SC-Camp 2015

Introduction to R and Data Analysis

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Summary

1. **Introduction to R**
2. **Crazy Examples**
3. **Practical Session**
   - Pre-requisites
   - Objectives
   - Practical Session Details

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R?

R (pronounced aRrgh – pirate style) is a programming language and environment for statistical computing and graphics

- oriented towards data handling analysis and storage facility
- R Base
- Packages tools and functions (user contributed)
- R Base and most R packages are available from the Comprehensive R Archive Network (CRAN)
- Use R console or IDE: **Rstudio**, Deducer, vim/emacs...
- Comment is #, help is **?** before a function name

Using R

Installing/using packages

Install and load the ggplot2 package (even if already installed)

```
install.packages("ggplot2")
library(ggplot2)
```

Or in one step, install if not available then load:

```
require(ggplot2) || {install.packages("ggplot2");
                     require(ggplot2)}
```

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Using R

Usefull Functions

- List all objects in memory: `ls()`
- Save an object: `save(obj, file)`
- Load an object: `load(file)`
- Set working directory: `setwd(dir)`

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Data Structures

- scalar:

  s = 3.14

- vector:

  v = c(1, 2, "ron")

- list:

  l = list(1:10, 'a', pi)

- matrix:

  m = matrix(seq(1:6), 2)

- **dataframe**:

  df = data.frame("col1" = seq(1:4), "col2" = c(5, 6, "cerveza", 6*7))

- ...

Entering Data

Reading CSV or text files

```
# comma separated values
dat.csv <- read.csv(<file or url>)
# tab separated values
dat.tab <- read.table(<file or url>,
    header=TRUE, sep = "\t")
```

Entering Data

Reading data from other software: Excel, SPSS...

Excel Spreadsheets – need `xlsx` package

```
read.xlsx()
```

SPSS and Stata both need the `foreign` package

```
dat.spss <- read.spss(<file or url>,
                      to.data.frame=TRUE)

dat.dta <- read.dta(<file or url>)
```

Data Frames

Most easy structure to use, have a matrix structure.

- **Observations** are arranged as **rows** and **variables**, either numerical or categorical, are arranged as **columns**.
- Individual rows, columns, and cells in a data frame can be accessed through many methods of indexing.
- We most commonly use **object[row,column]** notation.

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Accessing Items in a `data.frame`

Aside with R are provided example datasets, i.e. `mtcars` that can be used

```
data(mtcars)
head(mtcars)
colnames(mtcars)

# single cell value
mtcars[2,3]
# omitting row value implies all rows
mtcars[,3]
# omitting column values implies all columns
mtcars[2,]
```

Accessing Items in a `data.frame`

We can also access variables directly by using their names, either with **object[,"variable"]** notation or **object$variable** notation.

```
# get first 10 rows of variable 'mpg' using two methods:
mtcars[1:10, "mpg"]
mtcars$mpg[1:10]
```

Exploring Data

Description Of Dataset

- Using **dim**, we get the number of observations(rows) and variables(columns) in the dataset.
- Using **str**, we get the structure of the dataset, including the class(type) of all variables.

  dim(mtcars) str(mtcars)
- **summary** when used on a dataset, returns distributional summaries of variables in the dataset.

  summary(mtcars)
- **quantile** function enables to get statistical metrics on the selected data

  quantile(mtcars$mpg)

Exploring Data

Conditional Exploration

- **subset** enables to explore data conditionally

  subset(mtcars, cyl <= 5)

- **by** enables to call a particular function to sub-groups of data

  by(mtcars, mtcars$cyl, summary)

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Random Text Generation

```
library(XML)
stem <- "http://www.5novels.com/classics/u5688"
hobbit <- NULL
for(i in 1:74) {
    if(i==1) { url <- paste0(stem, ".html") }
    else { url <- paste0(stem, "_", i, ".html") }
    x <- htmlTreeParse(url, useInternalNodes=TRUE)
    xx <- xpathApply(x, "//p", xmlValue)
    hobbit <- c(hobbit, gsub("\r", "", xx[-length(xx)]))
    Sys.sleep(0.5)
}
hobbit = paste(hobbit, collapse=' ')
```

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Random Text Generation – 2

```
library(ngram)
ng2 <- ngram(hobbit, n=2)

babble(ng2, 128, seed=987654)
```

