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

```r
library(rsm)
ccd1.model2 <- rsm(Y~FO(x1,x2,x3)+TWI(x1,x2,x3)+PQ(x1,x2,x3),data=ccd1.df)
summary(ccd1.model2)
```

```
Call:
rsm(formula = Y ~ FO(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)
FO(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
```

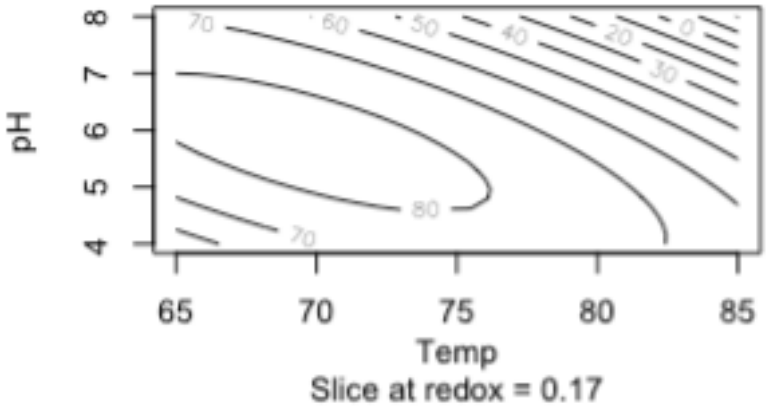
Three or More Predictors

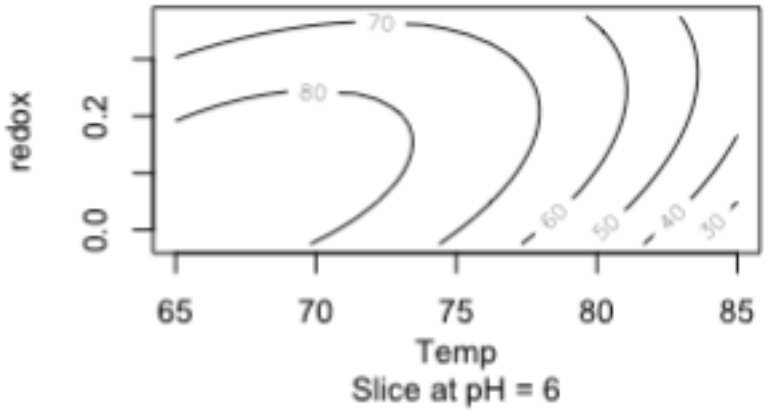
When a regression model has more than two continuous predictors, some additional issues arise[^1]:

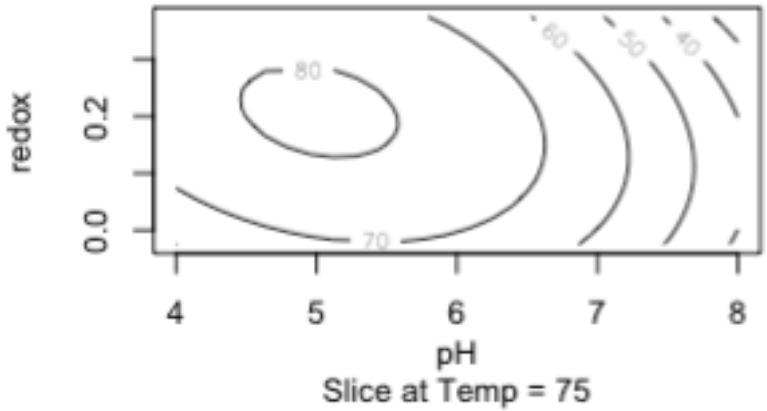
1. *We can use only two predictors at a time in image, counter or surface plot.*
2. *For two given predictors, the surface plot will change depending on the values of the other predictors. (The defaults for image contour, and persp is to use the average, but this can be changed).*
3. *There will be more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

Multiple Contour Plots

```r
par(mfrow=c(2,2))
contour(ccd1.model2,~x1+x2+x3)
```

