Assignment 6

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https://github.com/ankita1598/Walmart (https://github.com/ankita1598/Walmart)

```
#Loading Packages
library(mvtnorm)
```

```
## Warning: package 'mvtnorm' was built under R version 3.6.3
```

```
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 3.6.3
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(psych)
```

```
## Warning: package 'psych' was built under R version 3.6.3
```

```
library(lubridate)
```

```
## Warning: package 'lubridate' was built under R version 3.6.3
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
library("plyr")
```

```
## Warning: package 'plyr' was built under R version 3.6.3
```

```
## ------------------------------------------------------------------------------
```

```
## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr first, then dplyr:
## library(plyr); library(dplyr)
```

```
## ------------------------------------------------------------------------------
```

```
##
## Attaching package: 'plyr'
```

```
## The following objects are masked from 'package:dplyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

```
library("ggplot2")
```

```
## Warning: package 'ggplot2' was built under R version 3.6.3
```

```
##
## Attaching package: 'ggplot2'
```

```
## The following objects are masked from 'package:psych':
##
##     %+%, alpha
```

```
library(RColorBrewer)
library("dplyr")
```

```
#Loading Dataset
dataset = read.csv("data.csv", header= T)
head(dataset)
```

	Store <int>	Dept <int>	Date <fctr>	weeklySales <dbl>	isHoliday <fctr>	Type <fctr>	Size <int>	Temperature <dbl>	Fuel_Price <dbl>
1	1	1	2010-02-05	24924.50	False	A	151315	42.31	2.572
2	1	1	2010-02-12	46039.49	True	A	151315	38.51	2.548
3	1	1	2010-02-19	41595.55	False	A	151315	39.93	2.514
4	1	1	2010-02-26	19403.54	False	A	151315	46.63	2.561
5	1	1	2010-03-05	21827.90	False	A	151315	46.50	2.625
6	1	1	2010-03-12	21043.39	False	A	151315	57.79	2.667

6 rows | 1-10 of 17 columns

```
#We can see that there are few null values in the data set for column Markdown 1 - 5. We will also split the data column in
 3 as Day, Month and Year.
dataset$Year <- year(ymd(dataset$Date))
dataset$Month <- month(ymd(dataset$Date))
dataset$Day <- day(ymd(dataset$Date))
dataset$Dept = as.factor(dataset$Dept)
dataset$Store = as.factor(dataset$Store)
dataset$MarkDown1[is.na(dataset$MarkDown1)] = 0
dataset$MarkDown2[is.na(dataset$MarkDown2)] = 0
dataset$MarkDown3[is.na(dataset$MarkDown3)] = 0
dataset$MarkDown4[is.na(dataset$MarkDown4)] = 0
dataset$MarkDown5[is.na(dataset$MarkDown5)] = 0
dataset = fastDummies::dummy_cols(dataset, select_columns = "Type")
dataset$IsHoliday[dataset$isHoliday == "False"] = 0
dataset$IsHoliday[dataset$isHoliday == "True"] = 1
head(dataset)
```

	Store <fctr>	Dept <fctr>	Date <fctr>	weeklySales <dbl>	isHoliday <fctr>	Type <fctr>	Size <int>	Temperature <dbl>	Fuel_Price <dbl>
1	1	1	2010-02-05	24924.50	False	A	151315	42.31	2.572
2	1	1	2010-02-12	46039.49	True	A	151315	38.51	2.548
3	1	1	2010-02-19	41595.55	False	A	151315	39.93	2.514
4	1	1	2010-02-26	19403.54	False	A	151315	46.63	2.561
5	1	1	2010-03-05	21827.90	False	A	151315	46.50	2.625
6	1	1	2010-03-12	21043.39	False	A	151315	57.79	2.667

6 rows | 1-10 of 24 columns

```
dim(dataset)
```

```
## [1] 421570     23
```

```
names(dataset)
```

```
##  [1] "Store"        "Dept"         "Date"         "weeklySales"  "isHoliday"
##  [6] "Type"         "Size"         "Temperature"  "Fuel_Price"   "MarkDown1"
## [11] "MarkDown2"    "MarkDown3"    "MarkDown4"    "MarkDown5"    "CPI"
## [16] "Unemployment" "Year"         "Month"        "Day"          "Type_A"
## [21] "Type_B"       "Type_C"       "IsHoliday"
```

```
#correlation
dataset$Dept = as.numeric(as.factor(dataset$Dept))
dataset$Store = as.numeric(as.factor(dataset$Store))
features = c("Store","Dept","IsHoliday","Type_A","Type_B","Type_C","Size","Temperature","Fuel_Price","MarkDown1","MarkDown2"
,"MarkDown3","MarkDown4","MarkDown5","CPI","Unemployment","Year","Month","Day")
correlation = cor(select(dataset,features))
```

```
## Note: Using an external vector in selections is ambiguous.
## i Use `all_of(features)` instead of `features` to silence this message.
## i See <https://tidyselect.r-lib.org/reference/faq-external-vector.html>.
## This message is displayed once per session.
```

```
dataset_pca = prcomp(select(dataset,features), scale=TRUE)
#dataset_pca
summary(dataset_pca)
```

```
## Importance of components:
##                           PC1    PC2     PC3     PC4    PC5     PC6     PC7
## Standard deviation     1.7352 1.5514 1.34652 1.23219 1.1761 1.11613 1.09107
## Proportion of Variance 0.1585 0.1267 0.09543 0.07991 0.0728 0.06557 0.06265
## Cumulative Proportion  0.1585 0.2851 0.38057 0.46048 0.5333 0.59885 0.66150
##                            PC8     PC9    PC10    PC11    PC12    PC13   PC14
## Standard deviation     0.99898 0.97748 0.94011 0.90434 0.84491 0.78887 0.7163
## Proportion of Variance 0.05252 0.05029 0.04652 0.04304 0.03757 0.03275 0.0270
## Cumulative Proportion  0.71402 0.76431 0.81083 0.85387 0.89144 0.92420 0.9512
##                           PC15    PC16    PC17    PC18      PC19
## Standard deviation     0.66946 0.46495 0.38887 0.33406 3.732e-13
## Proportion of Variance 0.02359 0.01138 0.00796 0.00587 0.000e+00
## Cumulative Proportion  0.97479 0.98617 0.99413 1.00000 1.000e+00
```

```
#Recreating the summary table manually
dataset_eigen = dataset_pca$sdev^2
names(dataset_eigen) <- paste("PC",1:19,sep="")
dataset_eigen
```

```
##          PC1          PC2          PC3          PC4          PC5          PC6
## 3.010800e+00 2.406846e+00 1.813107e+00 1.518282e+00 1.383272e+00 1.245750e+00
##          PC7          PC8          PC9         PC10         PC11         PC12
## 1.190440e+00 9.979596e-01 9.554649e-01 8.838117e-01 8.178357e-01 7.138670e-01
##         PC13         PC14         PC15         PC16         PC17         PC18
## 6.223176e-01 5.130635e-01 4.481826e-01 2.161815e-01 1.512217e-01 1.115972e-01
##         PC19
## 1.393070e-25
```

```
sumlambdas = sum(dataset_eigen)
sumlambdas
```

```
## [1] 19
```

```
propvar = dataset_eigen/sumlambdas
propvar
```

```
##          PC1          PC2          PC3          PC4          PC5          PC6
## 1.584632e-01 1.266761e-01 9.542669e-02 7.990957e-02 7.280377e-02 6.556577e-02
##          PC7          PC8          PC9         PC10         PC11         PC12
## 6.265476e-02 5.252419e-02 5.028763e-02 4.651641e-02 4.304399e-02 3.757195e-02
##         PC13         PC14         PC15         PC16         PC17         PC18
## 3.275356e-02 2.700334e-02 2.358856e-02 1.137797e-02 7.959037e-03 5.873536e-03
##         PC19
## 7.331947e-27
```

```
dataset_cumvar <- cumsum(propvar)
dataset_cumvar
```

```
##       PC1       PC2       PC3       PC4       PC5       PC6       PC7       PC8
## 0.1584632 0.2851393 0.3805660 0.4604755 0.5332793 0.5988451 0.6614998 0.7140240
##       PC9      PC10      PC11      PC12      PC13      PC14      PC15      PC16
## 0.7643117 0.8108281 0.8538720 0.8914440 0.9241976 0.9512009 0.9747895 0.9861674
##      PC17      PC18      PC19
## 0.9941265 1.0000000 1.0000000
```

```
matlambdas <- rbind(dataset_eigen,propvar,dataset_cumvar)
rownames(matlambdas) <- c("Eigenvalues","Prop. variance","Cum. prop. variance")
round(matlambdas,4)
```

