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Essential Engineering Skills in Big Data Analytics

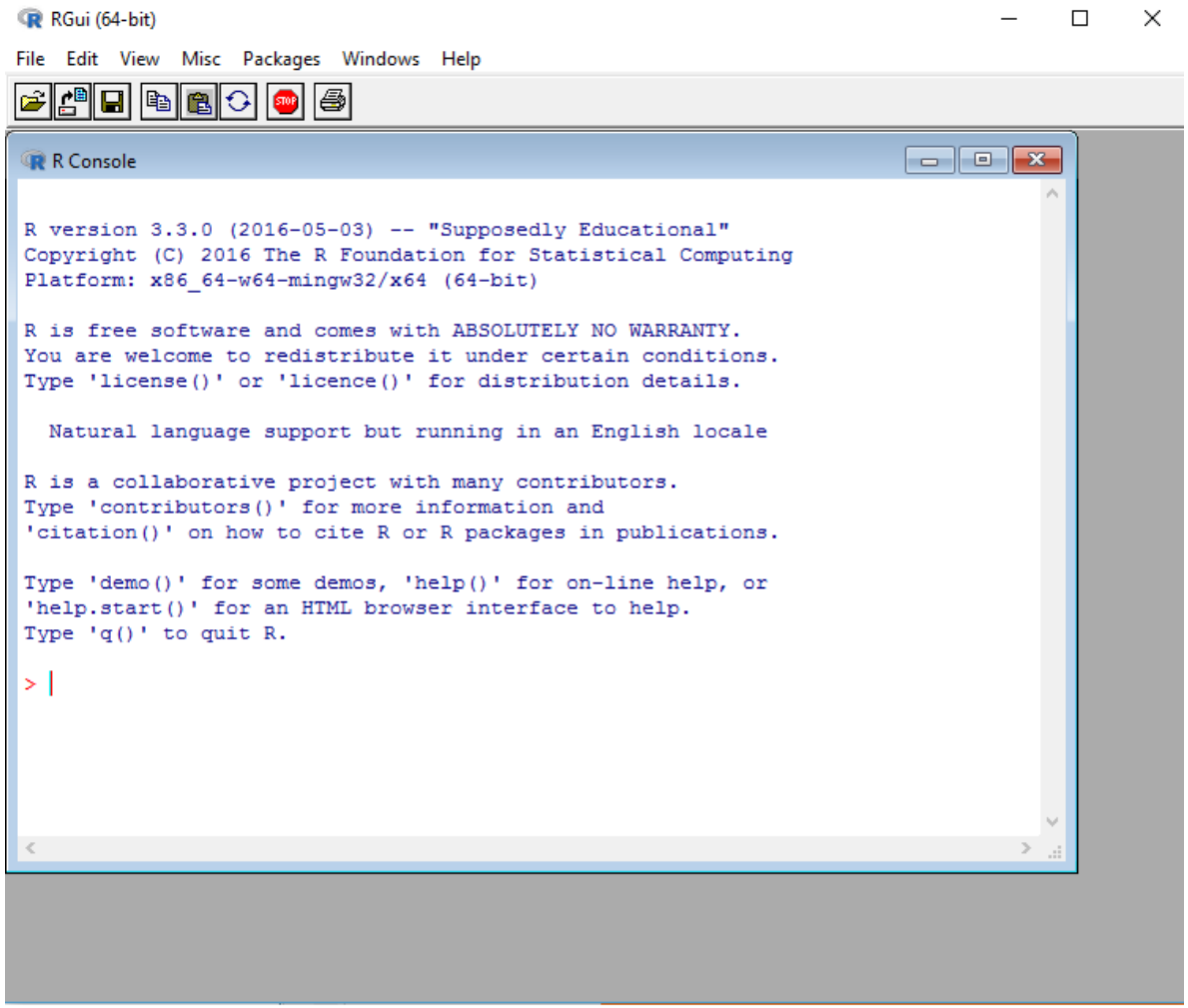
Introduction to R

25 March, 2017

Some of the slides are taken from
“Computing for Data Analysis” course

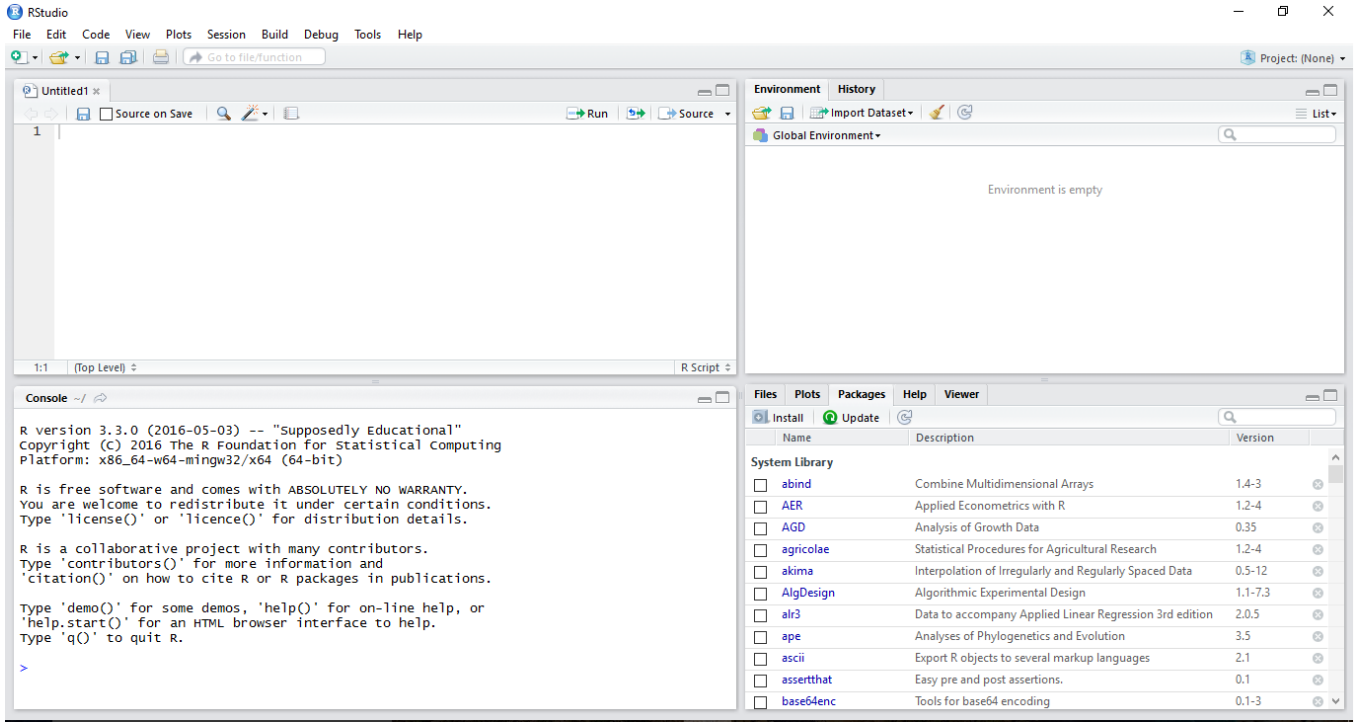
R

- Free software environment for statistical computing, data analytics and scientific research.
- Runs on a wide variety of UNIX platforms, Windows and MacOS.



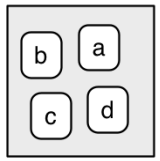
RStudio

