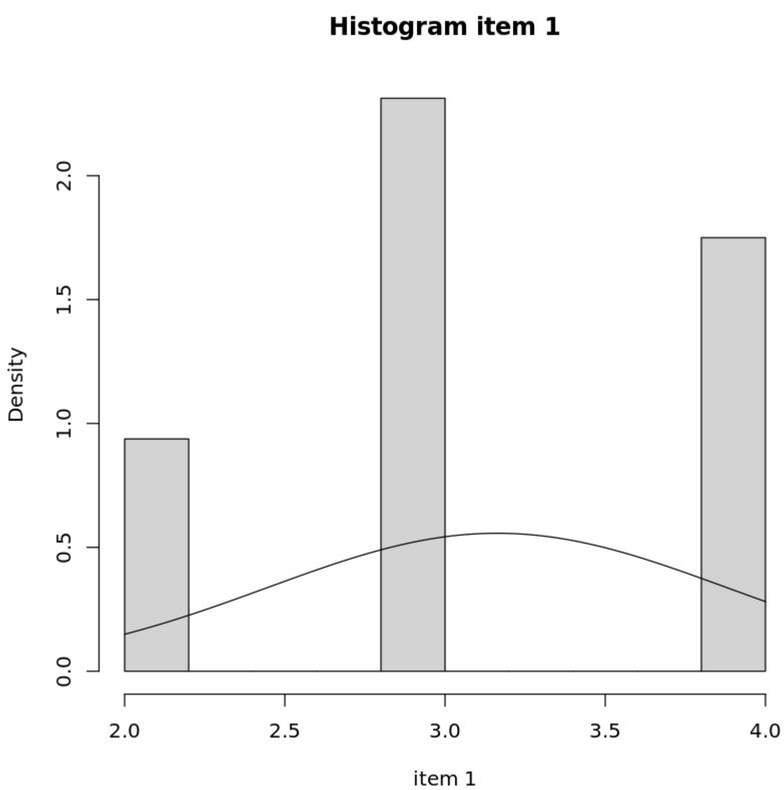
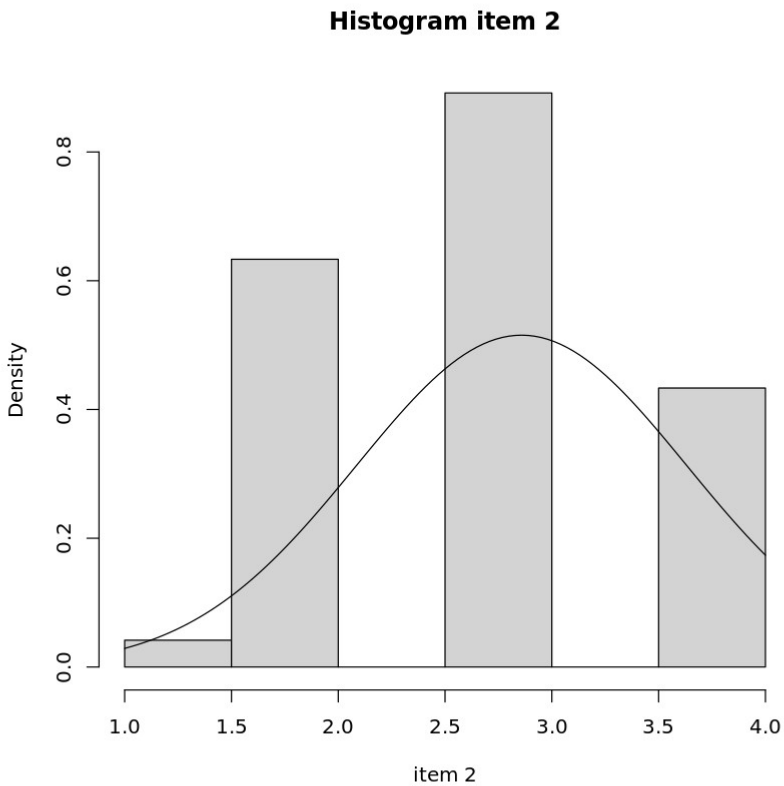
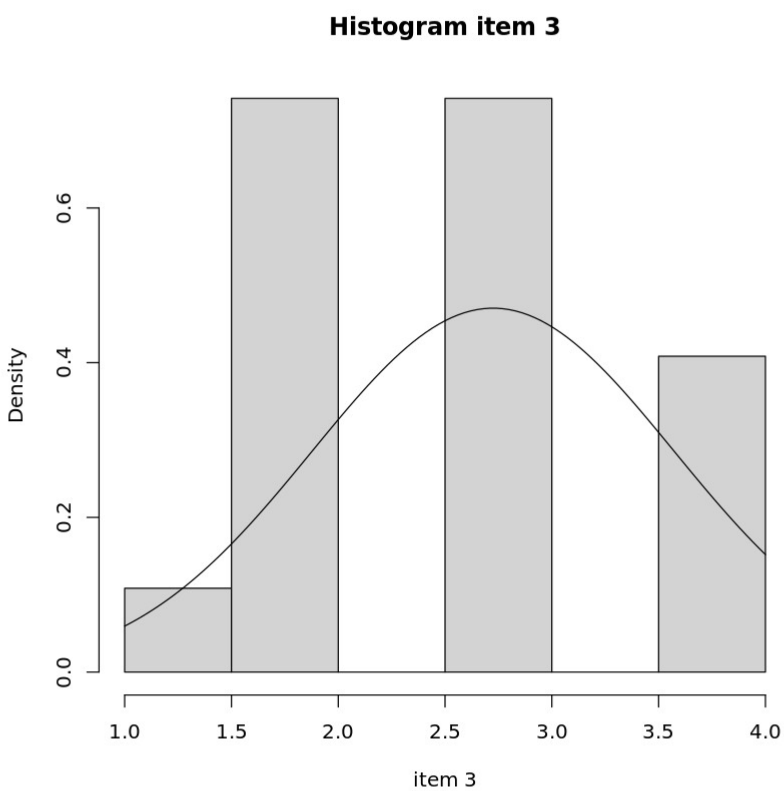
Histogramm:

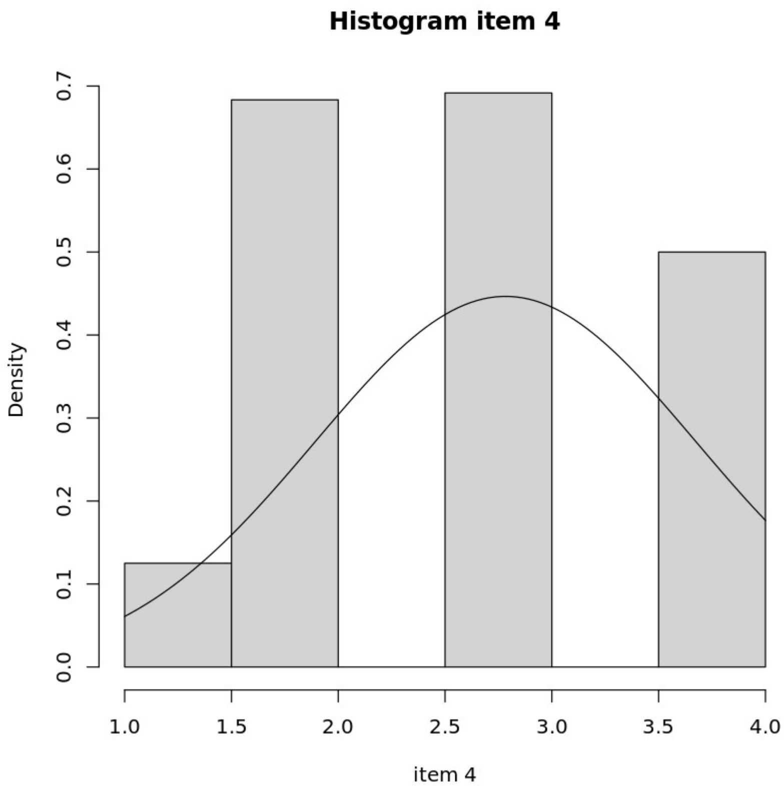
Ein erster Hinweis auf die Güte der Items ist sicherlich eine grobe Annäherung der Rohdaten an eine Normalverteilung

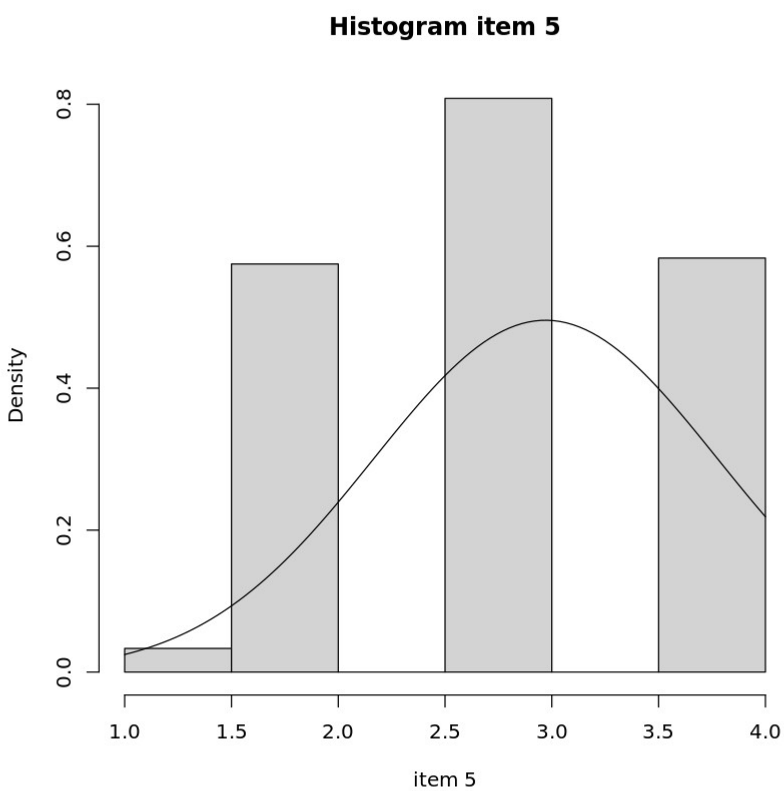
```
fallprozeile <- read.csv2
("https://paul-koop.org/fallprozeilenurdaten.csv", header=FALSE,
dec=",");

for (i in 1:36){
  hist(fallprozeile[,i],
       freq=FALSE,
       main=paste("Histogram item",i),
       xlab=paste("item",i)
       )
  x <- seq(1,4,0.01)

curve(dnorm(x,mean=mean(fallprozeile[,i]),sd=sd(fallprozeile[,i])),add
=TRUE)
}
```

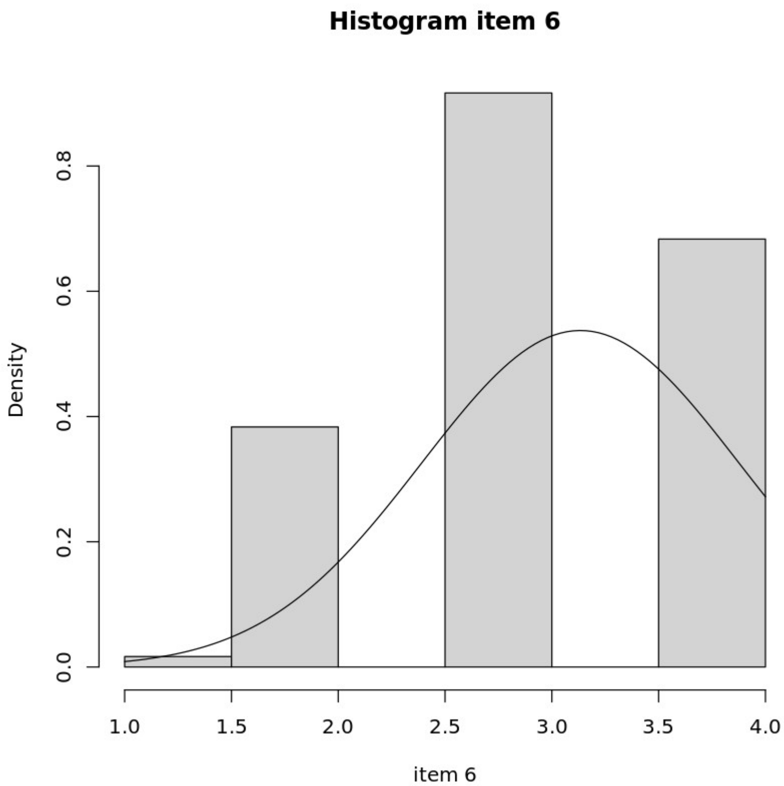


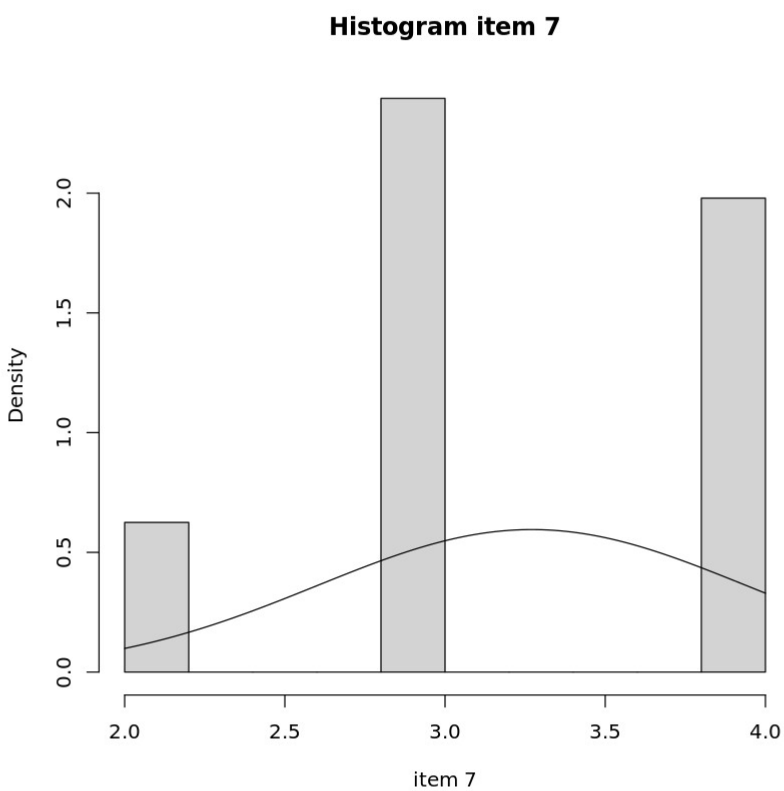

Histogram item 2
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 2


Histogram item 3
Density
0.0
0.2
0.4
0.6
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 3

