NARTI and University of Leeds Q-STEP Centre: Advanced Quantitative Analysis with R: Hierarchical Linear Modeling. Session 1. Introduction to R

R is a unique software environment for statistical programming, visualisation, data mining and quantitative data analysis. R is free, easy to install and relatively straightforward to use despite the intricacy of syntax based communication.

We begin this session by introducing the nuts and bolts of R syntax. We shall learn how to communicate with the software, create and invoke objects in R and, importantly, how to upload datasets, save them into data frames and perform elementary descriptive statistics.

Prior to introducing R syntax, it is worth nothing that not only is R a statistical programming language, but it above all is an ever gorwing community of users. R consists of some basic, built-in commands. Yet it relies mainly on packages developed for specific types of analysis. Information about R and packages can be obtained from the website: https://cran.r-project.org.

Packages can be installed from R Studio, using the command install.packages('package name'). Installation is a one-off procedure. Having installed the package, we need to invoke it prior to the analysis by using command library(package name). An example of the library function can be found below.

```
library(psych)
```

```
## Warning: package 'psych' was built under R version 3.2.5
```

Package 'psych' is a very useful one, as it contains plenty of helpful commands for data analysis. One of them allows producing extensive descriptive statistics.

Like most of the programming tools, R works with objects, created, named and operated by the user. Two operators are used to this effect: '=' or '<-' (there is no difference between the two). Let's create a simple mathematical object, a vector for instance (remember, a vector is a quantity that has both direction and magnitude).

```
a=c(1,2,3,4,5)
a
```

```
## [1] 1 2 3 4 5
```

```
print(a)
```

```
## [1] 1 2 3 4 5
```

In the syntax above, 'c' is a command that creates a vector object. The exact values of the vector are specified in parentheses, while 'a=' assigns the name (a) to the vector in question. Invoking the vector 'a' is simple, we just need to type in 'a' in the next line or apply the command 'print(a)'.

*Remeber, R syntax is CASE sensitive but not SPACE sensitive. This implies that you should distinguish between capital letter and lower case when creating and calling objects.

We can create as many vectors as we like. Now let's create vector 'b' of the same length but different parameters.We may then perform basic mathematical operations with vectors 'a' and 'b' (for example subtraction). The example below subtracts vector 'b' from vector 'a'. The outcomes is saved as vector 'c'.

```
b=c(5,2,10,6,1)
c=a-b
print(c)
```

```
## [1] -4  0 -7 -2  4
```

A typical dataset takes the matrix form, with columns and rows wherein the former signify variables and the latter individual scores. To have a glimpse of that, a matrix can be created as follows.

```
B=matrix(c(1,2,3,4,5,6,7,8,9,10),nrow=5,ncol=2)
B
```

```
##      [,1] [,2]
## [1,]    1    6
## [2,]    2    7
## [3,]    3    8
## [4,]    4    9
## [5,]    5   10
```

There are various sorts of operations one can perform with matrices. For example, transposing (swapping rows and columns)

```
t(B)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    2    3    4    5
## [2,]    6    7    8    9   10
```

We can combine matrix B with say matrix C composed of one column and 5 rows

```
C=c(1,2,3,4,5)
cbind(B,C)
```

```
##           C
## [1,] 1  6 1
## [2,] 2  7 2
## [3,] 3  8 3
## [4,] 4  9 4
## [5,] 5 10 5
```

To conclude simple exercises with matrices, let's perform some functions. For example, we can ask R to calculate the sum of each row in a matrix using the function 'apply'.

```
apply(B,1,sum)
```

```
## [1]  7  9 11 13 15
```

Apply is a very useful command. It has three key specifications in parenthesis: array, margin and function. The array is a generic data type (in our case matrix B); margin with regard to matrices indicates either rows ('1') or columns ('2'); function is the mathematical formulae to be applied (we used summary).

The beauty of R is that a function can be specified as a separate element, which opens up space for more complex operations. For example, we can write a special object for the function, specifying that the sum of each row should be enhanced further by two units.

```
sum.plus=function(x){sum(x)+2}
apply(B,1,sum.plus)
```

```
## [1]  9 11 13 15 17
```

R is one of the most effective programming tools for data analysis. When working with real-world data, R usually writes it into the data frame. Data frame is thus a data object. We can write matrix B into the data frame as follows.

```
df1=data.frame(B)
df1
```

```
##   X1 X2
## 1  1  6
## 2  2  7
## 3  3  8
## 4  4  9
## 5  5 10
```

As data analysts, we often deal with already collected data. In that case, we need to save an already existing data file into the data frame. The syntax below is just one of the multiple ways of doing it. The command will extract the specified data file from the project's working directory.

```
data=read.csv('WERS.csv')
data.frame=data
```

There are other ways of opening a dataset in R. A very convenient command permits selecting a data file from a pop-up window: 'read.csv(file choose())'.

