MT4113 Lecture 3

Good Programming Practice

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26 September 2018

Topics Covered*

- The advantages of using **functions**

**This lecture has been modified from material developed by Eric Rexstad*

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- The advantages of using **functions**
- Different types of **environments**
- Understanding the **scope** of variables
- Software **design** for statisticians
- Coding **conventions and style**

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Functions

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    - Avoid repeating the same code over and over

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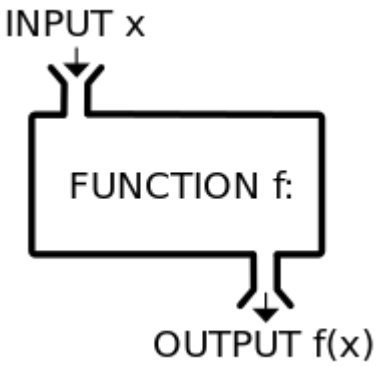

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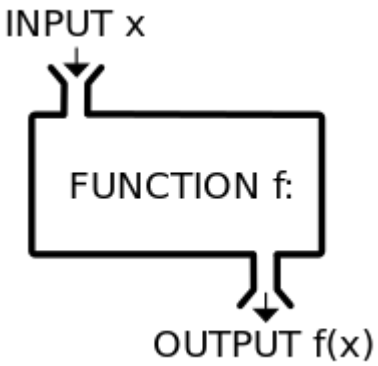

- Concept of **encapsulation**
  - send everything into function as arguments
  - return outputs explicitly with `return()` function
  - no global side effects 🚫🌍

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```
x ← 1:25

func ← function(){
  sum(x)/length(x)
  }

func()
```

```
# [1] 13
```

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```
# [1] 13
```

```
# my.mean calculates the mean
# of a numeric vector x

my.mean ← function(x){
  stopifnot(is.numeric(x))
  m ← sum(x)/length(x)
  return(m)
  }

x ← 1:25
my.mean(x)
```

```
# [1] 13
```

- **Q:** What are three things that make the example on the right better?

What happens in `f(x)` stays in `f(x)`

- Example from last class:

```
eda ← function (x) {
  par(mfrow = c(1 ,3))
  hist(x, probability = TRUE)
  lines(density(x))
  boxplot(x, horizontal = TRUE)
  rug(x)
  qqnorm(x)
  return(summary(x))
}
```

- Issues: no comments and global change in par()

What happens in `f(x)` stays in `f(x)`

```r
eda ← function (x) {
  # Function to generate descriptive plots of
  # a numeric vector x
  p ← par(no.readonly = TRUE) # save existing graphical params
  par(mfrow = c(1 ,3)) # setup 1×3 graphical device
  hist(x, probability = TRUE) # plot 1
  lines(density(x)) # add density
  boxplot(x, horizontal = TRUE) # plot 2
  rug(x) # add rug to boxplot
  qqnorm(x) # plot 3
  par(p) # reset graphical params
  return(summary(x)) # return summary stats
} # end eda
```

What happens in `f(x)` stays in `f(x)`

```
print.and.multiply ← function(x, y) {
   print(paste('At start of function x=', x, 'y=', y))
   x ← x*y
   print(paste('At end of function x=', x))
   return(x)
}

first ← 10
second ← 20
new.object ← print.and.multiply(first, second)
```

```
## [1] "At start of function x= 10 y= 20"
## [1] "At end of function x= 200"
```

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## [1] "At start of function x= 10 y= 20"
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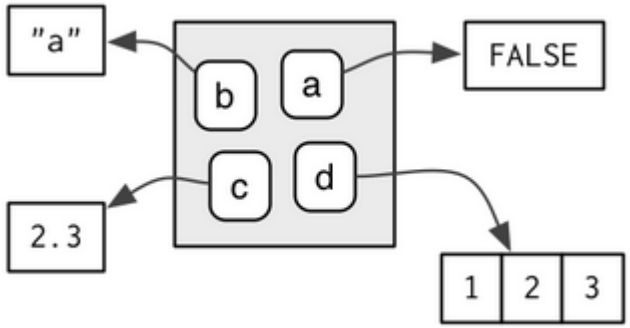
- **Q:** After running the above code, what is the value of `first`? Of `x`?

Environments

Environments are like address books

- An **environment** associates names with values



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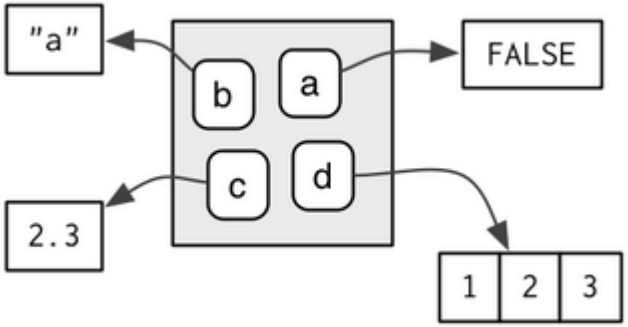

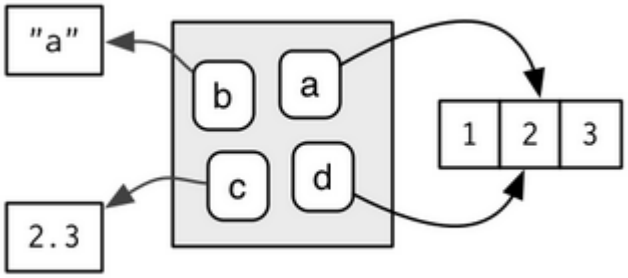

- Multiple names can point to the same values

What's in your environment?

```
ls()
```

```
## [1] "eda"              "first"           "func"
## [4] "my.mean"          "new.object"      "print.and.multiply"
## [7] "second"           "x"
```

Three types we care about

- Base environment
  - Contains packages like `base`, `utils`, `stats`, `graphics`

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- Base environment
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- Global environment
  - Additional variables you have created or packages you have loaded
  - Should "reset" every time you reopen R
- Current environment
  - Environment inside of a function

Scoping

Name Masking

- If a name isn't defined in the environment, `R` looks up one level

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```
pi
```

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## [1] 3.141593
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pi ← 1

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```
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```
pi
```

```
## [1] 3.141593
```

```
pi ← 1

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```

```
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```

😱😱😱

```
rm(pi)
```

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- You *can* have both `x ← 1:10` and `x ← function(x){x + 10}` ...
  - but please don't.
- Multiple functions can have the same name
  - R will default to the version in the most recently loaded package
  - order of search can be seen using `search()`

A fresh start

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- each use of a function is independent of any previous uses
- a function's environment is wiped clean for each new use

Dynamic lookup

- Lookup happens when code or function is executed

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- It does not matter what the value was when the code or function was created

```
x ← 15

f ← function(x){x+1}

f(x)
```

```
## [1] 16
```

```
x ← 20

f(x)
```

```
## [1] 21
```

Software Design

Strategies for designing code

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    - strategies include top-down (rigid) and bottom-up (iterative) approaches

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- Visual aids like flowcharts can be used for planning and documentation
- Outlines or pseudocode are helpful for breaking a big task into maneageable bits

Coding Conventions

Conventions and style

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- Increases readability
- As with the Oxford comma, people have strong opinions
- Consistency is most important

Conventions and style

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  - There should be spaces around operators and after commas
  - Lines should be <80 characters long
  - Use meaningful variable names in a consistent style

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Conventions and style

- Style guides are available at
  - https://google.github.io/styleguide/Rguide.xml
  - http://style.tidyverse.org/ (inc. packages to restyle code)