

```
# M3081    Potato Data           March 6, 2010
#
# From David M. Levine, Patricia P. Ramsey, Robert K. Smidt
# "Applied Statistics for Engineers and Scientists," Prentice Hall (2001) p616
#
# Data from Mountain States Potato Company of Idaho
# A by-product of their production are filter cakes, sold to feedlots.
# Feedlots are concerned about the solids content of the cakes.
#
# y = percent of solids
# x1 = PH (a measure of the acidity of the clarifier)
# x2 = Lower Pressure (pressure of the vacuum line below the fluid line in the
#       rotating drum
# x3 = Upper Pressure (pressure of the vacuum line above the fluid line in the
#       rotating drum
# x4 = Cake Thickness measured on the drum
# x5 = setting on the Varidrive to adjust the speed
# x6 = speed drum is rotated to collect filter cake
#
"y" "x1" "x2" "x3" "x4" "x5" "x6"
9.7 3.7 13 14 0.25 6 33
9.4 3.8 17 18 0.88 6 30.43
10.5 3.8 14 15 0.5 6 34
10.9 3.9 14 14 0.5 6 34
11.6 4.3 17 18 0.38 6 36.24
10.9 4.2 16 17 0.5 6 31.76
11 4.3 16 19 0.38 6 34
10.7 3.9 15 16 0.38 6 32.13
11.8 3.6 8 8 0.38 6 37
9.7 4 18 18 0.5 6 36
11.6 4 12 13 0.31 5 45
10.9 3.9 15 15 0.5 5 50
10 3.8 17 18 0.63 5 46.91
10.3 3.8 13 14 0.5 4 57.5
10.1 3.6 17 17 0.63 4 60.4
9.9 3.8 17 18 0.5 4 53.14
9.5 3.5 17 18 0.63 6 34.4
10.5 3.8 15 17 0.5 6 33.96
10.8 3.9 15 17 0.75 6 35
10.4 3.9 14 15 0.5 6 35
10.9 4 15 16 0.5 6 34
11.2 4.4 17 19 0.38 6 34
9.5 3.8 17 17 0.5 6 33.49
10.7 3.9 15 17 0.5 6 33.38
10.1 3.8 15 17 0.5 6 41
10.5 3.8 17 17 0.5 6 36
10.9 4 15 17 0.25 6 34
15.5 4.3 13 15 0.63 6 41
13.1 4 17 17 0.5 6 35
```

11 4 14 15 0.38 6 36  
12.5 4.2 15 17 0.31 6 37.72  
11.7 4.2 14 14 0.25 6 36  
11.9 4.4 15 16 0.38 6 36.52  
11.7 3.4 8 10 0.31 6 38.08  
17.8 4.3 12 12 0.31 6 38  
11.8 4.5 14 15 0.25 6 33  
10 3.7 12 13 0.25 5 48  
10.3 3.7 15 15 0.5 5 48  
9.8 3.8 14 15 0.5 5 47.24  
10 3.7 13 14 0.5 6 37  
10.6 4.1 14 15 0.5 6 33.7  
11.2 3.9 13 14 0.38 6 38.26  
10.9 3.7 13 14 0.31 6 38  
11 4.1 13 14 0.38 6 37  
11 4.1 14 15 0.38 6 38  
11.7 4.5 14 14 0.25 6 36.26  
11.8 4.4 13 14 0.25 6 37.45  
12 4.2 13 13 0.38 6 38  
11.8 4.6 14 14 0.38 6 36.9  
11.1 4 14 15 0.5 6 37  
11.6 3.9 14 14 0.5 6 37.5  
11 4 14 15 0.5 6 36  
11.2 3.9 15 15 0.31 6 35  
11 4.2 14 14 0.38 6 37

