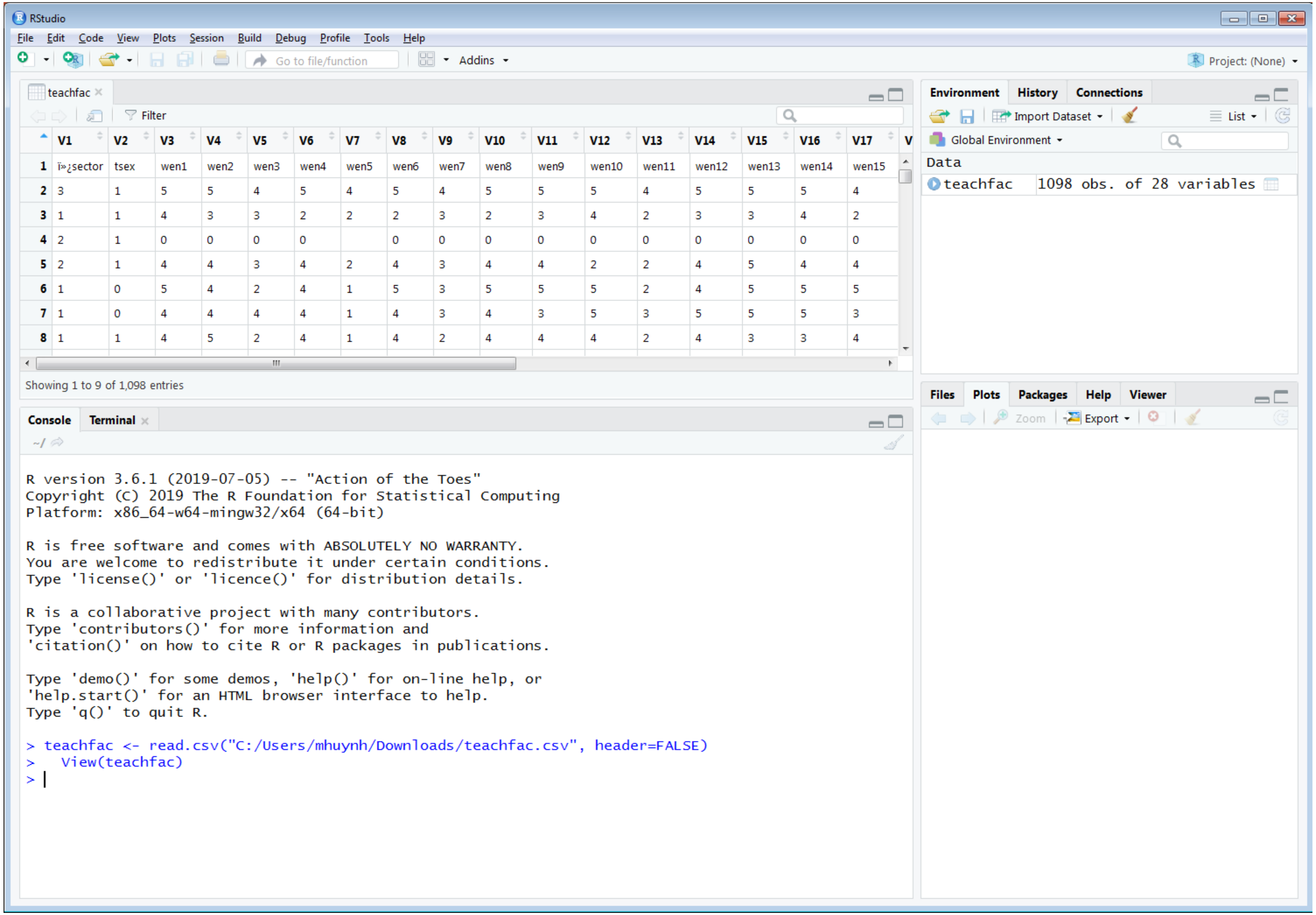
1 Import the Data File (teachfac.csv) from CANVAS


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
Export
Console Terminal
~/

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V
1	ï»¿sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	
2	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	
3	1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	
4	2	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	
5	2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	
6	1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5	
7	1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3	
8	1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4	

Showing 1 to 9 of 1,098 entries

Data

teachfac 1098 obs. of 28 variables

```
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Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> teachfac <- read.csv("C:/Users/mhuynh/Downloads/teachfac.csv", header=FALSE)
>   View(teachfac)
> |
```
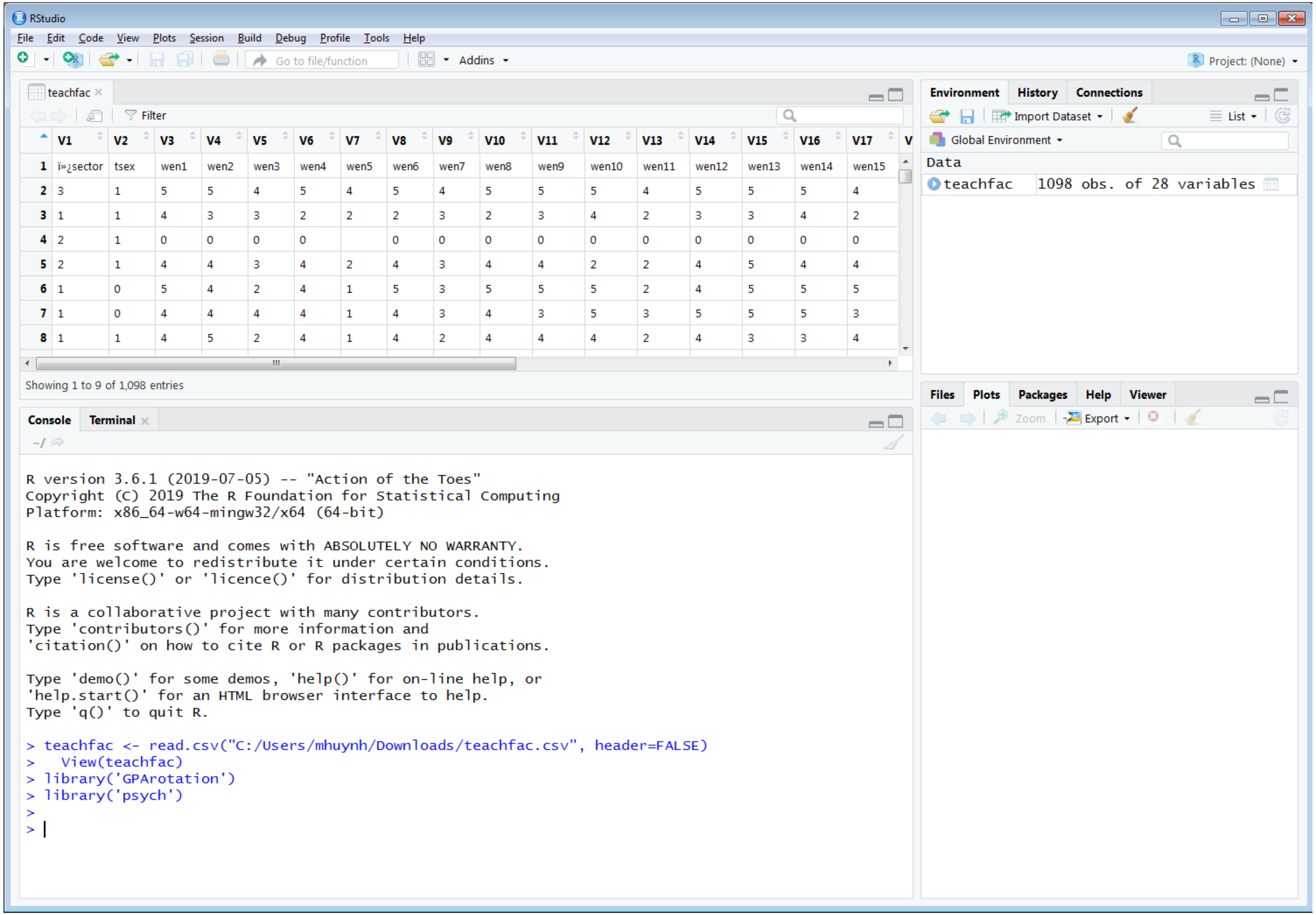

2 Load the necessary packages

```
>    library('GPArotation')
>    library('psych')
```


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
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~/

Data
teachfac 1098 obs. of 28 variables

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17
1	ï»¿sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15
2	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4
3	1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2
4	2	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0
5	2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4
6	1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5
7	1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3
8	1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4

Showing 1 to 9 of 1,098 entries

```
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> teachfac <- read.csv("C:/Users/mhuynh/Downloads/teachfac.csv", header=FALSE)
>   View(teachfac)
> library('GPArotation')
> library('psych')
>
> |
```
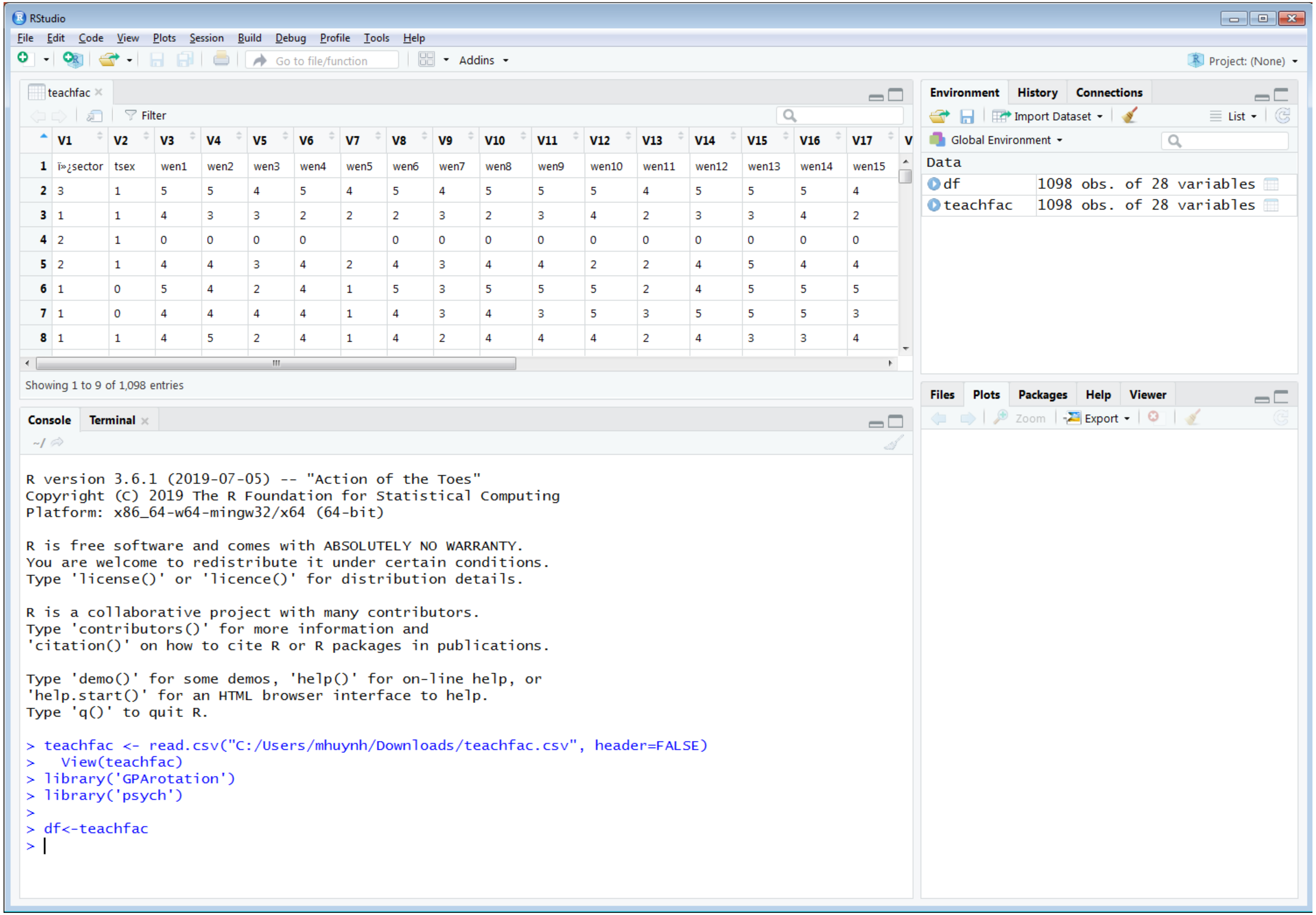

3 Define data with suitable name

> df<-teachfac



RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
Export
Console Terminal
~/

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V
1	ï»¿sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	
2	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	
3	1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	
4	2	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	
5	2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	
6	1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5	
7	1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3	
8	1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4	

Showing 1 to 9 of 1,098 entries

Data

df	1098 obs. of 28 variables
teachfac	1098 obs. of 28 variables

```
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> teachfac <- read.csv("C:/Users/mhuynh/Downloads/teachfac.csv", header=FALSE)
>   View(teachfac)
> library('GPArotation')
> library('psych')
>
> df<-teachfac
> |
```
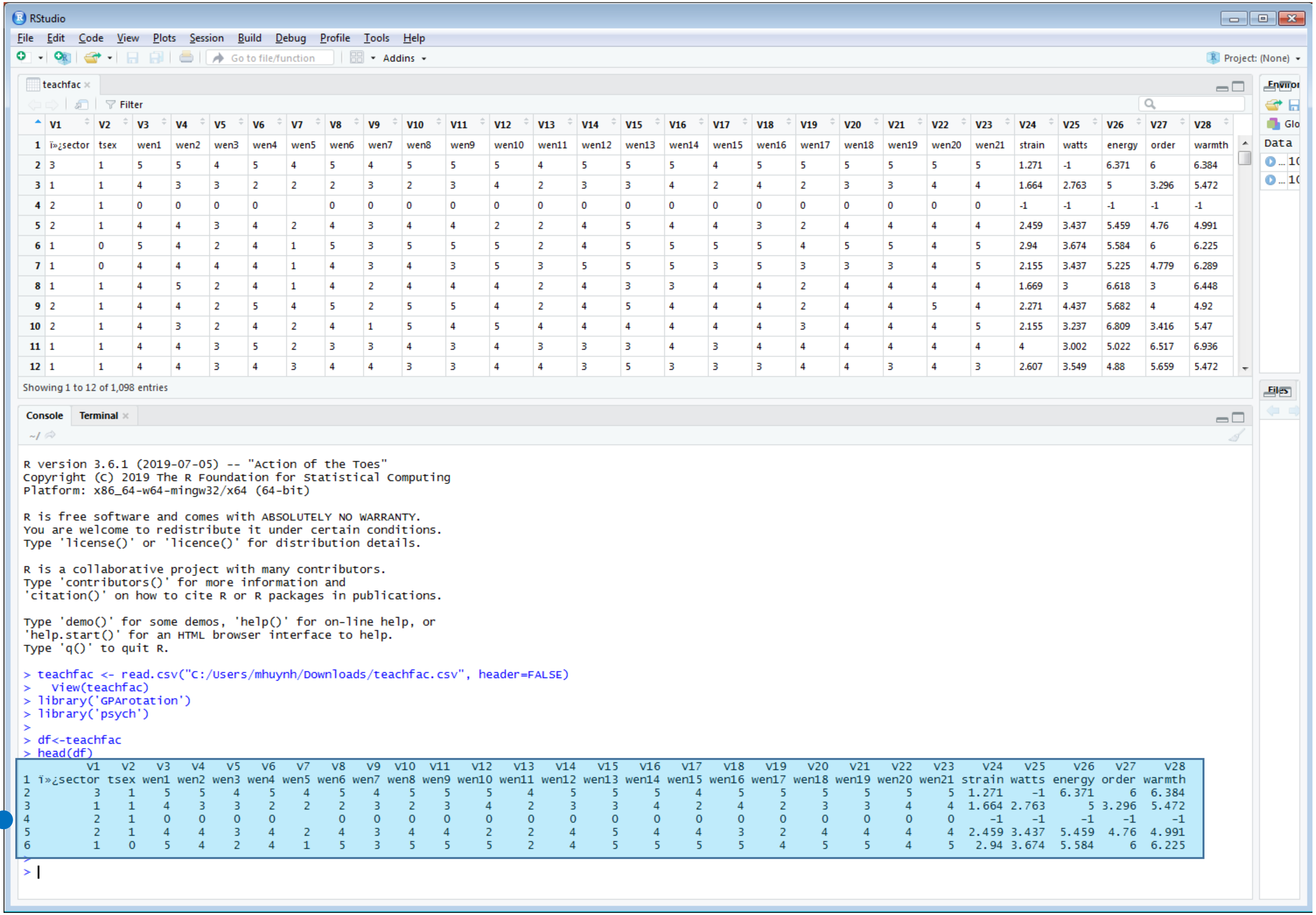

4 Inspect the current data frame

> head(df)

This reveals the data frame to consists of 28 variables:



	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28
1	ï»¿sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17	wen18	wen19	wen20	wen21	strain	watts	energy	order	warmth
2	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	5	5	5	5	5	5	1.271	-1	6.371	6	6.384
3	1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	4	2	3	3	4	4	1.664	2.763	5	3.296	5.472
4	2	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1
5	2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	3	2	4	4	4	4	2.459	3.437	5.459	4.76	4.991
6	1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5	5	4	5	5	4	5	2.94	3.674	5.584	6	6.225
7	1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3	5	3	3	3	4	5	2.155	3.437	5.225	4.779	6.289
8	1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4	4	2	4	4	4	4	1.669	3	6.618	3	6.448
9	2	1	4	4	2	5	4	5	2	5	5	4	2	4	5	4	4	4	2	4	4	5	4	2.271	4.437	5.682	4	4.92
10	2	1	4	3	2	4	2	4	1	5	4	5	4	4	4	4	4	4	3	4	4	4	5	2.155	3.237	6.809	3.416	5.47
11	1	1	4	4	3	5	2	3	3	4	3	4	3	3	3	4	3	4	4	4	4	4	4	4	3.002	5.022	6.517	6.936
12	1	1	4	4	3	4	3	4	4	3	3	4	4	3	5	3	3	3	4	4	3	4	3	2.607	3.549	4.88	5.659	5.472

