

# Introduction to R

Herczeg Róbert, Kehl Dániel

University of Pécs

2017/2018 őszi



PÉCSI EGYETEM  
ALFÖLDI KAR

# Motivation

- ▶ R is used all over the world in many fields
  - ▶ social sciences
  - ▶ econometrics
  - ▶ bioinformatics: <http://www.bioconductor.org>
  - ▶ ...
- ▶ it is free, open source
- ▶ user contributions are possible, and great advantage
- ▶ one of the most enthusiastic user group (r-help mailing list)
- ▶ a lot of great books (R series of Wiley, UseR!)
- ▶ both in (reproducible) research and teaching
- ▶ and here is a long story (maybe a little biased):  
<http://r4stats.com/articles/popularity>

# Table of contents

---

**1. R basics**

**2. Interactive graphs with Shiny**

**3. Personalized midterms with the exams package**

# R basics

## About the Project

- ▶ <http://www.r-project.org>
- ▶ developed from the S language
- ▶ free
- ▶ consists of so called packages
  - ▶ there are some basic packages (you have these after installing R)
  - ▶ you can find others (over 12350) on CRAN (The Comprehensive R Archive Network) – topic views
  - ▶ other user-provided functions and packages online
- ▶ also very popular in academics

# R basics

## Pros and cons

- ▶ you can basically find all (statistical) methods you might need
- ▶ produces high quality, customizable, publication ready graphs
- ▶ cooperates with other software packages (Excel, EViews, BUGS)
- ▶ freedom
- ▶ helps reproducible research
- ▶ script language (limited GUI and point-and-click functionality)
- ▶ running an analysis usually does not end with some tables and graphs (like in other software) but with objects containing information (and you can of course plot those or save them)

# R basics

## R Studio

- ▶ a popular IDE (integrated development environment)
- ▶ free, handy, convenient to use
- ▶ „Matlab like”
- ▶ you can download it at  
<https://www.rstudio.com/ide/download/>
- ▶ and here are some nice screenshots  
<https://www.rstudio.com/ide/screenshots/>
- ▶ we are going to use it on this short workshop

# R basics

## Basic functionality

- ▶ prompt: `>` - waiting for input
- ▶ try `demo()`, packages usually have demos, `demo(persp)`, `demo(graphics)`, `demo(plotmath)`, `demo(colors)` etc.
- ▶ use it as a calculator, simple operators and functions
- ▶ define scalar variables: `x = 1`, `x <- 1`, `1 -> x` (case sensitive!!!)
- ▶ access history by up and down arrows
- ▶ `#` indicates a comment in the code
- ▶ take a look at Appendix A (A sample session) in the R-intro.pdf!

# R basics

## Asking for help

- ▶ `?functionname` or `help(functionname)`
  - ▶ first help pages might seem messy and too complicated, you have to get used to it, after some (a lot in fact) experience they are easy to use, informative and well structured
  - ▶ go for the examples if nothing else works (`example(functionname)`)
- ▶ `help("char")` and `? "char"` work in case of some special characters
- ▶ `?packagename`
- ▶ `help.start()`
- ▶ `help.search()` or `??`
- ▶ `R-intro.pdf` comes with R
- ▶ `www`, `google`, <http://stats.stackexchange.com>
- ▶ if no result, ask your question on the r-help mailing list
  - ▶ please read <http://www.r-project.org/posting-guide.html>



# R basics

## Installing packages

- ▶ `install.packages(packagename)`
  - ▶ choose a mirror, this downloads the files needed from CRAN
  - ▶ you only have to do this once
  - ▶ try `install.packages("googleVis")`
- ▶ `library(packagename)`: activates the package (check `library()`)
  - ▶ now you can use the functions in the package
  - ▶ you have to do this every time you need the package
  - ▶ try `library("googleVis")`
- ▶ take a look at your new package with `?googleVis`
- ▶ try `demo(WorldBank)`, you probably have to wait a couple of seconds

# Interactive graphs with Shiny

## Webscraping with Shiny

- ▶ Collect semi-structured or unstructured data from websites
  - ▶ install shiny, shinydashboard package - app
  - ▶ install rvest package for webscraping
  - ▶ googleVis is already installed
- ▶ Develop a simple shiny app to visualize the data
- ▶ Use interactive graph to show the data

# Interactive graphs with Shiny

## Webscraping - download data

- ▶ Scraping data from web - ratebeer.com
  - ▶ html, body, table, tr, td
  - ▶ load rvest package
  - ▶ rvest::read\_html - download webpage
  - ▶ rvest::html\_table - get tables from webpage
  - ▶ find the right table
- ▶ data preprocessing

# Interactive graphs with Shiny

Webscraping - Shiny, shinydashboard

- ▶ easily create webapps with Shiny
  - ▶ ui.R - user interface
  - ▶ server.R - server interface for the calculation
  - ▶ app.R - combine ui.R and server.R
- ▶ shinydashboard
  - ▶ increased UX - user experience
  - ▶ more options - sidebar, widgets, tabs etc.