```
##                        PC1    PC2    PC3    PC4    PC5    PC6    PC7    PC8
## Eigenvalues         3.0108 2.4068 1.8131 1.5183 1.3833 1.2457 1.1904 0.9980
## Prop. variance      0.1585 0.1267 0.0954 0.0799 0.0728 0.0656 0.0627 0.0525
## Cum. prop. variance 0.1585 0.2851 0.3806 0.4605 0.5333 0.5988 0.6615 0.7140
##                        PC9   PC10   PC11   PC12   PC13   PC14   PC15   PC16
## Eigenvalues         0.9555 0.8838 0.8178 0.7139 0.6223 0.5131 0.4482 0.2162
## Prop. variance      0.0503 0.0465 0.0430 0.0376 0.0328 0.0270 0.0236 0.0114
## Cum. prop. variance 0.7643 0.8108 0.8539 0.8914 0.9242 0.9512 0.9748 0.9862
##                       PC17   PC18 PC19
## Eigenvalues         0.1512 0.1116    0
## Prop. variance      0.0080 0.0059    0
## Cum. prop. variance 0.9941 1.0000    1
```

```
summary(dataset_pca)
```

```
## Importance of components:
##                           PC1    PC2     PC3     PC4    PC5     PC6     PC7
## Standard deviation     1.7352 1.5514 1.34652 1.23219 1.1761 1.11613 1.09107
## Proportion of Variance 0.1585 0.1267 0.09543 0.07991 0.0728 0.06557 0.06265
## Cumulative Proportion  0.1585 0.2851 0.38057 0.46048 0.5333 0.59885 0.66150
##                            PC8     PC9    PC10    PC11    PC12    PC13   PC14
## Standard deviation     0.99898 0.97748 0.94011 0.90434 0.84491 0.78887 0.7163
## Proportion of Variance 0.05252 0.05029 0.04652 0.04304 0.03757 0.03275 0.0270
## Cumulative Proportion  0.71402 0.76431 0.81083 0.85387 0.89144 0.92420 0.9512
##                           PC15    PC16    PC17    PC18      PC19
## Standard deviation     0.66946 0.46495 0.38887 0.33406 3.732e-13
## Proportion of Variance 0.02359 0.01138 0.00796 0.00587 0.000e+00
## Cumulative Proportion  0.97479 0.98617 0.99413 1.00000 1.000e+00
```

```
dataset_pca$rotation
```

```
##                     PC1          PC2          PC3          PC4          PC5
## Store         0.101338347  0.091916309 -0.513516476  0.251997574 -0.001935214
## Dept         -0.004080003 -0.007831044 -0.046139485  0.018866256  0.009505749
## IsHoliday     0.012198689 -0.042117612  0.122765651  0.430598905  0.456416377
## Type_A       -0.269997489 -0.528338823 -0.185112881 -0.009266895 -0.013346619
## Type_B        0.146653872  0.403632005  0.488509836 -0.004351486 -0.076292464
## Type_C        0.210717990  0.223741121 -0.482751803  0.022405038  0.145479166
## Size         -0.300383406 -0.464123852  0.028723361  0.048095997 -0.091823360
## Temperature   0.019910709  0.010812768 -0.218666013 -0.510512052  0.200853851
## Fuel_Price   -0.275443967  0.294661098 -0.203742513 -0.123886920  0.121192144
## MarkDown1    -0.453413949  0.200206338  0.005221163  0.109824771 -0.089168444
## MarkDown2    -0.141257544  0.020994379  0.103183191  0.347793218  0.162072576
## MarkDown3    -0.009497715 -0.034055919  0.081007342  0.226594899  0.487643095
## MarkDown4    -0.390865591  0.174396291  0.014503077  0.150090049 -0.149722791
## MarkDown5    -0.335044476  0.096936758 -0.035119875  0.004296702  0.144248500
## CPI          -0.056574087 -0.083696668  0.141163027 -0.416193607  0.252065716
## Unemployment  0.171545851  0.020992482 -0.259550101  0.252639451 -0.190136441
## Year         -0.389065387  0.314135135 -0.130186448 -0.141176642  0.137111788
## Month         0.077922298 -0.079345988  0.005109959 -0.088709204  0.432577095
## Day           0.059412275 -0.036413098  0.006627105 -0.008888773  0.283046556
##                     PC6          PC7           PC8          PC9         PC10
## Store         0.061086191 -0.078145177  0.0299040623  0.073793008 -0.140951607
## Dept          0.018072337 -0.010273283 -0.9977935984 -0.032181832  0.005984284
## IsHoliday     0.107760643  0.006727446  0.0129311781  0.034867960  0.032563692
## Type_A       -0.050710292 -0.041302498  0.0119666806  0.030914991 -0.012453237
## Type_B       -0.139582813  0.142378737 -0.0274509310 -0.033940176 -0.021877852
## Type_C        0.309772095 -0.161681024  0.0245323503  0.003596134  0.056024880
## Size         -0.185567211  0.086119471  0.0010860492 -0.006638435 -0.008888054
## Temperature  -0.002198471  0.359324120  0.0088510932 -0.219426059  0.195431729
## Fuel_Price   -0.482204934 -0.022570393 -0.0025723236  0.076513162 -0.156817692
## MarkDown1     0.222747819  0.188452025  0.0049684296 -0.061031613  0.237184486
## MarkDown2     0.073828460 -0.247589409  0.0268547341 -0.612315382 -0.226740528
## MarkDown3    -0.098476660  0.133442483 -0.0149225410  0.553249762  0.249596232
## MarkDown4     0.322676103  0.224784551  0.0044506178 -0.014085200  0.333798845
## MarkDown5     0.089877318  0.089284428  0.0055416453 -0.063043394 -0.243641828
## CPI           0.451357854 -0.274497724  0.0092080205 -0.012353740  0.156274240
## Unemployment -0.161452270  0.391750111  0.0237151179 -0.217639424  0.292332377
## Year         -0.216978460 -0.214598559  0.0006121195  0.080368012 -0.083162286
## Month         0.046100158  0.535683306 -0.0014352308 -0.217696184 -0.364957414
## Day          -0.378676557 -0.271360815  0.0096460435 -0.381907173  0.567151486
```

```
##                     PC11         PC12         PC13          PC14          PC15
## Store         0.285937561 -0.098966639  0.035443355 -0.6654692527 -2.861076e-01
## Dept         -0.008419339  0.006238431  0.006405709 -0.0100002378  9.299369e-06
## IsHoliday    -0.350527166 -0.228194058  0.608349231  0.0556684274 -1.623773e-01
## Type_A       -0.040459037 -0.042276585  0.007406043  0.0035649783  1.082941e-02
## Type_B        0.051967567  0.046704622  0.048087260 -0.2557266645 -1.178871e-01
## Type_C       -0.016911522 -0.005388315 -0.090026625  0.4075224935  1.726276e-01
## Size         -0.014953982  0.008268893  0.016888929 -0.1196165401 -2.453827e-03
## Temperature  -0.290872963  0.011021819 -0.066663694 -0.0049459406 -5.871443e-01
## Fuel_Price   -0.224696355 -0.124326140  0.027088672 -0.0677477967  2.147245e-01
## MarkDown1     0.071395327 -0.148722198 -0.054028221 -0.0292195316  3.925485e-02
## MarkDown2    -0.264198371  0.143078463 -0.467690896 -0.0664937901 -1.026669e-01
## MarkDown3     0.002401877  0.273300215 -0.477165739 -0.0470998594 -4.538315e-02
## MarkDown4     0.083847097 -0.241194449 -0.081107535 -0.0008326417  1.811359e-02
## MarkDown5     0.408496632  0.641238287  0.314421877  0.2082893346 -1.865270e-01
## CPI          -0.126280354  0.212472767  0.122309601 -0.4708447432  3.336853e-01
## Unemployment -0.283622099  0.452012463  0.159435076 -0.1608653752  3.697968e-01
## Year         -0.146334233 -0.002483245  0.060832279 -0.0365537208  1.125417e-01
## Month         0.277924550 -0.269961065 -0.082262970 -0.0517141279  3.823286e-01
## Day           0.459901246 -0.097265167  0.083972506  0.0329275677  3.020507e-02
##                     PC16          PC17          PC18          PC19
## Store        -0.0201653518  0.0064646965 -0.0080510752 -7.788021e-14
## Dept         -0.0002017792 -0.0005154555  0.0001926768  4.343564e-15
## IsHoliday    -0.0208226765  0.0002087695  0.0156194400  6.273852e-16
## Type_A        0.4125947234 -0.0208444350  0.0374472527 -6.574321e-01
## Type_B       -0.1733601306  0.0108628680 -0.0403525786 -6.408318e-01
## Type_C       -0.4040517639  0.0170102351  0.0031287872 -3.963807e-01
## Size         -0.7802905632  0.0456654150 -0.1224051099  9.108548e-16
## Temperature  -0.0268032451  0.0109099849 -0.0198922461  3.097591e-16
## Fuel_Price   -0.0677427660 -0.4165298231  0.4547674844  3.375827e-16
## MarkDown1    -0.0038527297  0.5679082814  0.4838312343 -4.412066e-16
## MarkDown2     0.0126969980 -0.0605410731  0.0110476373  3.074830e-17
## MarkDown3     0.0133030849  0.0070851851  0.0066958749 -1.055134e-16
## MarkDown4     0.0319323891 -0.5663149078 -0.3339511006  2.342835e-16
## MarkDown5     0.0018146579 -0.1332996200  0.0632993671 -3.597752e-17
## CPI          -0.0591193049 -0.0919004682  0.0913705932 -2.443829e-16
## Unemployment  0.0837632981  0.0505364259 -0.0865456794 -1.651853e-16
## Year          0.0917821075  0.3792262438 -0.6296045956  7.958731e-16
## Month         0.0329757944  0.0609653457 -0.1113671062  5.321175e-16
## Day           0.0073597391 -0.0130023773  0.0050564269 -8.880060e-16
```