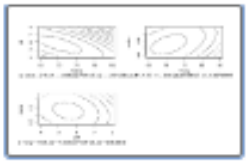


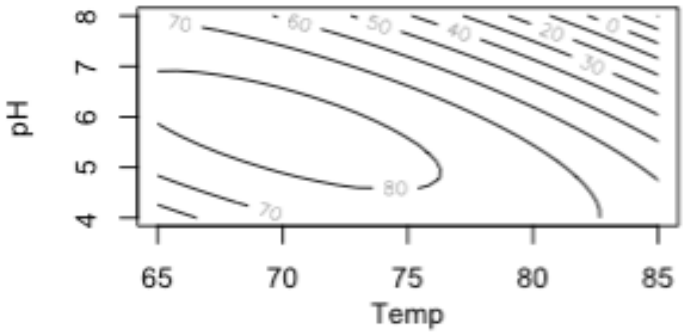


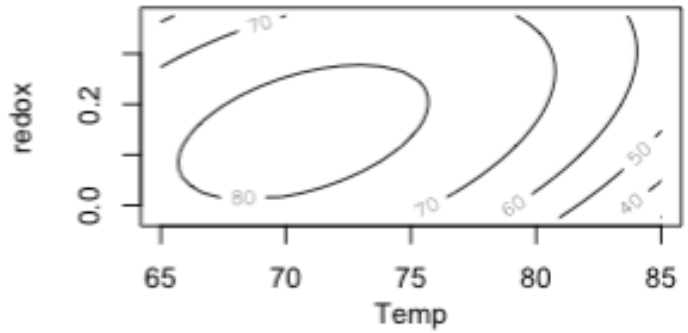


Multiple Contour Plots at Stationary Points

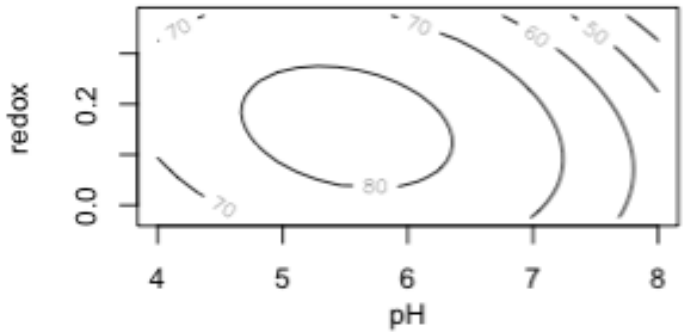
```r
xs <- canonical(ccd1.model2)$xs
par(mfrow=c(2,2))
contour(ccd1.model2,~x1+x2+x3,at=xs)
```







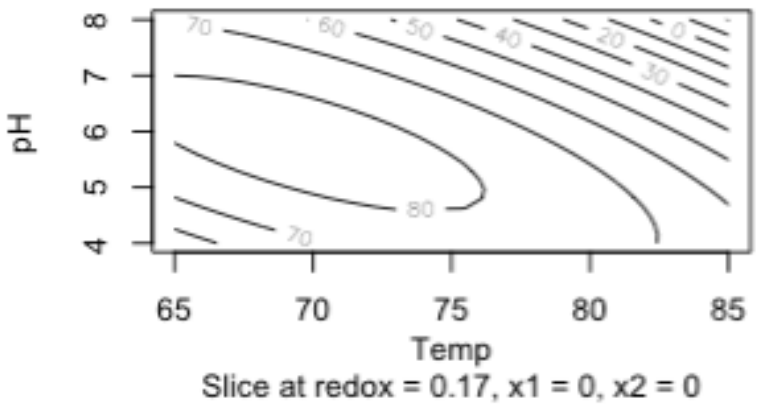
: at redox = 0.18, x1 = -0.60324207938147, x2 = -0.631233e at pH = 5.37, x1 = -0.60324207938147, x3 = 0.06768969



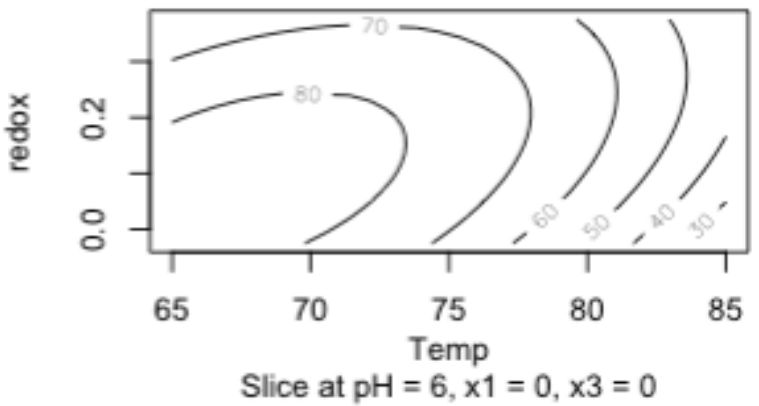
at Temp = 71.98, x2 = -0.63123374000138, x3 = 0.0676896

Multiple Contour Plots at Center Points.

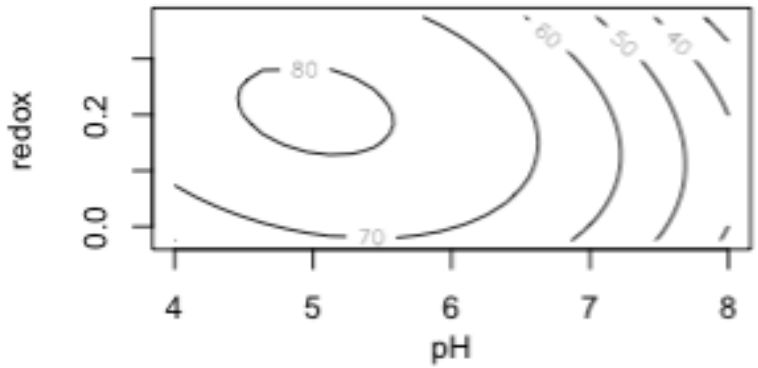
```r
library(rsm)
cp.df <- data.frame(0,0,0)
names(cp.df) <- c('x1','x2','x3')
par(mfrow=c(2,2))
contour(ccd1.model2,~x1+x2+x3,at=cp.df)
```



Slice at redox = 0.17, x1 = 0, x2 = 0

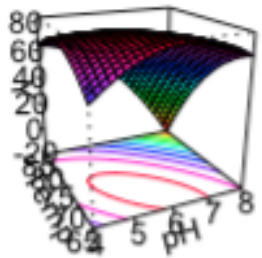


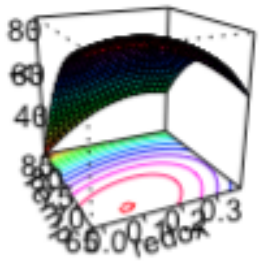
Slice at pH = 6, x1 = 0, x3 = 0



Multiple 3D Plots

```r
library(rsm)
par(mfrow=c(2,2))
persp(ccd1.model2,x1~x2,zlab="Y",col=rainbow(50),contours="colors")
persp(ccd1.model2,x1~x3,zlab="Y",col=rainbow(50),contours="colors")
persp(ccd1.model2,x2~x3,zlab="Y",col=rainbow(50),contours="colors")
```





Slice at redox = 0.17

Slice at pH = 6