Exercise 1.1:

If X to be normally distributed with some values for mean and variance, say, $X \sim N(\mu, \sigma^2)$, is the mean of $Y = e^X$ then

a) $e^{\mu + \sigma^2/2}$ or

b) $e^{\mu - \sigma^2/2}$?

Use the `rnorm()` function and the other functions from the first slide in the introduction session to figure it out.

Exercise 1.2:

Consider the second order polynomial equation

$$X^2 + 3X + 1 = 0 \qquad\qquad (a)$$

The general polynomial equation

$$AX^2 + BX + C = 0$$

has the solutions

$$\frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

1. Construct a vector of length 2 that contains the solutions to the equation (a), and display it on the screen with 1 decimal point.
2. Work out how much error you make (in percent) by referring to the solutions with just one decimal. The result will be different for the two solutions.

Exercise 1.3:

Construct the object x as

```
x <- rnorm(100, mean=.5, sd=.3)
```

Perform the following task (check out the help system as needed):

1. Calculate mean and standard deviation of x.

2. Plot a histogram of x.

3. Put the second axis on the right side of the histogram plot instead of on the left.

Exercise 2.1:

a) Study the function paste() via its help page and use it to paste together the string "R session" and the number 1. What type of object is returned?

b) What happens if we try to add a number to a data frame containing only numbers?

c) What happens if we try to add a number to a data frame with both number columns and character columns?

Exercise 2.2:

a) Create a function that takes a vector of numbers and returns the standardized values; ie. the data with the mean subtracted and rescaled so that the variance is 1.

b) Describe what happens if you apply your function to a vector of length 1, and why.

Exercise 2.3:

Consider the function

$$f(x) = 3 \sin\left(\frac{x}{2}\right) + x$$

a) Define a similar function f in R. Calculate $f(0)$, $f(-1)$ and $f(\pi)$.

b) Write a script that plots the function f over the interval from -7 to 7. Save the script on your system and close it. Then, execute the script in R with the source() command.

Exercise 3.1a:

a) Write a loop that investigates the contents of a matrix my.data. For each row starting from the first, the loop should write a line in the output window which differs according to the contents of the ith row of my.data:

    i.   If the ith row of my.data do not contain any negative values, the line should contain the sentence: "The mean of row number i is", where i should be the row number, and then the mean of the ith row of my.data.

    ii.   If the ith row contains negative values, but no more than 3 lines with negative numbers have been encountered, the line should contain the sentence "<Row i contains negative values>", where again i is the row number.

    iii.   If the ith row contains negative values, and at least 3 lines with negative numbers have been encountered, the line should contain the sentence "Too many negative values".

    If the line "Too many negative values" have been written, the loop should stop writing out lines immediately, otherwise it should stop when the last line of my.data have been investigated an a line has been written.

Exercise 3.1b:

b) Construct a dataset in the following way:

```
set.seed(1786)
data.exercise.3.1<-exp(matrix(rnorm(2000),nrow=100))
index1.temp<-sample(1:100,10)
index2.temp<-sample(1:20,10)
for(i in 1:10){
 data.exercise.3.1[index1.temp[i],index2.temp[i]]<--1
}
```

Assign the dataset data.exercise.3.1 to my.data and check that your algorithm works. You should write out 14 lines.

Exercise 3.2:

a) The function Sys.time() returns the current time. In the slide where we compared run times of elementwise squaring a matrix y containing elements generated with the rnorm() function, and doing it using the object-oriented form of R. We looked at a huge matrix with 1.000.000 elements. What is the effect for small matrices? Redo the runtime exercise with a matrix of dimension 10x10 instead of 1000x1000, and calculate the runtime increase factor. Comment.

b) Now, let k be the number of rows in the quadratic matrix y. calculate runtime increase factors as above for k=10, 20, 50, 100, 200, 500, 800 and 1000, and plot the runtime increase factors as a function of the number of elements in y.

Exercise 3.3:

1. Create a data frame with 10 rows and 100.000 columns, and fill it with random numbers generated with rnorm(). We want to calculate the mean of all 100.000 columns, and place it in a vector.

2. Calculate the runtime factor from looping over the 100.000 columns and using the mean function, in contrast to using sapply().

Exercise 4.1:

a) Explain what happens in the following matrix construction:

```
matrix(1:6,nrow=3,ncol=3)
```

b) What happens if we do not give any input vector at all when we define a matrix?

Exercise 4.2:

a) Explain what goes on here:

```
x<-matrix(1:12,4)
x
x[cbind(c(1,3,2),c(3,3,2))]
```

b) Calculate the following and explain the difference with (a)

```
x[c(1,3,2),c(3,3,2)]
```

Exercise 4.3

Create matrices row, column and A in the following way:

```
row<-matrix(rep(1:100,100),nrow=100)
column<-matrix(rep(1:100,100),nrow=100,byrow=T)
A<-3*column^3/(1+row*column)
```

a) Find an easy way to calculate the sum

$$\sum_{i=1}^{100}\sum_{j=1}^{100}\frac{3i^3}{1+ij}$$

b) Next, find an easy way to calculate

$$\sum_{i=1}^{100}\sum_{j=1}^{i}\frac{3i^3}{1+ij}$$

Exercise 5.1

1. Read the data from the file data.exercise5.1.dat into a data frame in R. If you have problems, study the help file accessed with ?read.table

2. Describe read.table()'s convention for columns without a name.

Exercise 5.2

1. Read the data from the file data.exercise5.2.dat into a data frame in R. If you have problems, study the help file accessed with ?read.table.

