Descriptive Statistics With R Software

Calculations with R Software

:::

Operations with Matrices

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Matrix

A matrix is a rectangular array with *p* rows and *n* columns.

An element in the *i*-th row and *j*-th column is denoted by X_{ij} (book version) or *X*[*i*, *j*] ("program version"), *i* = 1,2,...,*n*, *j* = 1,2,...,*p*.

We consider only numerical matrices, whose elements are generally real numbers.

Matrix

In R, a 4 × 2-matrix *X* can be created with a following command:

```
> x = matrix( nrow=4, ncol=2, data=c(1,2,3,
4,5,6,7,8) )
> x
     [,1] [,2]
[1,]    1    5
[2,]    2    6
[3,]    3    7
[4,]    4    8
```

Matrix

We see:

- **The parameter `nrow` defines the row number of a matrix.**

- **The parameter `ncol` defines the column number of a matrix.**

- **The parameter `data` assigns specified values to the matrix elements.**

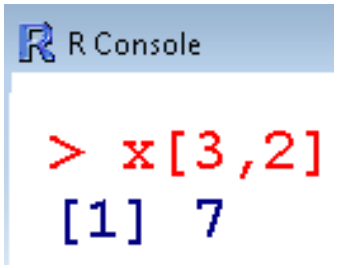
- **The values from the parameters are written column-wise in matrix.**

Matrix

```
> x
     [,1] [,2]
[1,]    1    5
[2,]    2    6
[3,]    3    7
[4,]    4    8
```

One can access a single element of a matrix with `x[i,j]`:

```
> x[3,2]
[1] 7
```



Matrix

In case, the data has to be entered row wise, then a 4 × 2-matrix *X* can be created with

```
> x = matrix( nrow=4, ncol=2, data=c(1,2,3,4,
5,6,7,8), byrow = TRUE)
> x
     [,1]  [,2]
[1,]    1    2
[2,]    3    4
[3,]    5    6
[4,]    7    8
```

Matrix

R Console

```
> x = matrix( nrow=4, ncol=2, data=c(1,2,3,4, 5,6,7,8), byrow = TRUE)
> x
     [,1] [,2]
[1,]    1    2
[2,]    3    4
[3,]    5    6
[4,]    7    8
```

Matrix

In case, the data has to be entered column wise, then a 4 × 2-matrix

***X* can be created with**

```
> x = matrix( nrow=4, ncol=2, data=c(1,2,3,4,
5,6,7,8), byrow = FALSE)
> x
     [,1]  [,2]
[1,]    1    5
[2,]    2    6
[3,]    3    7
[4,]    4    8
```

Matrix

R Console

```
> x = matrix( nrow=4, ncol=2, data=c(1,2,3,4, 5,6,7,8), byrow = FALSE)
> x
     [,1] [,2]
[1,]    1    5
[2,]    2    6
[3,]    3    7
[4,]    4    8
```

Matrix

Transpose of a matrix *X*: *X'*

Consider the matrix $x = \begin{pmatrix} 1 & 5 \\ 2 & 6 \\ 3 & 7 \\ 4 & 8 \end{pmatrix}$

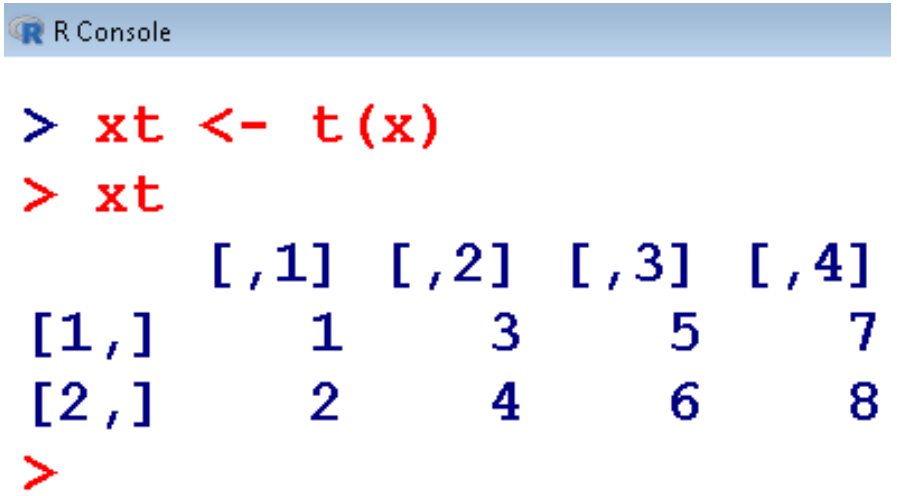
```
> x = matrix( nrow=4, ncol=2, data=c(1,2,3,4,
5,6,7,8), byrow = FALSE)

> x
     [,1]  [,2]
[1,]    1     5
[2,]    2     6
[3,]    3     7
[4,]    4     8
```

