Applied Statistics in R

Elena Parilina

Master's Program
Game Theory and Operations Research

Saint Petersburg State University

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References

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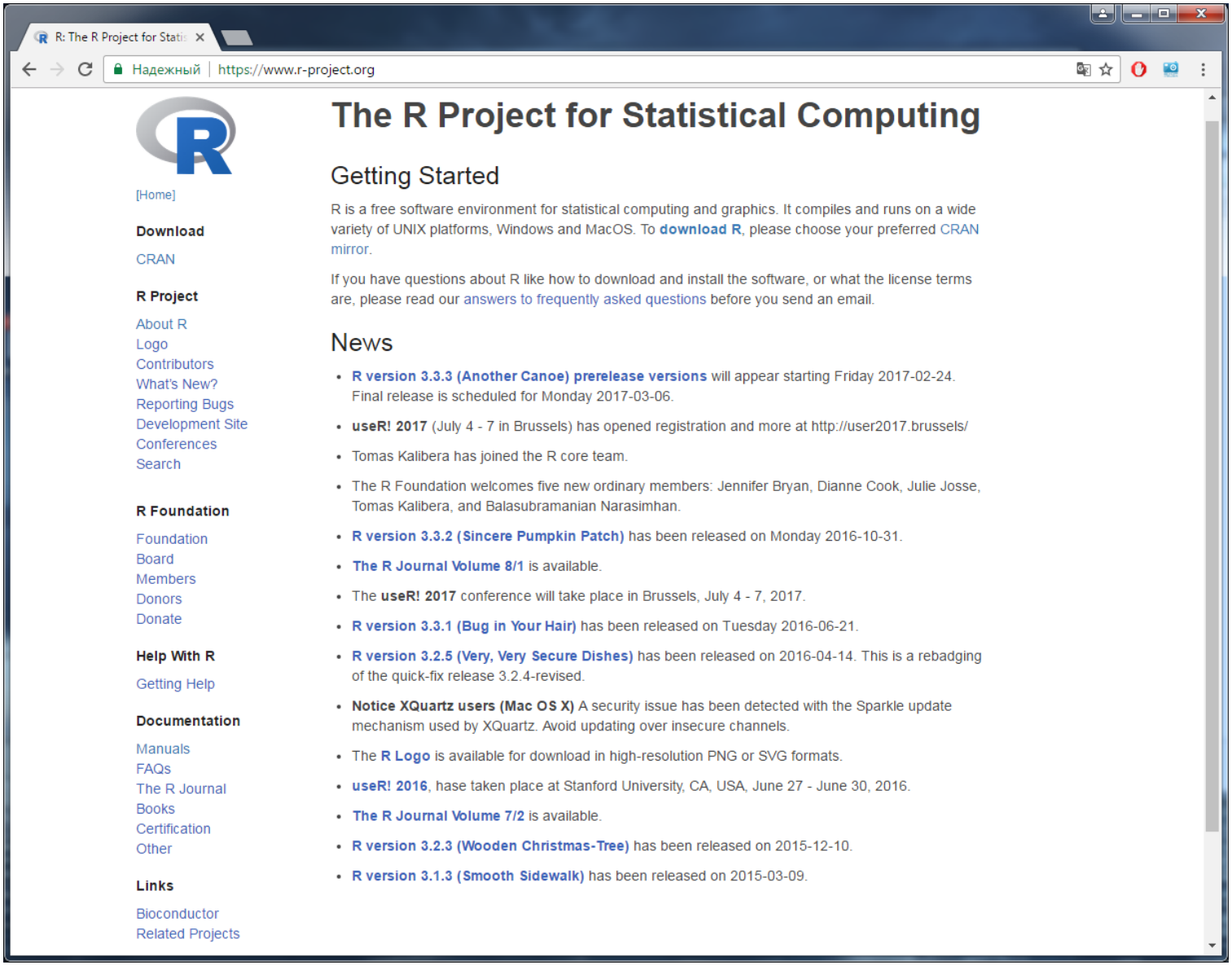
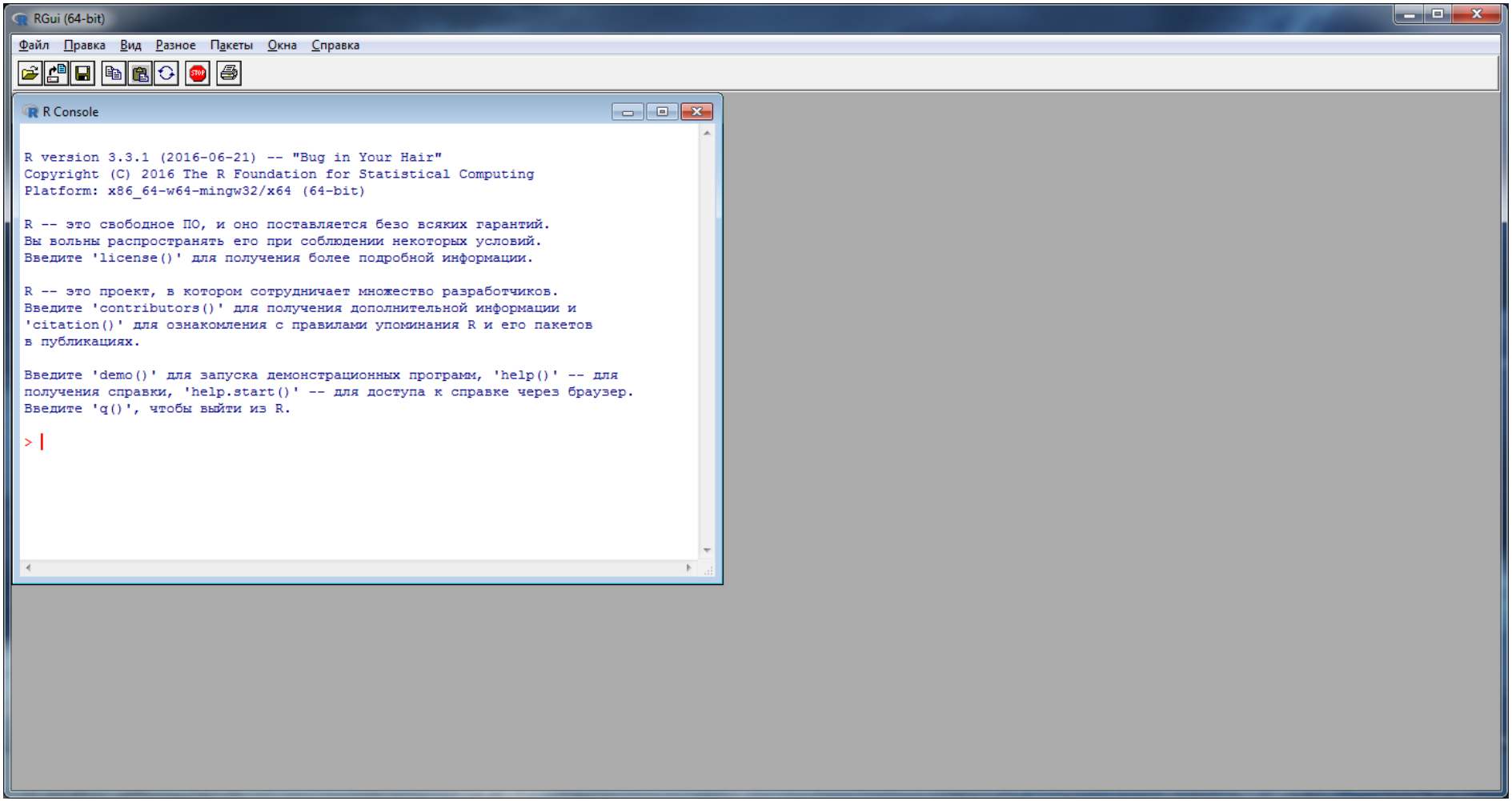
7. Maddala G.S., "Introduction to Econometrics", Macmillan Publishing Company, 2nd edition, 2007, 637 p.

