



Bridging Research Endeavour in Computer
and Mathematical Sciences

For more information, please visit <http://www.icms2015.org>

Organized by

: FACULTY of COMPUTER &
MATHEMATICAL SCIENCES
UITM KEDAH

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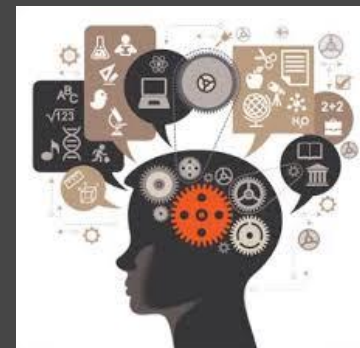
: RESEARCH & INDUSTRIAL LINKAGES

4th - 5th
November 2015

Langkawi Island,
MALAYSIA



REPRODUCIBLE RESEARCH WITH R



Ciprian Alexandru

R-omania Team | www.r-project.ro

Keynote Speaker

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Antoniade-Ciprian Alexandru

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LinkedIn

R-project.ro

GitHub

- Economics Faculty
Ecological University of
Bucharest, Romania -
Dean, Associate Professor



- National Institute of
Statistics, Romania -
Expert trainer in data
analysis and databases



- R-omania R-team member



R-omania Team

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- Our Team acts as user community for development of R project among the Romanian individual persons, institutions and commercial and noncommercial organizations.
- The Romanian Team promote the R project for statistical computing to provide a free and open source software environment for data analysis and graphics in Romania.
- Support the further development of R and related open source software projects in Romania.
- Initiate, promote and coordinate research projects, support communication within the R user community, and organize or sponsor courses.
- Organize R-related scientific conferences and workshops, participate at relevant R conferences sponsored by others, and promote the use and development of R and R-related software in Romania.
- Publish manuals, journal articles and other R-related documents in printed and electronic form.
- Promote the using of R environment in universities and offer support for curricula development in the field of statistical software.



The screenshot shows the website for the R-omania Team. The header includes the title "The R Project for Statistical Computing | R-omania Team" and a navigation menu with links: HOME, OUR TEAM, RESEARCH, EVENTS, LINKS, FAQ, CONTACT US, and a Romanian flag. The main content area is titled "Welcome to R-omania Team" and features a grid of team member portraits. To the left of the portraits, there is a list of "Conferences & Workshops" with links to various workshops and conferences from 2013 to 2016. Below this list is the R logo and the text "The R Project for Statistical Computing" with the website URL "www.r-project.org". Further down is the "Revolution Analytics" logo and website "www.revolutionanalytics.com". At the bottom, there is a link to "The Comprehensive R Archive Network" at "cran.r-project.org" and a "my LinkedIn profile" button. The source URL "source: https://www.r-project.ro/" is displayed at the bottom right of the screenshot.

source: <https://www.r-project.ro/>

R-omania Team – Conferences & Workshops

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- ❑ 2016 - Conference - New Challenges for Statistical Software - The Use of R in Official Statistics
- ❑ 2016 – Workshop - Applied R to Social Sciences
- ❑ 2015 - Conference - New Challenges for Statistical Software - The Use of R in Official Statistics
- ❑ 2014 - Workshop - New Challenges for Statistical Software - The Use of R in Official Statistics
- ❑ 2013 - Workshop - State-of-the-art statistical software commonly used in applied economics

