

Survey Analysis

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This document performs an exploratory factor analysis based on the initial survey data collected by Antonin Fusco at Carnegie Mellon University.

Summary Statistics

Below are summary statistics of the Survey dataset.

```
summary(Survey)
```

```
##      over      notseri      failbad      kidfun      ilearn
## Min.   :1.000   Min.   :1.000   Min.   :1.00   Min.   :1.000   Min.   :1.000
## 1st Qu.:4.000   1st Qu.:5.000   1st Qu.:6.00   1st Qu.:1.000   1st Qu.:4.000
## Median :5.000   Median :6.000   Median :7.00   Median :1.000   Median :4.000
## Mean   :4.924   Mean   :5.467   Mean   :6.19   Mean   :1.438   Mean   :4.438
## 3rd Qu.:6.000   3rd Qu.:6.000   3rd Qu.:7.00   3rd Qu.:2.000   3rd Qu.:6.000
## Max.   :7.000   Max.   :7.000   Max.   :7.00   Max.   :7.000   Max.   :7.000
##      welearn      likeme      relax      watch      follow
## Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
## 1st Qu.:6.000   1st Qu.:2.000   1st Qu.:5.000   1st Qu.:4.000   1st Qu.:2.000
## Median :7.000   Median :3.000   Median :6.000   Median :5.000   Median :3.000
## Mean   :6.314   Mean   :3.095   Mean   :5.457   Mean   :4.733   Mean   :3.076
## 3rd Qu.:7.000   3rd Qu.:4.000   3rd Qu.:6.000   3rd Qu.:6.000   3rd Qu.:4.000
## Max.   :7.000   Max.   :7.000   Max.   :7.000   Max.   :7.000   Max.   :7.000
##      nogoal      noplay      dream      perf      seri
## Min.   :1.00   Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
## 1st Qu.:5.00   1st Qu.:3.000   1st Qu.:4.000   1st Qu.:2.000   1st Qu.:3.000
## Median :6.00   Median :5.000   Median :5.000   Median :3.000   Median :5.000
## Mean   :5.41   Mean   :4.724   Mean   :5.162   Mean   :3.876   Mean   :4.533
## 3rd Qu.:6.00   3rd Qu.:6.000   3rd Qu.:6.000   3rd Qu.:5.000   3rd Qu.:6.000
## Max.   :7.00   Max.   :7.000   Max.   :7.000   Max.   :8.000   Max.   :8.000
##      failgood      kidlearn      break.      forkids      qualtime
## Min.   :0.000   Min.   :0.000   Min.   :1.000   Min.   :1.000   Min.   :0.000
## 1st Qu.:5.000   1st Qu.:5.000   1st Qu.:3.000   1st Qu.:2.000   1st Qu.:6.000
## Median :6.000   Median :6.000   Median :5.000   Median :3.000   Median :6.000
## Mean   :5.838   Mean   :5.771   Mean   :4.429   Mean   :3.057   Mean   :6.124
## 3rd Qu.:7.000   3rd Qu.:7.000   3rd Qu.:6.000   3rd Qu.:4.000   3rd Qu.:7.000
## Max.   :7.000   Max.   :7.000   Max.   :8.000   Max.   :8.000   Max.   :7.000
##      norelax      handson      try      steps      play
## Min.   :1.000   Min.   :0.000   Min.   :0.000   Min.   :1.000   Min.   :0.0
## 1st Qu.:3.000   1st Qu.:5.000   1st Qu.:4.000   1st Qu.:2.000   1st Qu.:5.0
## Median :5.000   Median :6.000   Median :5.000   Median :3.000   Median :6.0
## Mean   :4.419   Mean   :5.429   Mean   :5.048   Mean   :2.962   Mean   :5.6
## 3rd Qu.:6.000   3rd Qu.:6.000   3rd Qu.:6.000   3rd Qu.:4.000   3rd Qu.:7.0
## Max.   :8.000   Max.   :7.000   Max.   :7.000   Max.   :8.000   Max.   :7.0
##      prac
## Min.   :1.000
## 1st Qu.:2.000
## Median :3.000
## Mean   :2.876
```

```
## 3rd Qu.:3.000
## Max. :8.000
```

