

## Sample R Session Based on Koehler's Notes Through Slide #91

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Type ``demo()'` for some demos, ``help()'` for on-line help, or  
``help.start()'` for a HTML browser interface to help.  
Type ``q()'` to quit R.

```
> a<-matrix(c(3,6,2,1),2,2,byrow=T)
> a
      [,1] [,2]
[1,]    3    6
[2,]    2    1
> b<-matrix(c(7,-4,-3,2),2,2,byrow=T)
> b
      [,1] [,2]
[1,]    7   -4
[2,]   -3    2
> a+b
      [,1] [,2]
[1,]   10    2
[2,]    -1    3
> a-b
      [,1] [,2]
[1,]   -4   10
[2,]    5   -1
> c<-matrix(c(2,-1,3,0,4,-2),2,3,byrow=T)
> c
      [,1] [,2] [,3]
[1,]    2   -1    3
[2,]    0    4   -2
> d<-2*c
> d
      [,1] [,2] [,3]
[1,]    4   -2    6
[2,]    0    8   -4
> ct<-t(c)
> ct
      [,1] [,2]
[1,]    2    0
[2,]   -1    4
[3,]    3   -2
> a<-matrix(c(3,0,-2,1,-1,4),2,3,byrow=T)
> a
      [,1] [,2] [,3]
[1,]    3    0   -2
[2,]    1   -1    4
```

```

> b<-matrix(c(1,1,1,2,1,3),3,2,byrow=T)
> b
      [,1] [,2]
[1,]    1    1
[2,]    1    2
[3,]    1    3
> objects()
[1] "a"  "b"  "c"  "ct" "d"
> c
      [,1] [,2] [,3]
[1,]    2   -1    3
[2,]    0    4   -2
> c<-a%*%b
> c
      [,1] [,2]
[1,]    1   -3
[2,]    4   11
> x<-c(1,7,-6,4)
> y<-c(2,-2,1,5)
> x
[1]  1  7 -6  4
> y
[1]  2 -2  1  5
> t(x)%*%y
      [,1]
[1,]    2
> x%*%y
      [,1]
[1,]    2
> crossprod(x,y)
      [,1]
[1,]    2
> ynorm<-sqrt(crossprod(y,y))
> ynorm
      [,1]
[1,] 5.830952
> length(y)
[1] 4
> objects()
[1] "a"      "b"      "c"      "ct"     "d"      "x"      "y"      "ynorm"
> a<-matrix(c(3,6,2,1),2,2,byrow=t)
> a
      [,1] [,2]
[1,]    3    6
[2,]    2    1
> b<-matrix(c(7,-4,-3,2),2,2,byrow=T)
> b
      [,1] [,2]
[1,]    7   -4
[2,]   -3    2
> a*b
      [,1] [,2]
[1,]   21  -24
[2,]   -6    2

```

```

> a<-matrix(c(2,4,0,-2,3,-1),ncol=2,byrow=T)
> a
      [,1] [,2]
[1,]    2    4
[2,]    0   -2
[3,]    3   -1
> b<-matrix(c(5,3,2,1),2,2,byrow=T)
> b
      [,1] [,2]
[1,]    5    3
[2,]    2    1
> kronecker(a,b)
      [,1] [,2] [,3] [,4]
[1,]   10    6   20   12
[2,]    4    2    8    4
[3,]    0    0  -10   -6
[4,]    0    0   -4   -2
[5,]   15    9   -5   -3
[6,]    6    3   -2   -1
> kronecker(b,a)
      [,1] [,2] [,3] [,4]
[1,]   10   20    6   12
[2,]    0  -10    0   -6
[3,]   15   -5    9   -3
[4,]    4    8    2    4
[5,]    0   -4    0   -2
[6,]    6   -2    3   -1
> objects()
[1] "a"      "b"      "c"      "ct"     "d"      "x"      "y"      "ynorm"
> diag(rep(1,4))
      [,1] [,2] [,3] [,4]
[1,]    1    0    0    0
[2,]    0    1    0    0
[3,]    0    0    1    0
[4,]    0    0    0    1
> w<-matrix(c(1,2,3,4,5,6,7,8,10),3,3,byrow=T)
> w
      [,1] [,2] [,3]
[1,]    1    2    3
[2,]    4    5    6
[3,]    7    8   10
> tr<-sum(diag(w))
> tr
[1] 16
> w<-matrix(c(1,2,3,4,5,6,7,8,10),3,3,byrow=T)
> w
      [,1] [,2] [,3]
[1,]    1    2    3
[2,]    4    5    6
[3,]    7    8   10
> tr<-sum(diag(w))
> tr
[1] 16
> objects()
[1] "a"      "b"      "c"      "ct"     "d"      "tr"     "w"      "x"
"y"      "ynorm"