```
print(dataset_pca)
```

```
## Standard deviations (1, .., p=19):
##  [1] 1.735166e+00 1.551401e+00 1.346517e+00 1.232186e+00 1.176126e+00
##  [6] 1.116132e+00 1.091073e+00 9.989793e-01 9.774789e-01 9.401126e-01
## [11] 9.043427e-01 8.449065e-01 7.888711e-01 7.162845e-01 6.694644e-01
## [16] 4.649532e-01 3.888724e-01 3.340617e-01 3.732385e-13
##
## Rotation (n x k) = (19 x 19):
##                       PC1          PC2          PC3          PC4          PC5
## Store         0.101338347  0.091916309 -0.513516476  0.251997574 -0.001935214
## Dept         -0.004080003 -0.007831044 -0.046139485  0.018866256  0.009505749
## IsHoliday     0.012198689 -0.042117612  0.122765651  0.430598905  0.456416377
## Type_A       -0.269997489 -0.528338823 -0.185112881 -0.009266895 -0.013346619
## Type_B        0.146653872  0.403632005  0.488509836 -0.004351486 -0.076292464
## Type_C        0.210717990  0.223741121 -0.482751803  0.022405038  0.145479166
## Size         -0.300383406 -0.464123852  0.028723361  0.048095997 -0.091823360
## Temperature   0.019910709  0.010812768 -0.218666013 -0.510512052  0.200853851
## Fuel_Price   -0.275443967  0.294661098 -0.203742513 -0.123886920  0.121192144
## MarkDown1    -0.453413949  0.200206338  0.005221163  0.109824771 -0.089168444
## MarkDown2    -0.141257544  0.020994379  0.103183191  0.347793218  0.162072576
## MarkDown3    -0.009497715 -0.034055919  0.081007342  0.226594899  0.487643095
## MarkDown4    -0.390865591  0.174396291  0.014503077  0.150090049 -0.149722791
## MarkDown5    -0.335044476  0.096936758 -0.035119875  0.004296702  0.144248500
## CPI          -0.056574087 -0.083696668  0.141163027 -0.416193607  0.252065716
## Unemployment  0.171545851  0.020992482 -0.259550101  0.252639451 -0.190136441
## Year         -0.389065387  0.314135135 -0.130186448 -0.141176642  0.137111788
## Month         0.077922298 -0.079345988  0.005109959 -0.088709204  0.432577095
## Day           0.059412275 -0.036413098  0.006627105 -0.008888773  0.283046556
##                       PC6          PC7           PC8          PC9         PC10
## Store         0.061086191 -0.078145177  0.0299040623  0.073793008 -0.140951607
## Dept          0.018072337 -0.010273283 -0.9977935984 -0.032181832  0.005984284
## IsHoliday     0.107760643  0.006727446  0.0129311781  0.034867960  0.032563692
## Type_A       -0.050710292 -0.041302498  0.0119666806  0.030914991 -0.012453237
## Type_B       -0.139582813  0.142378737 -0.0274509310 -0.033940176 -0.021877852
## Type_C        0.309772095 -0.161681024  0.0245323503  0.003596134  0.056024880
## Size         -0.185567211  0.086119471  0.0010860492 -0.006638435 -0.008888054
## Temperature  -0.002198471  0.359324120  0.0088510932 -0.219426059  0.195431729
## Fuel_Price   -0.482204934 -0.022570393 -0.0025723236  0.076513162 -0.156817692
## MarkDown1     0.222747819  0.188452025  0.0049684296 -0.061031613  0.237184486
## MarkDown2     0.073828460 -0.247589409  0.0268547341 -0.612315382 -0.226740528
## MarkDown3    -0.098476660  0.133442483 -0.0149225410  0.553249762  0.249596232
```

```
## MarkDown4     0.322676103  0.224784551  0.0044506178 -0.014085200  0.333798845
## MarkDown5     0.089877318  0.089284428  0.0055416453 -0.063043394 -0.243641828
## CPI           0.451357854 -0.274497724  0.0092080205 -0.012353740  0.156274240
## Unemployment -0.161452270  0.391750111  0.0237151179 -0.217639424  0.292332377
## Year         -0.216978460 -0.214598559  0.0006121195  0.080368012 -0.083162286
## Month         0.046100158  0.535683306 -0.0014352308 -0.217696184 -0.364957414
## Day          -0.378676557 -0.271360815  0.0096460435 -0.381907173  0.567151486
##                       PC11         PC12         PC13          PC14          PC15
## Store         0.285937561 -0.098966639  0.035443355 -0.6654692527 -2.861076e-01
## Dept         -0.008419339  0.006238431  0.006405709 -0.0100002378  9.299369e-06
## IsHoliday    -0.350527166 -0.228194058  0.608349231  0.0556684274 -1.623773e-01
## Type_A       -0.040459037 -0.042276585  0.007406043  0.0035649783  1.082941e-02
## Type_B        0.051967567  0.046704622  0.048087260 -0.2557266645 -1.178871e-01
## Type_C       -0.016911522 -0.005388315 -0.090026625  0.4075224935  1.726276e-01
## Size         -0.014953982  0.008268893  0.016888929 -0.1196165401 -2.453827e-03
## Temperature  -0.290872963  0.011021819 -0.066663694 -0.0049459406 -5.871443e-01
## Fuel_Price   -0.224696355 -0.124326140  0.027088672 -0.0677477967  2.147245e-01
## MarkDown1     0.071395327 -0.148722198 -0.054028221 -0.0292195316  3.925485e-02
## MarkDown2    -0.264198371  0.143078463 -0.467690896 -0.0664937901 -1.026669e-01
## MarkDown3     0.002401877  0.273300215 -0.477165739 -0.0470998594 -4.538315e-02
## MarkDown4     0.083847097 -0.241194449 -0.081107535 -0.0008326417  1.811359e-02
## MarkDown5     0.408496632  0.641238287  0.314421877  0.2082893346 -1.865270e-01
## CPI          -0.126280354  0.212472767  0.122309601 -0.4708447432  3.336853e-01
## Unemployment -0.283622099  0.452012463  0.159435076 -0.1608653752  3.697968e-01
## Year         -0.146334233 -0.002483245  0.060832279 -0.0365537208  1.125417e-01
## Month         0.277924550 -0.269961065 -0.082262970 -0.0517141279  3.823286e-01
## Day           0.459901246 -0.097265167  0.083972506  0.0329275677  3.020507e-02
##                       PC16          PC17          PC18          PC19
## Store        -0.0201653518  0.0064646965 -0.0080510752 -7.788021e-14
## Dept         -0.0002017792 -0.0005154555  0.0001926768  4.343564e-15
## IsHoliday    -0.0208226765  0.0002087695  0.0156194400  6.273852e-16
## Type_A        0.4125947234 -0.0208444350  0.0374472527 -6.574321e-01
## Type_B       -0.1733601306  0.0108628680 -0.0403525786 -6.408318e-01
## Type_C       -0.4040517639  0.0170102351  0.0031287872 -3.963807e-01
## Size         -0.7802905632  0.0456654150 -0.1224051099  9.108548e-16
## Temperature  -0.0268032451  0.0109099849 -0.0198922461  3.097591e-16
## Fuel_Price   -0.0677427660 -0.4165298231  0.4547674844  3.375827e-16
## MarkDown1    -0.0038527297  0.5679082814  0.4838312343 -4.412066e-16
## MarkDown2     0.0126969980 -0.0605410731  0.0110476373  3.074830e-17
## MarkDown3     0.0133030849  0.0070851851  0.0066958749 -1.055134e-16
## MarkDown4     0.0319323891 -0.5663149078 -0.3339511006  2.342835e-16
```

```
## MarkDown5     0.0018146579 -0.1332996200  0.0632993671 -3.597752e-17
## CPI          -0.0591193049 -0.0919004682  0.0913705932 -2.443829e-16
## Unemployment  0.0837632981  0.0505364259 -0.0865456794 -1.651853e-16
## Year          0.0917821075  0.3792262438 -0.6296045956  7.958731e-16
## Month         0.0329757944  0.0609653457 -0.1113671062  5.321175e-16
## Day           0.0073597391 -0.0130023773  0.0050564269 -8.880060e-16
```

```
#1st Option Based on retating components that account for 70% to 90% of the variance, we need to retain PC1 to PC8 or PC1 to PC12.
#2nd Option Based on the rule of sum to choose all components with eigen values larger than 0.7, we need to retain PC1 to PC 12.
dataset_pca$x[1:10,] #Printing just first 10 rows
```

