Geog 413 Lab 1
Additional Elements

Matrix Multiplication

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{21} \\ a_{31} & a_{31} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} = \begin{bmatrix} a_{11}b_{11} + a_{12}b_{21} & a_{11}b_{12} + a_{12}b_{22} \\ a_{21}b_{11} + a_{22}b_{21} & a_{21}b_{12} + a_{22}b_{22} \\ a_{31}b_{11} + a_{32}b_{21} & a_{31}b_{12} + a_{32}b_{22} \end{bmatrix}$$

Matrix Vector product

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} a_{11}x_1 + a_{12}x_2 \\ a_{21}x_1 + a_{22}x_2 \\ a_{31}x_1 + a_{32}x_2 \end{bmatrix} = x_1 \begin{bmatrix} a_{11} \\ a_{21} \\ a_{31} \end{bmatrix} + x_2 \begin{bmatrix} a_{12} \\ a_{22} \\ a_{32} \end{bmatrix}$$

M = $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$

$$M^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$

A = $\begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix}$

$$A^{-1} = \frac{1}{6-5} \begin{bmatrix} 3 & -5 \\ -1 & 2 \end{bmatrix} = \begin{bmatrix} 3 & -5 \\ -1 & 2 \end{bmatrix}$$

$$AA^{-1} = \begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix} \begin{bmatrix} 3 & -5 \\ -1 & 2 \end{bmatrix} = \begin{bmatrix} 6-5 & -10+10 \\ 3-3 & -5+6 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Note: If the determinant of a matrix is zero (i.e. in illustration above ***ad - bc****),* then that matrix does not have an inverse

Exercise:
1 - Find the Inverse of the matrix M1 = matrix(c(5,3,-2,7),2,2). Note that for matrix multiplication, you should the notation: *m1%*% m2*

2 – Using the ***solve()*** function find the inverse of the matrices.

- M2 = matrix(1:9, 3,3)
- M3 = cbind(c(5,2,3),c(3,4,6),c(7,9,4))
- M4 = rbind(c(1,2,3),c(3,2,1),c(2,1,3))

Factors:
The function factor creates a vector with specific categories defined in levels parameter

```
#vector assignment
house.type <- c ("Bungalow", "Apartment", "Apartment", "Detached", "Apartment", "Townhouse", "Townhouse")

# a factor assignment
house.type <- factor(c ("Bungalow", "Apartment", "Apartment", "Detached", "Apartment", "Townhouse",
"Townhouse"), levels=c("Bungalow", "Detached", "Apartment", "Duplex", " Townhouse"))

the table function can be used to summarize
table(house.type)
```

- Levels control what can be assigned. Can you test this out?

Ordering
Ordering can be imposed on a factor by using the ordered function. See the difference between factor and ordered

```
income <-factor (c("High", "High", "Low", "Low","Low", "Medium", "Low", "Medium"), levels=c ("Low", "Medium", "High"))

income > "Low"

# levels in ordered defines a relative order
income <-ordered (c(High", "High", "Low", "Low", "Low", "Medium", "Low", "Medium"), levels=c ("Low", "Medium", "High") )
income > "Low"
```

Basic Plot Tools
Let's start by generating some random numbers.

```
x1 <- rnorm(100)
y1 <- rnorm(100)
plot(x1,y1)
plot(x1,y1,pch=14,col='red')
```