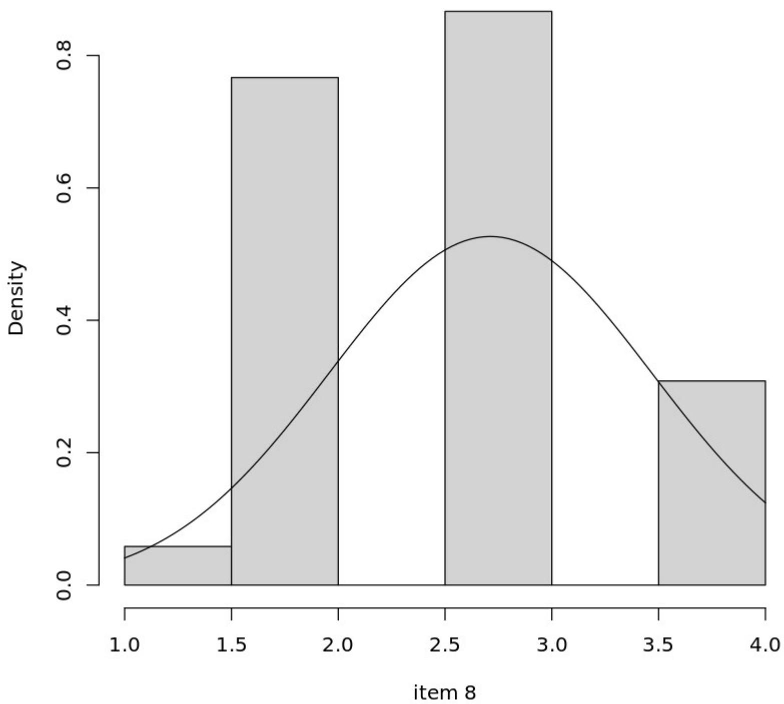

Histogram item 4
Density
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 4


Histogram item 5
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 5

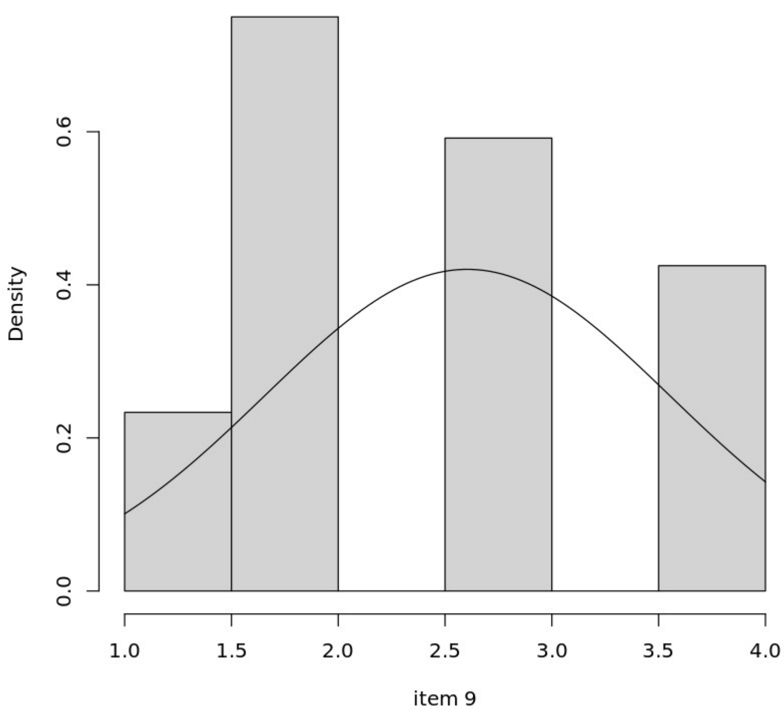

Histogram item 6
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 6

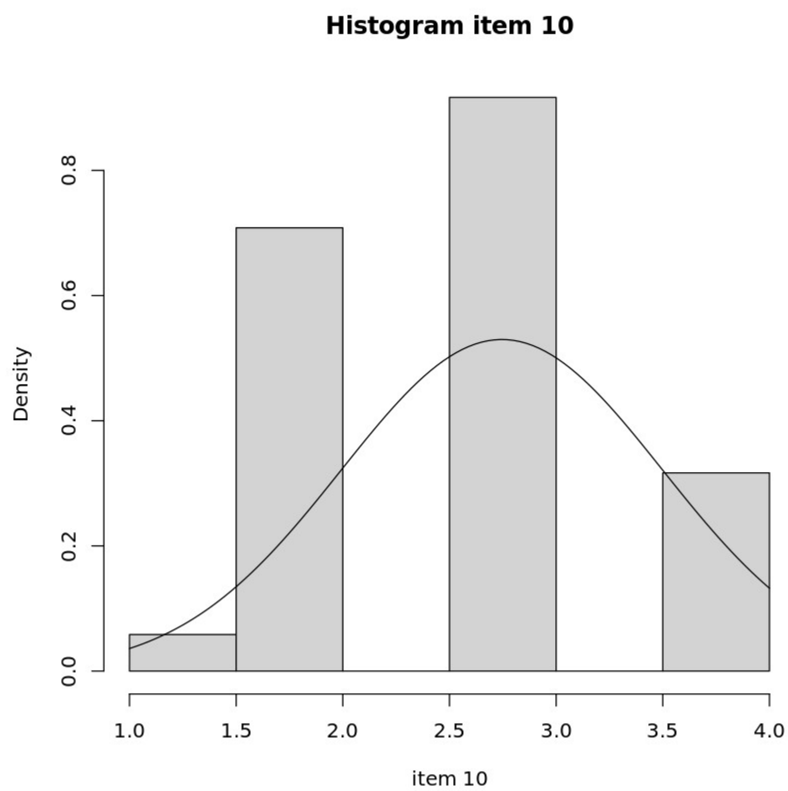

Histogram item 7
Density
0.0
0.5
1.0
1.5
2.0
2.0
2.5
3.0
3.5
4.0
item 7

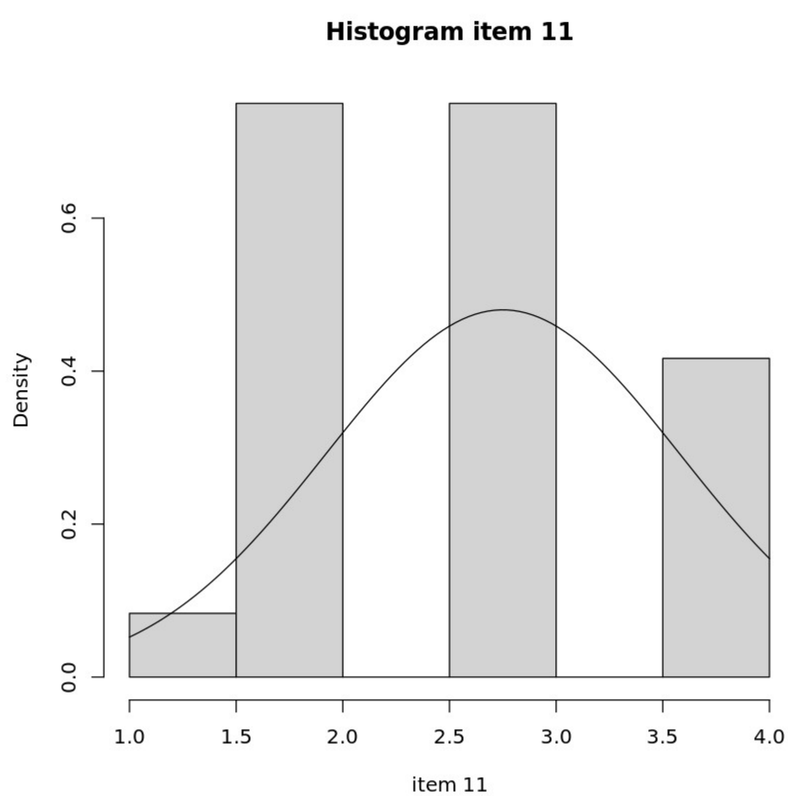
Histogram item 8

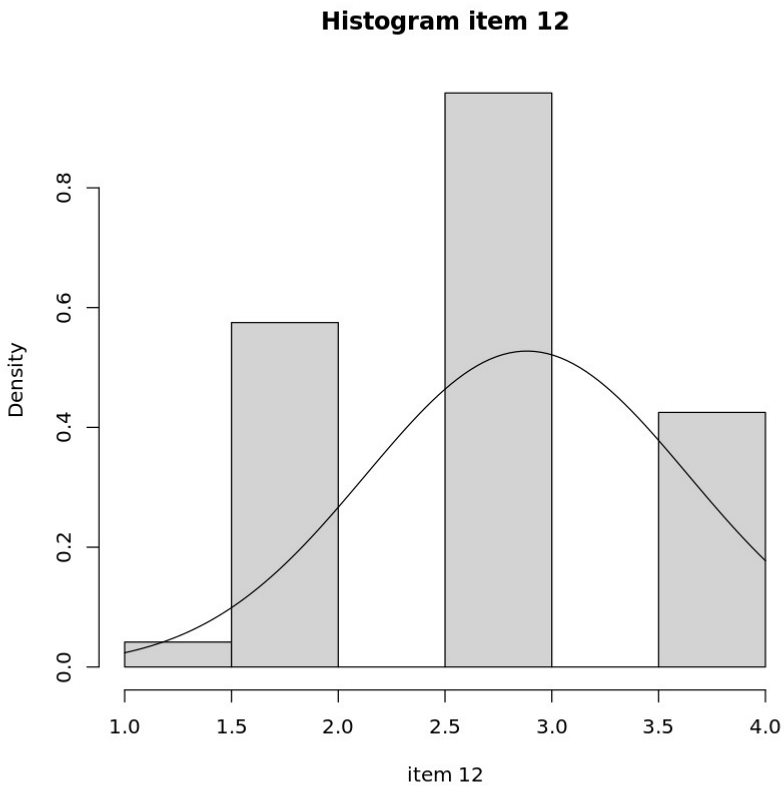


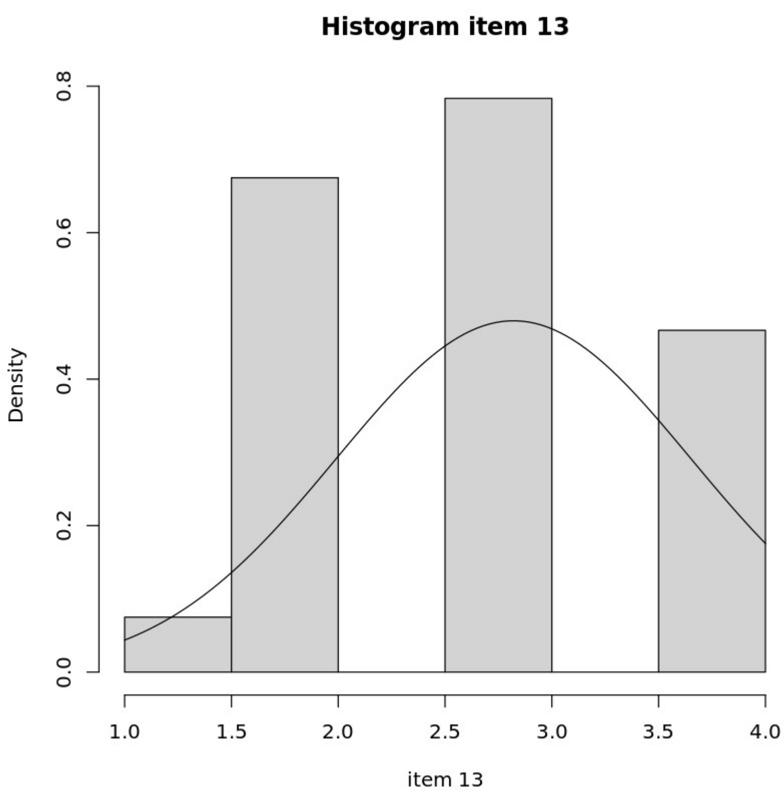
Histogram item 9

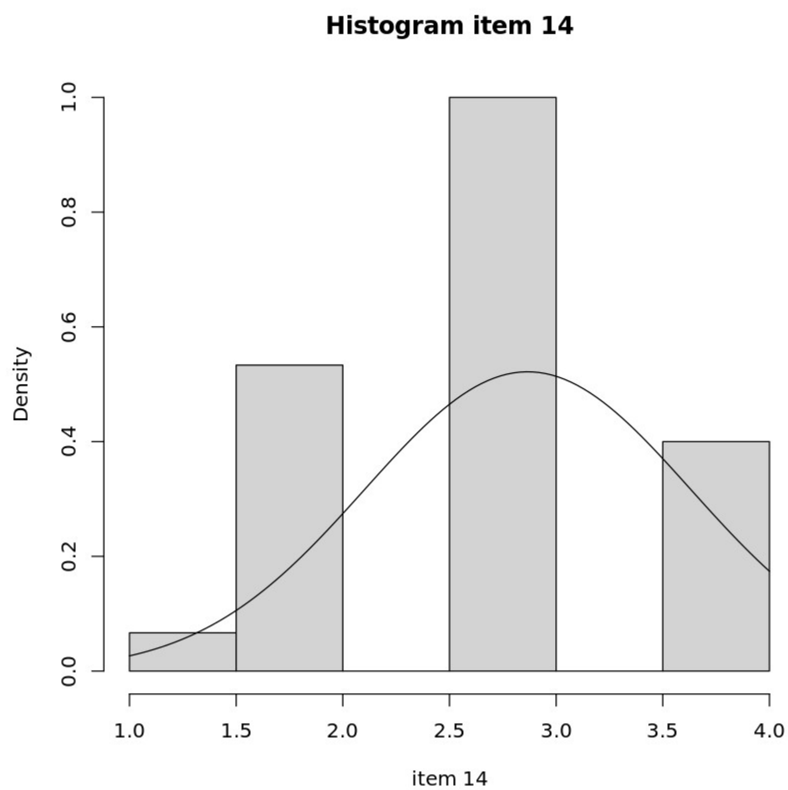


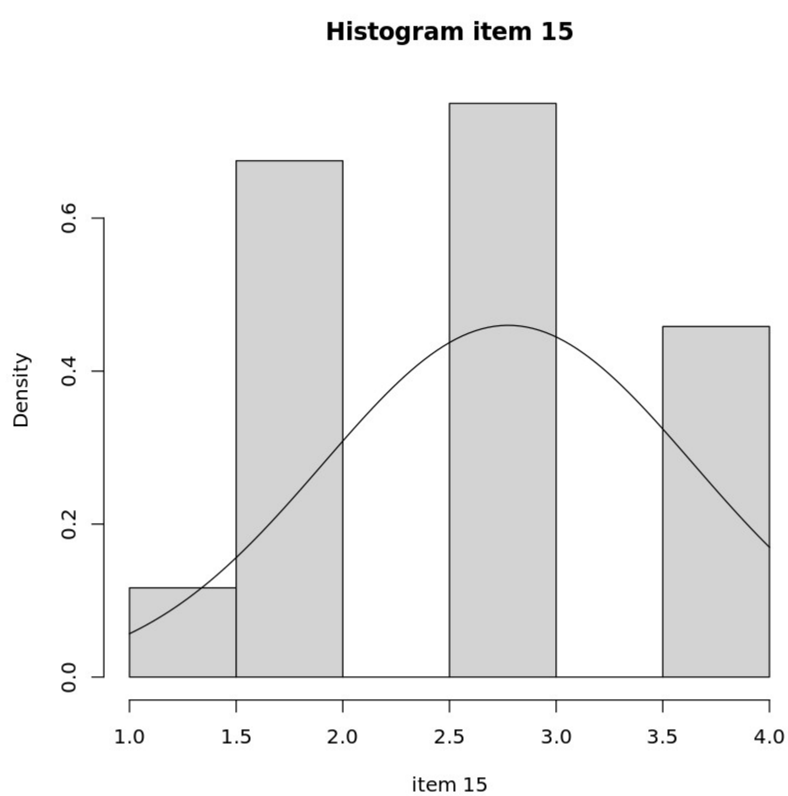

Histogram item 10