```
##             PC1       PC2       PC3         PC4        PC5       PC6
##  [1,] 0.4762275 -2.155530 1.2995075 -0.13207252 -1.4722427 1.4704239
##  [2,] 0.5815413 -2.367293 1.8410605  1.65458065  0.4919413 1.6163298
##  [3,] 0.6032438 -2.252848 1.3647845 -0.06680457 -1.0595536 0.9282895
##  [4,] 0.6297072 -2.247900 1.2698933 -0.27234587 -0.7476421 0.5755958
##  [5,] 0.4725706 -2.144022 1.2287826 -0.29239263 -1.2776023 1.4313256
##  [6,] 0.5069916 -2.139597 1.0817072 -0.62360266 -0.9170382 1.0833433
##  [7,] 0.5194372 -2.136185 1.1009098 -0.55444646 -0.7126955 0.7232671
##  [8,] 0.5566463 -2.159004 1.1372651 -0.47607994 -0.5185284 0.4059242
##  [9,] 0.4101165 -2.088581 1.0389944 -0.81327720 -1.0176861 1.4942992
## [10,] 0.4311499 -2.082398 0.9783668 -0.93141161 -0.7400460 1.1351404
##               PC7      PC8          PC9       PC10        PC11        PC12
##  [1,] -0.78175503 1.517000  0.803643335  0.2936406 -0.86119789  0.91894907
##  [2,] -1.04630708 1.573621  0.675724957  0.8430380 -1.79280253 -0.04605606
##  [3,] -1.26060966 1.531656  0.211408772  1.1961081 -0.06032684  0.77873868
##  [4,] -1.34963676 1.542328 -0.165851845  1.7046702  0.17867363  0.69238249
##  [5,] -0.53936083 1.518330  0.695446645  0.2083848 -0.86835974  0.82521981
##  [6,] -0.53873896 1.531232  0.262756625  0.7672820 -0.69928064  0.74296169
##  [7,] -0.81971541 1.537070  0.004431876  1.1680283 -0.30633666  0.64799703
##  [8,] -1.09688701 1.543168 -0.261675886  1.5835146  0.10554318  0.56402050
##  [9,] -0.03759353 1.517703  0.622296294 -0.0124714 -1.18792819  0.68408434
## [10,] -0.18579445 1.526807  0.282766535  0.4608660 -0.90111627  0.59354787
##              PC13      PC14        PC15      PC16        PC17       PC18
##  [1,] -0.09892970 0.7957933 0.505620605 0.4414650  0.03109857 0.14030646
##  [2,]  2.35967368 1.0426034 0.005815657 0.3747792  0.04073010 0.18605680
##  [3,]  0.04114778 0.8553459 0.604158730 0.4649718  0.06113238 0.09388361
##  [4,]  0.08695932 0.8725698 0.437341579 0.4541327  0.01192909 0.13738963
##  [5,] -0.13551149 0.7678422 0.517133314 0.4373313  0.00363176 0.15460898
##  [6,] -0.10658184 0.7845742 0.201888214 0.4205620 -0.03831487 0.18820651
##  [7,] -0.02521556 0.8059192 0.351621565 0.4235300 -0.09837063 0.24789319
##  [8,]  0.05333761 0.8336925 0.479330595 0.4324884 -0.12105686 0.26675263
##  [9,] -0.26824140 0.7545915 0.103118378 0.3955795 -0.05602001 0.20737021
## [10,] -0.21166763 0.7748007 0.035213124 0.3890123 -0.11016096 0.25766482
##                PC19
##  [1,] -2.406775e-13
##  [2,] -2.390275e-13
##  [3,] -2.421816e-13
##  [4,] -2.427448e-13
##  [5,] -2.404056e-13
##  [6,] -2.408954e-13
```

```
##  [7,] -2.416194e-13
##  [8,] -2.423720e-13
##  [9,] -2.395735e-13
## [10,] -2.401845e-13
```

```
weeklySales <- data.frame(WeeklySales=dataset$weeklySales)
dataset2_pca <- cbind(weeklySales, dataset_pca$x)
dataset2_pca[1:10,]
```

	WeeklySales <dbl>	PC1 <dbl>	PC2 <dbl>	PC3 <dbl>	PC4 <dbl>	PC5 <dbl>	PC6 <dbl>	PC7 <dbl>
1	24924.50	0.4762275	-2.155530	1.2995075	-0.13207252	-1.4722427	1.4704239	-0.78175503
2	46039.49	0.5815413	-2.367293	1.8410605	1.65458065	0.4919413	1.6163298	-1.04630708
3	41595.55	0.6032438	-2.252848	1.3647845	-0.06680457	-1.0595536	0.9282895	-1.26060966
4	19403.54	0.6297072	-2.247900	1.2698933	-0.27234587	-0.7476421	0.5755958	-1.34963676
5	21827.90	0.4725706	-2.144022	1.2287826	-0.29239263	-1.2776023	1.4313256	-0.53936083
6	21043.39	0.5069916	-2.139597	1.0817072	-0.62360266	-0.9170382	1.0833433	-0.53873896
7	22136.64	0.5194372	-2.136185	1.1009098	-0.55444646	-0.7126955	0.7232671	-0.81971541
8	26229.21	0.5566463	-2.159004	1.1372651	-0.47607994	-0.5185284	0.4059242	-1.09688701
9	57258.43	0.4101165	-2.088581	1.0389944	-0.81327720	-1.0176861	1.4942992	-0.03759353
10	42960.91	0.4311499	-2.082398	0.9783668	-0.93141161	-0.7400460	1.1351404	-0.18579445

1-10 of 10 rows | 1-9 of 21 columns

```
#tabmeansPC <- aggregate(dataset2_pca[,2:13],by=list(weeklySales=dataset$weeklySales),mean)
#tabmeansPC
```

```
#tabmeansPC <- tabmeansPC[rev(order(tabmeansPC$weeklySales)),]
#tabmeansPC
```

```
eigvec.dataset<-dataset_pca$rotation
print(eigvec.dataset)
```

```
##                      PC1          PC2          PC3          PC4          PC5
## Store         0.101338347  0.091916309 -0.513516476  0.251997574 -0.001935214
## Dept         -0.004080003 -0.007831044 -0.046139485  0.018866256  0.009505749
## IsHoliday     0.012198689 -0.042117612  0.122765651  0.430598905  0.456416377
## Type_A       -0.269997489 -0.528338823 -0.185112881 -0.009266895 -0.013346619
## Type_B        0.146653872  0.403632005  0.488509836 -0.004351486 -0.076292464
## Type_C        0.210717990  0.223741121 -0.482751803  0.022405038  0.145479166
## Size         -0.300383406 -0.464123852  0.028723361  0.048095997 -0.091823360
## Temperature   0.019910709  0.010812768 -0.218666013 -0.510512052  0.200853851
## Fuel_Price   -0.275443967  0.294661098 -0.203742513 -0.123886920  0.121192144
## MarkDown1    -0.453413949  0.200206338  0.005221163  0.109824771 -0.089168444
## MarkDown2    -0.141257544  0.020994379  0.103183191  0.347793218  0.162072576
## MarkDown3    -0.009497715 -0.034055919  0.081007342  0.226594899  0.487643095
## MarkDown4    -0.390865591  0.174396291  0.014503077  0.150090049 -0.149722791
## MarkDown5    -0.335044476  0.096936758 -0.035119875  0.004296702  0.144248500
## CPI          -0.056574087 -0.083696668  0.141163027 -0.416193607  0.252065716
## Unemployment  0.171545851  0.020992482 -0.259550101  0.252639451 -0.190136441
## Year         -0.389065387  0.314135135 -0.130186448 -0.141176642  0.137111788
## Month         0.077922298 -0.079345988  0.005109959 -0.088709204  0.432577095
## Day           0.059412275 -0.036413098  0.006627105 -0.008888773  0.283046556
##                      PC6          PC7           PC8          PC9         PC10
## Store         0.061086191 -0.078145177  0.0299040623  0.073793008 -0.140951607
## Dept          0.018072337 -0.010273283 -0.9977935984 -0.032181832  0.005984284
## IsHoliday     0.107760643  0.006727446  0.0129311781  0.034867960  0.032563692
## Type_A       -0.050710292 -0.041302498  0.0119666806  0.030914991 -0.012453237
## Type_B       -0.139582813  0.142378737 -0.0274509310 -0.033940176 -0.021877852
## Type_C        0.309772095 -0.161681024  0.0245323503  0.003596134  0.056024880
## Size         -0.185567211  0.086119471  0.0010860492 -0.006638435 -0.008888054
## Temperature  -0.002198471  0.359324120  0.0088510932 -0.219426059  0.195431729
## Fuel_Price   -0.482204934 -0.022570393 -0.0025723236  0.076513162 -0.156817692
## MarkDown1     0.222747819  0.188452025  0.0049684296 -0.061031613  0.237184486
## MarkDown2     0.073828460 -0.247589409  0.0268547341 -0.612315382 -0.226740528
## MarkDown3    -0.098476660  0.133442483 -0.0149225410  0.553249762  0.249596232
## MarkDown4     0.322676103  0.224784551  0.0044506178 -0.014085200  0.333798845
## MarkDown5     0.089877318  0.089284428  0.0055416453 -0.063043394 -0.243641828
## CPI           0.451357854 -0.274497724  0.0092080205 -0.012353740  0.156274240
## Unemployment -0.161452270  0.391750111  0.0237151179 -0.217639424  0.292332377
## Year         -0.216978460 -0.214598559  0.0006121195  0.080368012 -0.083162286
## Month         0.046100158  0.535683306 -0.0014352308 -0.217696184 -0.364957414
## Day          -0.378676557 -0.271360815  0.0096460435 -0.381907173  0.567151486
```

