An Introduction to R

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Informatik 7
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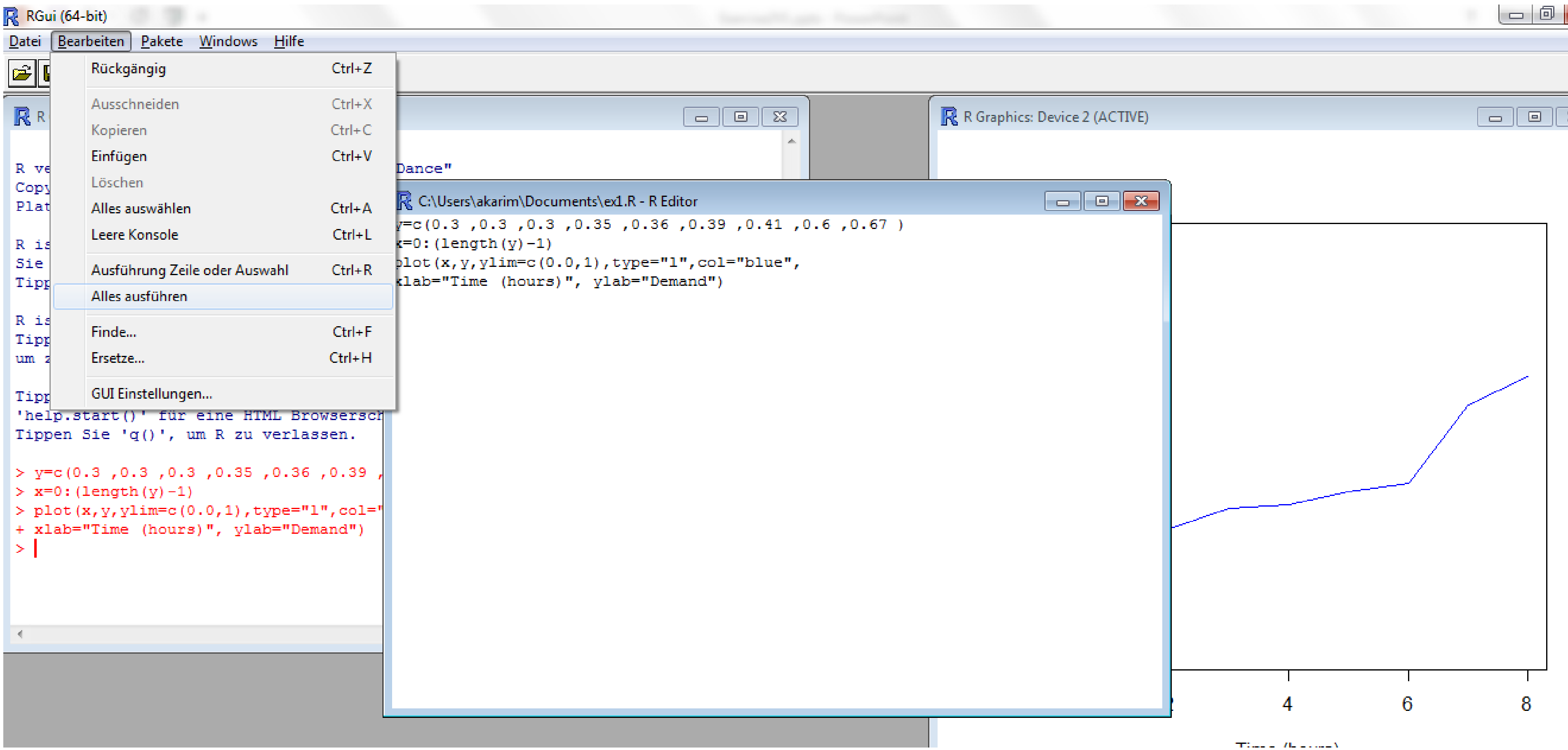
Why R?