Correlation between items

Below the correlation matrix for all items is displayed.

```
round(cor(Survey), 2)
```

```
##          over notseri failbad kidfun ilearn welearn likeme relax watch follow nogoyal
## over      1.00    0.18    0.10   -0.26    0.35    0.31   -0.14    0.39    0.00   -0.05    0.16
## notseri    0.18    1.00    0.04   -0.07    0.26    0.21   -0.26    0.24    0.04   -0.06    0.30
## failbad    0.10    0.04    1.00   -0.15   -0.17    0.05    0.08   -0.07    0.03    0.10   -0.14
## kidfun    -0.26   -0.07   -0.15    1.00    0.01   -0.30    0.10   -0.20    0.12    0.31   -0.08
## ilearn     0.35    0.26   -0.17    0.01    1.00    0.40   -0.45    0.31    0.12   -0.01    0.32
## welearn    0.31    0.21    0.05   -0.30    0.40    1.00   -0.24    0.31    0.05   -0.04    0.27
## likeme    -0.14   -0.26    0.08    0.10   -0.45   -0.24    1.00   -0.21   -0.07    0.01   -0.16
## relax     0.39    0.24   -0.07   -0.20    0.31    0.31   -0.21    1.00    0.07   -0.04    0.28
## watch     0.00    0.04    0.03    0.12    0.12    0.05   -0.07    0.07    1.00    0.24    0.12
## follow    -0.05   -0.06    0.10    0.31   -0.01   -0.04    0.01   -0.04    0.24    1.00   -0.01
## nogoyal    0.16    0.30   -0.14   -0.08    0.32    0.27   -0.16    0.28    0.12   -0.01    1.00
## noplay    -0.07   -0.13    0.15   -0.01   -0.22    0.05    0.11   -0.04    0.15    0.21   -0.14
## dream     0.09    0.13   -0.12    0.03    0.29    0.12   -0.20    0.29    0.14   -0.02    0.10
## perf      0.04   -0.04    0.00    0.16    0.07   -0.09    0.00    0.17   -0.09    0.08   -0.07
## seri       0.02    0.06    0.05    0.08   -0.01   -0.10    0.02    0.11    0.00   -0.02    0.07
## failgood   0.32    0.20   -0.10   -0.15    0.23    0.41   -0.25    0.18    0.03   -0.08    0.17
## kidlearn   0.26    0.19   -0.03   -0.27    0.25    0.29   -0.32    0.18    0.03   -0.05    0.17
## break.     0.10   -0.23    0.14    0.10   -0.05   -0.07    0.21   -0.04    0.12    0.21   -0.05
## forkids   -0.03    0.06    0.03    0.28    0.07   -0.14   -0.03    0.10    0.09    0.22    0.08
## qualtime   0.16    0.14   -0.15   -0.34    0.15    0.32   -0.26    0.26    0.10   -0.10    0.15
## norelax    0.10    0.07    0.11   -0.01    0.08   -0.06   -0.11    0.46    0.09    0.16   -0.03
## handson    0.09    0.28   -0.08   -0.09    0.37    0.21   -0.36    0.25    0.25   -0.03    0.26
## try        0.01    0.15   -0.17   -0.05    0.03    0.04   -0.20    0.12    0.05    0.05    0.09
## steps      0.02   -0.09    0.15    0.14   -0.24   -0.27    0.30   -0.13    0.07    0.09   -0.14
## play       0.28    0.17   -0.12   -0.25    0.24    0.25   -0.22    0.25    0.17    0.02    0.23
## prac      -0.13   -0.14    0.03    0.07   -0.04   -0.22    0.12   -0.06   -0.07    0.00   -0.05
##          noplay dream  perf  seri failgood kidlearn break. forkids qualtime norelax
## over      -0.07    0.09    0.04    0.02    0.32    0.26    0.10   -0.03    0.16    0.10
## notseri   -0.13    0.13   -0.04    0.06    0.20    0.19   -0.23    0.06    0.14    0.07
## failbad    0.15   -0.12    0.00    0.05   -0.10   -0.03    0.14    0.03   -0.15    0.11
## kidfun    -0.01    0.03    0.16    0.08   -0.15   -0.27    0.10    0.28   -0.34   -0.01
## ilearn    -0.22    0.29    0.07   -0.01    0.23    0.25   -0.05    0.07    0.15    0.08
## welearn    0.05    0.12   -0.09   -0.10    0.41    0.29   -0.07   -0.14    0.32   -0.06
## likeme    0.11   -0.20    0.00    0.02   -0.25   -0.32    0.21   -0.03   -0.26   -0.11
## relax    -0.04    0.29    0.17    0.11    0.18    0.18   -0.04    0.10    0.26    0.46
## watch     0.15    0.14   -0.09    0.00    0.03    0.03    0.12    0.09    0.10    0.09
## follow    0.21   -0.02    0.08   -0.02   -0.08   -0.05    0.21    0.22   -0.10    0.16
## nogoyal   -0.14    0.10   -0.07    0.07    0.17    0.17   -0.05    0.08    0.15   -0.03
## noplay    1.00   -0.14   -0.05   -0.07    0.02   -0.17    0.07    0.07   -0.04   -0.03
## dream     -0.14    1.00    0.15    0.15    0.04    0.05   -0.01    0.05    0.04    0.08
## perf     -0.05    0.15    1.00    0.57   -0.31   -0.24    0.11    0.17   -0.21    0.30
## seri      -0.07    0.15    0.57    1.00   -0.26   -0.21    0.10    0.18   -0.24    0.21
## failgood  0.02    0.04   -0.31   -0.26    1.00    0.45   -0.24   -0.32    0.63   -0.22
```

```

## kidlearn -0.17 0.05 -0.24 -0.21 0.45 1.00 -0.29 -0.40 0.71 -0.06
## break. 0.07 -0.01 0.11 0.10 -0.24 -0.29 1.00 0.34 -0.28 0.13
## forkids 0.07 0.05 0.17 0.18 -0.32 -0.40 0.34 1.00 -0.42 0.31
## qualtime -0.04 0.04 -0.21 -0.24 0.63 0.71 -0.28 -0.42 1.00 -0.10
## norelax -0.03 0.08 0.30 0.21 -0.22 -0.06 0.13 0.31 -0.10 1.00
## handson -0.15 0.24 -0.18 -0.12 0.44 0.52 -0.27 -0.23 0.55 -0.08
## try -0.08 0.14 -0.17 -0.29 0.41 0.32 -0.23 -0.16 0.50 -0.18
## steps 0.13 0.06 0.28 0.34 -0.43 -0.44 0.27 0.28 -0.51 0.13
## play -0.06 0.12 -0.10 -0.05 0.55 0.58 -0.14 -0.29 0.75 -0.03
## prac -0.06 0.14 0.40 0.45 -0.41 -0.49 0.17 0.34 -0.49 0.15
## handson try steps play prac
## over 0.09 0.01 0.02 0.28 -0.13
## notseri 0.28 0.15 -0.09 0.17 -0.14
## failbad -0.08 -0.17 0.15 -0.12 0.03
## kidfun -0.09 -0.05 0.14 -0.25 0.07
## ilearn 0.37 0.03 -0.24 0.24 -0.04
## welearn 0.21 0.04 -0.27 0.25 -0.22
## likeme -0.36 -0.20 0.30 -0.22 0.12
## relax 0.25 0.12 -0.13 0.25 -0.06
## watch 0.25 0.05 0.07 0.17 -0.07
## follow -0.03 0.05 0.09 0.02 0.00
## nogol 0.26 0.09 -0.14 0.23 -0.05
## noplay -0.15 -0.08 0.13 -0.06 -0.06
## dream 0.24 0.14 0.06 0.12 0.14
## perf -0.18 -0.17 0.28 -0.10 0.40
## seri -0.12 -0.29 0.34 -0.05 0.45
## failgood 0.44 0.41 -0.43 0.55 -0.41
## kidlearn 0.52 0.32 -0.44 0.58 -0.49
## break. -0.27 -0.23 0.27 -0.14 0.17
## forkids -0.23 -0.16 0.28 -0.29 0.34
## qualtime 0.55 0.50 -0.51 0.75 -0.49
## norelax -0.08 -0.18 0.13 -0.03 0.15
## handson 1.00 0.42 -0.47 0.50 -0.31
## try 0.42 1.00 -0.30 0.35 -0.29
## steps -0.47 -0.30 1.00 -0.43 0.37
## play 0.50 0.35 -0.43 1.00 -0.32
## prac -0.31 -0.29 0.37 -0.32 1.00

