Use of R environment in Evolutionary Ecology







Why R??

PROS

- Beautiful plots
- Big data
- Loop through files and analysis
- Repeat same analysis any time
- Open free language = big online community to help

CONS

- Not pushing buttons to get quick results*
- Learn to code*

• CONS

- Not pushing buttons to get quick results
- Learn to code

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• PROS

Understanding what we are doingLearn how to code!

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We are not goint to jump blindly into a bunch of code. Baby steps

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Basic R: How? Where?

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Basic **R** : How? Where?

Script (commands you want to run)

objects (data) loaded in R Environment

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D:/Dropbox/MOSKY/CURRO/Data/ 🔊	A		205 6	Sep 17, 2019, 11.20 AM
R is a collaborative project with many contributors. Type 'contributors()' for more information and	^			
'citation()' on how to cite R or R packages in publications.			6 4 KP	Oct 4, 2010, 2:19 PM
		SomerawData_guess.xisx	0.4 KB	Oct 4, 2019, 3:18 PM
Type demo() for an UTM browser interface to belo			225.5 IVIB	Sep 17, 2019, 2:59 AM
Type 'qQ' to quit R.			5 0 KD	0.4.46.0040.045.044
			5.8 KB	Oct 16, 2018, 2:45 PM
<pre>> #R sucks! > #This is actually part of an script, but I'm using it as a background for a presentation > getwd()</pre>				
<pre>[1] "D:/Dropbox/MOSKY/Documents" > setwd("this/is/a/path/name/to/a/very/cool/directory") Error in setwd("this/is/a/path/name/to/a/very/cool/directory") :</pre>				
cannot change working directory				
<pre>> stwd("D:/Dropbox/MOSKY/CURRO/Data") > sumer original object name creat table("Input file or so csy" header-TPUE)</pre>				
<pre>> View(super_original_object_name)</pre>				

Console > coded executed already and output messages (including errors) Directories and files in your computer

Basic R : How? Where?

File > New File > R Script (Ctrl+Shift+N)

Write something nice!

Comment

#

Notes for yourself that will be ignored by R# you should define the purpose of the script# kind of input file and describe each step

save a script file in your directory

Basic commands

Objects: any data saved in R environment

many kinds of objects can be saved in R memory variables, vectors, dataframes...

variables

Information stored with a unique name numerical values or text (string)

Basic commands

Declare variables:

: <-

3 < three
three → 3
two <- 2
three = 3
variable = "text string"</pre>

Execute with **Ctrl+Enter** and will appear at "Environment"

Basic commands

R does statistics and basic math

Operators:

+ - * / ^

Basic commands

a = 2 b = 10*4 $sum_ab = a+b$ > a=10*4
> b=2
> sum_ab=a+b
> sum_ab
[1] 42
> |

you can call an **object** any time sum_ab #42

The first rule of the coding club: "If you are typing a lot your are doing it wrong"

Use 'Tab':



(autocomplete)

Basic commands

• First command:

cat()

It is a powerful tool to con**cat**enate and write files.

But you will use me mainly to print things on screen



Basic commands: cat

Try to use cat() to print something in your console

cat(Hello World!)

Ctrl+Enter

Basic commands: cat

Tell R something is text by using "quotation marks"

cat("Hello World!")
cat(sum_ab)
cat (sum_ab, variable)

Basic commands: cat

- Commands may have multiple arguments
- Arguments are separated by commas ","
- Concatenate various arguments with cat()

cat("The answer is", sum_ab)

Basic commands: cat

Arguments can modify commands behaviour

sep: how to separate arguments when printing

\n <- will print each argument in a different line

cat("The answer is", sum_ab, sep="\n")

Basic commands

Summarising

- commands() can have many arguments
- arguments modify command behaviour
- arguments are separated by commas,
- text is defined with "quotation marks"

cat("The answer is", sum_ab, sep="\n")

Basic commands

Commands have help information check other arguments for cat:

?cat
help(cat)

Let's analyse our first data in R!