- It's free!
- Easy to Learn
- R has excellent tools
- R is flexible.
- It runs on a variety of platforms including Windows, Unix and MacOS.

Where to get R

- The R-project web site:
  - http://www.r-project.org
- The program can be downloaded from any one of the official mirrors of CRAN
  - http://cran.r-project.org
  - Download the compiled binary code for your operating system
  - See supplemental material on website describing how to download and install R

R you can write scripts



R Reference Material

- Intro to R (PDF available from help menu)
- Many books to reference

Contents

Fundamentals of the R language

Getting Started

- How to use help in R?
  - R has a very good help system built in.
  - If you know which function you want help with simply use ?_________ with the function in the blank.
  - Ex: ?hist.
  - If you don't know which function to use, then use help.search("_________").
  - Ex: help.search("histogram").
  - Or Google

R as a calculator

- Calculator
  - +, -, /, *, ^, log, exp, …:

```
> (14*0.5)^(1/3)

> log2(10)

>tan((30*pi/180))
>acos(0.8)
```

Assigning Values to variables

- Variables are assigned using '<-':

```
> x<-17.1
> x
[1] 17.1
Or =
> x=15
> x
[1] 15
```

- Variables that contains many values (vectors), e.g. with the **concatenate** function:

```
> y<-c(3,7,9,51)
> y
[1]  3  7  9 51
```

Vector Functions in R

- Typical operations on vectors include summary statistics (**mean**, **var**, **range**, **max**,…):

```
> y<-c(5,7,7,8,2,5,6,6,7,5,8,3,4)
> z<-13:1
> mean(y)
[1] 5.615385
> var(z)
[1] 15.16667
```

Matrix

- Matrix Arithmetic.
  - * is element wise multiplication
  - %*% is matrix multiplication
- > A<-rbind(c(1,2),c(3,4))
- > A
-      [,1] [,2]
- [1,]   1   2
- [2,]   3   4
- > B<-cbind(c(1,2),c(3,4))
- > B
-      [,1] [,2]
- [1,]   1   3
- [2,]   2   4

- > A*B
-       [,1] [,2]
- [1,]   1   6
- [2,]   6   16
- > A%*%B
-       [,1] [,2]
- [1,]   5   11
- [2,]   11   25

Importing and exporting Data

- How do we get data into R?
- First make sure your data is in an easy to read format such as CSV (Comma Separated Values).
- Sample code:
  - **D <- read.table(“data.txt”,sep=“,”,header=TRUE)**
  - **Or D<-read.table(„data.txt“)**
- **Write.table()** can be used to store data in a file
- Sample code:
- **write.table(x,"output.txt",append=TRUE , row.names= FALSE, col.names=FALSE)**

Working with data.

- Accessing columns.
- **D <- read.table("data.txt",sep=",",header=TRUE)**
- D has our data in it…. But you can't see it directly.
- To select a column use **D$columnname.**
- If there is no header,
- **D<-read.table("data.txt",sep=",",header=TRUE)**
- then we can use D$V1, D$V2,… to access the data

Working with data.

- Subsetting data.
- Use a logical operator to do this.
  - ==, >, <, <=, >=, <> are all logical operators.
  - Note that the "equals" logical operator is two = signs.
- Using subset function
- data1<- subset(data1, data1$Type=="Cars")
- Using indices
  - **`D[D$Type == "Cars",]`**
  - This will return the rows of D where Type is "Cars".
  - Remember R is case sensitive!
  - This code does nothing to the original dataset.
  - **`D.M <- D[D$Type == "Cars",]`** gives a dataset with the appropriate rows.

