Part 1: R Foundations

(c) Functions

Functions

- A function is a group of instructions that:
  - takes input,
  - uses the input to compute other value, and
  - returns a result (Matloff 2009).
- Functions are a fundamental building block of R
- Users of R should adopt the habit of creating simple functions which will make their work more effective and also more trustworthy (Chambers 2008).
- Functions:
  - are declared using the function reserved word
  - are objects

General Form

- **function** (*arguments*) *expression*
- arguments gives the arguments, separated by commas.
- Expression (body of the function) is any legal R expression, usually enclosed in { }
- Last evaluation is returned
- return() can also be used, but usually for exceptions.

```
f <- function(x)x^2 # this function squares a vector
f(1:3)
```

```
## [1] 1 4 9
```

Challenge 1.3

Write an R function (evens) that filters a vector to return all the even numbers. Use the modulus operator %%, and also logical filtering of vectors.

```
x <- 1:6
x
```

```
## [1] 1 2 3 4 5 6
```

```
y <- evens(x)
y
```

```
## [1] 2 4 6
```

Function Arguments

- It is useful to distinguish between formal arguments and the actual arguments
  - Formal arguments are the property of the function
  - Actual arguments can vary each time the function is called.
- When calling functions, arguments can be specified by
  - Complete name
  - Partial name
  - Position
- Guidelines (Wickham 2015)
  - Use positional mapping for the first one or two arguments (most commonly used)
  - Avoid using positional mapping for less commonly used attributes
  - Named arguments should always come after unnamed arguments

Function Arguments - Example

```
f1 <- function(arg1, arg2, arg3) arg1 * arg2  + arg3
f1(2, 3, 4) # positional
```

```
## [1] 10
```

```
f1(2, arg3=4,3) # name for arg3
```

```
## [1] 10
```

```
f1(arg3=4, arg2=3, 2) # name for arg2, arg3
```

```
## [1] 10
```

Default Arguments

- Function arguments in R can have default values
- R function arguments are "lazy" – only evaluated if actually used

```
g <- function(a=1,b=2) c(a,b)

g()
```

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

```
g(10)
```

```
## [1] 10  2
```

```
g(10,20)
```

```
## [1] 10 20
```

Functions are objects

- Functions are first class objects, so they can be passed to other functions
- Provides flexibility, and widely used in R

```
f1 <- function(f,v)f(v) # f is a function object

f1(min,c(2,4,6,7))
```

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

```
f1(max,c(2,4,6,7))
```

```
## [1] 7
```

Challenge 1.4

Write a function that takes in a vector and returns a vector with no duplicates. Make use of the R function duplicated().

```
x <- c(1, 2, 3, 4, 5, 1)
duplicated(x)
```

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

Environments

- Environments can be thought of as consisting of two things: a frame, which is a set of symbol-value pairs, and an enclosure, a pointer to an enclosing environment
- Every object (variable or function) in an environment has a unique name
- The working environment is known as the Global Environment
- Environments form a tree structure. The tree of environments is rooted in an empty environment, available through emptyenv(), which has no parent

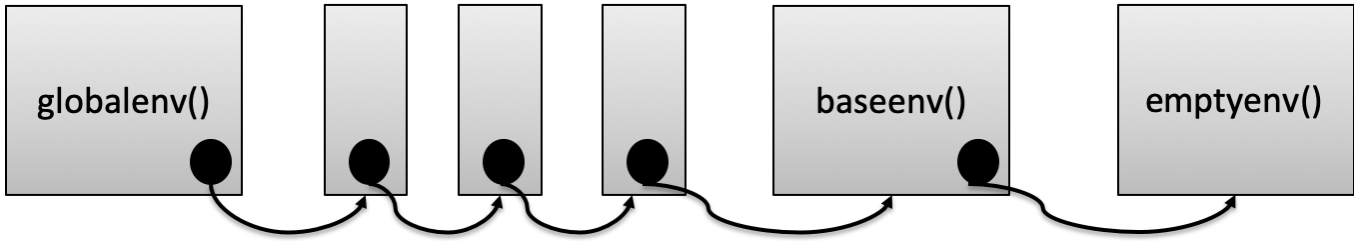


Figure 1: Environment Hierarchy in R

Using search() to explore the hierarchy

```
search()
```

```
##  [1] ".GlobalEnv"        "package:ggplot2"   "package:st
##  [4] "package:graphics"  "package:grDevices" "package:ut
##  [7] "package:datasets"  "package:methods"   "Autoloads"
## [10] "package:base"
```

Functions and Environments

- Functions are first class objects that exist in an environment
- Functions can access all variables contained in their enclosing environment
- If a name isn't defined inside a function, R will look one level up to the enclosing environment

```
x <- 2
g <- function(){
  y <- 1
  c(x,y)
}

g()
```