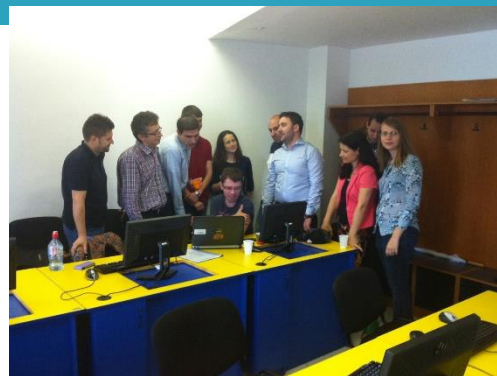


source: <https://www.r-project.ro/>

R-omania Team - Courses

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- 3 to 5 days Courses:
 - ▣ "Statistics with Applications in R"
 - ▣ "Data Analysis in Statistics with R"
 - ▣ "Introduction to Statistics - Applications in R"
 - ▣ "Introduction in Small Area Estimation Techniques with Applications in R"
- One-day courses:
 - ▣ "R Statistical Software – Presenting Advantages of its use for Data Analysis"
 - ▣ "Introducing Statistics, the Need for Official Statistics"
 - ▣ "Statistical Analysis – from Theory to Practice"
 - ▣ "Concepts, Models and Techniques for Data Analysis"



source: <https://www.r-project.ro/>

R-omania Team - Courses

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- Over 400 trained people from:
 - ▣ National Institute of Statistics – over 200
 - ▣ National Bank of Romania
 - ▣ Vodafone
 - ▣ Orange
 - ▣ UniCredit Bank
 - ▣ Ministry of Finance
 - ▣ Romanian Academy
 - ▣ Universities



BANCA NAȚIONALĂ A ROMÂNIEI 135



 **UniCredit Bank**



R-omania Team - Research

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- ❑ "R cu aplicatii in statistica", [en. "R with applications in statistics"], Published in 2015
- ❑ More than 25 research papers
- ❑ "R pentru Incepatori", the Romanian version of "R for Beginners" by Emmanuel Paradis, translated by Ana-Maria Dobre, Aug, 2013

source: <https://www.r-project.ro/>

Topics

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- ☐ Research where they are going?
- ☐ Replication or Reproducible?
- ☐ Why Reproducibility?
- ☐ What is necessary for Reproducibility?
- ☐ Research Pipeline
- ☐ Research about Reproducible Research
- ☐ Missing Reproducibility
- ☐ Literate (Statistical) Programming
- ☐ Research Pipeline in R
- ☐ Development Tools
- ☐ Presentation Tools
- ☐ Basic principles
- ☐ Markdown

Research where they are going?

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- A lot of
 - ▣ Computing
 - ▣ Data analysis
 - ▣ Data manipulation or processing
 - ▣ Big Data
 - ▣ Communicating the results
 - ▣ Reconstructing
 - ▣ **Reproducible**



Replication or Reproducible?

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- Replication – an independent study came with same conclusion as the original study

- Reproducible
 - ▣ original data and code are studied by an independent analysts obtaining the same results of the original study
 - ▣ *data analysis* can be repeated with same results

Reproducible \neq Correctness

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- a reproducible study could be wrong
- a wrong assumptions can be identified by an independent replication process

Why not Replication research?

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- Lack of time
- Lack of financial resources
- Unique

Why Reproducibility?

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- ❑ Enhancing scientific evidence
- ❑ It is the only guarantee about a study
- ❑ Ensures transparency
- ❑ Creates confidence
- ❑ Validation of the data analysis

What is necessary for Reproducibility?

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- ❑ Publication of data sources and programs (R code)
 - ▣ analytic data, analytic code, documentation, standard tools for distribution

- ❑ Conducting studies using independent data sources

How easy can do our work reproducible?