Create file in excel

3 variables (name them in the first raw), three columns of numbers

save as .csv

Excel file

Variables in columns Observations in rows

Export from Excel

1	CODE	Sex	Рори	Group	Alive	procesed	Spots	JawLei	HeadWi	TailLen	BodyLe	ength
2	PK021	fem	РК	PK-F	yes	TRUE	3	1.392	0.899	9.438	6.150	
3	PK022	fem	РК	PK-F	no	TRUE	5	1.290	0.855	9.319	6.340	
4	PK023	fem	РК	PK-F	yes	TRUE	6	1.277	0.849	1.060	5.894	
5	PK024	fem	РК	PK-F	yes	TRUE	4	1.315	0.852	8.727	5.848	
6	PK025	fem	РК	PK-F	yes	TRUE	4	1.408	0.933	6.938	6.367	
7	PK026	fem	PK	PK-F	yes	TRUE	4	1.206	0.856	8.804	5.994	
8	PK027	fem	РК	PK-F	yes	TRUE	2	1.299	0.830	7.260	6.175	
9	PK028	fem	PK	PK-F	no	FALSE	2	1.365	0.897	8.086	6.234	
10	PK029	fem	РК	PK-F	no	TRUE	2	1.385	0.912	7.849	6.043	
11	PK030	fem	PK	PK-F	yes	FALSE	3	1.282	0.836	0.933	5.573	
12	PK031	fem	РК	PK-F	no	TRUE	6	1.122	0.873	6.498	6.053	
13	PK032	fem	PK	PK-F	yes	TRUE	5	1.295	0.856	6.462	5.929	
14	PK033	fem	РК	PK-F	no	TRUE	9	1.336	0.888	8.849	6.220	
15	PK034	fem	PK	PK-F	no	TRUE	3	1.297	0.821	9.233	6.452	
16	PK035	fem	PK	PK-F	yes	TRUE	2	1.345	0.871	2.920	6.642	
17	PK036	fem	РК	PK-F	yes	TRUE	1	1.234	0.858	2.299	5.662	
18	PK037	fem	РК	PK-F	yes	FALSE	5	1.327	0.860	6.129	5.739	
19	PK038	fem	РК	PK-F	no	FALSE	5	1.359	0.953	4.977	6.264	
20	PK039	fem	PK	PK-F	no	FALSE	6	1.358	0.929	8.960	6.166	
21	PK040	fem	РК	PK-F	yes	TRUE	3	1.442	0.942	7.592	6.362	
22	PK041	fem	PK	PK-F	no	FALSE	5	1.281	0.892	8.352	6.588	
23	PK042	fem	РК	PK-F	yes	TRUE	6	1.359	0.894	8.221	5.881	
24	PK043	fem	PK	PK-F	no	FALSE	3	1.311	0.928	8.949	6.311	
25	РК044	fem	РК	PK-F	yes	TRUE	4	1.425	0.905	1.922	6.380	
26	PK045	fem	РК	PK-F	no	FALSE	6	1.402	0.926	9.174	6.569	
27	PK046	fem	РК	PK-F	no	TRUE	4	1.372	0.903	7.839	6.186	
28	PK001	mal	РК	PK-M	yes	TRUE	5	1.437	0.994	8.664	6.007	
29	PK003	mal	РК	PK-M	no	TRUE	2	1.508	1.091	6.943	6.748	
30	PK004	mal	РК	PK-M	yes	TRUE	3	1.608	1.094	1.559	6.456	
31	PK005	mal	PK	PK-M	no	TRUE	1	1.405	1.010	8.467	6.024	

• File>Save As: comma separated (.csv)

• Browse files in R: Working Directory

getwd()

To check the working directory (where R is reading your files from)

setwd()

To tell R where to find the files to analyse

setwd("path/")

1. Copy the path of the folder where you file is at



2. Paste it in R script and replace "\" with "/"

setwd("D:/Dropbox/MOSKY/CURRO/CLASS/evoleco20")

getwd() # check wd

• Import files to R

read.table()

Check ?read.table to see arguments

You need three arguments

- "file name"
- separator of columns (sep=",")
- header=? (TRUE/FALSE)

1	CODE	Sex	Ρορι	Group	Alive	procesed	Spots
2	PK021	fem	PK	PK-F	yes	TRUE	3
3	PK022	fem	PK	PK-F	no	TRUE	5
4	PK023	fem	РК	PK-F	yes	TRUE	6
5	PK024	fem	PK	PK-F	yes	TRUE	4
6	PK025	fem	РК	PK-F	yes	TRUE	4
7	PK026	fem	PK	PK-F	yes	TRUE	4
8	PK027	fem	PK	PK-F	yes	TRUE	2
9	PK028	fem	PK	PK-F	no	FALSE	2
10	PK029	fem	PK	PK-F	no	TRUE	2
11	PK030	fem	PK	PK-F	yes	FALSE	3
12	PK031	fem	PK	PK-F	no	TRUE	6
13	PK032	fem	РК	PK-F	yes	TRUE	5
14	PK033	fem	PK	PK-F	no	TRUE	9
15	PK034	fem	РК	PK-F	no	TRUE	3
16	PK035	fem	PK	PK-F	yes	TRUE	2
17	PK036	fem	PK	PK-F	yes	TRUE	1
18	PK037	fem	РК	PK-F	yes	FALSE	5
19	PK038	fem	РК	PK-F	no	FALSE	5
20	PK039	fem	РК	PK-F	no	FALSE	6
21	PK040	fem	PK	PK-F	yes	TRUE	3
22	PK041	fem	РК	PK-F	no	FALSE	5
23	PK042	fem	PK	PK-F	yes	TRUE	6
24	PK043	fem	PK	PK-F	no	FALSE	3
25	PK044	fem	PK	PK-F	yes	TRUE	4
26	PK045	fem	PK	PK-F	no	FALSE	6
27	PK046	fem	PK	PK-F	no	TRUE	4
28	PK001	mal	PK	PK-M	yes	TRUE	5
29	PK003	mal	РК	PK-M	no	TRUE	2
30	PK004	mal	PK	PK-M	yes	TRUE	3
31	PK005	mal	PK	PK-M	no	TRUE	1

