An introduction to R software environment

Prelude

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Institute of Bioeconomy, CNR-National Research Council of Italy

RISIS Winter School

Tools and methods for analysing complex Science, Technology and Innovation (STI) systems: A gentle introduction to Network Science (NS), Spatial Models (SM) and Machine Learning (ML)

ONLINE PLATFORM, February 15-26, 2021

1. What is R
   - That is the question!
   - Popularity
   - Objects oriented
2. What foR
   - Native foR statistical modeling
3. R at work
   - Work with data
   - Visualizing
4. Editor foR
5. Lesson Plan

is a free software environment for data analysis, graphics and statistical computing

The **R** name is based on the (first) names of the first two developers **R**obert Gentleman and **R**oss Ihaka, playing on the name of the **S** language, from which R is derived.

early 90s **Robert Gentleman** and **Ross Ihaka** start developing R as a derivation of *S language* at the Department of Statistics of the University of Auckland

1995 R is available under **General Public License** (GPL)

1997 **R core** group of programming developers is founded

2002 **R foundation for Statistical computing** is established in Vienna

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What is really R?

- a tool for data mining and statistical modeling?
- a programming language for data mining and statistical modeling?

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is a dialect

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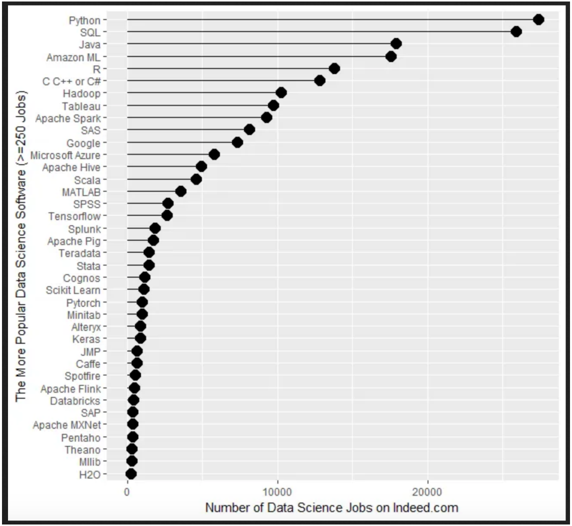
The Popularity of Data Science Software

r4stats.com



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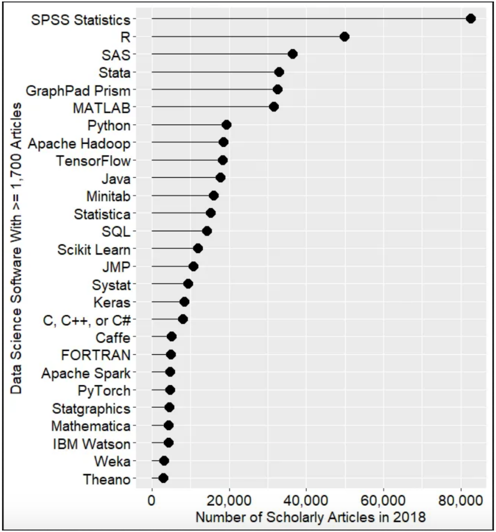

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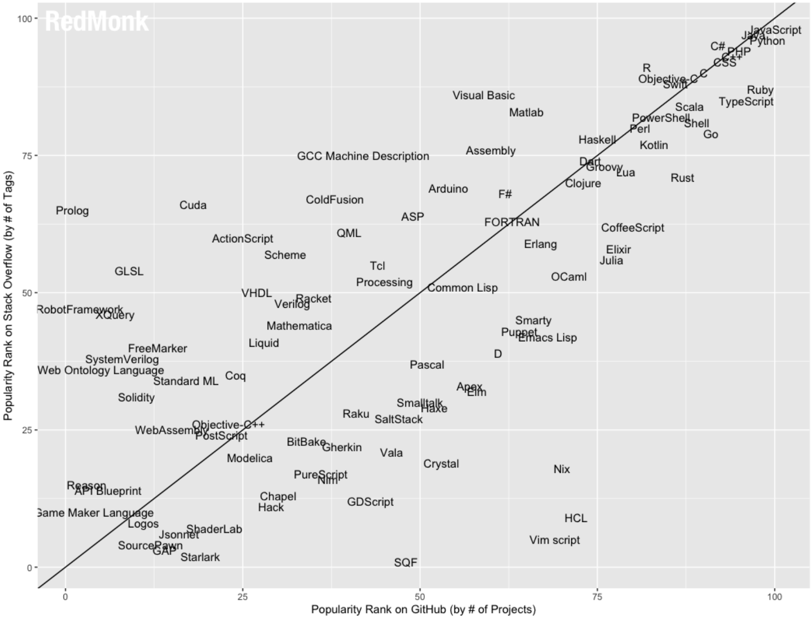
RedMonk Q320 Programming Language Rankings