Matrix

Transpose of a matrix *X*: *X'*

```
> xt <- t(x)
> xt
     [,1] [,2] [,3] [,4]
[1,]    1    3    5    7
[2,]    2    4    6    8
```

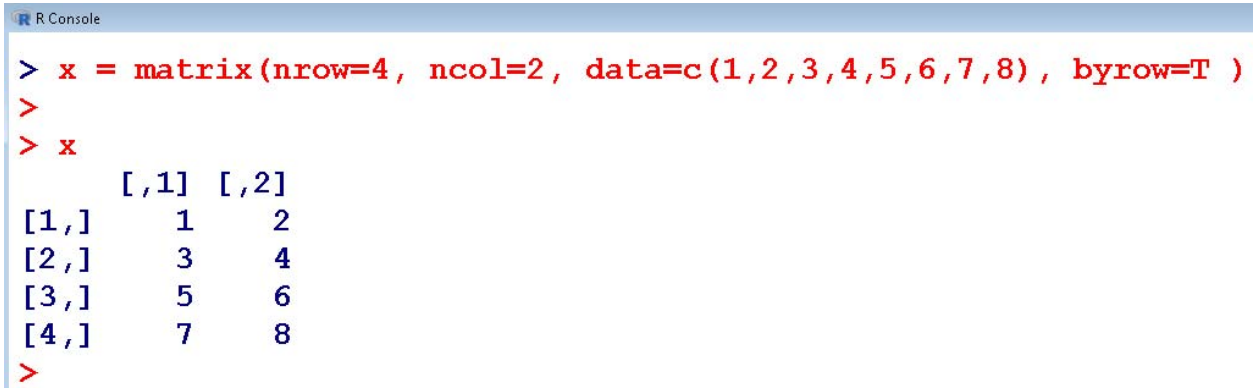


Matrix

Multiplication of a matrix with a constant

```
> x = matrix(nrow=4, ncol=2, data=c(1,2,3,4,
5,6,7,8), byrow=T )

> x
     [,1] [,2]
[1,]    1    2
[2,]    3    4
[3,]    5    6
[4,]    7    8
```



Matrix

Multiplication of a matrix with a constant

```
> x = matrix(nrow=4, ncol=2, data=c(1,2,3,4,
5,6,7,8), byrow=T )
> x
     [,1]  [,2]
[1,]    1     2
[2,]    3     4
[3,]    5     6
[4,]    7     8

> 5*x
 [,1] [,2]
[1,]    5   10
[2,]   15   20
[3,]   25   30
[4,]   35   40
```

Matrix

Multiplication of a matrix with a constant

R Console

```
> x = matrix(nrow=4, ncol=2, data=c(1,2,3,4,5,6,7,8), byrow=T )
>
> x
     [,1] [,2]
[1,]    1    2
[2,]    3    4
[3,]    5    6
[4,]    7    8
>
> 5*x
     [,1] [,2]
[1,]    5   10
[2,]   15   20
[3,]   25   30
[4,]   35   40
>
```