```

```

> winv<-solve(w)
> winv
      [,1]      [,2] [,3]
[1,] -0.6666667 -1.333333  1
[2,] -0.6666667  3.666667 -2
[3,]  1.0000000 -2.000000  1
> w%*%winv
      [,1]      [,2]      [,3]
[1,] 1.000000e+00 4.440892e-15 -2.664535e-15
[2,] 8.881784e-16 1.000000e+00 -8.881784e-16
[3,] 0.000000e+00 0.000000e+00 1.000000e+00
> determ<-function(M) Re(prod(eigen(M,only.values=T)$values))
> determ(w)
[1] -3
> x1<-matrix(c(1,2,3,4,5,6,7,8,9),ncol=3,byrow=T)
> x1
      [,1] [,2] [,3]
[1,]    1    2    3
[2,]    4    5    6
[3,]    7    8    9
> determ(x1)
[1] 3.154999e-15
> A<-matrix(c(1,1,1,2,5,-1),3,3,byrow=T)
> A
      [,1] [,2] [,3]
[1,]    1    1    1
[2,]    2    5   -1
[3,]    1    1    1
> qr(A)$rank
[1] 2
> A<-matrix(c(1,1,1,2,5,-1,0,1,1),3,3,byrow=T)
> A
      [,1] [,2] [,3]
[1,]    1    1    1
[2,]    2    5   -1
[3,]    0    1    1
> qr(A)$rank
[1] 3
> X<-matrix(c(1,1,0,0,
+           1,1,0,0,
+           1,0,1,0,
+           1,0,1,0,
+           1,0,0,1,
+           1,0,0,1),ncol=4,byrow=T)
> X
      [,1] [,2] [,3] [,4]
[1,]    1    1    0    0
[2,]    1    1    0    0
[3,]    1    0    1    0
[4,]    1    0    1    0
[5,]    1    0    0    1
[6,]    1    0    0    1
> qr(X)$rank
[1] 3

```

```

> XtX<-t(X)%*%X
> XtX
      [,1] [,2] [,3] [,4]
[1,]    6    2    2    2
[2,]    2    2    0    0
[3,]    2    0    2    0
[4,]    2    0    0    2
> qr(XtX)$rank
[1] 3
> w<-matrix(c(1,2,3,4,5,6,7,8,10),3,3,byrow=T)
> w
      [,1] [,2] [,3]
[1,]    1    2    3
[2,]    4    5    6
[3,]    7    8   10
> sum(w)
[1] 46
> apply(w,1,sum)
[1]  6 15 25
> apply(w,2,sum)
[1] 12 15 19
> apply(w,1,prod)
[1]  6 120 560
> apply(w,1,mean)
[1] 2.000000 5.000000 8.333333
> apply(w,1,var)
[1] 1.000000 1.000000 2.333333
> A<-matrix(c(1.96, .72, .72, 1.54),2,2,byrow=T)
> EA<-eigen(A)
> EA
$values
[1] 2.5 1.0

$vectors
      [,1] [,2]
[1,] -0.8  0.6
[2,] -0.6 -0.8

> EA$values
[1] 2.5 1.0
> EA$vectors
      [,1] [,2]
[1,] -0.8  0.6
[2,] -0.6 -0.8

```