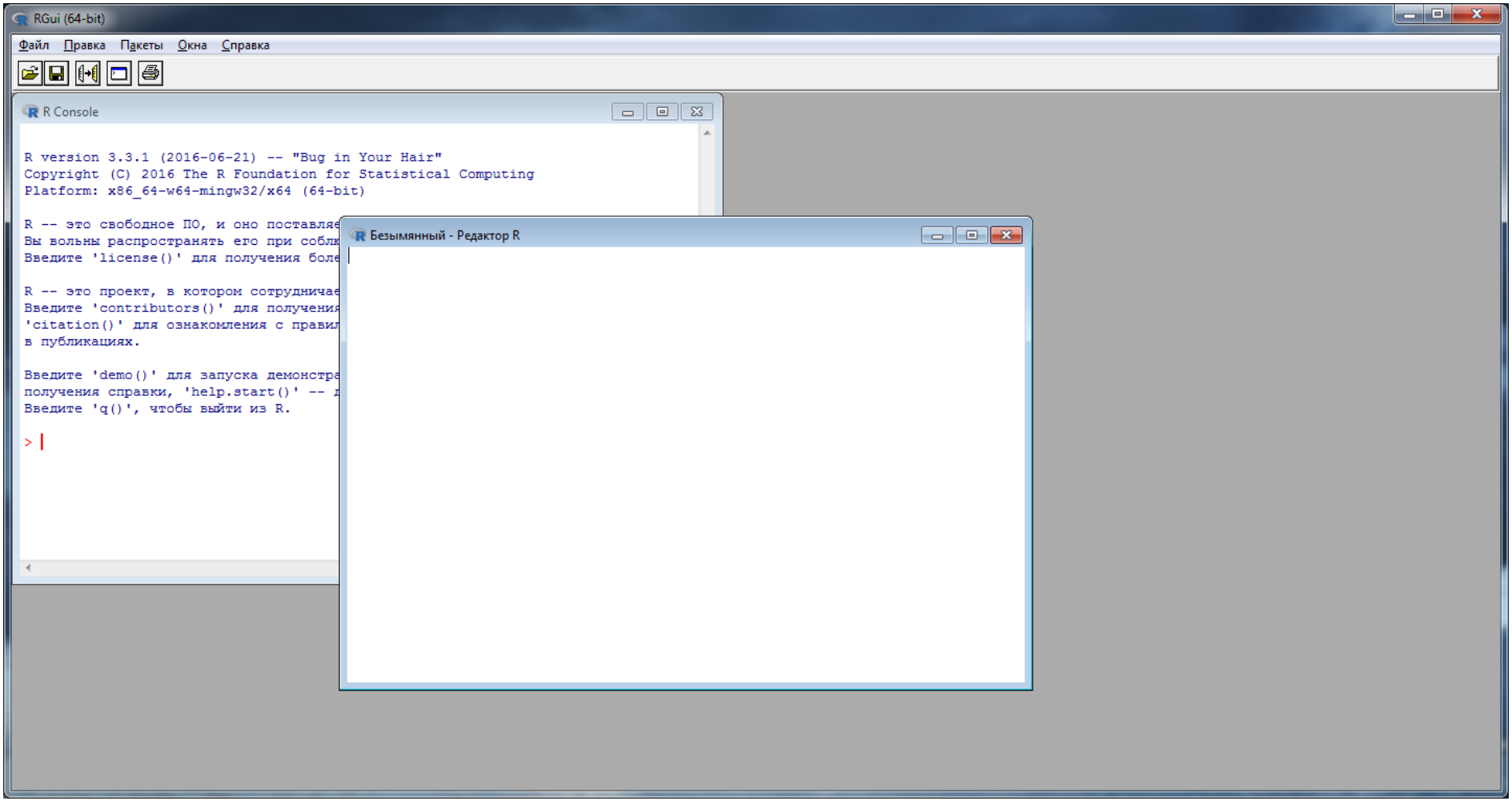
R Project: http://www.r-project.org/



RGui


RGui (64-bit)
Файл Правка Вид Разное Пакеты Окна Справка
R Console
R version 3.3.1 (2016-06-21) -- "Bug in Your Hair"
Copyright (C) 2016 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
R -- это свободное ПО, и оно поставляется безо всяких гарантий.
Вы вольны распространять его при соблюдении некоторых условий.
Введите 'license()' для получения более подробной информации.
R -- это проект, в котором сотрудничает множество разработчиков.
Введите 'contributors()' для получения дополнительной информации и
'citation()' для ознакомления с правилами упоминания R и его пакетов
в публикациях.
Введите 'demo()' для запуска демонстрационных программ, 'help()' -- для
получения справки, 'help.start()' -- для доступа к справке через браузер.
Введите 'q()', чтобы выйти из R.
>