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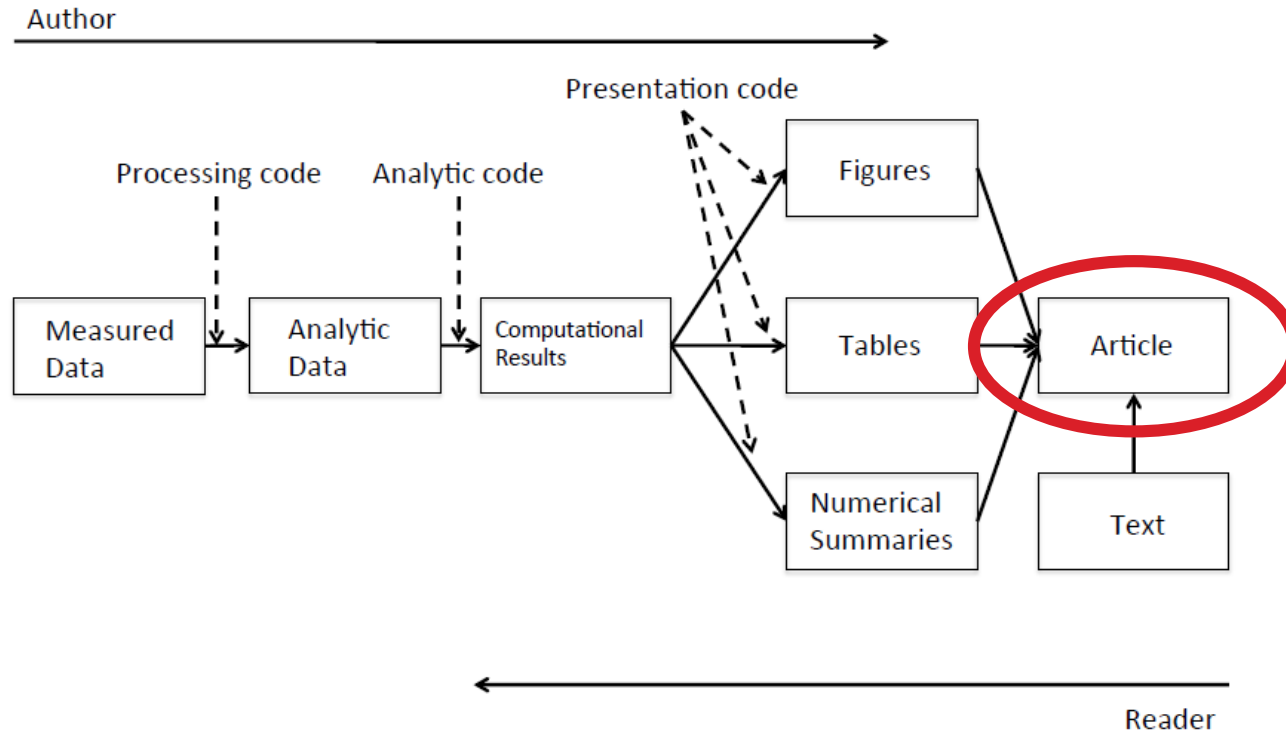
- ❑ preparation of data in a friendly format (standard)
- ❑ find a web server for uploading code & data with “almost” limitless availability
- ❑ using some tools to help readers (well known or well documented, eventually)
- ❑ making available a guidelines for future use

Conclusion:

a threshold between more “present time” consuming and saving for the future

Research Pipeline

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Roger D. Peng, *Reproducible Research: Concepts and Ideas*

Research about Reproducible Research

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Data Replication & Reproducibility

PERSPECTIVE

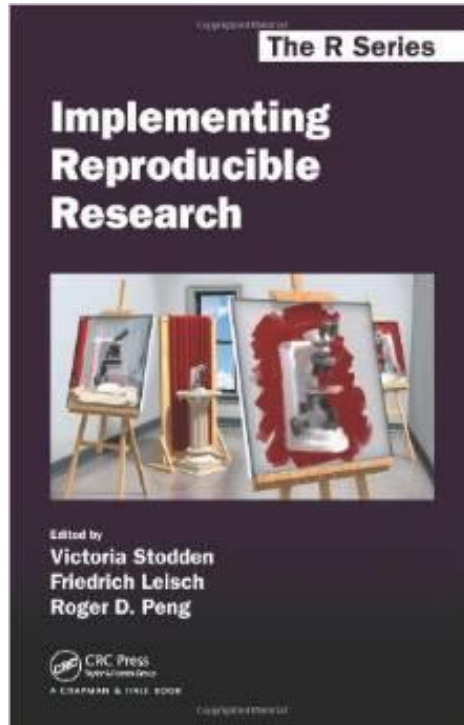
Reproducible Research in Computational Science

Roger D. Peng

Computational science has led to exciting new developments, but the nature of the work has exposed limitations in our ability to evaluate published findings. Reproducibility has the potential to serve as a minimum standard for judging scientific claims when full independent replication of a study is not possible.