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 10

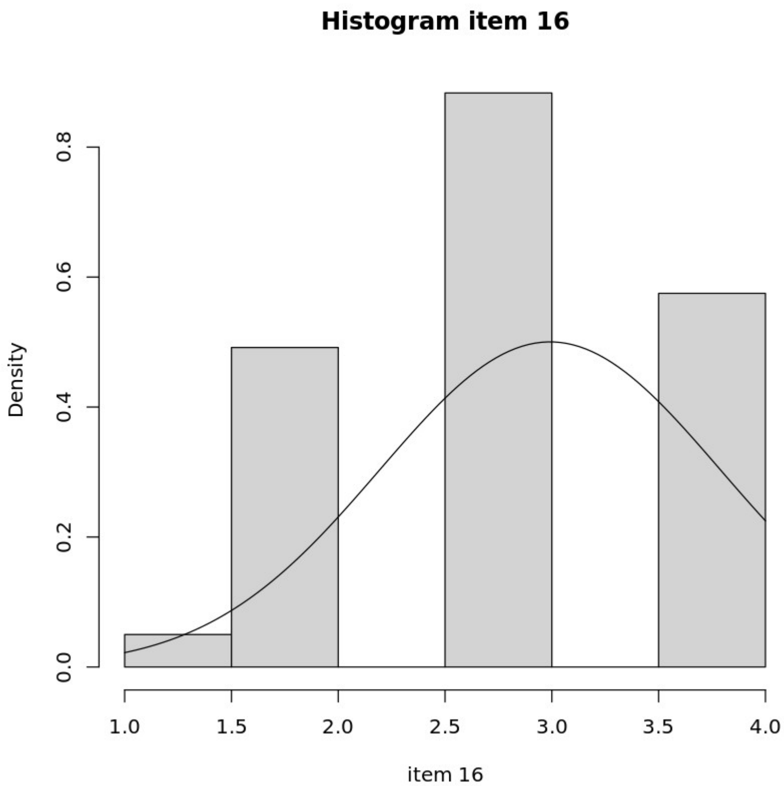

Histogram item 11
Density
0.0
0.2
0.4
0.6
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 11

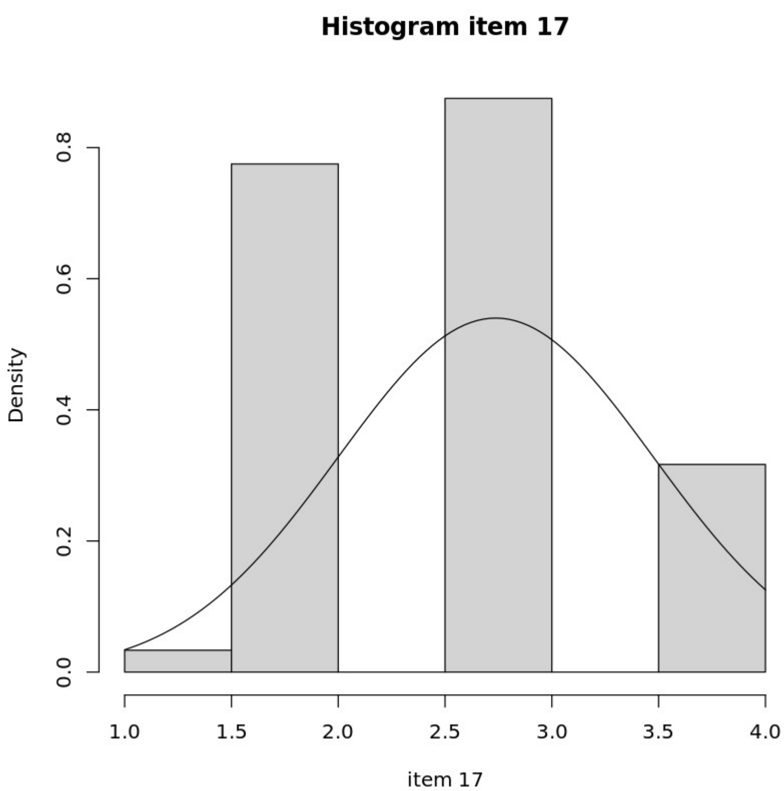

Histogram item 12
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 12

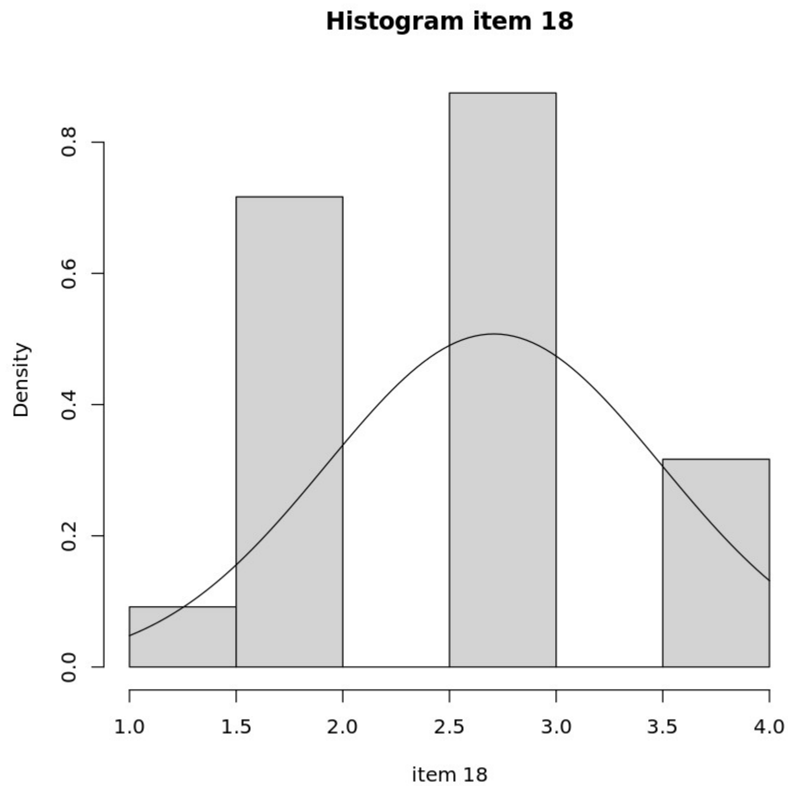

Histogram item 13
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 13

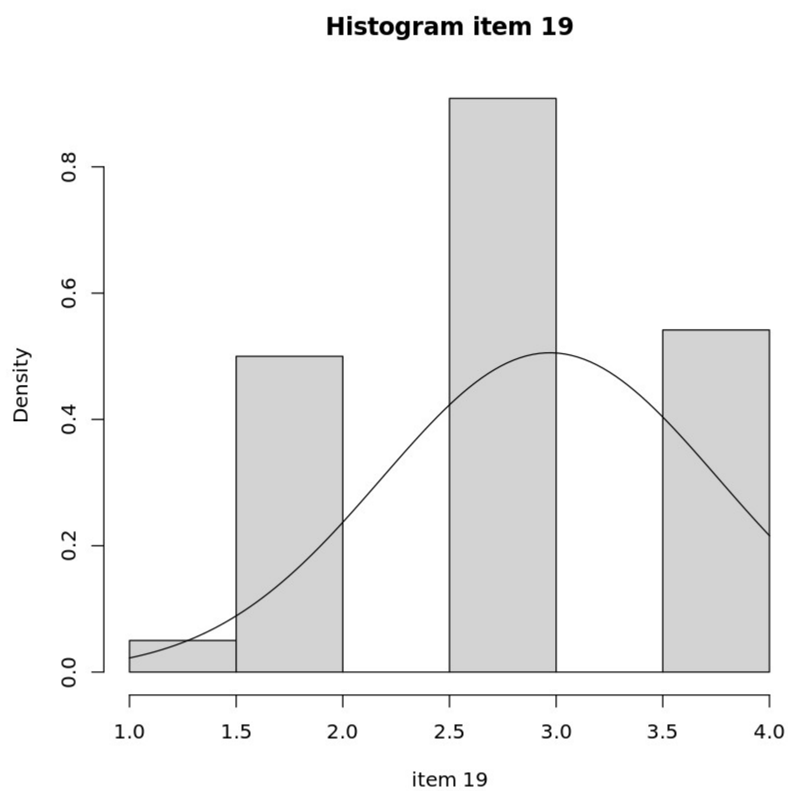

Histogram item 14
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 14

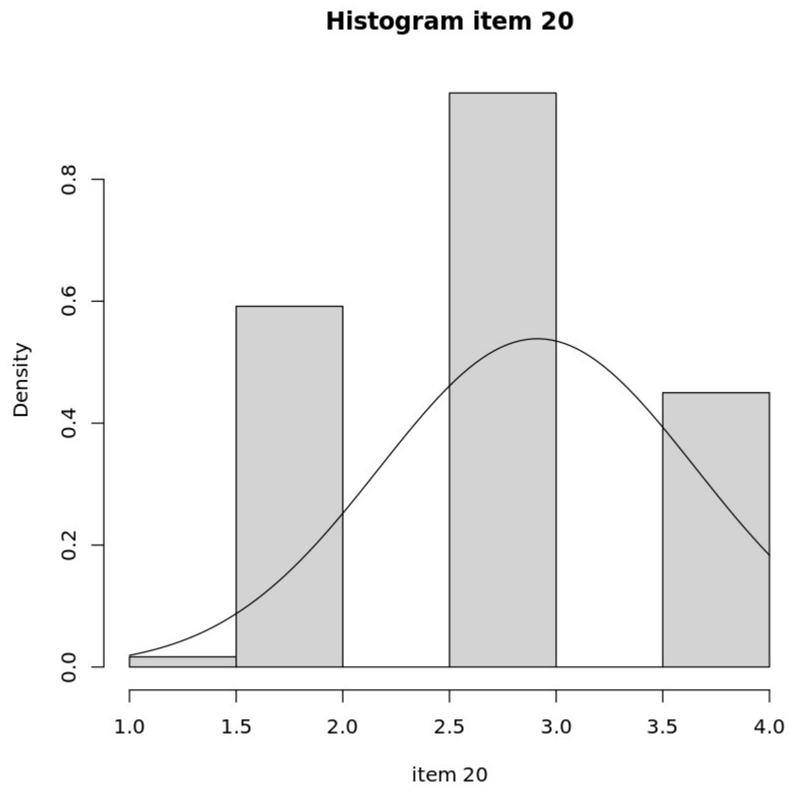

Histogram item 15
Density
0.0
0.2
0.4
0.6
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 15