Showing 1 to 12 of 1,098 entries

```
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Type 'q()' to quit R.

> teachfac <- read.csv("C:/Users/mhuynh/Downloads/teachfac.csv", header=FALSE)
>   View(teachfac)
> library('GPArotation')
> library('psych')
>
> df<-teachfac
> head(df)
         V1   V2   V3   V4   V5   V6   V7   V8   V9  V10  V11   V12   V13   V14   V15   V16   V17   V18   V19   V20   V21   V22   V23    V24   V25    V26   V27    V28
1 ï»¿sector tsex wen1 wen2 wen3 wen4 wen5 wen6 wen7 wen8 wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17 wen18 wen19 wen20 wen21 strain watts energy order warmth
2         3    1    5    5    4    5    4    5    4    5    5     5     4     5     5     5     4     5     5     5     5     5     5  1.271    -1  6.371     6  6.384
3         1    1    4    3    3    2    2    2    3    2    3     4     2     3     3     4     2     4     2     3     3     4     4  1.664 2.763      5 3.296  5.472
4         2    1    0    0    0    0         0    0    0    0     0     0     0     0     0     0     0     0     0     0     0     0     -1    -1     -1    -1     -1
5         2    1    4    4    3    4    2    4    3    4    4     2     2     4     5     4     4     3     2     4     4     4     4  2.459 3.437  5.459  4.76  4.991
6         1    0    5    4    2    4    1    5    3    5    5     5     2     4     5     5     5     5     4     5     5     4     5   2.94 3.674  5.584     6  6.225
>
> |
```
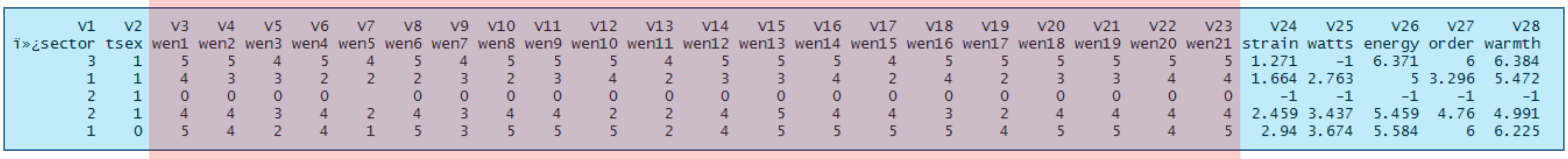
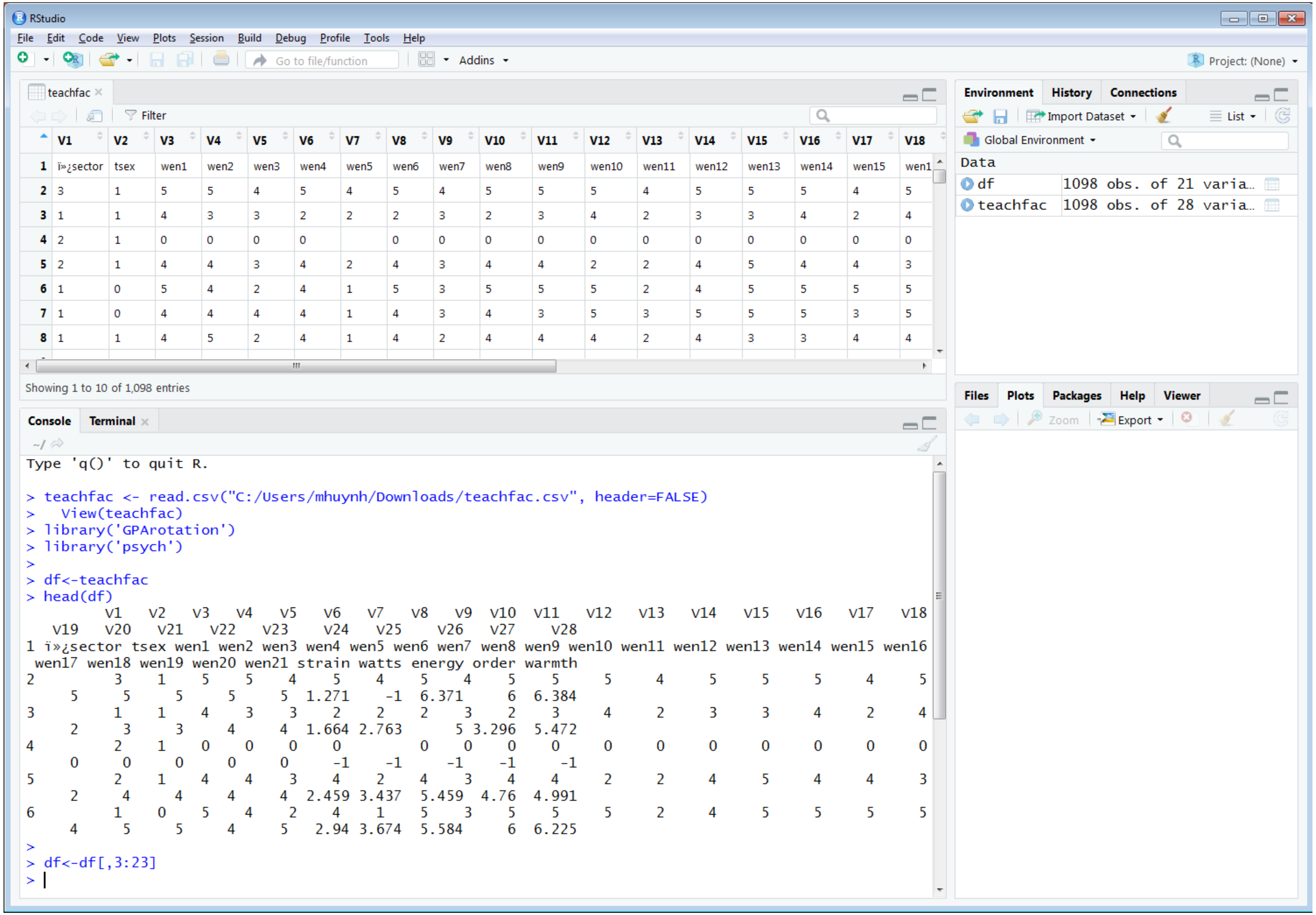

Note: For this exercise, we are only interested in the *wen* items (variable 3 to 23)



```
       V1   V2   V3   V4   V5   V6   V7   V8   V9  V10  V11   V12   V13   V14   V15   V16   V17   V18   V19   V20   V21   V22   V23    V24   V25    V26   V27    V28
ï»¿sector tsex wen1 wen2 wen3 wen4 wen5 wen6 wen7 wen8 wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17 wen18 wen19 wen20 wen21 strain watts energy order warmth
        3    1    5    5    4    5    4    5    4    5    5     5     4     5     5     5     4     5     5     5     5     5     5  1.271    -1  6.371     6  6.384
        1    1    4    3    3    2    2    2    3    2    3     4     2     3     3     4     2     4     2     3     3     4     4  1.664 2.763      5 3.296  5.472
        2    1    0    0    0    0         0    0    0    0     0     0     0     0     0     0     0     0     0     0     0     0     -1    -1     -1    -1     -1
        2    1    4    4    3    4    2    4    3    4    4     2     2     4     5     4     4     3     2     4     4     4     4  2.459 3.437  5.459  4.76  4.991
        1    0    5    4    2    4    1    5    3    5    5     5     2     4     5     5     5     5     4     5     5     4     5   2.94 3.674  5.584     6  6.225
```

5 Redefine data frame for variables of interest only (3:23)

```
>       df<-df[ ,3:23]
```



RStudio
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Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
Export
Console Terminal
~/

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18
1	ï»¿sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen1
2	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	5
3	1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	4
4	2	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
5	2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	3
6	1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5	5
7	1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3	5
8	1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4	4

Showing 1 to 10 of 1,098 entries

Data

- df 1098 obs. of 21 varia...
- teachfac 1098 obs. of 28 varia...

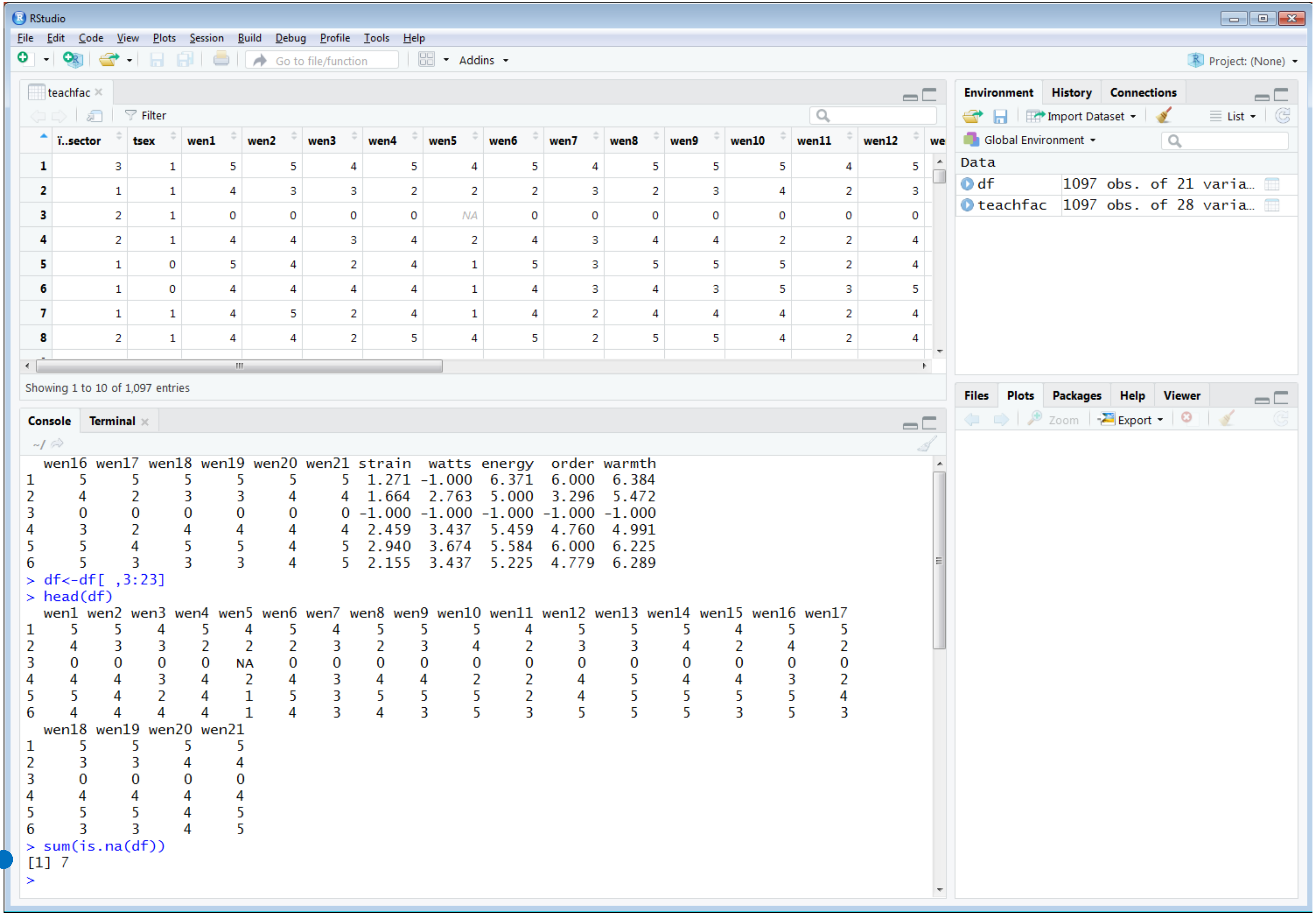
```
Type 'q()' to quit R.

> teachfac <- read.csv("C:/Users/mhuynh/Downloads/teachfac.csv", header=FALSE)
>   View(teachfac)
> library('GPArotation')
> library('psych')
>
> df<-teachfac
> head(df)
         V1   V2   V3   V4   V5   V6   V7   V8   V9  V10  V11   V12   V13   V14   V15   V16   V17   V18
   V19   V20   V21   V22   V23    V24    V25    V26   V27    V28
1 ï»¿sector tsex wen1 wen2 wen3 wen4 wen5 wen6 wen7 wen8 wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16
 wen17 wen18 wen19 wen20 wen21 strain watts energy order warmth
2         3    1    5    5    4    5    4    5    4    5    5     5     4     5     5     5     4     5
     5     5     5     5     5  1.271     -1  6.371     6  6.384
3         1    1    4    3    3    2    2    2    3    2    3     4     2     3     3     4     2     4
     2     3     3     4     4  1.664  2.763      5 3.296  5.472
4         2    1    0    0    0    0         0    0    0    0     0     0     0     0     0     0     0
     0     0     0     0     0     -1     -1     -1    -1     -1
5         2    1    4    4    3    4    2    4    3    4    4     2     2     4     5     4     4     3
     2     4     4     4     4  2.459  3.437  5.459  4.76  4.991
6         1    0    5    4    2    4    1    5    3    5    5     5     2     4     5     5     5     5
     4     5     5     4     5   2.94  3.674  5.584     6  6.225
>
> df<-df[,3:23]
> |
```

6 Determine number of missing cases

> sum(is.na(df))

Here we can see that it's seven



	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	we
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	
2	1	1	4	3	3	2	2	2	3	2	3	4	2	3	
3	2	1	0	0	0	0	NA	0	0	0	0	0	0	0	
4	2	1	4	4	3	4	2	4	3	4	4	2	2	4	
5	1	0	5	4	2	4	1	5	3	5	5	5	2	4	
6	1	0	4	4	4	4	1	4	3	4	3	5	3	5	
7	1	1	4	5	2	4	1	4	2	4	4	4	2	4	
8	2	1	4	4	2	5	4	5	2	5	5	4	2	4	

Showing 1 to 10 of 1,097 entries

Data

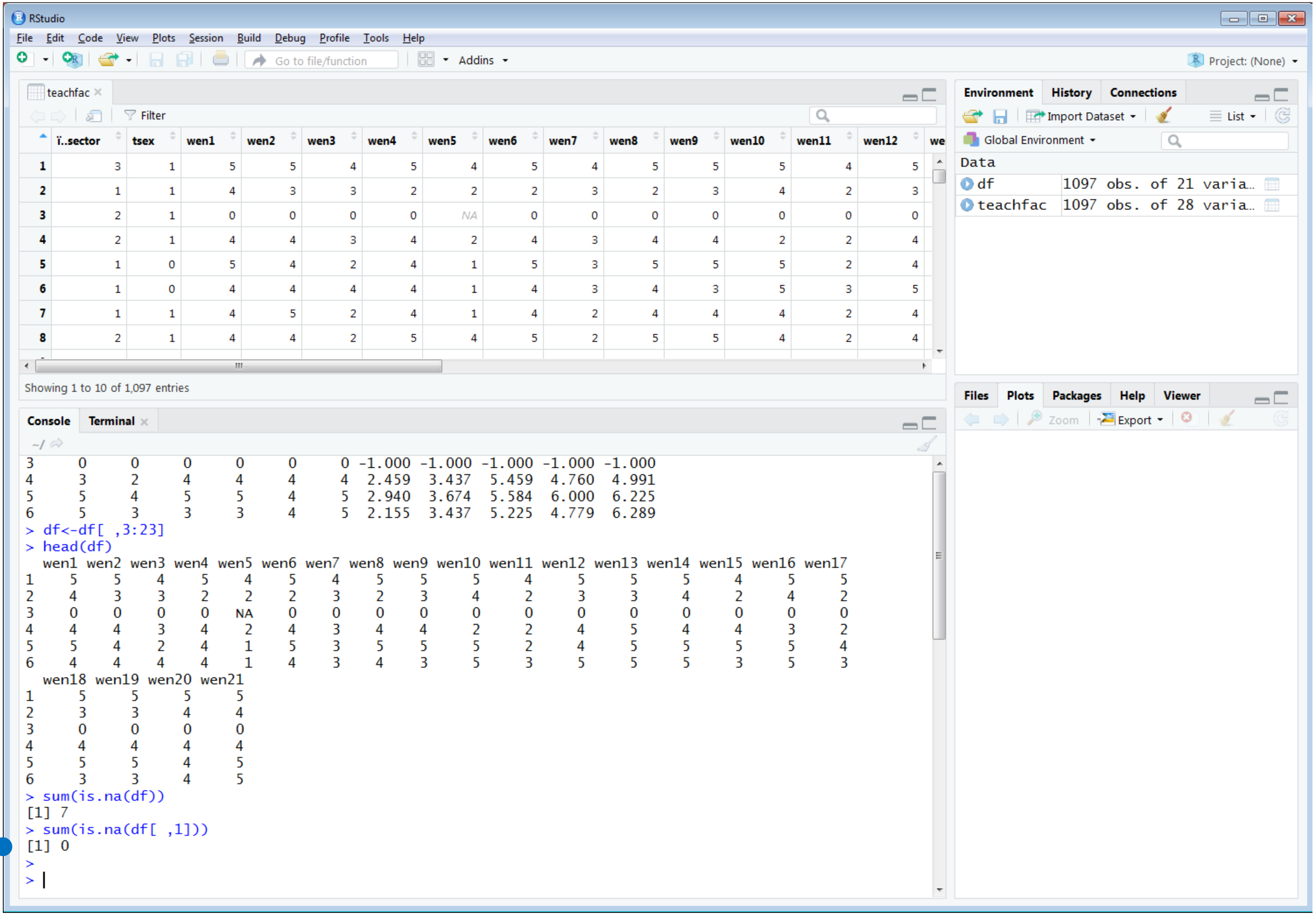
df	1097 obs. of 21 varia…
teachfac	1097 obs. of 28 varia…

```
  wen16 wen17 wen18 wen19 wen20 wen21 strain  watts energy  order warmth
1     5     5     5     5     5     5  1.271 -1.000  6.371  6.000  6.384
2     4     2     3     3     4     4  1.664  2.763  5.000  3.296  5.472
3     0     0     0     0     0     0 -1.000 -1.000 -1.000 -1.000 -1.000
4     3     2     4     4     4     4  2.459  3.437  5.459  4.760  4.991
5     5     4     5     5     4     5  2.940  3.674  5.584  6.000  6.225
6     5     3     3     3     4     5  2.155  3.437  5.225  4.779  6.289
> df<-df[ ,3:23]
> head(df)
  wen1 wen2 wen3 wen4 wen5 wen6 wen7 wen8 wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17
1    5    5    4    5    4    5    4    5    5     5     4     5     5     5     4     5     5
2    4    3    3    2    2    2    3    2    3     4     2     3     3     4     2     4     2
3    0    0    0    0   NA    0    0    0    0     0     0     0     0     0     0     0     0
4    4    4    3    4    2    4    3    4    4     2     2     4     5     4     4     3     2
5    5    4    2    4    1    5    3    5    5     5     2     4     5     5     5     5     4
6    4    4    4    4    1    4    3    4    3     5     3     5     5     5     3     5     3
  wen18 wen19 wen20 wen21
1     5     5     5     5
2     3     3     4     4
3     0     0     0     0
4     4     4     4     4
5     5     5     4     5
6     3     3     4     5
> sum(is.na(df))
[1] 7
>
```

7 Check how many missing cases there are in Column 1

> sum(is.na(df[,1]))

Here we can see that it's zero


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
Export
Console Terminal
~/

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	we
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	
2	1	1	4	3	3	2	2	2	3	2	3	4	2	3	
3	2	1	0	0	0	0	NA	0	0	0	0	0	0	0	
4	2	1	4	4	3	4	2	4	3	4	4	2	2	4	
5	1	0	5	4	2	4	1	5	3	5	5	5	2	4	
6	1	0	4	4	4	4	1	4	3	4	3	5	3	5	
7	1	1	4	5	2	4	1	4	2	4	4	4	2	4	
8	2	1	4	4	2	5	4	5	2	5	5	4	2	4	

Showing 1 to 10 of 1,097 entries

Data

df	1097 obs. of 21 varia…
teachfac	1097 obs. of 28 varia…

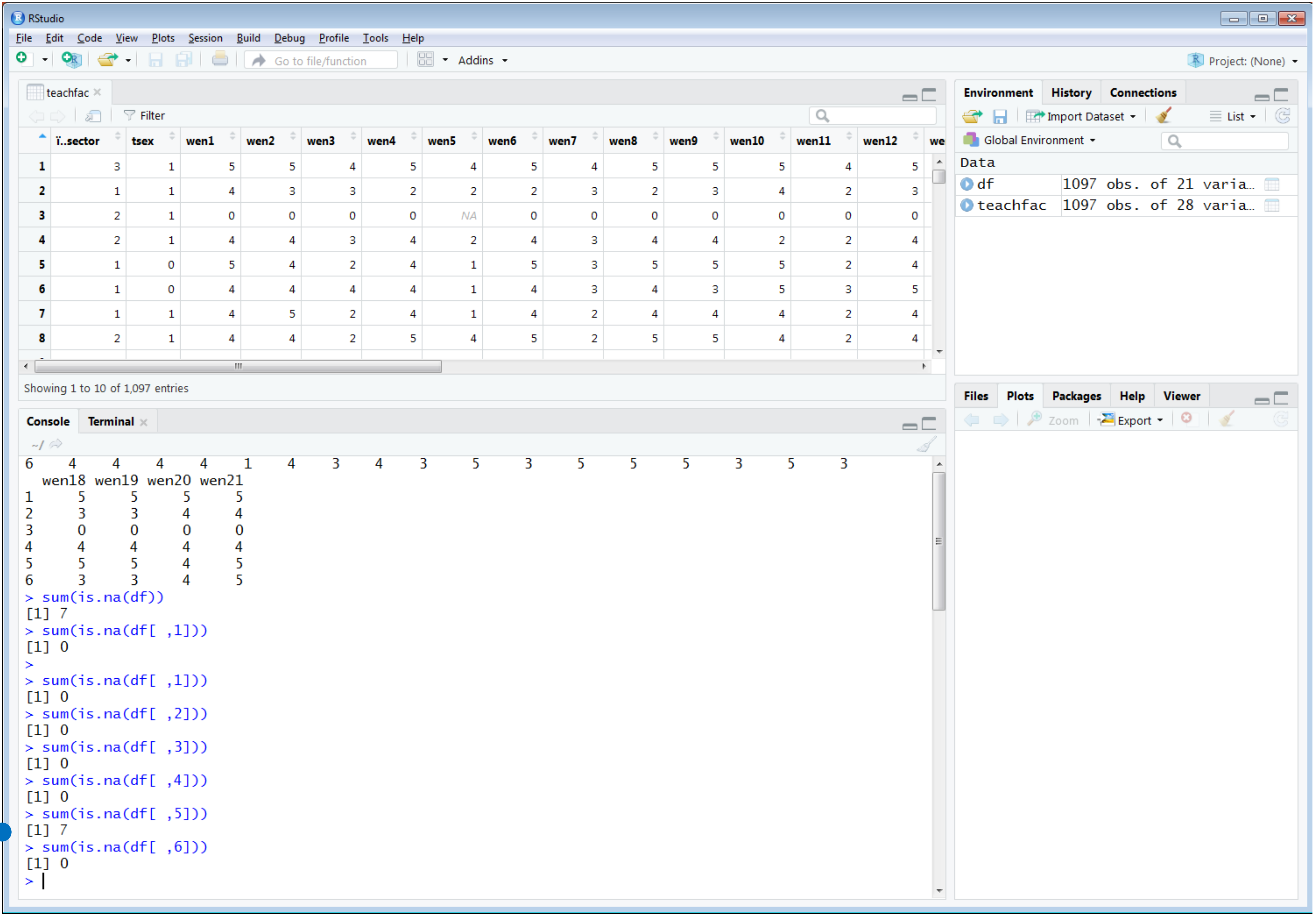
```
3      0      0      0      0      0      0 -1.000 -1.000 -1.000 -1.000 -1.000
4      3      2      4      4      4      4  2.459  3.437  5.459  4.760  4.991
5      5      4      5      5      4      5  2.940  3.674  5.584  6.000  6.225
6      5      3      3      3      4      5  2.155  3.437  5.225  4.779  6.289
> df<-df[ ,3:23]
> head(df)
  wen1 wen2 wen3 wen4 wen5 wen6 wen7 wen8 wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17
1    5    5    4    5    4    5    4    5    5     5     4     5     5     5     4     5     5
2    4    3    3    2    2    2    3    2    3     4     2     3     3     4     2     4     2
3    0    0    0    0   NA    0    0    0    0     0     0     0     0     0     0     0     0
4    4    4    3    4    2    4    3    4    4     2     2     4     5     4     4     3     2
5    5    4    2    4    1    5    3    5    5     5     2     4     5     5     5     5     4
6    4    4    4    4    1    4    3    4    3     5     3     5     5     5     3     5     3
  wen18 wen19 wen20 wen21
1     5     5     5     5
2     3     3     4     4
3     0     0     0     0
4     4     4     4     4
5     5     5     4     5
6     3     3     4     5
> sum(is.na(df))
[1] 7
> sum(is.na(df[ ,1]))
[1] 0
>
> |
```