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[R.app GUI 1.31 (5538) powerpc-apple-darwin8.11.1]

```

>#=====READ POTATO DATA=====
> tt <- read.table("M3081DataPotato.txt", header=TRUE); tt
  y  x1 x2 x3  x4 x5  x6
1  9.7 3.7 13 14 0.25 6 33.00
2  9.4 3.8 17 18 0.88 6 30.43
3 10.5 3.8 14 15 0.50 6 34.00
4 10.9 3.9 14 14 0.50 6 34.00
5 11.6 4.3 17 18 0.38 6 36.24
6 10.9 4.2 16 17 0.50 6 31.76
7 11.0 4.3 16 19 0.38 6 34.00
8 10.7 3.9 15 16 0.38 6 32.13
9 11.8 3.6 8 8 0.38 6 37.00
10 9.7 4.0 18 18 0.50 6 36.00
11 11.6 4.0 12 13 0.31 5 45.00
12 10.9 3.9 15 15 0.50 5 50.00
13 10.0 3.8 17 18 0.63 5 46.91
14 10.3 3.8 13 14 0.50 4 57.50
15 10.1 3.6 17 17 0.63 4 60.40
16 9.9 3.8 17 18 0.50 4 53.14
17 9.5 3.5 17 18 0.63 6 34.40
18 10.5 3.8 15 17 0.50 6 33.96
19 10.8 3.9 15 17 0.75 6 35.00
20 10.4 3.9 14 15 0.50 6 35.00
21 10.9 4.0 15 16 0.50 6 34.00
22 11.2 4.4 17 19 0.38 6 34.00
23 9.5 3.8 17 17 0.50 6 33.49
24 10.7 3.9 15 17 0.50 6 33.38
25 10.1 3.8 15 17 0.50 6 41.00
26 10.5 3.8 17 17 0.50 6 36.00
27 10.9 4.0 15 17 0.25 6 34.00
28 15.5 4.3 13 15 0.63 6 41.00
29 13.1 4.0 17 17 0.50 6 35.00
30 11.0 4.0 14 15 0.38 6 36.00
31 12.5 4.2 15 17 0.31 6 37.72
32 11.7 4.2 14 14 0.25 6 36.00
33 11.9 4.4 15 16 0.38 6 36.52
34 11.7 3.4 8 10 0.31 6 38.08
35 17.8 4.3 12 12 0.31 6 38.00
36 11.8 4.5 14 15 0.25 6 33.00
37 10.0 3.7 12 13 0.25 5 48.00
38 10.3 3.7 15 15 0.50 5 48.00
39 9.8 3.8 14 15 0.50 5 47.24
40 10.0 3.7 13 14 0.50 6 37.00
41 10.6 4.1 14 15 0.50 6 33.70
42 11.2 3.9 13 14 0.38 6 38.26
43 10.9 3.7 13 14 0.31 6 38.00
44 11.0 4.1 13 14 0.38 6 37.00
45 11.0 4.1 14 15 0.38 6 38.00
46 11.7 4.5 14 14 0.25 6 36.26
47 11.8 4.4 13 14 0.25 6 37.45
48 12.0 4.2 13 13 0.38 6 38.00
49 11.8 4.6 14 14 0.38 6 36.90

