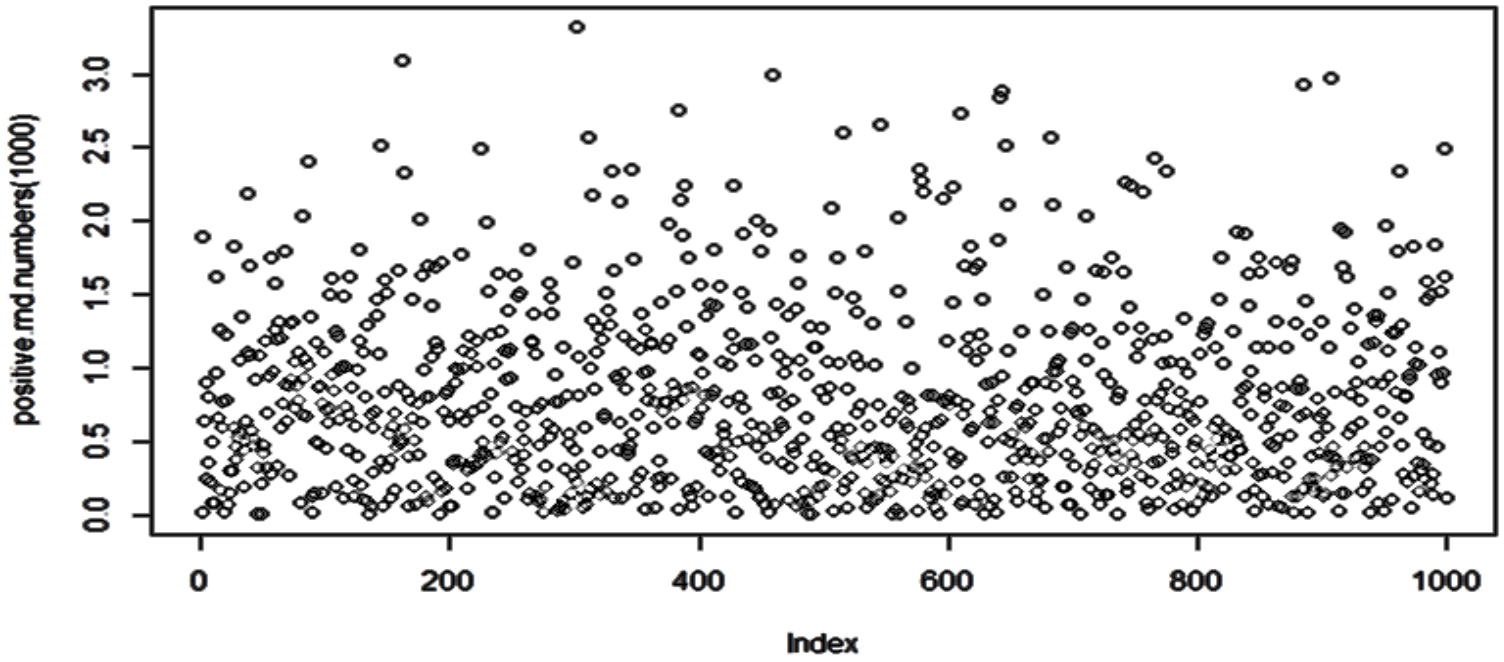
# Introduction to Computing for Economics and Management

Lecture 7: Loops Continued



# Previous lecture: looping

The most frequently used looping construct is

- `for(x in vec) {expression}`

- The for-loop iterates through all elements of the vector `vec`

- For each element of the vector `vec` there will be one iteration of the loop and `expression` is executed

- At each iteration, the variable `x` takes the value of the current element of `vec`
  - First iteration: `x = vec[1]`
  - Second iteration: `x = vec[2]`
  - …

# Previous lecture: print variable when iterating

Let's print out the value of variable `x` when iterating through the vector `vec`

```
> vec <- c(1:5)

> vec
[1] 1 2 3 4 5

> for(x in vec) {print (x)}
[1] 1
[1] 2
[1] 3
[1] 4
[1] 5
```

# Previous lecture: print variable when iterating

- The for-loops works with other modes beside numeric as well

Example: like before we print the value of the variable when iterating through a vector of strings

```
> word.vector <- c("a", "text", "consists",
"of")

> for(word in word.vector) {print (word)}
[1] "a"
[1] "text"
[1] "consists"
[1] "of"
```

# Previous lecture: print variable when iterating

As an alternative we can create a new vector which ranges from 1 until the length of the vector, iterate through this vector and access the original vector via indexing

```
> vector.indices <- 1:length(word.vector)

> vector.indices
[1] 1 2 3 4

> for(i in vector.indices) {print(word.vector[i])}
[1] "a"
[1] "text"
[1] "consists"
[1] "of"
```

# Previous lecture: print variable when iterating

We can write the alternative way in one line

```
> for(i in 1:length(word.vector)) {print
(word.vector[i])}
[1] "a"
[1] "text"
[1] "consists"
[1] "of"
```

# Previous lecture: compute length of a vector

Write our own function for computing the length of a vector

```
## function to compute length of vector vec
vec.length <- function(vec)
{
  # initialize counter
  counter <- 0

  # iterate through vec and increase counter
  for(x in vec) {counter <- counter + 1}

  # return counter
  return(counter)
}
```

# Previous lecture: compute Euclidean norm of a vector

```
## compute Euclidean norm of a vector vec
Euclid.norm <- function(vec)
{
  # initialize norm
  norm <- 0

  # compute sum of squared vector elements
  for(x in vec) {norm <- norm + x^2}

  # sqrt of sum
  norm <- sqrt(norm)

  return(norm)
}
```

# Previous lecture: p-norm of a vector

```
## compute p-norm of a vector vec
p.norm <- function(vec, p=2)
{
  # initialize norm
  norm <- 0

  # compute sum of  exponentiated vector elements
  for(x in vec) {norm <- norm + x^p}

  # p radical of sum
  norm <- (norm)^(1/p)

  return(norm)
}
```