Research about Reproducible Research

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Report Writing for Data Science in R



Roger D. Peng

Missing Reproducibility

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□ Duke University

Lesson Learned

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https://today.duke.edu/2014/02/reproducibility

SEARCH OR BROWSE ALL OF DUKE UNIVERSITY ▾

Duke**TODAY**

Search People, Places, Things GO

☐ Search Duke Today ☐ Search Duke Main

☐ Set Oct 31 | [Log in to Duke Today](#)

NEWS | OPINION | WORKING@DUKE | STUDENTS | ALUMNI

NEWS BY TOPIC ▾ | SERIES ▾

To Teach Scientific Reproducibility, Start Young

Introducing concept to undergrads could lead to more transparency in science

February 28, 2014 | [print](#) | [Facebook](#) | [Twitter](#) | [Google+](#) | [10](#)

ARTICLE

DURHAM, NC - The ability to duplicate an experiment and its results is a central tenet of the scientific method, but recent research has shown an alarming number of peer-reviewed papers are irreproducible.

A team of math and statistics professors has proposed a way to address one root of that problem by teaching reproducibility to aspiring scientists, using software that makes the concept feel logical rather than cumbersome.

Researchers from Smith College, Duke University and Amherst College looked at how introductory statistics students responded to a curriculum modified to stress reproducibility. Their work is detailed in a paper published Feb. 25 in the journal [Technological Innovations in](#)