```

Scree Plot and Alternate Estimations of Numbers of Factors

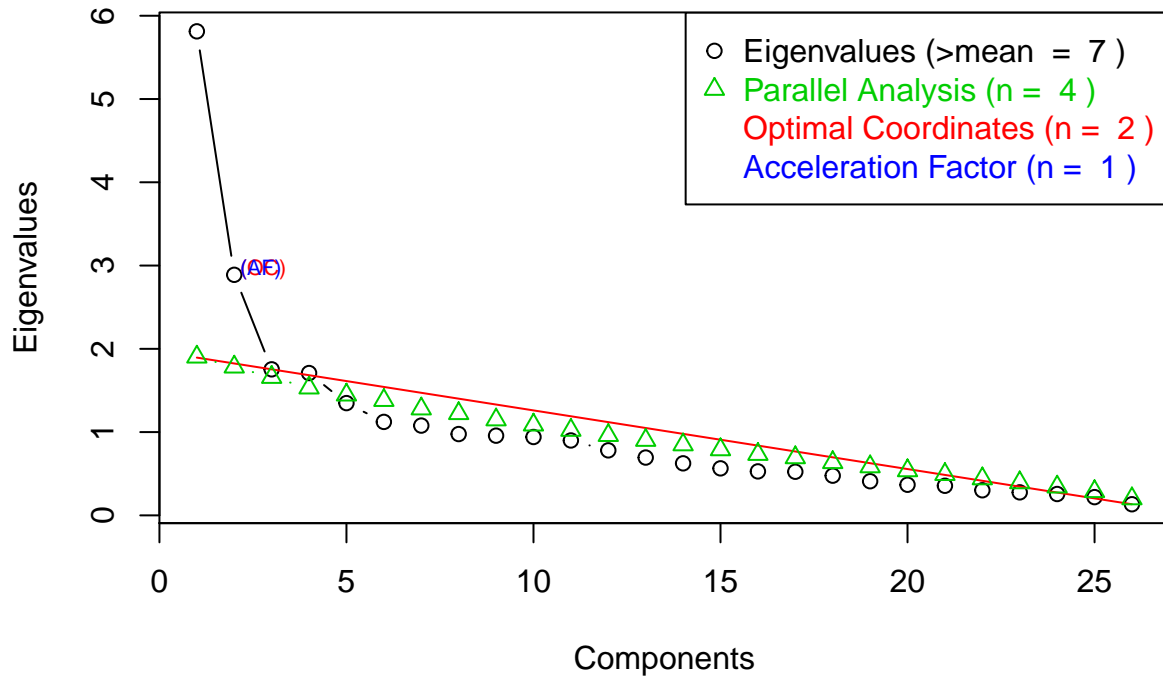
The plot below shows the Scree plot to determine the number of factors present in the data. Parallel Analysis is shown in green to give a more empirical measure of how many factors may be present in the data.

```

# Generate Scree plot to determine number of factors
ev <- eigen(cor(Survey)) # get eigenvalues
ap <- parallel(subject=nrow(Survey), var=ncol(Survey),
               rep=100, cent=.05)
nS <- nScree(x=ev$values, aparallel=ap$eigen$qevpea)
plotnScree(nS)