# Program today

- Loops cont'd
- Read data from file
- New data type: factor

- Nested loops

- Alternative loop constructs
  - While
  - Repeat

- Loop control
  - Break
  - Next

# Square elements of a vector

We can change the elements of the input vector and return a new vector, e.g. square the elements of a vector

```
## square elements of vector vec
square.vec <- function(vec)
{
  # initialize output vector vec.res
  vec.res <- vector()

  # fill vec.res with squared elements of vec
  ????

  return(????)
}
```

# Square elements of a vector

We can change the elements of the input vector and return a new vector, e.g. square the elements of a vector

```
## square elements of vector vec
square.vec <- function(vec)
{
  # initialize output vector vec.res
  vec.res <- vector()

  # fill vec.res with squared elements of vec
  for(x in vec) {vec.res <- c(vec.res, x^2)}

  return(vec.res)
}
```

# Square elements of a vector

We test our function

```
> square.vec(c(1,2,3))
[1] 1 4 9

> square.vec(7:10)
[1]  49  64  81 100

> (7:10)^2
[1]  49  64  81 100
```

# Variable access in functions

- Cannot access the variables of functions from outside

```
> f <- function(x){
  print (paste("x:",x));
  x<-x+1
  z<-x+1;
  print (paste("z:",z));
  }

> x <- 10;
> f(x)
[1] ??
[1] ??
> x
[1] ??
> z
[1] ??
```

# Function `findwords`

Now we are ready to program our word list function

```
## finds locations of each word in word.vec
findwords <- function(word.vec)
{
  # initialize word list
  word.list <- list()

  # iterate through word vector
  for(i in 1:length(word.vec))
  {
    # store current word in variable word
    word <- word.vec[i]
    # add current word to word.list
    word.list[[word]] <- c(word.list[[word]], i)
  }
  return(word.list)
}
> findwords(c("a", "text", "consists", "of", "a"))
```

# Function `findwords`

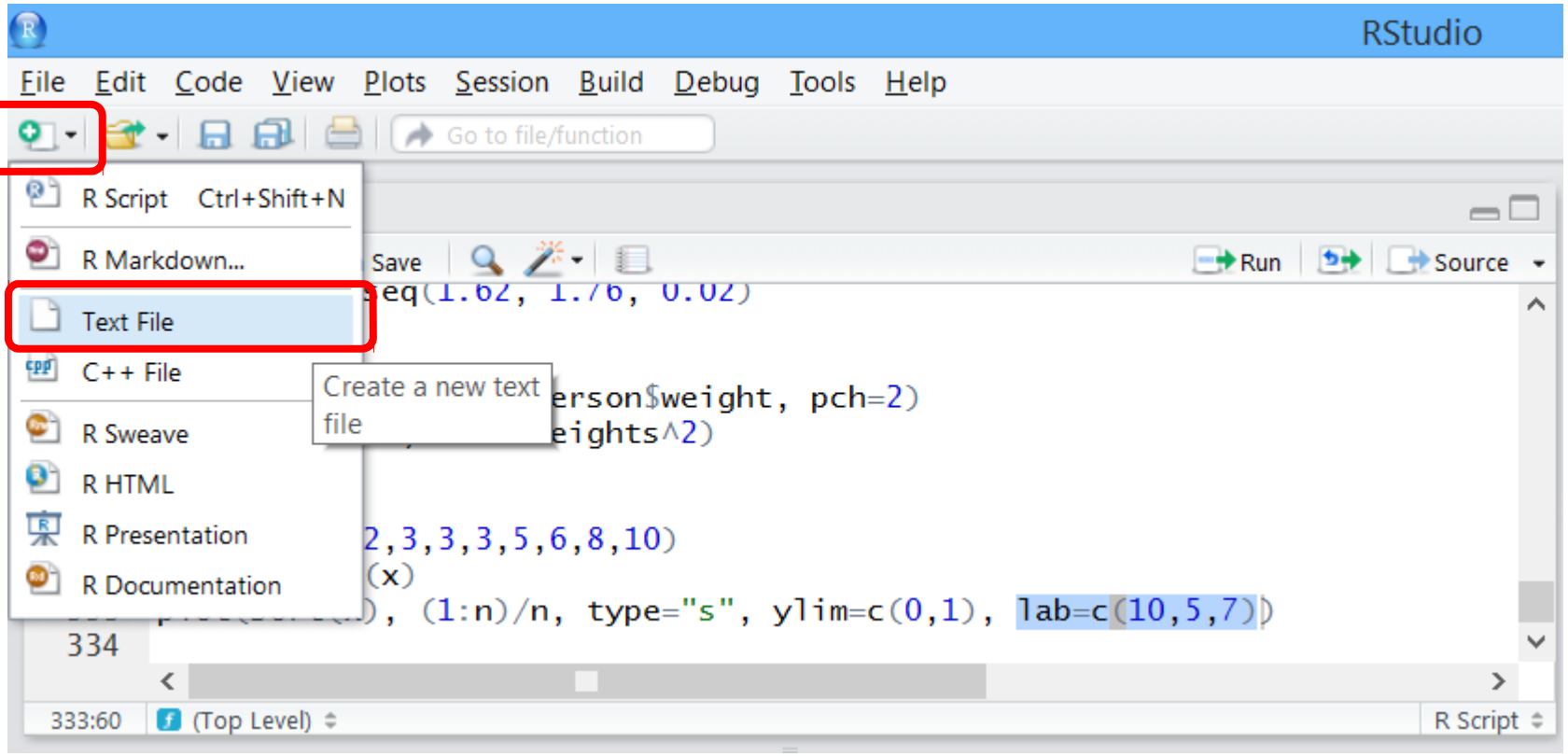
We test our function

```
> findwords(c("a", "text", "consists", "of", "a"))
$a
[1] 1 5

$text
[1] 2

$consists
[1] 3

$of
[1] 4
```

