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Saturday, April 15, 2023

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Section 1

MANE 6313

Subsection 1

Week 14, Module C

Student Learning Outcome

- Select an appropriate experimental design with one or more factors,
- Select an appropriate model with one or more factors,
- Evaluate statistical analyses of experimental designs,
- Assess the model adequacy of any experimental design, and
- Interpret model results.

Module Learning Outcome

Interpret Surface Plots with more than 3 factors

Reduced Model from Module A

```

135 > {r}
136 library(rsm)
137 ccd1.model2 <- rsm(Y~F0(x1,x2,x3)+TWI(x1,x2,x3)+PQ(x1,x2,x3),data=ccd1.df)
138 summary(ccd1.model2)
139 >

```

Call:

```
rsm(formula = Y ~ F0(x1, x2, x3) + TWI(x1, x2, x3) + PQ(x1, x2,
x3), data = ccd1.df)
```

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	77.17019	1.32414	58.2794	< 2.2e-16 ***
x1	-10.12083	0.87166	-11.6110	7.466e-11 ***
x2	-8.67917	0.87166	-9.9571	1.305e-09 ***
x3	-0.10417	0.87166	-0.1195	0.905961
x1:x2	-6.20625	1.06756	-5.8135	7.542e-06 ***
x1:x3	2.76875	1.06756	2.5935	0.016581 *
x2:x3	-1.68125	1.06756	-1.5749	0.129562
x1^2	-4.10481	0.78337	-5.2399	2.953e-05 ***
x2^2	-4.71731	0.78337	-6.0218	4.632e-06 ***
x3^2	-2.30481	0.78337	-2.9422	0.007538 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Multiple R-squared: 0.9395, Adjusted R-squared: 0.9147
F-statistic: 37.93 on 9 and 22 DF, p-value: 2.369e-11

Analysis of Variance Table

Response: Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
F0(x1, x2, x3)	3	4266.5	1422.16	77.9912	7.018e-12
TWI(x1, x2, x3)	3	784.2	261.39	14.3345	2.144e-05
PQ(x1, x2, x3)	3	1173.6	391.22	21.4543	9.926e-07
Residuals	22	401.2	18.23		
Lack of fit	5	69.4	13.87	0.7107	0.6237

Three or More Predictors

When a regression model has more than two continuous predictors, some additional issues arise^[1]:

- ① We can use only two predictors at a time in image, counter or surface plot.
- ② For two given predictors, the surface plot will change depending on the values of the other predictors. (The defaults for image contour, and persp is to use the average, but this can be changed).
- ③ There will be more than one surface plot; it is desirable to keep the scaling and coloring consistent among all of these plots. (This happens automatically in all three functions; there is no way to defeat it other than by manually plotting the retrieved surface data).

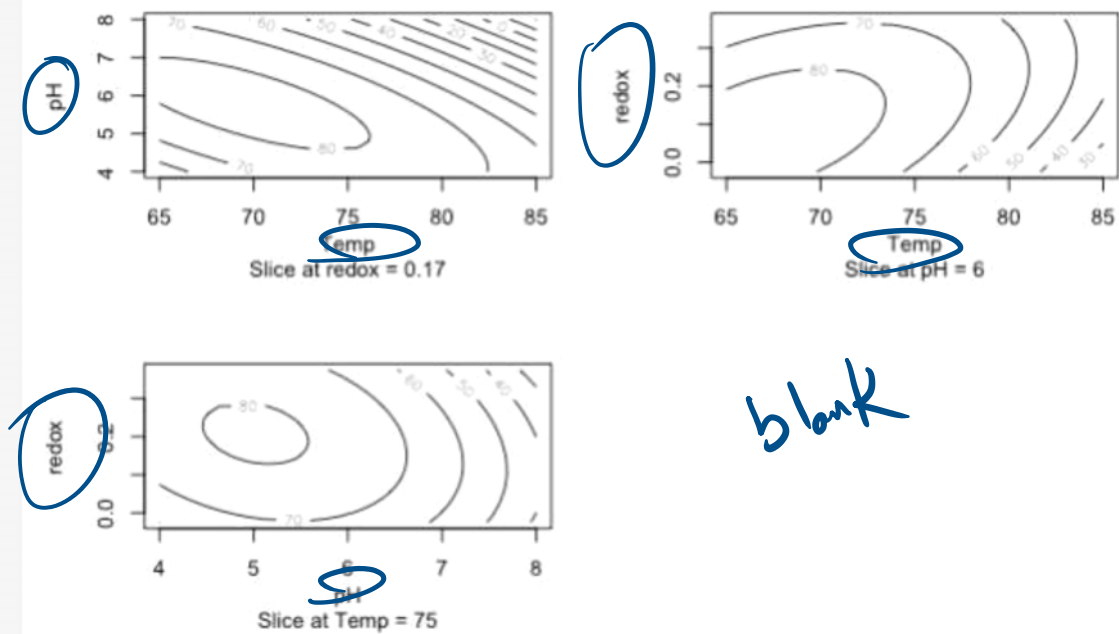
3 factors

$$\binom{3}{2} = \frac{3!}{2!(3-2)!} = 3 \quad \text{combination}$$

x_1 v. x_2
 x_1 v. x_3
 x_2 v. x_3

Multiple Contour Plots

```
148 > {r}  
149 par(mfrow=c(2,2))  
150 contour(ccd1.model2,~x1+x2+x3)  
151 >
```



