Functions and data structures

Programming in R for Data Science

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Objects of the game

In R we have objects which are **functions** and objects which are **data**.

Function examples:

- sin()
- integrate()
- plot()
- "+"()
- paste()

Data examples:

- 42
- 1:5
- "R"
- matrix(1:12, nrow=4, ncol=3)
- data.frame(a=1:5, tmt=c("a","b","a","b","a"))
- list(x=2, y="abc", x=1:10)

Singles

- Logical, e.g:

```
> TRUE
[1] TRUE
> 1==2
[1] FALSE
```

- Single numbers, e.g:

```
> 1
[1] 1
> 1.2
[1] 1.2
> sqrt(as.complex(-1))
[1] 0+1i
```

- Character, e.g:

```
> "5"
[1] "5"
> "abc"
[1] "abc"
```

Vectors

- Vector of numbers, e.g:

```
> c(1,1.2,pi,exp(1))
[1] 1.000000 1.200000 3.141593 2.718282
```

- We can have vectors of other things too, e.g:

```
> c(TRUE,1==2)
[1]  TRUE FALSE
> c("a","ab","abc")
[1] "a"   "ab"  "abc"
```

- But not combinations, e.g:

```
> c("a",5,1==2)
[1] "a"     "5"     "FALSE"
```

Notice that **R** just turned everything into characters!

Factor

- A special kind of vector is a called a factor
- It has a known finite set of levels (options), e.g:

```
> gl(2,10, labels=c("male", "female"))

 [1] male   male   male   male   male   male   male
 [8] male   male   male   female female female female
[15] female female female female female female
Levels: male female
```

- One could also do

```
> as.factor(c(rep("male",10),rep("female",10)))

 [1] male   male   male   male   male   male   male
 [8] male   male   male   female female female female
[15] female female female female female female
Levels: female male
```

Matrix, and arrays

- Similar to vectors we can have matrices of objects of the same type, e.g:

```
> matrix(c(1,2,3,4,5,6)+pi,nrow=2)
         [,1]     [,2]     [,3]
[1,] 4.141593 6.141593 8.141593
[2,] 5.141593 7.141593 9.141593
> matrix(c(1,2,3,4,5,6)+pi,nrow=2)<6
     [,1]  [,2]  [,3]
[1,] TRUE FALSE FALSE
[2,] TRUE FALSE FALSE
```

Matrix, and arrays

- We can create higher order arrays, e.g:

```
> array(c(1:24), dim=c(4,3,2))
, , 1

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

, , 2

     [,1] [,2] [,3]
[1,]   13   17   21
[2,]   14   18   22
[3,]   15   19   23
[4,]   16   20   24
```

Data frame

- A special data object is called a data frame (data.frame):
- We can create data frames by reading data in from files;
- or by using the function as.data.frame() on a set of vectors.
- A data frame is a set of parallel vectors, where the vectors can be of different types, e.g:

```
> data.frame(treatment=c("active","active","placebo"),
+            bp=c(80,85,90))
```

```
  treatment bp
1    active 80
2    active 85
3   placebo 90
```

- Compare to a matrix

```
> cbind(treatment=c("active","active","placebo"),
+       bp=c(80,85,90))
```

```
     treatment bp
[1,] "active"  "80"
[2,] "active"  "85"
[3,] "placebo" "90"
```

Lists

- Most general object type
- Elements can be of different types and lengths, e.g:

```
> list(a=1,b="abc",c=c(1,2,3),d=list(e=matrix(1:4,2), f=function(x)x^2))

$a
[1] 1

$b
[1] "abc"

$c
[1] 1 2 3

$d
$d$e
     [,1] [,2]
[1,]    1    3
[2,]    2    4

$d$f
function (x)
x^2
```

- The objects returned from many of the built-in functions in **R** are fairly complicated lists.

Functions

Let us consider the examples of functions that we listed at the start of the session:

Function examples:

- sin()
- integrate()
- plot()
- "+"()
- paste()

Typical input and output

- sine(): Input number, output number.
- integrate(): Input function and range, output list.
- plot(): Input vector, output NULL.
- "+"(): Input two numbers, output one number.
- paste(): Input character objects, output one character object.

Defining a simple function

The functions on the previous slide are **built-in functions**.

- it is simple to write your own functions
- A square function

```
> square<-function(x){
+   return(x*x)
+ }
> square(1:5)
```

```
[1]  1  4  9 16 25
```

- A power function with two arguments

```
> power<-function(x,pow){
+   return(x^pow)
+ }
> power(1:5,3)
```

```
[1]   1   8  27  64 125
```

Default arguments

- A function can have default arguments

```
> power<-function(x,pow=2){
+   return(x^pow)
+ }
> power(1:5)
[1]  1  4  9 16 25
> power(1:5,4)
[1]   1  16  81 256 625
```

Masking functions

Be careful when you write functions.