```

```

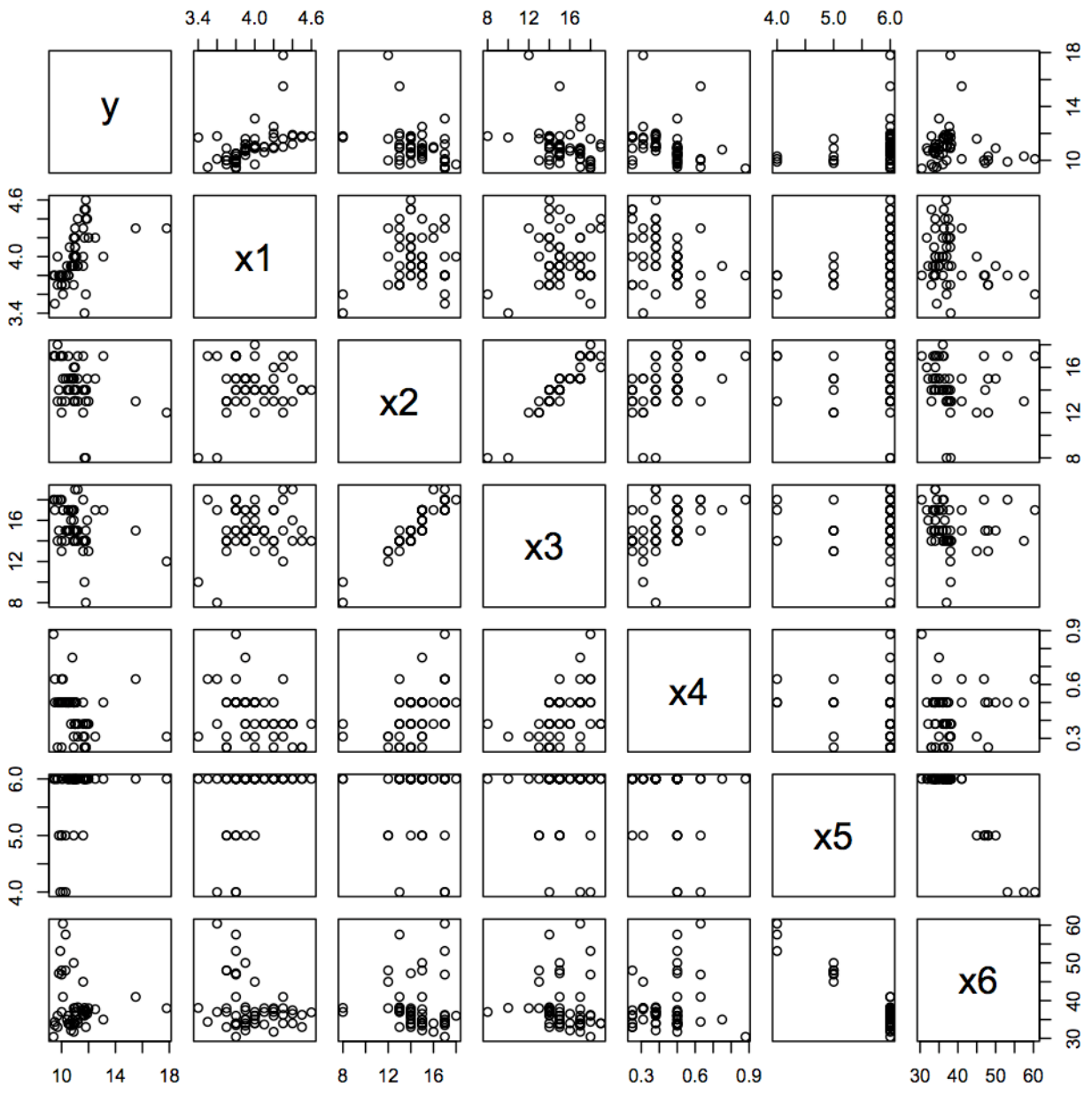
50 11.1 4.0 14 15 0.50 6 37.00
51 11.6 3.9 14 14 0.50 6 37.50
52 11.0 4.0 14 15 0.50 6 36.00
53 11.2 3.9 15 15 0.31 6 35.00
54 11.0 4.2 14 14 0.38 6 37.00

```

```
> attach(tt); summary(tt)
```

	y	x1	x2	x3	x4
Min.	: 9.40	Min. :3.400	Min. : 8.00	Min. : 8.00	Min. :0.2500
1st Qu.	:10.32	1st Qu.:3.800	1st Qu.:13.25	1st Qu.:14.00	1st Qu.:0.3800
Median	:10.90	Median :3.900	Median :14.00	Median :15.00	Median :0.5000
Mean	:11.09	Mean :3.981	Mean :14.43	Mean :15.31	Mean :0.4389
3rd Qu.	:11.60	3rd Qu.:4.200	3rd Qu.:15.00	3rd Qu.:17.00	3rd Qu.:0.5000
Max.	:17.80	Max. :4.600	Max. :18.00	Max. :19.00	Max. :0.8800
	x5	x6			
Min.	:4.000	Min. :30.43			
1st Qu.	:6.000	1st Qu.:34.00			
Median	:6.000	Median :36.39			
Mean	:5.778	Mean :38.21			
3rd Qu.	:6.000	3rd Qu.:38.00			
Max.	:6.000	Max. :60.40			

```
> pairs(tt)
```



```
>#=====FIT LINEAR (REDUCED) MODEL=====
```

```
> f1 <- lm(y~x1+x2+x3+x4+x5+x6);summary(f1); anova(f1)
```

```
Call:
```

```
lm(formula = y ~ x1 + x2 + x3 + x4 + x5 + x6)
```

```
Residuals:
```