```
##                     PC11         PC12         PC13          PC14          PC15
## Store         0.285937561 -0.098966639  0.035443355 -0.6654692527 -2.861076e-01
## Dept         -0.008419339  0.006238431  0.006405709 -0.0100002378  9.299369e-06
## IsHoliday    -0.350527166 -0.228194058  0.608349231  0.0556684274 -1.623773e-01
## Type_A       -0.040459037 -0.042276585  0.007406043  0.0035649783  1.082941e-02
## Type_B        0.051967567  0.046704622  0.048087260 -0.2557266645 -1.178871e-01
## Type_C       -0.016911522 -0.005388315 -0.090026625  0.4075224935  1.726276e-01
## Size         -0.014953982  0.008268893  0.016888929 -0.1196165401 -2.453827e-03
## Temperature  -0.290872963  0.011021819 -0.066663694 -0.0049459406 -5.871443e-01
## Fuel_Price   -0.224696355 -0.124326140  0.027088672 -0.0677477967  2.147245e-01
## MarkDown1     0.071395327 -0.148722198 -0.054028221 -0.0292195316  3.925485e-02
## MarkDown2    -0.264198371  0.143078463 -0.467690896 -0.0664937901 -1.026669e-01
## MarkDown3     0.002401877  0.273300215 -0.477165739 -0.0470998594 -4.538315e-02
## MarkDown4     0.083847097 -0.241194449 -0.081107535 -0.0008326417  1.811359e-02
## MarkDown5     0.408496632  0.641238287  0.314421877  0.2082893346 -1.865270e-01
## CPI          -0.126280354  0.212472767  0.122309601 -0.4708447432  3.336853e-01
## Unemployment -0.283622099  0.452012463  0.159435076 -0.1608653752  3.697968e-01
## Year         -0.146334233 -0.002483245  0.060832279 -0.0365537208  1.125417e-01
## Month         0.277924550 -0.269961065 -0.082262970 -0.0517141279  3.823286e-01
## Day           0.459901246 -0.097265167  0.083972506  0.0329275677  3.020507e-02
##                     PC16          PC17          PC18          PC19
## Store        -0.0201653518  0.0064646965 -0.0080510752 -7.788021e-14
## Dept         -0.0002017792 -0.0005154555  0.0001926768  4.343564e-15
## IsHoliday    -0.0208226765  0.0002087695  0.0156194400  6.273852e-16
## Type_A        0.4125947234 -0.0208444350  0.0374472527 -6.574321e-01
## Type_B       -0.1733601306  0.0108628680 -0.0403525786 -6.408318e-01
## Type_C       -0.4040517639  0.0170102351  0.0031287872 -3.963807e-01
## Size         -0.7802905632  0.0456654150 -0.1224051099  9.108548e-16
## Temperature  -0.0268032451  0.0109099849 -0.0198922461  3.097591e-16
## Fuel_Price   -0.0677427660 -0.4165298231  0.4547674844  3.375827e-16
## MarkDown1    -0.0038527297  0.5679082814  0.4838312343 -4.412066e-16
## MarkDown2     0.0126969980 -0.0605410731  0.0110476373  3.074830e-17
## MarkDown3     0.0133030849  0.0070851851  0.0066958749 -1.055134e-16
## MarkDown4     0.0319323891 -0.5663149078 -0.3339511006  2.342835e-16
## MarkDown5     0.0018146579 -0.1332996200  0.0632993671 -3.597752e-17
## CPI          -0.0591193049 -0.0919004682  0.0913705932 -2.443829e-16
## Unemployment  0.0837632981  0.0505364259 -0.0865456794 -1.651853e-16
## Year          0.0917821075  0.3792262438 -0.6296045956  7.958731e-16
## Month         0.0329757944  0.0609653457 -0.1113671062  5.321175e-16
## Day           0.0073597391 -0.0130023773  0.0050564269 -8.880060e-16
```

```
# Taking the first three PCs to generate linear combinations for all the variables with three factors
pcafactors.dataset <- eigvec.dataset[,1:3]
pcafactors.dataset
```

```
##                       PC1          PC2          PC3
## Store          0.101338347  0.091916309 -0.513516476
## Dept          -0.004080003 -0.007831044 -0.046139485
## IsHoliday      0.012198689 -0.042117612  0.122765651
## Type_A        -0.269997489 -0.528338823 -0.185112881
## Type_B         0.146653872  0.403632005  0.488509836
## Type_C         0.210717990  0.223741121 -0.482751803
## Size          -0.300383406 -0.464123852  0.028723361
## Temperature    0.019910709  0.010812768 -0.218666013
## Fuel_Price    -0.275443967  0.294661098 -0.203742513
## MarkDown1     -0.453413949  0.200206338  0.005221163
## MarkDown2     -0.141257544  0.020994379  0.103183191
## MarkDown3     -0.009497715 -0.034055919  0.081007342
## MarkDown4     -0.390865591  0.174396291  0.014503077
## MarkDown5     -0.335044476  0.096936758 -0.035119875
## CPI           -0.056574087 -0.083696668  0.141163027
## Unemployment   0.171545851  0.020992482 -0.259550101
## Year          -0.389065387  0.314135135 -0.130186448
## Month          0.077922298 -0.079345988  0.005109959
## Day            0.059412275 -0.036413098  0.006627105
```

```
# Multiplying each column of the eigenvector's matrix by the square-root of the corresponding eigenvalue in order to get the factor loadings
unrot.fact.dataset <- sweep(pcafactors.dataset,MARGIN=2,dataset_pca$sdev[1:3],`*`)
unrot.fact.dataset
```

```
##                      PC1         PC2          PC3
## Store         0.175838825  0.14259909 -0.691458506
## Dept         -0.007079482 -0.01214909 -0.062127586
## IsHoliday     0.021166747 -0.06534132  0.165305998
## Type_A       -0.468490387 -0.81966556 -0.249257584
## Type_B        0.254468772  0.62619524  0.657786648
## Type_C        0.365630632  0.34711228 -0.650033361
## Size         -0.521214989 -0.72004237  0.038676485
## Temperature   0.034548379  0.01677494 -0.294437436
## Fuel_Price   -0.477940930  0.45713763 -0.274342695
## MarkDown1    -0.786748341  0.31060038  0.007030383
## MarkDown2    -0.245105248  0.03257071  0.138937890
## MarkDown3    -0.016480109 -0.05283440  0.109077738
## MarkDown4    -0.678216576  0.27055864  0.019528636
## MarkDown5    -0.581357690  0.15038782 -0.047289498
## CPI          -0.098165416 -0.12984712  0.190078372
## Unemployment  0.297660481  0.03256776 -0.349488544
## Year         -0.675092922  0.48734967 -0.175298225
## Month         0.135208101 -0.12309747  0.006880645
## Day           0.103090143 -0.05649133  0.008923507
```

```
# Computing communalities
communalities.dataset <- rowSums(unrot.fact.dataset^2)
communalities.dataset
```

```
##        Store         Dept    IsHoliday       Type_A       Type_B       Type_C
##  0.529368657  0.004057557  0.032043592  0.953464223  0.889558106  0.676716062
##         Size  Temperature   Fuel_Price    MarkDown1    MarkDown2    MarkDown3
##  0.791621953  0.088168393  0.512666256  0.715494977  0.080441171  0.014961020
##    MarkDown4    MarkDown5          CPI Unemployment         Year        Month
##  0.533561069  0.362829556  0.062626512  0.211804663  0.723989625  0.033481562
##          Day
##  0.013898477
```

```
# Performing the varimax rotation. The default in the varimax function is norm=TRUE thus, Kaiser normalization is carried ou
t
rot.fact.dataset <- varimax(unrot.fact.dataset)
rot.fact.dataset
```

```
## $loadings
##
## Loadings:
##              PC1    PC2    PC3
## Store                       -0.725
## Dept
## IsHoliday                    0.167
## Type_A              -0.972
## Type_B               0.859  0.388
## Type_C               0.223 -0.785
## Size                -0.813  0.350
## Temperature                 -0.288
## Fuel_Price   -0.659         -0.270
## MarkDown1    -0.835          0.103
## MarkDown2    -0.219          0.177
## MarkDown3                    0.120
## MarkDown4    -0.720          0.101
## MarkDown5    -0.581 -0.150
## CPI                          0.235
## Unemployment  0.217         -0.404
## Year         -0.838         -0.140
## Month         0.178
## Day           0.118
##
##                  PC1   PC2   PC3
## SS loadings    2.858 2.454 1.919
## Proportion Var 0.150 0.129 0.101
## Cumulative Var 0.150 0.280 0.381
##
## $rotmat
##             [,1]      [,2]       [,3]
## [1,]  0.86667124 0.4429721 -0.2294705
## [2,] -0.49390610 0.8266632 -0.2696012
## [3,]  0.07026897 0.3469924  0.9352318
```