New R script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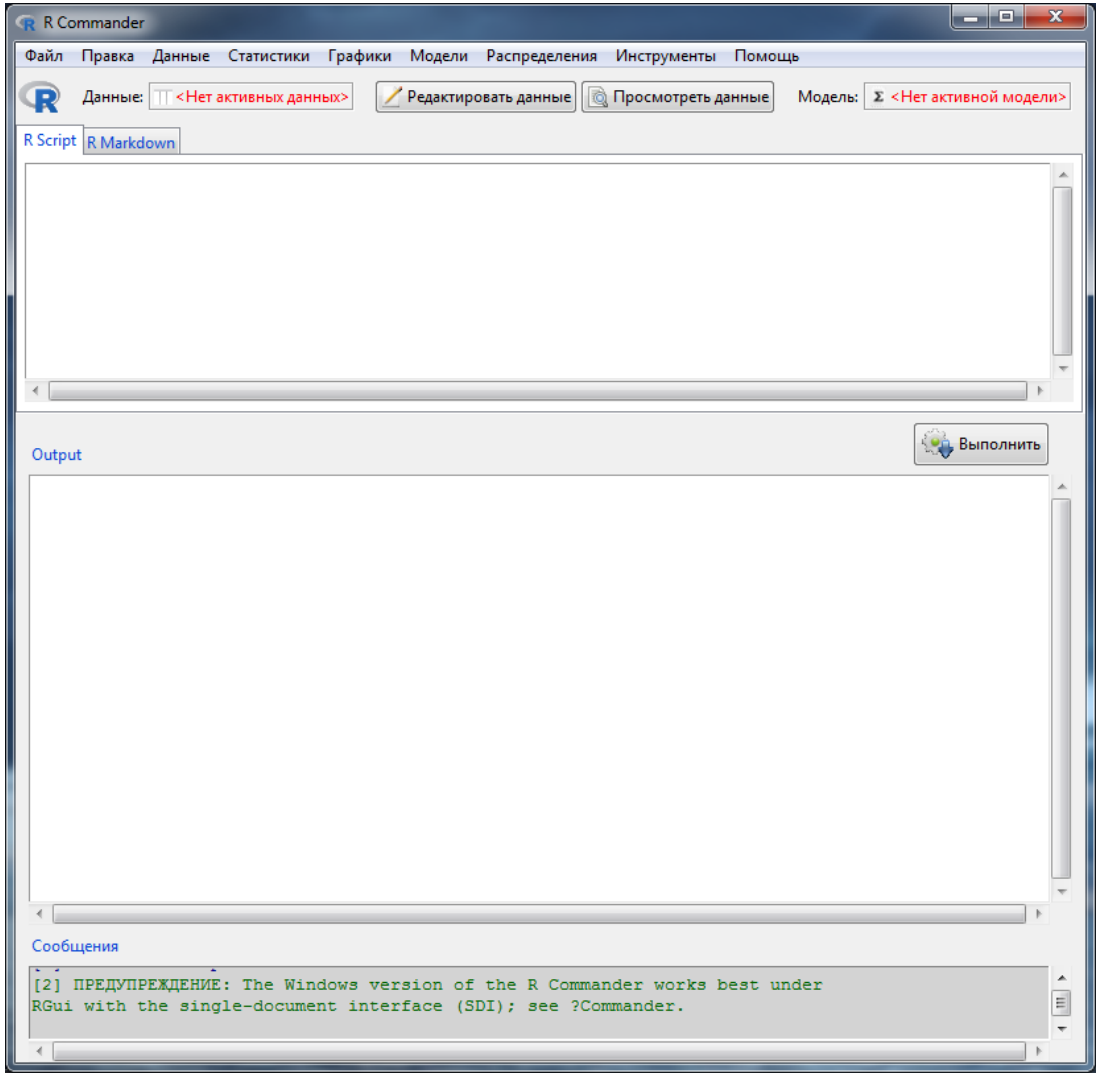
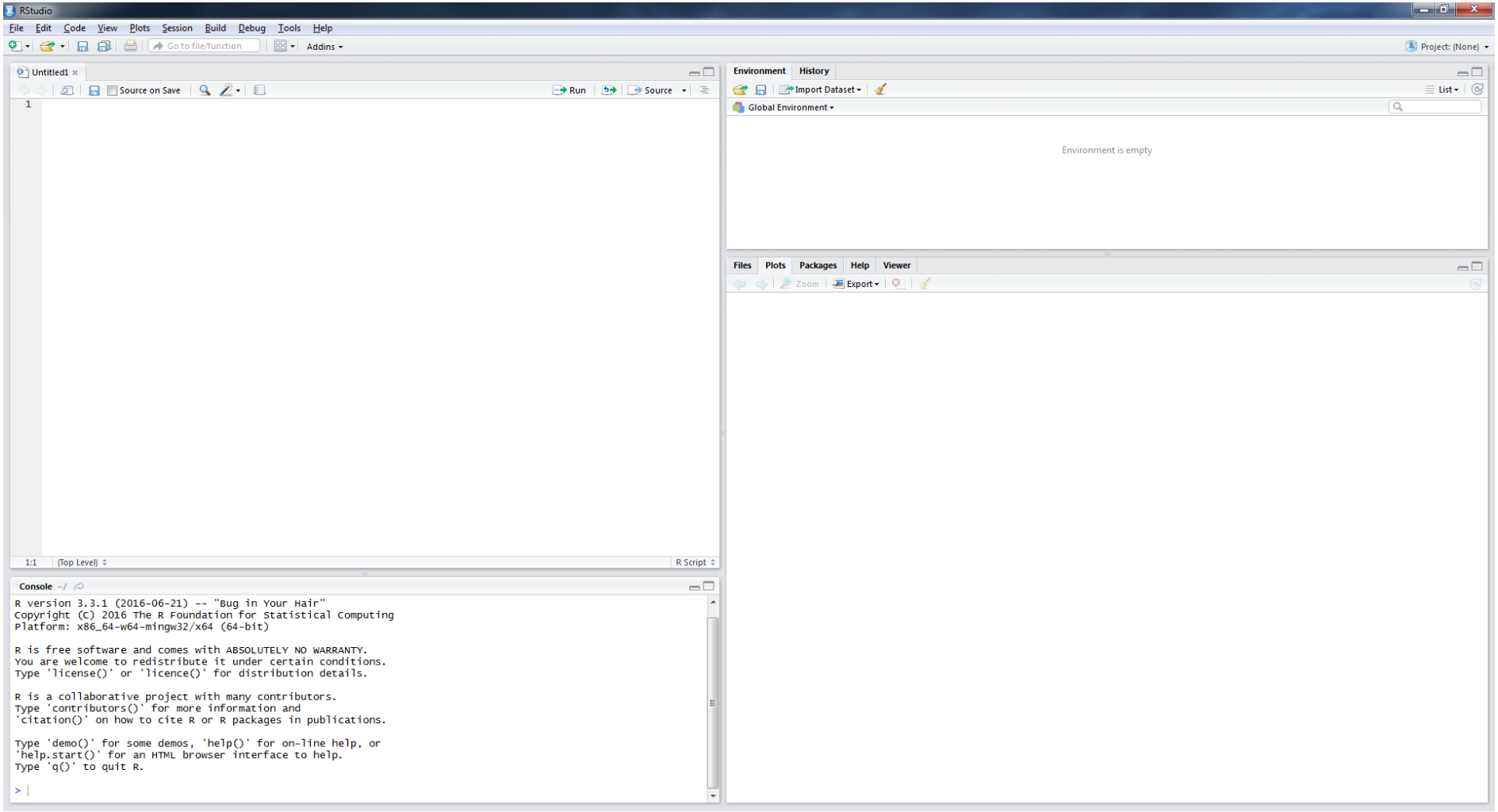
Введите 'q()', чтобы выйти из R.
>
Безымянный - Редактор R