# Read data from file

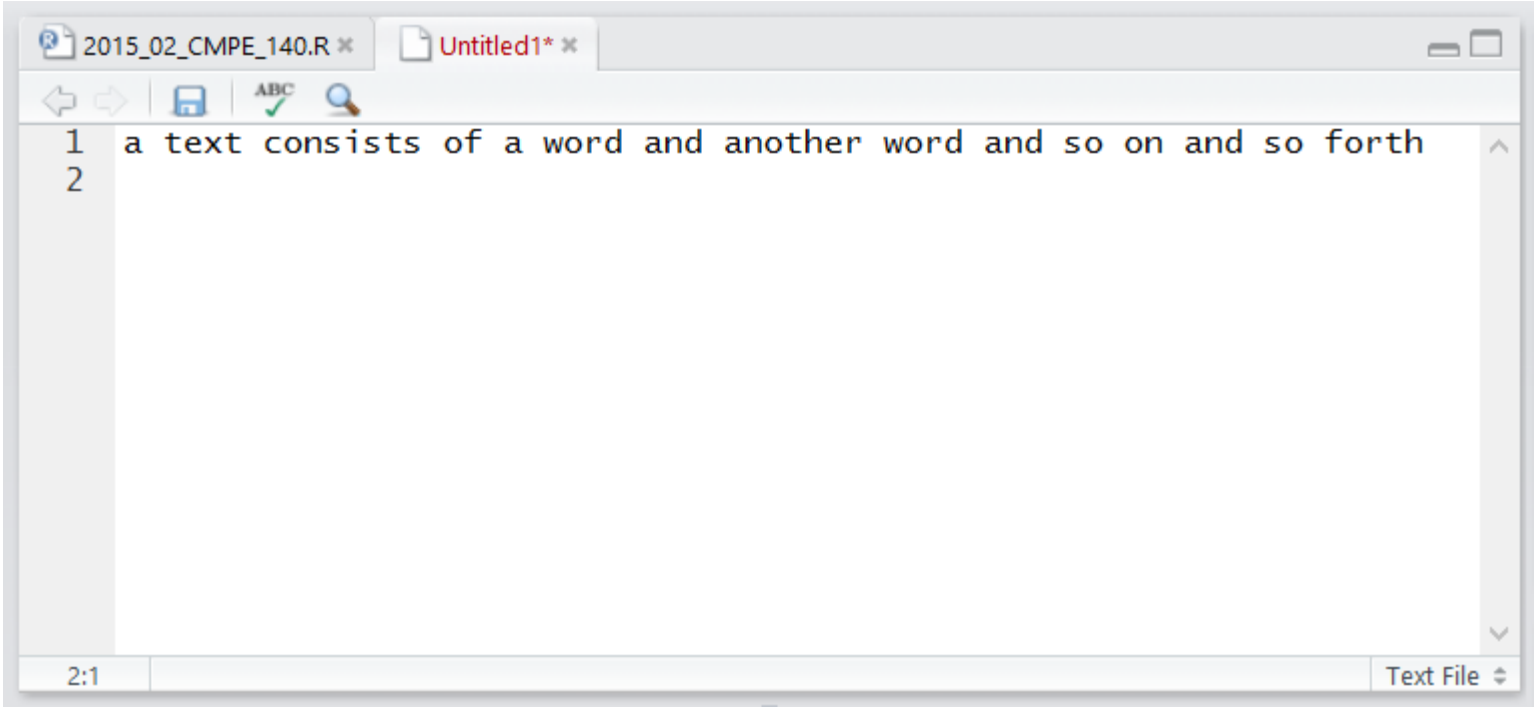
- The only drawback for now is that we still have to provide a vector of words
- It would be much more convenient if the function would read the text from a file
- We can use the `scan()` function which read data from a file into a vector

# Read data from file



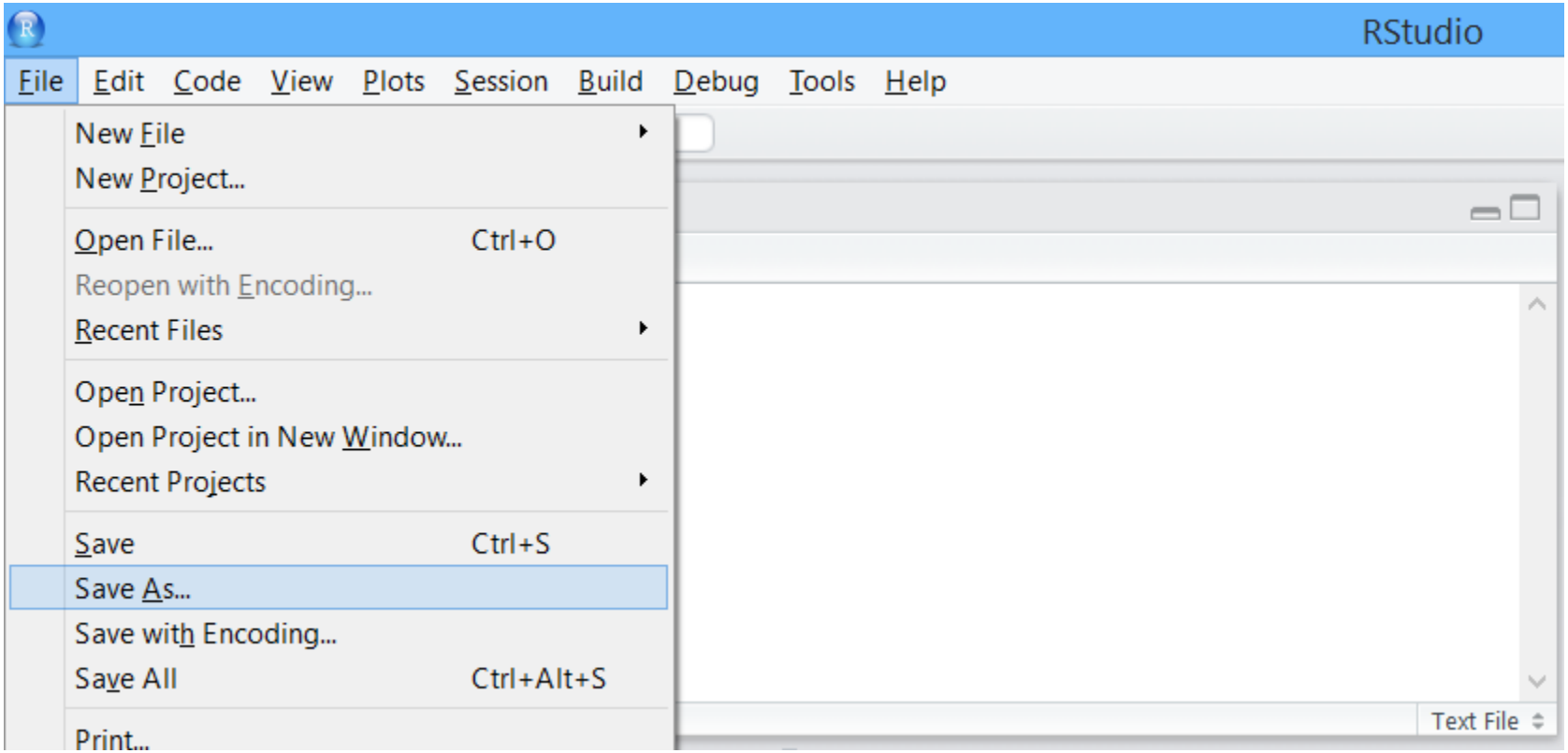

- As a first step we create a new text file using RStudio or an alternative text editor like Notepad++

