Tutorial: Sampling, Weighting and Estimation
Part 1

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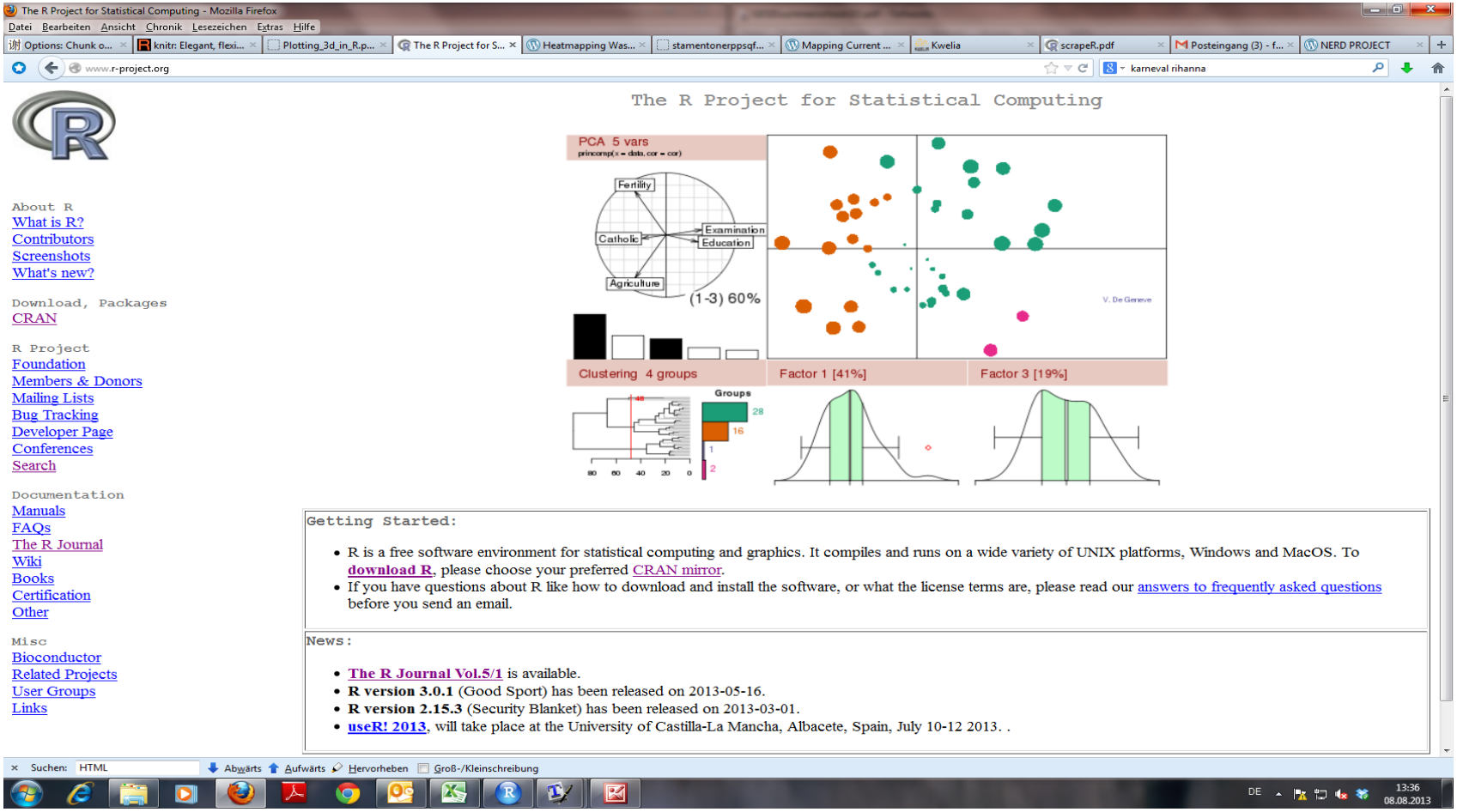
Why R?

- Open Source
- You can work with several datasets at the same time
- You can create your own objects, functions and packages
- Over 5,000 packages contributed by users available on CRAN