MORE INFORMATION

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EMAIL: erin.weeks@duke.edu

HOME PAGE FEATURES


Krzyzewski Commencement


The Value of Journals

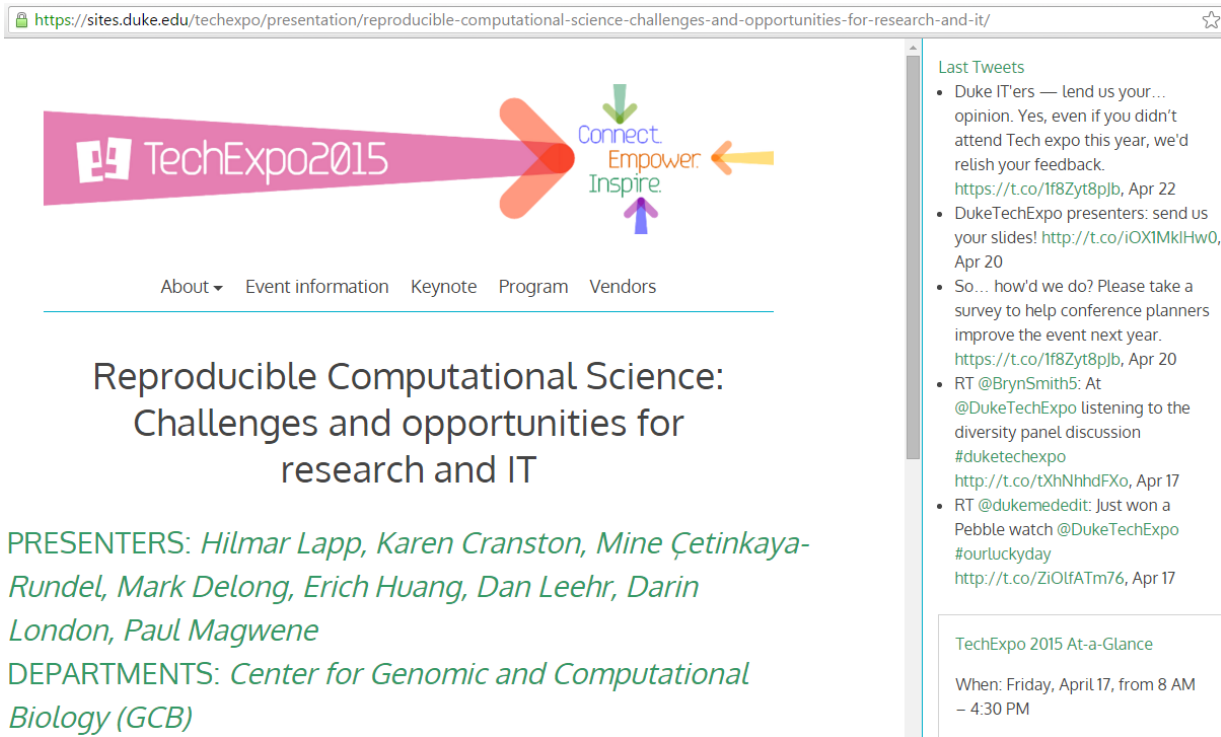

Von der Heyden Giff


Mike Merson

<https://today.duke.edu/2014/02/reproducibility>

Lesson Learned

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Reproducible Computational Science:
Challenges and opportunities for
research and IT

PRESENTERS: *Hilmar Lapp, Karen Cranston, Mine Çetinkaya-Rundel, Mark Delong, Erich Huang, Dan Leehr, Darin London, Paul Magwene*

DEPARTMENTS: *Center for Genomic and Computational Biology (GCB)*

Last Tweets

- Duke IT'ers — lend us your... opinion. Yes, even if you didn't attend Tech expo this year, we'd relish your feedback.
<https://t.co/1f8Zyt8pJb>, Apr 22
- DukeTechExpo presenters: send us your slides! <http://t.co/iOX1MklHw0>, Apr 20
- So... how'd we do? Please take a survey to help conference planners improve the event next year.
<https://t.co/1f8Zyt8pJb>, Apr 20
- RT @BrynSmith5: At @DukeTechExpo listening to the diversity panel discussion #duketecheexpo
<http://t.co/tXhNhhdfXo>, Apr 17
- RT @dukemededit: Just won a Pebble watch @DukeTechExpo #ourluckyday
<http://t.co/ZiOlfaTm76>, Apr 17

TechExpo 2015 At-a-Glance

When: Friday, April 17, from 8 AM – 4:30 PM

<https://sites.duke.edu/techexpo/presentation/reproducible-computational-science-challenges-and-opportunities-for-research-and-it/>

Literate (Statistical) Programming

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- ❑ a research paper/an article = a stream of text and code chunks
- ❑ code chunks = loads and manipulate data, computes results, presents tables, figures etc.
- ❑ literate programs produce:
 - ▣ human-readable documents
 - ▣ machine-readable documents

