Advanced R Programming - Lecture 1

Leif Jonsson

Linköping University

leif.jonsson@ericsson.com
leif.r.jonsson@liu.se

August 30, 2016

Today

About the course

- Aim of the course

Presentation(s)

- Presentation(s)

Course Practicals

Why R?

Basic R

- Data structures
- Logic and sets
- Subsetting/filtering
- Functions

Learn to

- Write R programs and packages
- Write performant code
- Learn basic software engineering practices

But most important...

But most important...

Your primary tool in the next 2 years

Course Plan

Part 1: R Syntax

Period: Week 1-2
Students work: Individually
Lab: Documented R file
Computer lab

Topics

- Basic R Syntax
- Basic data structures
- Program control
- R packages

Part 2: Advanced topics

Period: Week 3-7
Students work: In groups
Turn in: R package on GitHub
Seminar

Topics

- Performant code: Writing quality code
- Linear algebra, Object orientation, Graphics
- Advanced I/O
- Performant code: Writing fast code
- Intro to basic Machine learning in R

Today

Presentation(s)

Me - AKA, Leif Jonsson

My background

1. Computer Science, Uppsala 1998
2. Ericsson
3. PhD Student Applied Machine Learning, LiU, PELAB - STIMA

Figure: Me

You

- Backgound?
- Why this course?
- Expectations?

Course Practicals...

Course Practicals...

- Course code: 732A94
- https://www.ida.liu.se/~732A94/index.en.shtml
- https://github.com/MansMeg/AdvRCourse
- https://www.rstudio.com/
- https://cran.r-project.org/
- https://git-scm.com/

Course litterature...

Course litterature...

- Matloff, N. The art of R programming [online]
- Wickham, H. Advanced R [online]
- Wickham, H. R packages [online]
- ...and articles.

Examination

Weekly mandatory labs/projects
– deadline: One week after corresponding lecture
Computer exam

Why R?

The One main reason

Choose the right tool for the job!

The One main reason

Choose the right tool for the job!

Your main job will be statistics and data analysis...
R is the right tool for that job!

Pros

- Popular (among statisticians)
- Good graphics support
- Open source - all major platforms!
- High-level language - focus on data analysis
- Strong community - vast amount of packages
- Powerful for communicating results
- API's to high-performance languages as C/C++ and Java

Cons

- "Ad hoc", complex, language (Compare Perl, Awk, Sh...)
- Can be slooooow
- Can be memory inefficient
- (Still) Hard'ish to troubleshoot
- (Still) Inferior IDE support compared to state of the art

Pros/Cons

- Niche language
- Specialized syntax
- Very permissive

Variable types

Variable type	Short	typeof()	R example
Boolean	logi	logical	TRUE
Integer	int	integer	1L
Real	num	double	1.2
Complex	cplx	complex	0+1i
Character	chr	character	"I <3 R"

Variable types

	Variable type	Short	typeof()	R example	
⇓	Boolean	logi	logical	TRUE	⇓
	Integer	int	integer	1L	
Coersion	Real	num	double	1.2	Coersion
	Complex	cplx	complex	0+1i	
⇓	Character	chr	character	"I <3 R"	⇓

Data structures

Dimension	Homogeneous data	Heterogeneous data
1	vector	list
2	matrix	data.frame
n	array	

- Constructors: vector() list() ...
- Name dimensions: dimnames()

Arithmetics

- Vectorized operations (element wise)
- Recycling
- Statistical functions

See reference card...

Logic operators

In symbols	A	B	$\neg$A	A$\wedge$B	A$\vee$B
In R	A	B	!A	A&B	$A \vert B$
	TRUE	FALSE	?	?	?
	TRUE	TRUE	?	?	?
	FALSE	FALSE	?	?	?
	FALSE	TRUE	?	?	?

Logic operators

In symbols	A	B	¬A	A∧B	A∨B
In R	*A*	*B*	!*A*	A&B	*A*|*B*
	TRUE	FALSE	FALSE	?	?
	TRUE	TRUE	?	?	?
	FALSE	FALSE	?	?	?
	FALSE	TRUE	?	?	?

Logic operators

In symbols	A	B	¬A	A∧B	A∨B
In R	A	B	$!A$	A&B	$A \vert B$
	TRUE	FALSE	FALSE	FALSE	?
	TRUE	TRUE	?	?	?
	FALSE	FALSE	?	?	?
	FALSE	TRUE	?	?	?

Logic operators

In symbols	A	B	¬A	A∧B	A∨B
In R	A	B	!A	A&B	$A \vert B$
	TRUE	FALSE	FALSE	FALSE	TRUE
	TRUE	TRUE	?	?	?
	FALSE	FALSE	?	?	?
	FALSE	TRUE	?	?	?

Logic operators

In symbols	A	B	¬A	A∧B	A∨B
In R	A	B	$!A$	A&B	$A \vert B$
	TRUE	FALSE	FALSE	FALSE	TRUE
	TRUE	TRUE	FALSE	TRUE	TRUE
	FALSE	FALSE	TRUE	FALSE	FALSE
	FALSE	TRUE	TRUE	FALSE	TRUE

Logic operators

In symbols	$\wedge_{i=1}^{N} a_i$	$\vee_{i=1}^{N} a_i$	$\{j : a_j == TRUE\}$
In R	$all(A)$	$any(A)$	$which(A)$

Relational operators

In symbols	$a<b$	$a \leq b$	$a \neq b$	$a = b$	$a \in b$
In R	$a < b$	$a <= b$	$a! = b$	a == b	a %in% b

Vectors

- Use []
- index by:
  - positive integers: include element(s)
  - negative integers: exclude element(s)
  - logical: include TRUEs

```
vect <- c(6,7,8,9)
> vect[vect>7]
[1] 8 9
> vect[1:2]
[1] 6 7
> vect[c(1,2)]
[1] 6 7
> vect[c(-1,-2)]
[1] 8 9
```

Matrices

- Use [,]
- Two dimensions
- Index as vectors
- Can reduce (drop class) to vector

Matrices

```
> mat <- matrix(c(1,2,3,4,5,6),nrow=2)
> mat
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
> mat[c(1,2),c(1,2)]
     [,1] [,2]
[1,]    1    3
[2,]    2    4
> mat[c(1,2),]
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
> mat[mat>4]
[1] 5 6
```

Lists

- Use [] to access list elements
- Use [[]] to access list content
- Index as vectors
- Use $ to access list element by name
- Not like typical lists in other programming languages

Lists

```
> lst <- list(a=47,b=11)
> lst[1]
$a
[1] 47

> lst[[1]]
[1] 47
> lst$b
[1] 11
```

Data frames

- Very powerful data structure
- Can roughly think about it as the R representation of a CSV file
- Can be loaded from a CSV file
- Can be accessed both as a matrix and a list

Assigning subsets

- Change values in data structures
- Works for all above mentioned data types

Assigning subsets

```
> mat
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
> mat[mat>4] = 75
> mat
     [,1] [,2] [,3]
[1,]    1    3   75
[2,]    2    4   75
```

Functions

```
my_function_name <- function(x, y){
        z <- x^2 + y^2
        return(z)
}
```

Unlike in many languages, `return` in R is a **function**. In other languages, `return` is usually a **reserved word** (like `if`). This means you must use `return` as a function call with parenthesis. By default R returns the last computed value of the function, so return is not strictly necessary in simple cases.

The End... for today.

Questions?

See you next time!