8

Repeat for all 21 columns to find columns with missing

```
>     sum(is.na(df[ ,1]))
>     sum(is.na(df[ ,2]))
>     sum(is.na(df[ ,3]))
>     sum(is.na(df[ ,4]))
>     sum(is.na(df[ ,5]))
>              …
>     sum(is.na(df[ ,21]))
```

Here we can stop at column 5 because all seven were found in the same column


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
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Console Terminal
~/

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	we
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	
2	1	1	4	3	3	2	2	2	3	2	3	4	2	3	
3	2	1	0	0	0	0	NA	0	0	0	0	0	0	0	
4	2	1	4	4	3	4	2	4	3	4	4	2	2	4	
5	1	0	5	4	2	4	1	5	3	5	5	5	2	4	
6	1	0	4	4	4	4	1	4	3	4	3	5	3	5	
7	1	1	4	5	2	4	1	4	2	4	4	4	2	4	
8	2	1	4	4	2	5	4	5	2	5	5	4	2	4	

Showing 1 to 10 of 1,097 entries

Data

df	1097 obs. of 21 varia…
teachfac	1097 obs. of 28 varia…

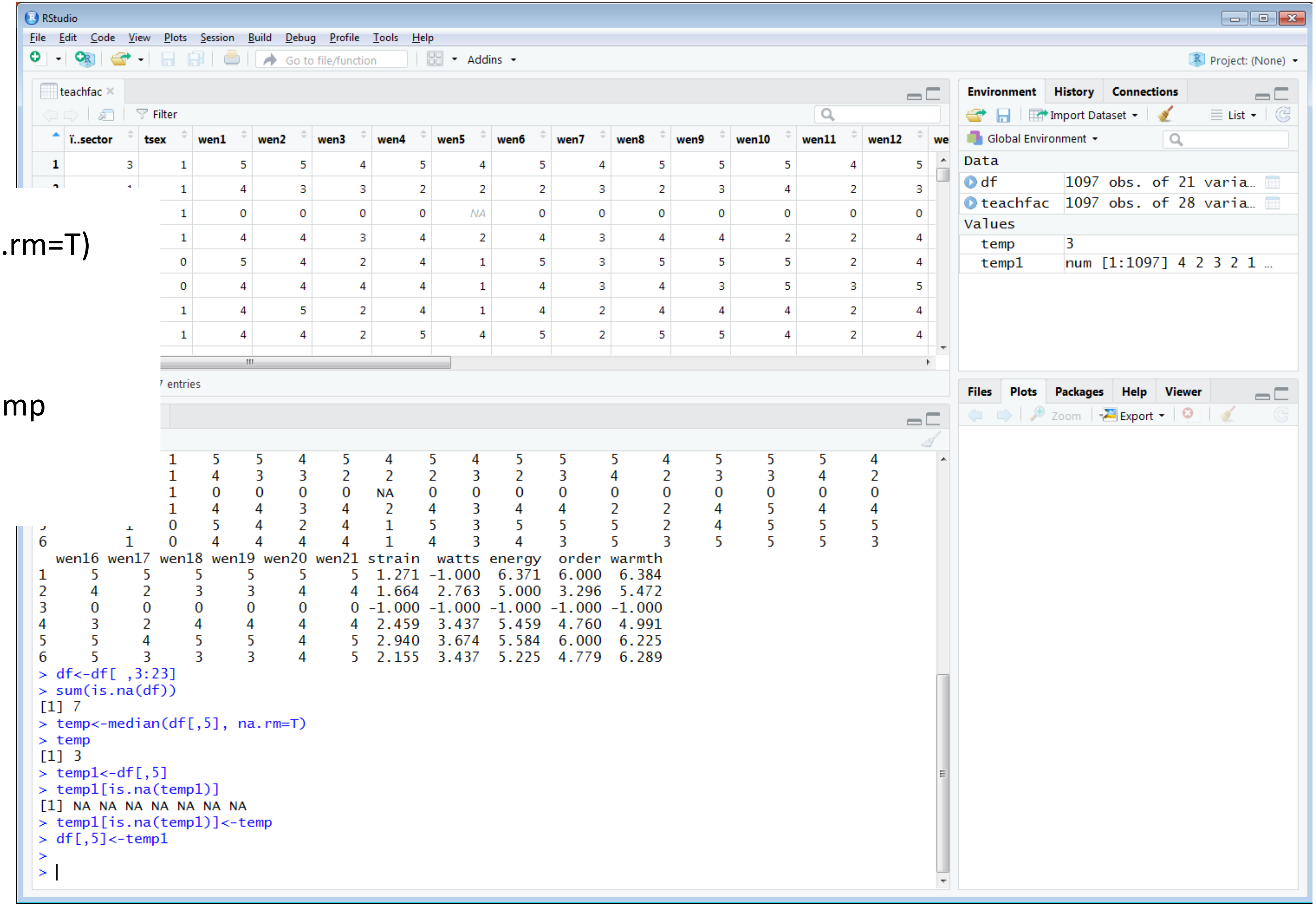
```
6      4      4      4      4      1      4      3      4      3      5      3      5      5      5      3      5      3
  wen18 wen19 wen20 wen21
1     5     5     5     5
2     3     3     4     4
3     0     0     0     0
4     4     4     4     4
5     5     5     4     5
6     3     3     4     5
> sum(is.na(df))
[1] 7
> sum(is.na(df[ ,1]))
[1] 0
>
> sum(is.na(df[ ,1]))
[1] 0
> sum(is.na(df[ ,2]))
[1] 0
> sum(is.na(df[ ,3]))
[1] 0
> sum(is.na(df[ ,4]))
[1] 0
> sum(is.na(df[ ,5]))
[1] 7
> sum(is.na(df[ ,6]))
[1] 0
> |
```

Bonus task (for later): write a code that loops through all columns

9

Replace the missing values from column 5 with the median

```
>       temp<-median(df[,5], na.rm=T)
>       temp
>       temp1<-df[,5]
>       temp1[is.na(temp1)]
>       temp1[is.na(temp1)]<-temp
>       df[,5]<-temp1
```



RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
Export

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	we
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	
2	1	1	4	3	3	2	2	2	3	2	3	4	2	3	
		1	0	0	0	0	NA	0	0	0	0	0	0	0	
		1	4	4	3	4	2	4	3	4	4	2	2	4	
		0	5	4	2	4	1	5	3	5	5	5	2	4	
		0	4	4	4	4	1	4	3	4	3	5	3	5	
		1	4	5	2	4	1	4	2	4	4	4	2	4	
		1	4	4	2	5	4	5	2	5	5	4	2	4	

7 entries

```
                1    5    5    4    5    4    5    4    5    5    5    4    5    5    5    4
                1    4    3    3    2    2    2    3    2    3    4    2    3    3    4    2
                1    0    0    0    0   NA    0    0    0    0    0    0    0    0    0    0
                1    4    4    3    4    2    4    3    4    4    2    2    4    5    4    4
5          1    0    5    4    2    4    1    5    3    5    5    5    2    4    5    5    5
6          1    0    4    4    4    4    1    4    3    4    3    5    3    5    5    5    3
  wen16 wen17 wen18 wen19 wen20 wen21 strain  watts energy  order warmth
1     5     5     5     5     5     5  1.271 -1.000  6.371  6.000  6.384
2     4     2     3     3     4     4  1.664  2.763  5.000  3.296  5.472
3     0     0     0     0     0     0 -1.000 -1.000 -1.000 -1.000 -1.000
4     3     2     4     4     4     4  2.459  3.437  5.459  4.760  4.991
5     5     4     5     5     4     5  2.940  3.674  5.584  6.000  6.225
6     5     3     3     3     4     5  2.155  3.437  5.225  4.779  6.289
> df<-df[ ,3:23]
> sum(is.na(df))
[1] 7
> temp<-median(df[,5], na.rm=T)
> temp
[1] 3
> temp1<-df[,5]
> temp1[is.na(temp1)]
[1] NA NA NA NA NA NA NA
> temp1[is.na(temp1)]<-temp
> df[,5]<-temp1
>
> |
```

Data

df	1097 obs. of 21 varia…
teachfac	1097 obs. of 28 varia…

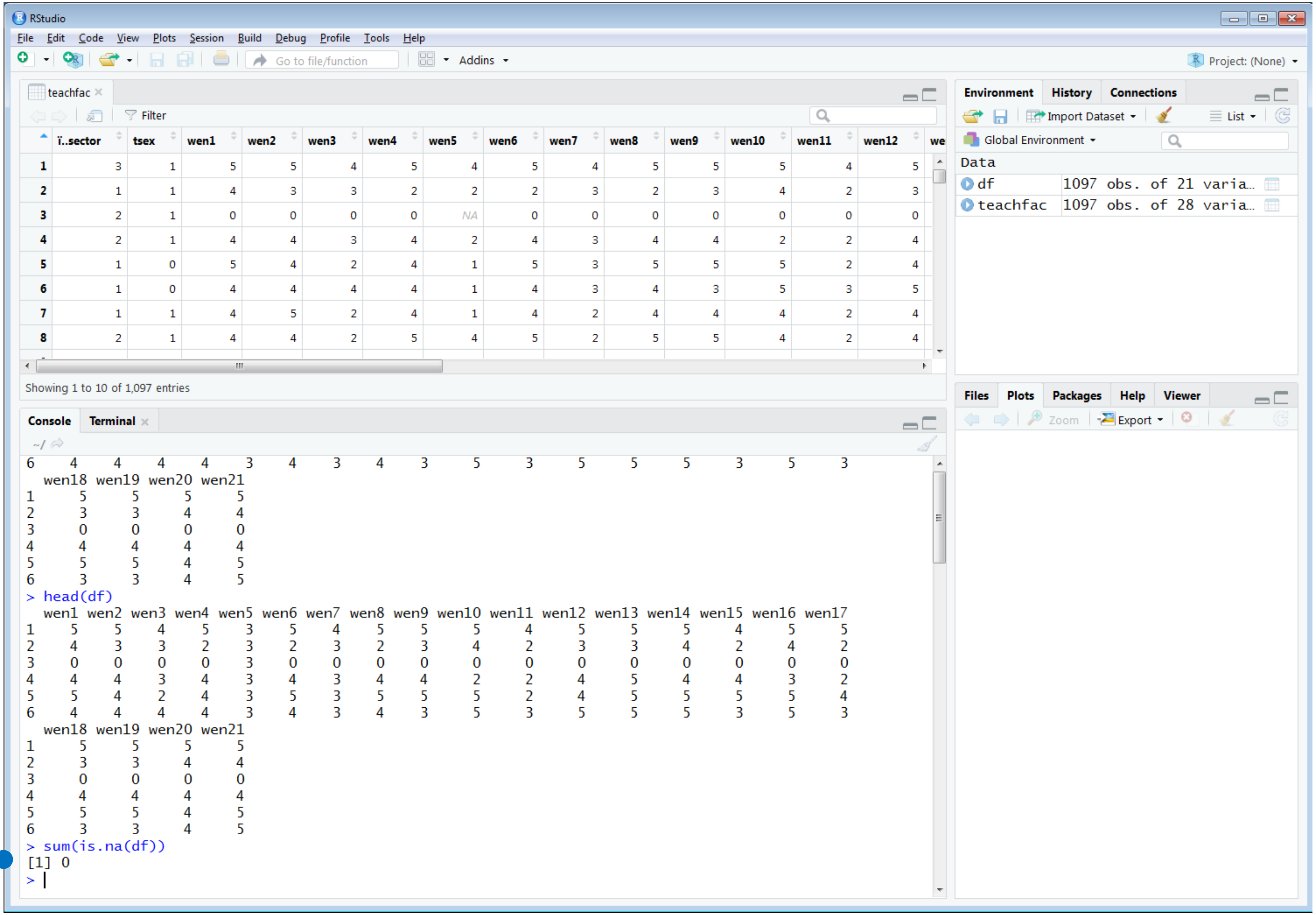
Values

temp	3
temp1	num [1:1097] 4 2 3 2 1 …

10 Recheck the number of missing cases (should be zero now)

> sum(is.na(df))

Here we can see that it’s zero after replacing with the median


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter
Environment History Connections
Import Dataset
List
Global Environment
Files Plots Packages Help Viewer
Zoom
Export
Console Terminal
~/

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	we
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	
2	1	1	4	3	3	2	2	2	3	2	3	4	2	3	
3	2	1	0	0	0	0	NA	0	0	0	0	0	0	0	
4	2	1	4	4	3	4	2	4	3	4	4	2	2	4	
5	1	0	5	4	2	4	1	5	3	5	5	5	2	4	
6	1	0	4	4	4	4	1	4	3	4	3	5	3	5	
7	1	1	4	5	2	4	1	4	2	4	4	4	2	4	
8	2	1	4	4	2	5	4	5	2	5	5	4	2	4	

Showing 1 to 10 of 1,097 entries

Data

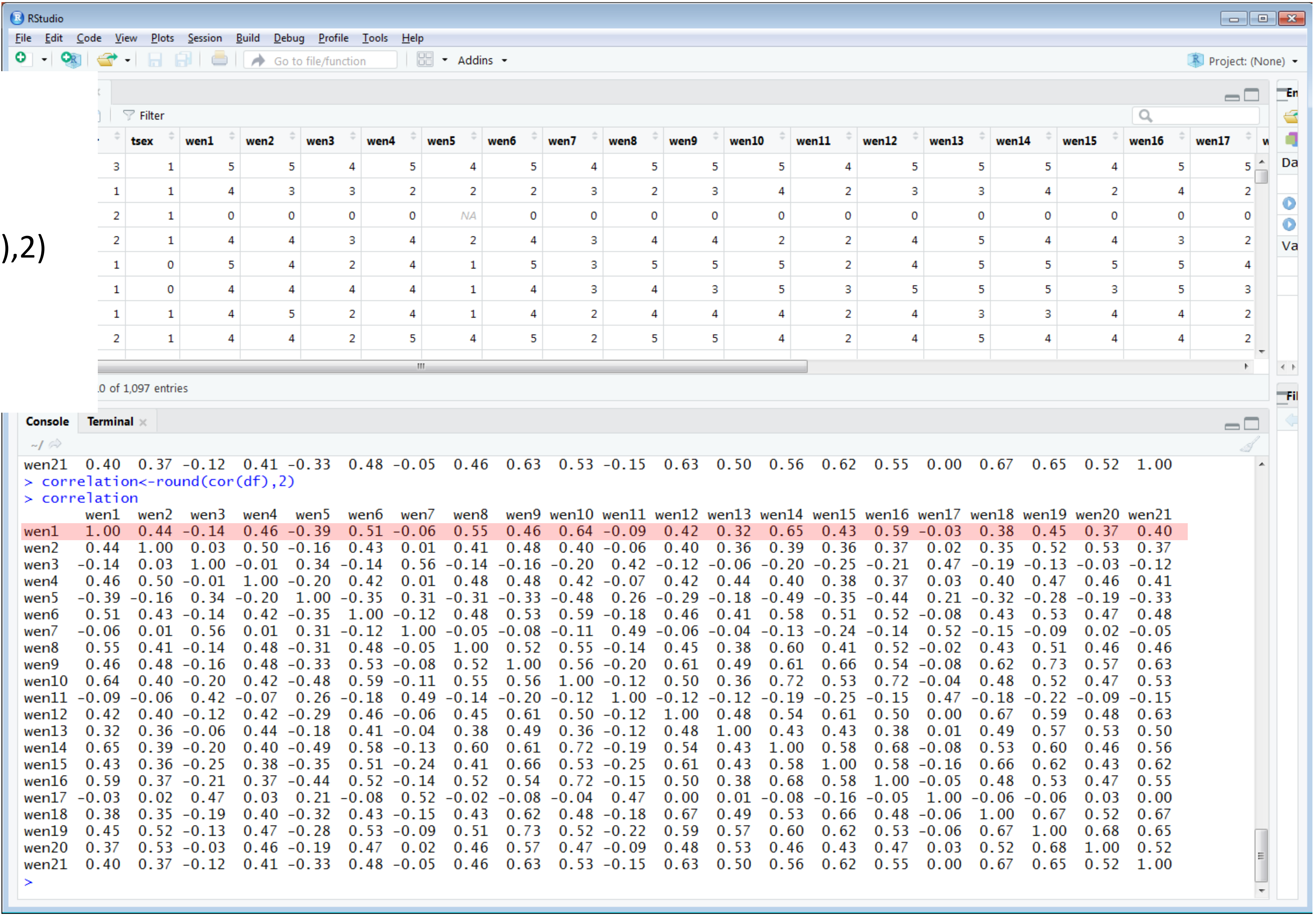
df	1097 obs. of 21 varia…
teachfac	1097 obs. of 28 varia…

```
6    4    4    4    4    3    4    3    4    3     5     3     5     5     5     3     5     3
  wen18 wen19 wen20 wen21
1     5     5     5     5
2     3     3     4     4
3     0     0     0     0
4     4     4     4     4
5     5     5     4     5
6     3     3     4     5
> head(df)
  wen1 wen2 wen3 wen4 wen5 wen6 wen7 wen8 wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17
1    5    5    4    5    3    5    4    5    5     5     4     5     5     5     4     5     5
2    4    3    3    2    3    2    3    2    3     4     2     3     3     4     2     4     2
3    0    0    0    0    3    0    0    0    0     0     0     0     0     0     0     0     0
4    4    4    3    4    3    4    3    4    4     2     2     4     5     4     4     3     2
5    5    4    2    4    3    5    3    5    5     5     2     4     5     5     5     5     4
6    4    4    4    4    3    4    3    4    3     5     3     5     5     5     3     5     3
  wen18 wen19 wen20 wen21
1     5     5     5     5
2     3     3     4     4
3     0     0     0     0
4     4     4     4     4
5     5     5     4     5
6     3     3     4     5
> sum(is.na(df))
[1] 0
> |
```

11 Check the correlation matrix

> correlation<-round(cor(df),2)
> correlation

Do all variables have **at least one** correlation with another variable that is larger than .30?



