effects' *p*-value with the F test.

(k) Construct, without excel, a partial model based on the F-tests in (j) and perform ANOVA for the partial model.

(l) Calculate, without excel, the R^2 and adjusted R^2 for the model built in (k).