```
# The print method of varimax omits loadings less than abs(0.1). In order to display all the loadings, it is necessary to as
k explicitly the contents of the object $loadings
fact.load.dataset <- rot.fact.dataset$loadings[1:7,1:3]
fact.load.dataset
```

```
##                    PC1         PC2         PC3
## Store      0.033375818 -0.04415777 -0.72546868
## Dept      -0.004500715 -0.03473702 -0.05320375
## IsHoliday  0.062232970  0.01272095  0.16735838
## Type_A    -0.018704397 -0.97160599  0.09537388
## Type_B    -0.042518892  0.85862209  0.38796695
## Type_C     0.099763507  0.22335243 -0.78541517
## Size      -0.093370964 -0.81269574  0.34989919
```

```
# Computing the rotated factor scores
scale.dataset <- scale(select(dataset,features))
scale.dataset[1:10,]
```

```
##           Store      Dept  IsHoliday    Type_A     Type_B     Type_C      Size
##  [1,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [2,] -1.658197 -1.560343  3.6349564 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [3,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [4,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [5,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [6,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [7,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [8,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##  [9,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
## [10,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##       Temperature Fuel_Price  MarkDown1  MarkDown2   MarkDown3  MarkDown4
##  [1,]  -0.9637969  -1.720832 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [2,]  -1.1697821  -1.773175 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [3,]  -1.0928087  -1.847328 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [4,]  -0.7296243  -1.744823 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [5,]  -0.7366712  -1.605241 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [6,]  -0.1246784  -1.513641 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [7,]  -0.2986817  -1.398051 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [8,]  -0.4683484  -1.371879 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##  [9,]   0.1181672  -1.400232 -0.4279428 -0.1730687 -0.08466239 -0.2781163
## [10,]   0.3127690  -1.289003 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##        MarkDown5      CPI Unemployment      Year      Month        Day
##  [1,] -0.3951803 1.018773   0.07820083 -1.215485 -1.3719433 -1.2192919
##  [2,] -0.3951803 1.022497   0.07820083 -1.215485 -1.3719433 -0.4196162
##  [3,] -0.3951803 1.023696   0.07820083 -1.215485 -1.3719433  0.3800594
##  [4,] -0.3951803 1.024475   0.07820083 -1.215485 -1.3719433  1.1797350
##  [5,] -0.3951803 1.025254   0.07820083 -1.215485 -1.0636075 -1.2192919
##  [6,] -0.3951803 1.026033   0.07820083 -1.215485 -1.0636075 -0.4196162
##  [7,] -0.3951803 1.021819   0.07820083 -1.215485 -1.0636075  0.3800594
##  [8,] -0.3951803 1.016773   0.07820083 -1.215485 -1.0636075  1.1797350
##  [9,] -0.3951803 1.011727  -0.08173081 -1.215485 -0.7552717 -1.5620100
## [10,] -0.3951803 1.006681  -0.08173081 -1.215485 -0.7552717 -0.7623344
```

```
print(head(as.matrix(scale.dataset)))
```

```
##          Store      Dept  IsHoliday    Type_A     Type_B     Type_C      Size
## [1,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
## [2,] -1.658197 -1.560343  3.6349564 0.9779769 -0.7959371 -0.3352624 0.2392087
## [3,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
## [4,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
## [5,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
## [6,] -1.658197 -1.560343 -0.2751058 0.9779769 -0.7959371 -0.3352624 0.2392087
##      Temperature Fuel_Price  MarkDown1  MarkDown2   MarkDown3  MarkDown4
## [1,]  -0.9637969  -1.720832 -0.4279428 -0.1730687 -0.08466239 -0.2781163
## [2,]  -1.1697821  -1.773175 -0.4279428 -0.1730687 -0.08466239 -0.2781163
## [3,]  -1.0928087  -1.847328 -0.4279428 -0.1730687 -0.08466239 -0.2781163
## [4,]  -0.7296243  -1.744823 -0.4279428 -0.1730687 -0.08466239 -0.2781163
## [5,]  -0.7366712  -1.605241 -0.4279428 -0.1730687 -0.08466239 -0.2781163
## [6,]  -0.1246784  -1.513641 -0.4279428 -0.1730687 -0.08466239 -0.2781163
##       MarkDown5      CPI Unemployment      Year     Month        Day
## [1,] -0.3951803 1.018773   0.07820083 -1.215485 -1.371943 -1.2192919
## [2,] -0.3951803 1.022497   0.07820083 -1.215485 -1.371943 -0.4196162
## [3,] -0.3951803 1.023696   0.07820083 -1.215485 -1.371943  0.3800594
## [4,] -0.3951803 1.024475   0.07820083 -1.215485 -1.371943  1.1797350
## [5,] -0.3951803 1.025254   0.07820083 -1.215485 -1.063607 -1.2192919
## [6,] -0.3951803 1.026033   0.07820083 -1.215485 -1.063607 -0.4196162
```

```
solve(t(fact.load.dataset)%*%fact.load.dataset)
```

```
##           PC1        PC2       PC3
## PC1 97.721586 -2.5263148  9.270060
## PC2 -2.526315  0.4869228 -0.186569
## PC3  9.270060 -0.1865690  1.572842
```

```
fit.pc <- principal((select(dataset,features)), nfactors=3, rotate="varimax")
```

```
## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
```

```
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.
```

```
## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.

## Warning in pchisq(df = result$dof, ncp = x, q = result$STATISTIC):
## pnchisq(x=1.41338e+07, ..): not converged in 1000000 iter.
```

```
fit.pc
```

```
## Principal Components Analysis
## Call: principal(r = (select(dataset, features)), nfactors = 3, rotate = "varimax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                RC1   RC2   RC3     h2    u2 com
## Store        -0.03  0.04  0.73 0.5294 0.471 1.0
## Dept          0.00  0.03  0.05 0.0041 0.996 1.7
## IsHoliday    -0.06 -0.01 -0.17 0.0320 0.968 1.3
## Type_A        0.02  0.97 -0.10 0.9535 0.047 1.0
## Type_B        0.04 -0.86 -0.39 0.8896 0.110 1.4
## Type_C       -0.10 -0.22  0.79 0.6767 0.323 1.2
## Size          0.09  0.81 -0.35 0.7916 0.208 1.4
## Temperature   0.00  0.07  0.29 0.0882 0.912 1.1
## Fuel_Price    0.66 -0.07  0.27 0.5127 0.487 1.4
## MarkDown1     0.83  0.09 -0.10 0.7155 0.285 1.1
## MarkDown2     0.22  0.03 -0.18 0.0804 0.920 2.0
## MarkDown3    -0.02  0.01 -0.12 0.0150 0.985 1.1
## MarkDown4     0.72  0.07 -0.10 0.5336 0.466 1.1
## MarkDown5     0.58  0.15 -0.05 0.3628 0.637 1.1
## CPI           0.01  0.08 -0.24 0.0626 0.937 1.3
## Unemployment -0.22 -0.04  0.40 0.2118 0.788 1.6
## Year          0.84 -0.04  0.14 0.7240 0.276 1.1
## Month        -0.18  0.04 -0.01 0.0335 0.967 1.1
## Day          -0.12  0.00  0.00 0.0139 0.986 1.0
##
##                        RC1  RC2  RC3
## SS loadings           2.86 2.45 1.92
## Proportion Var        0.15 0.13 0.10
## Cumulative Var        0.15 0.28 0.38
## Proportion Explained  0.40 0.34 0.27
## Cumulative Proportion 0.40 0.73 1.00
##
## Mean item complexity =  1.3
## Test of the hypothesis that 3 components are sufficient.
##
## The root mean square of the residuals (RMSR) is  0.09
##  with the empirical chi square  1098154  with prob <  0
##
## Fit based upon off diagonal values = 0.77
```

```
round(fit.pc$values, 3)
```

```
##  [1] 3.011 2.407 1.813 1.518 1.383 1.246 1.190 0.998 0.955 0.884 0.818 0.714
## [13] 0.622 0.513 0.448 0.216 0.151 0.112 0.000
```

```
fit.pc$loadings
```

```
##
## Loadings:
##              RC1    RC2    RC3
## Store                        0.725
## Dept
## IsHoliday                   -0.167
## Type_A                0.972
## Type_B               -0.859 -0.388
## Type_C               -0.223  0.785
## Size                  0.813 -0.350
## Temperature                  0.288
## Fuel_Price    0.659          0.270
## MarkDown1     0.835         -0.103
## MarkDown2     0.219         -0.177
## MarkDown3                   -0.120
## MarkDown4     0.720         -0.101
## MarkDown5     0.581  0.150
## CPI                         -0.235
## Unemployment -0.217          0.404
## Year          0.838          0.140
## Month        -0.178
## Day          -0.118
##
##                    RC1   RC2   RC3
## SS loadings      2.858 2.454 1.919
## Proportion Var   0.150 0.129 0.101
## Cumulative Var   0.150 0.280 0.381
```