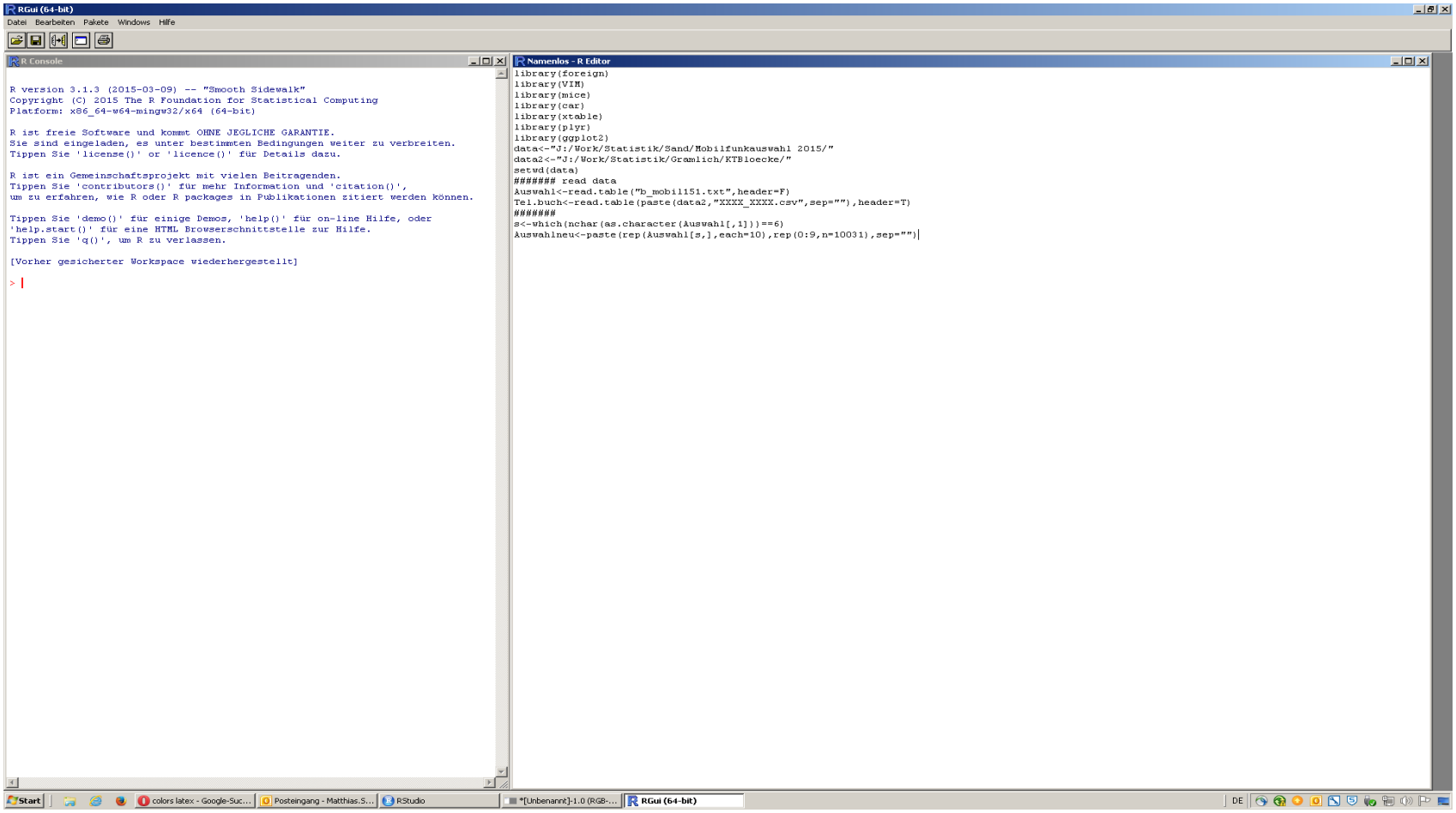
→ Rapid implementation of new (scientific) developments