We have now stored the data set into the data frame and called this object 'data'. The dataset in question is the 2011 Workplace Employment Relations Study (the 2011 WERS), a nationally representative survey of work and employment relations in the UK. The dataset is a truncated survey of employees.

Basic descriptives for all variables in the dataset can be produced using the command'summary'. It is also useful to check variable names, a task that can be accomplished with the help of commands 'names' or 'colnames'.

```
names(data)
```

```
##  [1] "serno" "qa1"   "qa2"   "qa3"   "qa4"   "qa5a"  "qa5b"  "qa5c"
##  [9] "qa6"   "qa7a"  "qa7b"  "qa7c"  "qa7d"  "qa7e"  "qa8a"  "qa8b"
## [17] "qa8c"  "qa8d"  "qa8e"  "qa8f"  "qa8g"  "qa8h"  "qa9a"  "qa9b"
## [25] "qa9c"  "qa9d"  "qa9e"  "qa9f"  "qb2a"  "qb2b"  "qb3"   "qb4"
## [33] "qb6a"  "qb6b"  "qb6c"  "qb6d"  "qb7a"  "qb7b"  "qb7c"  "qb8"
## [41] "qc1a"  "qc1b"  "qc1c"  "qc1d"  "qc2a"  "qc2b"  "qc2c"  "qc2d"
## [49] "qc2e"  "qc2f"  "qc3"   "qd1"   "qd3"   "qd4"   "qd5a"  "qd5b"
## [57] "qd5c"  "qe1"   "qe2"   "qe3"   "qe11"  "qe13"  "qe14"  "qe15"
```

```
summary(data)
```

```
##      serno              qa1             qa2            qa3
##  Min.   :1001004   Min.   :1.000   Min.   :1.00   Min.   : 0.00
##  1st Qu.:1106001   1st Qu.:3.000   1st Qu.:1.00   1st Qu.:30.00
##  Median :2057036   Median :4.000   Median :1.00   Median :37.00
##  Mean   :2881904   Mean   :3.532   Mean   :1.11   Mean   :33.07
##  3rd Qu.:3062005   3rd Qu.:5.000   3rd Qu.:1.00   3rd Qu.:38.00
##  Max.   :9119010   Max.   :5.000   Max.   :3.00   Max.   :96.00
##                    NA's   :166     NA's   :151    NA's   :677
##       qa4            qa5a           qa5b            qa5c
##  Min.   : 0.0   Min.   :1.00   Min.   :1.000   Min.   :1.00
##  1st Qu.:30.0   1st Qu.:1.00   1st Qu.:2.000   1st Qu.:2.00
##  Median :38.0   Median :2.00   Median :3.000   Median :2.00
##  Mean   :35.1   Mean   :1.85   Mean   :2.708   Mean   :2.54
##  3rd Qu.:42.0   3rd Qu.:2.00   3rd Qu.:4.000   3rd Qu.:3.00
##  Max.   :97.0   Max.   :5.00   Max.   :5.000   Max.   :5.00
##  NA's   :646    NA's   :321    NA's   :540     NA's   :987
##       qa6             qa7a            qa7b           qa7c
##  Min.   :1.000   Min.   :1.000   Min.   :1.00   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:1.000   1st Qu.:1.00   1st Qu.:1.000
##  Median :3.000   Median :2.000   Median :2.00   Median :1.000
```

```
##  Mean   :2.766   Mean   :1.901   Mean   :1.95   Mean   :1.679
##  3rd Qu.:3.000   3rd Qu.:2.000   3rd Qu.:2.00   3rd Qu.:2.000
##  Max.   :5.000   Max.   :4.000   Max.   :4.00   Max.   :4.000
##  NA's   :206     NA's   :287     NA's   :415    NA's   :360
##       qa7d            qa7e            qa8a           qa8b
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:1.000   1st Qu.:1.000   1st Qu.:2.000   1st Qu.:2.000
##  Median :1.000   Median :2.000   Median :2.000   Median :2.000
##  Mean   :1.705   Mean   :2.423   Mean   :2.143   Mean   :2.114
##  3rd Qu.:2.000   3rd Qu.:4.000   3rd Qu.:3.000   3rd Qu.:2.000
##  Max.   :4.000   Max.   :4.000   Max.   :5.000   Max.   :5.000
##  NA's   :371     NA's   :402     NA's   :222     NA's   :260
##       qa8c           qa8d            qa8e           qa8f
##  Min.   :1.0   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:2.0   1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000
##  Median :2.0   Median :2.000   Median :2.000   Median :3.000
##  Mean   :2.4   Mean   :2.588   Mean   :2.621   Mean   :2.995
##  3rd Qu.:3.0   3rd Qu.:3.000   3rd Qu.:3.000   3rd Qu.:4.000
##  Max.   :5.0   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :385   NA's   :390     NA's   :345     NA's   :283
##       qa8g            qa8h            qa9a           qa9b
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:2.000   1st Qu.:3.000   1st Qu.:4.000
##  Median :2.000   Median :2.000   Median :3.000   Median :5.000
##  Mean   :2.592   Mean   :2.142   Mean   :3.377   Mean   :4.184
##  3rd Qu.:3.000   3rd Qu.:2.000   3rd Qu.:4.000   3rd Qu.:5.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :748     NA's   :271     NA's   :239     NA's   :300
##       qa9c            qa9d            qa9e           qa9f
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000   1st Qu.:4.000