```
# Loadings with more digits
pc.load.dataset <- fit.pc$loadings[1:7,1:3]
print(pc.load.dataset)
```

```
##                    RC1         RC2         RC3
## Store     -0.033375818  0.04415777  0.72546868
## Dept       0.004500715  0.03473702  0.05320375
## IsHoliday -0.062232970 -0.01272095 -0.16735838
## Type_A     0.018704397  0.97160599 -0.09537388
## Type_B     0.042518892 -0.85862209 -0.38796695
## Type_C    -0.099763507 -0.22335243  0.78541517
## Size       0.093370964  0.81269574 -0.34989919
```

```
# Communalities
fit.pc$communality
```

```
##        Store         Dept    IsHoliday       Type_A       Type_B       Type_C
##  0.529368657  0.004057557  0.032043592  0.953464223  0.889558106  0.676716062
##         Size  Temperature   Fuel_Price    MarkDown1    MarkDown2    MarkDown3
##  0.791621953  0.088168393  0.512666256  0.715494977  0.080441171  0.014961020
##    MarkDown4    MarkDown5          CPI Unemployment         Year        Month
##  0.533561069  0.362829556  0.062626512  0.211804663  0.723989625  0.033481562
##          Day
##  0.013898477
```

```
# Rotated factor scores
fit.pc$scores[1:10,]
```

```
##              RC1       RC2        RC3
##  [1,] -0.9919166 0.6921177 -1.2141877
##  [2,] -1.1401967 0.6385139 -1.6131994
##  [3,] -1.0897467 0.6947256 -1.2596406
##  [4,] -1.0964374 0.7097867 -1.1893738
##  [5,] -0.9827354 0.7051447 -1.1635490
##  [6,] -0.9908440 0.7319005 -1.0560759
##  [7,] -0.9969759 0.7219564 -1.0671742
##  [8,] -1.0247229 0.7152478 -1.0914698
##  [9,] -0.9239868 0.7404549 -1.0303553
## [10,] -0.9293602 0.7474143 -0.9843901
```

```
# Factor Analysis utilities
fa.parallel(select(dataset,features))
```

```
## In smc, smcs < 0 were set to .0
## In smc, smcs < 0 were set to .0
## In smc, smcs < 0 were set to .0
```

```
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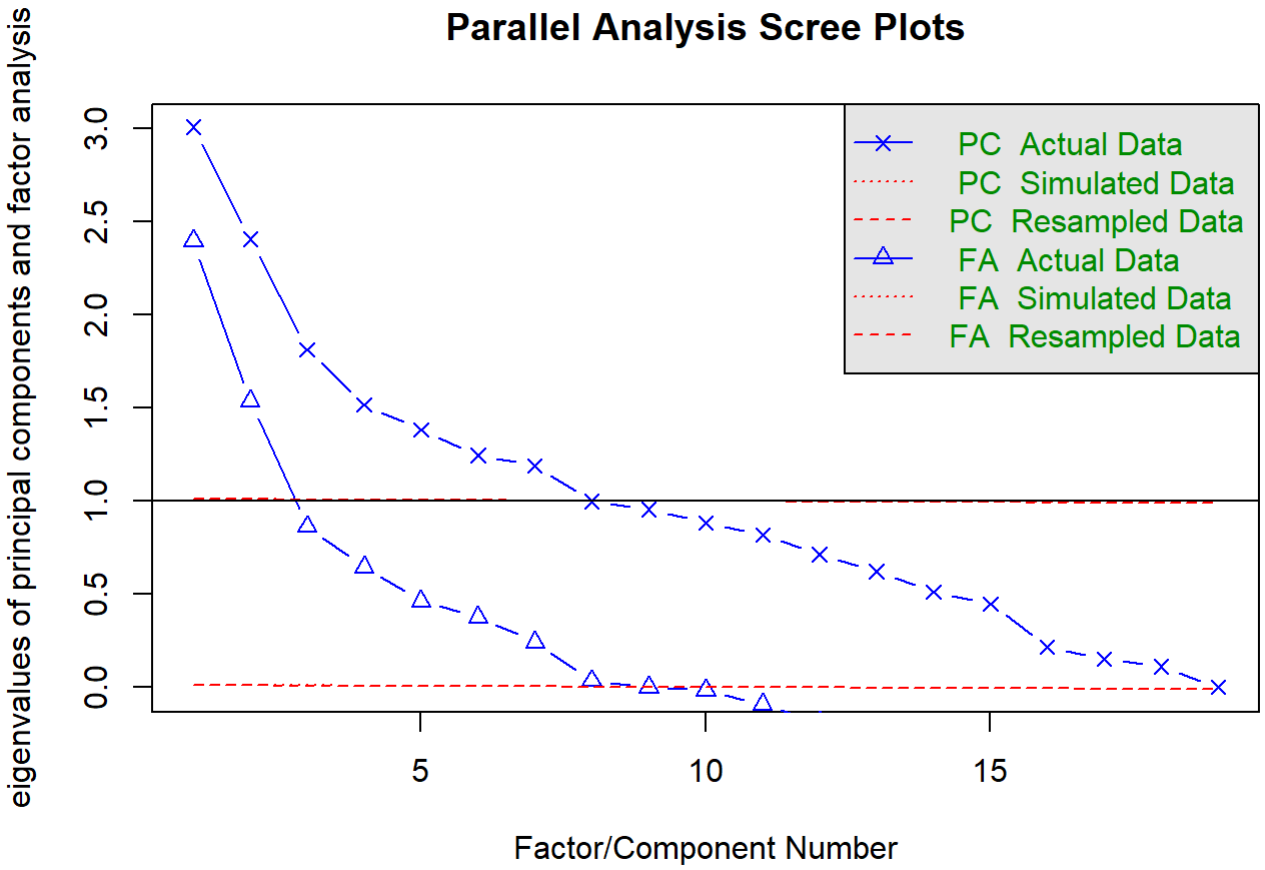
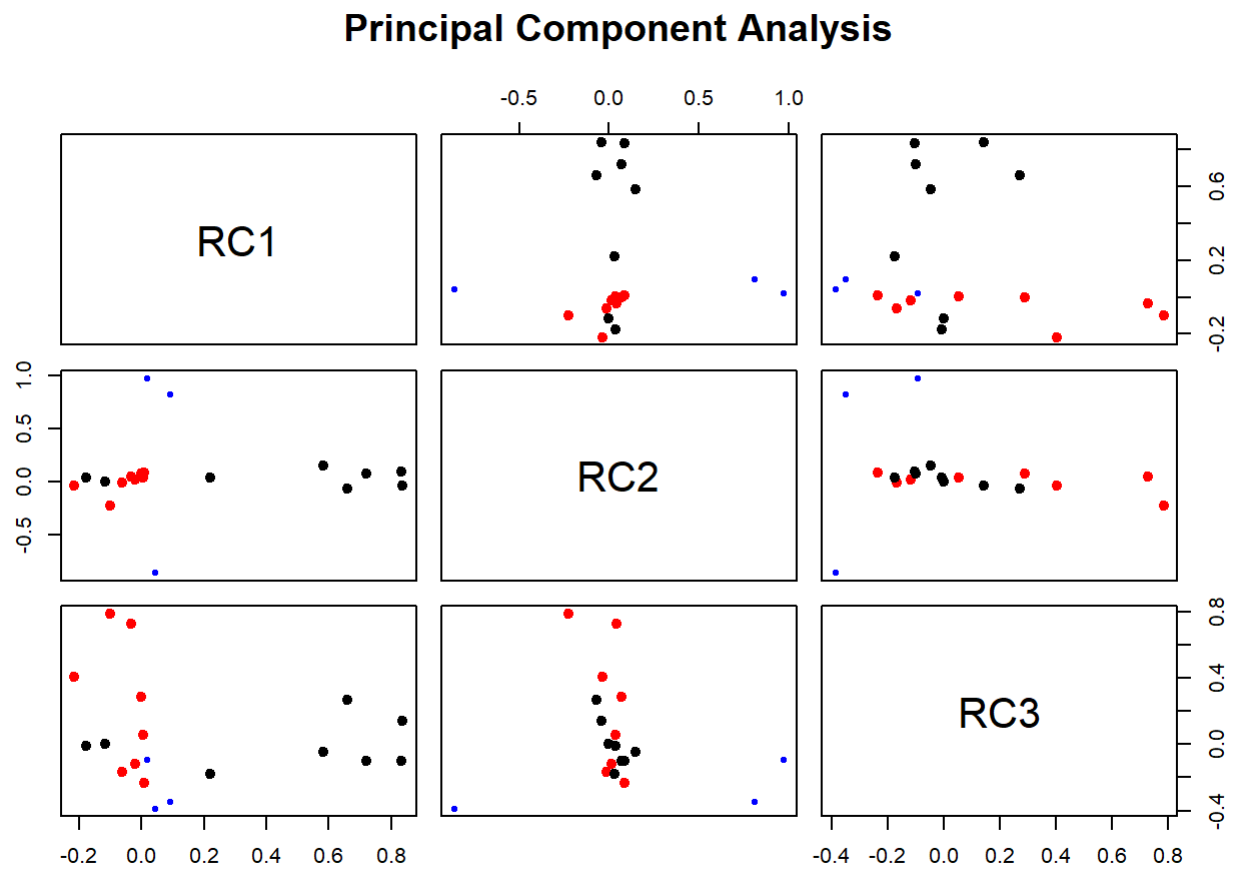
```

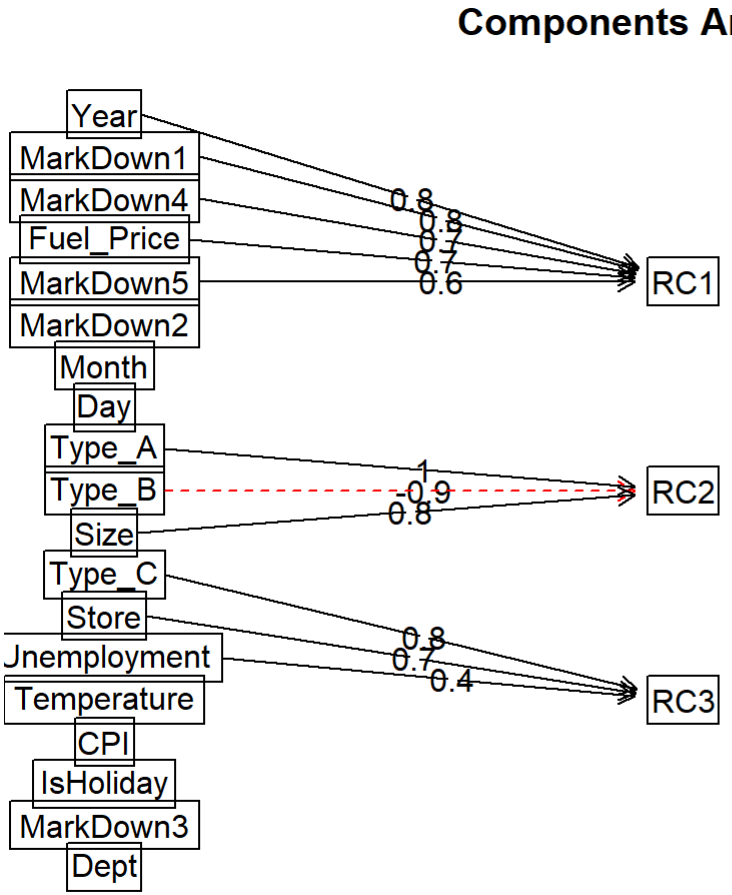