→ Quick development of new tools that fit the user's demand

Getting Started - Download R

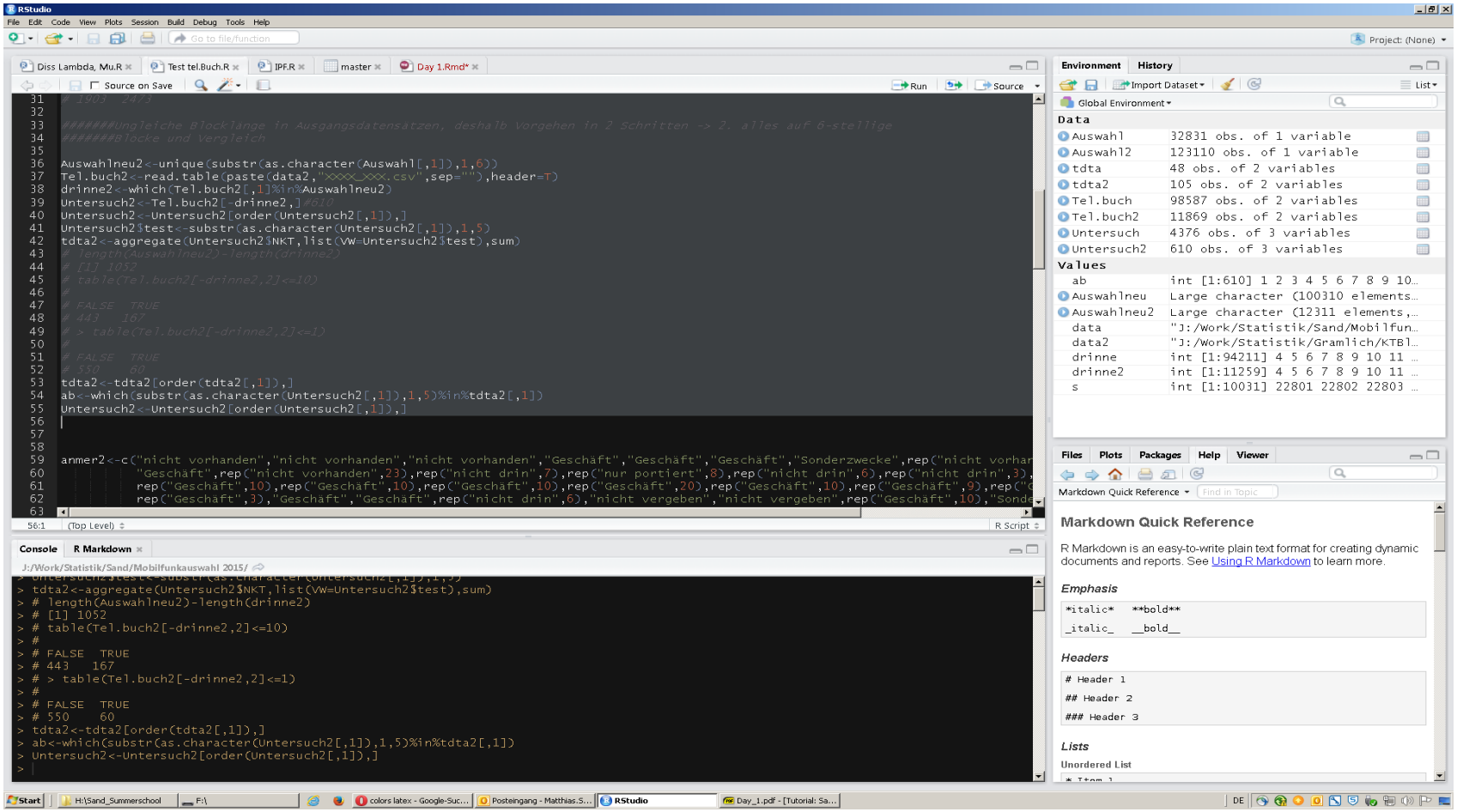


https://www.r-project.org



- most R-user prefer the graphical user interface (GUI) RStudio

R Studio



https://www.rstudio.com

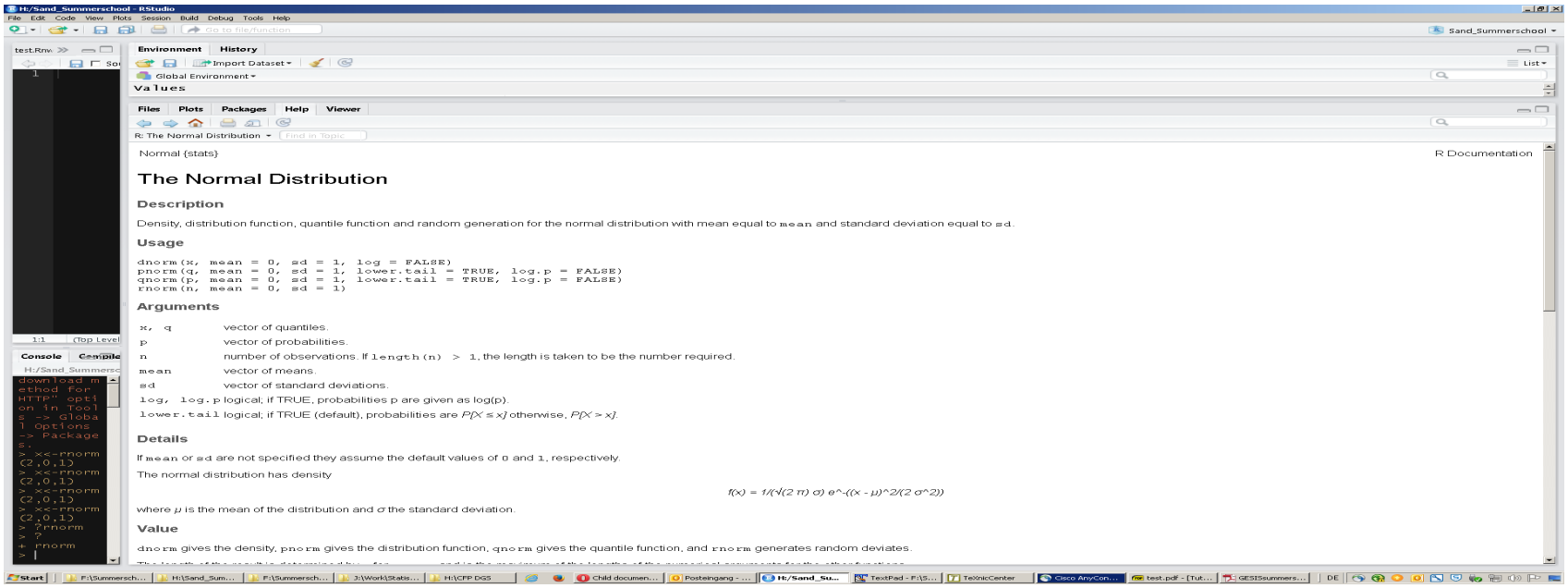
Basic R Commands

- `<-` assignment operator
- `#` can be used to comment your script
- `x<-rnorm(10,0,1)` creates a vector with ten standardnormal-distributed values
- `mean(x)` calculates the mean of variable `x`; `length(x)` returns the number of observations in `x`

```
mean(x)

## [1] -0.05681029

length(x)

## [1] 10
```

Getting Help

- *?command*



- CRAN
- Quick-R
- stackoverflow.com

Types of Data

numeric	`x<-c(1,2)`
logical	`x<-c(T,F)`
character	`x<-c("A","B")`
factor	`x<-as.factor(c("White","Black"))`