	Min	1Q	Median	3Q	Max
	-1.42617	-0.47113	-0.07366	0.33549	4.87137

```
Coefficients:
```

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-13.4345	7.8594	-1.709	0.0940 .
x1	2.9267	0.6469	4.524	4.12e-05 ***
x2	-0.1528	0.2103	-0.727	0.4711
x3	-0.1056	0.1966	-0.537	0.5939
x4	1.4312	1.3841	1.034	0.3064
x5	1.7956	0.8399	2.138	0.0377 *
x6	0.1490	0.0701	2.125	0.0388 *

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

```
Residual standard error: 1.044 on 47 degrees of freedom
```

```
Multiple R-squared: 0.4875, Adjusted R-squared: 0.4221
```

```
F-statistic: 7.451 on 6 and 47 DF, p-value: 1.218e-05
```

```
Analysis of Variance Table
```

```
Response: y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	25.359	25.3591	23.2616	1.526e-05 ***
x2	1	16.211	16.2106	14.8698	0.0003492 ***
x3	1	0.493	0.4931	0.4523	0.5045320
x4	1	1.566	1.5664	1.4368	0.2366665
x5	1	0.185	0.1851	0.1698	0.6821361
x6	1	4.925	4.9247	4.5174	0.0388377 *

```
Residuals 47 51.238 1.0902
```

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

```
>#=====FIT QUADRATIC (FULL) MODEL=====
```

```
> x11<-x1*x1;x12<-x1*x2;x13<-x1*x3;x14<-x1*x4;x15<-x1*x5;x16<-x1*x6
```

```
> x22<-x2*x2;x23<-x2*x3;x24<-x2*x4;x25<-x2*x5;x26<-x2*x6
```

```
> x33<-x3*x3;x34<-x3*x4;x35<-x3*x5;x36<-x3*x6
```

```
> x44<-x4*x4;x45<-x4*x5;x46<-x4*x6;x55<-x5*x5;x56<-x5*x6;x66<-x6*x6
```

```
> f2<-lm(y~x1+x2+x3+x4+x5+x6+x11+x12+x13+x14+x15+x16+x22+x23+x24+x25  
+x26+x33+x34+x35+x36+x44+x45+x46+x55+x56+x66)
```

```
> summary(f2);anova(f2)
```

```
Call:
```

```
lm(formula = y ~ x1 + x2 + x3 + x4 + x5 + x6 + x11 + x12 + x13 +  
x14 + x15 + x16 + x22 + x23 + x24 + x25 + x26 + x33 + x34 +  
x35 + x36 + x44 + x45 + x46 + x55 + x56 + x66)
```