- Integrated development environment (IDE) for R.
- Available in open source and commercial editions
- Runs on
  - The desktop (Windows, Mac, and Linux) or
  - In a browser connected to RStudio Server or RStudio Server Pro

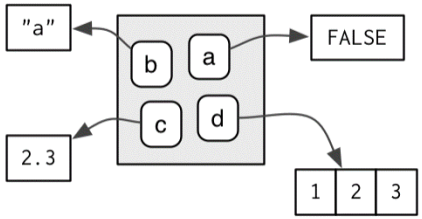


Environment

- Environment can be thought of as a bag of names

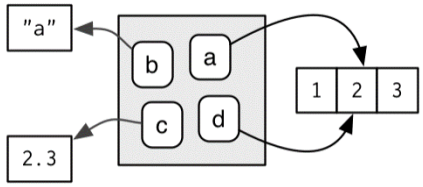


- Each name points to an object stored elsewhere in memory:



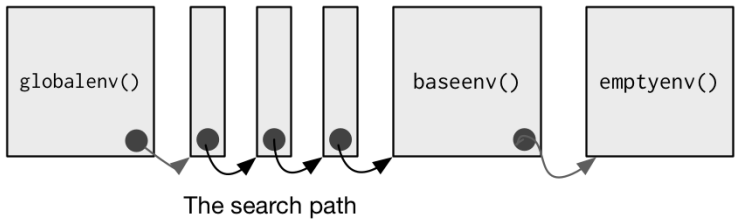

```
e <- new.env()
e$a <- FALSE
e$b <- "a"
e$c <- 2.3
e$d <- 1:3
```