`str()` returns the type of your data

```
x<-as.factor(c("White","Black"))
str(x)

##  Factor w/ 2 levels "Black","White": 2 1
```

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Indexing a Vector:

```
A1<-c(1,2,3,4)
A1[1]

## [1] 1

A1[1:3]

## [1] 1 2 3

A1[-2]

## [1] 1 3 4
```

Indexing a data frame:

```
A2<-4:1
AA<-cbind(A1,A2)
AA[1,]

## A1 A2
##  1  4

AA[,1]

## [1] 1 2 3 4

AA[1:3,2]

## [1] 4 3 2

AA[,-1]
```

Indexing an array

```
A3<-array(1:8,c(2,2,2))
A3

## , , 1
##
##      [,1] [,2]
## [1,]    1    3
## [2,]    2    4
##
## , , 2
##
##      [,1] [,2]
## [1,]    5    7
## [2,]    6    8

A3[,,2]

##      [,1] [,2]
## [1,]    5    7
## [2,]    6    8
```

Indexing a list

```
A4<-list(A1,c("Summer","Winter"))
A4

## [[1]]
## [1] 1 2 3 4
##
## [[2]]
## [1] "Summer" "Winter"

A4[[1]]

## [1] 1 2 3 4
```

Sequences

```
1:5

## [1] 1 2 3 4 5

rep("A",times=10)

##  [1] "A" "A" "A" "A" "A" "A" "A" "A" "A" "A"

rep(1:3,times=2,each=3)

##  [1] 1 1 1 2 2 2 3 3 3 1 1 1 2 2 2 3 3 3

seq(-5,5,by=2.5)

## [1] -5.0 -2.5  0.0  2.5  5.0
```

Random Numbers

Function	Distribution	Important parameter
`runif()`	Uniform distribution	n, min, max
`rnorm()`	Normal distribution	n, mean, sd
`rpois()`	Poisson distribution	n, lambda
...	...	...

Important Functions
of the {base}-Package

Function	Meaning	Example
`length()`	Length	`length(x)`
`max()`	Maximum	`max(x)`
`min()`	Minimum	`min(x)`
`sd()`	Standard deviation	`sd(x)`
`var()`	Variance	`var(x)`
`mean()`	Mean	`mean(x)`
`median()`	Median	`median(x)`

These functions do only need one argument
Other functions need to be specified by further arguments:

`quantile()`	90% Quantile	`quantile(x,.9)`
`sample()`	Draw a sample	`sample(x,1)`

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of the {base}-Package

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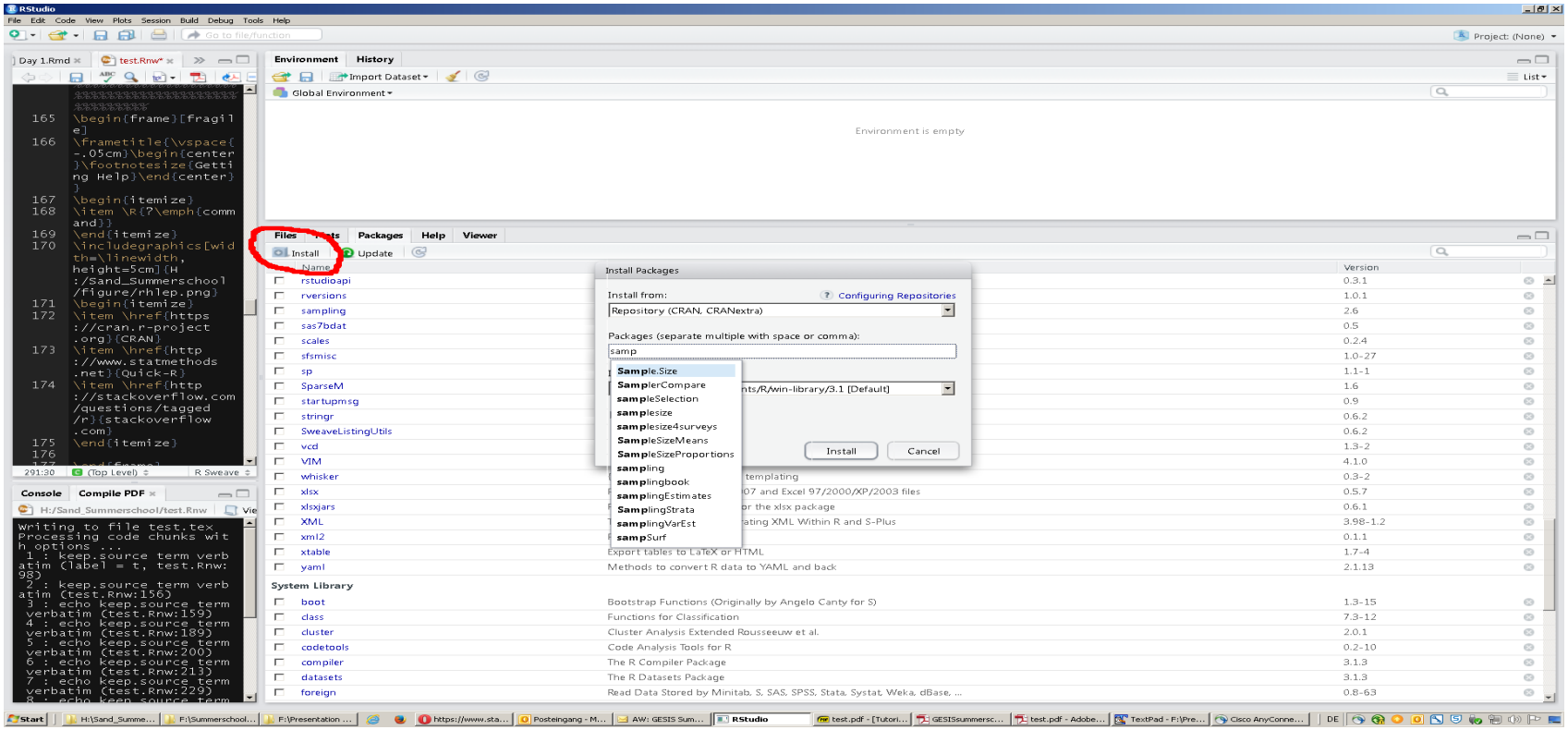
`quantile()`	90% Quantile	`quantile(x,.9)`
`sample()`	Draw a sample	`sample(x,1)`

