Advanced Topics in Algebra – Lab#1

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Topic 1: Matrix operations in R (4 hours)

```
10^3/2
5 %% 2
a <- 1
a <- a+10
a
rm(a)    #removes the variable
vec1 <- c(3,5)
sum(vec1)
vec2 <- rnorm(10, mean=1, sd=3)
mean(vec2)
plot(vec2)
help(plot)
example(rnorm)
```

Matrix Examples[1]

```
# the matrix function
# R wants the data to be entered by columns starting with column one
# 1st arg: c(2,3,-2,1,2,2) the values of the elements filling the columns
# 2nd arg: 3 the number of rows
# 3rd arg: 2 the number of columns

> A <- matrix(c(2,3,-2,1,2,2),3,2)
> A

     [,1] [,2]
[1,]    2    1
[2,]    3    2
[3,]   -2    2
```

Is Something a Matrix

```
> is.matrix(A)

[1] TRUE

> is.vector(A)

[1] FALSE
```

Multiplication by a Scalar

```
> c <- 3
> c*A

     [,1] [,2]
[1,]    6    3
[2,]    9    6
[3,]   -6    6
```

Matrix Multiplication

```
> D <- matrix(c(2,-2,1,2,3,1),2,3)
> D

     [,1] [,2] [,3]
[1,]    2    1    3
[2,]   -2    2    1

> C <- D %*% A
> C

     [,1] [,2]
[1,]    1   10
[2,]    0    4

> C <- A %*% D
> C

     [,1] [,2] [,3]
[1,]    2    4    7
[2,]    2    7   11
[3,]   -8    2   -4

> D <- matrix(c(2,1,3),1,3)
> D

     [,1] [,2] [,3]
[1,]    2    1    3

> C <- D %*% A
> C

     [,1] [,2]
[1,]    1   10

> C <- A %*% D

Error in A %*% D : non-conformable arguments
```

Transpose of a Matrix

```
> AT <- t(A)
> AT

> ATT <- t(AT)
>ATT
```

Common Vectors

Unit Vector

```
> U <- matrix(1,3,1)
> U

     [,1]
[1,]    1
[2,]    1
[3,]    1
```

Zero Vector

```
> Z <- matrix(0,3,1)
> Z

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

Common Matrices

Unit Matrix

```
> U <- matrix(1,3,2)
```

Zero Matrix

```
> Z <- matrix(0,3,2)
```

Diagonal Matrix

```
> S <- matrix(c(2,3,-2,1,2,2,4,2,3),3,3)

> D <- diag(S)
> D

[1] 2 2 3
```

[1] http://www.philender.com/courses/multivariate/notes/matr.html

```
> D <- diag(diag(S))
> D
```

Identity Matrix

```
> I <- diag(c(1,1,1))
> I
```

Inverse of a Matrix

```
> A <- matrix(c(4,4,-2,2,6,2,2,8,4),3,3)
> A


> AI <- solve(A)
> AI


> A %*% AI

     [,1] [,2] [,3]
[1,]    1    0    0
[2,]    0    1    0
[3,]    0    0    1

> AI %*% A

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

Determinant of a Matrix

```
> C <- matrix(c(2,1,6,1,3,4,6,4,-2),3,3)

> d <- det(C)
> d

[1] -102
```

Number of Rows & Columns

```
> X <- matrix(c(3,2,4,3,2,-2,6,1),4,2)
> X

> dim(X)

[1] 4 2

> r <- nrow(X)
> r

[1] 4

> c <- ncol(X)
> c
-
[1] 2
```

Computing Column & Row Sums

```
# note the uppercase S

> A <- matrix(c(2,3,-2,1,2,2),3,2)
> A

> c <- colSums(A)
> c


> r <- rowSums(A)
> r

> a <- sum(A)
> a

[1] 8
```

Computing Column & Row Means

```
# note the uppercase M

> cm <- colMeans(A)
> cm

[1] 1.000000 1.666667

> rm <- rowMeans(A)
> rm

[1] 1.5 2.5 0.0

> m <- mean(A)
> m

[1] 1.333333
```

Horizontal Concatenation

```
> A

     [,1] [,2]
[1,]    2    1
[2,]    3    2
[3,]   -2    2

> B <- matrix(c(1,3,2,1,4,2),3,2)
> B

     [,1] [,2]
[1,]    1    1
[2,]    3    4
[3,]    2    2

> C <- cbind(A,B)
> C

     [,1] [,2] [,3] [,4]
[1,]    2    1    1    1
[2,]    3    2    3    4
[3,]   -2    2    2    2
```

Vertical Concatenation (Appending)

```
> C <- rbind(A,B)
> C

     [,1] [,2]
[1,]    2    1
[2,]    3    2
[3,]   -2    2
[4,]    1    1
[5,]    3    4
[6,]    2    2
```

SVD – first example

```
> s <- svd(C)
> s
> s$u %*% diag(s$d) %*% t( s$v )
> # Singular Value Decomposition: C = U D t(V)
```