# BHao_Assign2

## Problem Set 1

1) In general, A may not be a square matrix; in which case, A would be a m x n matrix. As such $A^TA$ will be a n x n matrix; whereas $AA^T$ will be a m x m matrix. Therefore $A^TA \neq AA^T$ in general.

2)

```
# A is 2 x 3 matrix
A = matrix(seq(1:6), nrow = 2)

# result is 3 x 3 matrix
t(A) %*% A
```

```
##      [,1] [,2] [,3]
## [1,]    5   11   17
## [2,]   11   25   39
## [3,]   17   39   61
```

```
# result is a 2 x 2 matrix
A %*% t(A)
```

```
##      [,1] [,2]
## [1,]   35   44
## [2,]   44   56
```

## Problem Set 2

```
A = matrix(c(1,3,5,8,2,3,5,2,6,2,4,5,1,3,7,8), nrow = 4)

# as per instructions, no allowance made for zero pivots and row permutations
factorize_matrix = function(A) {
  U = A
  L = diag(nrow(A))
  c = 1
  for (e in 2:nrow(A)) {  # loop through n - 1 elements
    for (r in e:nrow(A)) {  # loop through n - 1 - e rows
      multiplier = U[r, c]  / U[e - 1, c]
      U[r,] = U[r,] - multiplier * U[e - 1,]
      L[r, c] = multiplier
    }
    c = c + 1
  }
  return(list('L' = L, 'U' = U))
}

L = factorize_matrix(A)$L
U = factorize_matrix(A)$U
A_LU = A == L %*% U

L
```

```
##      [,1]     [,2] [,3] [,4]
## [1,]    1 0.000000  0.0    0
## [2,]    3 1.000000  0.0    0
## [3,]    5 1.666667  1.0    0
## [4,]    8 4.666667 47.5    1
```

```
U
```

```
##      [,1] [,2]        [,3] [,4]
## [1,]    1    2   6.0000000    1
## [2,]    0   -3 -16.0000000    0
## [3,]    0    0   0.6666667    2
## [4,]    0    0   0.0000000  -95
```

```
A_LU
```

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

```
# was trying to use the function below format matrices into latex friendly format
# but was not able to get latex to cooperate so gave up on function
format_matrix = function(A) {
  n = nrow(A)
  A_ = paste0(toString(A), ', ')
  A_ = str_extract_all(A_, paste0("(\\d\\,\\s){", n, "}"))[[1]]
  paste(str_replace_all(A_, "(, )$", " \\\\ "), sep = "", collapse = "")
}
```