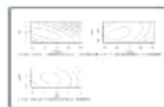
Multiple Contour Plots at Stationary Points

```

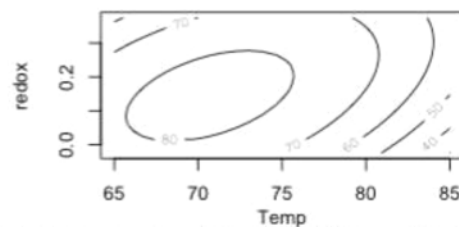
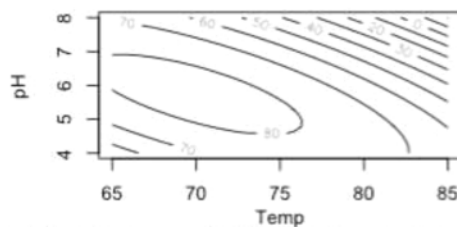
153 > {r}
154 xs <- canonical(ccd1.model2)$xs
155 par(mfrow=c(2,2))
156 contour(ccd1.model2, ~x1+x2+x3, at=xs)
157 >

```

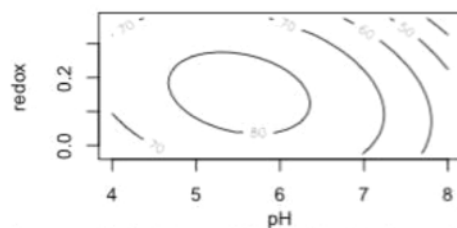
← Plots value of stationary point
in variable x_5



R Console



at redox = 0.18, $x_1 = -0.60324207938147$, $x_2 = -0.63123374000138$ at pH = 5.37, $x_1 = -0.60324207938147$, $x_3 = 0.06768969$



at Temp = 71.98, $x_2 = -0.63123374000138$, $x_3 = 0.06768969$

Multiple Contour Plots at Center Points.

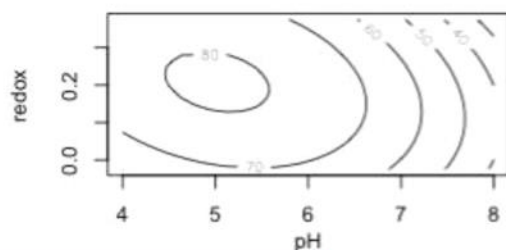
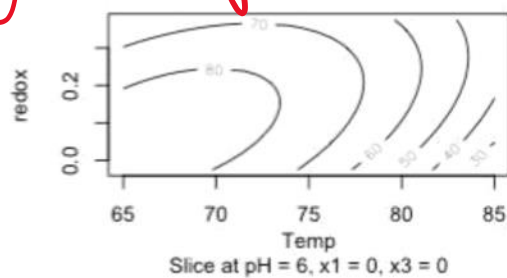
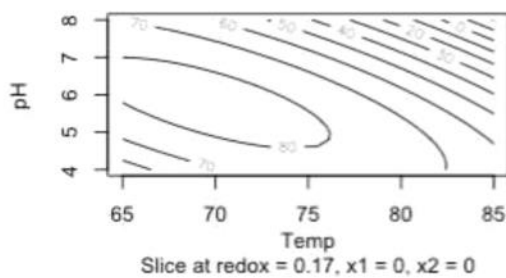
```

160 > ```{r}
161 library(rsm)
162 cp.df <- data.frame(0,0,0)
163 names(cp.df) <- c('x1','x2','x3')
164 par(mfrow=c(2,2))
165 contour(ccd1.model2, ~x1+x2+x3, at=cp.df)
166 > ```

```

} define center points
as a data frame

generic: any values for x_1, x_2, x_3

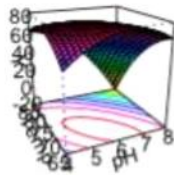


Multiple 3D Plots

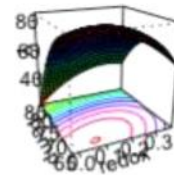
```

168 ~ ``{r}
169 library(rsm)
170 par(mfrow=c(2,2))
171 persp(ccd1.model2,x1-x2,zlab="Y",col=rainbow(50),contours="colors")
172 persp(ccd1.model2,x1-x3,zlab="Y",col=rainbow(50),contours="colors")
173 persp(ccd1.model2,x2-x3,zlab="Y",col=rainbow(50),contours="colors")
174 ~ ``

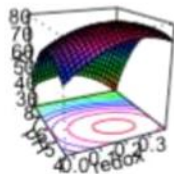
```



Slice at redox = 0.17



Slice at pH = 6



for K factors
 $\binom{K}{2}$ plots