# Exercises 2

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*April 27, 2018*

1.

(a)

```
A <- matrix(
  c(1, 5, -2, 1, 2, -1, 3, 6, -3),
  nrow = 3,
  ncol = 3
  )
A
```

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

```
A%%A%%A
```

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

(b)

```
A[,3] <- A[,2] + A[,3]
A
```

```
##      [,1] [,2] [,3]
## [1,]    1    1    4
## [2,]    5    2    8
## [3,]   -2   -1   -4
```

2.

```
B <- matrix(
  c(10,-10,10),
  byrow = TRUE,
  ncol = 3,
  nrow = 15
  )
crossprod(B)
```

```
##       [,1]  [,2]  [,3]
## [1,]  1500 -1500  1500
## [2,] -1500  1500 -1500
## [3,]  1500 -1500  1500
```

3.

```
matE <- matrix(
  0,
  nrow = 6,
```

```
  ncol = 6
)
matE[abs(col(matE)-row(matE))==1] <- 1
matE
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6]
## [1,]    0    1    0    0    0    0
## [2,]    1    0    1    0    0    0
## [3,]    0    1    0    1    0    0
## [4,]    0    0    1    0    1    0
## [5,]    0    0    0    1    0    1
## [6,]    0    0    0    0    1    0
```

4.

```
a <- 0:4
A <- outer(a,a,"+")
A
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    0    1    2    3    4
## [2,]    1    2    3    4    5
## [3,]    2    3    4    5    6
## [4,]    3    4    5    6    7
## [5,]    4    5    6    7    8
```

5.

(a)

```
outer(0:4,0:4,"+")%%5
```

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

(b)

```
outer(0:9,0:9,"+")%%10
```

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
##  [1,]    0    1    2    3    4    5    6    7    8     9
##  [2,]    1    2    3    4    5    6    7    8    9     0
##  [3,]    2    3    4    5    6    7    8    9    0     1
##  [4,]    3    4    5    6    7    8    9    0    1     2
##  [5,]    4    5    6    7    8    9    0    1    2     3
##  [6,]    5    6    7    8    9    0    1    2    3     4
##  [7,]    6    7    8    9    0    1    2    3    4     5
##  [8,]    7    8    9    0    1    2    3    4    5     6
##  [9,]    8    9    0    1    2    3    4    5    6     7
## [10,]    9    0    1    2    3    4    5    6    7     8
```

(c)

```
outer(0:8,0:8,"-")%%9
```

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
```

```
##  [1,]    0    8    7    6    5    4    3    2    1
##  [2,]    1    0    8    7    6    5    4    3    2
##  [3,]    2    1    0    8    7    6    5    4    3
##  [4,]    3    2    1    0    8    7    6    5    4
##  [5,]    4    3    2    1    0    8    7    6    5
##  [6,]    5    4    3    2    1    0    8    7    6
##  [7,]    6    5    4    3    2    1    0    8    7
##  [8,]    7    6    5    4    3    2    1    0    8
##  [9,]    8    7    6    5    4    3    2    1    0
```

6.

```
ymatrix <- c(7, -1, -3, 5, 17)
Amatrix <- matrix(0,nr=5,nc=5)
Amatrix <- abs(col(Amatrix)-row(Amatrix))+1
xmatrix <- solve(Amatrix,ymatrix)
xmatrix
```

```
## [1] -2  3  5  2 -4
```

7.

```
set.seed(75)
aMat <- matrix(sample(10, size=60, replace=TRUE), nr=6)
aMat
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
## [1,]    3    6    7    7    2    4    3    7    1     4
## [2,]    1    9    8    7    2    6   10    9    5     2
## [3,]    7   10    8    4   10    5    4    8    4     4
## [4,]    4    3    1    1    3    3    9    7    4     2
## [5,]    1    8    1    9    9    8    1    3    7     7
## [6,]    2    6    7    5    6   10    4    6   10     1
```

(a)

```
apply(aMat, 1, function(x){sum(x>4)})
```

```
## [1] 4 7 6 2 6 7
```

(b)

```
which( apply(aMat, 1,function(x){sum(x==7)==2}))
```

```
## [1] 5
```

(c)

```
which( outer(colSums(aMat),colSums(aMat),"+")>75, arr.ind=T )
```

```
##      row col
## [1,]   2   2
## [2,]   6   2
## [3,]   8   2
## [4,]   2   6
## [5,]   8   6
## [6,]   2   8
## [7,]   6   8
## [8,]   8   8
```

What if repetitions are not permitted?

```
aMatColSums <- colSums(aMat)
logicalMat <- outer(aMatColSums,aMatColSums,"+")>75
logicalMat[lower.tri(logicalMat,diag=T)] <- F
which(logicalMat, arr.ind=T)
```

```
##      row col
## [1,]   2   6
## [2,]   2   8
## [3,]   6   8
```

8.

(a)

```
sum((1:20)^4) * sum(1/(3+(1:5)))
```

```
## [1] 639215.3
```

(b)

```
sum((1:20)^4 / (3 + outer(1:20,1:5,"*")))
```

```
## [1] 89912.02
```

(c)

```
sum(outer(1:10,1:10,function(i,j){ (i>=j)*i^4/(3+i*j) }))
```

```
## [1] 6944.743
```