	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17
3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	5	5
1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	4	2
2	1	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0
2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	3	2
1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5	5	4
1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3	5	3
1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4	4	2
2	1	4	4	2	5	4	5	2	5	5	4	2	4	5	4	4	4	2

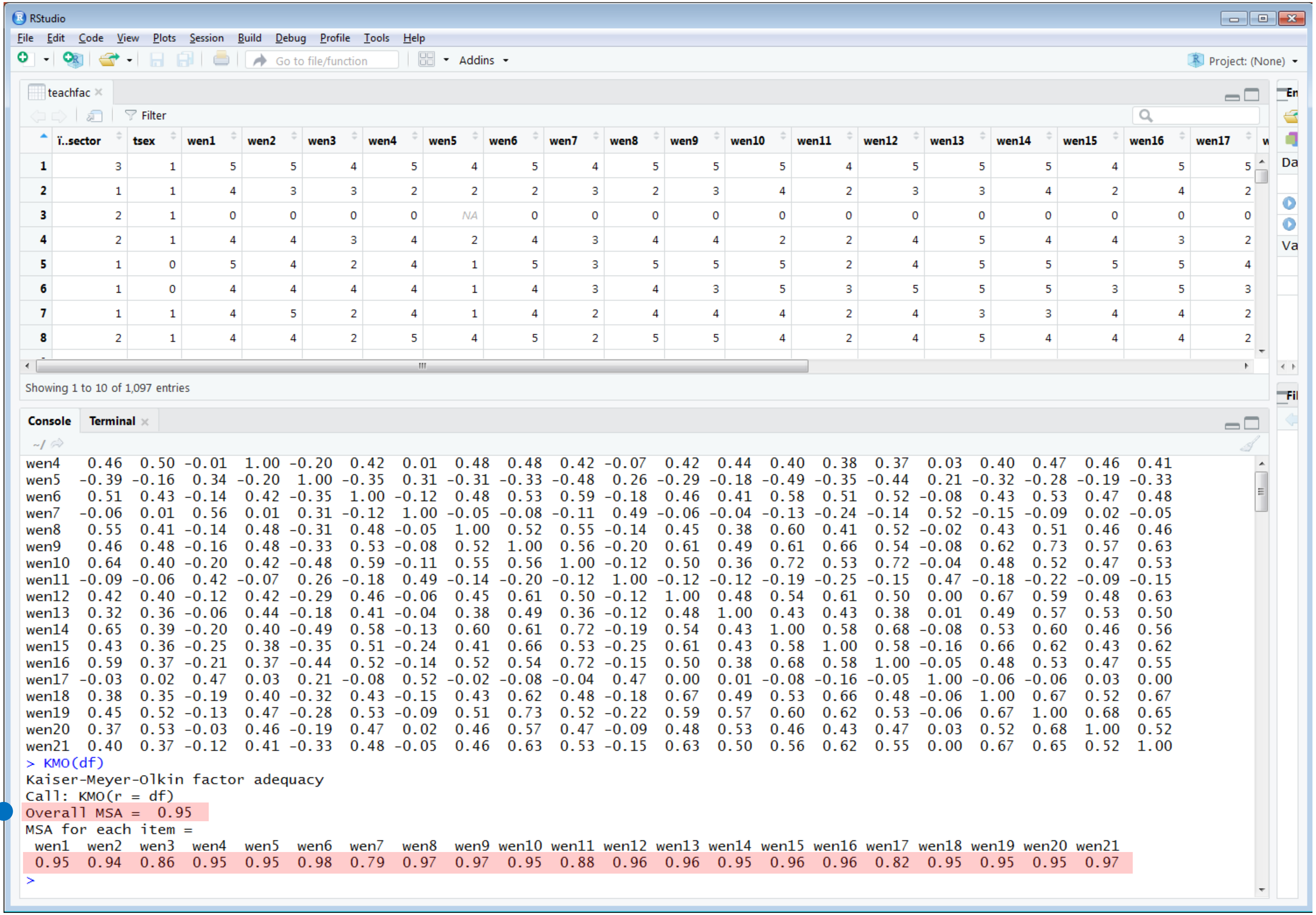
.0 of 1,097 entries

```
wen21  0.40  0.37 -0.12  0.41 -0.33  0.48 -0.05  0.46  0.63  0.53 -0.15  0.63  0.50  0.56  0.62  0.55  0.00  0.67  0.65  0.52  1.00
> correlation<-round(cor(df),2)
> correlation
       wen1  wen2  wen3  wen4  wen5  wen6  wen7  wen8  wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17 wen18 wen19 wen20 wen21
wen1   1.00  0.44 -0.14  0.46 -0.39  0.51 -0.06  0.55  0.46  0.64 -0.09  0.42  0.32  0.65  0.43  0.59 -0.03  0.38  0.45  0.37  0.40
wen2   0.44  1.00  0.03  0.50 -0.16  0.43  0.01  0.41  0.48  0.40 -0.06  0.40  0.36  0.39  0.36  0.37  0.02  0.35  0.52  0.53  0.37
wen3  -0.14  0.03  1.00 -0.01  0.34 -0.14  0.56 -0.14 -0.16 -0.20  0.42 -0.12 -0.06 -0.20 -0.25 -0.21  0.47 -0.19 -0.13 -0.03 -0.12
wen4   0.46  0.50 -0.01  1.00 -0.20  0.42  0.01  0.48  0.48  0.42 -0.07  0.42  0.44  0.40  0.38  0.37  0.03  0.40  0.47  0.46  0.41
wen5  -0.39 -0.16  0.34 -0.20  1.00 -0.35  0.31 -0.31 -0.33 -0.48  0.26 -0.29 -0.18 -0.49 -0.35 -0.44  0.21 -0.32 -0.28 -0.19 -0.33
wen6   0.51  0.43 -0.14  0.42 -0.35  1.00 -0.12  0.48  0.53  0.59 -0.18  0.46  0.41  0.58  0.51  0.52 -0.08  0.43  0.53  0.47  0.48
wen7  -0.06  0.01  0.56  0.01  0.31 -0.12  1.00 -0.05 -0.08 -0.11  0.49 -0.06 -0.04 -0.13 -0.24 -0.14  0.52 -0.15 -0.09  0.02 -0.05
wen8   0.55  0.41 -0.14  0.48 -0.31  0.48 -0.05  1.00  0.52  0.55 -0.14  0.45  0.38  0.60  0.41  0.52 -0.02  0.43  0.51  0.46  0.46
wen9   0.46  0.48 -0.16  0.48 -0.33  0.53 -0.08  0.52  1.00  0.56 -0.20  0.61  0.49  0.61  0.66  0.54 -0.08  0.62  0.73  0.57  0.63
wen10  0.64  0.40 -0.20  0.42 -0.48  0.59 -0.11  0.55  0.56  1.00 -0.12  0.50  0.36  0.72  0.53  0.72 -0.04  0.48  0.52  0.47  0.53
wen11 -0.09 -0.06  0.42 -0.07  0.26 -0.18  0.49 -0.14 -0.20 -0.12  1.00 -0.12 -0.12 -0.19 -0.25 -0.15  0.47 -0.18 -0.22 -0.09 -0.15
wen12  0.42  0.40 -0.12  0.42 -0.29  0.46 -0.06  0.45  0.61  0.50 -0.12  1.00  0.48  0.54  0.61  0.50  0.00  0.67  0.59  0.48  0.63
wen13  0.32  0.36 -0.06  0.44 -0.18  0.41 -0.04  0.38  0.49  0.36 -0.12  0.48  1.00  0.43  0.43  0.38  0.01  0.49  0.57  0.53  0.50
wen14  0.65  0.39 -0.20  0.40 -0.49  0.58 -0.13  0.60  0.61  0.72 -0.19  0.54  0.43  1.00  0.58  0.68 -0.08  0.53  0.60  0.46  0.56
wen15  0.43  0.36 -0.25  0.38 -0.35  0.51 -0.24  0.41  0.66  0.53 -0.25  0.61  0.43  0.58  1.00  0.58 -0.16  0.66  0.62  0.43  0.62
wen16  0.59  0.37 -0.21  0.37 -0.44  0.52 -0.14  0.52  0.54  0.72 -0.15  0.50  0.38  0.68  0.58  1.00 -0.05  0.48  0.53  0.47  0.55
wen17 -0.03  0.02  0.47  0.03  0.21 -0.08  0.52 -0.02 -0.08 -0.04  0.47  0.00  0.01 -0.08 -0.16 -0.05  1.00 -0.06 -0.06  0.03  0.00
wen18  0.38  0.35 -0.19  0.40 -0.32  0.43 -0.15  0.43  0.62  0.48 -0.18  0.67  0.49  0.53  0.66  0.48 -0.06  1.00  0.67  0.52  0.67
wen19  0.45  0.52 -0.13  0.47 -0.28  0.53 -0.09  0.51  0.73  0.52 -0.22  0.59  0.57  0.60  0.62  0.53 -0.06  0.67  1.00  0.68  0.65
wen20  0.37  0.53 -0.03  0.46 -0.19  0.47  0.02  0.46  0.57  0.47 -0.09  0.48  0.53  0.46  0.43  0.47  0.03  0.52  0.68  1.00  0.52
wen21  0.40  0.37 -0.12  0.41 -0.33  0.48 -0.05  0.46  0.63  0.53 -0.15  0.63  0.50  0.56  0.62  0.55  0.00  0.67  0.65  0.52  1.00
>
```

12 Check sampling accuracy with KMO

> kmo(df)

The overall MSA is larger than 0.60



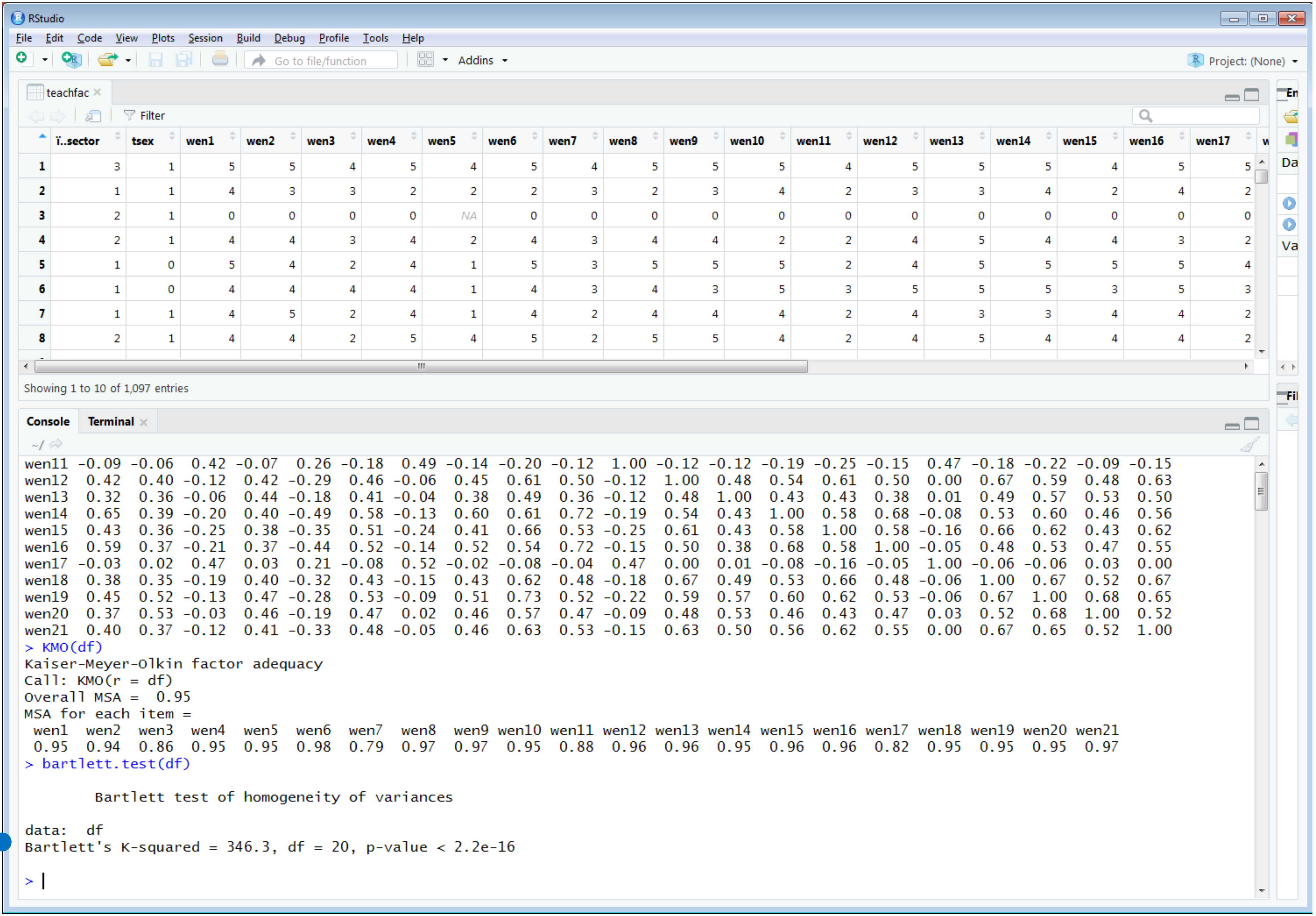
	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	5	5
2	1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	4	2
3	2	1	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0
4	2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	3	2
5	1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5	5	4
6	1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3	5	3
7	1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4	4	2
8	2	1	4	4	2	5	4	5	2	5	5	4	2	4	5	4	4	4	2

Showing 1 to 10 of 1,097 entries

```
wen4    0.46  0.50 -0.01  1.00 -0.20  0.42  0.01  0.48  0.48  0.42 -0.07  0.42  0.44  0.40  0.38  0.37  0.03  0.40  0.47  0.46  0.41
wen5   -0.39 -0.16  0.34 -0.20  1.00 -0.35  0.31 -0.31 -0.33 -0.48  0.26 -0.29 -0.18 -0.49 -0.35 -0.44  0.21 -0.32 -0.28 -0.19 -0.33
wen6    0.51  0.43 -0.14  0.42 -0.35  1.00 -0.12  0.48  0.53  0.59 -0.18  0.46  0.41  0.58  0.51  0.52 -0.08  0.43  0.53  0.47  0.48
wen7   -0.06  0.01  0.56  0.01  0.31 -0.12  1.00 -0.05 -0.08 -0.11  0.49 -0.06 -0.04 -0.13 -0.24 -0.14  0.52 -0.15 -0.09  0.02 -0.05
wen8    0.55  0.41 -0.14  0.48 -0.31  0.48 -0.05  1.00  0.52  0.55 -0.14  0.45  0.38  0.60  0.41  0.52 -0.02  0.43  0.51  0.46  0.46
wen9    0.46  0.48 -0.16  0.48 -0.33  0.53 -0.08  0.52  1.00  0.56 -0.20  0.61  0.49  0.61  0.66  0.54 -0.08  0.62  0.73  0.57  0.63
wen10   0.64  0.40 -0.20  0.42 -0.48  0.59 -0.11  0.55  0.56  1.00 -0.12  0.50  0.36  0.72  0.53  0.72 -0.04  0.48  0.52  0.47  0.53
wen11  -0.09 -0.06  0.42 -0.07  0.26 -0.18  0.49 -0.14 -0.20 -0.12  1.00 -0.12 -0.12 -0.19 -0.25 -0.15  0.47 -0.18 -0.22 -0.09 -0.15
wen12   0.42  0.40 -0.12  0.42 -0.29  0.46 -0.06  0.45  0.61  0.50 -0.12  1.00  0.48  0.54  0.61  0.50  0.00  0.67  0.59  0.48  0.63
wen13   0.32  0.36 -0.06  0.44 -0.18  0.41 -0.04  0.38  0.49  0.36 -0.12  0.48  1.00  0.43  0.43  0.38  0.01  0.49  0.57  0.53  0.50
wen14   0.65  0.39 -0.20  0.40 -0.49  0.58 -0.13  0.60  0.61  0.72 -0.19  0.54  0.43  1.00  0.58  0.68 -0.08  0.53  0.60  0.46  0.56
wen15   0.43  0.36 -0.25  0.38 -0.35  0.51 -0.24  0.41  0.66  0.53 -0.25  0.61  0.43  0.58  1.00  0.58 -0.16  0.66  0.62  0.43  0.62
wen16   0.59  0.37 -0.21  0.37 -0.44  0.52 -0.14  0.52  0.54  0.72 -0.15  0.50  0.38  0.68  0.58  1.00 -0.05  0.48  0.53  0.47  0.55
wen17  -0.03  0.02  0.47  0.03  0.21 -0.08  0.52 -0.02 -0.08 -0.04  0.47  0.00  0.01 -0.08 -0.16 -0.05  1.00 -0.06 -0.06  0.03  0.00
wen18   0.38  0.35 -0.19  0.40 -0.32  0.43 -0.15  0.43  0.62  0.48 -0.18  0.67  0.49  0.53  0.66  0.48 -0.06  1.00  0.67  0.52  0.67
wen19   0.45  0.52 -0.13  0.47 -0.28  0.53 -0.09  0.51  0.73  0.52 -0.22  0.59  0.57  0.60  0.62  0.53 -0.06  0.67  1.00  0.68  0.65
wen20   0.37  0.53 -0.03  0.46 -0.19  0.47  0.02  0.46  0.57  0.47 -0.09  0.48  0.53  0.46  0.43  0.47  0.03  0.52  0.68  1.00  0.52
wen21   0.40  0.37 -0.12  0.41 -0.33  0.48 -0.05  0.46  0.63  0.53 -0.15  0.63  0.50  0.56  0.62  0.55  0.00  0.67  0.65  0.52  1.00
> KMO(df)
Kaiser-Meyer-Olkin factor adequacy
Call: KMO(r = df)
Overall MSA =  0.95
MSA for each item = 
 wen1  wen2  wen3  wen4  wen5  wen6  wen7  wen8  wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17 wen18 wen19 wen20 wen21 
 0.95  0.94  0.86  0.95  0.95  0.98  0.79  0.97  0.97  0.95  0.88  0.96  0.96  0.95  0.96  0.96  0.82  0.95  0.95  0.95  0.97 
> 
```

13 Compare correlation matrix to identity matrix

> bartlett.test(df)



	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	5	5
2	1	1	4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	4	2
3	2	1	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0
4	2	1	4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	3	2
5	1	0	5	4	2	4	1	5	3	5	5	5	2	4	5	5	5	5	4
6	1	0	4	4	4	4	1	4	3	4	3	5	3	5	5	5	3	5	3
7	1	1	4	5	2	4	1	4	2	4	4	4	2	4	3	3	4	4	2
8	2	1	4	4	2	5	4	5	2	5	5	4	2	4	5	4	4	4	2

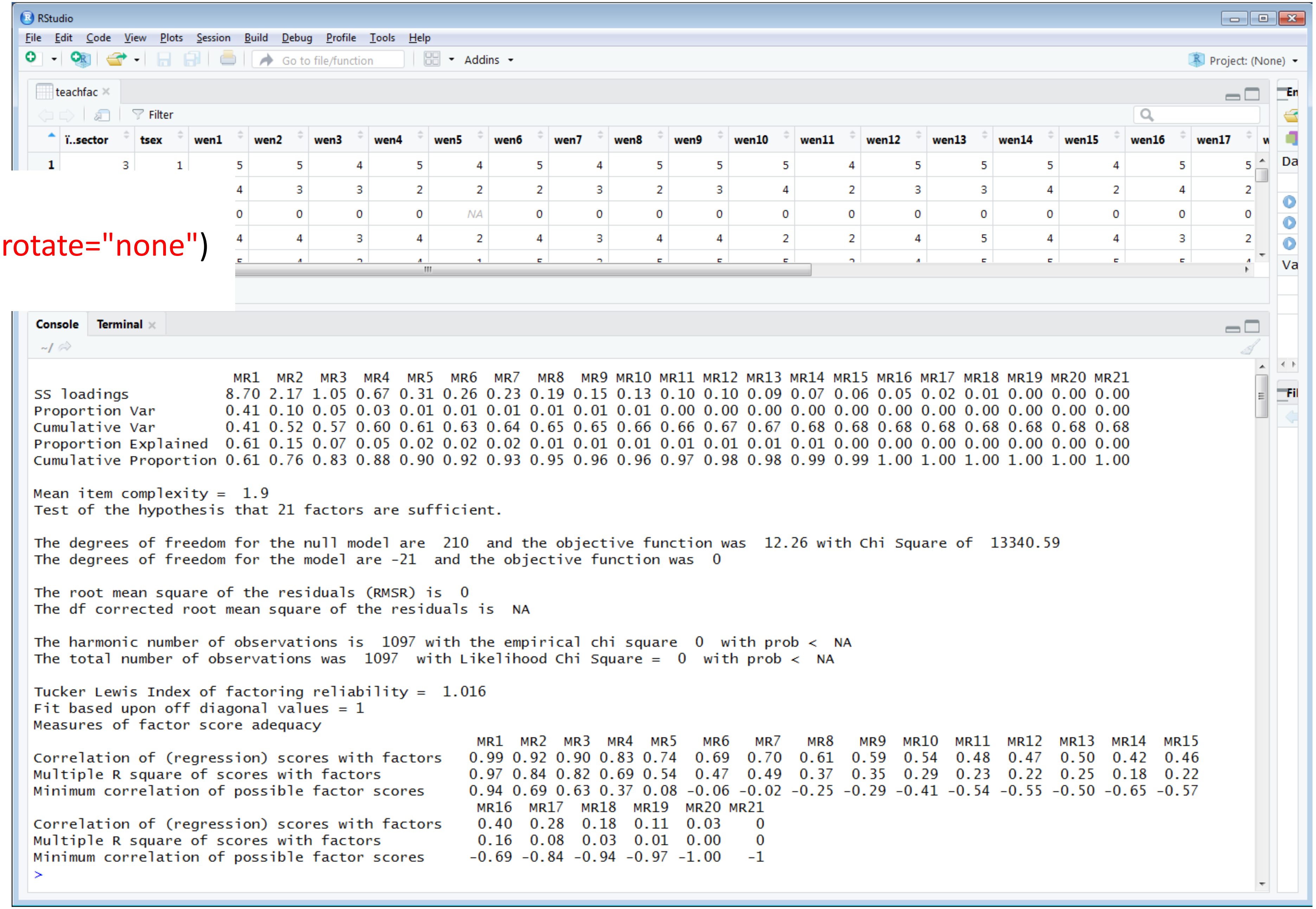
Showing 1 to 10 of 1,097 entries

```
wen11 -0.09 -0.06  0.42 -0.07  0.26 -0.18  0.49 -0.14 -0.20 -0.12  1.00 -0.12 -0.12 -0.19 -0.25 -0.15  0.47 -0.18 -0.22 -0.09 -0.15
wen12  0.42  0.40 -0.12  0.42 -0.29  0.46 -0.06  0.45  0.61  0.50 -0.12  1.00  0.48  0.54  0.61  0.50  0.00  0.67  0.59  0.48  0.63
wen13  0.32  0.36 -0.06  0.44 -0.18  0.41 -0.04  0.38  0.49  0.36 -0.12  0.48  1.00  0.43  0.43  0.38  0.01  0.49  0.57  0.53  0.50
wen14  0.65  0.39 -0.20  0.40 -0.49  0.58 -0.13  0.60  0.61  0.72 -0.19  0.54  0.43  1.00  0.58  0.68 -0.08  0.53  0.60  0.46  0.56
wen15  0.43  0.36 -0.25  0.38 -0.35  0.51 -0.24  0.41  0.66  0.53 -0.25  0.61  0.43  0.58  1.00  0.58 -0.16  0.66  0.62  0.43  0.62
wen16  0.59  0.37 -0.21  0.37 -0.44  0.52 -0.14  0.52  0.54  0.72 -0.15  0.50  0.38  0.68  0.58  1.00 -0.05  0.48  0.53  0.47  0.55
wen17 -0.03  0.02  0.47  0.03  0.21 -0.08  0.52 -0.02 -0.08 -0.04  0.47  0.00  0.01 -0.08 -0.16 -0.05  1.00 -0.06 -0.06  0.03  0.00
wen18  0.38  0.35 -0.19  0.40 -0.32  0.43 -0.15  0.43  0.62  0.48 -0.18  0.67  0.49  0.53  0.66  0.48 -0.06  1.00  0.67  0.52  0.67
wen19  0.45  0.52 -0.13  0.47 -0.28  0.53 -0.09  0.51  0.73  0.52 -0.22  0.59  0.57  0.60  0.62  0.53 -0.06  0.67  1.00  0.68  0.65
wen20  0.37  0.53 -0.03  0.46 -0.19  0.47  0.02  0.46  0.57  0.47 -0.09  0.48  0.53  0.46  0.43  0.47  0.03  0.52  0.68  1.00  0.52
wen21  0.40  0.37 -0.12  0.41 -0.33  0.48 -0.05  0.46  0.63  0.53 -0.15  0.63  0.50  0.56  0.62  0.55  0.00  0.67  0.65  0.52  1.00
> KMO(df)
Kaiser-Meyer-Olkin factor adequacy
Call: KMO(r = df)
Overall MSA =  0.95
MSA for each item = 
 wen1  wen2  wen3  wen4  wen5  wen6  wen7  wen8  wen9 wen10 wen11 wen12 wen13 wen14 wen15 wen16 wen17 wen18 wen19 wen20 wen21 
 0.95  0.94  0.86  0.95  0.95  0.98  0.79  0.97  0.97  0.95  0.88  0.96  0.96  0.95  0.96  0.96  0.82  0.95  0.95  0.95  0.97 
> bartlett.test(df)

	Bartlett test of homogeneity of variances

data:  df
Bartlett's K-squared = 346.3, df = 20, p-value < 2.2e-16

> |
```