##  Median :4.000   Median :4.000   Median :4.000   Median :5.000
##  Mean   :3.849   Mean   :4.099   Mean   :4.053   Mean   :4.247
##  3rd Qu.:5.000   3rd Qu.:5.000   3rd Qu.:5.000   3rd Qu.:5.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :312     NA's   :368     NA's   :292     NA's   :276
##       qb2a            qb2b            qb3            qb4
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:4.000   1st Qu.:1.000   1st Qu.:2.000
##  Median :3.000   Median :4.000   Median :3.000   Median :2.000
##  Mean   :3.227   Mean   :3.975   Mean   :2.931   Mean   :2.342
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:3.000
##  Max.   :5.000   Max.   :5.000   Max.   :6.000   Max.   :5.000
##  NA's   :127     NA's   :195     NA's   :187     NA's   :161
##       qb6a            qb6b            qb6c           qb6d
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000
##  Median :2.000   Median :3.000   Median :2.000   Median :3.000
##  Mean   :2.568   Mean   :2.687   Mean   :2.585   Mean   :2.788
##  3rd Qu.:3.000   3rd Qu.:3.000   3rd Qu.:3.000   3rd Qu.:4.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :362     NA's   :528     NA's   :624     NA's   :1405
##       qb7a            qb7b            qb7c           qb8
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
```

```
##  1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000
##  Median :3.000   Median :3.000   Median :3.000   Median :3.000
##  Mean   :2.716   Mean   :2.819   Mean   :3.061   Mean   :2.784
##  3rd Qu.:3.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:3.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :564     NA's   :896     NA's   :1682    NA's   :103
##       qc1a            qc1b            qc1c            qc1d
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:2.000   1st Qu.:1.000   1st Qu.:1.000
##  Median :2.000   Median :2.000   Median :2.000   Median :2.000
##  Mean   :2.194   Mean   :2.269   Mean   :2.098   Mean   :2.185
##  3rd Qu.:3.000   3rd Qu.:3.000   3rd Qu.:3.000   3rd Qu.:3.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :411     NA's   :608     NA's   :269     NA's   :246
##       qc2a            qc2b          qc2c            qc2d
##  Min.   :1.000   Min.   :1.0   Min.   :1.000   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:2.0   1st Qu.:2.000   1st Qu.:2.000
##  Median :3.000   Median :2.0   Median :2.000   Median :2.000
##  Mean   :2.714   Mean   :2.6   Mean   :2.558   Mean   :2.453
##  3rd Qu.:3.000   3rd Qu.:3.0   3rd Qu.:3.000   3rd Qu.:3.000
##  Max.   :5.000   Max.   :5.0   Max.   :5.000   Max.   :5.000
##  NA's   :558     NA's   :464   NA's   :548     NA's   :654
##       qc2e            qc2f           qc3             qd1
##  Min.   :1.000   Min.   :1.00   Min.   :1.00   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:2.00   1st Qu.:2.00   1st Qu.:1.000
##  Median :2.000   Median :2.00   Median :2.00   Median :2.000
##  Mean   :2.497   Mean   :2.56   Mean   :2.38   Mean   :2.086
##  3rd Qu.:3.000   3rd Qu.:3.00   3rd Qu.:3.00   3rd Qu.:3.000
##  Max.   :5.000   Max.   :5.00   Max.   :5.00   Max.   :3.000
##  NA's   :445     NA's   :395    NA's   :147    NA's   :124
##       qd3             qd4             qd5a            qd5b
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:1.000   1st Qu.:1.000   1st Qu.:2.000   1st Qu.:2.000
##  Median :2.000   Median :1.000   Median :2.000   Median :2.000
##  Mean   :2.122   Mean   :1.538   Mean   :2.265   Mean   :2.519
##  3rd Qu.:3.000   3rd Qu.:2.000   3rd Qu.:3.000   3rd Qu.:3.000
##  Max.   :3.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :10937   NA's   :4657    NA's   :11975   NA's   :12060
##       qd5c            qe1             qe2             qe3
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:2.000   1st Qu.:1.000   1st Qu.:5.000   1st Qu.:2.000
##  Median :3.000   Median :2.000   Median :6.000   Median :2.000
##  Mean   :2.728   Mean   :1.562   Mean   :5.778   Mean   :1.897
##  3rd Qu.:3.000   3rd Qu.:2.000   3rd Qu.:7.000   3rd Qu.:2.000
##  Max.   :5.000   Max.   :2.000   Max.   :9.000   Max.   :4.000
##  NA's   :12060   NA's   :146     NA's   :157     NA's   :215
##       qe11            qe13            qe14            qe15
##  Min.   : 1.000   Min.   : 1.000   Min.   :1.000   Min.   :1.00
##  1st Qu.: 6.000   1st Qu.: 1.000   1st Qu.:1.000   1st Qu.:1.00
##  Median : 9.000   Median : 1.000   Median :2.000   Median :1.00
##  Mean   : 8.362   Mean   : 1.785   Mean   :1.883   Mean   :1.19
##  3rd Qu.:11.000   3rd Qu.: 1.000   3rd Qu.:2.000   3rd Qu.:1.00
##  Max.   :14.000   Max.   :17.000   Max.   :8.000   Max.   :5.00
##  NA's   :993      NA's   :799      NA's   :934     NA's   :912
```