```
## Parallel analysis suggests that the number of factors =  8  and the number of components =  7
```

```
#Based on the plot, we should retain two factors(based on the first elbow)
fa.plot(fit.pc)
```




```
fa.diagram(fit.pc)
```




```
#This diagram visualizes the relationship

vss(select(dataset,features))
```

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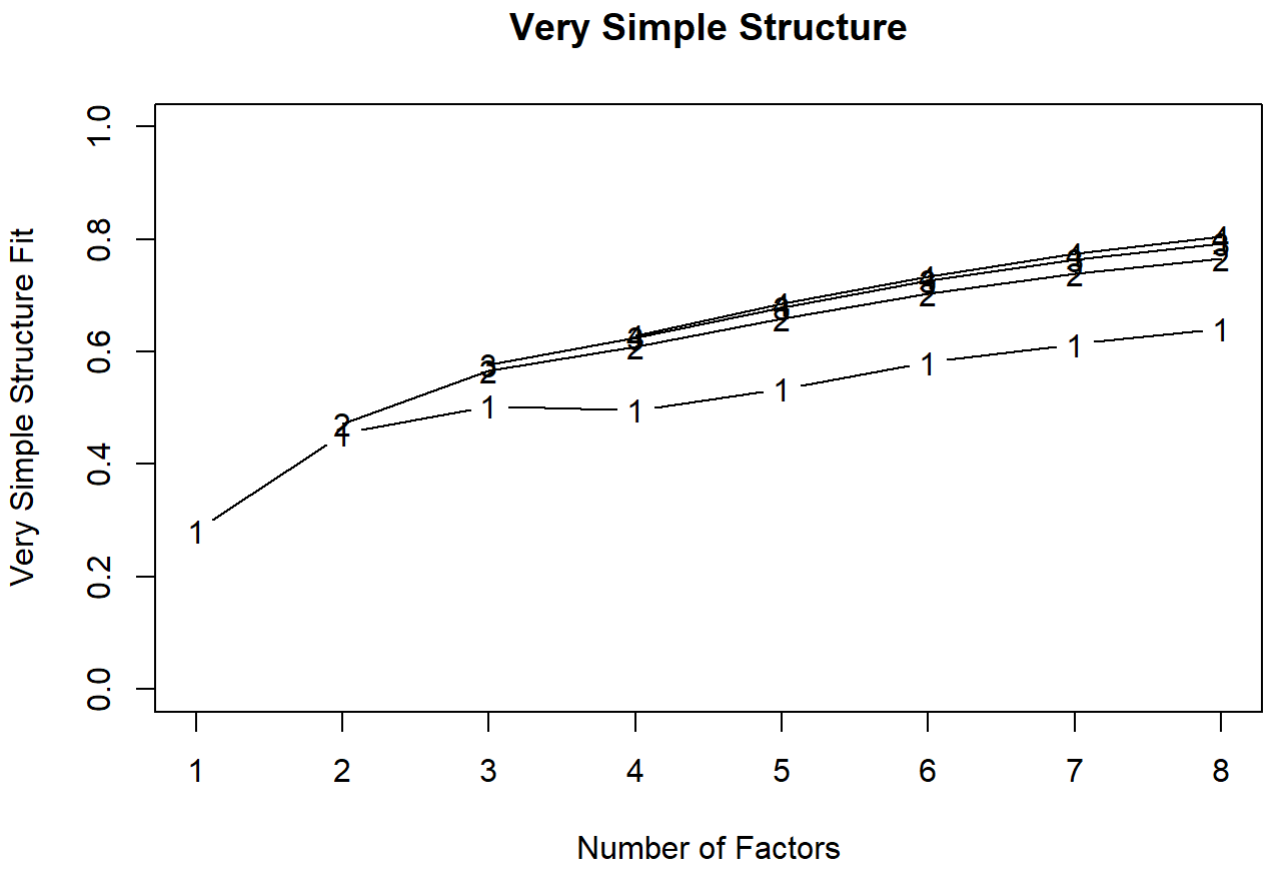
```

```
## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs = np.obs, :
## The estimated weights for the factor scores are probably incorrect. Try a
## different factor score estimation method.
```

```
## Warning in fac(r = r, nfactors = nfactors, n.obs = n.obs, rotate = rotate, : An
## ultra-Heywood case was detected. Examine the results carefully
```


Very Simple Structure
Very Simple Structure Fit
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
8
Number of Factors

```
##
## Very Simple Structure
## Call: vss(x = select(dataset, features))
## Although the VSS complexity 1 shows  8  factors, it is probably more reasonable to think about  3  factors
## VSS complexity 2 achieves a maximimum of 0.77  with  8  factors
##
## The Velicer MAP achieves a minimum of 0.04  with  1  factors
## BIC achieves a minimum of  12065348  with  8  factors
## Sample Size adjusted BIC achieves a minimum of  12065497  with  8  factors
##
## Statistics by number of factors
##   vss1 vss2   map dof   chisq prob sqresid  fit RMSEA     BIC   SABIC complex
## 1 0.28 0.00 0.037 152 1.5e+07    0    21.6 0.28  0.49 1.5e+07 1.5e+07     1.0
## 2 0.45 0.47 0.042 134 1.5e+07    0    15.9 0.47  0.51 1.5e+07 1.5e+07     1.2
## 3 0.50 0.57 0.044 117 1.3e+07    0    12.8 0.58  0.52 1.3e+07 1.3e+07     1.4
## 4 0.50 0.61 0.049 101 1.3e+07    0    11.2 0.63  0.54 1.3e+07 1.3e+07     1.5
## 5 0.53 0.66 0.055  86 1.2e+07    0     9.4 0.69  0.58 1.2e+07 1.2e+07     1.7
## 6 0.58 0.70 0.056  72 1.2e+07    0     7.8 0.74  0.63 1.2e+07 1.2e+07     1.6
## 7 0.61 0.74 0.056  59 1.2e+07    0     6.6 0.78  0.70 1.2e+07 1.2e+07     1.5
## 8 0.64 0.77 0.068  47 1.2e+07    0     5.6 0.81  0.78 1.2e+07 1.2e+07     1.5
##    eChisq  SRMR eCRMS    eBIC
## 1 2700345 0.137 0.145 2698376
## 2 1355106 0.097 0.110 1353370
## 3  775467 0.073 0.089  773952
## 4  468277 0.057 0.074  466969
## 5  286518 0.045 0.063  285404
## 6  147110 0.032 0.049  146178
## 7   41654 0.017 0.029   40890
## 8   18931 0.011 0.022   18322
```