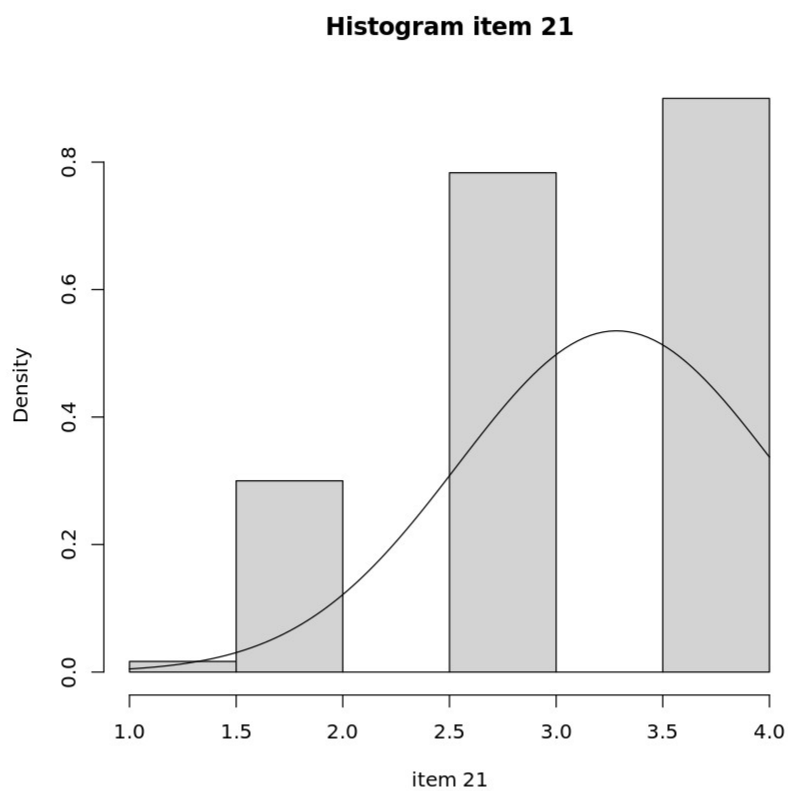

Histogram item 16
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 16

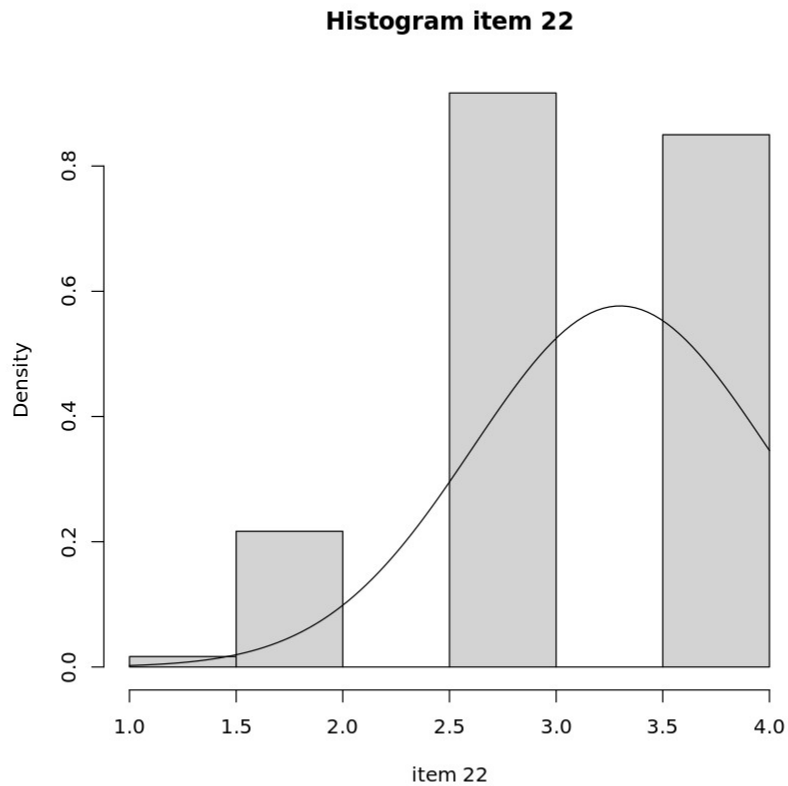

Histogram item 17
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 17

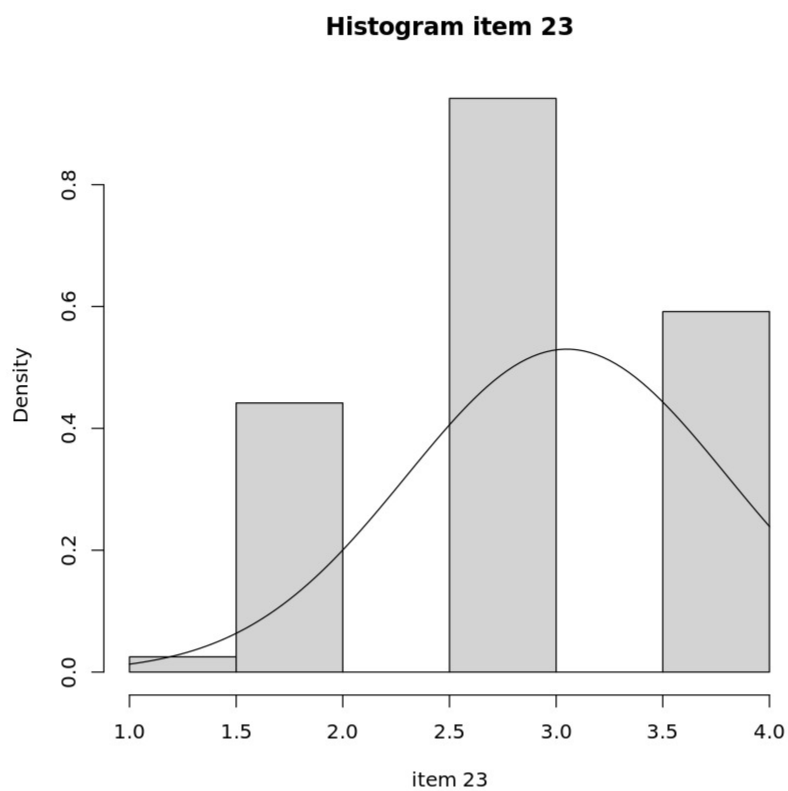

Histogram item 18
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 18

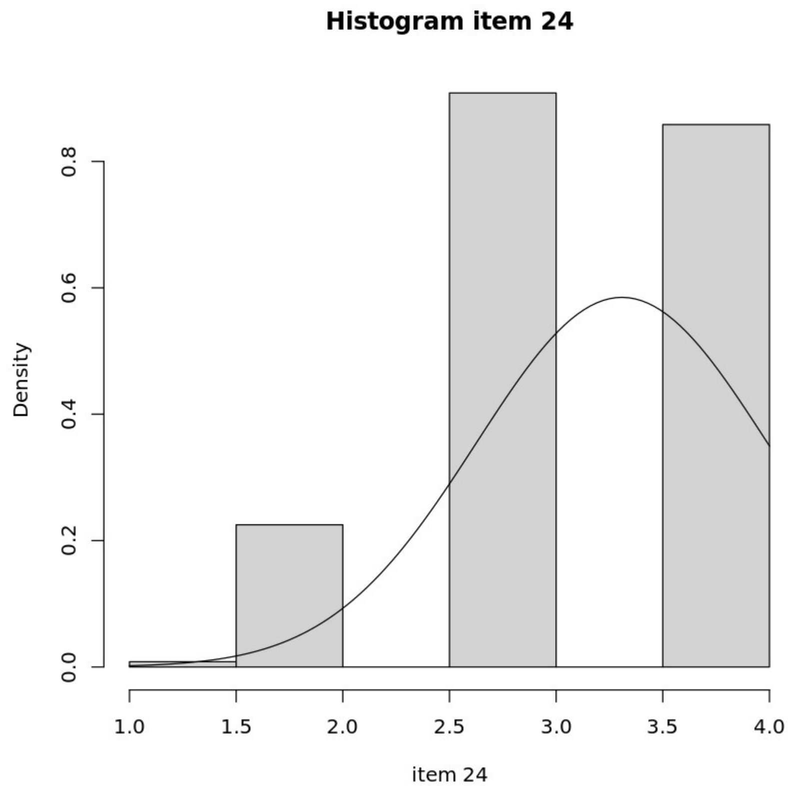

Histogram item 19
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 19

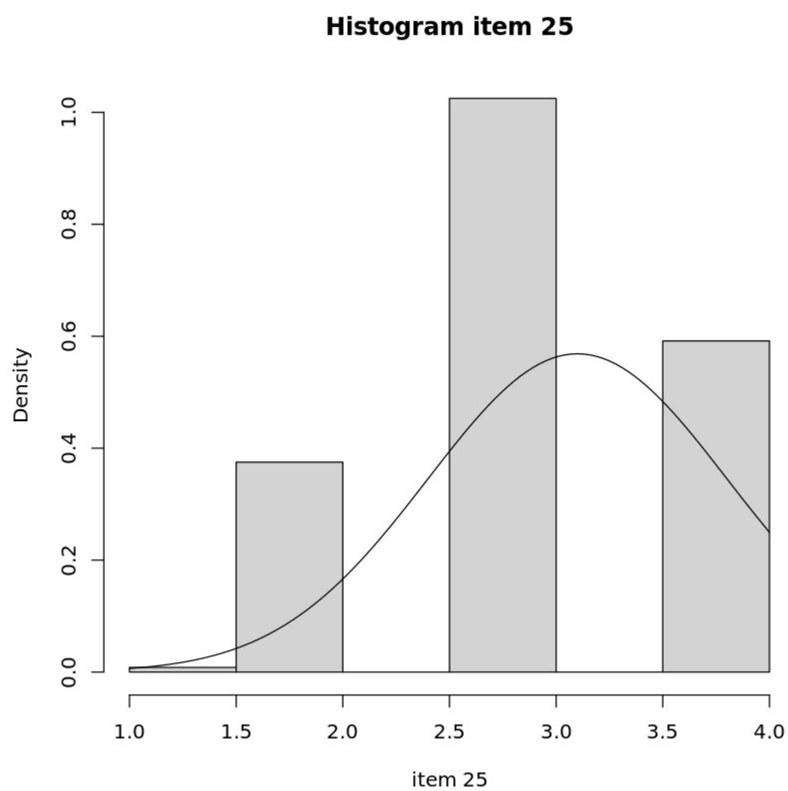

Histogram item 20
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 20

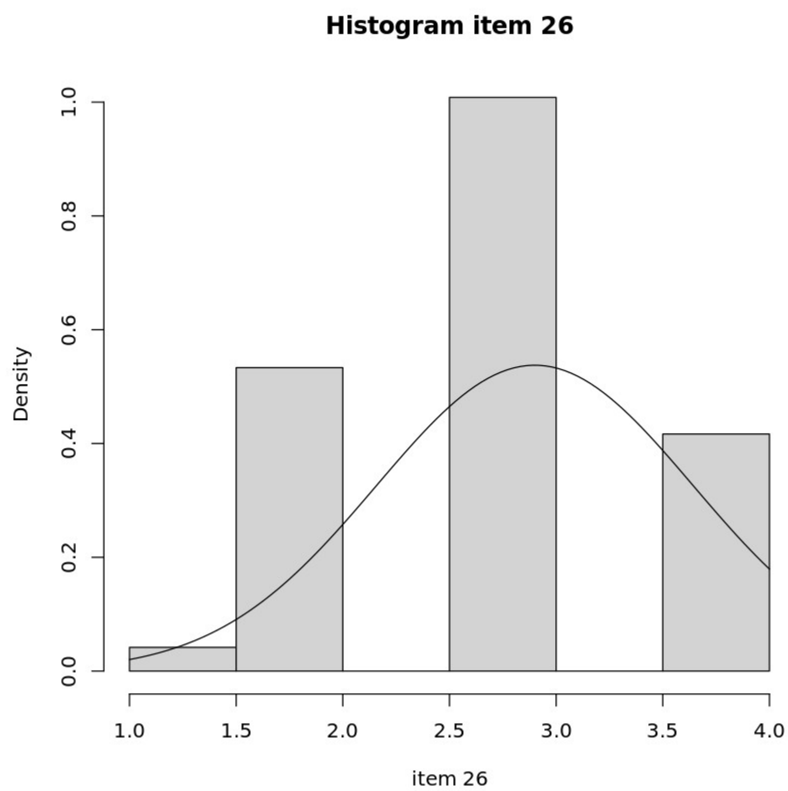

Histogram item 21
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 21

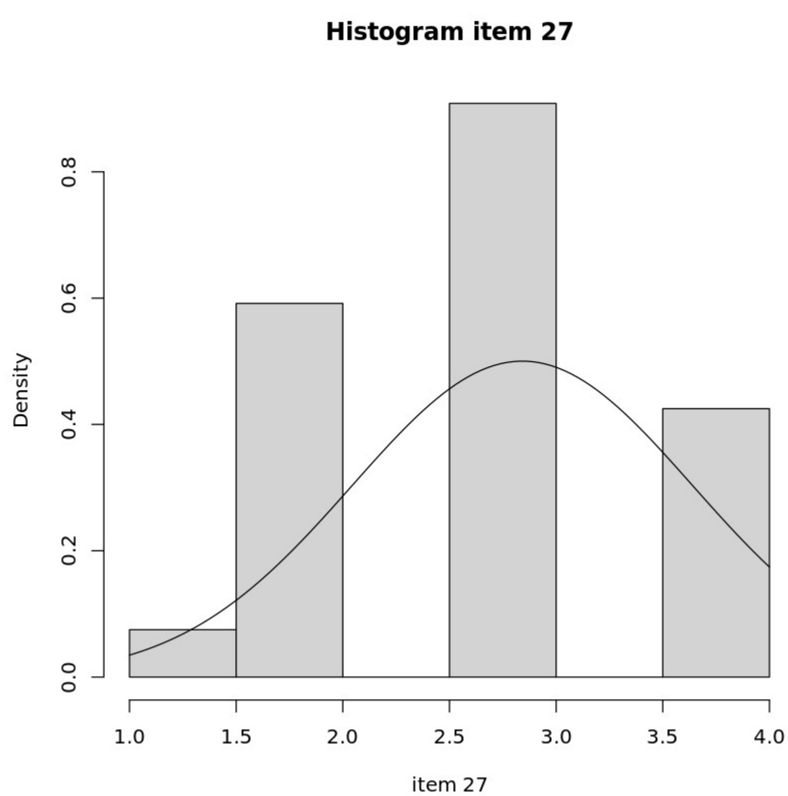

Histogram item 22
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 22