# Read data from file




- Next, we write our text into the new file

# Read data from file




- Finally we save the file

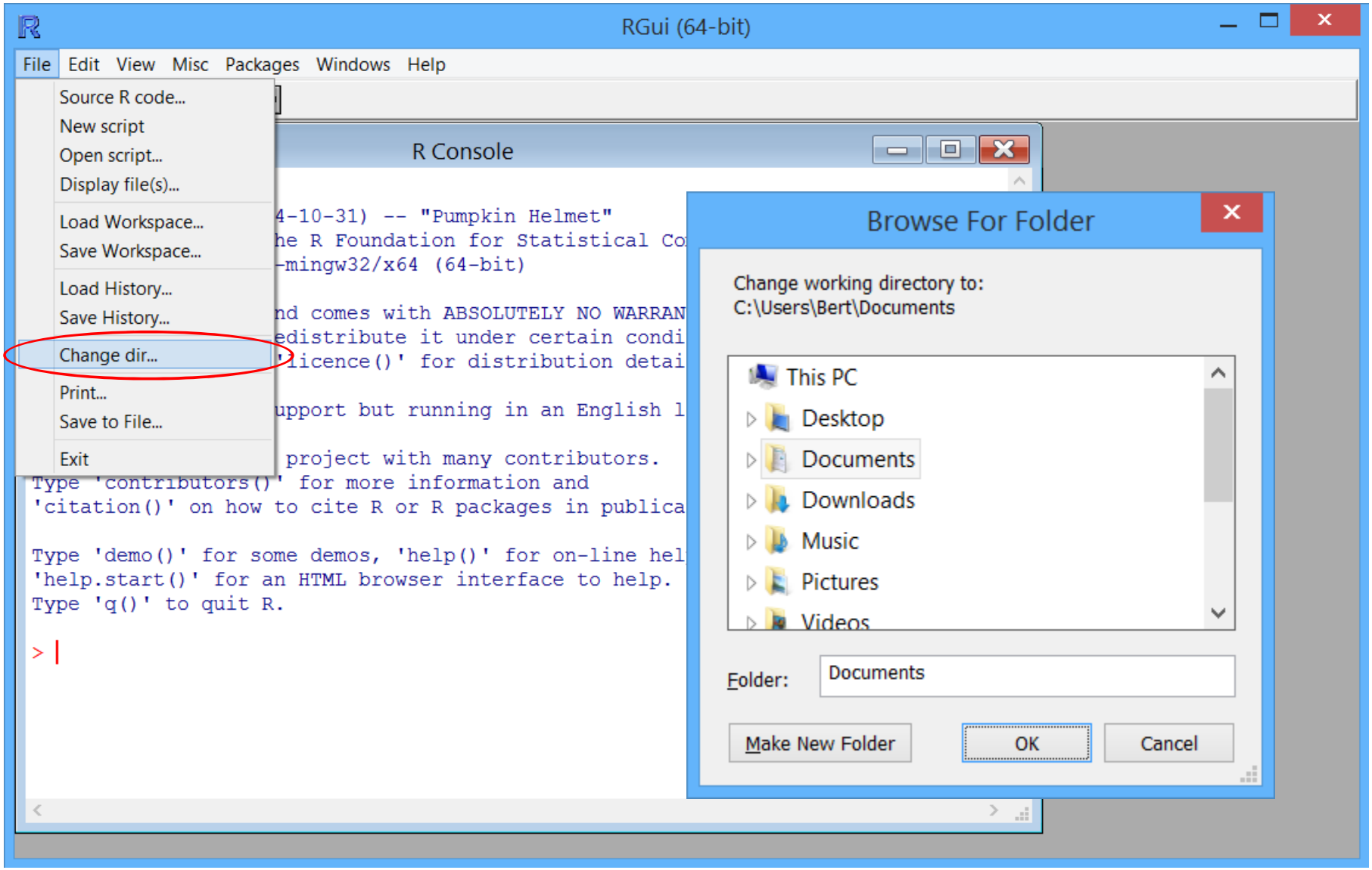
# Working directory

Before the actual import, we need to check the current working directory to make sure which path to use when importing the data file