Plot

```
plot(xvalues,yvalues, ylab = "Label for y axis",
   xlab = "Label for x axis")
```

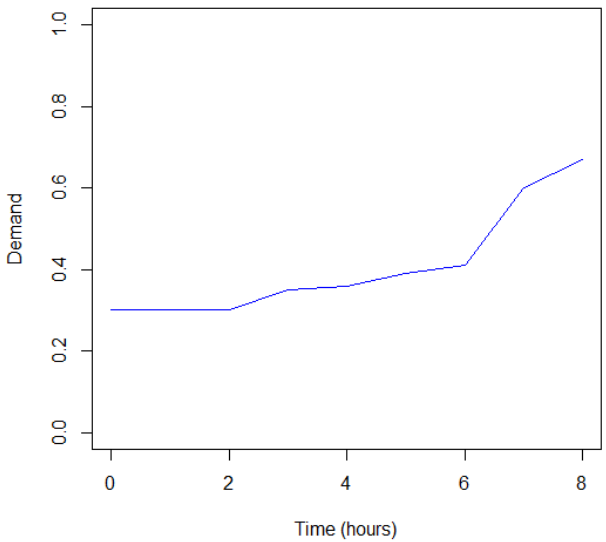
- **`ylab, xlab`** : changes the annotation of the axis labels;
- col="blue”: changes the color.

- To get full range of changes about graphical parameters:

```
>?par
```

Example: Plot on the screen

```
y=c(0.3 ,0.3 ,0.3 ,0.35 ,0.36 ,0.39 ,0.41 ,0.6 ,0.67 )
x=0:(length(y)-1)
plot(x,y,ylim=c(0.0,1),type="l",col="blue",
xlab="Time (hours)", ylab="Demand")
```

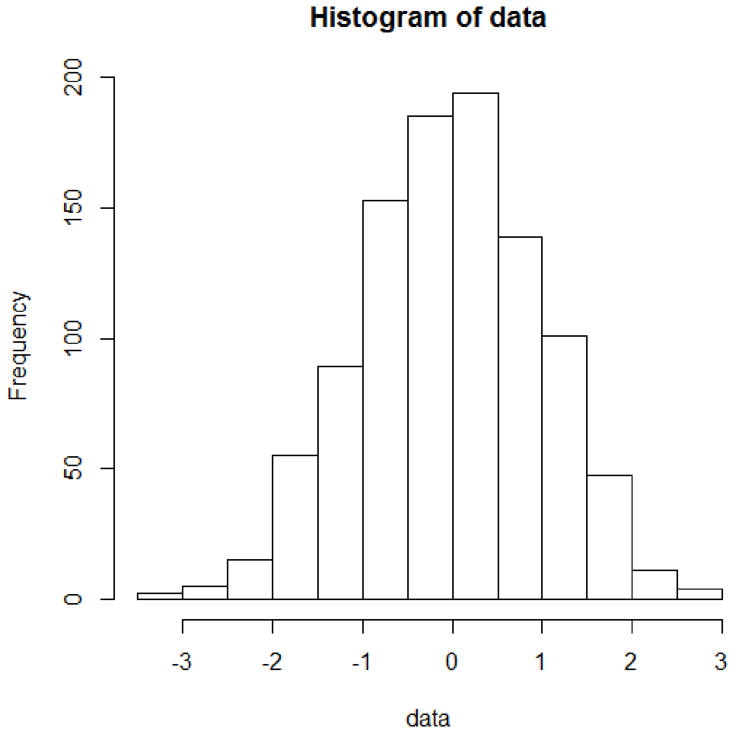


Example: generate a graphic as pdf file

```
y=c(0.3 ,0.3 ,0.3 ,0.35 ,0.36 ,0.39 ,0.41 ,0.6 ,0.67 )
pdf(file = "data.pdf",width = 5.1, height = 3.5)
par(mar=c(4.1, 4.1, 1.1, 0.1))
x=0:(length(y)-1)
plot(x,y,ylim=c(0.0,1),type="l",col="blue",
xlab="Time (hours)", ylab="Demand")
graphics.off()
```