R’s pros and cons (very short list)

Pros

17058 available packages (retrieved from CRAN Feb 9, 2021)

2138 open projects on R-forge

large community

Cons

limits in processing extremely large files (R generally processes data in-memory).

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R is an interpreted language

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It means that **CODE** entered into the **R CONSOLE** (or run as R script in batch mode) is executed by the **interpreter**, a program within the R system.

Object oriented programming

Data are stored in objects.

vector

matrix

array

factors

dataframe

list

...

Every object has a **type** (double, complex, etc.) and is a member of a **class** (numeric, character, etc.).

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R code is composed of

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a series of expressions

- arithmetic expressions
- assignment statements
- conditional statements
- loops
- ...

functions

- pre-loaded
- via packages to be installed and loaded
- own

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Statistical modeling

Most statistical theory focuses on `data modeling`, `prediction` and `inference`.

Packages for classical and advanced statistical models:

- Time series analysis
- Regression and Classification
- Principal Component Analysis
- Spatio-temporal Analysis
- Bayesian modeling
- ...

Among them:

- Network Science (NS)
- Spatial Models (SM)
- Machine Learning (ML)

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Data import

Supported data files

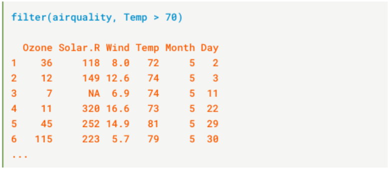
- .xls
- .csv
- .txt
- NetCDF
- .....

Connection to databases

- SAS
- Microsoft Access
- MySQL
- STATA
- .....

Data manipulation: `dplyr` package

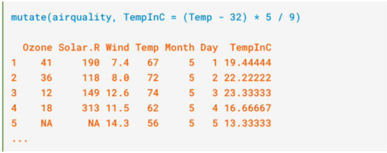
Data manipulation is the process of **arranging data** in order to make data analysis process, such as visualizing and modeling.



```
filter(airquality, Temp > 70)

  Ozone Solar.R Wind Temp Month Day
1    36     118  8.0   72     5   2
2    12     149 12.6   74     5   3
3     7      NA  6.9   74     5  11
4    11     320 16.6   73     5  22
5    45     252 14.9   81     5  29
6   115     223  5.7   79     5  30
...
```

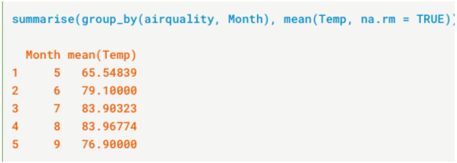
(a)



```
mutate(airquality, TempInC = (Temp - 32) * 5 / 9)

  Ozone Solar.R Wind Temp Month Day  TempInC
1    41     190  7.4   67     5   1 19.44444
2    36     118  8.0   72     5   2 22.22222
3    12     149 12.6   74     5   3 23.33333
4    18     313 11.5   62     5   4 16.66667
5    NA      NA 14.3   56     5   5 13.33333
...
```

(b)



```
summarise(group_by(airquality, Month), mean(Temp, na.rm = TRUE))

  Month mean(Temp)
1     5   65.54839
2     6   79.10000
3     7   83.90323
4     8   83.96774
5     9   76.90000
```

(c)