- The objects don't live in the environment so multiple names can point to the same object:



Four special environments

- Global Environment
  - This is the environment in which you normally work.
  - The parent of the global environment is the last package that you attached with library() or require().
- Base environment
  - Is the environment of the base package. Its parent is the empty environment.
- Empty environment
  - Is the ultimate ancestor of all environments, and the only environment without a parent.



http://adv-r.had.co.nz/Environments.html

R Atomic Objects

- Character
- Numeric (real numbers)
- Integer
- Complex
- Logical (True/False)

http://www.r-tutor.com/r-introduction/basic-data-types

Vector

- The most basic object is a vector
  - A vector can only contain objects of the same class
  - BUT: one exception is a list, which is represented as a vector but can contain objects of different classes
- Empty vectors can be created with
  - The **vector()** function.

Evaluation and Printing

```
> x <- 5          ## nothing printed
```

- The **<-** symbol is the **assignment** operator.

```
> x              ## auto-printing occurs
[1] 5
```

```
> print(x)       ## explicit printing
[1] 5
```

- The [1] indicates that x is a vector and 5 is the first element.

Evaluation and Printing contd.

```
> x <- 1:20
```

- The : operator is used to create integer sequences.

```
> x
[1] 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
[16] 16 17 18 19 20
```

Creating Vectors

The c() function can be used to create vectors of objects.

```
> x <- c(0.5, 0.6) ## numeric
> x <- c(TRUE, FALSE) ## logical
> x <- c(T, F) ## logical
> x <- c("a", "b", "c") ## character
> x <- 9:29 ## integer
> x <- c(1+0i, 2+4i) ## complex
```

Concatenate

Using the vector() function

```
> x <- vector("numeric", length = 10)
> x
[1] 0 0 0 0 0 0 0 0 0 0
```

Matrices

- Matrices are vectors with a dimension attribute.
- Dimension attribute is itself an integer vector of length 2 (nrow, ncol)

```
> m <- matrix(nrow = 2, ncol = 3)
> m
     [,1] [,2] [,3]
[1,]   NA   NA   NA
[2,]   NA   NA   NA
> dim(m)
[1] 2 3
> attributes(m)
$dim
```

Matrices cont..

Matrices are constructed column-wise.

```
> m <- matrix(1:6, nrow = 2, ncol = 3)
> m
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
```

cbind-ing and rbind-ing

Matrices can be created by column-binding or row-binding with cbind() and rbind().

```
> x <- 1:3
> y <- 10:12
> cbind(x, y)
     x  y
[1,] 1 10
[2,] 2 11
[3,] 3 12
> rbind(x, y)
  [,1] [,2] [,3]
x    1    2    3
y   10   11   12
```

Data Frames

- Data frames are used to store tabular data
  - Unlike matrices, data frames can store different classes of objects in each column; matrices must have every element be the same class
  - Can be converted to a matrix by calling data.matrix()

Data Frames cont…

```
> x <- data.frame(Cid = 1:4, Purchase = c(T, T, F, F))
> x
  Cid Purchase
1   1     TRUE
2   2     TRUE
3   3    FALSE
4   4    FALSE
> nrow(x)
[1] 4
> ncol(x)
[1] 2
```

Subsetting

```
> x <- c("a", "b", "c", "c", "d", "a")
> x[1]
[1] "a"
> x[2]
[1] "b"
> x[1:4]
[1] "a" "b" "c" "c"
> x[x > "a"]
[1] "b" "c" "c" "d"
> u <- x > "a"
> u
[1] FALSE TRUE TRUE TRUE TRUE FALSE
> x[u]
[1] "b" "c" "c" "d"
```


Numeric index

Range index

Subsetting a Matrix

Matrices can be subsetted in the usual way with (i , j) type indices.

```
> x <- matrix(1:6, 2, 3)
> x[1, 2]
[1] 3
> x[2, 1]
[1] 2
```

Indices can also be missing.