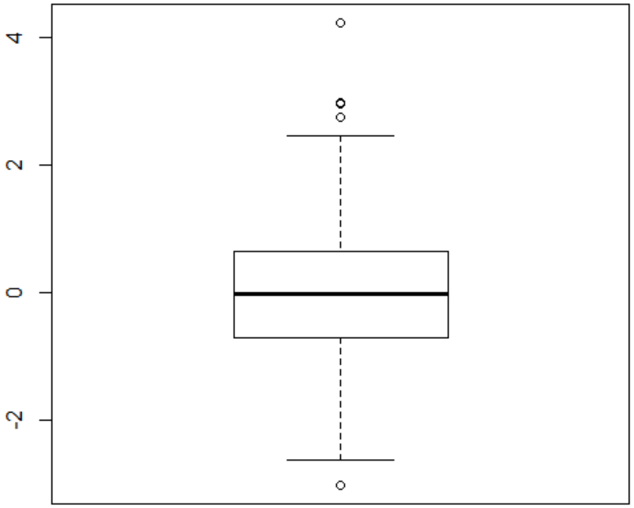
Histogram

- generate 1000 random numbers whose distribution is normal
- **data=rnorm(1000)**
- **hist(data)**



Boxplot

- data=rnorm(1000)
- boxplot(data)

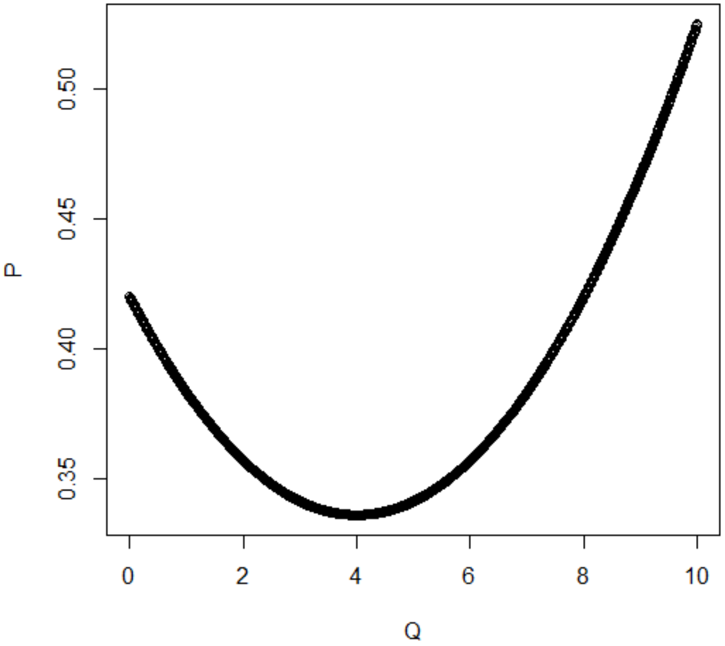


Example 3:

- A 8 MW/4 Mvar load is supplied at 13.8 kV through a feeder with an impedance of (1+ j2) . The load is compensated with a capacitor whose output, Qcap, can be varied in 0.5 Mvar steps between 0 and 10.0 Mvars. What value of Qcap minimizes the real power line losses? What value of Qcap minimizes the MVA power into the feeder?