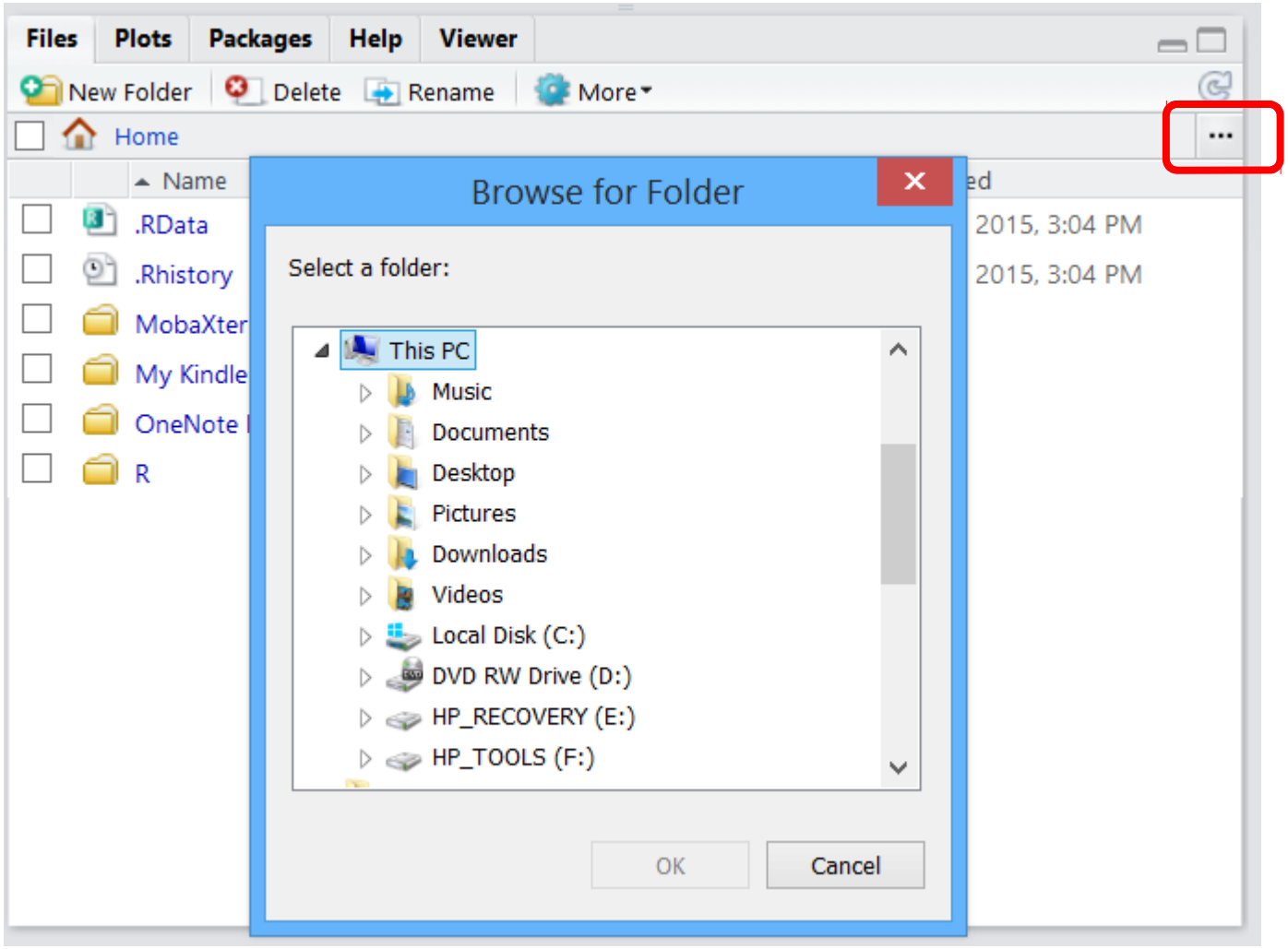
```
> getwd()
[1] "/home/c7031082/R"
```

- We change working directory to the path where our data file is located in order to simplify data import

# Change working directory in R

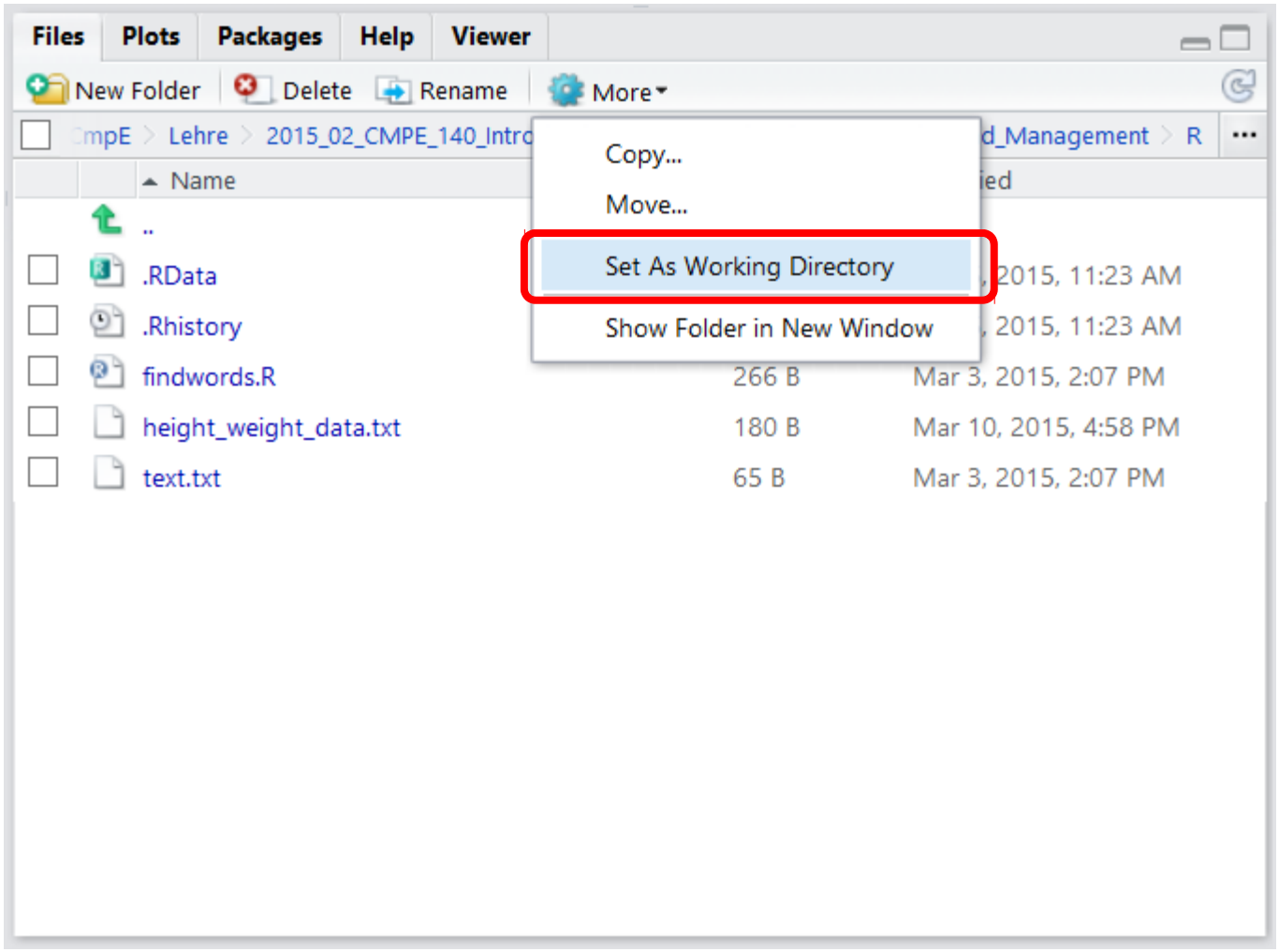


# Change working directory in RStudio




- In the files tab we select the "…" item and browse to the folder in which we have stored the text file

