

Working with Vectors and Matrices

Programming in R for Data Science

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Constructing vectors

- Integers from 9 to 17

```
> x<-9:17
```

```
> x
```

```
[1]  9 10 11 12 13 14 15 16 17
```

- A sequence of 11 numbers from 0 to 1

```
> y<-seq(0,1,length=11)
```

```
> y
```

```
[1] 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
```

- The same number or the same vector several times

```
> z<-rep(1:2, 5)
```

```
> z
```

```
[1] 1 2 1 2 1 2 1 2 1 2
```

- Combine numbers, vectors or both into a new vector

```
> xz10<-c(x,z,10)
```

```
> xz10
```

```
[1]  9 10 11 12 13 14 15 16 17  1  2  1  2  1  2  1  2  1  2 10
```

Constructing matrices

- Combine rows into a matrix

```
> A<-rbind(1:3, c(1,1,2))  
> A
```

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

- Or columns

```
> B<-cbind(1:3, c(1,1,2))  
> B
```

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

- Define a matrix from one long vector

```
> C<-matrix(c(1,0,0,1,1,0,1,1,1), nrow=3, ncol=3)  
> C
```

	[,1]	[,2]	[,3]
[1,]	1	1	1
[2,]	0	1	1
[3,]	0	0	1

Can also be done by rows by adding “, byrow=TRUE” before the last parenthesis

Index and logical index

- ▶ Important for optimal use of **R**
- ▶ Example: Define a vector with integers from (-5) to 5 and extract the numbers with absolute value less than 3.

```
> x<- (-5):5  
> x
```

```
[1] -5 -4 -3 -2 -1  0  1  2  3  4  5
```

- ▶ by their index in the vector

```
> x[4:8]
```

```
[1] -2 -1  0  1  2
```

- ▶ by negative selection (set a minus in front of the indices we don't want)

```
> x[-c(1:3,9:11)]
```

```
[1] -2 -1  0  1  2
```

- ▶ A logical vector can be defined by

```
> index<-abs(x)<3  
> index
```

```
[1] FALSE FALSE FALSE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE FALSE FALSE
```

- ▶ Now this vector can be used to extract the wanted numbers

```
> x[index]
```

```
[1] -2 -1  0  1  2
```

Index and logical index

- ▶ This also works for matrices:

```
> A<-matrix((-4):5, nrow=2, ncol=5)
```

```
> A
```

	[,1]	[,2]	[,3]	[,4]	[,5]
[1,]	-4	-2	0	2	4
[2,]	-3	-1	1	3	5

```
> A[A<0]
```

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

- ▶ And for assignments

```
> A[A<0]<-0
```

```
> A
```

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

- ▶ Matrix rows can be selected by

```
> A[2,]
```

```
[1] 0 0 1 3 5
```

- ▶ and similarly for columns

```
> A[,c(2,4)]
```

	[,1]	[,2]
[1,]	0	2
[2,]	0	3

Properties of vectors and matrices

The mode of the vector or matrix detects the type of singles that is stored:

```
> A<-matrix(rep(c(TRUE,FALSE),2),nrow=2)
> B<-rnorm(4)
> C<-matrix(LETTERS[1:9],nrow=3)
> A;B;C

      [,1] [,2]
[1,]  TRUE  TRUE
[2,] FALSE FALSE

[1]  0.6613129  0.8583421  1.2516685 -1.2147030

      [,1] [,2] [,3]
[1,] "A"  "D"  "G"
[2,] "B"  "E"  "H"
[3,] "C"  "F"  "I"

> mode(A);mode(B);mode(C)

[1] "logical"
[1] "numeric"
[1] "character"
```

Properties of vectors and matrices

Vectors and matrices have *lengths*: The length is the number of elements:

```
> x<-matrix(c(NA,2:12),ncol=3)
> x
```

	[,1]	[,2]	[,3]
[1,]	NA	5	9
[2,]	2	6	10
[3,]	3	7	11
[4,]	4	8	12

```
> length(x[1,])
[1] 3
> length(x)
[1] 12
```

The dimension of a matrix is the number of rows and columns: The number of columns is the second element.

```
> dim(x); dim(x)[2]
[1] 4 3
[1] 3
```

Naming rows and columns in a matrix

We can add names to a matrix with the `dimnames()` function:

```
> x<-matrix(rnorm(12),nrow=4)
> x
```

	[,1]	[,2]	[,3]
[1,]	1.5231529	-0.5784787	-0.7314045
[2,]	-1.2359829	0.2717685	-0.8343691
[3,]	1.6658531	-0.3012827	0.6278903
[4,]	-0.5035843	-0.4158793	0.7975808

```
> dimnames(x)[[2]]<-paste("data",1:3,sep="")
> dimnames(x)[[1]]<-paste("obs",1:4,sep="")
> x
```

	data1	data2	data3
obs1	1.5231529	-0.5784787	-0.7314045
obs2	-1.2359829	0.2717685	-0.8343691
obs3	1.6658531	-0.3012827	0.6278903
obs4	-0.5035843	-0.4158793	0.7975808

Retrieval:

```
> rownames(x)
[1] "obs1" "obs2" "obs3" "obs4"
> colnames(x)
[1] "data1" "data2" "data3"
```