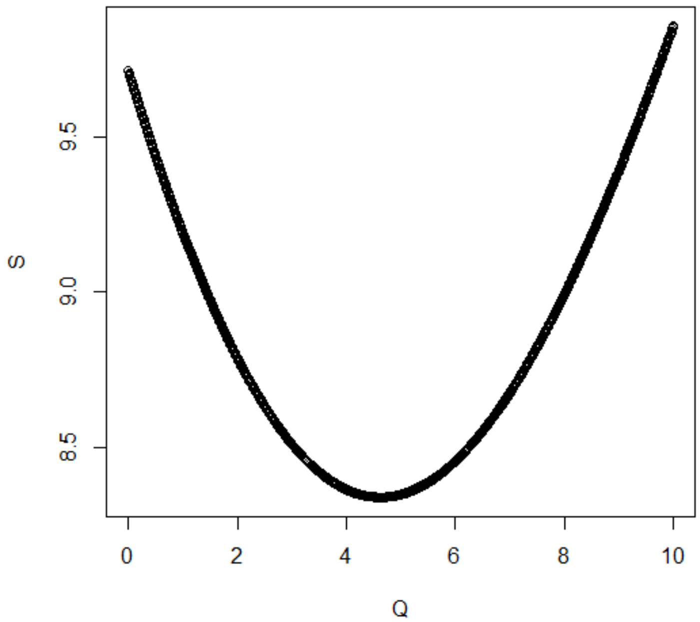
Solution-Part1

- Q <- seq(0,10,by=.01)
- P=(64+(4-Q)^2)/13.8^2
- plot(Q,P)
- min(P)
- (which.min(P))*0.01



Solution-Part2

```
Q <- seq(0,10,by=.01)
S=sqrt(((64+(4-Q)^2)/13.8^2+8)^2+(2*(64+(4 -
Q)^2)/13.8^2+(4-Q))^2)
plot(Q,S)
min(S)
which.min(S)*0.01
```



Example 4

- A three-phase line, which has an impedance of (2 + j4) per phase, feeds a balanced Y-connected three-phase load that has an impedance of 22-4j. The line is energized at the sending end from a 50-Hz, three-phase, balanced voltage source of 230√3 V (rms, line-to-line). Determine:

- The current, real power, and reactive power delivered by the sending-end source.
- The line-to-line voltage at the load.

Solution

- Vs=230
- ZLine=2+4i
- ZLoad=22-4i
- Ztotal=ZLine+ZLoad
- I=Vs/Ztotal
- S=3*Vs*Conj(I)
- P=Re(S)
- Q=Im(S)
- VLine=I*(ZLine)
- Vload=Vs-VLine
- Mod(Vload) # magnitude
- Arg(Vload)*180/pi #phase in degrees
- print (I)
- print (P)
- print (Q)
- print (Vload)

Example5

- A industrial company has an average power consumption of 500 kW with average power factor of 0.7 and 4000 working hours. Assume that the company must not pay for reactive power if they maintain the power factor above 0.9.

Calculate

- Annual electricity consumption (active power)
- The electricity cost for active and reactive power if 1 kWh costs 9 cents and 1 kVArh costs 1.5 cents
- Would it be profitable to install a 300 kVAr capacitor bank that costs 8000 euros?

Solution

- Pannual=500*4000
- Active_Power_Costs=Pannual*0.09
- S=500/0.7
- phi=acos(0.7)
- Q=S*sin(phi)
- Annual_Reactive_consumption=Q*4000
- #allowed_reactive_power
- phi_allowed=acos(0.9)
- S_allowed=500/0.9
- Qallowed=S_allowed*sin(phi_allowed)
- Q_annual_allowed=Qallowed*4000
- Qabove_allowed=Annual_Reactive_consumption-Q_annual_allowed
- Reactive_Power_Costs=Qabove_allowed*0.015
- #if Cap (300 kVAR) is installed
- pf=cos(atan((Q-300)/500))

- print(Active_Power_Costs)
- print(Reactive_Power_Costs)
- print (pf)

Example 6

- The fuel-cost curves for two generators are given as follows:

$$C1(P1) = 600 + 15\,P1 + 0.05\;P1^2$$

$$C2(P2) = 700 + 20P2 + 0.04\;P2^2$$

- Assuming the system is lossless, calculate the optimal dispatch values of P1 and P2 for a total load of 1000 MW, the incremental operating cost, and the total operating cost.

Solution

- P1 <- seq(0,100,by=0.01)
- C1=600+15*P1+0.05*P1^2
- P2=100-P1
- C2=700+20*P2+0.04*P2^2
- Ctotal=C1+C2
- plot(P1,Ctotal)
- Mincosts=min(Ctotal)
- P1opt=(which.min(Ctotal))*0.01
- P2opt=100-P1opt

- print (P1opt)
- print (P2opt)
- print (Mincosts)
- IncCosts=15+0.1*P1opt
- print (IncCosts)