- `R` is a modular program with many functions included in basic `R`
- more specific functions are embedded in further packages

Installing and Loading Packages

```
install.package("sampling")
```




```
library(sampling) or require(sampling)
```

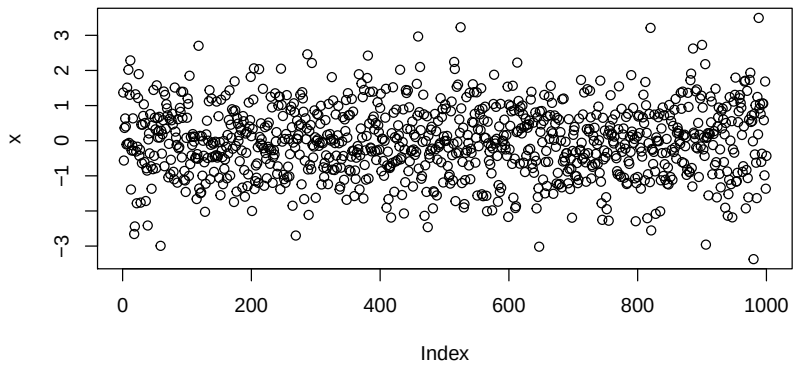
Useful Packages

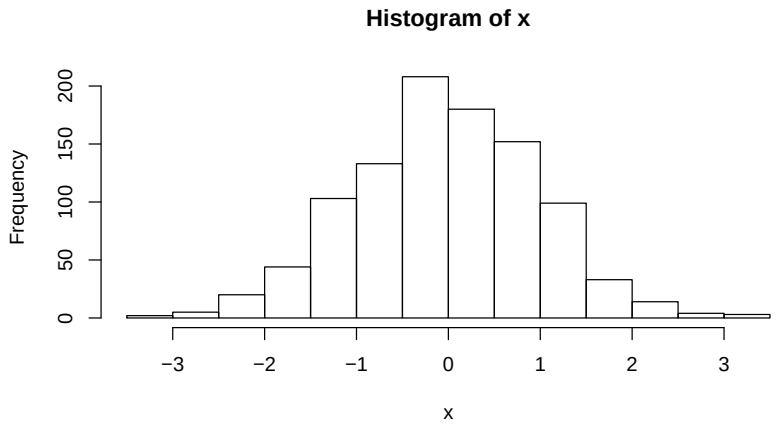
Library	Subject
`foreign`	reading and writing of data in numerous formats (e.g. *.dta*, *.sav*)
`sampling`	drawing and weighting samples
`survey`	analysis of complex survey samples
`xlsx`	read and write data in Excell-Format
`xtable`	export tables to LaTex and HTML
`mice`	multiple imputation by chain equation
`reshape`	alter structure of datasets
`car`	applied regressions
`VIM`	visualization and imputation of Missing Values
`lattice`	high-level data visualization
`ggplot2`	grammar for graphics in `R`

```r
set.seed(42)
x <- rnorm(1000,0,1)
plot(x)
```

`set.seed()` is used to specify a starting point

```r
hist(x)
```





⇒ we will use *42* as seed-value for future exercises to obtain comparable results

The Basic `sample` Function

sample {base} R Documentation

Random Samples and Permutations

Description

`sample` takes a sample of the specified size from the elements of `x` using either with or without replacement.

Usage

```
sample(x, size, replace = FALSE, prob = NULL)
```

x: From what do we want to sample ?

```
sample(x=1:10,n=1,replace=T)
```

The Basic sample Function

sample {base} R Documentation

Random Samples and Permutations

Description

`sample` takes a sample of the specified size from the elements of `x` using either with or without replacement.

Usage

```
sample(x, size, replace = FALSE, prob = NULL)
```

n: How many elements do we want to draw?

```
sample(x=1:10,n=1,replace=T)
```

The Basic sample Function

sample {base} R Documentation

Random Samples and Permutations

Description

`sample` takes a sample of the specified size from the elements of `x` using either with or without replacement.

