Introduction to R Programming
Lecture 5

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1 Matrix Algebra

R for MATLAB users: http://mathesaurus.sourceforge.net/octave-r.html

```
> set.seed(123)
> A = matrix(sample(100,15), nrow=5, ncol=3)
> set.seed(234)
> B = matrix(sample(100,15), nrow=5, ncol=3)
> set.seed(321)
> X = matrix(sample(100,25), nrow=5, ncol=5)
> set.seed(213)
> b = matrix(sample(100,5),nrow=5, ncol=1)
> A

     [,1] [,2] [,3]
[1,]   29    5   87
[2,]   79   50   98
[3,]   41   83   60
[4,]   86   51   94
[5,]   91   42    9

> B

     [,1] [,2] [,3]
[1,]   75   62   51
[2,]   78   88   49
[3,]    2   67   52
[4,]   76   86   90
[5,]    7   26    1

> X
```

```
     [,1] [,2] [,3] [,4] [,5]
[1,]   96   33   55   18   86
[2,]   93   43   95   54   79
[3,]   24   27   68   34   73
[4,]   25   42    4   98  100
[5,]   38   74   51   52   44
```

```
> b
```

```
     [,1]
[1,]    3
[2,]   35
[3,]   62
[4,]   57
[5,]   41
```

```
> #  + - * / ^
> #Element-wise addition, subtraction, multiplication, division
> #, and exponentiation, respectively.
> A + 2
```

```
     [,1] [,2] [,3]
[1,]   31    7   89
[2,]   81   52  100
[3,]   43   85   62
[4,]   88   53   96
[5,]   93   44   11
```

```
> A * 2
```

```
     [,1] [,2] [,3]
[1,]   58   10  174
[2,]  158  100  196
[3,]   82  166  120
[4,]  172  102  188
[5,]  182   84   18
```

```
> A ^ 2
```

```
     [,1] [,2] [,3]
[1,]  841   25 7569
[2,] 6241 2500 9604
[3,] 1681 6889 3600
[4,] 7396 2601 8836
[5,] 8281 1764   81
```

```
> #Matrix multiplication
> t(A) %*% B
```

```
      [,1]  [,2]  [,3]
[1,] 15592 21259 15313
[2,]  8611 15749 11653
[3,] 21496 26356 20828
```

```
> #Returns a vector containing the column means of A.
> colMeans(A)
```

```
[1] 65.2 46.2 69.6
```

```
> #Returns a vector containing the column sums of A.
> colSums(A)
```

```
[1] 326 231 348
```

```
> #Returns a vector containing the row means of A.
> rowMeans(A)
```

```
[1] 40.33333 75.66667 61.33333 77.00000 47.33333
```

```
> #Returns a vector containing the row sums of A.
> rowSums(A)
```

```
[1] 121 227 184 231 142
```

```
> #Matrix Crossproduct
> # A'A
> crossprod(A)
```

```
      [,1]  [,2]  [,3]
[1,] 24440 15706 21628
[2,] 15706 13779 15487
[3,] 21628 15487 29690
```

```
> # A'B
> crossprod(A,B)
```

```
      [,1]  [,2]  [,3]
[1,] 15592 21259 15313
[2,]  8611 15749 11653
[3,] 21496 26356 20828
```

```
> #Inverse of A where A is a square matrix.
> solve(X)
```

```
             [,1]         [,2]          [,3]          [,4]         [,5]
[1,]  0.005613920  0.010231429 -0.0169120729  0.0005830023 -0.002609067
[2,]  0.008482937 -0.016566915  0.0004314519 -0.0039590679  0.021446920
[3,] -0.009636337  0.009519483  0.0107155725 -0.0063872060 -0.001518871
[4,] -0.016672892  0.019685497 -0.0106940350  0.0088482442 -0.005123760
[5,]  0.011758574 -0.015272319  0.0140983398  0.0031012668 -0.003273400
```

```
> #Solves for vector x in the equation b = Ax.
> # b = Xv
> v = solve(X, b)
> v

           [,1]
[1,] -0.7473474
[2,]  0.1260136
[3,]  0.5422939
[4,]  0.2702193
[5,]  0.4174044

> #Returns a vector containing the elements of the principal diagonal
> diag(X)

[1] 96 43 68 98 44

> #Creates a diagonal matrix with the elements of x in the principal diagonal.
> diag(c(1,2,3,4))

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

> #If k is a scalar, this creates a k x k identity matrix.
> diag(5)

     [,1] [,2] [,3] [,4] [,5]
[1,]    1    0    0    0    0
[2,]    0    1    0    0    0
[3,]    0    0    1    0    0
[4,]    0    0    0    1    0
[5,]    0    0    0    0    1

> #Eigenvalues and eigenvectors of A.
> eigen(X)

$values
[1] 277.41449+ 0.00000i  58.39588+ 6.55948i  58.39588- 6.55948i
[4] -22.60313+29.96419i -22.60313-29.96419i

$vectors
             [,1]                      [,2]                      [,3]
[1,] 0.4488450+0i  0.74412580+0.00000000i  0.74412580+0.00000000i
[2,] 0.5594059+0i  0.19946808+0.03821859i  0.19946808-0.03821859i
[3,] 0.3416482+0i -0.38355207+0.09959650i -0.38355207-0.09959650i
```

```
[4,] 0.4364984+0i -0.46905017-0.15636245i -0.46905017+0.15636245i
[5,] 0.4223136+0i -0.05844621+0.01112305i -0.05844621-0.01112305i
                      [,4]                  [,5]
[1,] -0.2318343-0.1214549i -0.2318343+0.1214549i
[2,]  0.0164659+0.5611941i  0.0164659-0.5611941i
[3,] -0.2372177-0.1165173i -0.2372177+0.1165173i
[4,] -0.3706598-0.2584861i -0.3706598+0.2584861i
[5,]  0.5850122+0.0000000i  0.5850122+0.0000000i
```

2 Afterword

Google & English

The R Project (http://www.r-project.org/): The official R website and your first stop for all things R. The site includes extensive documentation, including An Introduction to R, The R Language Definition, Writing R Extensions, R Data Import/Export, R Installation and Administration, and The R FAQ.

The R Journal (http://journal.r-project.org/): A freely accessible refereed journal containing articles on the R project and contributed packages.

R Bloggers (http://www.r-bloggers.com/): A central hub (blog aggregator) collecting content from bloggers writing about R. Contains new articles daily. I am addicted to it.

Planet R (http://planetr.stderr.org): Another good site-aggregator, including information from a wide range of sources. Updated daily.

R Graph Gallery (http://addictedtor.free.fr/graphiques/): A collection of innovative graphs, along with their source code.

R Graphics Manual (http://bm2.genes.nig.ac.jp/): A collection of R graphics from all R packages, arranged by topic, package, and function. At last count, there were 35,000+ images!

Journal of Statistical Software (http://www.jstatsoft.org/): A freely accessible refereed journal containing articles, book reviews, and code snippets on statistical computing. Contains frequent articles about R.

Quick-R (http://www.statmethods.net): The website of R in Action author.