Lignite Converted

## Data from Handout

In a study concerning coal conservation into oils, the hydrogenolysis of a Canadian lignite using carbon monoxide and hydrogen mixtures as reducing agents was investigated.

:

#setwd("F:/Lexar/stat 482 data sets")  
lignite.dat = read.csv('lignite.csv')  
  
cor(lignite.dat)

## temperature molar.ratio pressure time conversion  
## temperature 1.0000000 0.000000 0.000000 0.0000000 0.5735635  
## molar.ratio 0.0000000 1.000000 0.000000 0.0000000 0.3613450  
## pressure 0.0000000 0.000000 1.000000 0.0000000 0.4559830  
## time 0.0000000 0.000000 0.000000 1.0000000 0.2136524  
## conversion 0.5735635 0.361345 0.455983 0.2136524 1.0000000

attach(lignite.dat)

## The following object is masked from package:datasets:  
##   
## pressure

lignite.mod = lm(conversion ~ temperature + molar.ratio + pressure + time)  
summary(lignite.mod)

##   
## Call:  
## lm(formula = conversion ~ temperature + molar.ratio + pressure +   
## time)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -7.0250 -3.5125 0.1375 2.9875 7.6750   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -5.36750 16.55028 -0.324 0.75178   
## temperature 0.12500 0.03520 3.552 0.00454 \*\*  
## molar.ratio 12.60000 5.63128 2.238 0.04691 \*   
## pressure 1.98750 0.70391 2.824 0.01656 \*   
## time 0.09312 0.07039 1.323 0.21269   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.631 on 11 degrees of freedom  
## Multiple R-squared: 0.7131, Adjusted R-squared: 0.6088   
## F-statistic: 6.836 on 4 and 11 DF, p-value: 0.005123

anova(lignite.mod)

## Analysis of Variance Table  
##   
## Response: conversion  
## Df Sum Sq Mean Sq F value Pr(>F)   
## temperature 1 400.00 400.00 12.6138 0.004539 \*\*  
## molar.ratio 1 158.76 158.76 5.0064 0.046906 \*   
## pressure 1 252.81 252.81 7.9722 0.016563 \*   
## time 1 55.50 55.50 1.7502 0.212689   
## Residuals 11 348.83 31.71   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

x1 = 2\*(temperature-mean(temperature))/ (range(temperature)[2]-range(temperature)[1])  
x2 = 2\*(molar.ratio-mean(molar.ratio))/ (range(molar.ratio)[2]-range(molar.ratio)[1])  
x3 = 2\*(pressure-mean(pressure))/ (range(pressure)[2]-range(pressure)[1])  
x4 = 2\*(time-mean(time))/ (range(time)[2]-range(time)[1])  
  
cbind(x1,x2,x3,x4)

## x1 x2 x3 x4  
## [1,] -1 -1 -1 -1  
## [2,] 1 -1 -1 -1  
## [3,] -1 1 -1 -1  
## [4,] 1 1 -1 -1  
## [5,] -1 -1 1 -1  
## [6,] 1 -1 1 -1  
## [7,] -1 1 1 -1  
## [8,] 1 1 1 -1  
## [9,] -1 -1 -1 1  
## [10,] 1 -1 -1 1  
## [11,] -1 1 -1 1  
## [12,] 1 1 -1 1  
## [13,] -1 -1 1 1  
## [14,] 1 -1 1 1  
## [15,] -1 1 1 1  
## [16,] 1 1 1 1

orthog.mod = lm(conversion ~ x1+x2+x3+x4)  
summary(orthog.mod)

##   
## Call:  
## lm(formula = conversion ~ x1 + x2 + x3 + x4)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -7.0250 -3.5125 0.1375 2.9875 7.6750   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 74.312 1.408 52.785 1.39e-14 \*\*\*  
## x1 5.000 1.408 3.552 0.00454 \*\*   
## x2 3.150 1.408 2.238 0.04691 \*   
## x3 3.975 1.408 2.824 0.01656 \*   
## x4 1.862 1.408 1.323 0.21269   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.631 on 11 degrees of freedom  
## Multiple R-squared: 0.7131, Adjusted R-squared: 0.6088   
## F-statistic: 6.836 on 4 and 11 DF, p-value: 0.005123

accepted.mod = lm(conversion ~ x1+x2+x3)  
summary(accepted.mod)

##   
## Call:  
## lm(formula = conversion ~ x1 + x2 + x3)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -8.8875 -4.7375 0.8375 4.6750 6.8125   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 74.312 1.451 51.209 2.02e-15 \*\*\*  
## x1 5.000 1.451 3.446 0.00484 \*\*   
## x2 3.150 1.451 2.171 0.05073 .   
## x3 3.975 1.451 2.739 0.01796 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.805 on 12 degrees of freedom  
## Multiple R-squared: 0.6675, Adjusted R-squared: 0.5843   
## F-statistic: 8.029 on 3 and 12 DF, p-value: 0.003352