# Change working directory in RStudio




- In the menu “More”, we select “Set As Working Directory”

# Read data from file

We read text data from a file into a vector

```
> word.vec <- scan("text.txt", "")
Read 15 items

> word.vec
 [1] "a"        "text"     "consists" "of"
 [5] "a"        "word"     "and"      "another"
 [9] "word"     "and"      "so"       "on"
[13] "and"      "so"       "forth"
```

- The second argument is a short form of `what=""` to indicate that we intend to import text data

- Similar like in `read.table()` the separator between items is 'white space' by default: one or more spaces, tabs, newlines or carriage returns

# Function `findwords`

Now, we can use the imported word vector

```
> findwords(word.vec)
$a
[1] 1 5

$text
[1] 2

$consists
[1] 3

$of
[1] 4

$word
[1] 6 9

...
```

# Function `findwords`

- As a next step, we can enhance our function `findwords` by adding the text file import functionality
- In this way we don’t need to import the text into a vector beforehand
- Instead of a word vector, the enhanced function needs a file name as input

# Function `findwords`

```
## finds locations of each word in file
findwords <- function(file)
{
  # fill word.vec from data in file
  word.vec <- scan(file, "")

  # initialize word list
  word.list <- list()

  # iterate through word vector
  for(i in 1:length(word.vec))
  {
    # store current word in variable word
    word <- word.vec[i]
    # add current word to word.list
    word.list[[word]] <- c(word.list[[word]], i)
  }
  return(word.list)
}
```

# Function `findwords`

We test our enhanced function

```
> findwords("text.txt")
$a
[1] 1 5

$text
[1] 2

$consists
[1] 3

$of
[1] 4

$word
[1] 6 9

...
```

# Sort word list by word frequency

- Now we are ready to obtain the word frequencies from any text
- The output of our function can be improved
- So far, we report words in the order how the words appeared in the text
- It would be more convenient to sort the result alphabetically or by word frequency

# Sort word list by word frequency

- In a previous lecture we have already learned how to sort our word list by word frequency

- First, we determine the word frequency

```
> word.freq <- sapply(word.list, length)
```

- Next, we compute the order of the word frequency

```
> word.freq.order <- order(word.freq)
```

- Finally, we use the obtained order of the word frequency for sorting our word list

```
> word.list[word.freq.order]
```

# Sort word list by word frequency

- We can write all three steps in one line

```
> word.list[order(sapply(word.list, length))]
```

- We can revert the sorting order by specifying the argument `decreasing = T` in the `order` function

```
> word.list[order(sapply(word.list, length),
decreasing = T)]
```

# Sort word list alphabetically

- In a previous lecture we have already learned how to sort our word list alphabetically

- First, we obtain the words from `word.list` using `names()`

```
> words <- names(word.list)
```

- Second, we sort the words alphabetically

```
> words.sorted <- sort(words)
```

- Finally, we sort `word.list` using `words.sorted`

```
> word.list[words.sorted]
```

- We can write all three steps in one line

```
> word.list[sort(names(word.list))]
```

# Function `findwords`

- We enhance our function `findwords` by sorting the word list alphabetically per default
- We further enhance our function `findwords` by providing an additional sort option `sort.by.freq`
  - Default value of `sort.by.freq = FALSE` and thus word list is sorted alphabetically by default
  - In case `sort.by.freq = TRUE` we will sort the word list by word frequency

# if-else

- In order to implement the sorting feature, we need a control flow construct with the following functionality:
  - Check the value of the variable `sort.by.freq`
  - In case the condition `sort.by.freq = TRUE` is satisfied, sort by word frequency else sort alphabetically
- A control flow construct which provide this functionality is the so called if-else statement

```
if (condition) {expression1} else {expression2}
```

- Depending on whether `condition` is true, the result is `expression1` or else `expression2`

# if-else

```
> x <- 2
> y <- if(x == 2) x else x+1
> y
[1] 2

> x <- 3
> y <- if(x == 2) x else x+1
> y
[1] 4

> x <- 3
> y <- if(x == 2){z<-5; x} else {x+1}
> y
[1] 4
> z
```

# if-else

- In our findwords function we need to check the value of the variable sort.by.freq

In case the condition sort.by.freq = TRUE is satisfied, we sort by word frequency else we sort alphabetically

```
if(sort.by.freq)
{
  # sort by word frequency
  return(word.list[order(sapply(word.list, length),
decreasing = T)])
}
else
{
  # sort alphabetically
  return(word.list[sort(names(word.list))])
}
```

# Function `findwords`

```
## finds locations of each word in file
findwords <- function(file, sort.by.freq = F)
{
  # fill word.vec from data in file
  word.vec <- scan(file, "")
  # initialize word list
  word.list <- list()

  # iterate through word vector
  for(i in 1:length(word.vec))
  {
    # store current word in variable word
    word <- word.vec[i]
    # add current word to word.list
    word.list[[word]] <- c(word.list[[word]], i)
  }
  # sort by word frequency or else sort alphabetically
  if(sort.by.freq)
       {return(word.list[order(sapply(word.list, length),
decreasing = T)])}
  else {return(word.list[sort(names(word.list))])}
```

# Function `findwords`

```
> findwords("text.txt")
Read 15 items
$a
[1] 1 5

$and
[1]  7 10 13

$another
[1] 8

$consists
[1] 3

$forth
[1] 15
...
```

# Function `findwords`

```
> findwords("text.txt", sort.by.freq=T)
Read 15 items
$and
[1]  7 10 13

$a
[1] 1 5

$word
[1] 6 9

$so
[1] 11 14

$text
[1] 2
...
```