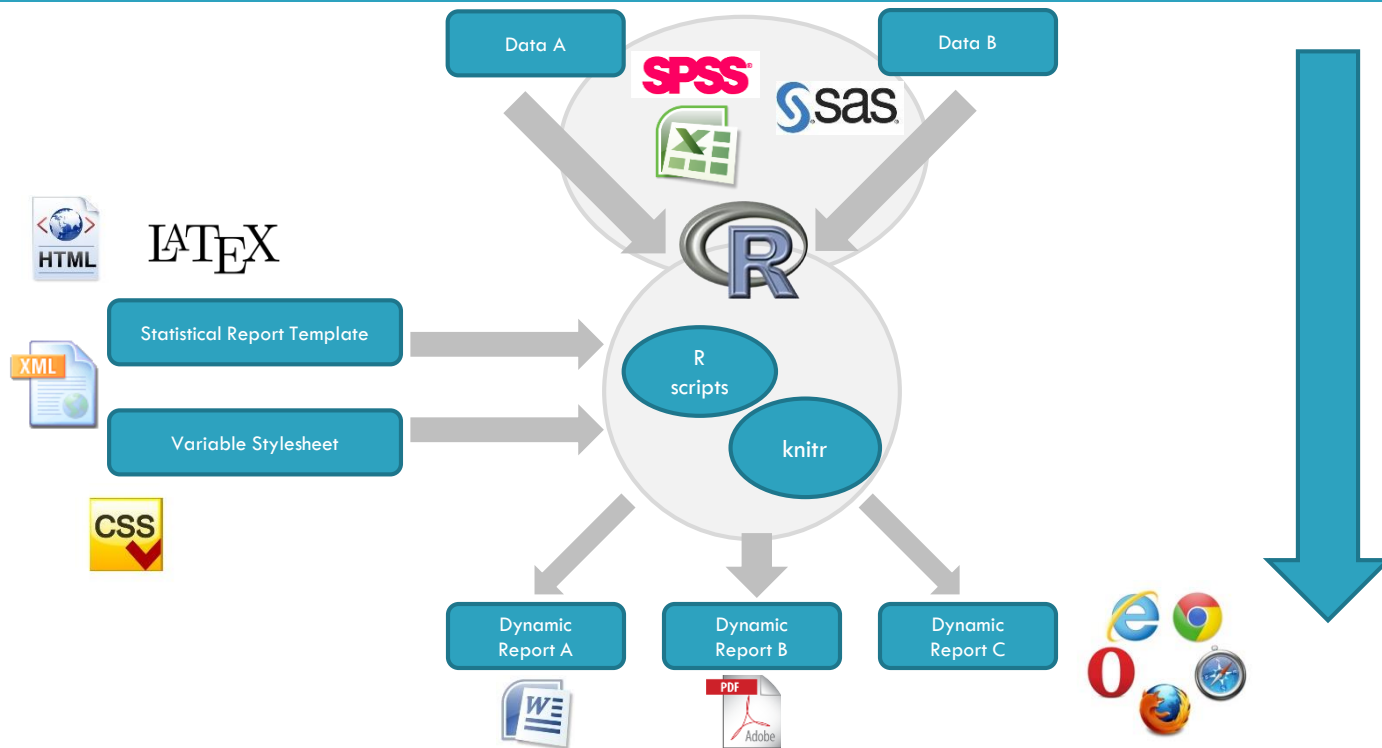
Where do we start?

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- Using some tools
- Basic principles

Research Pipeline in R

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Development Tools

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- Documentation language (human readable)
 - ▣ Sweave ($\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$) [<http://leisch.userweb.mwn.de/Sweave/>]
 - ▣ knitr ($\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$, Markdown, HTML) [<http://yihui.name/knitr/>]
- Programming language (machine readable)
 - ▣ R
 - ▣ Python

Presentation Tools

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- ❑ GitHub - powerful collaboration, code review, and code management for open source and private projects [<https://github.com/>]
- ❑ RPubS - web publishing from R [<https://rpubs.com/>]

Sweave

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- ❑ Included in R basic installation
- ❑ Documentation language L^AT_EX
- ❑ Lacks features like caching, multiple plots, per chunk, mixing programming languages
- ❑ Not frequently updated
- ❑ Developed by Fritz Leisch, core member of R

<http://leisch.userweb.mwn.de/Sweave/>

knitr

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- ❑ Contributed package (need installation)
- ❑ Documentation language:
 - ▣ L^AT_EX
 - ▣ Markdown
 - ▣ HTML
- ❑ Mix other programming languages
- ❑ Very popular package
- ❑ Developed by Yihui Xie while he was a graduate student at Iowa State

<http://yihui.name/knitr/>

Basic principles

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“Golden Rule of Reproducibility: Script Everything”,
Roger D. Peng

Basic principles - Data

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- Create an analysis folder unique for each research
- Raw data
 - ▣ Saved data - stored in your analysis folder
 - ▣ Web data – include url, description, accessed date
- Processed data
 - ▣ Named clearly (files and variable)
 - ▣ Make it tidy

Basic principles - Figures

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- ❑ Exploratory figures
 - ▣ In general include all data set
 - ▣ Explore your data until they told you everything
 - ▣ They are not pretty, but very useful