Usage

```
sample(x, size, replace = FALSE, prob = NULL)
```

Do we want to draw with or without replacement?

```
sample(x=1:10,n=1,replace=T)
```

Simple Example on Sampling

```r
id <- 1:10000
set.seed(42)
education <- sample(c("none","low","average","high"),10000,
                    replace = T,prob = c(.072,.356,.289,.283))

gender <- sample(c("male","female"),10000,
                 replace = T,prob = c(.488,.512))

iq <- rnorm(10000,100,20)
my.pop <- data.frame(id,gender,education,iq)
head(my.pop)

##   id gender education        iq
## 1  1   male      high 123.26218
## 2  2   male      none  96.19531
## 3  3   male       low  94.21088
## 4  4 female      high  92.02308
## 5  5   male   average 114.18485
## 6  6   male   average  67.54705
```

Simple Example on Sampling

Summary of the dataset

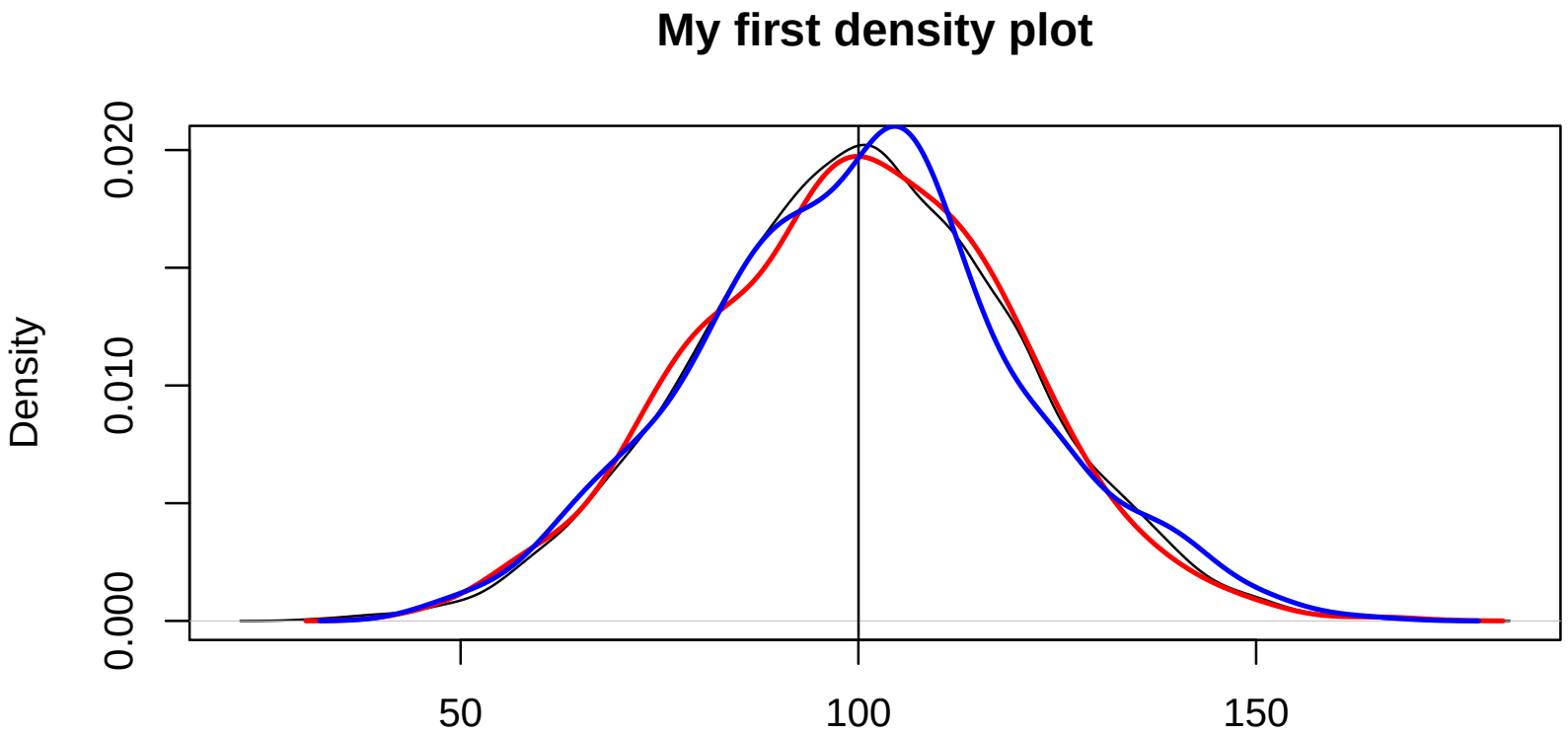
```r
summary(my.pop)

##        id            gender       education          iq
##  Min.   :    1   female:5125   average:2851   Min.   : 30.93
##  1st Qu.: 2501   male  :4875   high   :2820   1st Qu.: 86.50
##  Median : 5000                  low    :3588   Median :100.08
##  Mean   : 5000                  none   : 741   Mean   :100.02
##  3rd Qu.: 7500                                 3rd Qu.:113.60
##  Max.   :10000                                 Max.   :173.26

prop.table(table(my.pop$gender, my.pop$education))

##
##          average   high    low   none
##   female  0.1449 0.1465 0.1844 0.0367
##   male    0.1402 0.1355 0.1744 0.0374

var(my.pop$iq) * (nrow(my.pop) - 1)/nrow(my.pop)

## [1] 406.1684
```