# Plotting word frequencies

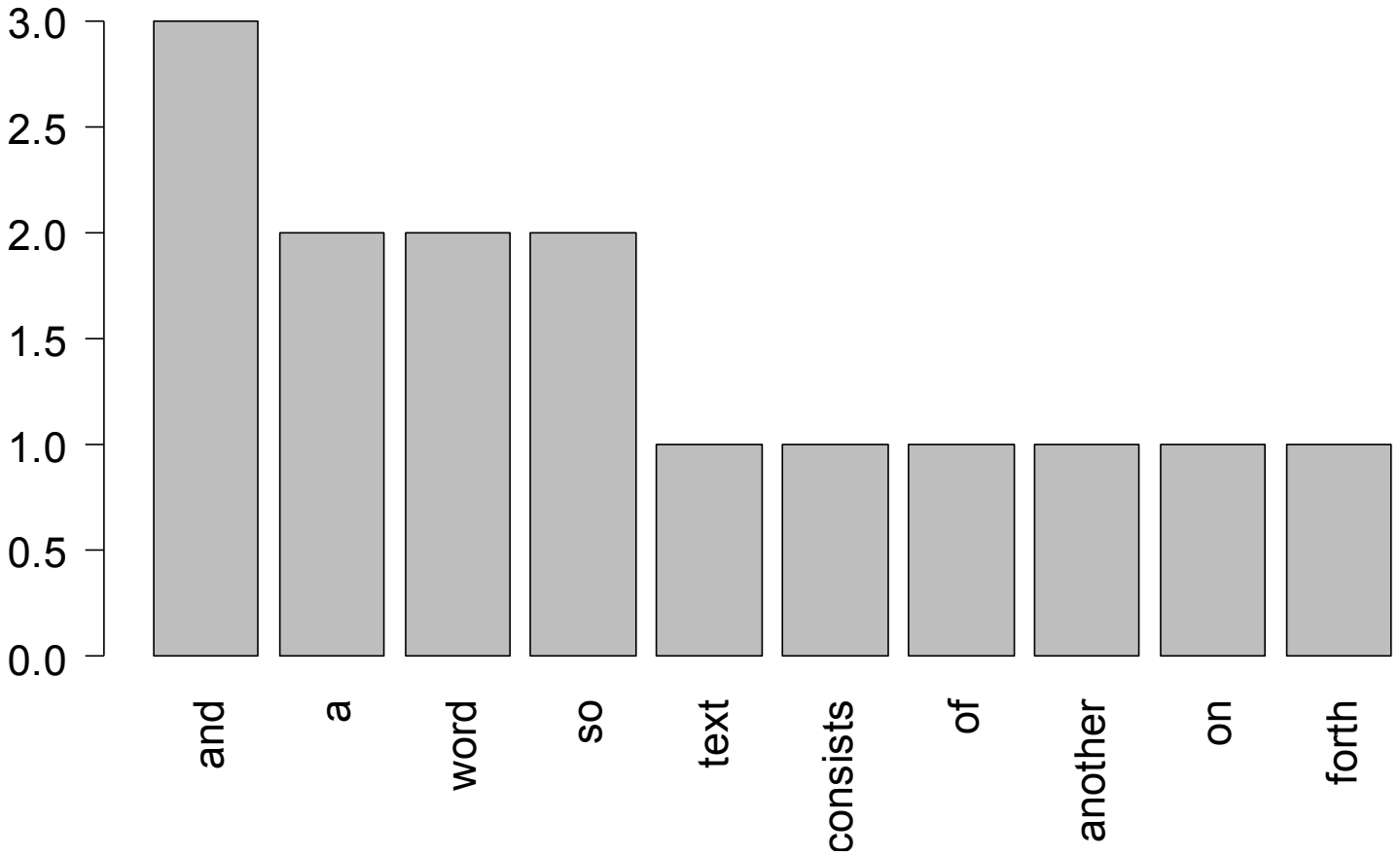
From the resulting list of word positions returned by `findwords` we can easily calculate the word frequencies using `sapply`

```
> word.list <- findwords("text.txt",
sort.by.freq=T)
Read 15 items

> word.freq <- sapply(word.list, length)

> word.freq
     and        a     word       so     text
       3        2        2        2        1
consists       of  another       on    forth
       1        1        1        1        1
```