Bartlett's test is significant so FA is suitable

14 Obtain the initial (un-rotated) factor loadings

```
>       m1<-fa(df, nfactors = 21, rotate="none")
```



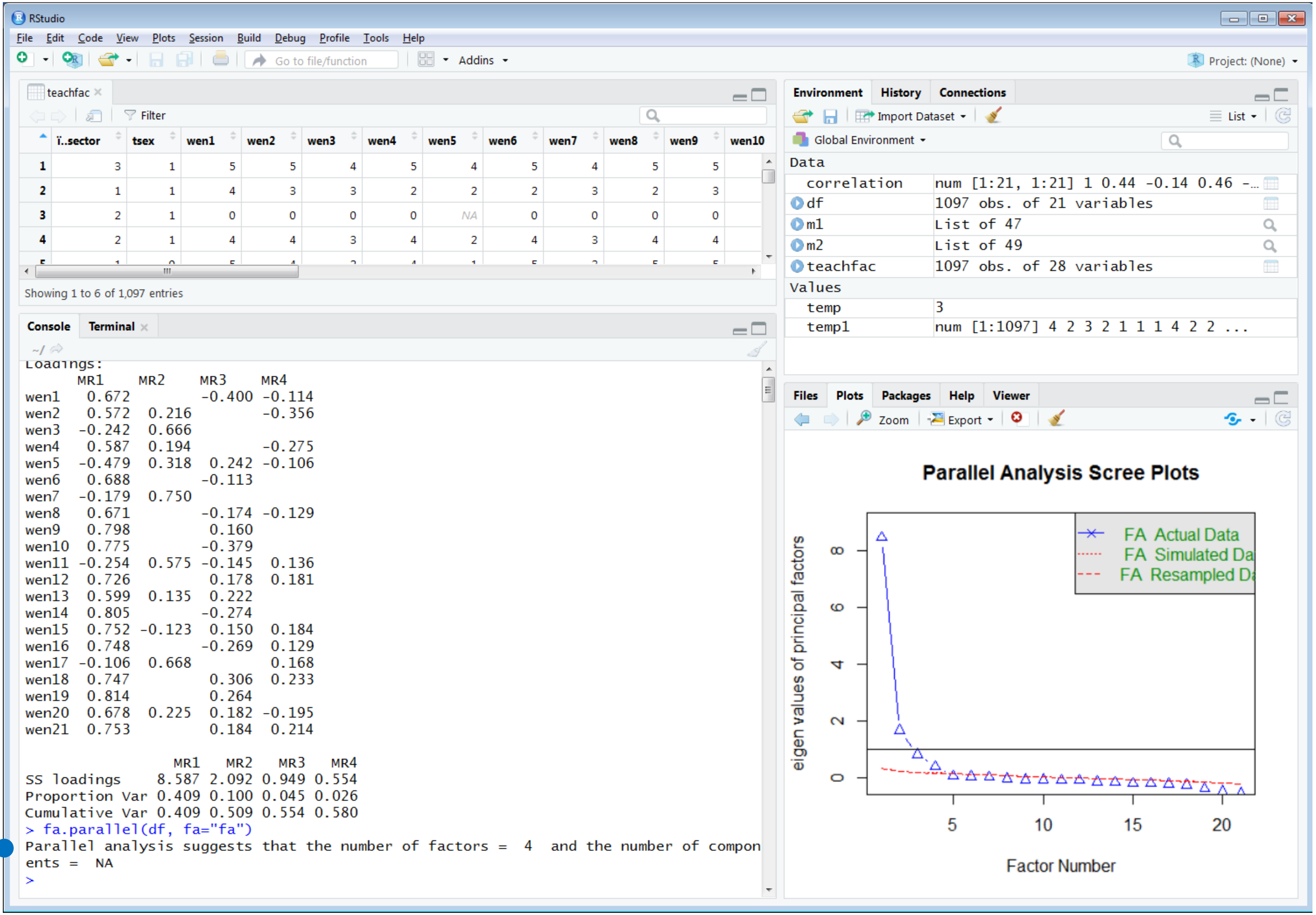
	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17
1	3	1	5	5	4	5	4	5	4	5	5	5	4	5	5	5	4	5	5
			4	3	3	2	2	2	3	2	3	4	2	3	3	4	2	4	2
			0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0
			4	4	3	4	2	4	3	4	4	2	2	4	5	4	4	3	2

```
                        MR1  MR2  MR3  MR4  MR5  MR6  MR7  MR8  MR9 MR10 MR11 MR12 MR13 MR14 MR15 MR16 MR17 MR18 MR19 MR20 MR21
SS loadings            8.70 2.17 1.05 0.67 0.31 0.26 0.23 0.19 0.15 0.13 0.10 0.10 0.09 0.07 0.06 0.05 0.02 0.01 0.00 0.00 0.00
Proportion Var         0.41 0.10 0.05 0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Cumulative Var         0.41 0.52 0.57 0.60 0.61 0.63 0.64 0.65 0.65 0.66 0.66 0.67 0.67 0.68 0.68 0.68 0.68 0.68 0.68 0.68 0.68
Proportion Explained   0.61 0.15 0.07 0.05 0.02 0.02 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Cumulative Proportion  0.61 0.76 0.83 0.88 0.90 0.92 0.93 0.95 0.96 0.96 0.97 0.98 0.98 0.99 0.99 1.00 1.00 1.00 1.00 1.00 1.00

Mean item complexity =  1.9
Test of the hypothesis that 21 factors are sufficient.

The degrees of freedom for the null model are  210  and the objective function was  12.26 with Chi Square of  13340.59
The degrees of freedom for the model are -21  and the objective function was  0 

The root mean square of the residuals (RMSR) is  0 
The df corrected root mean square of the residuals is  NA 

The harmonic number of observations is  1097 with the empirical chi square  0  with prob <  NA 
The total number of observations was  1097  with Likelihood Chi Square =  0  with prob <  NA 

Tucker Lewis Index of factoring reliability =  1.016
Fit based upon off diagonal values = 1
Measures of factor score adequacy             
                                                 MR1  MR2  MR3  MR4  MR5   MR6   MR7   MR8   MR9  MR10  MR11  MR12  MR13  MR14  MR15
Correlation of (regression) scores with factors 0.99 0.92 0.90 0.83 0.74  0.69  0.70  0.61  0.59  0.54  0.48  0.47  0.50  0.42  0.46
Multiple R square of scores with factors        0.97 0.84 0.82 0.69 0.54  0.47  0.49  0.37  0.35  0.29  0.23  0.22  0.25  0.18  0.22
Minimum correlation of possible factor scores   0.94 0.69 0.63 0.37 0.08 -0.06 -0.02 -0.25 -0.29 -0.41 -0.54 -0.55 -0.50 -0.65 -0.57
                                                 MR16  MR17  MR18  MR19  MR20 MR21
Correlation of (regression) scores with factors  0.40  0.28  0.18  0.11  0.03    0
Multiple R square of scores with factors         0.16  0.08  0.03  0.01  0.00    0
Minimum correlation of possible factor scores   -0.69 -0.84 -0.94 -0.97 -1.00   -1
> 
```

15

Determine a suitable number of factors

> fa.parallel(df, fa="fa")



RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
2	1	1	4	3	3	2	2	2	3	2	3	
3	2	1	0	0	0	0	NA	0	0	0	0	
4	2	1	4	4	3	4	2	4	3	4	4	

Showing 1 to 6 of 1,097 entries

```
Data
  correlation  num [1:21, 1:21] 1 0.44 -0.14 0.46 -...
  df           1097 obs. of 21 variables
  m1           List of 47
  m2           List of 49
  teachfac     1097 obs. of 28 variables
Values
  temp         3
  temp1        num [1:1097] 4 2 3 2 1 1 1 4 2 2 ...
```

```
Loadings:
       MR1    MR2    MR3    MR4   
wen1    0.672        -0.400 -0.114
wen2    0.572  0.216        -0.356
wen3   -0.242  0.666              
wen4    0.587  0.194        -0.275
wen5   -0.479  0.318  0.242 -0.106
wen6    0.688        -0.113       
wen7   -0.179  0.750              
wen8    0.671        -0.174 -0.129
wen9    0.798         0.160       
wen10   0.775        -0.379       
wen11  -0.254  0.575 -0.145  0.136
wen12   0.726         0.178  0.181
wen13   0.599  0.135  0.222       
wen14   0.805        -0.274       
wen15   0.752 -0.123  0.150  0.184
wen16   0.748        -0.269  0.129
wen17  -0.106  0.668         0.168
wen18   0.747         0.306  0.233
wen19   0.814         0.264       
wen20   0.678  0.225  0.182 -0.195
wen21   0.753         0.184  0.214

                 MR1   MR2   MR3   MR4
SS loadings    8.587 2.092 0.949 0.554
Proportion Var 0.409 0.100 0.045 0.026
Cumulative Var 0.409 0.509 0.554 0.580
> fa.parallel(df, fa="fa")
Parallel analysis suggests that the number of factors =  4  and the number of compon
ents =  NA 
>
```

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FA Actual Data
FA Simulated Da
FA Resampled Da
eigen values of principal factors
0
2
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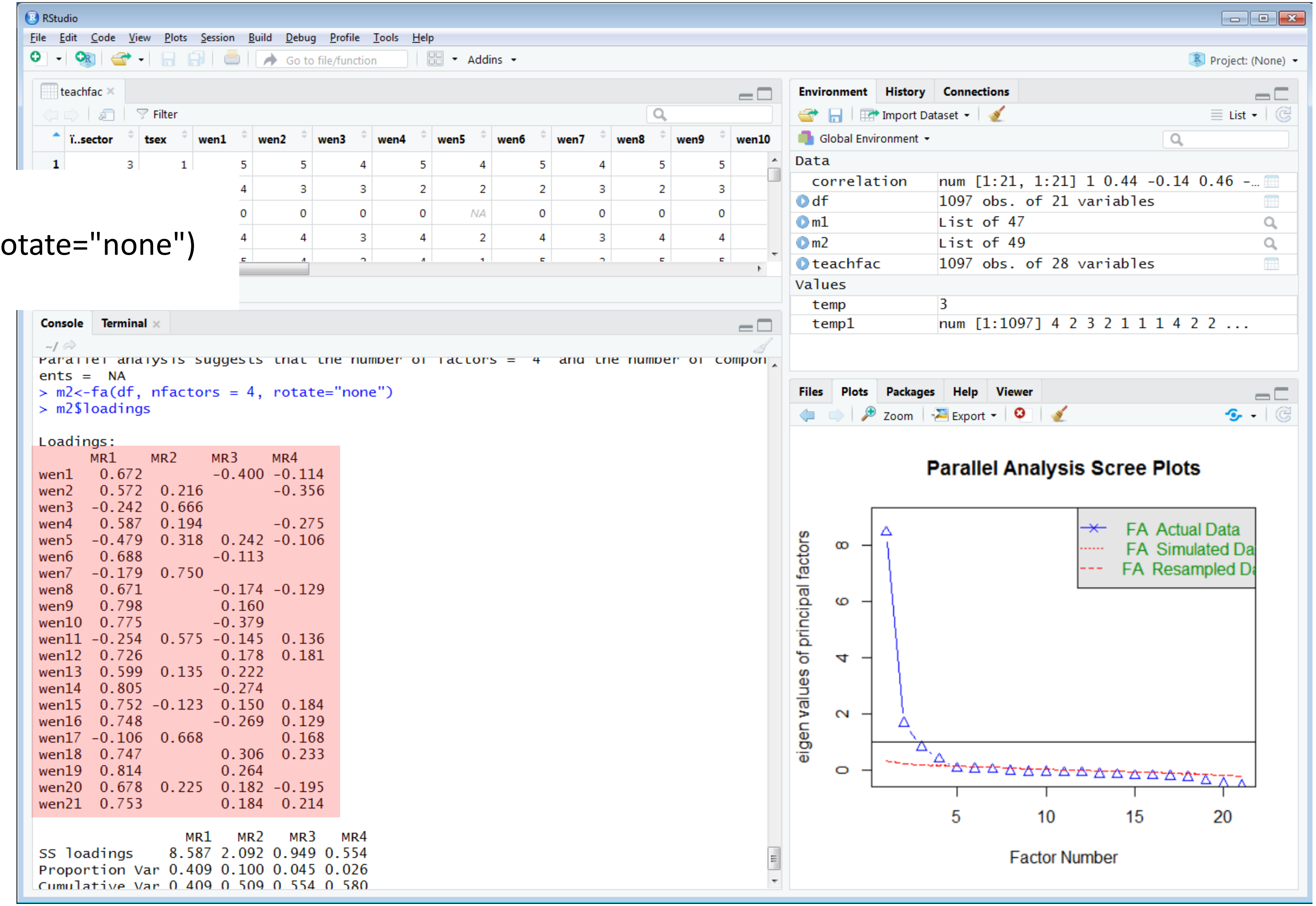
20
Factor Number

16 Run a second model with 4 factors (still un-rotated)

```
>       m2<-fa(df, nfactors = 4, rotate="none")
>       m2$loadings
```

This is not a simple structure (where each variable loads highly onto one and only one factor) so rotation is required



	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
			4	3	3	2	2	2	3	2	3	
			0	0	0	0	NA	0	0	0	0	
			4	4	3	4	2	4	3	4	4	

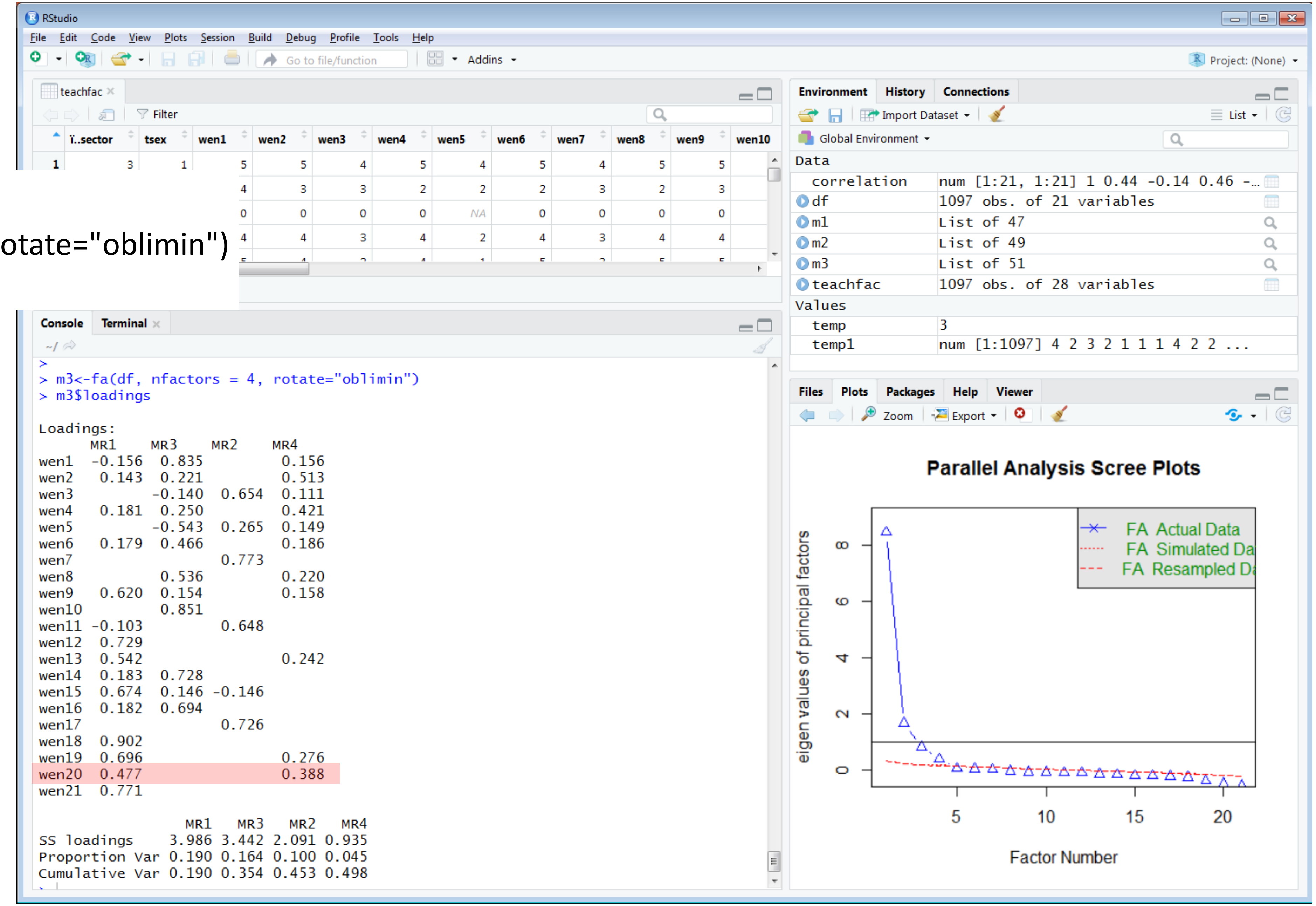
```
Data
  correlation    num [1:21, 1:21] 1 0.44 -0.14 0.46 -...
  df             1097 obs. of 21 variables
  m1             List of 47
  m2             List of 49
  teachfac       1097 obs. of 28 variables
Values
  temp           3
  temp1          num [1:1097] 4 2 3 2 1 1 1 4 2 2 ...
```

```
Parallel analysis suggests that the number of factors =  4  and the number of compon
ents =  NA
> m2<-fa(df, nfactors = 4, rotate="none")
> m2$loadings

Loadings:
      MR1    MR2    MR3    MR4   
wen1   0.672        -0.400 -0.114
wen2   0.572  0.216        -0.356
wen3  -0.242  0.666              
wen4   0.587  0.194        -0.275
wen5  -0.479  0.318  0.242 -0.106
wen6   0.688        -0.113       
wen7  -0.179  0.750              
wen8   0.671        -0.174 -0.129
wen9   0.798         0.160       
wen10  0.775        -0.379       
wen11 -0.254  0.575 -0.145  0.136
wen12  0.726         0.178  0.181
wen13  0.599  0.135  0.222       
wen14  0.805        -0.274       
wen15  0.752 -0.123  0.150  0.184
wen16  0.748        -0.269  0.129
wen17 -0.106  0.668         0.168
wen18  0.747         0.306  0.233
wen19  0.814         0.264       
wen20  0.678  0.225  0.182 -0.195
wen21  0.753         0.184  0.214

                 MR1   MR2   MR3   MR4
SS loadings    8.587 2.092 0.949 0.554
Proportion Var 0.409 0.100 0.045 0.026
Cumulative Var 0.409 0.509 0.554 0.580
```