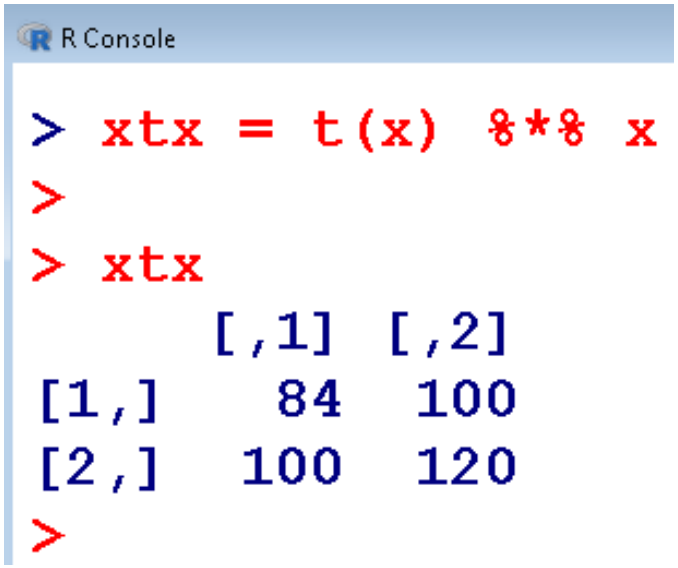
Matrix

Matrix multiplication: operator %*%

Consider the multiplication of *X*' with *X*

```
> xtx = t(x) %*% x

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



Matrix

Matrix multiplication: operator %*%

```
> y = matrix(nrow=2, ncol=2, data=c(1,2,3,4), byrow=T )

> z = matrix(nrow=2, ncol=2, data=c(11,12,13, 14), byrow=T )
```

```
> y
     [,1] [,2]
[1,]    1    2
[2,]    3    4
```

```
> z
     [,1] [,2]
[1,]   11   12
[2,]   13   14
```

Matrix

Matrix multiplication: operator %*%

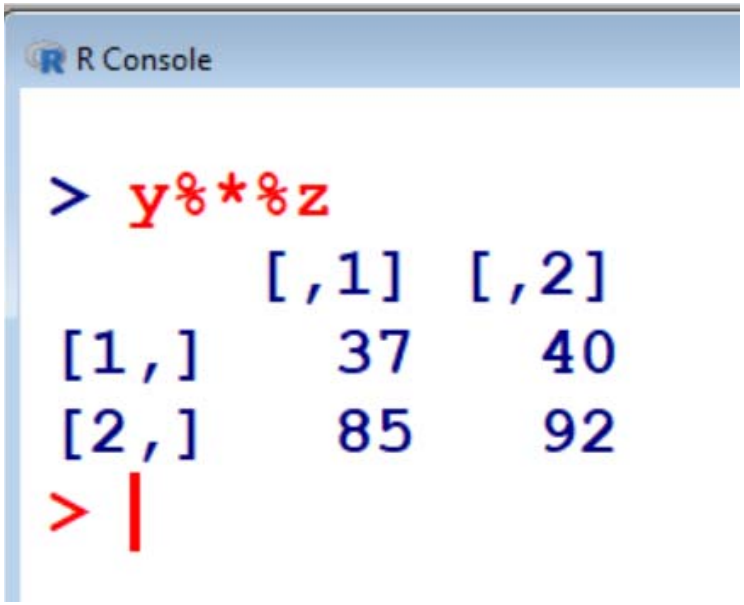
R Console