# Personalized exams

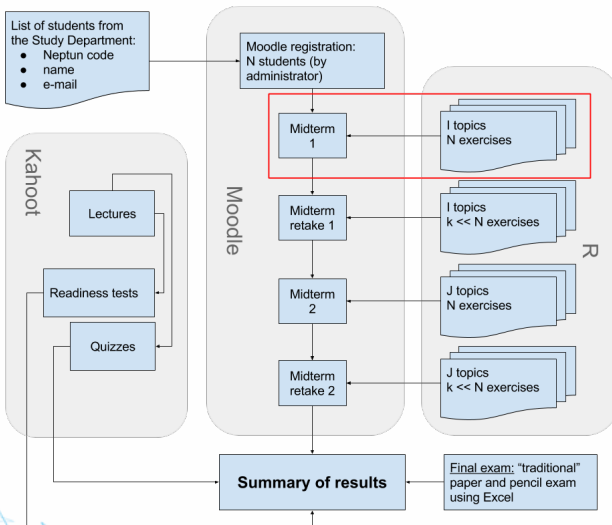
## Main challenges in big classes

- ▶ high number of student especially on the Hungarian Programme
  - ▶ high number of exams, takes a lot of time grading, creating new problems, datasets etc.
  - ▶ after midterms students want to check their exams, solutions etc.
- ▶ desire to „force” students to continuously follow the course material throughout the semester
  - ▶ in-class short, 5 minute quizzes every lab session
  - ▶ two Excel-based midterms
- ▶ exams at the computer makes cheating easier

One possible solution is personalized exams (with Moodle) and R.

# Personalized midterms

## Assessment structure of the semester



# Personalized midterms

## Storing exercise text and data in spreadsheets

### The example of estimation/hypothesis testing of the population mean

text	text2	mu	sigma	round
Egy üzleti döntés előkészítéséhez meg kell becsülnünk a termékünk ellenőrzéséhez szükséges átlagos időt (percben). Ehhez az alábbi nnnn elemű mintát választottuk.	Egy üzleti döntés előkészítéséhez meg kell vizsgálnunk a termékünk ellenőrzéséhez szükséges átlagos időt (percben). Ehhez az alábbi nnnn elemű mintát választottuk. A termelési igazgató állítása szerint az ellenőrzéshez szükséges átlagos idő mumumu	100	15	1
Egy nagyvállalatnál éves TeljesítményÉrtékelési Rendszer (TÉR) működik. A kitöltéshez szükséges átlagos időt kívánjuk megbecsülni. Véletlenszerűen kiválasztott nnnn munkavállaló esetén mértük ezt az időt.	Egy nagyvállalatnál éves TeljesítményÉrtékelési Rendszer (TÉR) működik. A kitöltéshez szükséges átlagos időt kívánjuk vizsgálni véletlenszerűen kiválasztott nnnn munkavállaló segítségével. A TÉR-t szállító külső vállalat állítása szerint az	25	5	1
A fogyasztói árindex számításához szükségünk van az egy kilogrammos fehér kenyér magyarországi átlagárára. Ennek érdekében az alábbi reprezentatív árösszeírásokat végeztük.	Az egyik politikai párt szerint az egy kilogrammos fehér kenyér magyarországi átlagára mumumu forint. Ennek ellenőrzésére az alábbi reprezentatív árösszeírásokat végeztük.	250	20	0
Egy vállalatnak készített marketing	Egy vállalatnak készített marketing			