# Plotting word frequencies

We create a barplot of the word frequencies

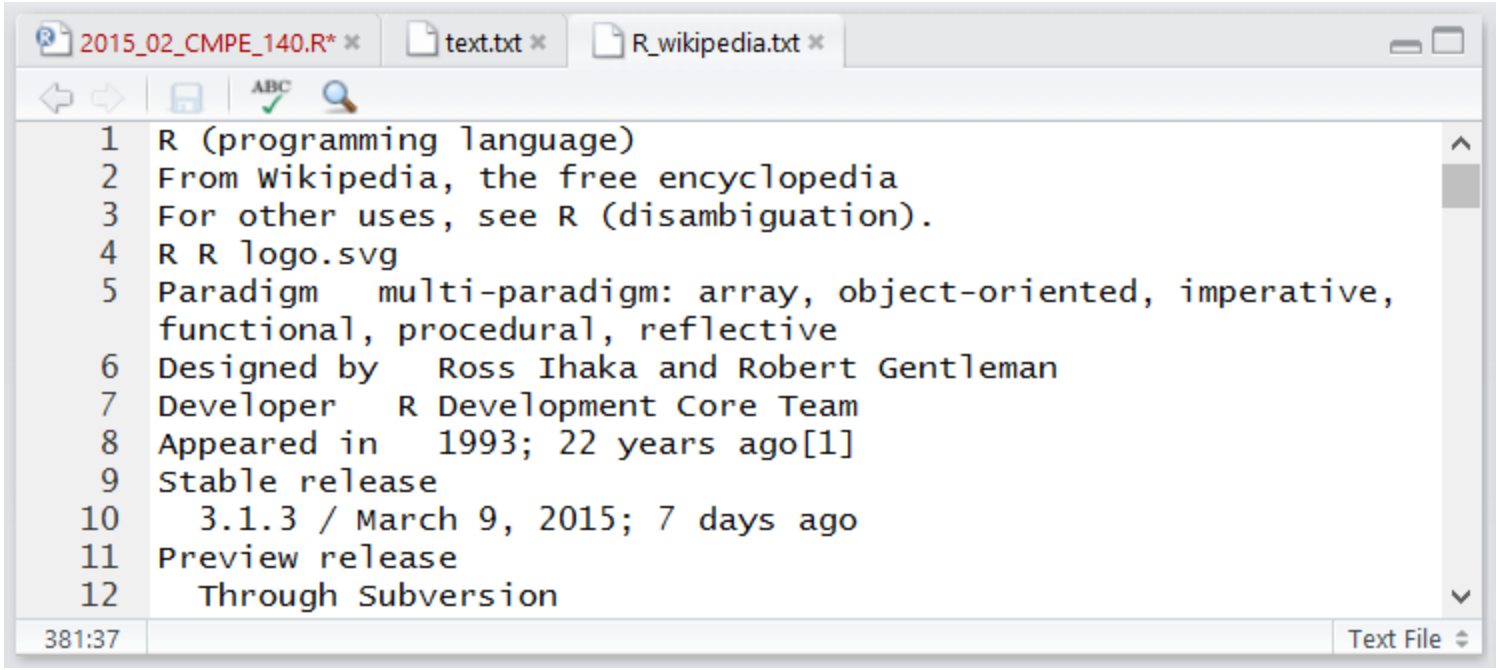
```
> barplot(word.freq, las=2)
```



# Word frequency in Wikipedia

- Since the for loop allows us to iterate through large texts, let's apply our function to Wikipedia
- We select the Wikipedia article about the R programming language
- We copy the article in a text editor
- We apply findwords and we create a barplot of the 10 most frequent words

# Word frequency in Wikipedia

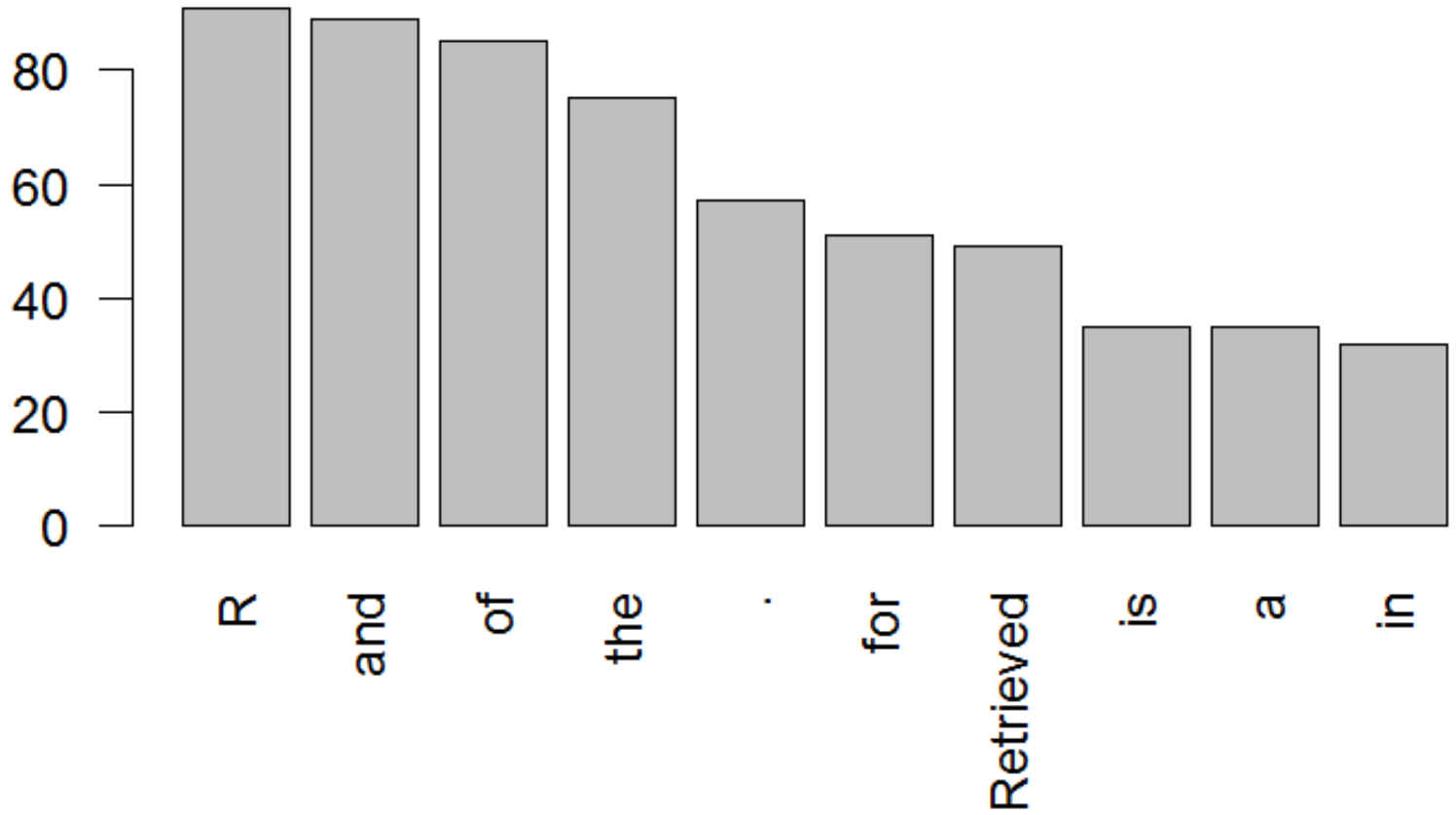



- We copy the Wikipedia article about R programming language and save it as `R_wikipedia.txt`

# Word frequency in Wikipedia

```
> word.list <- findwords("R_wikipedia.txt",
sort.by.freq=T)
Read 3395 items

> word.freq <- sapply(word.list, length)

> barplot(word.freq[1:10], las=2)
```

# Word frequency in Wikipedia



# Homework

1. Write a function that iterates through a vector and computes the sum of vector's elements

2. Write a function that iterates through all columns and rows of a matrix and computes the means of the columns and the rows

3. Create a barplot of the 10 most frequent used words in your favorite Wikipedia article