

# DAT 520 Problem Set 1 R for Probability Matrices

**Prep Work*:*** To perform exponential math on a matrix, you will need to load the expm package. If you are prompted for a mirror, simply select the state you are in.

Install the ability to exponentiate matrices by typing the following at the prompt in R:

>install.packages("expm")

>library(expm)

**Matrix Math Overview in R**: The following information provides a basis for the homework. Please review A-D below:

1. Matrix Multiplication

Row by column

Multiplying 2x2 matrices:



Gives you another 2x2 matrix as a result.

Multiplying a 1x2 with a 2x2 matrix:

1x2

One into two matrix with AB multiplied by two into two matrix with C, D, E, and F is equal to one into one matrix with AC plus BE in parenthesis and AD plus BF in parenthesis.

Gives you a 1x2 matrix as a result.

Reference: [An Introduction to R](http://cran.r-project.org/doc/manuals/R-intro.html#Multiplication)

To multiply two conforming matrices in R:

matresults <-

To multiply two matrices with compatible dimensions (i.e., the number of columns of the first matrix equals the number of columns of the second matrix), we use the matrix multiplication operator %\*%.

1. Matrix Exponentiation (raising to a power like squared or cubed)

To square a matrix:

matresults <- matrix1 %^% 2

To cube a matrix:

matresults <- matrix1 %^% 3

1. Populate Matrices with Data in R

To create a matrix in R, we may use the matrix function. We need to provide a vector containing the elements of the matrix, and specify either the number of rows or the number of columns of the matrix. This number should divide evenly into the length of the vector, or we will get a warning. For example, to make a 2 x 3 matrix named M consisting of the integers 1 through 6, we can do this:

> M <- matrix( 1:6, nrow=2 )

or this:

> M <- matrix( 1:6, ncol=3 )

We get:

> M

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

[1,] 1 3 5

[2,] 2 4 6

Note that R places the row numbers on the left and the column numbers on top. Also note that R filled in the matrix column-by-column. If we prefer to fill in the matrix row-by-row, we must activate the byrow setting, e.g.,

> M <- matrix( 1:6, ncol=3, byrow=TRUE )

Then we get:

> M

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

[1,] 1 2 3

[2,] 4 5 6

In place of the vector 1:6 you would place any vector containing the desired elements of the matrix.

the matrix content is filled along the column orientation by default.

To easily populate matrices in R:

matrix1 <- matrix(c(1,2,3,4), 2, byrow=T)

The concept is that you dump everything in, but divide it by rows of 2 (the … 2, byrow=T part)

Reference:[R Library: Matrices and Matrix Computations in R](http://www.ats.ucla.edu/stat/r/library/matrix_alg.htm)

**Definitely learn these few commands through-and-through and commit them to memory.**

1. Order of Operations

**Be mindful of your open and close parentheses.**

For correct order of operations, use these parentheses strategically.

**Examples:** The following section provides some examples to reference when completing the problem set.

* First we have to create data sets to perform our operations on. This is the method for loading data values:

*[R commands... ]*

mat1 <- matrix(c(1,2,3,4), 2, byrow=T)

mat2 <- matrix(c(5,6,7,8), 2, byrow=T)

* Not we want to multiply the mat1 and mat2 we created in the last step:

Two into two matrix with the numbers one, two, three, and four multiplied by two into two matrix with the numbers five, six, seven, and eight.

Tell R to multiply mat1 and mat2

mat1 %\*% mat2

*[R output... ]*

[,1] [,2]

[1,] 19 22

[2,] 43 50

* Now let’s exponentiate the matrix:

> mat1 %^% 2

*[R output... ]*

[,1] [,2]

[1,] 7 10

[2,] 15 22

* Let’s continue to build by adding mat1 to mat2 cubed:

>mat1 + (mat2 %^% 3)

*[R output... ]*

[,1] [,2]

[1,] 882 1028

[2,] 1200 1398

* Finally, let’s add the square root of mat1 to mat2 cubed:

> (mat1%^% .5) + (mat2 %^% 3)

*[R output... ]*

[,1] [,2]

[1,] 882 1026

[2,] 1197 1395

**Common Mistakes in R:**

* R is **not** straightforward about matrix manipulations. For example, you **cannot** do a proper matrix multiplication by stating:

mat1 \* mat2

This is **wrong**. It will simply do an item-by item multiplication. To do the real matrix multiplication, you must state it the **correct** way:

mat1 %\*% mat2

* Similarly, with exponentiation, the **correct** way you must state it is:

mat1 %^% mat2

**Homework Problems:** Now, calculate these matrices using R. Copy the R session showing your commands and results and paste into a Word document to submit to the classroom. All problems below can be completed using the information found in the prior sections of this document. If you have any questions, please post to the General Questions area of your classroom and your instructor or other students will be able to assist you. Feel free to extend your learning and practice additional matrix commands. Post any questions you have.

Hint: Remember to create the datasets as your first step and then perform the math operation.

1)

Two into two matrix with the numbers one, two, three, and four multiplied by two into two matrix with the numbers five, six, seven, and eight.

mat1.a%\*%mat1.b

2)

Two into two matrix with the numbers point five, point five, point two five, and point seven five multiplied by two into two matrix point three three, point six seven, point six seven, and point three three.

mat2.a%\*%mat2.b

3)

Two into two matrix with the numbers point five, point five, point two five, and point seven five with the whole matrix squared

mat2.a%^%2

4)

Two into two matrix with the numbers point five, point five, point two five, and point seven five with the whole matrix cubed

mat2.a%^%3

5)

Two into two matrix with the numbers point one five, point eight five, point zero zero one, and point nine nine nine to the power four plus two into two matrix with the numbers point zero two, point nine eight, point one nine, and point eight one to the power of seven. 

install.packages("expm")

library(expm)

mat5.a

mat5.b = matrix (c(.02,.98,.19,.81), 2 , byrow =T )

mat5.b

mat5.a = matrix (c(.15,.85,.001,.999), 2 , byrow =T )

(mat5.a%^%4) + (mat5.b%^%7)

6)

One into two matrix with the numbers one and two multiplied by two into two matrix with the numbers five, six, seven, and eight.

mat6.a%\*%mat1.b

7)

One into two matrix with the numbers point zero eight and point zero nine two multiplied by two into two matrix with the numbers point three seven five, point six two five, point three nine nine, and point six zero one.

mat7.a%\*%mat7.b

8) Remember to use the correct order of operations by careful use of parentheses:

One into two matrix with the numbers point zero eight and point zero nine two multiplied by two into two matrix with the numbers point three seven five, point six two five, point three nine nine, and point six zero one.

9)

One into one matrix with the numbers point five and point five multiplied by two into two matrix with the numbers point five, point five, point five, and point five, with the matrix whole squared.

(mat9.a)%\*%(mat9.b%^%2)

10)

One into one matrix with the numbers point zero one four and point nine eight six multiplied by a two into two matrix with the numbers point one three five, point eight six five, point five zero one, and point four nine nine.

install.packages("expm")

library(expm)

mat10.a = matrix (c(.014,.986), 1 , byrow =T )

mat10.a

mat10.b = matrix (c(.135,.865,.501,.499), 2 , byrow =T )

(mat10.a)%\*%(mat10.b%^%7)