# Personalized midterms

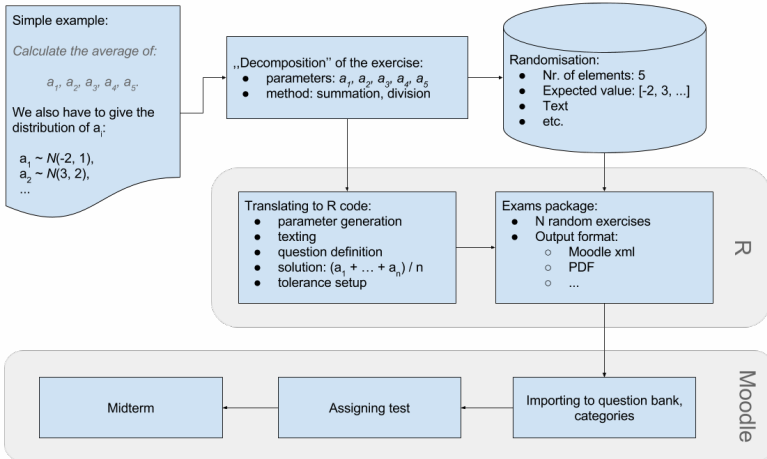
## The R-code – generating questions, setting tolerances

```
25 ## QUESTION/ANSWER GENERATION
26 questions <- character(4)
27 solutions <- logical(4)
28 tolerances <- rep(0.0001, 4)
29
30 questions[1] <- "Mekkora a hipotézisellenőrzés során használt sztenderd hiba nagysága?"
31 solutions[1] <- se
32
33 questions[2] <- paste0("Adja meg a ", 100*signLevel, "\\%-os szignifikancia szinthez
    tartozó kétoldalú alternatív hipotézishez tartozó kritikus érték abszolút értékét!")
34 solutions[2] <- tkrit
35
36 questions[3] <- "Adja meg a próbafüggvény empirikus értékét!"
37 solutions[3] <- temp
38
39 if(runif(1) > 0.5) {
40   questions[4] <- "Adja meg a kétoldalú alternatív hipotézishez tartozó p-értéket!"
41   solutions[4] <- pertek
42 } else {
43   questions[4] <- "Adja meg az egyoldalú kisebb alternatív hipotézishez tartozó p
    -értéket!"
44   solutions[4] <- pt(temp, n - 1)
45 }
46 @
```



# Personalized midterms

## The general idea – workflow



# Personalized midterms

## The R-code – generating a midterm

```
1 source("functions.R")
2
3 mywd <- getwd()
4 folder <- "exercises/prob_stat/estimation/"
5 exerc1617osz1 <- c("binom.Rnw", "hipgeom.Rnw", "poisson.Rnw", "norm.Rnw", "2valt.Rnw")
6 exerc1617osz2 <- c("mean_est.Rnw", "prop_est.Rnw", "prop_hip.Rnw", "f_egyez.Rnw")
7 exerc1617tavasz1 <- c("leiro_stat.Rnw", "binom.Rnw", "hipgeom.Rnw", "poisson.Rnw")
8 exerc1617tavasz1pot <- c("leiro_stat.Rnw", "binom.Rnw", "hipgeom.Rnw", "poisson.Rnw")
9 exerc1617tavasz2 <- c("mean_est.Rnw", "mean_hip.Rnw", "paros.Rnw", "prop_est.Rnw", "prop_
10
11 exerc <- c("mean_est.Rnw", "prop_hip.Rnw", "f_egyez.Rnw")
12
13 myexam <- paste0(folder, exerc)
14
15 exams2pdf(myexam, n = 20, name = c(paste0(c(sub(".Rnw","",unique(exerc)),"exam"), collapse=""),
16                                     paste0(c(sub(".Rnw","",unique(exerc)),"solution"), collapse="")),
17       encoding = "UTF-8",
18       edir = "exercises",
19       dir = "output",
20       template = c("templates/exam.tex", "templates/solution.tex"),
21       header = list(
22         Date = "2017-09-09",
23         ID = function(i) formatC(i, width = 5, flag = "0")
24       )
25
26
27 exams2moodle(myexam, n = 50, name = c("szeged"),
28       encoding = "UTF-8",
29       edir = "exercises",
30       dir = "output")
```

# As a result

our students face

- ▶ very similar question types (let's say one-sample t-test, ANOVA, estimation and linear regression)

**BUT**

- ▶ different „stories”
- ▶ different questions (give the empirical value vs. give the critical value vs. give the p-value etc.)
- ▶ different datasets
- ▶ different numeric solutions
- ▶ immediate feedback and results
- ▶ possibility to „flag” questions in Moodle

# Summary of our experiences

---

- ▶ results are fairly similar in comparison to previous years
- ▶ students do not complain about it, like the quick response
- ▶ preparing a midterm takes longer (see R code)
- ▶ setting up a question bank is an initial investment
- ▶ going through flagged questions is fairly quick
- ▶ saving a lot of time with automatic grading
- ▶ cheating seems to be harder

# Useful links and materials

---

- ▶ <https://moodle.org/>
- ▶ R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.
- ▶ Achim Zeileis, Nikolaus Umlauf, Friedrich Leisch (2014). Flexible Generation of E-Learning Exams in R: Moodle Quizzes, OLAT Assessments, and Beyond. Journal of Statistical Software 58(1), 1-36. doi:10.18637/jss.v058.i01
- ▶ <https://cran.r-project.org/web/packages/exams/vignettes/exams.pdf>
- ▶ <https://cran.r-project.org/web/packages/exams/exams.pdf>
- ▶ exams\_skeleton function