Assignment2

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Problem Set 1:

1. Show that $A^TA \neq AA^T$

```
# First create matrix A
A <- matrix(c(1,2,3,4,5,6,7,8,9), nrow = 3)
A
```

```
##      [,1] [,2] [,3]
## [1,]    1    4    7
## [2,]    2    5    8
## [3,]    3    6    9
```

```
# Then transpose matrix A using t()
AT <- t(A)
AT
```

```
##      [,1] [,2] [,3]
## [1,]    1    2    3
## [2,]    4    5    6
## [3,]    7    8    9
```

```
# Multiply the transposed matrix A by matrix A
ATA <- AT %*% A
ATA
```

```
##      [,1] [,2] [,3]
## [1,]   14   32   50
## [2,]   32   77  122
## [3,]   50  122  194
```

```
# Multiply A by transposed matrix A (AA^T)
AAT <- A %*% AT
AAT
```

```
##      [,1] [,2] [,3]
## [1,]   66   78   90
## [2,]   78   93  108
## [3,]   90  108  126
```

```
# You can see that the matrices are not identical

ATA != AAT
```

```
##      [,1] [,2] [,3]
## [1,] TRUE TRUE TRUE
## [2,] TRUE TRUE TRUE
## [3,] TRUE TRUE TRUE
```

2. For a special type of square matrix A, we get $A^TA = AA^T$. Under what conditions could this be true?

```
## The only time this would work is if the item is an identity matrix; it can also in
clude a constant multiplier (i.e. diag * c)


# Using Identity Matrix of 3x3
I <- diag(3)
I
```

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

```
# Transpose the id matrix
IT <- t(I)

# try both
I1 <- IT %*% I
I2 <- I %*% IT

# check using logic
I1 != I2
```

```
##       [,1]  [,2]  [,3]
## [1,] FALSE FALSE FALSE
## [2,] FALSE FALSE FALSE
## [3,] FALSE FALSE FALSE
```

Solving a system of equations using R only not built in functions

```
A = matrix(c(1,2,-1,1,-1,-2,3,5,4), nrow=3, ncol=3)
b = matrix(c(1, 2, 6), nrow = 3)

calc <- function (A,b){
full = cbind(A,b)

k=0
#initialize Lower
L = diag(dim(A)[2])

while (k < ncol(A)){
  k = k+1
  i = k
  j = k
  while (i <= nrow(full)-1){
    c = full[i+1,j]/full[j,j]
    full[i+1,] = full[i+1,]-c*full[j,]
    L[i+1,j] = c
    i = 1+i
  }
}

if (nrow(A) == 3){
  j=nrow(A)-1
  x3 = full[j+1,j+2]/full[j+1,j+1]
  x2 = (full[j,j+2] - full[j,j+1]*x3)/full[j,j]
  x1 = (full[j-1,j+2] - full[j-1,j+1]*x3 - full[j-1,j]*x2 )/full[j-1,j-1]
}

sol = cbind(x1, x2, x3)
print("The following is the upper matrix")
print(full[,1:3])
print("The following is the lower matrix")
print(L)
}

calc(A,b)
```

```
## [1] "The following is the upper matrix"
##      [,1] [,2]      [,3]
## [1,]    1    1  3.000000
## [2,]    0   -3 -1.000000
## [3,]    0    0  7.333333
## [1] "The following is the lower matrix"
##      [,1]      [,2] [,3]
## [1,]    1 0.0000000    0
## [2,]    2 1.0000000    0
## [3,]   -1 0.3333333    1
```