2. Which items does R interpret as missing here?

3. What would have happened if the blank space had been in column w rather than in column y?

Exercise 5.3

Read the contents of the file Exercise 5.3.xlsx into an R data frame.

Exercise 5.4

1. Read the data in the file Exercise 5.4a.txt into a data frame.

2. Read the data in the file Exercise 5.4b.txt into a list.

Exercise 6.1

Create two data frames with the commands

```
set.seed(9007)
my.data<-data.frame(x=rnorm(10),y=rnorm(10)+5,z=rchisq(10,1))
additional.data<-data.frame(x=rnorm(3),y=rnorm(3)+5,z=rchisq(3,1))
```

1. write my.data to a file called "Exercise 6.txt" (preferably in a Data subdirectory), without row and column names.

2. You realize that you have more data that you need to write to the file. Consult ?read.table, and figure out a way to add the contents of the dataset additional.data to the contents of the file "Exercise 6.txt".

Exercise 6.2

Create the data my.data as

```
set.seed(45)
my.data<-data.frame(x=rnorm(10),y=rnorm(10),z=rnorm(10))
```

1. Write the data to a csv file with write.csv2. If your regional settings determines that write.csv is compatible with Excel standards rather than write.csv2, use write.csv instead.

2. Open the file with Excel, save it as an xlsx workbook, and confirm that the file export has happened as it should.

Exercise 6.3

1. Make R write the following data:

   "a";"b"
   "A";1
   "B";2
   "C";3
   "D";4
   "E";5

2. Write the following data file:

   TITLE extra line
   2 3 5 7
   11 13 17
   One more line

Exercise 6.4

Create the data my.data as Exercise 6.2

```
set.seed(45)
my.data<-data.frame(x=rnorm(10),y=rnorm(10),z=rnorm(10))
```

1. Save it to your system with the save() function.

2. Remove my.data from the R memory with the rm() function.

3. Then, read my.data back into the system, and display head(my.data) on the screen.

Exercise 7.1

1. Find the column names and types of the table 'sentiment' from the SQL server msedxeus.database.windows.net described on the slides, without fetching the entire table.

2. Find the number of rows in 'sentiment' without fetching the entire table.

    Server Name: msedxeus.database.windows.net
    Database Name: DAT209x01
    User ID: Rlogin
    Password: P@ssw0rd

Exercise 7.2

Construct a dataset based on the table 'sentiment' from Exercise 7.1 with average score by Date for the State 'WA'. The dataset should also contain the column 'Date'.

Server Name: msedxeus.database.windows.net
Database Name: DAT209x01
User ID: Rlogin
Password: P@ssw0rd

Exercise 8.1

Create the two data frames

```
data.frame.x<-data.frame(names=c("Gretha","Robert","John","Heather"),
                         age=c(30,18,25,70),
                         nickname=c("Quicksilver","The Man","Nifty","Starlight"))
data.frame.y<-data.frame("Person_name"=c("William","Nancy","Charlotte","Henry),
                         age=c(15,75,32,51),
                         "pet_dog"=c("King","Whity","Captain Vom","Doggie"))
```

1. What happens if you merge data.frame.x and data.frame.y, without specifying a 'by' option? What happens if you merge data.frame.y and data.frame.x, without specifying a 'by' option?

2. Merge this information into the data frame data.frame.z, which should contain the 4 columns "Person_name","age","pet_dog" and "nickname". Display the data frame.

Exercise 8.2

Create a subset of the built-in data set iris, setosa.data, containing the data for the species setosa, where the sepal length is less than the median for all data. setosa.data should of course not contain a column with the species name.

Exercise 8.3

Create a text objects as

```
my.text<-"Over the last decade, bluetongue virus have
spread northwards from the mediterranean area. Initially
this was ascribed to climate changes, but it has since
been realized that a major contributing factor has been
new transmitting vectors, culicoides obsoletus and
culicoides pulicaris, which have the ability to aquire
and transmit the disease. Recently, schmallenberg virus
has emerged in northern europe, transmitted by biting
midges as well."
```

Change the object my.text so that the words bluetongue, culicoides, europe, mediterranean, northern and schmallenberg all starts with a capital letter.

Exercise 8.4

Create as set of date-time objects (POSIXct):

```
set.seed(885)
my.posixct<-as.POSIXct(sample((60*60*24*365*50):(60*60*24*365*55),20),
                    origin = as.Date("1960-01-01"))
```

Display my.posixct. Create a new set of date.time objects, my.posixct2, by adding 2 hours, 30 minutes and 10 seconds to the date-time objects in my.posixct. Display the head of a data frame with my.posixct and my.posixct2.

Exercise 9.1

The built in presidents dataset contains quarterly approval ratings for American presidents from 1945 to 1974. Use the cycle() function and tapply() to obtain a vector of quarterly approval ratings. Consider how to handle missing data.

Exercise 9.2

Sometimes you may wish to group data according to a continuous variable. Study the cut() function, and use it to construct 10 intervals that covers the values airquality$Wind, and work out group means of airquality$Solar.R according to grouped values of wind with tapply().

Exercise 9.3

Sometimes you may wish to calculate means according to groupings of more than 1 variable. Use the cut() function on the built-in dataset swiss to cut the variables Agriculture and Catholic into 10 intervals, and use this to construct a matrix of mean values of the Fertility variable, according to the cross-classification by Agriculture and Catholic.