Simple Example on Sampling

```r
set.seed(42)
s.SRS <- sample(1:nrow(my.pop), 500, replace = T)
s.SRSWOR <- sample(1:nrow(my.pop), 500, replace = F)
my.samp.SRS <- my.pop[s.SRS, ]
my.samp.SRSWOR <- my.pop[s.SRSWOR, ]
summary(my.samp.SRS)

##        id          gender      education         iq
##  Min.   :   3   female:257   average:132   Min.   : 45.95
##  1st Qu.:2322   male  :243   high   :134   1st Qu.: 85.38
##  Median :4804                low    :192   Median :100.00
##  Mean   :4896                none   : 42   Mean   : 99.60
##  3rd Qu.:7434                              3rd Qu.:113.20
##  Max.   :9966                              Max.   :165.63

nrow(unique(my.samp.SRS))

## [1] 487
```

Simple Example on Sampling

```
plot(density(my.pop$iq),
     main = "My first density plot",
     xlab = "IQ")
abline(v=mean(my.pop$iq), col = "black")
lines(density(my.samp.SRS$iq),col = "red",lwd=2)
lines(density(my.samp.SRSWOR$iq),col = "blue",lwd=2)
```



Simple Example on Sampling

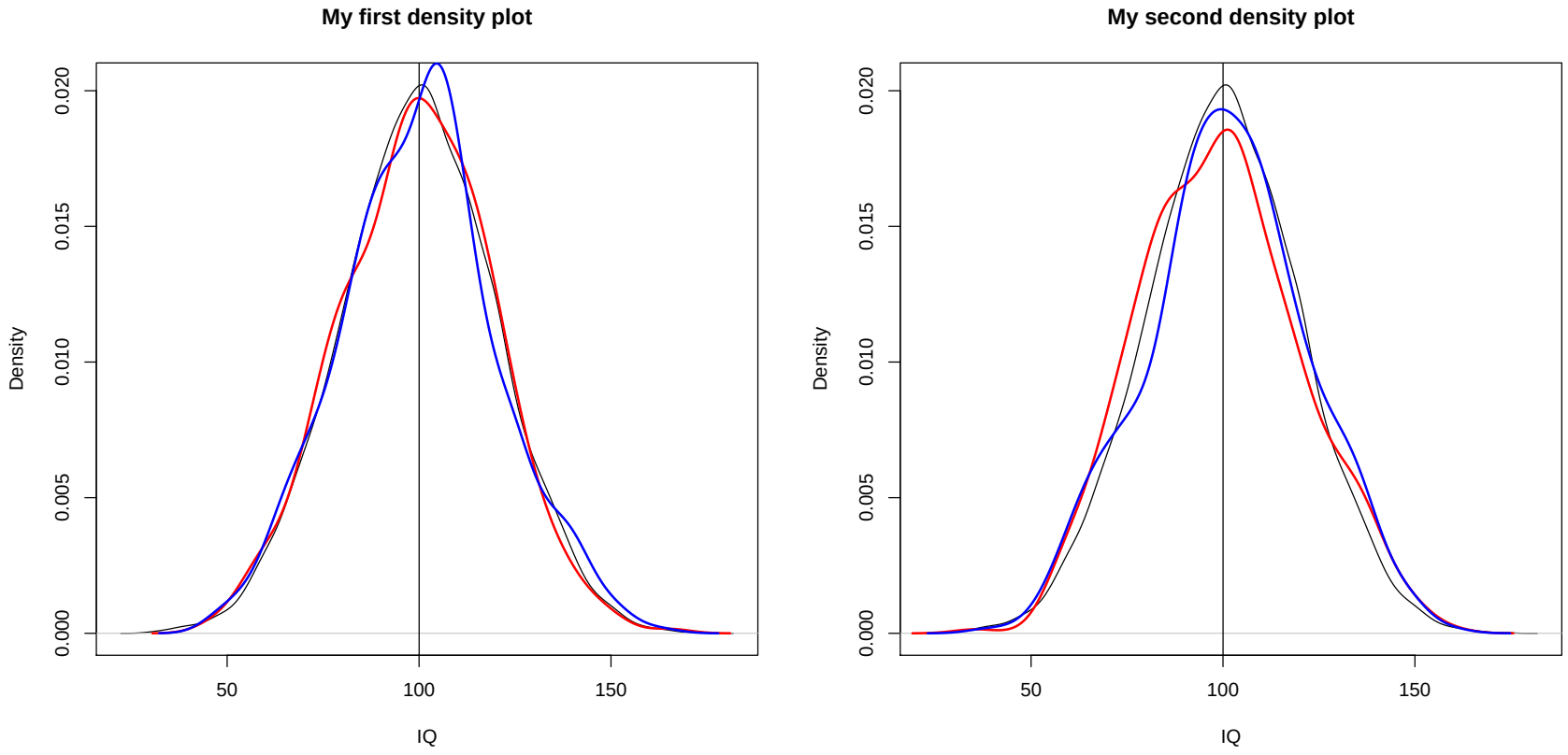
the sampling package

```
library(sampling)
set.seed(42)
s.SRS1 <- srswr(500,nrow(my.pop))
s.SRSWOR1 <- srswor(500,nrow(my.pop))
my.samp.SRS1 <- rbind(my.pop[s.SRS1!=0,],
                      my.pop[s.SRS1>1,])
my.samp.SRSWOR1 <- my.pop[s.SRSWOR1==1,]
```

