Week 5 Assignment

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Problem Set 1

Question 1

Script to compute A^TA and A^Tb Use the given matrix in the Problem set which is unsolvable

```
A <- matrix(c(1,1,1,1,0,1,3,4), ncol=2)
b <- c(0,8,8,19)

A
```

```
##      [,1] [,2]
## [1,]    1    0
## [2,]    1    1
## [3,]    1    3
## [4,]    1    4
```

```
b
```

```
## [1]  0  8  8 19
```

Compute A^TA

```
(AtA <- t(A) %*% A)
```

```
##      [,1] [,2]
## [1,]    4    8
## [2,]    8   26
```

Compute A^Tb

```
(Atb <- t(A) %*% b)
```

```
##      [,1]
## [1,]   35
## [2,]  108
```

Solve for $\hat{x}$ by doing $A^TA\hat{}\{-1\}$ divided by A^Tb

```
(solve(AtA) %*% Atb)
```

```
##      [,1]
## [1,] 1.15
## [2,] 3.80
```

Compute the error e give the change in the variable which is now p

```
p <- c(1, 5, 13, 17)
(Atp <- t(A) %*% p)
```

```
##      [,1]
## [1,]   36
## [2,]  112
```

```
(x_hat <- solve(AtA) %*% Atp)
```

```
##      [,1]
## [1,]    1
## [2,]    4
```

```
(e <- p - A %*% x_hat)
```

```
##             [,1]
## [1,]  0.000e+00
## [2,] -8.882e-16
## [3,] -3.553e-15
## [4,] -3.553e-15
```

Find the error e=b-p

```
(e = b - p)
```

```
## [1] -1  3 -5  2
```

Check if e is orthogonal to P and each col of A

```
all.equal(e %*% p, p %*% e)
```

```
## [1] TRUE
```

```
all.equal(e %*% A[,1], A[,1] %*% e)
```

```
## [1] TRUE
```

```
all.equal(e %*% A[,2], A[,2] %*% e)
```

```
## [1] TRUE
```

Question 2 Take the auto-mpg data extracts to an A matric from the first 4 columns and b vector from the fifth (*mpg*) column. Read in the table. **Note you will need to change your Working Directory to your local for this to work.**

```
setwd('/users/bcarancibia/CUNY_IS_605')
data <- read.table("auto-mpg.data")
```

Name the columns

```
names(data) <- c("displacement", "horsepower", "weight", "acceleration", "mpg")
```

Divide up the data into two matrices so that it is easier to manipulate.

```
A <- as.matrix(data[,1:4])
b <- as.matrix(data[,5])
```

Use a least squares methodology and then calculate the $\hat{x}$ in order to find the best fitting equation.

```
AtA <- t(A) %*% A
Atb <- t(A) %*% b
(x_hat <- solve(AtA) %*% Atb)
```

```
##                   [,1]
## displacement -0.030038
## horsepower    0.157116
## weight       -0.006218
## acceleration  1.997321
```

Find the error in prediction

```
(e <- sqrt(sum(((A %*% x_hat) - b)^2)))
```

```
## [1] 114.5
```