17

Run a third model using a rotation method (e.g. oblimin)

```
>       m3<-fa(df, nfactors = 4, rotate="oblimin")
>       m3$loadings
```



RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
teachfac
Filter

	i..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
			4	3	3	2	2	2	3	2	3	
			0	0	0	0	NA	0	0	0	0	
			4	4	3	4	2	4	3	4	4	

```
Data
  correlation   num [1:21, 1:21] 1 0.44 -0.14 0.46 -...
  df            1097 obs. of 21 variables
  m1            List of 47
  m2            List of 49
  m3            List of 51
  teachfac      1097 obs. of 28 variables
Values
  temp          3
  temp1         num [1:1097] 4 2 3 2 1 1 1 4 2 2 ...
```

```
>
> m3<-fa(df, nfactors = 4, rotate="oblimin")
> m3$loadings

Loadings:
      MR1    MR3    MR2    MR4   
wen1  -0.156  0.835         0.156
wen2   0.143  0.221         0.513
wen3         -0.140  0.654  0.111
wen4   0.181  0.250         0.421
wen5         -0.543  0.265  0.149
wen6   0.179  0.466         0.186
wen7                 0.773       
wen8          0.536         0.220
wen9   0.620  0.154         0.158
wen10         0.851              
wen11 -0.103         0.648       
wen12  0.729                     
wen13  0.542                0.242
wen14  0.183  0.728              
wen15  0.674  0.146 -0.146       
wen16  0.182  0.694              
wen17                0.726       
wen18  0.902                     
wen19  0.696                0.276
wen20  0.477                0.388
wen21  0.771                     

                 MR1   MR3   MR2   MR4
SS loadings    3.986 3.442 2.091 0.935
Proportion Var 0.190 0.164 0.100 0.045
Cumulative Var 0.190 0.354 0.453 0.498
```

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FA Resampled Da
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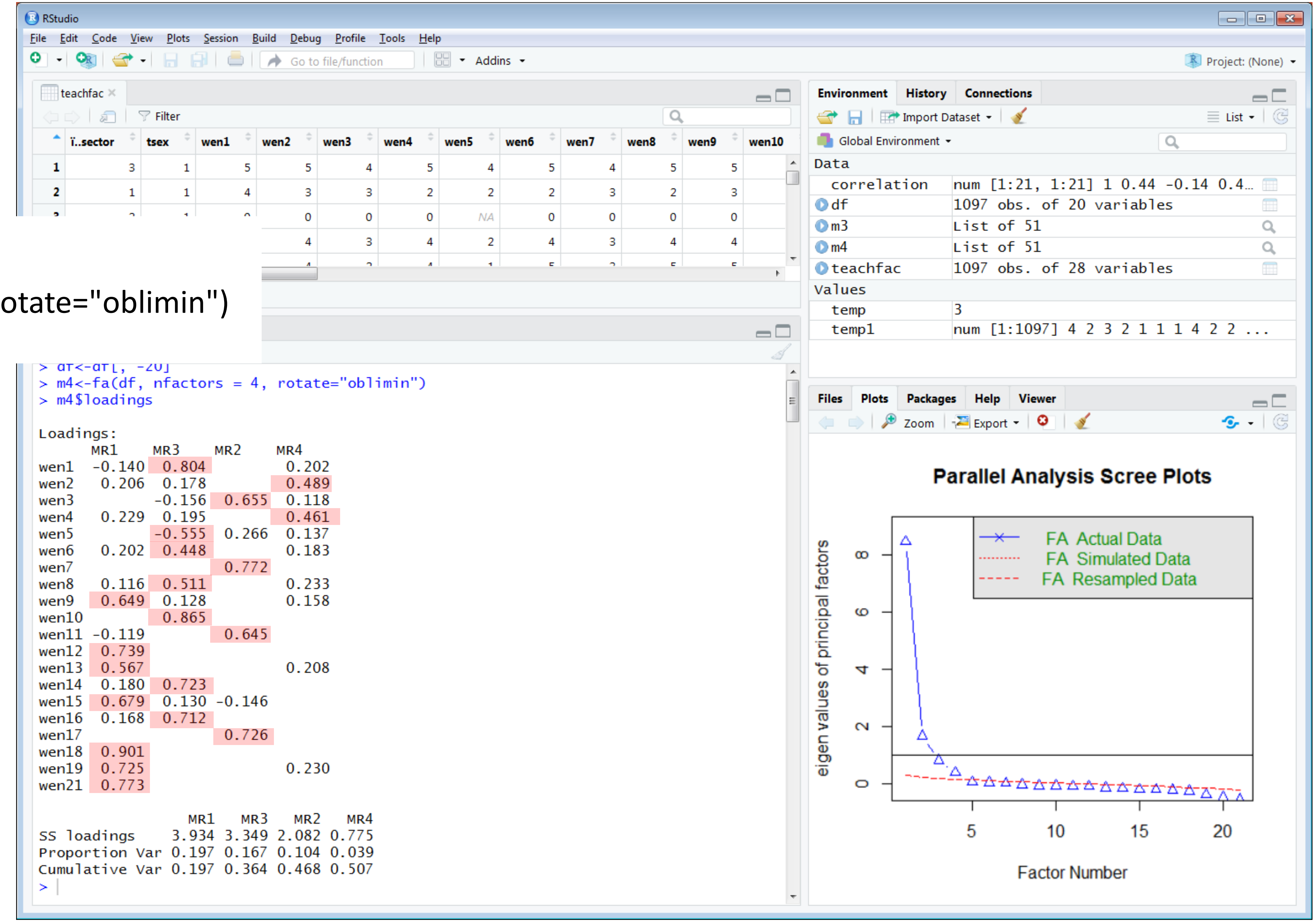
20
Factor Number

Item 20 is still loading highly across multiple factors (we should remove this item)

18 Remove item 20 and run a forth model

```
>	df<-df[, -20]
>	m4<-fa(df, nfactors = 4, rotate="oblimin")
>	m4$loadings
```

Here factor 4 only has two items loading highly onto it. We need to decide whether or not to remove it (for this example we will remove)



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Files Plots Packages Help Viewer
Zoom
Export
Parallel Analysis Scree Plots
eigen values of principal factors
Factor Number
0
2
4
6
8
5
10
15
20
FA Actual Data
FA Simulated Data
FA Resampled Data

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
2	1	1	4	3	3	2	2	2	3	2	3	
				0	0	0	NA	0	0	0	0	
				4	3	4	2	4	3	4	4	

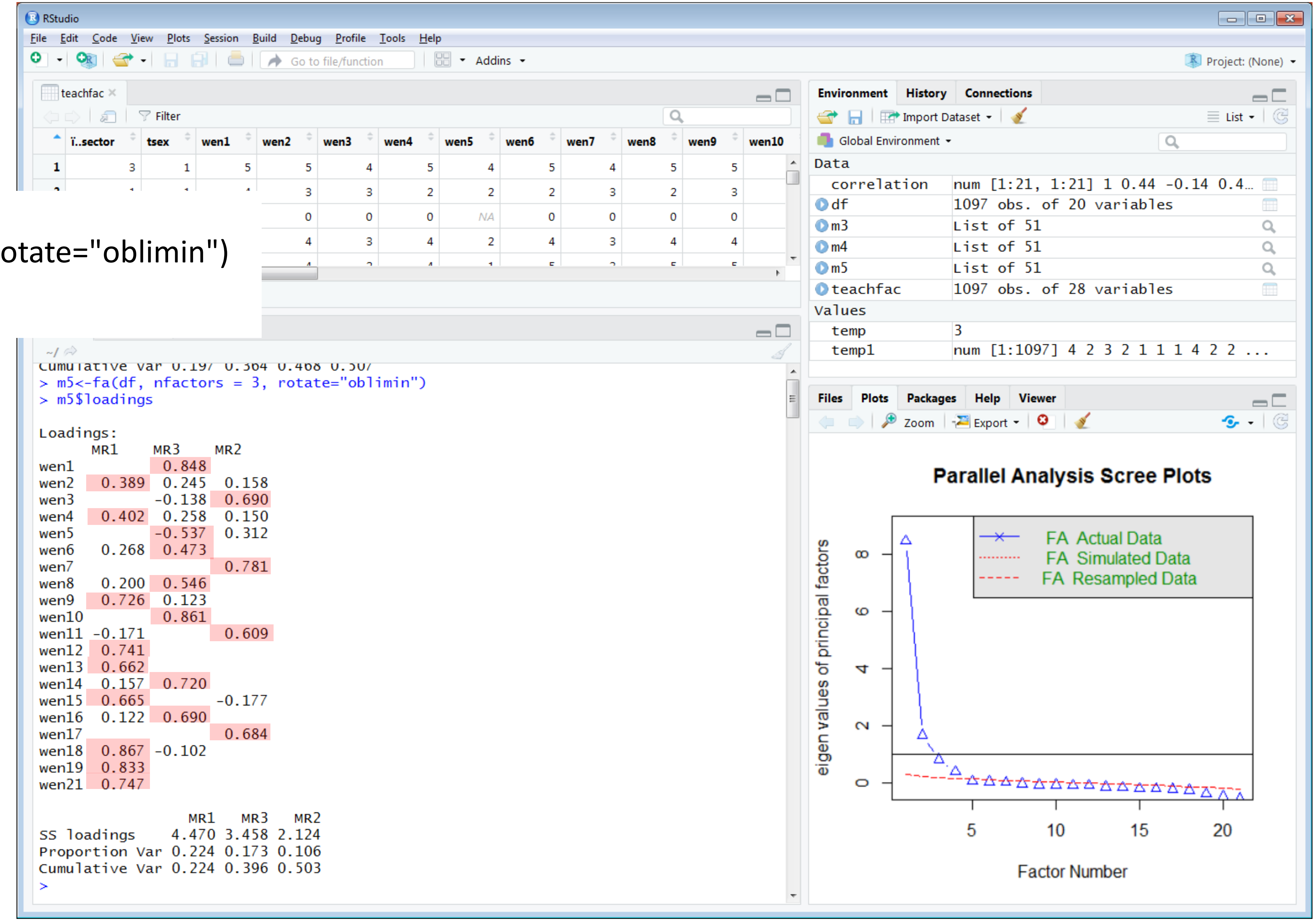
```
Data
  correlation  num [1:21, 1:21] 1 0.44 -0.14 0.4…
  df           1097 obs. of 20 variables
  m3           List of 51
  m4           List of 51
  teachfac     1097 obs. of 28 variables
Values
  temp         3
  temp1        num [1:1097] 4 2 3 2 1 1 1 4 2 2 ...
```

```
> df<-df[, -20]
> m4<-fa(df, nfactors = 4, rotate="oblimin")
> m4$loadings

Loadings:
       MR1    MR3    MR2    MR4   
wen1   -0.140  0.804         0.202
wen2    0.206  0.178         0.489
wen3          -0.156  0.655  0.118
wen4    0.229  0.195         0.461
wen5          -0.555  0.266  0.137
wen6    0.202  0.448         0.183
wen7                  0.772       
wen8    0.116  0.511         0.233
wen9    0.649  0.128         0.158
wen10          0.865              
wen11  -0.119         0.645       
wen12   0.739                     
wen13   0.567                0.208
wen14   0.180  0.723              
wen15   0.679  0.130 -0.146       
wen16   0.168  0.712              
wen17                 0.726       
wen18   0.901                     
wen19   0.725                0.230
wen21   0.773                     

                 MR1   MR3   MR2   MR4
SS loadings    3.934 3.349 2.082 0.775
Proportion Var 0.197 0.167 0.104 0.039
Cumulative Var 0.197 0.364 0.468 0.507
> 
```

19 Remove item 20 and run a forth model

```
>   m5<-fa(df, nfactors = 3, rotate="oblimin")

>   m5$loadings
```

Much better:


RStudio
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Export
Parallel Analysis Scree Plots
FA Actual Data
FA Simulated Data
FA Resampled Data
eigen values of principal factors
0
2
4
6
8
5
10
15
20
Factor Number

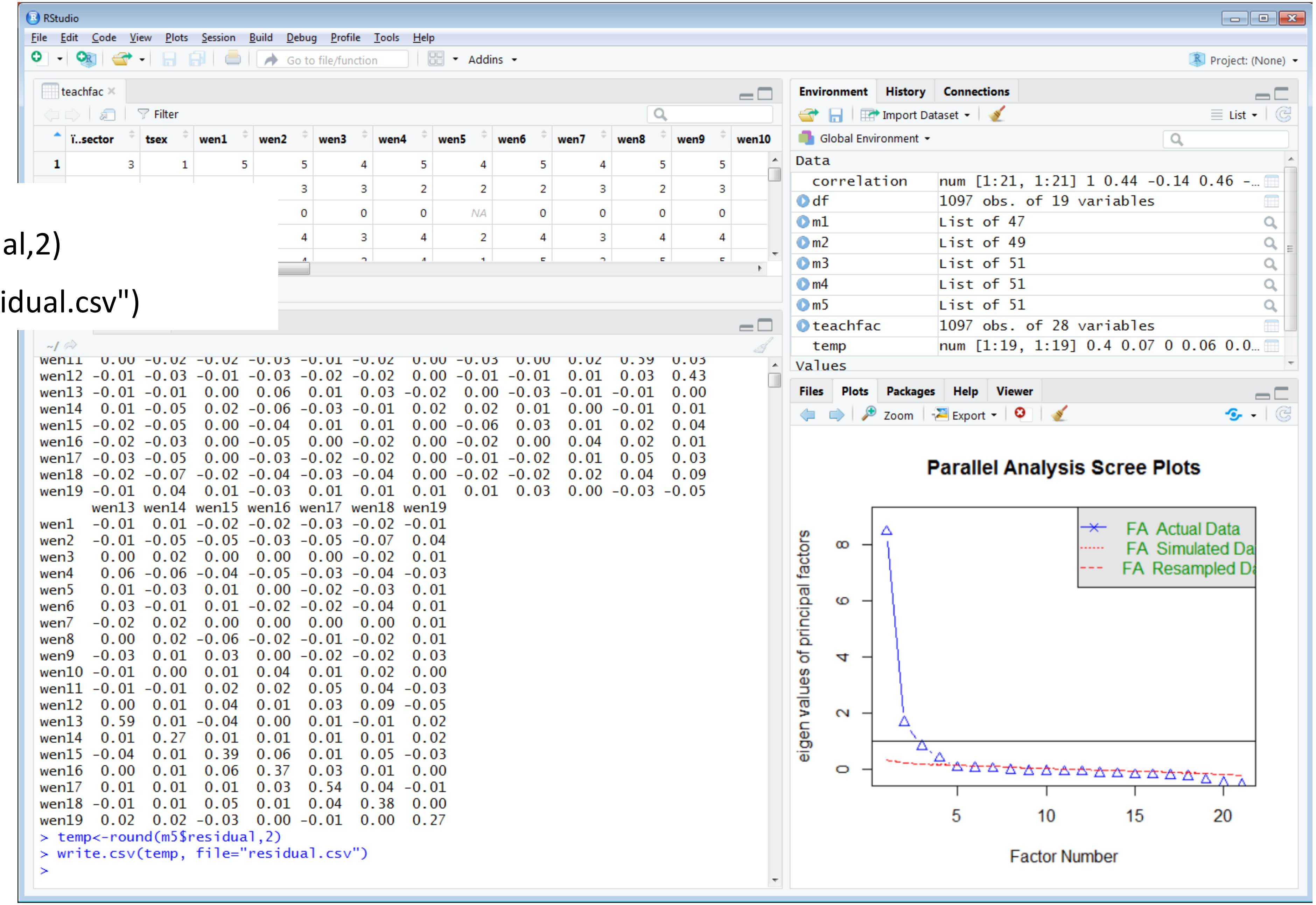
	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
				3	3	2	2	2	3	2	3	
				0	0	0	NA	0	0	0	0	
				4	3	4	2	4	3	4	4	

```
Data
  correlation   num [1:21, 1:21] 1 0.44 -0.14 0.4...
  df            1097 obs. of 20 variables
  m3            List of 51
  m4            List of 51
  m5            List of 51
  teachfac      1097 obs. of 28 variables
Values
  temp          3
  temp1         num [1:1097] 4 2 3 2 1 1 1 4 2 2 ...
```

```
Cumulative Var 0.197 0.364 0.468 0.507
> m5<-fa(df, nfactors = 3, rotate="oblimin")
> m5$loadings

Loadings:
      MR1    MR3    MR2   
wen1          0.848       
wen2   0.389  0.245  0.158
wen3         -0.138  0.690
wen4   0.402  0.258  0.150
wen5         -0.537  0.312
wen6   0.268  0.473       
wen7                 0.781
wen8   0.200  0.546       
wen9   0.726  0.123       
wen10         0.861       
wen11 -0.171         0.609
wen12  0.741              
wen13  0.662              
wen14  0.157  0.720       
wen15  0.665        -0.177
wen16  0.122  0.690       
wen17                0.684
wen18  0.867 -0.102       
wen19  0.833              
wen21  0.747              

                 MR1   MR3   MR2
SS loadings    4.470 3.458 2.124
Proportion Var 0.224 0.173 0.106
Cumulative Var 0.224 0.396 0.503
>
```

20 Export the residual matrix as a csv file

```
>    temp<-round(m5$residual,2)

>    write.csv(temp, file="residual.csv")
```



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FA Simulated Da
FA Resampled Da
eigen values of principal factors
0
2
4
6
8
5
10
15
20
Factor Number

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
				3	3	2	2	2	3	2	3	
				0	0	0	NA	0	0	0	0	
				4	3	4	2	4	3	4	4	

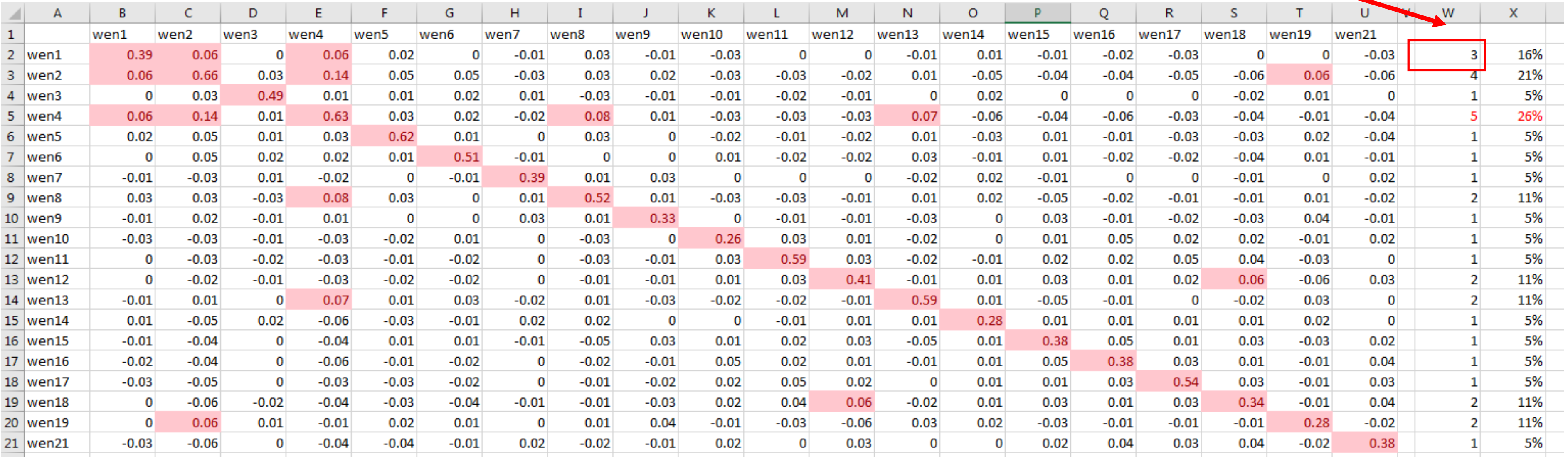
```
Data
  correlation   num [1:21, 1:21] 1 0.44 -0.14 0.46 -...
df              1097 obs. of 19 variables
m1              List of 47
m2              List of 49
m3              List of 51
m4              List of 51
m5              List of 51
teachfac        1097 obs. of 28 variables
  temp          num [1:19, 1:19] 0.4 0.07 0 0.06 0.0...
Values
```

```
~/
wen11  0.00 -0.02 -0.02 -0.03 -0.01 -0.02  0.00 -0.03  0.00  0.02  0.59  0.03
wen12 -0.01 -0.03 -0.01 -0.03 -0.02 -0.02  0.00 -0.01 -0.01  0.01  0.03  0.43
wen13 -0.01 -0.01  0.00  0.06  0.01  0.03 -0.02  0.00 -0.03 -0.01 -0.01  0.00
wen14  0.01 -0.05  0.02 -0.06 -0.03 -0.01  0.02  0.02  0.01  0.00 -0.01  0.01
wen15 -0.02 -0.05  0.00 -0.04  0.01  0.01  0.00 -0.06  0.03  0.01  0.02  0.04
wen16 -0.02 -0.03  0.00 -0.05  0.00 -0.02  0.00 -0.02  0.00  0.04  0.02  0.01
wen17 -0.03 -0.05  0.00 -0.03 -0.02 -0.02  0.00 -0.01 -0.02  0.01  0.05  0.03
wen18 -0.02 -0.07 -0.02 -0.04 -0.03 -0.04  0.00 -0.02 -0.02  0.02  0.04  0.09
wen19 -0.01  0.04  0.01 -0.03  0.01  0.01  0.01  0.01  0.03  0.00 -0.03 -0.05
      wen13 wen14 wen15 wen16 wen17 wen18 wen19
wen1  -0.01  0.01 -0.02 -0.02 -0.03 -0.02 -0.01
wen2  -0.01 -0.05 -0.05 -0.03 -0.05 -0.07  0.04
wen3   0.00  0.02  0.00  0.00  0.00 -0.02  0.01
wen4   0.06 -0.06 -0.04 -0.05 -0.03 -0.04 -0.03
wen5   0.01 -0.03  0.01  0.00 -0.02 -0.03  0.01
wen6   0.03 -0.01  0.01 -0.02 -0.02 -0.04  0.01
wen7  -0.02  0.02  0.00  0.00  0.00  0.00  0.01
wen8   0.00  0.02 -0.06 -0.02 -0.01 -0.02  0.01
wen9  -0.03  0.01  0.03  0.00 -0.02 -0.02  0.03
wen10 -0.01  0.00  0.01  0.04  0.01  0.02  0.00
wen11 -0.01 -0.01  0.02  0.02  0.05  0.04 -0.03
wen12  0.00  0.01  0.04  0.01  0.03  0.09 -0.05
wen13  0.59  0.01 -0.04  0.00  0.01 -0.01  0.02
wen14  0.01  0.27  0.01  0.01  0.01  0.01  0.02
wen15 -0.04  0.01  0.39  0.06  0.01  0.05 -0.03
wen16  0.00  0.01  0.06  0.37  0.03  0.01  0.00
wen17  0.01  0.01  0.01  0.03  0.54  0.04 -0.01
wen18 -0.01  0.01  0.05  0.01  0.04  0.38  0.00
wen19  0.02  0.02 -0.03  0.00 -0.01  0.00  0.27
> temp<-round(m5$residual,2)
> write.csv(temp, file="residual.csv")
>
```