```
> y = matrix(nrow=2, ncol=2, data=c(1,2, 3,4), byrow=T )
> y
     [,1] [,2]
[1,]    1    2
[2,]    3    4
> z = matrix(nrow=2, ncol=2, data=c(11, 12,13,14), byrow=T )
> z
     [,1] [,2]
[1,]   11   12
[2,]   13   14
> 
```

Matrix

Matrix multiplication: operator %*%

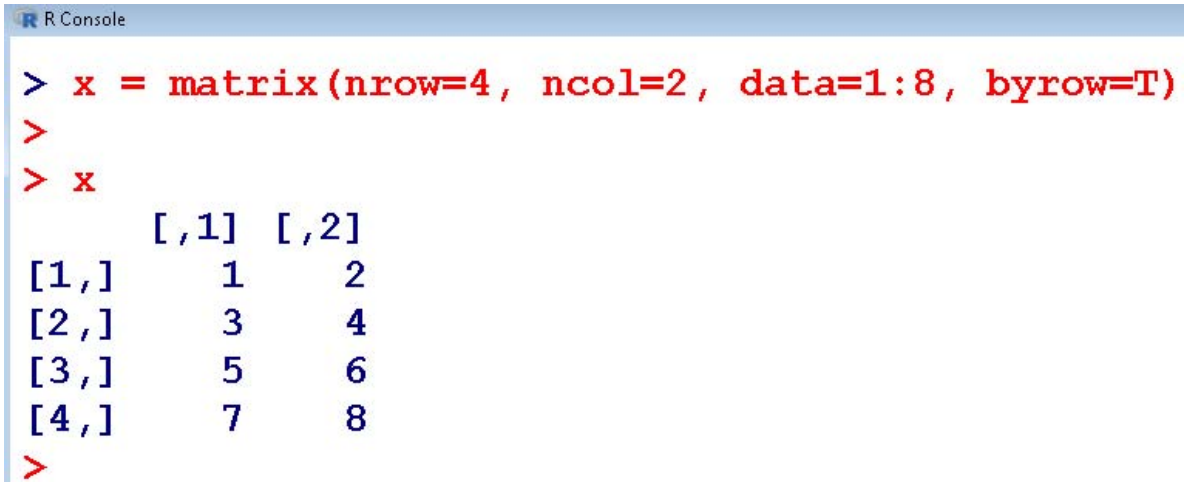
```
> y%*%z
     [,1] [,2]
[1,]   37   40
[2,]   85   92
```



Matrix

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
```

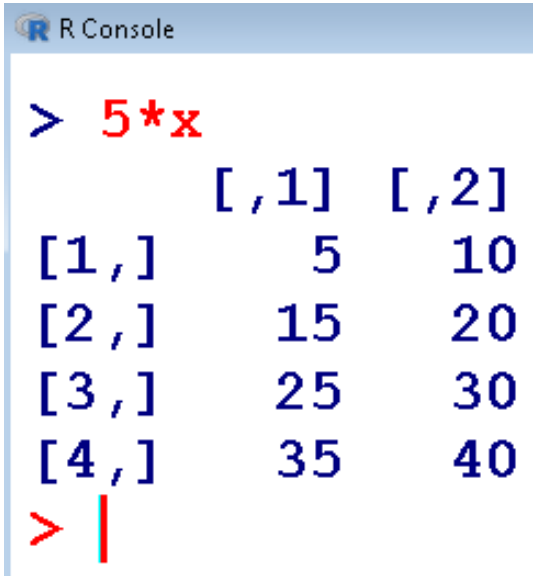


Matrix

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

Create another matrix.

```
> 5*x
     [,1] [,2]
[1,]    5   10
[2,]   15   20
[3,]   25   30
[4,]   35   40
```

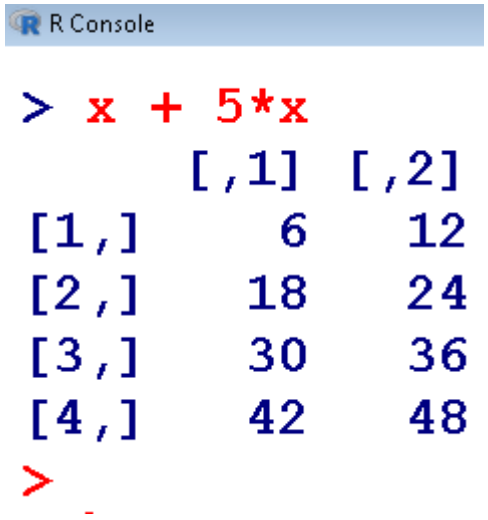


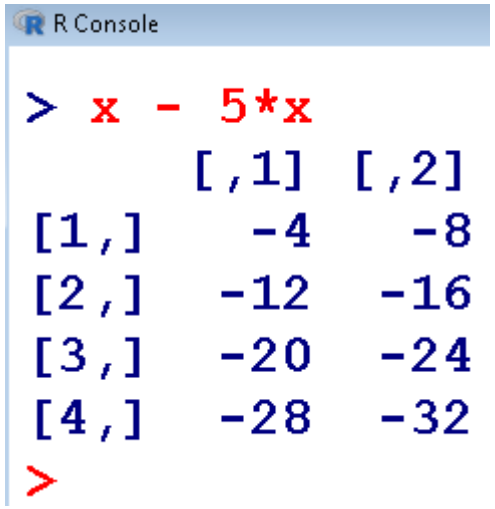
Matrix

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

```
> x + 5*x
 [,1] [,2]
[1,]    6   12
[2,]   18   24
[3,]   30   36
[4,]   42   48
```

```
> x - 5*x
     [,1] [,2]
[1,]   -4   -8
[2,]  -12  -16
[3,]  -20  -24
[4,]  -28  -32
```