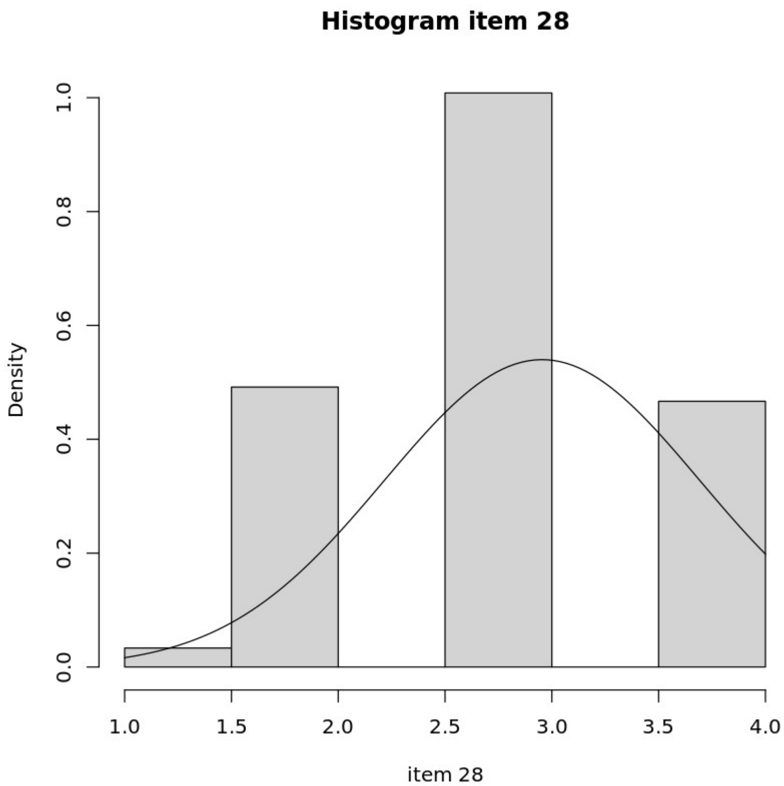

Histogram item 23
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 23


Histogram item 24
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 24

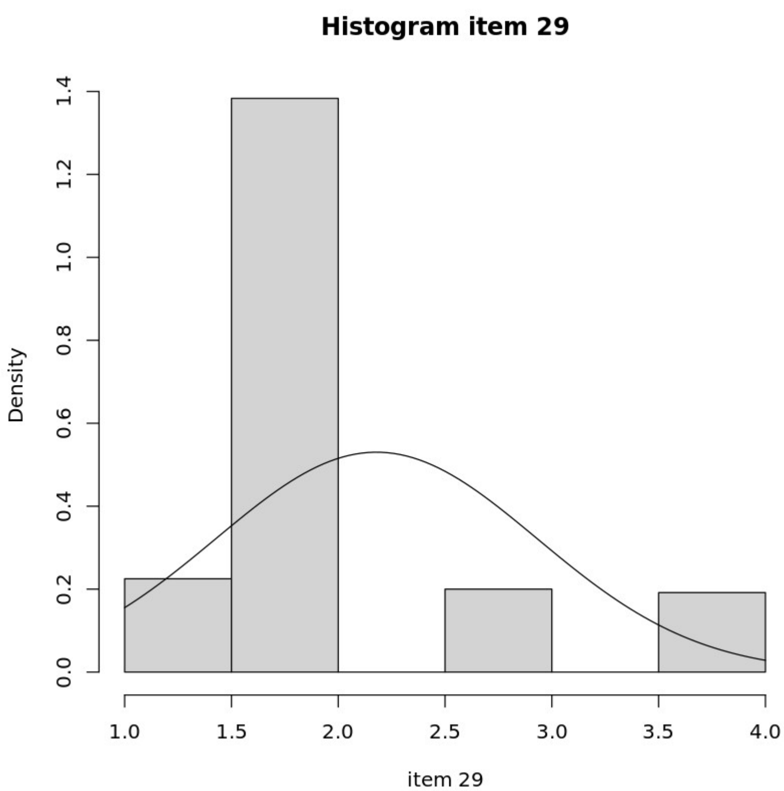

Histogram item 25
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 25


Histogram item 26
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 26

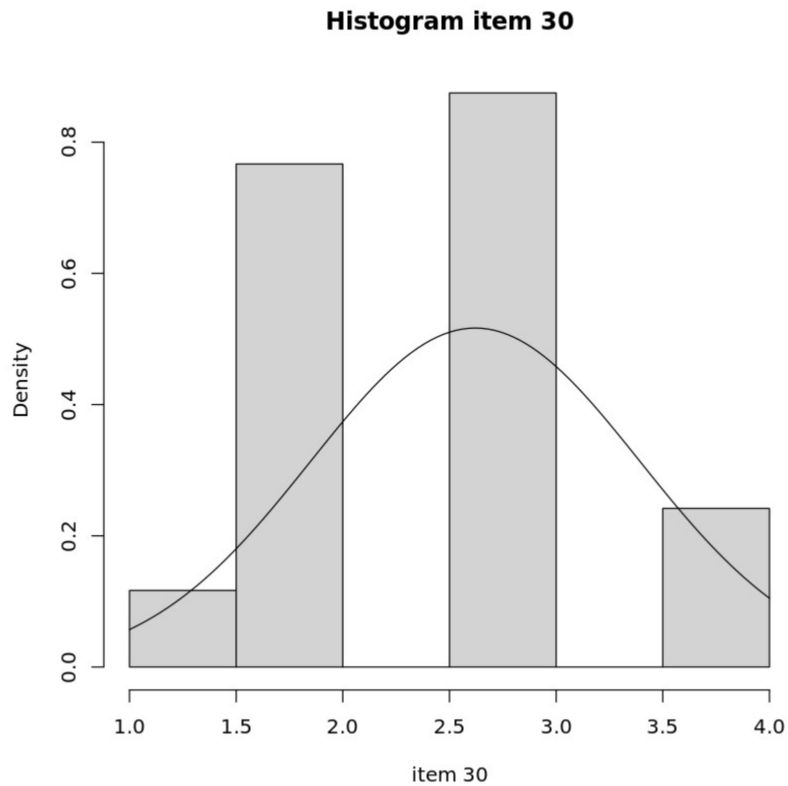

Histogram item 27
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 27

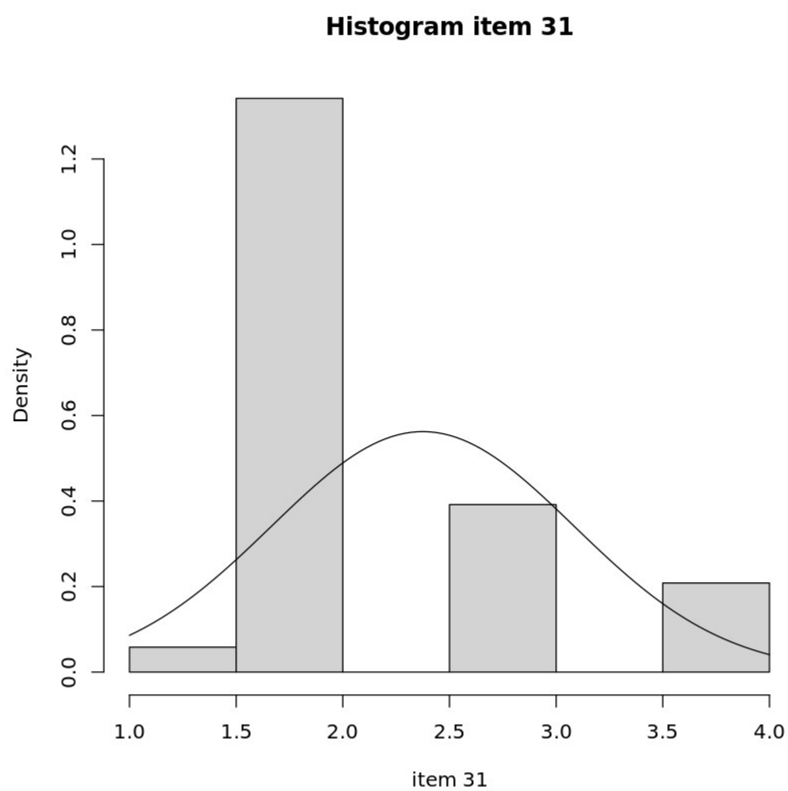


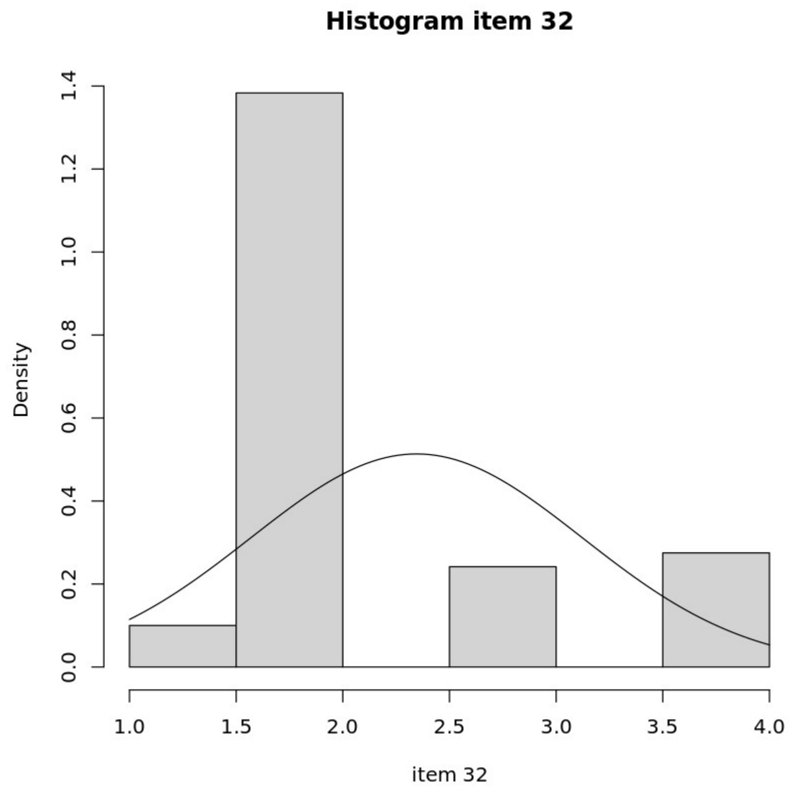
Histogram item 28
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 28

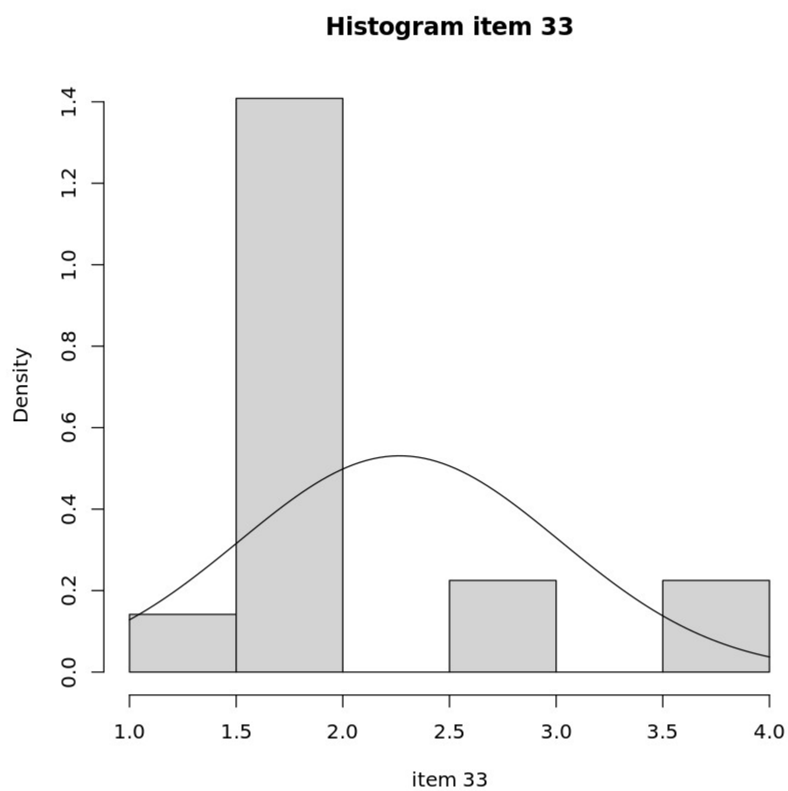


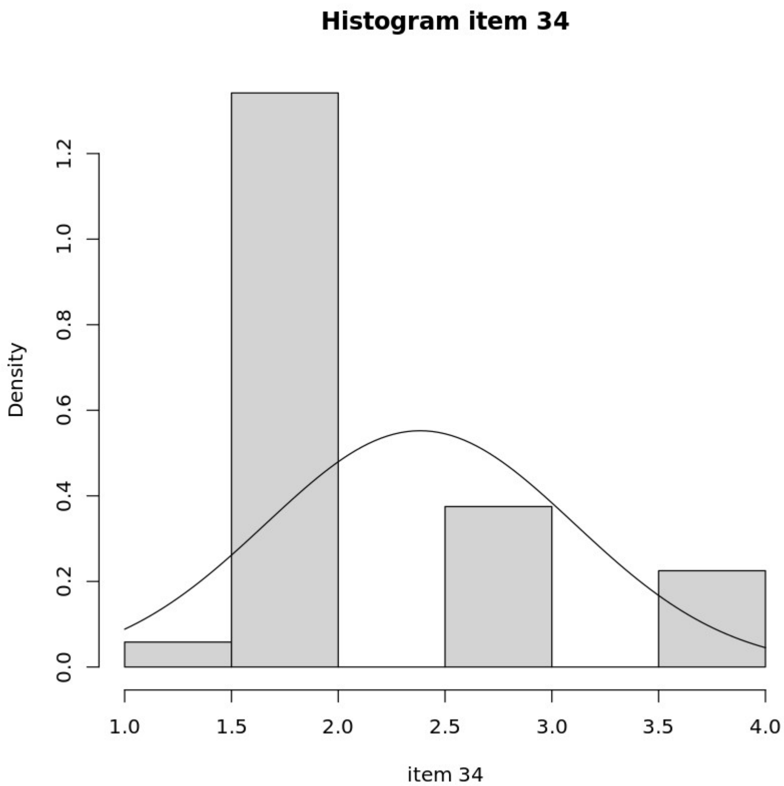
Histogram item 29
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 29


