

Introduction to R Software

Basics of Calculations

:::

Matrix Operations

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- **Multiplication of a matrix with a constant**

```
> x <- matrix(nrow=4, ncol=2, data=1:8, byrow=T )
```

```
> x
```

	[,1]	[,2]
[1,]	1	2
[2,]	3	4
[3,]	5	6
[4,]	7	8

R Console

```
> x <- matrix(nrow=4, ncol=2, data=1:8, byrow=T )
```

```
>
```

```
> x
```

	[,1]	[,2]
[1,]	1	2
[2,]	3	4
[3,]	5	6
[4,]	7	8

```
> |
```

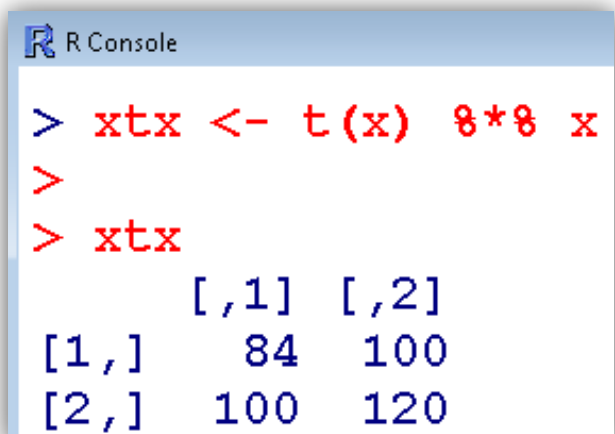
- **Matrix multiplication: operator %*%**

Consider the multiplication of X' with X

```
> xtx <- t(x) %*% x
```

```
> xtx
```

```
      [,1] [,2]  
[1,]   84  100  
[2,]  100  120
```



```
R Console  
> xtx <- t(x) %*% x  
>  
> xtx  
      [,1] [,2]  
[1,]   84  100  
[2,]  100  120
```

- Cross product of a matrix X , $X'X$, with a function `crossprod`

```
> xtx2 <- crossprod(x)
```

```
> xtx2
```

```
      [,1] [,2]
[1,]   84  100
[2,]  100  120
```

R Console

```
> xtx2 <- crossprod(x)
```

```
> xtx2
```

```
      [,1] [,2]
[1,]   84  100
[2,]  100  120
```

```
> |
```

Note: Command `crossprod()` executes the multiplication faster than the conventional method with `t(x) %*% x`

- **Addition and subtraction of matrices (of same dimensions) can be executed with the usual operators + and -**

```
> x <- matrix(nrow=4, ncol=2, data=1:8, byrow=T)
```

```
> x
```

	[,1]	[,2]
[1,]	1	2
[2,]	3	4
[3,]	5	6
[4,]	7	8

R Console

```
> x <- matrix(nrow=4, ncol=2, data=1:8, byrow=T)
```

```
> x
```

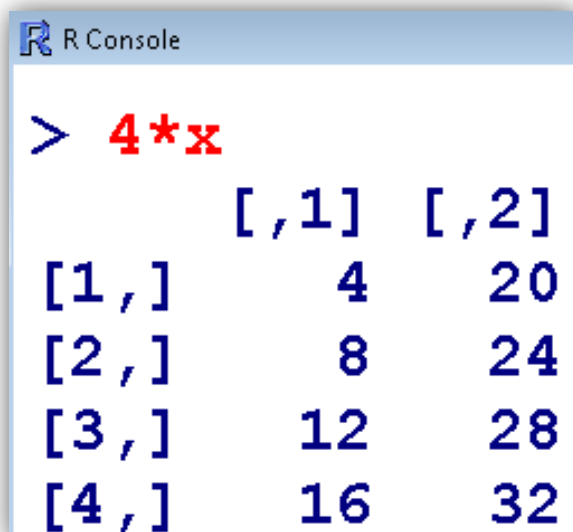
	[,1]	[,2]
[1,]	1	2
[2,]	3	4
[3,]	5	6
[4,]	7	8

```
>
```

- Addition and subtraction of matrices (of same dimensions!) can be executed with the usual operators + and -