More advanced descriptives can be produced via the package we have already installed ('psych'). Since this R session has not been terminated, there is no need to call upon the package by using the command 'library'. Otherwise, the latter should have been executed.

The syntax below is twofold. The first line returns descriptives for all variables in the data set, while the second line provides descriptive statistics for specified variables (we selected columns 3-10 in the dataset: variables that capture job satisfaction)

```
describe(data)
```

```
##       vars     n       mean         sd  median    trimmed        mad
## serno    1 21981 2881904.10 2389975.94 2057036 2371540.76 1433702.37
## qa1      2 21815       3.53       1.32       4       3.66       1.48
## qa2      3 21830       1.11       0.42       1       1.00       0.00
## qa3      4 21304      33.07       9.80      37      34.41       2.97
## qa4      5 21335      35.10      12.93      38      36.07       8.90
## qa5a     6 21660       1.85       0.78       2       1.77       1.48
## qa5b     7 21441       2.71       1.09       3       2.72       1.48
## qa5c     8 20994       2.54       1.11       2       2.47       1.48
## qa6      9 21775       2.77       1.00       3       2.79       1.48
## qa7a    10 21694       1.90       0.93       2       1.77       1.48
## qa7b    11 21566       1.95       0.97       2       1.81       1.48
## qa7c    12 21621       1.68       0.83       1       1.54       0.00
## qa7d    13 21610       1.70       0.86       1       1.56       0.00
## qa7e    14 21579       2.42       1.19       2       2.40       1.48
## qa8a    15 21759       2.14       0.92       2       2.04       0.00
## qa8b    16 21721       2.11       0.92       2       2.00       0.00
## qa8c    17 21596       2.40       0.96       2       2.34       1.48
## qa8d    18 21591       2.59       1.08       2       2.54       1.48
## qa8e    19 21636       2.62       1.08       2       2.57       1.48
## qa8f    20 21698       2.99       1.13       3       2.95       1.48
## qa8g    21 21233       2.59       1.07       2       2.53       1.48
## qa8h    22 21710       2.14       0.89       2       2.05       0.00
## qa9a    23 21742       3.38       1.03       3       3.40       1.48
## qa9b    24 21681       4.18       1.04       5       4.35       0.00
## qa9c    25 21669       3.85       1.04       4       3.97       1.48
## qa9d    26 21613       4.10       1.04       4       4.26       1.48
## qa9e    27 21689       4.05       1.04       4       4.20       1.48
## qa9f    28 21705       4.25       1.03       5       4.44       0.00
## qb2a    29 21854       3.23       1.12       3       3.26       1.48
## qb2b    30 21786       3.97       0.78       4       4.03       0.00
## qb3     31 21794       2.93       1.60       3       2.83       1.48
## qb4     32 21820       2.34       0.84       2       2.37       1.48
## qb6a    33 21619       2.57       1.13       2       2.50       1.48
## qb6b    34 21453       2.69       1.13       3       2.64       1.48
## qb6c    35 21357       2.59       1.05       2       2.54       1.48
## qb6d    36 20576       2.79       1.16       3       2.73       1.48
## qb7a    37 21417       2.72       1.14       3       2.66       1.48
## qb7b    38 21085       2.82       1.12       3       2.78       1.48
## qb7c    39 20299       3.06       1.11       3       3.04       1.48
## qb8     40 21878       2.78       0.99       3       2.77       1.48
## qc1a    41 21570       2.19       0.89       2       2.11       0.00
## qc1b    42 21373       2.27       0.86       2       2.22       1.48
## qc1c    43 21712       2.10       0.91       2       2.00       1.48
## qc1d    44 21735       2.18       0.99       2       2.08       1.48
```