Matrix

Matrix Addition:

```
> y = matrix(nrow=2, ncol=2, data=c(1,2,3,4), byrow=T )

> z = matrix(nrow=2, ncol=2, data=c(11,12,13, 14), byrow=T )
```

```
> y
     [,1] [,2]
[1,]    1    2
[2,]    3    4
```

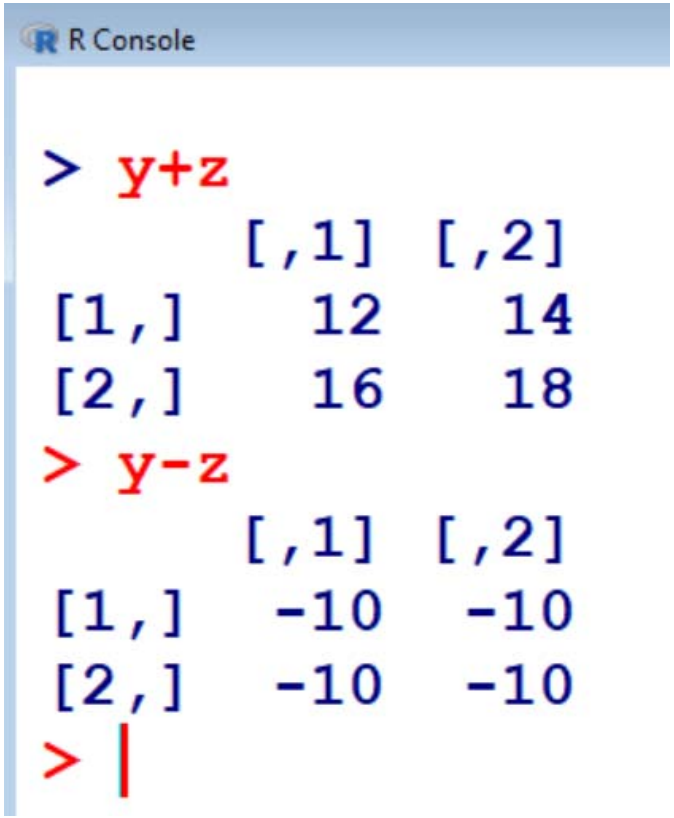
```
> z
     [,1] [,2]
[1,]   11   12
[2,]   13   14
```

Matrix

Matrix Addition and Subtraction:

```
> y+z
     [,1] [,2]
[1,]   12   14
[2,]   16   18
```

```
> y-z
     [,1] [,2]
[1,]  -10  -10
[2,]  -10  -10
```



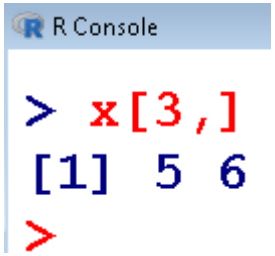
Matrix

Access to rows, columns or submatrices:

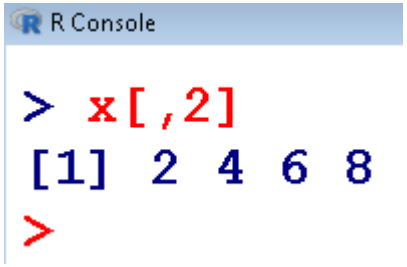
R Console

```
> 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
>
```

```
> x[3,]
  [1] 5 6
```




```
> x[,2]
  [1] 2 4 6 8
```



Matrix

Access to rows, columns or submatrices:

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
>
```

```
> x[1:3, 1:2]
     [,1] [,2]
[1,]    1    2
[2,]    3    4
[3,]    5    6
```

R Console

```
> x[1:3, 1:2]
     [,1] [,2]
[1,]    1    2
[2,]    3    4
[3,]    5    6
>
```