> 4*x

	[,1]	[,2]
[1,]	4	8
[2,]	12	16
[3,]	20	24
[4,]	28	32



R Console

```
> 4*x
```

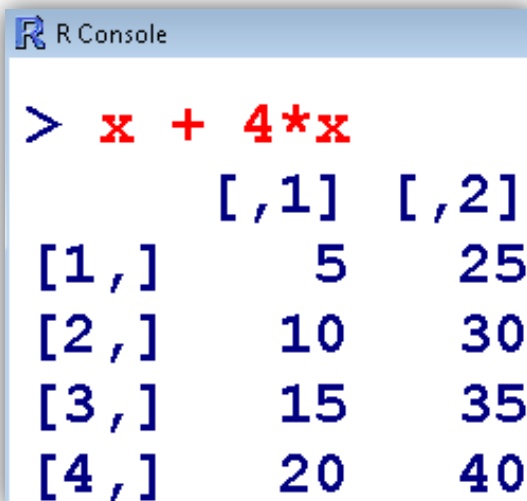
	[,1]	[,2]
[1,]	4	20
[2,]	8	24
[3,]	12	28
[4,]	16	32

The screenshot shows an R console window with the command `> 4*x` and its output. The output is a 4x2 matrix with columns labeled [,1] and [,2], and rows labeled [1,], [2,], [3,], and [4,]. The values are 4, 20, 8, 24, 12, 28, 16, and 32 respectively.

- **Addition and subtraction of matrices (of same dimensions!) can be executed with the usual operators + and -**

```
> x + 4*x
```

	[,1]	[,2]
[1,]	5	10
[2,]	15	20
[3,]	25	30
[4,]	35	40

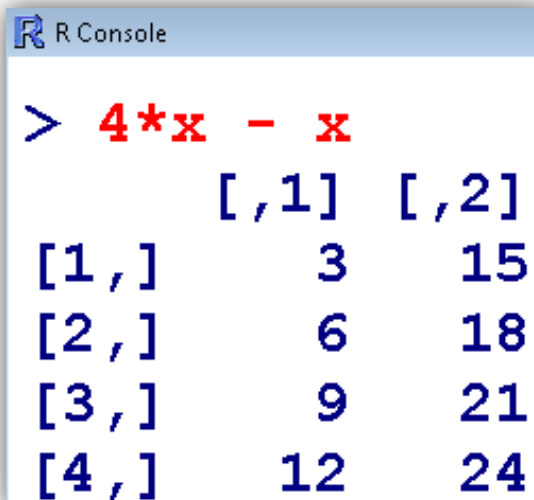


```
> x + 4*x
```

	[,1]	[,2]
[1,]	5	25
[2,]	10	30
[3,]	15	35
[4,]	20	40

```
> 4*x - x
```

	[,1]	[,2]
[1,]	3	6
[2,]	9	12
[3,]	15	18
[4,]	21	24



```
> 4*x - x
```

	[,1]	[,2]
[1,]	3	15
[2,]	6	18
[3,]	9	21
[4,]	12	24

- **Access to rows, columns or submatrices:**

```
> x <- matrix( nrow=5, ncol=3, byrow=T, data=1:15)
```

```
> x
```

	[,1]	[,2]	[,3]
[1,]	1	2	3
[2,]	4	5	6
[3,]	7	8	9
[4,]	10	11	12
[5,]	13	14	15

R Console

```
> x <- matrix( nrow=5, ncol=3, byrow=T, data=1:15)
```

```
> x
```

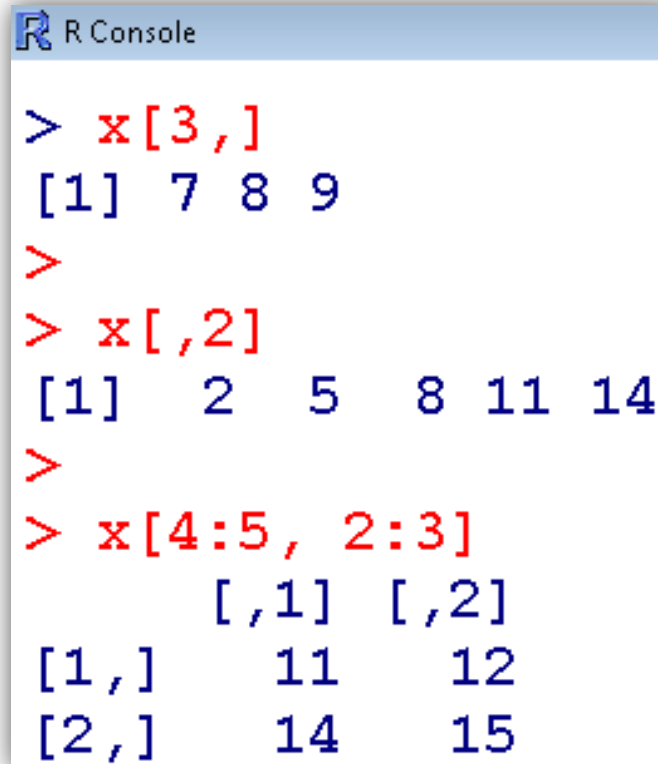
	[,1]	[,2]	[,3]
[1,]	1	2	3
[2,]	4	5	6
[3,]	7	8	9
[4,]	10	11	12
[5,]	13	14	15