- ❑ Final figures
 - ▣ Use the most representative figures
 - ▣ Axes/Labels/Colors are set to make the figures clear and easy understandable
 - ▣ Multiple panels is preferred

Basic principles – R code

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- Raw / unused scripts
 - ▣ Small comments is recommended (our memory is not a HDD)
 - ▣ Use multiple versions
 - ▣ Keep all intermediary analysis, until you are sure that they are useless

- Final scripts
 - ▣ Clear commented (small in row, large for sections)
 - ▣ Include processing details
 - ▣ Keep only relevant analysis, that are included in final paper

- R markdown files
 - ▣ Used for generate reproducible reports
 - ▣ Integrates Text and R code

Basic principles – Text

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- ❑ README files
 - ▣ Optional for R markdown
 - ▣ Include all instructions for analysis

- ❑ Text of analysis / report
 - ▣ Title, introduction, methods, results and conclusions
 - ▣ Include only relevant analysis regarding the conclusions
 - ▣ References are important

Coding Standards for R

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- ❑ Use text files and editor
- ❑ Indent the code, 4 spaces minimum, or 8 (better)
- ❑ Width of the code – limits to 80 columns
- ❑ Functions – keep it small

Markdown

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Italics

This text will appear italicized!

Bold

****This text will appear bold!****

Headings

This is a secondary heading

This is a tertiary heading

Markdown

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Unordered Lists

- first item in list
- second item in list
- third item in list

Ordered Lists

1. first item in list
2. second item in list
3. third item in list

Markdown

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Links

[Johns Hopkins Bloomberg School of Public Health] (<http://www.jhsph.edu/>)

[Download R] (<http://www.r-project.org/>)

[RStudio] (<http://www.rstudio.com/>)

Markdown

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Advanced Linking

I spend so much time reading [R bloggers][1] and [Simply Statistics][2]!

[1]: <http://www.r-bloggers.com/> "R bloggers"

[2]: <http://simplystatistics.org/> "Simply Statistics"

Markdown

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Newlines require a double space after the end of a line.

First line

Second line

First line Second line

First line

Second line

Markdown

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- ❑ The Official Markdown Documentation
[<http://daringfireball.net/projects/markdown/basics>]
- ❑ Github's Markdown Guide
[<https://help.github.com/articles/github-flavored-markdown/>]

Romanian Social Data Archive

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□ www.roda.ro



Reproducible Research - Economics

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The diagram illustrates the combination of two resources to achieve reproducible research. On the left, the *RePEc* logo is shown with a blue horizontal glow behind it. This is followed by a large black plus sign. To the right of the plus sign is the RODA logo, which consists of a green square containing a stylized orange and green leaf-like shape, with the text "RODA" above it and "ARHIVA ROMÂNĂ DE DATE SOCIALE" below it. To the right of the RODA logo is a large black equals sign. Finally, on the far right, the text "Reproducible Research Papers" is written in a black sans-serif font.

$$\text{RePEc} + \text{RODA} = \text{Reproducible Research Papers}$$

GitHub

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□ <https://github.com/>

GitHub

References

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- ❑ The Real Reason Reproducible Research is Important [<http://simplystatistics.org/2014/06/06/the-real-reason-reproducible-research-is-important/>]
- ❑ Reproducible Data Analysis [<http://www.biomedicale.univ-paris5.fr/SpikeOMatic/ReproducibleDataAnalysis/ReproducibleDataAnalysis.html>]
- ❑ Get your R education going with GitHub [<http://www.r-bloggers.com/get-your-r-education-going-with-github/>]
- ❑ Everyone loves R markdown and Github; stories from the R Summit, day two [<http://www.r-bloggers.com/everyone-loves-r-markdown-and-github-stories-from-the-r-summit-day-two/>]
- ❑ Introducing the Reproducible R Toolkit and the checkpoint package [<http://www.r-bloggers.com/introducing-the-reproducible-r-toolkit-and-the-checkpoint-package/>]

Thank you!

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