Online Homework System

Assignment Worksheet
8/2/20 - 2:52:26 PM EDT

Name: ____________________________ **Class:**
Class #: ____________________________ **Section #:** ____________________________
Instructor: Nathaniel Stevens **Assignment:** Quiz 12

Question 1: (2 points)

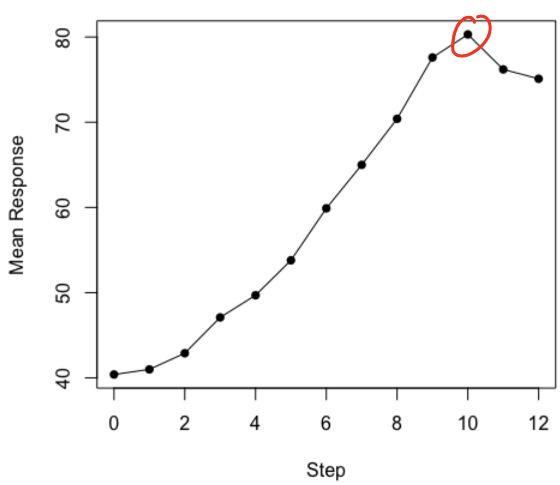
Suppose that you are performing a method of steepest descent analysis. You just ran a condition at $\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -1 \\ 0.5 \end{bmatrix}$ and the results suggest that you should take another step of size $\lambda = 0.2$ along the gradient $\mathbf{g} = \begin{bmatrix} 0.75 \\ 0.30 \end{bmatrix}$. In the boxes below, state the coordinates of the location of the next condition along the path of steepest descent. Round your answers to three decimals.

- x_1: -1.15
- x_2: 0.44

$$x' = x - \lambda g = \begin{bmatrix} -1 \\ 0.5 \end{bmatrix} - 0.2 \begin{bmatrix} 0.75 \\ 0.3 \end{bmatrix} = \begin{bmatrix} -1.15 \\ 0.44 \end{bmatrix}$$

Question 2: (1 point)

An experimenter is interested in response maximization so they perform a steepest ascent analysis. The results are shown below.

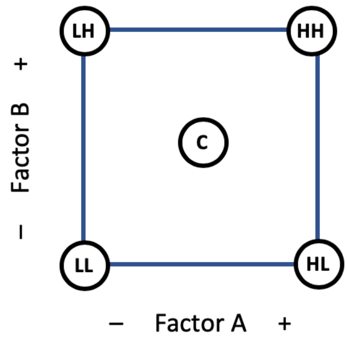


At which step was the experimenter *most likely* closest to the optimum?

10

Question 3: (1 point)

Suppose that interest lies in determining optimal levels of two factors A and B. The experimenter decides that as a part of the method of steepest ascent a test for quadratic curvature would be helpful. To do so a 2^2 factorial design with a center point condition is run. This design is visualized in the figure below.



The estimate of the second order linear predictor at each of these five conditions is summarized in the table below.

Condition	Estimate
LL	$\hat{\eta}_{LL} = \bar{y}_{LL} = 38.4$
HL	$\hat{\eta}_{HL} = \bar{y}_{HL} = 40.1$
LH	$\hat{\eta}_{LH} = \bar{y}_{LH} = 41.5$
HH	$\hat{\eta}_{HH} = \bar{y}_{HH} = 39.9$
C	$\hat{\eta}_{C} = \bar{y}_{C} = 41.9$

Calculate the pure quadratic effect based on these data. Round your answer to 3 decimal places and input it in the box below.

______

$$\hat{\beta}_{PQ} = \frac{\hat{\eta}_{LL} + \hat{\eta}_{HL} + \hat{\eta}_{LH} + \hat{\eta}_{HH}}{4} - \hat{\eta}_C = 39.975 - 41.9$$

$$= -1.925$$

Question 4: (1 point)

Suppose that interest lies in determining whether there is quadratic curvature in the relationship between a continuous response y and two factors x_1 and x_2. In order to make this determination a first order linear regression model with interaction and a pure quadratic effect is fit. The output of this model is shown below.

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  40.4000     0.0922 438.200 1.17e-12 ***
x1            0.7625     0.0461  16.541 1.47e-05 ***
x2            0.3125     0.0461   6.779  0.00106 **
x1:x2        -0.0375     0.0461  -0.813  0.45292
xPQ           0.0125     0.1031   0.121  0.90820
--- Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

TRUE or FALSE: At a 5% significance level, there is evidence of quadratic curvature.