Histogram item 30
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 30

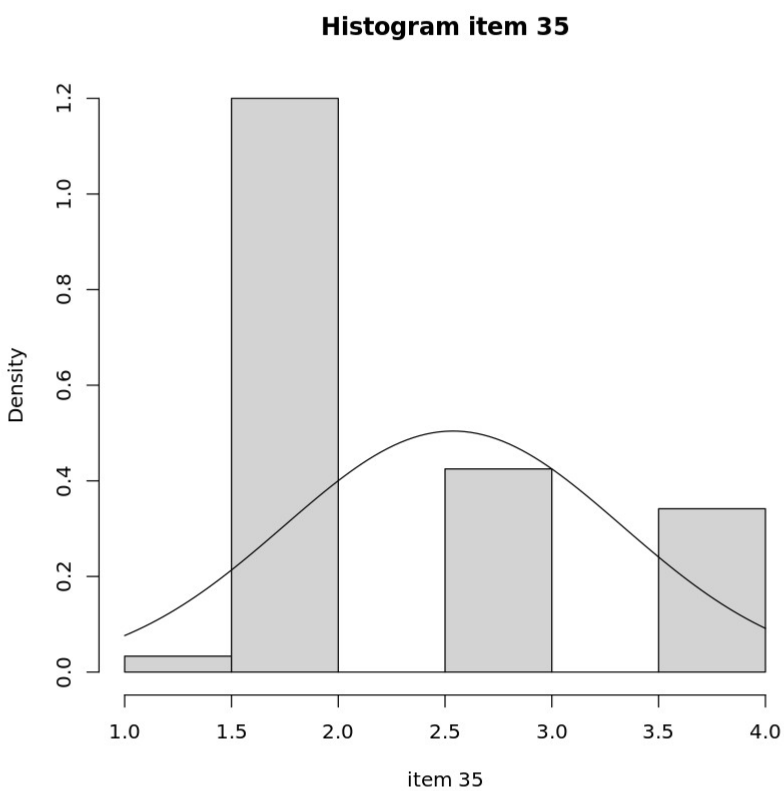

Histogram item 31
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 31


Histogram item 32
Density
item 32
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.0
1.5
2.0
2.5
3.0
3.5
4.0

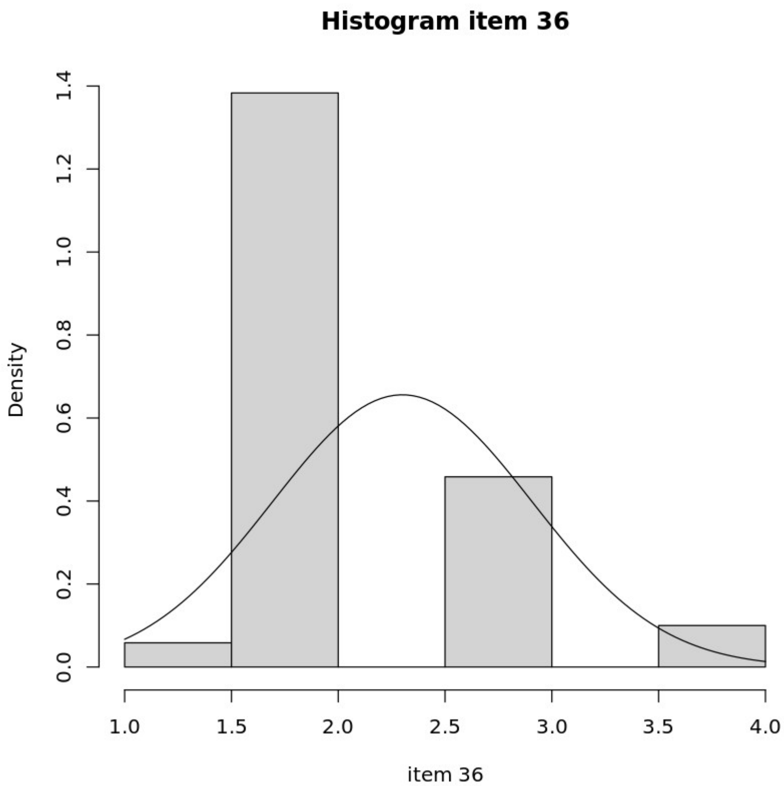

Histogram item 33
Density
item 33
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.0
1.5
2.0
2.5
3.0
3.5
4.0



Histogram item 34
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 34



Histogram item 35
Density
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.0
1.5
2.0
2.5
3.0
3.5
4.0
item 35



Ein erstes objektives Merkmal der Validität eines Tests ist die Trennschärfe der Items. Valide ist ein Test dann, wenn er auch tatsächlich die Variable misst, die er auch vorgibt zu messen. Unter der Trennschärfe eines Items versteht man die Korrelation des Items mit dem Gesamtergebnis der jeweils gemessenen Dimension eines Tests.

```
Fachkompetenz:
```

```
fachkompetenz <- read.csv2 ("https://paul-koop.org/SV.csv",
header=TRUE, dec=",");
fachkompetenz$ts <- rowSums(fachkompetenz[,-1])
round(cor(fachkompetenz[,-1]),2)
```

```
    X21  X22  X23  X24  X25  X26  X27  X28  ts
X21 1.00 0.61 0.47 0.49 0.48 0.39 0.46 0.42 0.75
X22 0.61 1.00 0.45 0.50 0.47 0.50 0.47 0.36 0.75
X23 0.47 0.45 1.00 0.42 0.56 0.42 0.44 0.41 0.72
X24 0.49 0.50 0.42 1.00 0.54 0.28 0.46 0.27 0.68
X25 0.48 0.47 0.56 0.54 1.00 0.45 0.43 0.40 0.75
X26 0.39 0.50 0.42 0.28 0.45 1.00 0.52 0.46 0.70
X27 0.46 0.47 0.44 0.46 0.43 0.52 1.00 0.56 0.76
```

```
X28 0.42 0.36 0.41 0.27 0.40 0.46 0.56 1.00 0.68
ts  0.75 0.75 0.72 0.68 0.75 0.70 0.76 0.68 1.00
```

Arbeitsverhalten:

```
arbeitsverhalten <- read.csv2 ("https://paul-koop.org/AV.csv",
header=TRUE, dec=",");
arbeitsverhalten$ts <- rowSums(arbeitsverhalten[,-1])
round(cor(arbeitsverhalten[,-1]),2)
```

```
    X1   X2   X3   X4   X5   X6   X7   X8   X9   X10  ts
X1  1.00 0.41 0.45 0.40 0.41 0.43 0.55 0.40 0.39 0.43 0.69
X2  0.41 1.00 0.44 0.56 0.36 0.35 0.35 0.49 0.51 0.35 0.69
X3  0.45 0.44 1.00 0.60 0.42 0.35 0.34 0.54 0.56 0.41 0.75
X4  0.40 0.56 0.60 1.00 0.43 0.31 0.36 0.61 0.46 0.49 0.76
X5  0.41 0.36 0.42 0.43 1.00 0.29 0.45 0.53 0.43 0.43 0.68
X6  0.43 0.35 0.35 0.31 0.29 1.00 0.64 0.27 0.31 0.26 0.59
X7  0.55 0.35 0.34 0.36 0.45 0.64 1.00 0.33 0.28 0.43 0.66
X8  0.40 0.49 0.54 0.61 0.53 0.27 0.33 1.00 0.55 0.52 0.76
X9  0.39 0.51 0.56 0.46 0.43 0.31 0.28 0.55 1.00 0.37 0.72
X10 0.43 0.35 0.41 0.49 0.43 0.26 0.43 0.52 0.37 1.00 0.67
ts  0.69 0.69 0.75 0.76 0.68 0.59 0.66 0.76 0.72 0.67 1.00
```

Sozialverhalten:

```
sozialverhalten <- read.csv2 ("https://paul-koop.org/SV.csv",
header=TRUE, dec=",");
sozialverhalten$ts <- rowSums(sozialverhalten[,-1])
round(cor(sozialverhalten[,-1]),2)
```

```
    X21  X22  X23  X24  X25  X26  X27  X28  ts
X21 1.00 0.61 0.47 0.49 0.48 0.39 0.46 0.42 0.75
X22 0.61 1.00 0.45 0.50 0.47 0.50 0.47 0.36 0.75
X23 0.47 0.45 1.00 0.42 0.56 0.42 0.44 0.41 0.72
X24 0.49 0.50 0.42 1.00 0.54 0.28 0.46 0.27 0.68
X25 0.48 0.47 0.56 0.54 1.00 0.45 0.43 0.40 0.75
X26 0.39 0.50 0.42 0.28 0.45 1.00 0.52 0.46 0.70
X27 0.46 0.47 0.44 0.46 0.43 0.52 1.00 0.56 0.76
X28 0.42 0.36 0.41 0.27 0.40 0.46 0.56 1.00 0.68
ts  0.75 0.75 0.72 0.68 0.75 0.70 0.76 0.68 1.00
```

Lernverhalten:

```
lernverhalten <- read.csv2 ("https://paul-koop.org/LV.csv",
header=TRUE, dec=",");
```

```
lernverhalten$ts <- rowSums(lernverhalten[,-1])
round(cor(lernverhalten[,-1]),2)
```

```
    X11  X12  X13  X14  X15  X16  X17  X18  X19  X20  ts
X11 1.00 0.54 0.52 0.47 0.55 0.47 0.53 0.50 0.46 0.46 0.77
X12 0.54 1.00 0.53 0.48 0.50 0.49 0.45 0.29 0.53 0.42 0.73
X13 0.52 0.53 1.00 0.35 0.51 0.45 0.48 0.44 0.48 0.46 0.74
X14 0.47 0.48 0.35 1.00 0.50 0.38 0.43 0.28 0.52 0.48 0.68
X15 0.55 0.50 0.51 0.50 1.00 0.39 0.34 0.34 0.44 0.44 0.71
X16 0.47 0.49 0.45 0.38 0.39 1.00 0.49 0.33 0.52 0.42 0.69
X17 0.53 0.45 0.48 0.43 0.34 0.49 1.00 0.45 0.48 0.42 0.71
X18 0.50 0.29 0.44 0.28 0.34 0.33 0.45 1.00 0.46 0.45 0.64
X19 0.46 0.53 0.48 0.52 0.44 0.52 0.48 0.46 1.00 0.55 0.76
X20 0.46 0.42 0.46 0.48 0.44 0.42 0.42 0.45 0.55 1.00 0.71
ts  0.77 0.73 0.74 0.68 0.71 0.69 0.71 0.64 0.76 0.71 1.00
```

Interkorrelation:

Einen weiteren ersten qualitativen Hinweis auf die Güte der Items bieten ihre Interkorrelationen innerhalb der Dimensionen, denen die Items zugeordnet sind. Denn wenn die Items eine gemeinsame Dimension messen, müssen sie positiv miteinander korreliert sein.

```
install.packages("psych", repos='http://cran.us.r-project.org')
library(psych)
options(max.print = 9999)
interkorrelation <- read.csv2 ("https://paul-koop.org/rohdaten.csv",
header=TRUE, dec=",");
round(cor(interkorrelation[,-1]),2)
```

```
Installing package into ‘/srv/rlibs’
(as ‘lib’ is unspecified)
```

```
    X1    X2   X3    X4   X5   X6   X7   X8   X9   X10  ⋯ X27   X28
X29  X30
X1   1.00 0.41  0.45 0.40 0.41 0.43 0.55 0.40 0.39 0.43 ⋯  0.28  0.22
0.12 0.32
X2   0.41 1.00  0.44 0.56 0.36 0.35 0.35 0.49 0.51 0.35 ⋯  0.18  0.33
0.12 0.36
X3   0.45 0.44  1.00 0.60 0.42 0.35 0.34 0.54 0.56 0.41 ⋯  0.24  0.30
0.08 0.43
X4   0.40 0.56  0.60 1.00 0.43 0.31 0.36 0.61 0.46 0.49 ⋯  0.30  0.31
0.06 0.43
X5   0.41 0.36  0.42 0.43 1.00 0.29 0.45 0.53 0.43 0.43 ⋯  0.08  0.10
0.12 0.27
X6   0.43 0.35  0.35 0.31 0.29 1.00 0.64 0.27 0.31 0.26 ⋯  0.32  0.21
```

```
0.31 0.29
X7   0.55 0.35  0.34 0.36 0.45 0.64 1.00 0.33 0.28 0.43 ⋯  0.21  0.18
0.30 0.31
X8   0.40 0.49  0.54 0.61 0.53 0.27 0.33 1.00 0.55 0.52 ⋯  0.21  0.18
0.06 0.44
X9   0.39 0.51  0.56 0.46 0.43 0.31 0.28 0.55 1.00 0.37 ⋯  0.20  0.30
0.15 0.38
X10  0.43 0.35  0.41 0.49 0.43 0.26 0.43 0.52 0.37 1.00 ⋯  0.30  0.27
0.08 0.36
X11  0.44 0.56  0.48 0.49 0.41 0.33 0.34 0.52 0.48 0.49 ⋯  0.27  0.23
0.04 0.42
X12  0.47 0.49  0.43 0.38 0.45 0.34 0.43 0.45 0.54 0.36 ⋯  0.26  0.36
0.08 0.25
X13  0.55 0.42  0.44 0.38 0.49 0.42 0.43 0.42 0.48 0.49 ⋯  0.29  0.37
0.09 0.34
X14  0.33 0.39  0.45 0.51 0.37 0.33 0.36 0.46 0.37 0.45 ⋯  0.38  0.32
0.13 0.37
X15  0.48 0.44  0.54 0.49 0.44 0.38 0.36 0.52 0.40 0.46 ⋯  0.27  0.28
0.07 0.27
X16  0.46 0.44  0.44 0.53 0.38 0.38 0.44 0.38 0.42 0.38 ⋯  0.24  0.31
0.06 0.31
X17  0.41 0.54  0.42 0.46 0.43 0.39 0.41 0.47 0.53 0.47 ⋯  0.23  0.30
0.15 0.44
X18  0.30 0.39  0.32 0.39 0.33 0.32 0.36 0.41 0.46 0.50 ⋯  0.29  0.25
0.13 0.44
X19  0.44 0.49  0.45 0.54 0.46 0.41 0.50 0.47 0.48 0.45 ⋯  0.33  0.35
0.15 0.39
X20  0.37 0.40  0.41 0.43 0.43 0.42 0.48 0.46 0.37 0.48 ⋯  0.33  0.21
0.19 0.42
X21  0.43 0.37  0.37 0.38 0.29 0.34 0.43 0.29 0.24 0.24 ⋯  0.46  0.42
0.27 0.34
X22  0.30 0.29  0.30 0.34 0.18 0.37 0.37 0.27 0.19 0.24 ⋯  0.47  0.36
0.19 0.33
X23  0.21 0.26  0.30 0.38 0.26 0.25 0.26 0.36 0.27 0.29 ⋯  0.44  0.41
0.14 0.34
X24  0.41 0.21  0.22 0.25 0.22 0.40 0.40 0.30 0.21 0.19 ⋯  0.46  0.27
0.20 0.25
X25  0.40 0.27  0.32 0.32 0.23 0.32 0.33 0.31 0.18 0.31 ⋯  0.43  0.40
0.11 0.38
X26  0.31 0.25  0.30 0.39 0.07 0.15 0.15 0.23 0.19 0.29 ⋯  0.52  0.46
0.09 0.31
X27  0.28 0.18  0.24 0.30 0.08 0.32 0.21 0.21 0.20 0.30 ⋯  1.00  0.56
0.19 0.24
X28  0.22 0.33  0.30 0.31 0.10 0.21 0.18 0.18 0.30 0.27 ⋯  0.56  1.00
0.07 0.28
X29  0.12 0.12  0.08 0.06 0.12 0.31 0.30 0.06 0.15 0.08 ⋯  0.19  0.07
1.00 0.28
X30  0.32 0.36  0.43 0.43 0.27 0.29 0.31 0.44 0.38 0.36 ⋯  0.24  0.28
0.28 1.00
X31  0.02 0.15 -0.07 0.03 0.13 0.06 0.16 0.06 0.06 0.11 ⋯ -0.13 -0.07
```

```
0.12 0.17
X32  0.10 0.06  0.14 0.23 0.10 0.22 0.24 0.11 0.08 0.20 ⋯  0.11  0.07
0.12 0.28
X33  0.00 0.07  0.10 0.10 0.02 0.14 0.20 0.05 0.08 0.25 ⋯  0.01  0.01
0.20 0.27
X34  0.07 0.05  0.18 0.11 0.16 0.31 0.31 0.13 0.08 0.18 ⋯  0.09  0.03
0.33 0.35
X35 -0.01 0.11  0.12 0.11 0.25 0.08 0.27 0.15 0.00 0.15 ⋯ -0.18 -0.09
0.08 0.27
X36  0.19 0.09  0.11 0.21 0.16 0.22 0.30 0.21 0.00 0.22 ⋯  0.05 -0.05
0.12 0.28
    X31   X32  X33   X34   X35   X36
X1   0.02 0.10  0.00  0.07 -0.01  0.19
X2   0.15 0.06  0.07  0.05  0.11  0.09
X3  -0.07 0.14  0.10  0.18  0.12  0.11
X4   0.03 0.23  0.10  0.11  0.11  0.21
X5   0.13 0.10  0.02  0.16  0.25  0.16
X6   0.06 0.22  0.14  0.31  0.08  0.22
X7   0.16 0.24  0.20  0.31  0.27  0.30
X8   0.06 0.11  0.05  0.13  0.15  0.21
X9   0.06 0.08  0.08  0.08  0.00  0.00
X10  0.11 0.20  0.25  0.18  0.15  0.22
X11  0.08 0.06  0.05  0.16  0.00  0.17
X12  0.10 0.15 -0.13  0.14  0.09  0.08
X13 -0.02 0.09  0.01  0.11  0.01  0.09
X14  0.03 0.16  0.08  0.27  0.18  0.19
X15  0.03 0.05 -0.05  0.20  0.10  0.19
X16 -0.08 0.23 -0.07 -0.01  0.01  0.01
X17  0.10 0.15  0.12  0.12  0.07  0.18
X18  0.23 0.12  0.22  0.18  0.09  0.25
X19 -0.03 0.22  0.02  0.13  0.05  0.11
X20  0.07 0.21  0.19  0.30  0.23  0.23
X21  0.01 0.04  0.10  0.25  0.09  0.15
X22  0.04 0.20  0.03  0.30  0.16  0.14
X23 -0.12 0.06  0.08  0.10 -0.06  0.08
X24 -0.16 0.11  0.08  0.13 -0.06  0.08
X25 -0.03 0.14  0.14  0.16  0.08  0.15
X26  0.04 0.17  0.00  0.15 -0.04  0.11
X27 -0.13 0.11  0.01  0.09 -0.18  0.05
X28 -0.07 0.07  0.01  0.03 -0.09 -0.05
X29  0.12 0.12  0.20  0.33  0.08  0.12
X30  0.17 0.28  0.27  0.35  0.27  0.28
X31  1.00 0.26  0.24  0.26  0.47  0.36
X32  0.26 1.00  0.14  0.37  0.46  0.37
X33  0.24 0.14  1.00  0.44  0.31  0.30
X34  0.26 0.37  0.44  1.00  0.49  0.49
X35  0.47 0.46  0.31  0.49  1.00  0.42
X36  0.36 0.37  0.30  0.49  0.42  1.00
```

Cronbachs Alpha:

Ein Test muss eine Variable aber auch möglichst genau messen. Ein Maß für die Genauigkeit der Messung ist die Reliabilität. Wenn es nicht möglich ist, an derselben Testgruppe einen Wiederholungstest zu machen oder die Testergebnisse mit anderen bereits als valide und reliabel eingestuften Tests zu korrelieren, wird häufig der Split-Half Test und die Konsistenzanalyse nach Cronbach durchgeführt. Bei der Split-Half Analyse wird der Test über alle Dimensionen in zwei Hälften aufgeteilt und diese beiden Hälften werden miteinander korreliert.

```
install.packages("psych", repos='http://cran.us.r-project.org')
library(psych)
cronalpha <- read.csv2 ("https://paul-koop.org/rohdaten.csv",
header=TRUE, dec=",");
alpha(cronalpha[,-1])#paket psych

cronalpha <- cronalpha[,-1]

erste_haelfte <- cronalpha[,1:18]
zweite_haelfte <- cronalpha[,19:36]

cor(rowSums(erste_haelfte),rowSums(zweite_haelfte))
```

```
Installing package into '/srv/rlibs'
(as 'lib' is unspecified)



Reliability analysis
Call: alpha(x = cronalpha[, -1])

  raw_alpha std.alpha G6(smc) average_r S/N    ase mean   sd median_r
      0.94      0.94    0.96      0.29  15 0.0057  2.8 0.43     0.31

    95% confidence boundaries
         lower alpha upper
Feldt     0.92  0.94  0.95
Duhachek  0.93  0.94  0.95

 Reliability if an item is dropped:
    raw_alpha std.alpha G6(smc) average_r S/N alpha se var.r med.r
X1       0.93      0.93    0.96      0.29  14   0.0059 0.025  0.30
X2       0.93      0.93    0.96      0.29  14   0.0060 0.025  0.30
X3       0.93      0.93    0.96      0.29  14   0.0060 0.025  0.30
X4       0.93      0.93    0.96      0.28  14   0.0060 0.025  0.30
X5       0.93      0.93    0.96      0.29  14   0.0059 0.026  0.31
X6       0.93      0.93    0.96      0.29  14   0.0059 0.026  0.30
X7       0.93      0.93    0.96      0.29  14   0.0060 0.026  0.30
X8       0.93      0.93    0.96      0.29  14   0.0060 0.025  0.31
X9       0.93      0.93    0.96      0.29  14   0.0059 0.025  0.31
```

X10	0.93	0.93	0.96	0.29	14	0.0060	0.026	0.31
X11	0.93	0.93	0.96	0.28	14	0.0060	0.025	0.30
X12	0.93	0.93	0.96	0.29	14	0.0060	0.025	0.31
X13	0.93	0.93	0.96	0.29	14	0.0060	0.025	0.30
X14	0.93	0.93	0.96	0.29	14	0.0060	0.026	0.30
X15	0.93	0.93	0.96	0.29	14	0.0060	0.025	0.30
X16	0.93	0.93	0.96	0.29	14	0.0059	0.025	0.30
X17	0.93	0.93	0.96	0.29	14	0.0060	0.026	0.30
X18	0.93	0.93	0.96	0.29	14	0.0059	0.026	0.31
X19	0.93	0.93	0.96	0.28	14	0.0060	0.025	0.30
X20	0.93	0.93	0.96	0.28	14	0.0060	0.026	0.30
X21	0.93	0.93	0.96	0.29	14	0.0059	0.026	0.30
X22	0.93	0.93	0.96	0.29	14	0.0059	0.026	0.31
X23	0.93	0.93	0.96	0.29	14	0.0059	0.026	0.31
X24	0.94	0.93	0.96	0.29	14	0.0059	0.026	0.31
X25	0.93	0.93	0.96	0.29	14	0.0059	0.026	0.30
X26	0.94	0.93	0.96	0.29	14	0.0058	0.026	0.31
X27	0.94	0.93	0.96	0.29	14	0.0058	0.025	0.31
X28	0.94	0.94	0.96	0.29	14	0.0058	0.025	0.31
X29	0.94	0.94	0.96	0.30	15	0.0057	0.025	0.32
X30	0.93	0.93	0.96	0.29	14	0.0059	0.026	0.30
X31	0.94	0.94	0.96	0.30	15	0.0056	0.023	0.32
X32	0.94	0.94	0.96	0.30	15	0.0057	0.025	0.32
X33	0.94	0.94	0.96	0.30	15	0.0056	0.024	0.32
X34	0.94	0.94	0.96	0.29	15	0.0057	0.025	0.31
X35	0.94	0.94	0.96	0.30	15	0.0056	0.024	0.32
X36	0.94	0.94	0.96	0.30	15	0.0057	0.025	0.32

Item statistics

	n	raw.r	std.r	r.cor	r.drop	mean	sd
X1	240	0.62	0.63	0.62	0.60	3.2	0.72
X2	240	0.64	0.63	0.62	0.60	2.9	0.77
X3	240	0.66	0.65	0.64	0.63	2.7	0.85
X4	240	0.70	0.69	0.69	0.67	2.8	0.89
X5	240	0.59	0.58	0.57	0.55	3.0	0.80
X6	240	0.59	0.60	0.59	0.56	3.1	0.74
X7	240	0.65	0.66	0.66	0.63	3.3	0.67
X8	240	0.66	0.66	0.65	0.64	2.7	0.76
X9	240	0.61	0.60	0.59	0.57	2.6	0.95
X10	240	0.65	0.64	0.64	0.62	2.7	0.75
X11	240	0.69	0.68	0.68	0.66	2.8	0.83
X12	240	0.64	0.64	0.63	0.61	2.9	0.76
X13	240	0.66	0.65	0.64	0.62	2.8	0.83
X14	240	0.67	0.67	0.66	0.64	2.9	0.76
X15	240	0.65	0.64	0.63	0.61	2.8	0.87
X16	240	0.62	0.61	0.60	0.58	3.0	0.80
X17	240	0.66	0.66	0.65	0.63	2.7	0.74
X18	240	0.61	0.61	0.60	0.58	2.7	0.79
X19	240	0.71	0.71	0.70	0.68	3.0	0.79
X20	240	0.70	0.70	0.69	0.67	2.9	0.74