```
## qc2a    45 21423       2.71       1.06       3       2.69       1.48
## qc2b    46 21517       2.60       1.06       2       2.55       1.48
## qc2c    47 21433       2.56       1.04       2       2.51       1.48
## qc2d    48 21327       2.45       1.02       2       2.38       1.48
## qc2e    49 21536       2.50       1.04       2       2.44       1.48
## qc2f    50 21586       2.56       1.10       2       2.49       1.48
## qc3     51 21834       2.38       1.03       2       2.30       1.48
## qd1     52 21857       2.09       0.91       2       2.11       1.48
## qd3     53 11044       2.12       0.89       2       2.15       1.48
## qd4     54 17324       1.54       0.82       1       1.36       0.00
## qd5a    55 10006       2.27       0.84       2       2.21       0.00
## qd5b    56  9921       2.52       0.90       2       2.49       1.48
## qd5c    57  9921       2.73       0.93       3       2.71       1.48
## qe1     58 21835       1.56       0.50       2       1.58       0.00
## qe2     59 21824       5.78       1.39       6       5.81       1.48
## qe3     60 21766       1.90       0.58       2       1.86       0.00
## qe11    61 20988       8.36       3.33       9       8.51       2.97
## qe13    62 21182       1.79       2.58       1       1.06       0.00
## qe14    63 21047       1.88       1.09       2       1.73       0.00
## qe15    64 21069       1.19       0.80       1       1.00       0.00
##           min     max   range  skew kurtosis       se
## serno 1001004 9119010 8118006  1.73     1.69 16120.18
## qa1         1       5       4 -0.54    -0.80     0.01
## qa2         1       3       2  3.85    13.74     0.00
## qa3         0      96      96 -1.02     2.32     0.07
## qa4         0      97      97 -0.62     0.74     0.09
## qa5a        1       5       4  0.79     0.66     0.01
## qa5b        1       5       4  0.02    -0.86     0.01
## qa5c        1       5       4  0.55    -0.45     0.01
## qa6         1       5       4  0.01    -0.59     0.01
## qa7a        1       4       3  0.85    -0.15     0.01
## qa7b        1       4       3  0.78    -0.40     0.01
## qa7c        1       4       3  1.12     0.58     0.01
## qa7d        1       4       3  1.13     0.56     0.01
## qa7e        1       4       3  0.16    -1.50     0.01
## qa8a        1       5       4  0.97     1.03     0.01
## qa8b        1       5       4  0.96     0.96     0.01
## qa8c        1       5       4  0.61     0.07     0.01
## qa8d        1       5       4  0.51    -0.39     0.01
## qa8e        1       5       4  0.47    -0.42     0.01
## qa8f        1       5       4  0.21    -0.94     0.01
## qa8g        1       5       4  0.60    -0.29     0.01
## qa8h        1       5       4  0.98     1.23     0.01
## qa9a        1       5       4 -0.14    -0.45     0.01
## qa9b        1       5       4 -1.15     0.57     0.01
## qa9c        1       5       4 -0.69    -0.09     0.01
## qa9d        1       5       4 -1.02     0.32     0.01
## qa9e        1       5       4 -0.97     0.29     0.01
## qa9f        1       5       4 -1.33     1.06     0.01
## qb2a        1       5       4 -0.37    -0.70     0.01
## qb2b        1       5       4 -0.78     1.15     0.01
## qb3         1       6       5  0.22    -1.11     0.01
## qb4         1       5       4 -0.09    -0.41     0.01
## qb6a        1       5       4  0.52    -0.50     0.01
```