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Install and Run R

1. On your local machine:
   - Find a release that fits your distribution at CRAN Archive — http://cran.r-project.org/
   - Install and launch R-Studio — https://www.rstudio.com/
2. On the cluster
   First connect to the cluster, then submit a job to run R.

```
(localhost)$> ssh gaia-cluster
(frontend)$> oarsub -I -l core=1,walltime="00:30:00"
(node)$> module load lang/R/3.2.0-ictce-7.3.5-bare
(node)$> R
```

3. Install and Load a Package

```
(R-shell)$> install.packages("ggplot2")
(R-shell)$> library(ggplot2)
```

Objectives of this Practical Session

- Being able to plot data
  - histogram for data distribution
  - plot in different colors from different data sources
- Know some tips to organize your data
  - aggregate a dataset by column and apply an aggregation function
  - data.table package for binary search in datasets
  - performance in R operations
- R in parallel
  - on one machine
  - on a cluster with socket communications
  - MPI communications

Exercises

- Start the tutorial https://github.com/ULHPC/tutorials/tree/devel/advanced/R
  - Plot 2 graphs in section Simple Plotting
  - Answer 2 questions at the end of section Organizing your Data
  - Compare performance of aggregation operations w/wo parallelization
- Plot a speedup graph
  - with different number of cores and/or machines
  - needs: ggplot, parallel R

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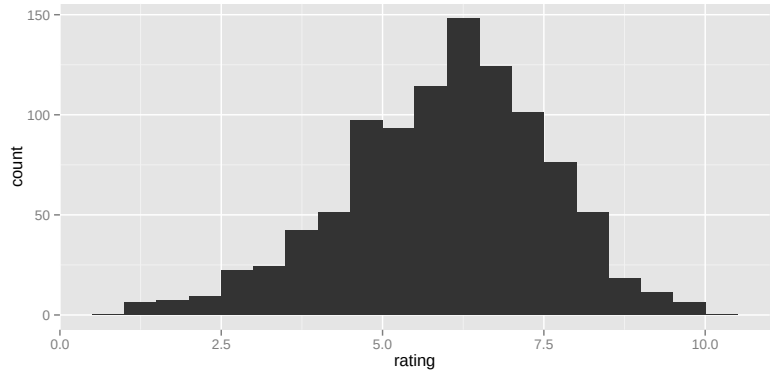
After the Practical Session: Problems

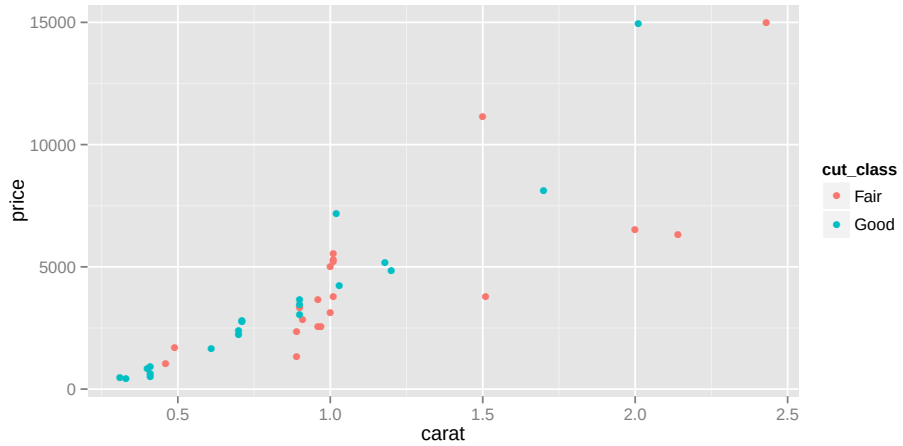
- regression models: example and exercise
- parallelization of K-means Clustering: example and exercise

Simple Plotting

Movies Histogram:



Diamonds Plot with 2 colours:



PS Questions

Question: use ddply instead of tapply in the first example

```
ddply(DT, .(x), summarize, sum(v))
```

Question: return the min and max instead of the sum.

```
min_max = function(data){
            c(min(data), max(data))
          }
DT[,min_max(v),by=x]

## or

DT[,c(min(v), max(v)),by=x]
```

Questions?

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Usefull links

- CRAN Archive http://cran.r-project.org/
- ggplot2 Documentation http://docs.ggplot2.org/current/
- CRAN HPC Packages http://cran.r-project.org/web/views/HighPerformanceComputing.html
- Advanced R programming by Hadley Wickham http://adv-r.had.co.nz/