(a) True

(b) False

Question 5: (1 point)

Suppose that you fit a model with main effects, two-factor interactions, and the quadratic effect β_{PQ}. Suppose that you find β_{PQ} is not significantly different from 0. Why might this be?

(a) There is no significant quadratic curvature.

(b) There is significant quadratic curvature but you're in the vicinity a saddle point, so you're being misled.

(c) Both of above the reasons are plausible.

Question 6: (2 points)

Suppose that interest lies in fitting a second order response surface model for $K' = 2$ factors. To do so, a central composite design (CCD) is used. In the box below, enter the number of experimental conditions in this CCD.

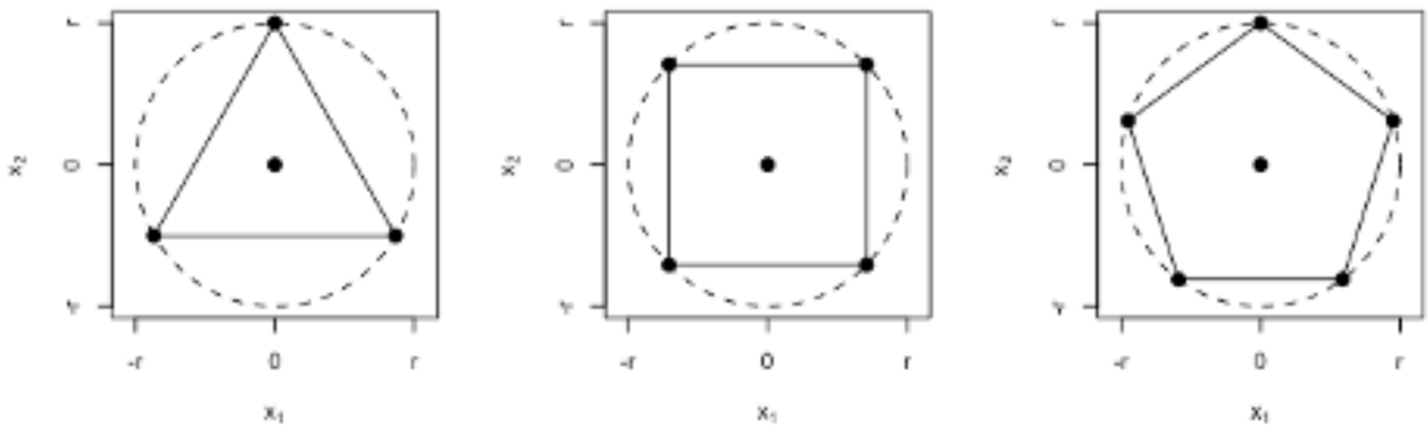
______________ $2^{K'} + 2K' + 1 = 2^2 + 2 \times 2 + 1 = 9$

In the scenario described above, what is the *smallest number* of experimental conditions required by a response surface design in order to estimate all of the β's in the model's linear predictor? Enter your numeric response in the box below.

______________ $\frac{(K'+1)(K'+2)}{2} = \frac{3 \times 4}{2} = 6$

Question 7: (2 points)

In class we discussed central composite designs as one particular type of response surface design. Another class of response surface designs are *equiradial designs.* An equiradial design of radius r that explores K' factors has 1 center point condition and n_s spherical conditions equidistant from the center point. When $K' = 2$, the spherical design points are dispersed on a circle of radius r and the designs constitute regular polygons. Examples for $n_s = 3, 4, 5$ are shown below.



TRUE or FALSE: A central composite design with $a = \sqrt{2}$ is an equiradial design.

(a) True All axial and factorial conditions are $\sqrt{2}$ units from the center point.

(b) False

Equiradial designs are sometimes preferred to CCDs because they are able to estimate all of the β's in a second-order model with fewer conditions. What is the *smallest* equiradial design that would allow us to estimate all of the β's in a second-order model when $K' = 2$?

(a) Triangle (4 conditions)

(b) Square (5 conditions)

(c) Pentagon (6 conditions)

(d) Hexagon (7 conditions)

(e) Septagon (8 conditions)

(f) Octagon (9 conditions)

$\frac{(K'+1)(K'+2)}{2} = \frac{3 \times 4}{2} = 6$

this is the number of β's in a second order model with $K'=2$ factors.

Question 8: (1 point)

TRUE or FALSE: The optimal factor values, as determined by a second order response surface model, always correspond to one of the experimental conditions considered in the response surface design.

(a) True

(b) False