```

Non Graphical Solutions to Scree Test



Factor Analysis based on 3 factors

The Scree plot indicated that 3 factors seems like a reasonable assumption. The output below shows the uniqueness measure of each survey item, the factor loadings, and the sums of squares and variance loadings of the factors. The varimax rotation is used for the analysis. The hypothesis test that 3 factors is sufficient is significant at $p = 0.03$.

```
factanal(Survey, factors = 3)
```

```
##
## Call:
## factanal(x = Survey, factors = 3)
##
## Uniquenesses:
##   over notseri failbad kidfun  ilearn  welearn  likeme  relax  watch  follow
## 0.812  0.816  0.972  0.882  0.395  0.729  0.694  0.636  0.972  0.987
## nogal  noplay  dream   perf    seri failgood kidlearn break. forkids qualtime
## 0.802  0.946  0.820  0.488  0.495  0.492  0.420  0.889  0.722  0.060
## norelax handson   try    steps  play   prac
## 0.787  0.525  0.722  0.592  0.371  0.567
##
## Loadings:
##           Factor1 Factor2 Factor3
## over      0.117  0.409
## notseri    0.422
```

```

## failbad -0.116 -0.115
## kidfun -0.340
## ilearn 0.777
## welearn 0.237 0.451 -0.106
## likeme -0.172 -0.524
## relax 0.188 0.489 0.300
## watch 0.149
## follow -0.101
## nogoal 0.438
## noplay -0.232
## dream 0.372 0.204
## perf -0.203 0.684
## seri -0.217 0.675
## failgood 0.590 0.301 -0.263
## kidlearn 0.684 0.298 -0.153
## break. -0.274 0.165
## forkids -0.471 0.114 0.207
## qualtime 0.951 0.181
## norelax -0.126 0.173 0.409
## handson 0.492 0.463 -0.136
## try 0.482 0.112 -0.183
## steps -0.467 -0.272 0.340
## play 0.731 0.298
## prac -0.484 0.441
##
## Factor1 Factor2 Factor3
## SS loadings 3.872 2.753 1.781
## Proportion Var 0.149 0.106 0.069
## Cumulative Var 0.149 0.255 0.323
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 291.05 on 250 degrees of freedom.
## The p-value is 0.0381

```

Factor Analysis based on 4 factors

Because the parallel analysis indicated that there might be 4 factors, I conducted another factor analysis for 4 factors. The same output is displayed below. The chi squared test of whether 4 factors is sufficient is not significant ($p = .251$), lending more evidence to the survey having 3 factors.

```
factanal(Survey, factors = 4)
```

```

##
## Call:
## factanal(x = Survey, factors = 4)
##
## Uniquenesses:
##   over notseri failbad kidfun ilearn welearn likeme relax watch follow
## 0.530 0.815 0.890 0.707 0.405 0.604 0.682 0.581 0.952 0.975
## nogoal noplay dream perf seri failgood kidlearn break. forkids qualtime
## 0.804 0.921 0.782 0.480 0.499 0.474 0.418 0.857 0.717 0.063
## norelax handson try steps play prac
## 0.771 0.422 0.651 0.572 0.371 0.558

```

```

##
## Loadings:
##      Factor1 Factor2 Factor3 Factor4
## over          0.278          0.621
## notseri        0.403          0.128
## failbad   -0.185  -0.173          0.213
## kidfun    -0.229          -0.484
## ilearn          0.751          0.178
## welearn   0.138   0.343  -0.121   0.495
## likeme   -0.200  -0.525
## relax    0.137   0.403   0.309   0.377
## watch          0.179
## follow          -0.124
## nogoa      0.416          0.131
## noplay     -0.261
## dream      0.403   0.226
## perf     -0.160          0.696
## seri     -0.179          0.679
## failgood  0.535   0.244  -0.281   0.319
## kidlearn  0.648   0.239  -0.167   0.278
## break.   -0.307  -0.124   0.165
## forkids  -0.437   0.144   0.231  -0.133
## qualtime  0.919   0.116          0.271
## norelax  -0.138   0.126   0.422   0.127
## handson   0.546   0.512  -0.131
## try       0.528   0.160  -0.184  -0.103
## steps    -0.480  -0.279   0.343
## play      0.709   0.239          0.257
## prac     -0.432          0.457  -0.214
##
##      Factor1 Factor2 Factor3 Factor4
## SS loadings    3.603   2.443   1.874   1.581
## Proportion Var 0.139   0.094   0.072   0.061
## Cumulative Var 0.139   0.233   0.305   0.365
##
## Test of the hypothesis that 4 factors are sufficient.
## The chi square statistic is 240.89 on 227 degrees of freedom.
## The p-value is 0.251

```