Simple Example on Sampling

the sampling package

```r
par(mfrow = c(1, 2))
```

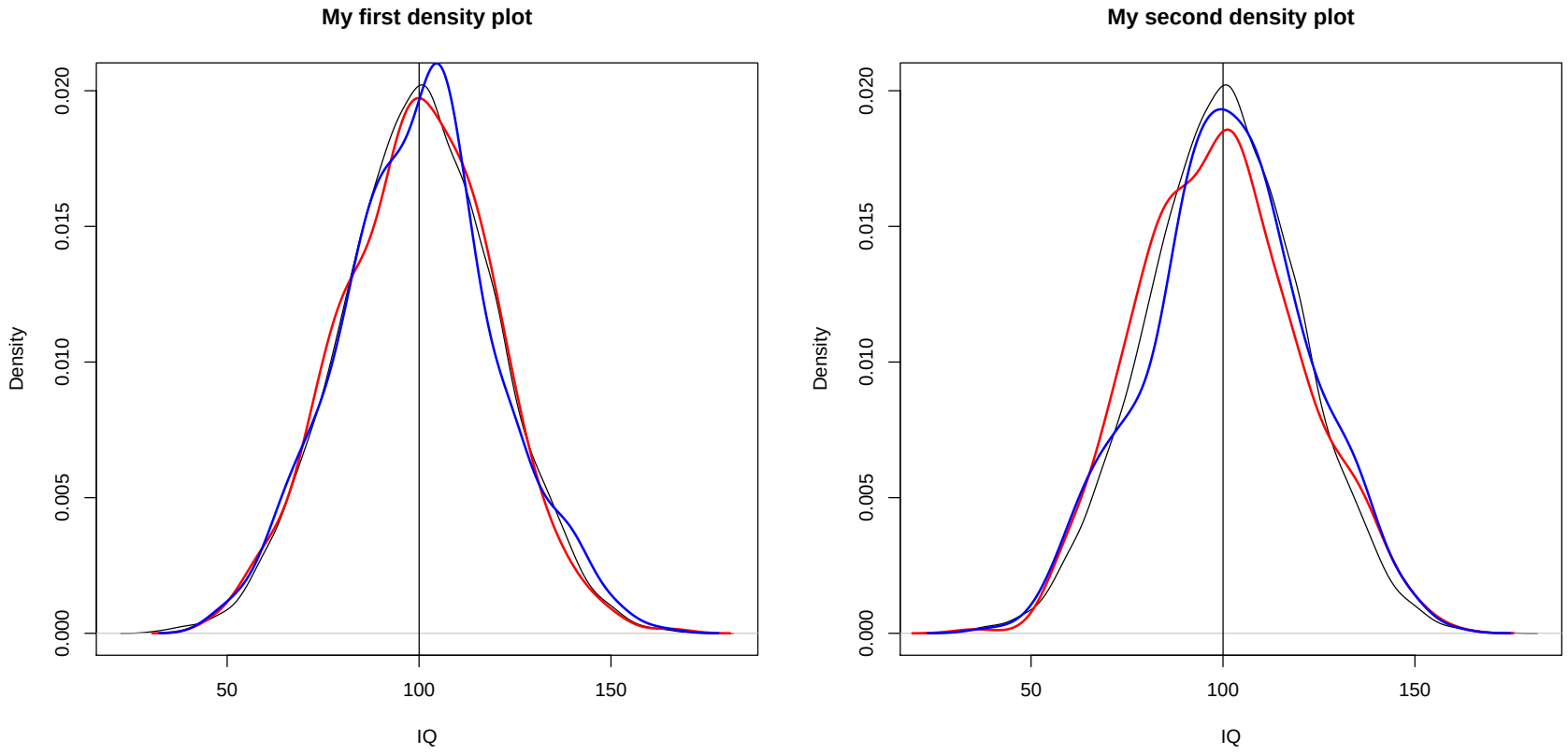



```r
dev.off()
```

Simple Example on Sampling

the sampling package

```
par(mfrow = c(1, 2))
```




```
dev.off()
```

- should yield same results

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Declaring a working directory

```
path<-"H:/Sand_ Summerschool/Data Day1/"
setwd(path)
```

- It is always useful to define and set your working directory at the beginning of each script
- `getwd()` displays you your current working directory
- `dir()` shows you all objects in a specific directory
- `ls()` lists all objects in your workspace
- `rm()` removes a object from your workspace

Example:

```
rm(list = ls())
```

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Writing/ saving data and results

```
write.table(my.pop,"Synthetic Data Day1.csv",
row.names = F, quote = F, dec = ".",sep = ",")
```

OR:

```
save(my.samp.SRS,s.SRS,my.samp.SRSWOR1,file = "Day1.Rdata")
```

⇒ See also: `write.csv` and `write.csv2` (`sep = ";"`)

Reading/ loading data and results

```
d1 <- read.table("Synthetic Data Day1.csv",
header = F, dec = ".",sep = ",")
```

OR:

```
load("Day1.Rdata")
```