X21	240	0.61	0.62	0.61	0.58	3.3	0.75
X22	240	0.60	0.61	0.60	0.57	3.3	0.69
X23	240	0.54	0.55	0.53	0.51	3.0	0.75
X24	240	0.52	0.53	0.51	0.48	3.3	0.68
X25	240	0.59	0.59	0.58	0.55	3.1	0.70
X26	240	0.51	0.51	0.50	0.47	2.9	0.74
X27	240	0.49	0.49	0.48	0.45	2.8	0.80
X28	240	0.48	0.48	0.46	0.44	3.0	0.74
X29	240	0.29	0.30	0.27	0.25	2.2	0.75
X30	240	0.63	0.63	0.62	0.60	2.6	0.77
X31	240	0.18	0.18	0.16	0.13	2.4	0.71
X32	240	0.33	0.34	0.32	0.29	2.3	0.78
X33	240	0.23	0.24	0.22	0.19	2.3	0.75
X34	240	0.40	0.41	0.39	0.35	2.4	0.72
X35	240	0.27	0.27	0.26	0.22	2.5	0.79
X36	240	0.35	0.36	0.34	0.31	2.3	0.61

Non missing response frequency for each item

	1	2	3	4	miss
X1	0.00	0.19	0.46	0.35	0
X2	0.02	0.32	0.45	0.22	0
X3	0.05	0.37	0.37	0.20	0
X4	0.06	0.34	0.35	0.25	0
X5	0.02	0.29	0.40	0.29	0
X6	0.01	0.19	0.46	0.34	0
X7	0.00	0.12	0.48	0.40	0
X8	0.03	0.38	0.43	0.15	0
X9	0.12	0.38	0.30	0.21	0
X10	0.03	0.35	0.46	0.16	0
X11	0.04	0.38	0.38	0.21	0
X12	0.02	0.29	0.48	0.21	0
X13	0.04	0.34	0.39	0.23	0
X14	0.03	0.27	0.50	0.20	0
X15	0.06	0.34	0.38	0.23	0
X16	0.03	0.25	0.44	0.29	0
X17	0.02	0.39	0.44	0.16	0
X18	0.05	0.36	0.44	0.16	0
X19	0.03	0.25	0.45	0.27	0
X20	0.01	0.30	0.47	0.22	0
X21	0.01	0.15	0.39	0.45	0
X22	0.01	0.11	0.46	0.42	0
X23	0.01	0.22	0.47	0.30	0
X24	0.00	0.11	0.45	0.43	0
X25	0.00	0.19	0.51	0.30	0
X26	0.02	0.27	0.50	0.21	0
X27	0.04	0.30	0.45	0.21	0
X28	0.02	0.25	0.50	0.23	0
X29	0.11	0.69	0.10	0.10	0
X30	0.06	0.38	0.44	0.12	0
X31	0.03	0.67	0.20	0.10	0

```
X32 0.05 0.69 0.12 0.14    0
X33 0.07 0.70 0.11 0.11    0
X34 0.03 0.67 0.19 0.11    0
X35 0.02 0.60 0.21 0.17    0
X36 0.03 0.69 0.23 0.05    0
```

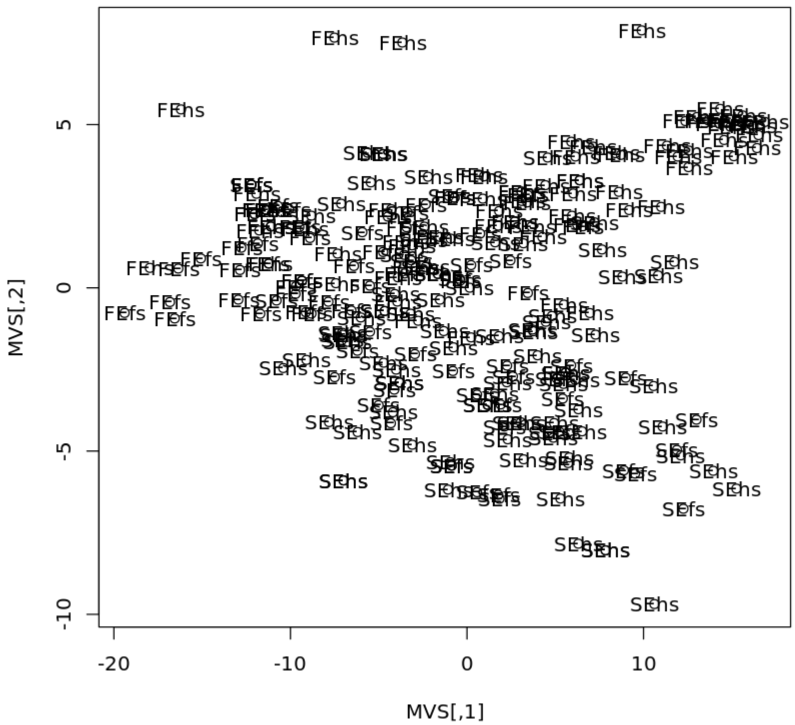
```
[1] 0.674236
```

Hauptkomponentenanalyse PCA

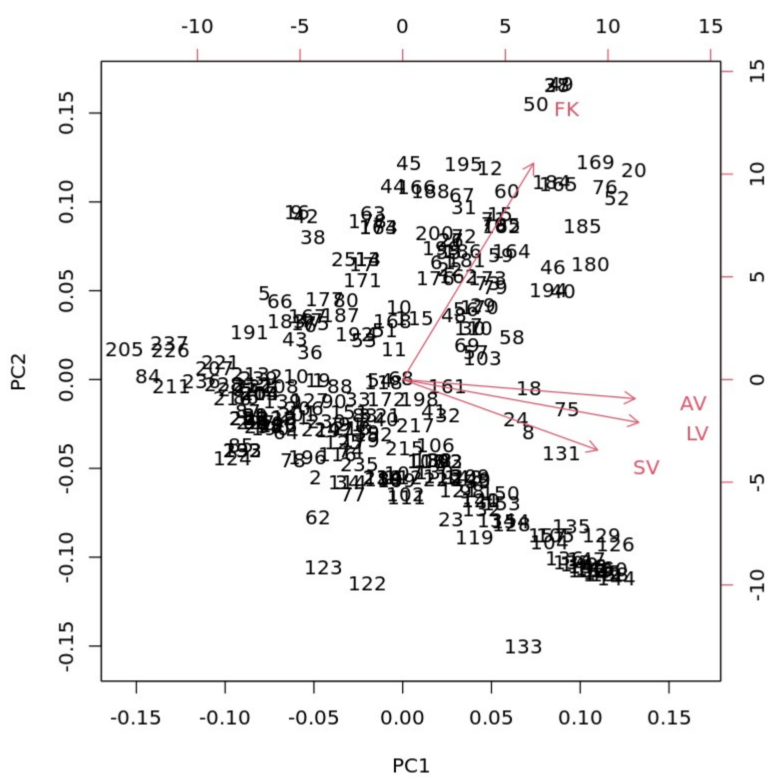
Die Hauptkomponentenanalyse (abgekürzt: PCA) ist eine Methode der multivariaten Statistik und strukturiert Datensätze durch Approximation einer großen Anzahl statistischer Variablen mit einer kleineren Anzahl korrelierter linearer Hauptkomponenten.

```
install.packages("stats", repos='http://cran.us.r-project.org')
library(psych)
tabellePCAMVS <- read.csv2 ("https://paul-koop.org/PCAMVS.csv",
header=TRUE, dec=",");
PCAbeobachtung <- tabellePCAMVS;

PCAMVSnr  <- PCAbeobachtung[,1]; PCAbeobachtung <- PCAbeobachtung[,-
1];
PCAMVSart <- PCAbeobachtung[,1];PCAbeobachtung <- PCAbeobachtung[,-1];


MVS <-cmdscale(dist(PCAbeobachtung));
plot (MVS, type = "p", col = 1);
text(MVS[,1],
     MVS[,2],
     PCAMVSart,
     col=1)

PCA<-prcomp(scale(PCAbeobachtung))
biplot(PCA,choices=c(1,2))
```

```
Installing package into ‘/srv/rlibs’
(as ‘lib’ is unspecified)

Warning message:
“package ‘stats’ is a base package, and should not be updated”
```



MVS[,2]
MVS[,1]
-20
-10
0
10
5
0
-5
-10



PC1
PC2
FK
AV
LV
SV
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
-10
-5
0
5
10
15

Faktorenanalyse:

Mithilfe der Faktorenanalyse wird überprüft, ob sich die Items in mehrere Subskalen unterteilen lassen.

```
install.packages("psych", repos='http://cran.us.r-project.org')
library(psych)
rohdaten <- read.csv2 ("http://paul-koop.org/rohdaten.csv",
header=TRUE, dec=",");
rohdaten <- rohdaten[,-1]
KMO(rohdaten)
scree(rohdaten)
print(factanal(rohdaten, factors=4, rotation="varimax",
scores="Bartlett"), digits=2, cutoff=.3)
print(factanal(rohdaten, factors=6, rotation="varimax",
scores="Bartlett"), digits=2, cutoff=.3)
```

```
Installing package into ‘/srv/rlibs’
(as ‘lib’ is unspecified)


Kaiser-Meyer-Olkin factor adequacy
Call: KMO(r = rohdaten)
Overall MSA =  0.9
MSA for each item =
  X1   X2   X3   X4   X5   X6   X7   X8   X9  X10  X11  X12  X13  X14
X15  X16
0.91 0.92 0.94 0.93 0.93 0.88 0.89 0.93 0.91 0.91 0.92 0.91 0.95 0.95
0.94 0.94
 X17  X18  X19  X20  X21  X22  X23  X24  X25  X26  X27  X28  X29  X30
X31  X32
0.96 0.90 0.94 0.95 0.90 0.90 0.92 0.87 0.90 0.85 0.89 0.85 0.76 0.93
0.68 0.70
 X33  X34  X35  X36
0.68 0.82 0.68 0.85


Call:
factanal(x = rohdaten, factors = 4, scores = "Bartlett", rotation =
"varimax")

Uniquenesses:
  X1   X2   X3   X4   X5   X6   X7   X8   X9  X10  X11  X12  X13  X14
X15  X16
0.50 0.53 0.51 0.45 0.53 0.48 0.24 0.44 0.48 0.56 0.45 0.52 0.50 0.53
0.55 0.53
 X17  X18  X19  X20  X21  X22  X23  X24  X25  X26  X27  X28  X29  X30
```

```
X31  X32
0.52 0.63 0.46 0.52 0.49 0.45 0.56 0.51 0.52 0.48 0.45 0.59 0.83 0.57
0.69 0.73
 X33  X34  X35  X36
0.75 0.46 0.42 0.60

Loadings:
    Factor1 Factor2 Factor3 Factor4
X1   0.53                   0.43
X2   0.66
X3   0.66
X4   0.67
X5   0.62
X6   0.33                   0.58
X7   0.40                   0.70
X8   0.72
X9   0.71
X10  0.60
X11  0.69
X12  0.63
X13  0.62
X14  0.51    0.40
X15  0.62
X16  0.57
X17  0.65
X18  0.53
X19  0.61    0.30
X20  0.51
X21          0.58           0.31
X22          0.65
X23          0.59
X24          0.52           0.43
X25          0.60
X26          0.67
X27          0.71
X28          0.57
X29
X30  0.44    0.30    0.38
X31                  0.53
X32                  0.49
X33                  0.50
X34                  0.70
X35                  0.75
X36                  0.62

               Factor1 Factor2 Factor3 Factor4
SS loadings       7.88    4.19    2.89    2.01
Proportion Var    0.22    0.12    0.08    0.06
Cumulative Var    0.22    0.34    0.42    0.47
```

```
Test of the hypothesis that 4 factors are sufficient.
The chi square statistic is 1022.46 on 492 degrees of freedom.
The p-value is 2.15e-39

Call:
factanal(x = rohdaten, factors = 6, scores = "Bartlett", rotation =
"varimax")

Uniquenesses:
  X1   X2   X3   X4   X5   X6   X7   X8   X9  X10  X11  X12  X13  X14
X15  X16
0.50 0.52 0.47 0.39 0.51 0.47 0.26 0.37 0.46 0.52 0.44 0.31 0.47 0.48
0.51 0.53
 X17  X18  X19  X20  X21  X22  X23  X24  X25  X26  X27  X28  X29  X30
X31  X32
0.49 0.41 0.46 0.51 0.47 0.37 0.53 0.48 0.51 0.46 0.43 0.55 0.81 0.53
0.53 0.72
 X33  X34  X35  X36
0.59 0.49 0.30 0.61

Loadings:
    Factor1 Factor2 Factor3 Factor4 Factor5 Factor6
X1   0.53                    0.42
X2   0.65
X3   0.66
X4   0.68
X5   0.63
X6   0.33                    0.60
X7   0.40                    0.69
X8   0.74
X9   0.71
X10  0.59
X11  0.68
X12  0.65                           -0.34
X13  0.61
X14  0.52    0.42
X15  0.62
X16  0.58
X17  0.63
X18  0.51                            0.45
X19  0.61    0.30
X20  0.51
X21          0.57            0.32
X22          0.67
X23          0.57
X24          0.49            0.46
X25          0.58
X26          0.69
X27          0.71
X28          0.58
```

```
X29                          0.32
X30  0.42            0.35
X31                  0.57                        0.34
X32                  0.50
X33                  0.45            0.44
X34                  0.67
X35                  0.81
X36                  0.58

               Factor1 Factor2 Factor3 Factor4 Factor5 Factor6
SS loadings       7.83    4.17    2.87    2.14    0.91    0.60
Proportion Var    0.22    0.12    0.08    0.06    0.03    0.02
Cumulative Var    0.22    0.33    0.41    0.47    0.50    0.51

Test of the hypothesis that 6 factors are sufficient.
The chi square statistic is 810.71 on 429 degrees of freedom.
The p-value is 7.64e-26
```