R Commander

```
library(Rcmdr);
```



RStudio: https://www.rstudio.com



R packages

- To load a package in R:

```
> library()
```

- To install a package in R:

```
> install.packages()
```

- To install several packages in R:

```
> install.packages(c("tree","maptree"))
```

Basic operations in R

- To combine a vector in R:

```
> c(1,2,3,4)
[1] 1 2 3 4
```

- Operators with vectors:

```
> c(1,2,3,4)+c(10,20,30,40)
[1] 11 22 33 44
```

```
> c(1,2,3,4)*c(10,20,30,40)
[1] 10 40 90 160
```

```
> 1/c(1,2,3,4)
[1] 1.000 0.500 0.333 0.250
```

```
> c(1,2,3,4)+c(10,100)
[1] 11 102 13 104
```

Variables

- To assign a value to a variable:

```
> x <- 1
> y <- 2
> z <- x+y
```

- To refer to a member of a vector:

```
> b <- c(1,2,3,4,5,6,7,8,9,10)
> b[7]
[1] 7

> b[1:6]
[1] 1 2 3 4 5 6
```

Lists in R

- A list is a generic vector containing other objects. For example, the following variable x is a list containing copies of three vectors n, s, b, and a numeric value 3:

```
> n = c(2, 3, 5)
> s = c("aa", "bb", "cc", "dd", "ee")
> b = c(TRUE, FALSE, TRUE, FALSE, FALSE)
> x = list(n, s, b, 3) # x contains copies of n, s, b
```

- To access an item in the list:

```
> x[2]
[1] "aa" "bb" "cc" "dd" "ee"
```

Lists in R

- In order to reference a list member directly, use the double square bracket "[[]]" operator. The following object x[[2]] is the second member of x. In other words, x[[2]] is a copy of s, but is not a slice containing s or its copy:

```
> x[[2]]
[1] "aa" "bb" "cc" "dd" "ee"
```

Named lists in R

- ```
  > v = list(bob=c(2, 3, 5), john=c("aa", "bb"))
  > v
  $bob
  [1] 2 3 5
  $john
  [1] "aa" "bb"
  ```
- In order to reference a list member directly, use the double square bracket "[[]]" operator. The following references a member of v by name:
  ```
  > v[["bob"]]
  [1] 2 3 5
  ```
- A named list member can also be referenced directly with the "$" operator in lieu of the double square bracket operator:
  ```
  > v$bob
  [1] 2 3 5
  ```
  ```

Data frame

Data frame is a list that contains multiple named vectors that are the same length. Data frame is a lot like a database table. For example, there is a data frame with win/loss results in the National League (NL) East in 2008:

```
> teams <- c("PHI","NYM","FLA","ATL","WSN")
> w <- c(92, 89, 94, 72, 59)
> l <- c(70, 73, 77, 90, 102)
> nleast <- data.frame(teams,w,l)
> nleast
```

	teams	w	l
1	PHI	92	70
2	NYM	89	73
3	FLA	94	77
4	ATL	72	90
5	WSN	59	102

Data frame

- To refer the components of a data frame use "$" operator:

```
> nleast$w
[1] 92 89 94 72 59
```

- Suppose you want to find the number of losses by Florida Marlins (FLA). You can calculate it like this:

```
> nleast$teams=="FLA"
[1] FALSE FALSE TRUE FALSE FALSE
```

- Then you can use thia vector to refer to the right element in the losses vector:

```
> nleast$l[nleast$teams=="FLA"]
[1] 77
```

Data input

- XLS-file:

```
library(gdata)
data <- read.xls("C:/noname.xls", sheet = 1, header =
TRUE)
```

- XLSX-file:

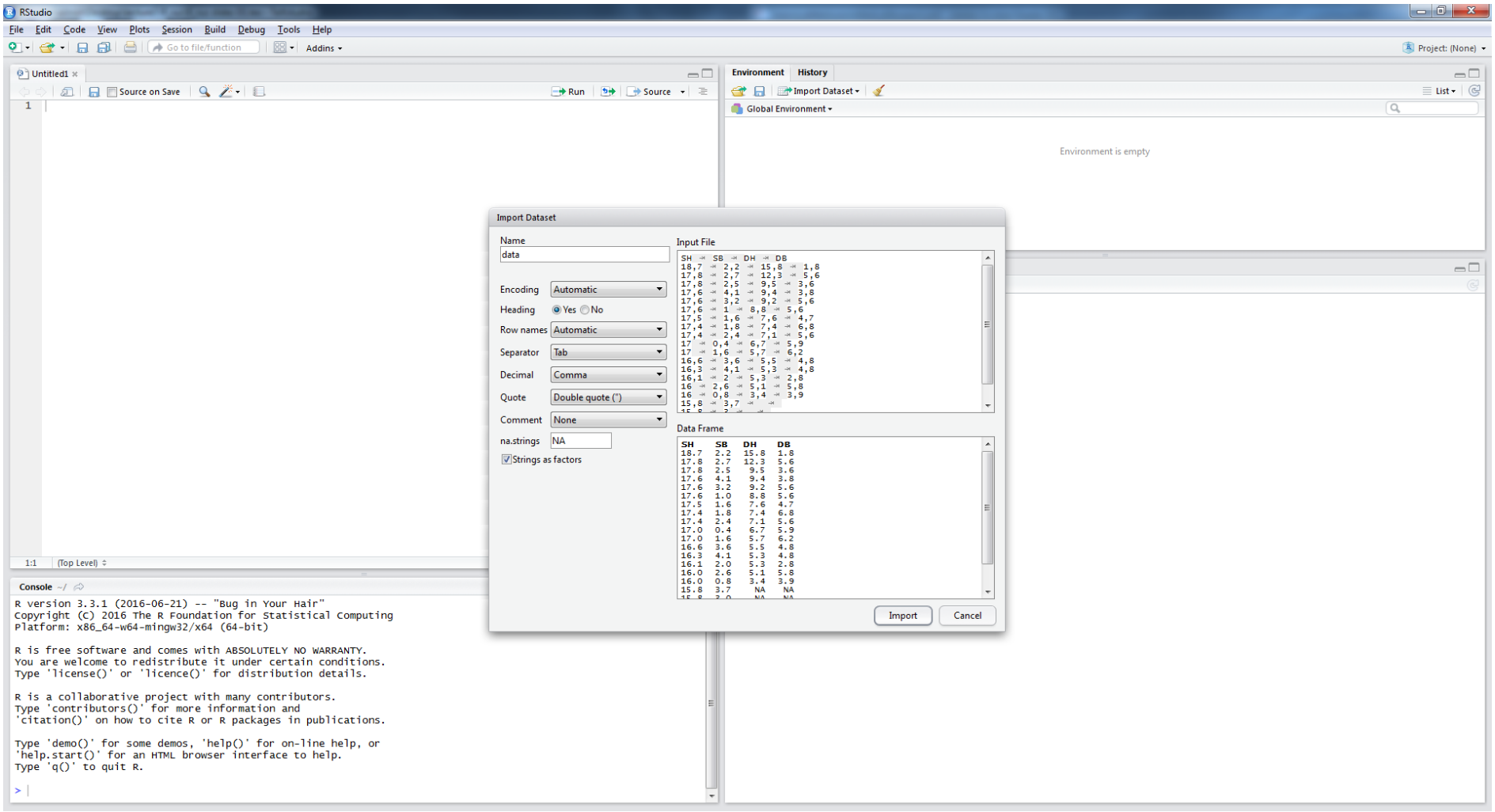
```
library(readxl)
data <- read_excel("C:/haemolytic.xlsx", sheet = 1,
col_names = TRUE)
```

- TXT-file:

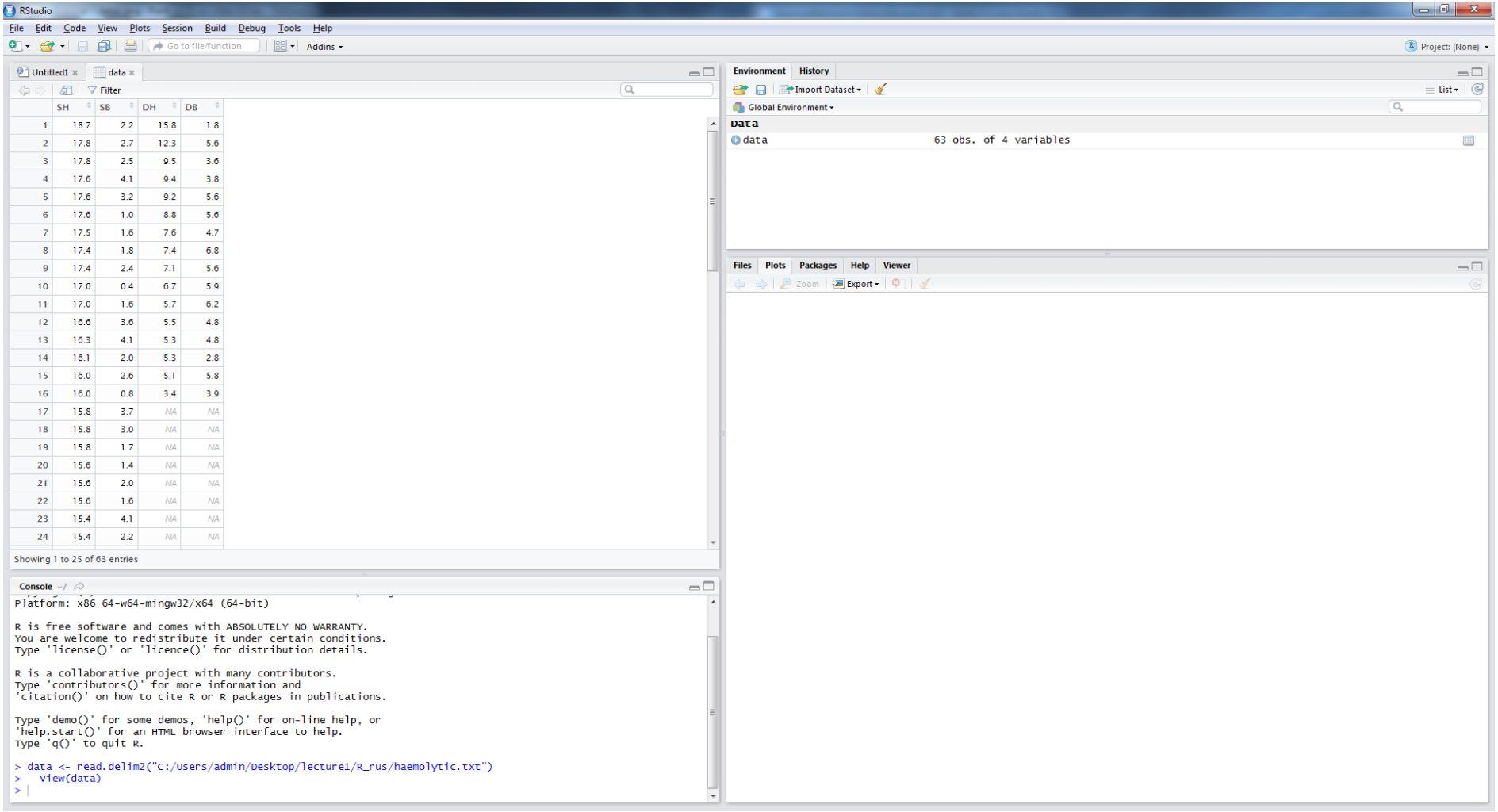
```
data <- read.table("C:/noname.txt", header=TRUE,
sep="\t", na.strings="NA", dec=",")
```

Data input (RStudio)

Tools → Import Dataset → From Local File...



Data input (RStudio)



Missing values: NA

To check if there are NA entries in data:
`is.na(data$DH)`

To produce a vector without NA entries:
`data$DH[! is.na(data$DH)]`

Vectors