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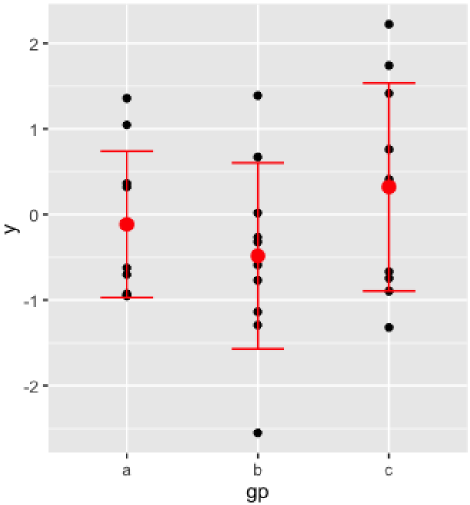
Visualizing data: `ggplot2` package



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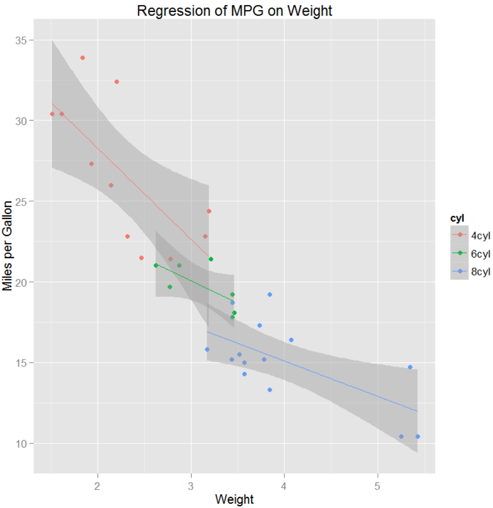

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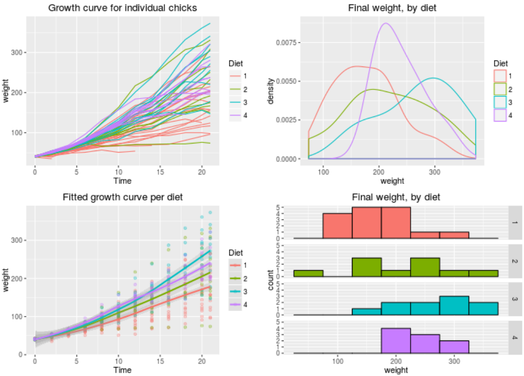

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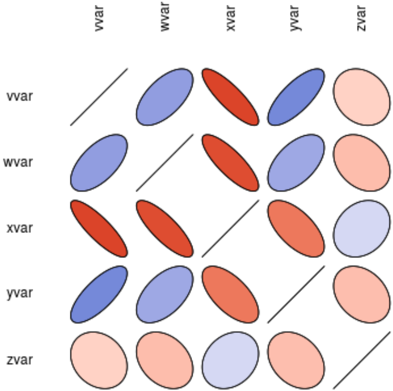
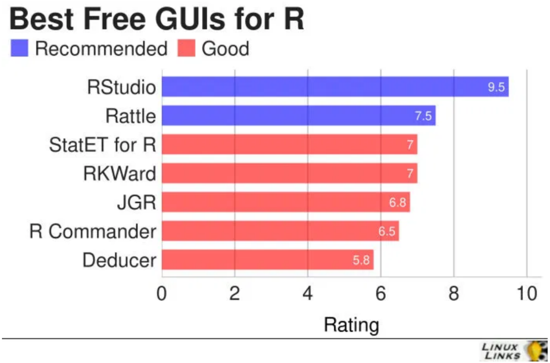


Graphical User Interfaces for R

LinuxLinks



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Monday 15th of February 2021 - afternoon

First part (15.15 - 16.00)

- Presentation of **RStudio** editor and its utilities
- Introduction to basic **R syntax**
- Installation of **R packages** and use of functions
- Comfort break (15 minutes)

Second part (16.15 - 17.00)

- **if else** statement and **loop**
- Writing **own functions**
- Comfort break (5 minutes)

Last part (17.05 - 17.30)

- Grouping and summarizing data: the **dplyr** package

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