21 Check which variables have high residuals

=COUNTIF(B2:U2,">.05")

Consider removing item 4

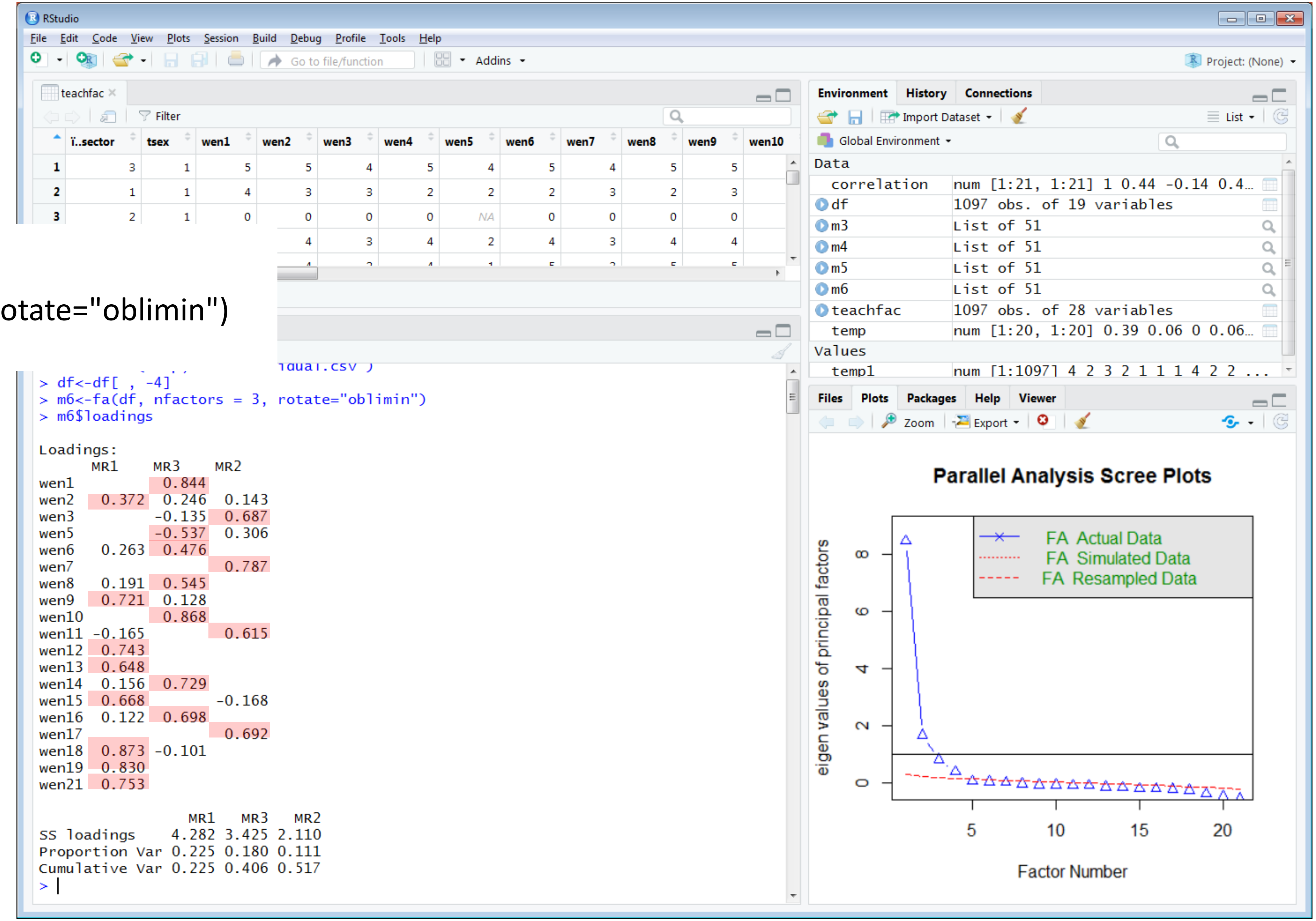


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1		wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17	wen18	wen19	wen21			
2	wen1	0.39	0.06	0	0.06	0.02	0	-0.01	0.03	-0.01	-0.03	0	0	-0.01	0.01	-0.01	-0.02	-0.03	0	0	-0.03		3	16%
3	wen2	0.06	0.66	0.03	0.14	0.05	0.05	-0.03	0.03	0.02	-0.03	-0.03	-0.02	0.01	-0.05	-0.04	-0.04	-0.05	-0.06	0.06	-0.06		4	21%
4	wen3	0	0.03	0.49	0.01	0.01	0.02	0.01	-0.03	-0.01	-0.01	-0.02	-0.01	0	0.02	0	0	0	-0.02	0.01	0		1	5%
5	wen4	0.06	0.14	0.01	0.63	0.03	0.02	-0.02	0.08	0.01	-0.03	-0.03	-0.03	0.07	-0.06	-0.04	-0.06	-0.03	-0.04	-0.01	-0.04		5	26%
6	wen5	0.02	0.05	0.01	0.03	0.62	0.01	0	0.03	0	-0.02	-0.01	-0.02	0.01	-0.03	0.01	-0.01	-0.03	-0.03	0.02	-0.04		1	5%
7	wen6	0	0.05	0.02	0.02	0.01	0.51	-0.01	0	0	0.01	-0.02	-0.02	0.03	-0.01	0.01	-0.02	-0.02	-0.04	0.01	-0.01		1	5%
8	wen7	-0.01	-0.03	0.01	-0.02	0	-0.01	0.39	0.01	0.03	0	0	0	-0.02	0.02	-0.01	0	0	-0.01	0	0.02		1	5%
9	wen8	0.03	0.03	-0.03	0.08	0.03	0	0.01	0.52	0.01	-0.03	-0.03	-0.01	0.01	0.02	-0.05	-0.02	-0.01	-0.01	0.01	-0.02		2	11%
10	wen9	-0.01	0.02	-0.01	0.01	0	0	0.03	0.01	0.33	0	-0.01	-0.01	-0.03	0	0.03	-0.01	-0.02	-0.03	0.04	-0.01		1	5%
11	wen10	-0.03	-0.03	-0.01	-0.03	-0.02	0.01	0	-0.03	0	0.26	0.03	0.01	-0.02	0	0.01	0.05	0.02	0.02	-0.01	0.02		1	5%
12	wen11	0	-0.03	-0.02	-0.03	-0.01	-0.02	0	-0.03	-0.01	0.03	0.59	0.03	-0.02	-0.01	0.02	0.02	0.05	0.04	-0.03	0		1	5%
13	wen12	0	-0.02	-0.01	-0.03	-0.02	-0.02	0	-0.01	-0.01	0.01	0.03	0.41	-0.01	0.01	0.03	0.01	0.02	0.06	-0.06	0.03		2	11%
14	wen13	-0.01	0.01	0	0.07	0.01	0.03	-0.02	0.01	-0.03	-0.02	-0.02	-0.01	0.59	0.01	-0.05	-0.01	0	-0.02	0.03	0		2	11%
15	wen14	0.01	-0.05	0.02	-0.06	-0.03	-0.01	0.02	0.02	0	0	-0.01	0.01	0.01	0.28	0.01	0.01	0.01	0.01	0.02	0		1	5%
16	wen15	-0.01	-0.04	0	-0.04	0.01	0.01	-0.01	-0.05	0.03	0.01	0.02	0.03	-0.05	0.01	0.38	0.05	0.01	0.03	-0.03	0.02		1	5%
17	wen16	-0.02	-0.04	0	-0.06	-0.01	-0.02	0	-0.02	-0.01	0.05	0.02	0.01	-0.01	0.01	0.05	0.38	0.03	0.01	-0.01	0.04		1	5%
18	wen17	-0.03	-0.05	0	-0.03	-0.03	-0.02	0	-0.01	-0.02	0.02	0.05	0.02	0	0.01	0.01	0.03	0.54	0.03	-0.01	0.03		1	5%
19	wen18	0	-0.06	-0.02	-0.04	-0.03	-0.04	-0.01	-0.01	-0.03	0.02	0.04	0.06	-0.02	0.01	0.03	0.01	0.03	0.34	-0.01	0.04		2	11%
20	wen19	0	0.06	0.01	-0.01	0.02	0.01	0	0.01	0.04	-0.01	-0.03	-0.06	0.03	0.02	-0.03	-0.01	-0.01	-0.01	0.28	-0.02		2	11%
21	wen21	-0.03	-0.06	0	-0.04	-0.04	-0.01	0.02	-0.02	-0.01	0.02	0	0.03	0	0	0.02	0.04	0.03	0.04	-0.02	0.38		1	5%

22 Remove item 4 and run a sixth model

```
>     df<-df[ , -4]
>     m6<-fa(df, nfactors = 3, rotate="oblimin")
>     m6$loadings
```

Factor loadings are still good:



RStudio
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Parallel Analysis Scree Plots
FA Actual Data
FA Simulated Data
FA Resampled Data
eigen values of principal factors
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2
4
6
8
5
10
15
20
Factor Number

	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
2	1	1	4	3	3	2	2	2	3	2	3	
3	2	1	0	0	0	0	NA	0	0	0	0	
				4	3	4	2	4	3	4	4	

Data	
correlation	num [1:21, 1:21] 1 0.44 -0.14 0.4…
df	1097 obs. of 19 variables
m3	List of 51
m4	List of 51
m5	List of 51
m6	List of 51
teachfac	1097 obs. of 28 variables
temp	num [1:20, 1:20] 0.39 0.06 0 0.06…
Values	
temp1	num [1:1097] 4 2 3 2 1 1 1 4 2 2 ...

```
idual.csv")
> df<-df[ , -4]
> m6<-fa(df, nfactors = 3, rotate="oblimin")
> m6$loadings

Loadings:
       MR1    MR3    MR2   
wen1           0.844       
wen2    0.372  0.246  0.143
wen3          -0.135  0.687
wen5          -0.537  0.306
wen6    0.263  0.476       
wen7                  0.787
wen8    0.191  0.545       
wen9    0.721  0.128       
wen10          0.868       
wen11 -0.165          0.615
wen12  0.743               
wen13  0.648               
wen14  0.156  0.729        
wen15  0.668         -0.168
wen16  0.122  0.698        
wen17                 0.692
wen18  0.873 -0.101        
wen19  0.830               
wen21  0.753               

                 MR1   MR3   MR2
SS loadings    4.282 3.425 2.110
Proportion Var 0.225 0.180 0.111
Cumulative Var 0.225 0.406 0.517
> 
```

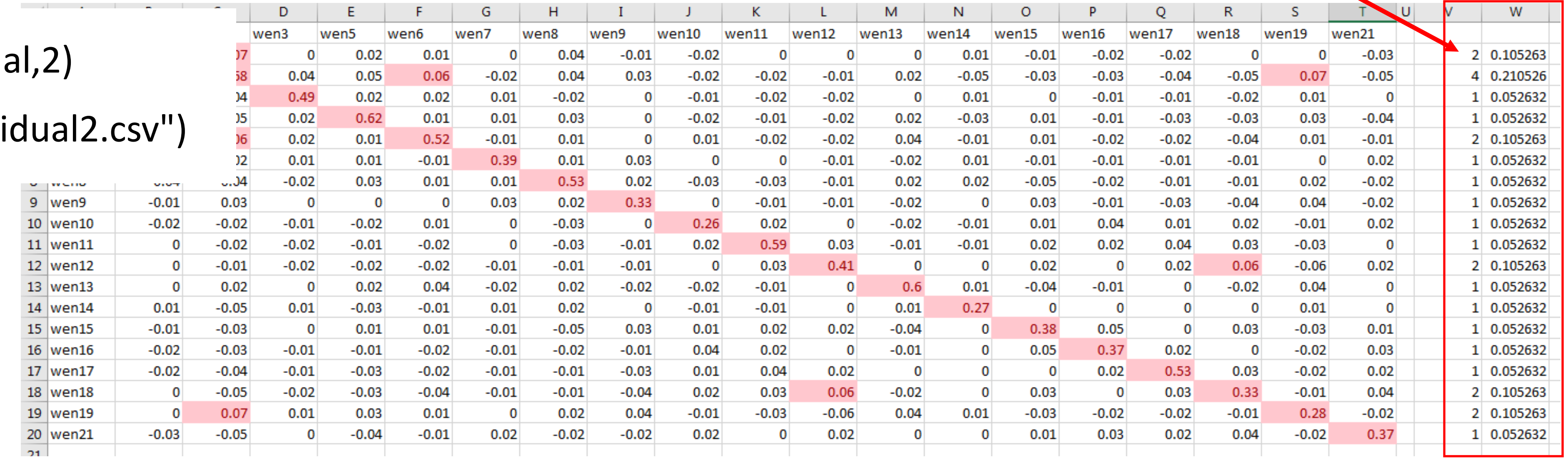
23

Export the residual matrix as a csv file for the new model

```
>	temp<-round(m6$residual,2)
>	write.csv(temp, file="residual2.csv")
```

=COUNTIF(B2:U2,">.05")

Much better:

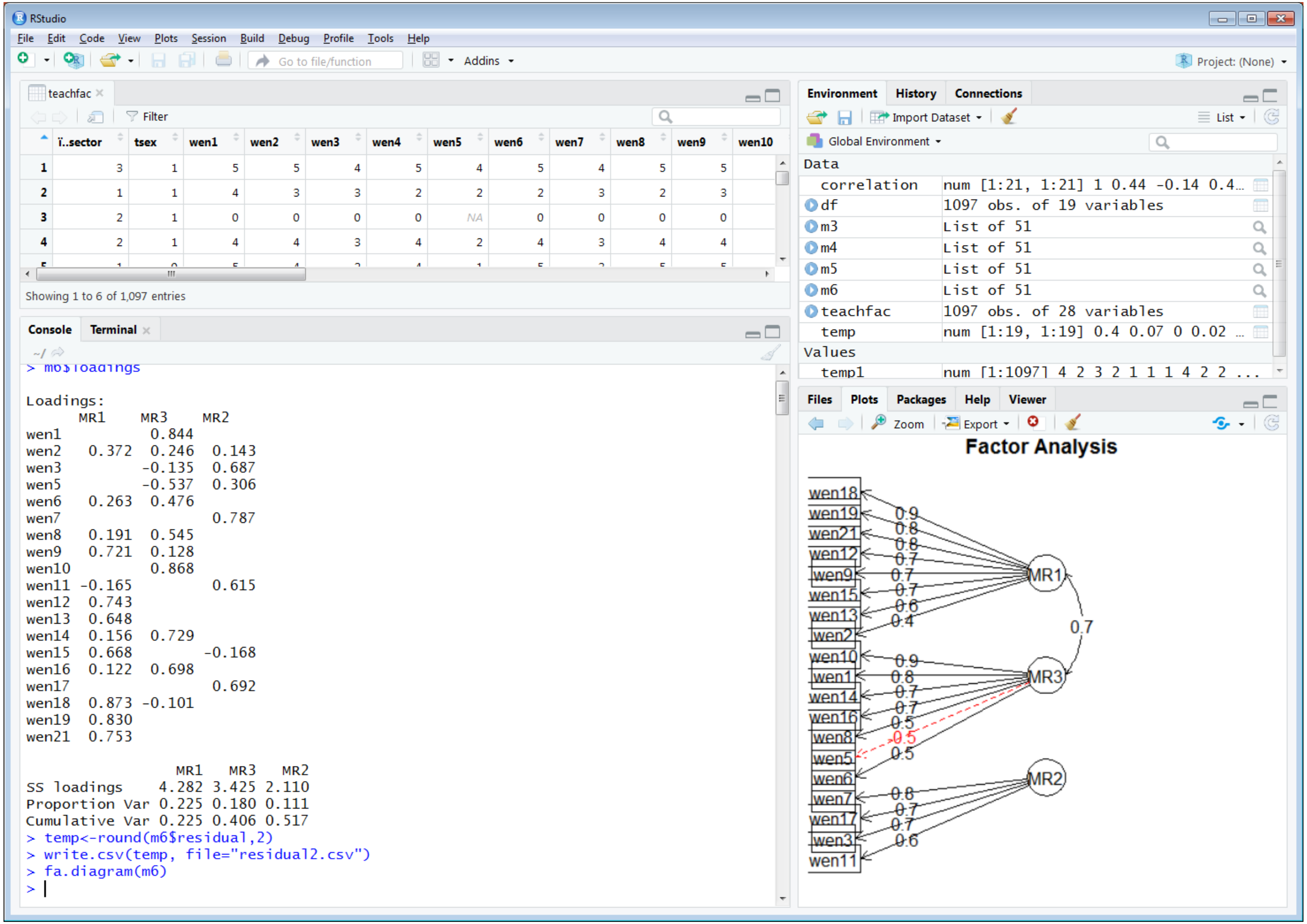


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
				wen3	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17	wen18	wen19	wen21			
			07	0	0.02	0.01	0	0.04	-0.01	-0.02	0	0	0	0.01	-0.01	-0.02	-0.02	0	0	-0.03		2	0.105263
			58	0.04	0.05	0.06	-0.02	0.04	0.03	-0.02	-0.02	-0.01	0.02	-0.05	-0.03	-0.03	-0.04	-0.05	0.07	-0.05		4	0.210526
			04	0.49	0.02	0.02	0.01	-0.02	0	-0.01	-0.02	-0.02	0	0.01	0	-0.01	-0.01	-0.02	0.01	0		1	0.052632
			05	0.02	0.62	0.01	0.01	0.03	0	-0.02	-0.01	-0.02	0.02	-0.03	0.01	-0.01	-0.03	-0.03	0.03	-0.04		1	0.052632
			06	0.02	0.01	0.52	-0.01	0.01	0	0.01	-0.02	-0.02	0.04	-0.01	0.01	-0.02	-0.02	-0.04	0.01	-0.01		2	0.105263
			02	0.01	0.01	-0.01	0.39	0.01	0.03	0	0	-0.01	-0.02	0.01	-0.01	-0.01	-0.01	-0.01	0	0.02		1	0.052632
			04	-0.02	0.03	0.01	0.01	0.53	0.02	-0.03	-0.03	-0.01	0.02	0.02	-0.05	-0.02	-0.01	-0.01	0.02	-0.02		1	0.052632
9	wen9	-0.01	0.03	0	0	0	0.03	0.02	0.33	0	-0.01	-0.01	-0.02	0	0.03	-0.01	-0.03	-0.04	0.04	-0.02		1	0.052632
10	wen10	-0.02	-0.02	-0.01	-0.02	0.01	0	-0.03	0	0.26	0.02	0	-0.02	-0.01	0.01	0.04	0.01	0.02	-0.01	0.02		1	0.052632
11	wen11	0	-0.02	-0.02	-0.01	-0.02	0	-0.03	-0.01	0.02	0.59	0.03	-0.01	-0.01	0.02	0.02	0.04	0.03	-0.03	0		1	0.052632
12	wen12	0	-0.01	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	0	0.03	0.41	0	0	0.02	0	0.02	0.06	-0.06	0.02		2	0.105263
13	wen13	0	0.02	0	0.02	0.04	-0.02	0.02	-0.02	-0.02	-0.01	0	0.6	0.01	-0.04	-0.01	0	-0.02	0.04	0		1	0.052632
14	wen14	0.01	-0.05	0.01	-0.03	-0.01	0.01	0.02	0	-0.01	-0.01	0	0.01	0.27	0	0	0	0	0.01	0		1	0.052632
15	wen15	-0.01	-0.03	0	0.01	0.01	-0.01	-0.05	0.03	0.01	0.02	0.02	-0.04	0	0.38	0.05	0	0.03	-0.03	0.01		1	0.052632
16	wen16	-0.02	-0.03	-0.01	-0.01	-0.02	-0.01	-0.02	-0.01	0.04	0.02	0	-0.01	0	0.05	0.37	0.02	0	-0.02	0.03		1	0.052632
17	wen17	-0.02	-0.04	-0.01	-0.03	-0.02	-0.01	-0.01	-0.03	0.01	0.04	0.02	0	0	0	0.02	0.53	0.03	-0.02	0.02		1	0.052632
18	wen18	0	-0.05	-0.02	-0.03	-0.04	-0.01	-0.01	-0.04	0.02	0.03	0.06	-0.02	0	0.03	0	0.03	0.33	-0.01	0.04		2	0.105263
19	wen19	0	0.07	0.01	0.03	0.01	0	0.02	0.04	-0.01	-0.03	-0.06	0.04	0.01	-0.03	-0.02	-0.02	-0.01	0.28	-0.02		2	0.105263
20	wen21	-0.03	-0.05	0	-0.04	-0.01	0.02	-0.02	-0.02	0.02	0	0.02	0	0	0.01	0.03	0.02	0.04	-0.02	0.37		1	0.052632
21																							

