

## Problem 1

```
> library(faraway)
> data(odor)
> nrow(odor)
[1] 15
> odor[1:3, ]
  odor temp gas pack
1   66   -1  -1    0
2   39    1  -1    0
3   43   -1   1    0
```

(a)

```
> fit1=lm(odor~temp+gas+pack+I(temp^2)+I(gas^2)+I(pack^2)
+         +I(temp*gas)+I(temp*pack)+I(gas*pack), data=odor)
> summary(fit1)
```

Call:

```
lm(formula = odor ~ temp + gas + pack + I(temp^2) + I(gas^2) +
    I(pack^2) + I(temp * gas) + I(temp * pack) + I(gas * pack),
    data = odor)
```

Residuals:

```
      1      2      3      4      5      6      7      8
 9    -20.6250 10    -6.8750 11     6.8750 12    20.6250 13    15.5000
250 -22.3750 -22.3750 22.3750 -5.1250 -0.3333  1.7500 -1.7500 -15.5000
14    -4.3333 15     4.6667 5.1
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-30.667	12.978	-2.363	0.06451 .
temp	-12.125	7.947	-1.526	0.18761
gas	-17.000	7.947	-2.139	0.08542 .
pack	-21.375	7.947	-2.690	0.04332 *
I(temp^2)	32.083	11.698	2.743	0.04067 *
I(gas^2)	47.833	11.698	4.089	0.00946 **
I(pack^2)	6.083	11.698	0.520	0.62524
I(temp * gas)	8.250	11.239	0.734	0.49588
I(temp * pack)	1.500	11.239	0.133	0.89903
I(gas * pack)	-1.750	11.239	-0.156	0.88236

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

Residual standard error: 22.48 on 5 degrees of freedom

Multiple R-squared: 0.882, Adjusted R-squared: 0.6696

F-statistic: 4.152 on 9 and 5 DF, p-value: 0.06569

F test statistic = 4.152

Under the null hypothesis, the test statistic has an F distribution with 9 and 5 degrees freedom.

p-value = 0.06569 < 0.10, hence Reject Ho at  $\alpha = 0.10$ .

Hence this quadratic model including interaction terms is significant at 10% significance level.

(b)

```
> fit2=lm(odor~temp+gas+pack+I(temp^2)+I(gas^2)+I(pack^2), data=odor)
> anova(fit2, fit1)
```

Analysis of Variance Table

```
Model 1: odor ~ temp + gas + pack + I(temp^2) + I(gas^2) + I(pack^2)
Model 2: odor ~ temp + gas + pack + I(temp^2) + I(gas^2) + I(pack^2) +
  I(temp * gas) + I(temp * pack) + I(gas * pack)
  Res. Df    RSS Df Sum of Sq    F Pr(>F)
1        8 2819.9
2         5 2526.4  3    293.5 0.1936 0.8965
```

F test statistic = 0.1936

Under the null hypothesis, the test statistic has an F distribution with 3 and 5 degrees freedom.

p-value = 0.8965 > 0.10, hence Do Not Reject  $H_0$  at  $\alpha = 0.10$ .

Hence the quadratic model excluding interaction terms is a better model.