```
## qb6b        1       5       4  0.39    -0.65     0.01
## qb6c        1       5       4  0.48    -0.25     0.01
## qb6d        1       5       4  0.33    -0.68     0.01
## qb7a        1       5       4  0.43    -0.64     0.01
## qb7b        1       5       4  0.31    -0.67     0.01
## qb7c        1       5       4  0.11    -0.69     0.01
## qb8         1       5       4  0.26    -0.30     0.01
## qc1a        1       5       4  0.74     0.48     0.01
## qc1b        1       5       4  0.61     0.52     0.01
## qc1c        1       5       4  0.91     0.92     0.01
## qc1d        1       5       4  0.74     0.31     0.01
## qc2a        1       5       4  0.38    -0.48     0.01
## qc2b        1       5       4  0.54    -0.37     0.01
## qc2c        1       5       4  0.57    -0.22     0.01
## qc2d        1       5       4  0.69     0.04     0.01
## qc2e        1       5       4  0.59    -0.15     0.01
## qc2f        1       5       4  0.59    -0.32     0.01
## qc3         1       5       4  0.63    -0.07     0.01
## qd1         1       3       2 -0.17    -1.76     0.01
## qd3         1       3       2 -0.24    -1.69     0.01
## qd4         1       5       4  1.74     2.71     0.01
## qd5a        1       5       4  0.72     0.75     0.01
## qd5b        1       5       4  0.50     0.06     0.01
## qd5c        1       5       4  0.28    -0.12     0.01
## qe1         1       2       1 -0.25    -1.94     0.00
## qe2         1       9       8 -0.36     0.37     0.01
## qe3         1       4       3  0.46     1.77     0.00
## qe11        1      14      13 -0.35    -0.62     0.02
## qe13        1      17      16  3.72    13.58     0.02
## qe14        1       8       7  3.43    14.55     0.01
## qe15        1       5       4  4.30    17.07     0.01
```

```
describe(data[,3:10])
```

```
##      vars     n  mean    sd median trimmed  mad min max range  skew
## qa2     1 21830  1.11  0.42      1    1.00 0.00   1   3     2  3.85
## qa3     2 21304 33.07  9.80     37   34.41 2.97   0  96    96 -1.02
## qa4     3 21335 35.10 12.93     38   36.07 8.90   0  97    97 -0.62
## qa5a    4 21660  1.85  0.78      2    1.77 1.48   1   5     4  0.79
## qa5b    5 21441  2.71  1.09      3    2.72 1.48   1   5     4  0.02
## qa5c    6 20994  2.54  1.11      2    2.47 1.48   1   5     4  0.55
## qa6     7 21775  2.77  1.00      3    2.79 1.48   1   5     4  0.01
## qa7a    8 21694  1.90  0.93      2    1.77 1.48   1   4     3  0.85
##      kurtosis   se
## qa2     13.74 0.00
## qa3      2.32 0.07
## qa4      0.74 0.09
## qa5a     0.66 0.01
## qa5b    -0.86 0.01
## qa5c    -0.45 0.01
## qa6     -0.59 0.01
## qa7a    -0.15 0.01
```

Lastly, descriptive statistics can be saved in a convenient format using the package 'xtable'. The first line ought to look familiar, as it calls upon the specific package (xtable in our case). The lines below the library

function create an object called 'sum', which is basic descriptives for our data. The object sum is then converted into a table format. Using command 'print.xtable', the object is saved into an HTML file.

```
library(xtable)
sum=describe(data)
sumtable=xtable(sum)
print.xtable(sumtable, type="html", file="summary.html")
```