24

Obtain a summary factor diagram to see which items load where

```
>       fa.diagram(m6)
```



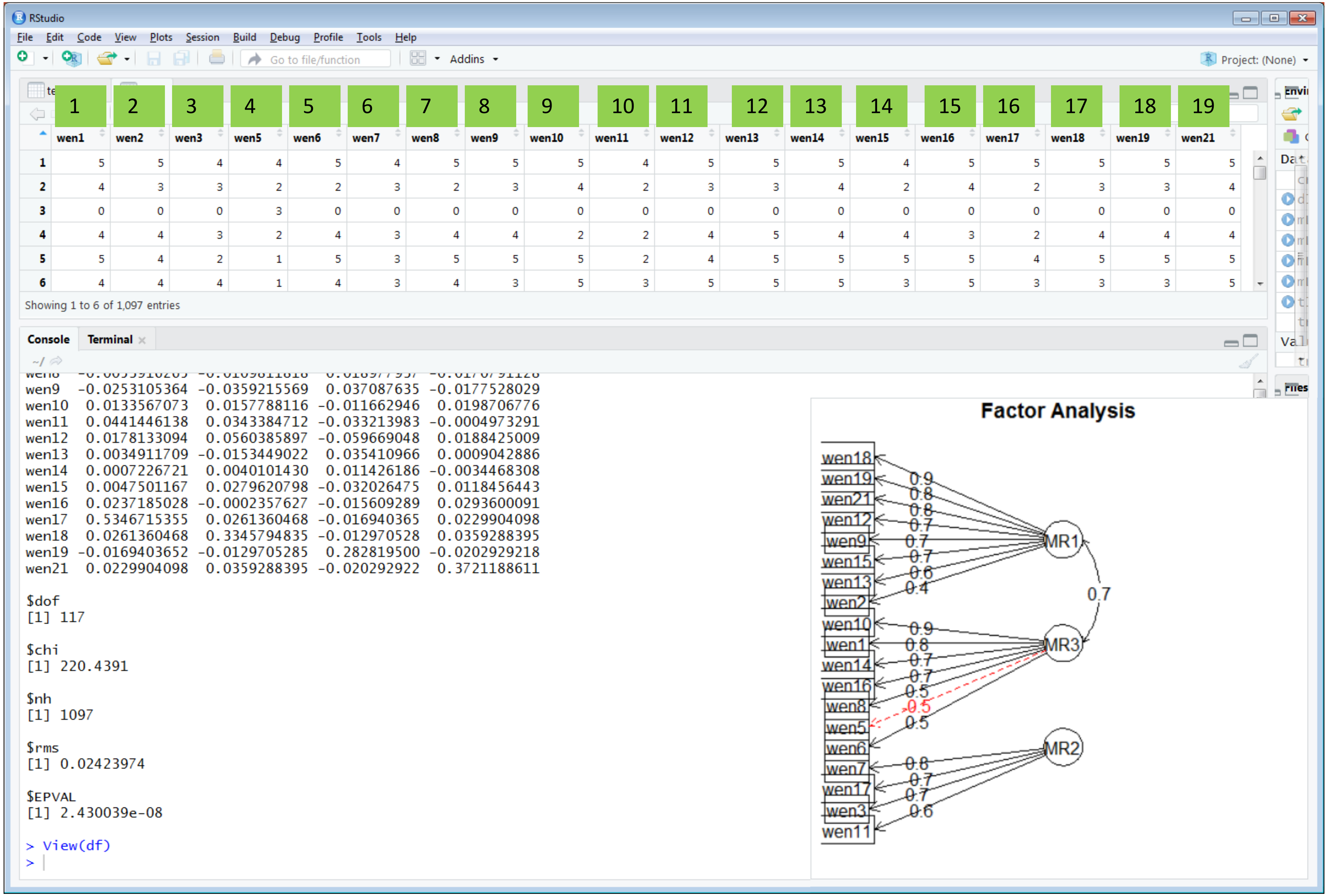
	ï..sector	tsex	wen1	wen2	wen3	wen4	wen5	wen6	wen7	wen8	wen9	wen10
1	3	1	5	5	4	5	4	5	4	5	5	
2	1	1	4	3	3	2	2	2	3	2	3	
3	2	1	0	0	0	0	NA	0	0	0	0	
4	2	1	4	4	3	4	2	4	3	4	4	

Showing 1 to 6 of 1,097 entries

Data	
correlation	num [1:21, 1:21] 1 0.44 -0.14 0.4...
df	1097 obs. of 19 variables
m3	List of 51
m4	List of 51
m5	List of 51
m6	List of 51
teachfac	1097 obs. of 28 variables
temp	num [1:19, 1:19] 0.4 0.07 0 0.02 ...
Values	
temp1	num [1:1097] 4 2 3 2 1 1 1 4 2 2 ...

```
> m6$loadings

Loadings:
      MR1    MR3    MR2   
wen1          0.844       
wen2   0.372  0.246  0.143
wen3         -0.135  0.687
wen5         -0.537  0.306
wen6   0.263  0.476       
wen7                 0.787
wen8   0.191  0.545       
wen9   0.721  0.128       
wen10         0.868       
wen11 -0.165         0.615
wen12  0.743              
wen13  0.648              
wen14  0.156  0.729       
wen15  0.668        -0.168
wen16  0.122  0.698       
wen17                0.692
wen18  0.873 -0.101       
wen19  0.830              
wen21  0.753              

                 MR1   MR3   MR2
SS loadings    4.282 3.425 2.110
Proportion Var 0.225 0.180 0.111
Cumulative Var 0.225 0.406 0.517
> temp<-round(m6$residual,2)
> write.csv(temp, file="residual2.csv")
> fa.diagram(m6)
> 
```

25 Recount the column numbers for the remaining variables



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	wen1	wen2	wen3	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17	wen18	wen19	wen21
1	5	5	4	4	5	4	5	5	5	4	5	5	5	4	5	5	5	5	5
2	4	3	3	2	2	3	2	3	4	2	3	3	4	2	4	2	3	3	4
3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	4	3	2	4	3	4	4	2	2	4	5	4	4	3	2	4	4	4
5	5	4	2	1	5	3	5	5	5	2	4	5	5	5	5	4	5	5	5
6	4	4	4	1	4	3	4	3	5	3	5	5	5	3	5	3	3	3	5

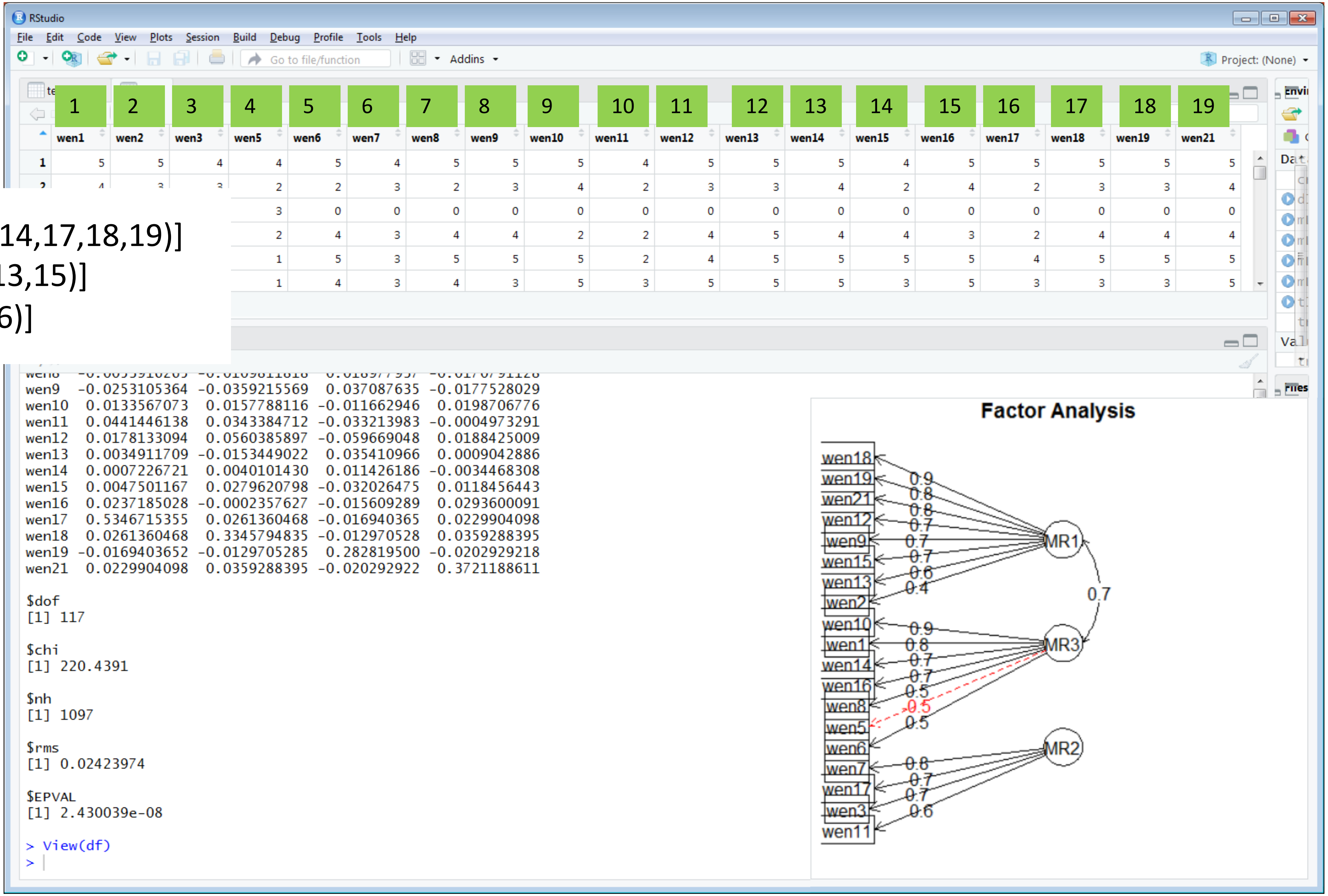
Showing 1 to 6 of 1,097 entries

```
wen8  -0.0055910205 -0.0109811818  0.018977957 -0.0170791128
wen9  -0.0253105364 -0.0359215569  0.037087635 -0.0177528029
wen10  0.0133567073  0.0157788116 -0.011662946  0.0198706776
wen11  0.0441446138  0.0343384712 -0.033213983 -0.0004973291
wen12  0.0178133094  0.0560385897 -0.059669048  0.0188425009
wen13  0.0034911709 -0.0153449022  0.035410966  0.0009042886
wen14  0.0007226721  0.0040101430  0.011426186 -0.0034468308
wen15  0.0047501167  0.0279620798 -0.032026475  0.0118456443
wen16  0.0237185028 -0.0002357627 -0.015609289  0.0293600091
wen17  0.5346715355  0.0261360468 -0.016940365  0.0229904098
wen18  0.0261360468  0.3345794835 -0.012970528  0.0359288395
wen19 -0.0169403652 -0.0129705285  0.282819500 -0.0202929218
wen21  0.0229904098  0.0359288395 -0.020292922  0.3721188611

$dof
[1] 117

$chi
[1] 220.4391

$nh
[1] 1097

$rms
[1] 0.02423974

$EPVAL
[1] 2.430039e-08

> View(df)
> 
```

26

Define the three factors based upon the variable's column *N*

```
>	factor1<-df[ , c(2,8,11,12,14,17,18,19)]
>	factor2<-df[ , c(1,4,5,7,9,13,15)]
>	factor3<-df[ , c(3, 6, 10, 16)]
```

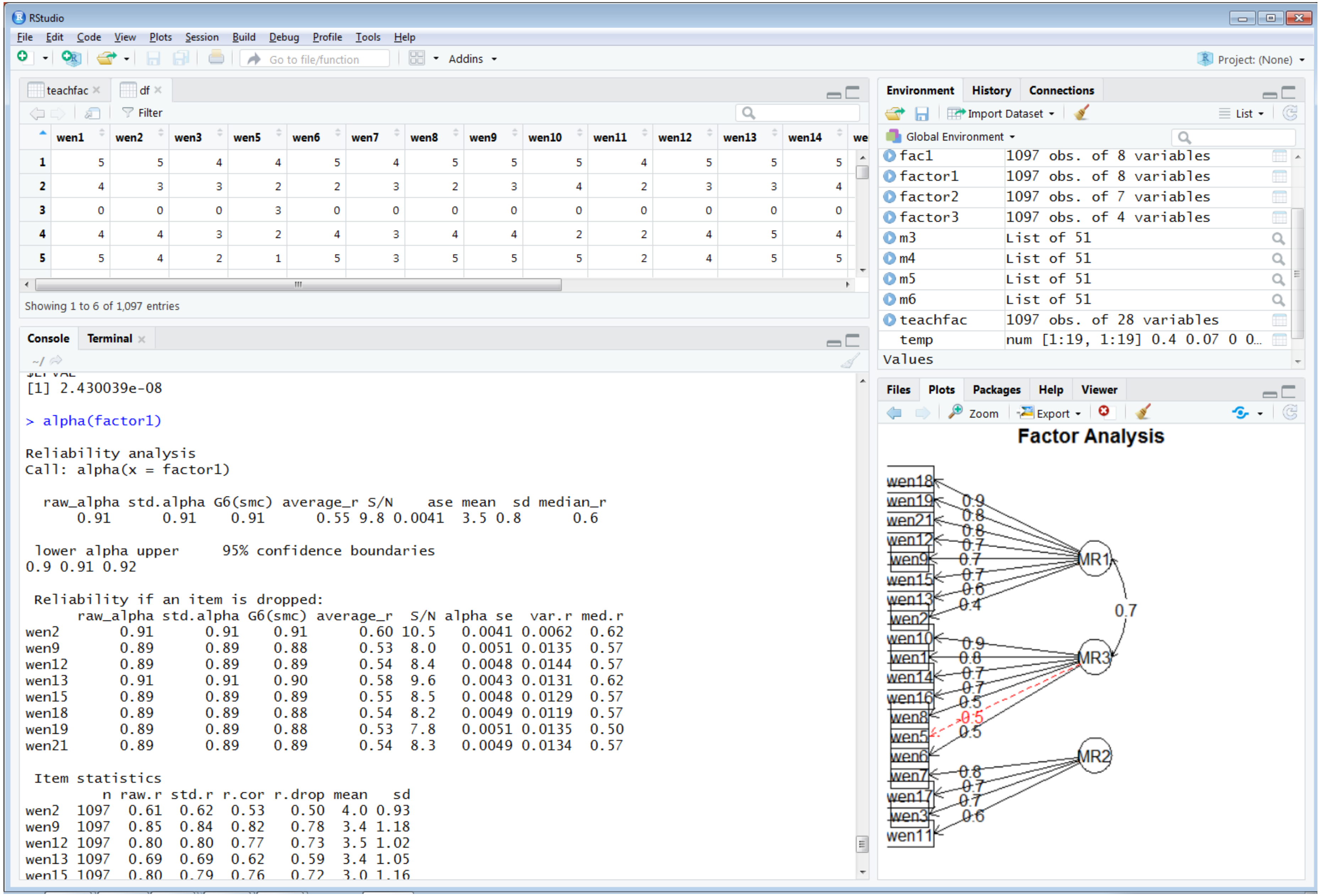


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	wen1	wen2	wen3	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	wen15	wen16	wen17	wen18	wen19	wen21
1	5	5	4	4	5	4	5	5	5	4	5	5	5	4	5	5	5	5	5
2	4	3	3	2	2	3	2	3	4	2	3	3	4	2	4	2	3	3	4
				3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				2	4	3	4	4	2	2	4	5	4	4	3	2	4	4	4
				1	5	3	5	5	5	2	4	5	5	5	5	4	5	5	5
				1	4	3	4	3	5	3	5	5	5	3	5	3	3	3	5

```
wen9  -0.0253105364 -0.0359215569  0.037087635 -0.0177528029
wen10  0.0133567073  0.0157788116 -0.011662946  0.0198706776
wen11  0.0441446138  0.0343384712 -0.033213983 -0.0004973291
wen12  0.0178133094  0.0560385897 -0.059669048  0.0188425009
wen13  0.0034911709 -0.0153449022  0.035410966  0.0009042886
wen14  0.0007226721  0.0040101430  0.011426186 -0.0034468308
wen15  0.0047501167  0.0279620798 -0.032026475  0.0118456443
wen16  0.0237185028 -0.0002357627 -0.015609289  0.0293600091
wen17  0.5346715355  0.0261360468 -0.016940365  0.0229904098
wen18  0.0261360468  0.3345794835 -0.012970528  0.0359288395
wen19 -0.0169403652 -0.0129705285  0.282819500 -0.0202929218
wen21  0.0229904098  0.0359288395 -0.020292922  0.3721188611

$dof
[1] 117

$chi
[1] 220.4391

$nh
[1] 1097

$rms
[1] 0.02423974

$EPVAL
[1] 2.430039e-08

> View(df)
> 
```

27 Assess the reliability for factor 1

> Alpha(factor1)



	wen1	wen2	wen3	wen5	wen6	wen7	wen8	wen9	wen10	wen11	wen12	wen13	wen14	we
1	5	5	4	4	5	4	5	5	5	4	5	5	5	
2	4	3	3	2	2	3	2	3	4	2	3	3	4	
3	0	0	0	3	0	0	0	0	0	0	0	0	0	
4	4	4	3	2	4	3	4	4	2	2	4	5	4	
5	5	4	2	1	5	3	5	5	5	2	4	5	5	

fac1	1097 obs. of 8 variables
factor1	1097 obs. of 8 variables
factor2	1097 obs. of 7 variables
factor3	1097 obs. of 4 variables
m3	List of 51
m4	List of 51
m5	List of 51
m6	List of 51
teachfac	1097 obs. of 28 variables
temp	num [1:19, 1:19] 0.4 0.07 0 0...

Values

```
[1] 2.430039e-08

> alpha(factor1)

Reliability analysis
Call: alpha(x = factor1)

  raw_alpha std.alpha G6(smc) average_r S/N    ase mean  sd median_r
      0.91      0.91    0.91      0.55 9.8 0.0041  3.5 0.8      0.6

 lower alpha upper     95% confidence boundaries
0.9 0.91 0.92

 Reliability if an item is dropped:
      raw_alpha std.alpha G6(smc) average_r  S/N alpha se  var.r med.r
wen2       0.91      0.91    0.91      0.60 10.5   0.0041 0.0062  0.62
wen9       0.89      0.89    0.88      0.53  8.0   0.0051 0.0135  0.57
wen12      0.89      0.89    0.89      0.54  8.4   0.0048 0.0144  0.57
wen13      0.91      0.91    0.90      0.58  9.6   0.0043 0.0131  0.62
wen15      0.89      0.89    0.89      0.55  8.5   0.0048 0.0129  0.57
wen18      0.89      0.89    0.88      0.54  8.2   0.0049 0.0119  0.57
wen19      0.89      0.89    0.88      0.53  7.8   0.0051 0.0135  0.50
wen21      0.89      0.89    0.89      0.54  8.3   0.0049 0.0134  0.57

 Item statistics
         n raw.r std.r r.cor r.drop mean   sd
wen2  1097  0.61  0.62  0.53   0.50  4.0 0.93
wen9  1097  0.85  0.84  0.82   0.78  3.4 1.18
wen12 1097  0.80  0.80  0.77   0.73  3.5 1.02
wen13 1097  0.69  0.69  0.62   0.59  3.4 1.05
wen15 1097  0.80  0.79  0.76   0.72  3.0 1.16
```