- **Access to rows, columns or submatrices:**

```
> x[3,]  
[1] 7 8 9
```

```
> x[,2]  
[1] 2 5 8 11 14
```

```
> x[4:5, 2:3]  
      [,1] [,2]  
[1,]    11    12  
[2,]    14    15
```



```
R Console  
> x[3,]  
[1] 7 8 9  
>  
> x[,2]  
[1] 2 5 8 11 14  
>  
> x[4:5, 2:3]  
      [,1] [,2]  
[1,]    11    12  
[2,]    14    15
```

- **Inverse of a matrix:**

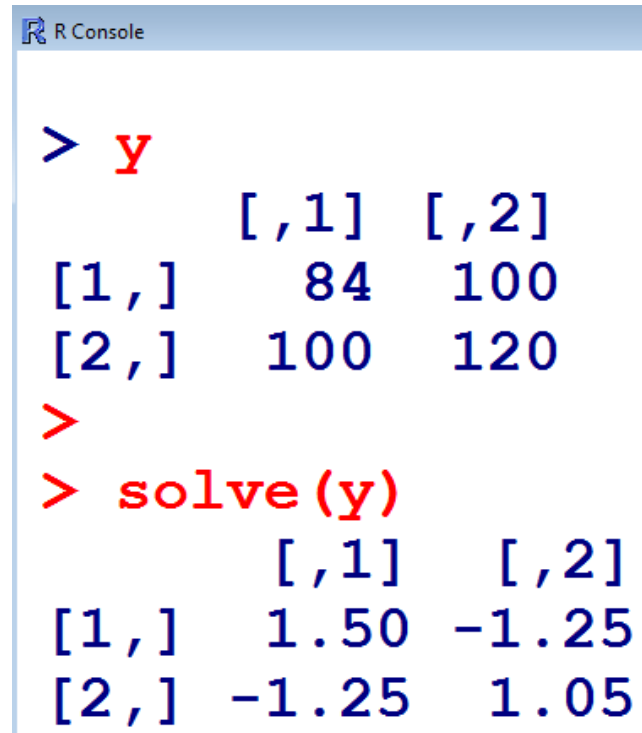
`solve()` finds the inverse of a positive definite matrix

Example:

```
> y<- matrix( nrow=2, ncol=2, byrow=T,  
data=c(84,100,100,120) )
```

```
> y  
      [,1] [,2]  
[1,]   84  100  
[2,]  100  120
```

```
> solve(y)  
      [,1] [,2]  
[1,]  1.50 -1.25  
[2,] -1.25  1.05
```



```
R Console  
  
> y  
      [,1] [,2]  
[1,]   84  100  
[2,]  100  120  
  
>  
> solve(y)  
      [,1] [,2]  
[1,]  1.50 -1.25  
[2,] -1.25  1.05
```

- **Eigen Values and Eigen Vectors:**

`eigen()` finds the eigen values and eigen vectors of a positive definite matrix

Example:

```
> y
```

```
      [,1] [,2]
[1,]    84  100
[2,]   100  120
```

```
> eigen(y)
```

```
$values
```

```
[1] 203.6070864    0.3929136
```

```
$vectors
```

```
      [,1]      [,2]
[1,] 0.6414230 -0.7671874
[2,] 0.7671874  0.6414230
```

```
R Console

> y
      [,1] [,2]
[1,]    84  100
[2,]   100  120
> eigen(y)
$values
[1] 203.6070864    0.3929136

$vectors
      [,1]      [,2]
[1,] 0.6414230 -0.7671874
[2,] 0.7671874  0.6414230
```