Stat 482, Homework #8 Solutions

1. w is midarm circumference, X_1 is triceps thickness, X_2 is thigh circumfere

(a) $r_{w1} = .458$, $r_{w2} = .085$, $r_{12} = .924$

(b) $F_2^* = 0.13$, p-value $= .72$ The observed data is compatible with the reduced model. It is not necessary to add thigh measurement to the no effects model for predicting midarm measurement.

(c) $F_{2|1}^* = 1388.6$, p-value $= .000$ The observed data is not compatible with the reduced model. We accept the addition of thigh measurement to a model which already includes triceps measurement.

(d) $\hat{w} = 62.33 + 1.88 X_1 - 1.61 X_2$

(e) Investigating relationships in higher dimensions requires higher level statistical methods, such as regression analysis. Two-dimensional methods and graphs are insufficient.

2. y is crew productivity, X_1 is crew size, X_2 is bonus pay

(a) A design is orthogonal if $X'X$ is diagonal. For orthogonal designs, regression coefficients estimates and variance explained by inputs do not depend on which other inputs are included in the model.

(b) $b_1 = 5.375$, $SE(b_1) = 0.6638$, $t_1^* = 8.097$

$b_2 = 4.625$, $SE(b_1) = 0.6638$, $t_2^* = 6.968$

HW 8 Computing

Data from Table 7.1

Our goal is to model the relationship among the predictor variables in the body fat example. Specifically, we wish to model midarm (w) as a function of triceps (x1) and thigh (x2).

:

```
hw8a.data =
read.table('http://users.stat.ufl.edu/~rrandles/sta4210/Rclassnotes/data/textdatasets/KutnerData/Chapter%20%207%20Data%20Sets/CH07TA01.txt')
colnames(hw8a.data)=c("triceps","thigh","midarm","body.fat")
str(hw8a.data)
```

```
## 'data.frame':    20 obs. of  4 variables:
##  $ triceps : num  19.5 24.7 30.7 29.8 19.1 25.6 31.4 27.9 22.1 25.5 ...
##  $ thigh   : num  43.1 49.8 51.9 54.3 42.2 53.9 58.5 52.1 49.9 53.5 ...
##  $ midarm  : num  29.1 28.2 37 31.1 30.9 23.7 27.6 30.6 23.2 24.8 ...
##  $ body.fat: num  11.9 22.8 18.7 20.1 12.9 21.7 27.1 25.4 21.3 19.3 ...
```

```
cor(hw8a.data)
```

```
##            triceps     thigh    midarm  body.fat
## triceps  1.0000000 0.9238425 0.4577772 0.8432654
## thigh    0.9238425 1.0000000 0.0846675 0.8780896
## midarm   0.4577772 0.0846675 1.0000000 0.1424440
## body.fat 0.8432654 0.8780896 0.1424440 1.0000000
```

```
m1 = lm(midarm ~ triceps, data=hw8a.data)
m2 = lm(midarm ~ thigh, data=hw8a.data)
m12 = lm(midarm ~ triceps + thigh, data=hw8a.data)
```

```
anova(m2)
```

```
## Analysis of Variance Table
##
## Response: midarm
##           Df  Sum Sq Mean Sq F value Pr(>F)
## thigh      1   1.812  1.8117    0.13 0.7227
## Residuals 18 250.920 13.9400
```

```r
anova(m1,m12)
```

```
## Analysis of Variance Table
##
## Model 1: midarm ~ triceps
## Model 2: midarm ~ triceps + thigh
##   Res.Df     RSS Df Sum of Sq      F    Pr(>F)
## 1     18 199.769
## 2     17   2.416  1    197.35 1388.6 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
summary(m12)
```

```
##
## Call:
## lm(formula = midarm ~ triceps + thigh, data = hw8a.data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.58200 -0.30625  0.02592  0.29526  0.56102
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 62.33083    1.23934   50.29   <2e-16 ***
## triceps      1.88089    0.04498   41.82   <2e-16 ***
## thigh       -1.60850    0.04316  -37.26   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.377 on 17 degrees of freedom
## Multiple R-squared:  0.9904, Adjusted R-squared:  0.9893
## F-statistic: 880.7 on 2 and 17 DF,  p-value: < 2.2e-16
```

HW 8 Computing

Data from Table 7.6

We wish to investigate the relationship between crew productivity (y) and crew size (x1) and bonus pay (x2).

:

```
hw8b.data =
read.table('http://users.stat.ufl.edu/~rrandles/sta4210/Rclassnotes/data/textdatasets/KutnerData/Chapter%20%207%20Data%20Sets/CH07TA06.txt')
colnames(hw8b.data)=c("crew.size","bonus.pay","productivity")
hw8b.data
```

```
##   crew.size bonus.pay productivity
## 1         4         2           42
## 2         4         2           39
## 3         4         3           48
## 4         4         3           51
## 5         6         2           49
## 6         6         2           53
## 7         6         3           61
## 8         6         3           60
```

```
attach(hw8b.data)

x1 = 2*(crew.size-mean(crew.size))/ (range(crew.size)[2]-range(crew.size)[1])
x2 = 2*(bonus.pay-mean(bonus.pay))/ (range(bonus.pay)[2]-range(bonus.pay)[1])
```

```
coded.mod = lm(productivity ~ x1+x2)
summary(coded.mod)
```

```
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  50.3750     0.6638  75.889 7.53e-09 ***
## x1            5.3750     0.6638   8.097 0.000466 ***
## x2            4.6250     0.6638   6.968 0.000937 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.877 on 5 degrees of freedom
## Multiple R-squared:  0.958,  Adjusted R-squared:  0.9412
## F-statistic: 57.06 on 2 and 5 DF,  p-value: 0.000361
```