```
Residuals:
```

	Min	1Q	Median	3Q	Max
	-1.46745	-0.39300	-0.05315	0.28248	3.27769

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-6.518e+02	7.995e+02	-0.815	0.422
x1	3.684e+01	6.592e+01	0.559	0.581
x2	4.772e+01	3.459e+01	1.379	0.180
x3	-2.903e+01	2.843e+01	-1.021	0.317
x4	-1.657e+02	1.475e+02	-1.124	0.271
x5	9.958e+01	1.558e+02	0.639	0.528
x6	1.074e+01	1.207e+01	0.890	0.382
x11	-4.678e+00	3.595e+00	-1.301	0.205
x12	4.637e-01	1.642e+00	0.282	0.780
x13	-1.199e+00	1.458e+00	-0.823	0.418
x14	5.962e+00	1.254e+01	0.475	0.639
x15	1.049e+00	8.645e+00	0.121	0.904
x16	1.966e-01	4.972e-01	0.395	0.696
x22	-1.231e-03	3.814e-01	-0.003	0.997
x23	-9.587e-02	6.160e-01	-0.156	0.878
x24	1.711e+00	4.102e+00	0.417	0.680
x25	-6.056e+00	4.253e+00	-1.424	0.166
x26	-3.560e-01	2.796e-01	-1.273	0.214
x33	1.362e-01	2.823e-01	0.483	0.633
x34	-8.597e-02	2.996e+00	-0.029	0.977
x35	4.250e+00	3.618e+00	1.175	0.251
x36	1.583e-01	2.125e-01	0.745	0.463
x44	4.836e-01	1.286e+01	0.038	0.970
x45	1.127e+01	1.627e+01	0.693	0.494
x46	1.405e+00	1.289e+00	1.091	0.285
x55	-4.207e+00	7.121e+00	-0.591	0.560
x56	-9.579e-01	1.227e+00	-0.781	0.442
x66	-5.019e-02	5.272e-02	-0.952	0.350

Residual standard error: 1.106 on 26 degrees of freedom

Multiple R-squared: 0.6821, Adjusted R-squared: 0.3521

F-statistic: 2.067 on 27 and 26 DF, p-value: 0.03404

Analysis of Variance Table

Response: y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
x1	1	25.359	25.3591	20.7476	0.0001088	***
x2	1	16.211	16.2106	13.2628	0.0011811	**
x3	1	0.493	0.4931	0.4034	0.5308736	
x4	1	1.566	1.5664	1.2815	0.2679487	
x5	1	0.185	0.1851	0.1515	0.7002977	
x6	1	4.925	4.9247	4.0292	0.0552207	.
x11	1	0.253	0.2532	0.2071	0.6528091	
x12	1	0.434	0.4344	0.3554	0.5562318	
x13	1	0.362	0.3625	0.2965	0.5906964	
x14	1	1.606	1.6056	1.3137	0.2621725	
x15	1	0.000	0.0001	4.448e-05	0.9947296	
x16	1	1.532	1.5317	1.2532	0.2731803	
x22	1	8.184	8.1843	6.6960	0.0156055	*
x23	1	0.018	0.0176	0.0144	0.9054977	
x24	1	0.224	0.2236	0.1830	0.6723624	

```

x25      1  0.057  0.0574   0.0470  0.8300887
x26      1  1.423  1.4226   1.1639  0.2905600
x33      1  1.182  1.1815   0.9667  0.3345725
x34      1  0.127  0.1268   0.1038  0.7499415
x35      1  1.397  1.3969   1.1429  0.2948735
x36      1  0.014  0.0143   0.0117  0.9147077
x44      1  0.010  0.0103   0.0084  0.9275830
x45      1  0.651  0.6506   0.5323  0.4721672
x46      1  0.717  0.7169   0.5865  0.4506545
x55      1  0.010  0.0098   0.0081  0.9291777
x56      1  0.151  0.1512   0.1237  0.7278678
x66      1  1.108  1.1079   0.9064  0.3498365
Residuals 26 31.779  1.2223
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

>#=====PARTIAL F-TEST=====
>#=====H0: 2ND ORDER TERMS ARE ZERO IN FULL QUADRATIC MODEL=====

```

```

> FFF <- ((51.238-31.779)/(47-26))/(31.779/26);FFF
[1] 0.7581137

```

```

> pf(FFF,21,26,lower.tail=FALSE)
[1] 0.7393321

```

```

>#=====WE ARE UNABLE TO REJECT THE NULL HYPOTHESIS=====
>#=====ALTERNATIVE TO SAME PARTIAL F-TEST=====

```

```

> anova(f1,f2)

```

Analysis of Variance Table

Model 1:  $y \sim x_1 + x_2 + x_3 + x_4 + x_5 + x_6$

Model 2:  $y \sim x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{33} + x_{34} + x_{35} + x_{36} + x_{44} + x_{45} + x_{46} + x_{55} + x_{56} + x_{66}$

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	47	51.238				
2	26	31.779	21	19.459	0.7581	0.7393