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

Subsetting a Matrix cont…

By default, when a single element of a matrix is retrieved, it is returned as a vector of length 1 rather than a 1x1 matrix. This behaviour can be turned off by setting drop = FALSE.

```
> x <- matrix(1:6, 2, 3)
> x[1, 2]
[1] 3

> x[1, 2, drop = FALSE]
     [,1]
[1,]    3
```

Subsetting a Matrix cont…

Similarly, subsetting a single column or a single row will give you a vector, not a matrix (by default).

```
> x <- matrix(1:6, 2, 3)
> x[1, ]
[1] 1 3 5

> x[1, , drop = FALSE]
     [,1] [,2] [,3]
[1,]    1    3    5
```

Subsetting Lists cont...

Extracting multiple elements of a list.

```
> x <- list(foo = 1:4, bar = 0.6, baz = "hello")
> x[c(1, 3)]
$foo
[1] 1 2 3 4
$baz
[1] "hello"
```

Vectorized Operations

Many operations in R are vectorised making code more efficient, concise, and easier to read.

```
> x <- 1:4; y <- 6:9
> x + y
[1] 7 9 11 13
> x > 2
[1] FALSE FALSE TRUE TRUE
> x * y
[1] 6 14 24 36
```

Reading Data

- There are a few principal functions reading data into R.
  - read.table, read.csv, for reading tabular data
  - readLines, for reading lines of a text file
  - source, for reading in R code files (inverse of dump)
  - load, for reading in saved workspaces

RStudio

Writing Data

- There are analogous functions for writing data to files
  - write.table
  - writeLines
  - save

Control Structures

- **if**, **else**: testing a condition
- **for**: execute a loop a fixed number of times
- **while**: execute a loop while a condition is true
- **repeat**: execute an infinite loop
- **break**: break the execution of a loop
- **next**: skip an iteration of a loop
- **return**: exit a function

Control Structures: if

```
if(<condition>) {
## do something
} else {
## do something else
}
```

Of course, the else clause is not necessary.

```
if(<condition1>) {  }

if(<condition2>) {  }
```

```
if(<condition1>) {
## do something
} else if(<condition2>) {
## do something different
} else {
## do something different
}
```

for

These three loops have the same behaviour.

```
x <- c("a", "b", "c", "d")

for(i in 1:4) {
        print(x[i])
}

for(i in seq_along(x)) {
        print(x[i])
}

for(letter in x) {
        print(letter)
}
```

while

```
count <- 0

while(count < 10) {
        print(count)
        count <- count + 1
}
```

Functions

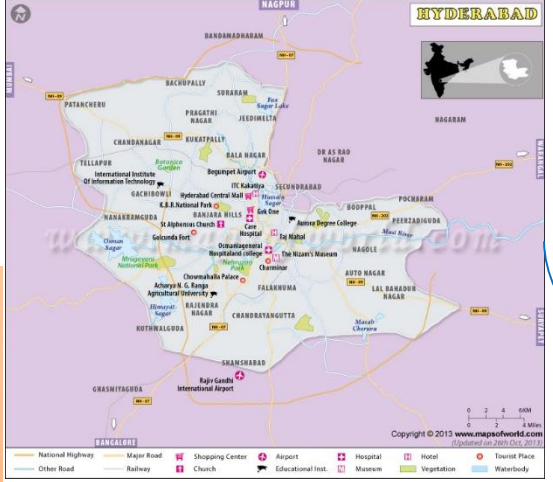
Functions are created using the **function() directive** and are stored as **R objects** of class "function".

```
f <- function(<arguments>) {
## Do something
}
```

Functions can be treated much like any other R object.

- Functions can be passed as arguments to other functions
- Functions can be nested
  - Define a function inside of another function

The return value of a function is the last expression in the function body to be evaluated.



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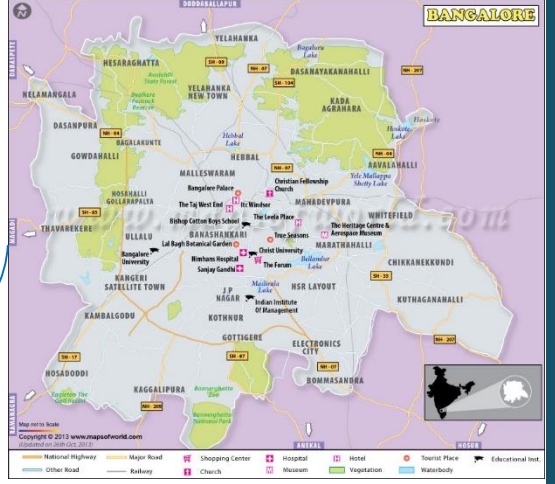

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