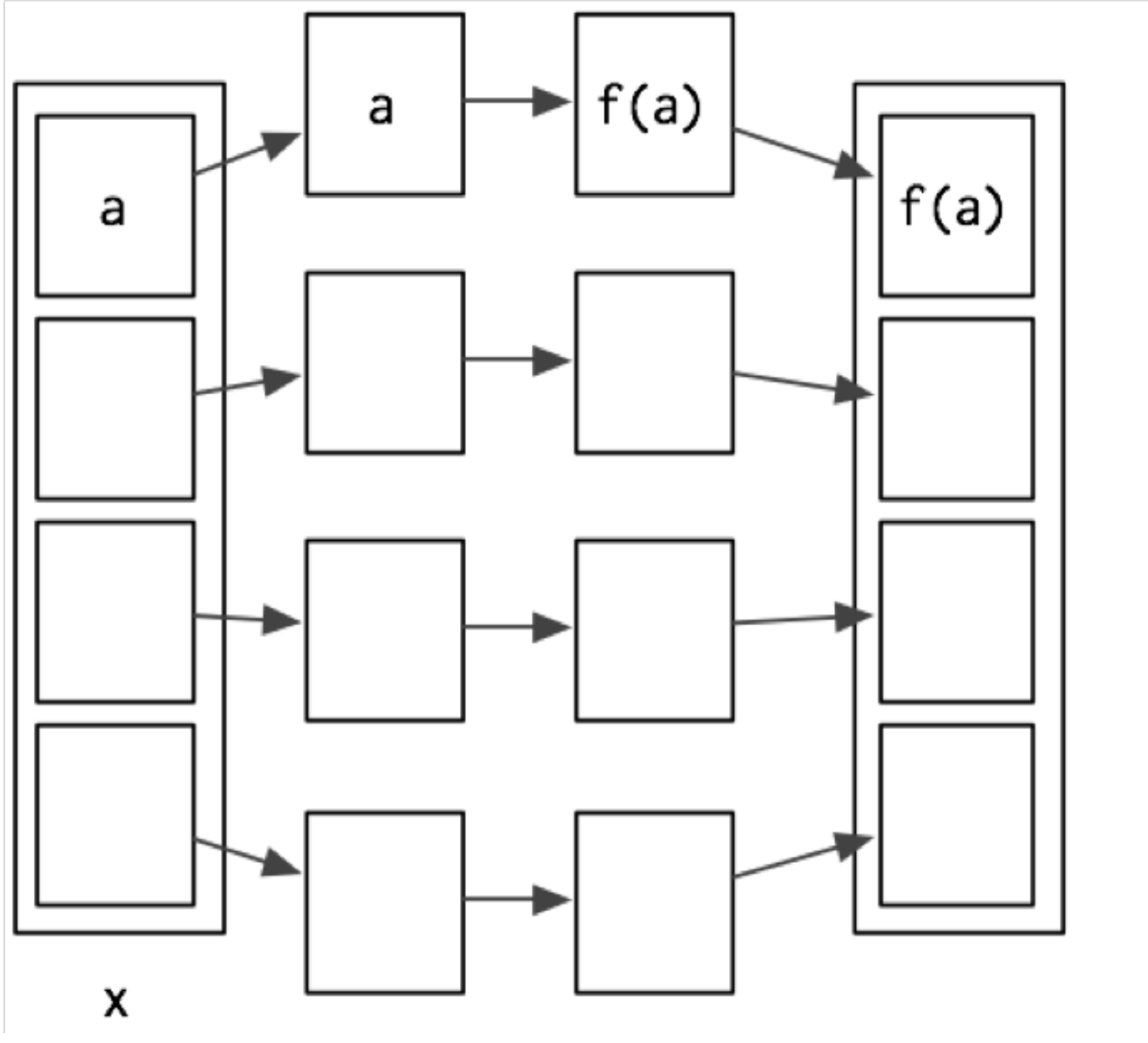
```
## [1] 2 1
```

Functionals

- A functional is a function that takes a function as an input and returns a vector as output
- Commonly used as an alternative for loops
- Common ones
  - sapply()
  - apply()
  - lapply()

Common Pattern (Wickham 2015)

- Create a container for output
- Apply f() to each component of the list
- Fill the container with the results



sapply()

- The general form of the **sapply(x,f,fargs)** function is as follows:
  - **x** is the target vector or list
  - **f** is the function to be called and applied to each element
  - **fargs** are the optional set of arguments that can be applied to the function f.
- sapply() returns a vector

```
x <- 1:3
y <- sapply(x,function(v)v*2)
y
```

```
## [1] 2 4 6
```

apply() - process matrices/data frames

The general form of this function is **apply(m, dimcode, f, fargs)**, where: - m is the target matrix - dimcode identifies whether it's a row or column target. The number 1 applies to rows, whereas 2 applies to columns - f is the function to be called, and fargs are the optional set of arguments that can be applied to the function f.

```
m <- matrix(1:10,nrow = 2)
m
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    3    5    7    9
## [2,]    2    4    6    8   10
```

```
apply(m,1,sum) # sum the row
```

```
## [1] 25 30
```

```
apply(m,2,sum) # sum the columns
```

```
## [1]  3  7 11 15 19
```

Test Slide with Plot