```
x <- c(1,3,0,2,1,4,2,1,5,0)
x <- seq(-4,4,0.01)

length(x)
table(x)
summary(x)

x[4]
x[c(2,3,6)]
x[1:3]
x[-1]
x[-length(x)]
```

- `max(x)`: maximum value in `x`
- `min(x)`: minimum value in `x`
- `sum(x)`: total of all the values in `x`
- `mean(x)`: arithmetic average of the values in `x`
- `median(x)`: median value in `x`
- `range(x)`: vector of min(x) and max(x)
- `var(x)`: sample variance of `x`
- `sd`: sample standard deviation of `x`
- `cor(x,y)`: correlation between vectors `x` and `y`
- `sort(x)`: a sorted version of `x`
- `rank(x)`: vector of the ranks of the values in `x`
- `quantile(x)`: vector containing the minimum, lower quartile, median, upper quartile, and maximum of `x`
- `cumsum(x)`: vector containing the sum of all of the elements up to that point
- `cumprod(x)`: vector containing the product of all of the elements up to that point

Generating random samples

- `rnorm(n,m,sd)`;
- `runif(n,a,b)`;
- `rweibull(n,shape,scale)`;
- `rpois(n,lambda)`;
- `rgamma(n,shape,scale)`;
- `rbinom(n,size,prob)`;
- `rchisq(n,df)`;
- `rexp(n,rate)`;
- `rf(n,df1,df2)`;
- `rt(n,df)`.

PDF, CDF, quantiles

PDF: replace `r` with `d`

```
curve(dnorm(x,m=10,sd=2),from=0,to=20,main="Probability
density function N(10,4)")
```

CDF: replace `r` with `p`

```
curve(pnorm(x,m=10,sd=2),from=0,to=20,main="Cumulative
distribution function N(10,4)")
```

Quantiles: replace `r` with `q`.

Plot

`hist(x)`: histogram of `x`;
`boxplot(x)`: boxplot of `x`;

`ecdf(x)`: empirical cdf of `x`:
`plot(ecdf(x))`
`plot(x, y)`: x–y plotting

```
plot(ecdf(x), lty=1)
lines(ecdf(rnorm(10000, 0, .5)), lty=2)
```
`lines`: add connected line segments to a plot

`points(x)`: add points to a plot