- Masking the c() function:
- ```
  > c<-function(x,y) x*y
  > c(2,3)

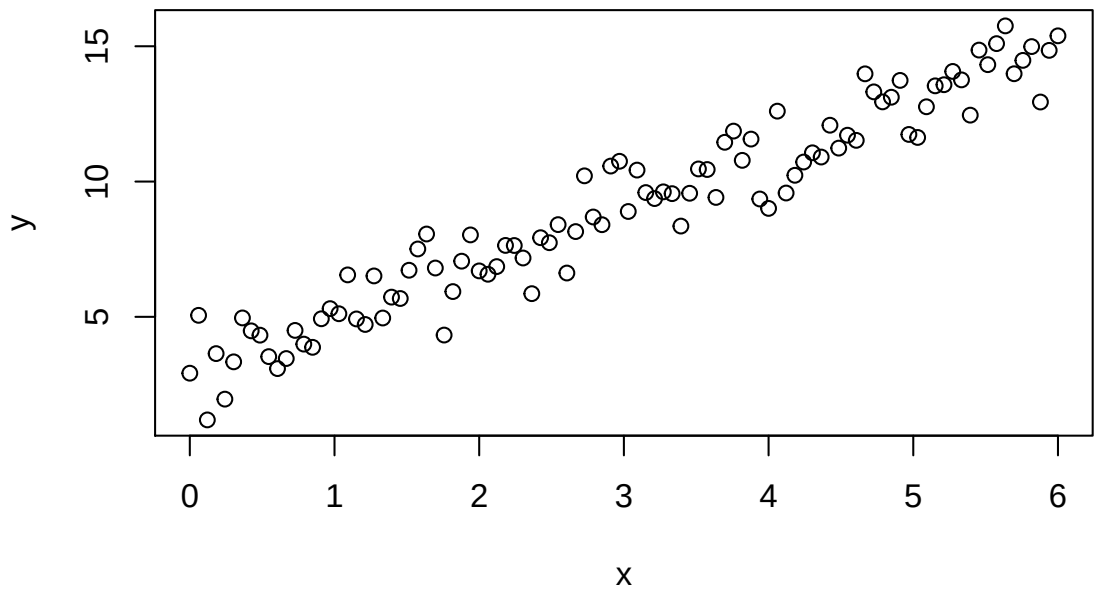
  [1] 6

  > rm(c)
  > c(2,3)

  [1] 2 3
  ```
- If you use a reserved function identifier, you mask the function.
  ```

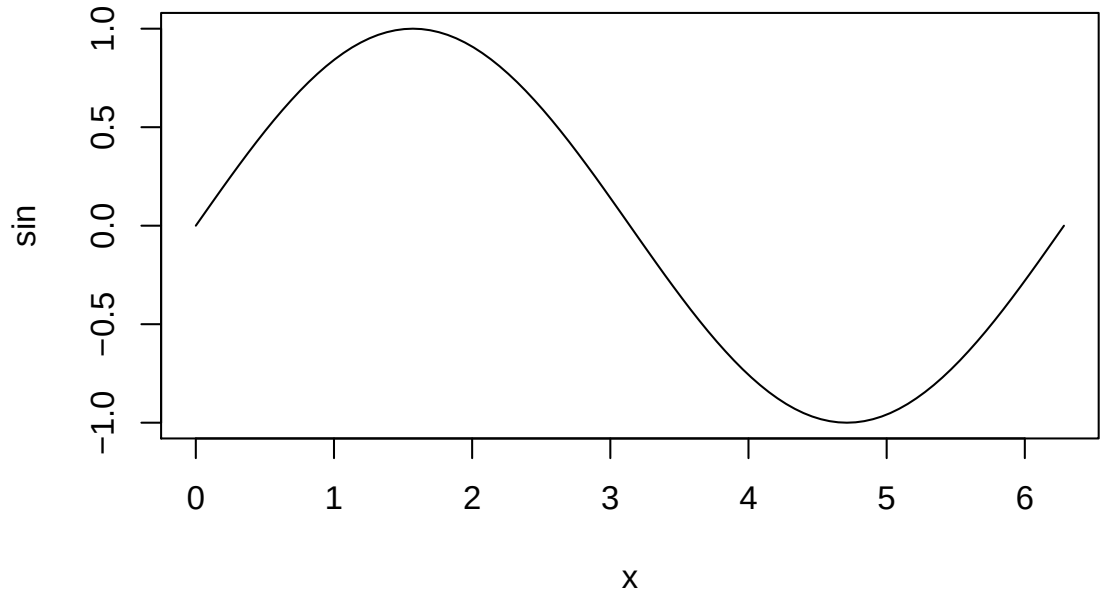
Simple plotting

```
> x<-seq(0,6, length=100)
> y<-2*x+3+rnorm(100)
> plot(x,y)
```



Simple plotting

```
> plot(sin,0,2*pi)
```



Editor and the function `source()`

- If you write programs spanning more than a few lines it is convenient to write them in an editor.
- A frequently used approach is to write your code in the editor and then paste blocks into R to run it.
- Once the script is complete, the file is saved, and we can run it all by typing:

  ```
  > source("C:/programdir/script.R")
  ```

- Lines starting with "#" are ignored by R and can be used to insert comments in the script.