• Import files to R

read.table("moja_tablica.csv", header=TRUE, sep=",")

This way we see it, but can't we save it in R environment?

Basic commands

Save files to R environment

You can redirect the output of most commands to an object

```
tablica1 <- read.table( ... )</pre>
```

Check your data!!

• Read the description in 'Environment'

Dataset

Head and body measurements from lizards (*Podarcis sicula*) from two Adriatic islands











"It is our hope that we or other biologists can follow the dynamics of these introductions over a period of years to gain further insight into the competitive dynamics between *L. melisellensis* and *L. sicula*."

35 years later – Herrel et al. 2008, PNAS; Versust et al. 2007, Oikos





redo with lizards_practical_data

redo with lizards_practical_data

save as object "lizards"

Check your data again!!

str(lizards)

data frame organisation: \$
Each column from our excel is a different variable
stored in a different \$ slot

lizards\$Sex

'd	ata.frame':	86	obs. of 11 variables:
\$	CODE :	chr	"РКО21" "РКО22" "РКО23" "РКО24"
\$	Sex :	chr	"fem" "fem" "fem"
\$	Population:	chr	"РК" "РК" "РК" "РК"
\$	Group :	chr	"РК-F" "РК-F" "РК-F"
\$	Alive :	chr	"yes" "no" "yes" "yes"
\$	procesed :	logi	TRUE TRUE TRUE TRUE TRUE
\$	Spots :	int	3 5 6 4 4 4 2 2 2 3
\$	JawLength :	num	1.39 1.29 1.28 1.31 1.41
\$	HeadWidth :	num	0.899 0.855 0.849 0.852 0.933 0.856 0.83 0.897 0.912 0.836
\$	TailLength:	num	9.44 9.32 1.06 8.73 6.94
\$	BodyLength:	num	6.15 6.34 5.89 5.85 6.37
>			

R differentiates some types of variables



- Are categorical variables
- We will use them to define groups
- In most analysis they are used as "grouping", "treatment"

or "explanatory variables"





R differentiates some types of variables

Tail Length and Body Length "num"

\$ TailLength: num 9.44 9.32 1.06 8.73 6.94 ... \$ BodyLength: num 6.15 6.34 5.89 5.85 6.37 ...

- Continuous numerical variables
- In mostly are used as "response variables"
- We will analyse if their values are different among groups



Let's analyse the data

Are there significant differences in Body Lenght between males and females?



Let's analyse the data

Are there significant differences in Body Lenght between males and females?

aov() = analysis of variance = ANOVA

2 arguments

formula: response variable ~ grouping variable data frame name: lizards

Let's analyse the data

ANOVA aov(BodyLength~Sex, data=lizards)

Summarize: summary() Pr (>F) 1.91e-05 ***

Save for later
results_aov <- summary(aov(. . .))</pre>

BASIC PLOT

boxplot(BodyLength~Sex, data=lizards)



EXERCISE

Now try to do the same for Head Width and Populations

Are there significant differences in Head Width between Populations?

You will need: aov(), summary(), and boxplot()

save results to a file

First check format str(results_aov) This is ugly

```
> str(results_aov)
List of 1
$ :Classes 'anova' and 'data.frame': 2 obs. of 5 variables:
..$ Df   : num [1:2] 1 84
..$ Sum Sq : num [1:2] 3.76 15.37
..$ Mean Sq: num [1:2] 3.761 0.183
..$ F value: num [1:2] 20.5 NA
..$ Pr(>F) : num [1:2] 1.91e-05 NA
- attr(*, "class")= chr [1:2] "summary.aov" "listof"
```

We actually want it as the output that appears in Console

save results to a file

1.- <u>capture output</u> as seen on screen: capture.output
results_aov <- summary(aov(...))</pre>

capture.output(results_aov)

print_aov <- capture.output(results_aov)</pre>

2.- print to a file: 'cat' with argument "file" and "sep"

cat(print_aov, sep="\n", file="aov_out.txt")