```
curve(pnorm(x, 0, 1), -4, 4)
curve(pnorm(x, 0, 0.5), add=TRUE)
```
`curve(expr)`: draw function plots

Data for seminar 1. Dataset "Babyboom"

- NAME: Time of Birth, Sex, and Birth Weight of 44 Babies
- TYPE: Observational
- SIZE: 44 observations, 4 variables

DESCRIPTIVE ABSTRACT:

The dataset contains the time of birth, sex, and birth weight for each of 44 babies born in one 24-hour period at a Brisbane, Australia, hospital. Also included is the number of minutes since midnight for each birth.

SOURCE:

The data appeared in the Brisbane newspaper "The Sunday Mail" on December 21, 1997.

REFERENCE:

Steele, S. (December 21, 1997), "Babies by the Dozen for Christmas: 24-Hour Baby Boom," "The Sunday Mail" (Brisbane), p. 7.

Data for seminar 1. Dataset "Babyboom"

VARIABLE DESCRIPTIONS:

Columns

1 - 8 Time of birth recorded on the 24-hour clock

9 - 16 Sex of the child (1 = girl, 2 = boy)

17 - 24 Birth weight in grams

25 - 32 Number of minutes after midnight of each birth

Values are aligned and delimited by blanks. There are no missing values.

Data for seminar 1. Dataset "Babyboom"

STORY BEHIND THE DATA:

Forty-four babies – a new record – were born in one 24-hour period at the Mater Mothers' Hospital in Brisbane, Queensland, Australia, on December 18, 1997. For each of the 44 babies, "The Sunday Mail" recorded the time of birth, the sex of the child, and the birth weight in grams.

PEDAGOGICAL NOTES:

The data can be used to demonstrate fitting the binomial distribution (the number of boys/girls born out of 44 births), the geometric distribution (the number of births until a boy or girl is born), the Poisson distribution (births per hour for each hour), and the exponential distribution (times between births). The normal distribution is found to be unsuitable for modeling the birth weights, but better results are obtained when birth weights are separated by sex. The dataset can also be used to illustrate hypothesis tests about proportions, comparisons of birth weights by gender, the runs test of randomness of gender, and skewed data.

Data for seminar 1. Dataset "Airport"

NAME: US AIRPORT STATISTICS
TYPE: Census (sort of)
SIZE: 135 observations, 7 variables (5 numeric, 2 character)
DESCRIPTIVE ABSTRACT:
This dataset consists of all 135 large and medium sized air hubs in the United States as defined by the Federal Aviation Administration.
SOURCE:
U.S. Federal Aviation Administration and Research and Special Programs Administration, 'Airport Activity Statistics' (1990).
SPECIAL NOTES:
These are the only cities provided in this source. Although, it is not a census of all air hubs, it is a census of all medium and large hubs as classified by FAA.
STORY BEHIND THE DATA:
Author, who is very interested in maps, geography, and U.S.

Data for seminar 1. Dataset "Airport"

transportation system entered this as part of a 'U.S. infrastructure series' (along with highway and others) this summer.

VARIABLE DESCRIPTIONS:

Airport	Columns 1-21
City	Columns 22-43
Scheduled departures	Columns 44-49
Performed departures	Columns 51-56
Enplaned passengers	Columns 58-65
Enplaned revenue tons of freight	Columns 67-75
Enplaned revenue tons of mail	Columns 77-85

PEDAGOGICAL NOTES:

It does allow a teacher to use some actual data when teaching concepts of descriptive statistics, such as graphical and numeric descriptions of a set of measurements.

Data for seminar 1. Dataset "Euroweight"

NAME: The Weight of Euro Coins
TYPE: Fitting distributions to data
SIZE: 2000 observations, 3 variables
DESCRIPTIVE ABSTRACT:
In many statistical models the normal distribution of the response is an essential assumption. This paper uses a dataset of 2000 euro coins with information (up to the milligram) about the weight of each coin. As the physical coin production process is subject to a multitude of (very small) variability sources, it seems reasonable to expect that the empirical distribution of the weight of euro coins does agree with the normal distribution. Goodness of fit tests however show that this is not the case. Moreover, some outliers complicate the analysis. Mixtures of normal distributions and skew normal distributions are fitted to the data, revealing that the normality assumption might not hold for those weights.

Data for seminar 1. Dataset "Euroweight"

SOURCE:
The data were collected by Herman Callaert at Hasselt University in Belgium. The euro coins were "borrowed" at a local bank. Two assistants, Sofie Bogaerts and Saskia Litiere weighted the coins one by one, in laboratory conditions on a weighing scale of the type Sartorius BP 310s.
VARIABLE DESCRIPTIONS:
Columns

1 - 8 ID	this is the case number
9 - 16 weight	weight of the euro coin in grams
17 batch	number of the package

Values are aligned and tab-delimited. There are no missing values

Data for seminar 1. Dataset "Euroweight"

STORY BEHIND THE DATA:

Curriculum reform in Flanders (the Flemish part of Belgium) resulted in a significant increase of statistical topics in grades 8-12. A group of university professors and high school teachers took this opportunity for reshaping statistics education towards "more concepts and more real data". In Belgium, as in many countries in Europe, the introduction of the Euro has had a major impact on the life of people. That's why it was decided to study a characteristic (the weight) of the "Belgian 1 Euro" coin, and use this dataset in schools.

PEDAGOGICAL NOTES:

Graphical methods can be used, perhaps in conjunction with a simple goodness of fit test. Also the story behind the data gathering process, and the lesson to be learned here, is crucial in any real life statistical experiment. A first year college course could delve a bit deeper, while a full analysis (introducing mixtures and the skew normal) can be revealing in a second course in statistics.