P1

GR5241
HW1
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HW1

1. $P(X|\theta) = P(X|\mu,\nu) = \left(\frac{\nu}{\mu}\right)^{\nu} \frac{X^{\nu-1}}{\Gamma(\nu)} \exp\left(-\frac{\nu X}{\mu}\right)$

$L(\theta) = \prod_{i=1}^{n} P(X_i|\theta) = \left(\frac{\nu}{\mu}\right)^{n\nu} \frac{\prod X_i^{\nu-1}}{\Gamma^{(n)}(\nu)} \exp\left(-\frac{\nu}{\mu}\sum_{i=1}^{n} X_i\right)$

suppose $l(\theta)$ to be log-likelihood.

$l(\theta) = \log L(\theta) = n\nu(\log\nu - \log\mu) - n\log\Gamma(\nu) + \sum_{i=1}^{n}(\nu-1)\log(X_i) - \frac{\nu}{\mu}\sum_{i=1}^{n} X_i$

2. ① $\frac{\partial l(\theta)}{\partial \mu} = -\frac{1}{\mu} n\nu + \frac{\nu}{\mu^2}\sum_{i=1}^{n} X_i = 0 \Rightarrow \frac{\sum_{i=1}^{n} X_i}{\mu} = n \quad \hat{\mu} = \frac{\Sigma X_i}{n}$

3. ② $\frac{\partial l(\theta)}{\partial \nu} = n(\log\nu - \log\mu) + n - n\frac{\Gamma'(\nu)}{\Gamma(\nu)} + \sum_{i=1}^{n}\log(X_i) - \frac{\sum_{i=1}^{n} X_i}{\mu} = 0$

$\Rightarrow n(\log\nu - \log\mu) + \Sigma\log X_i = \Sigma\log\left(\frac{X_i\hat{\nu}}{\mu}\right)$

$-n\frac{\Gamma'(\nu)}{\Gamma(\nu)} = -\Sigma\phi(\hat{\nu})$

So ② $= \Sigma\log\left(\frac{X_i\hat{\nu}}{\mu}\right) - \frac{\Sigma X_i}{\mu} + n - \Sigma\phi(\hat{\nu}) = \Sigma\left(\log\left(\frac{X_i\hat{\nu}}{\mu}\right) - \left(\frac{X_i}{\mu} - 1\right) - \phi(\hat{\nu})\right) = 0$

P2. our target is to get $\min R(f)$, due to monotonicity of integral, $\min R(f)$ is to get $\min R(f|x)$ $\left(R(f) = \int_{R^d} R(f(x))\,p(x)\,dx\right)$

So we need to find f to get $\min R(f|x) = \sum_{y\in[k]} L^{0-1}(y, f(x))\,P(y|x)$

$f(x) = \underset{y\in[k]}{\operatorname{argmin}} \sum_{y\in[k]} L^{0-1}(y, f(x))\,P(y|x)$

$= \underset{y\in[k]}{\operatorname{argmin}}\,(1 - P(y|x))$ (explain: mismatch loss is 1 and match Loss 0

$0\cdot P(\text{match}) + 1\cdot P(\text{mismatch})$

$= 1\cdot(1 - P(\text{match})) = 1 - P(y|x)$

So $f(x) = \arg\max_{y \in [K]} P(y|x)$

this is exactly $f_0(x) = \arg\max_{y \in [K]} P(y|x)$

So $f_0(x)$ is the classifier with minimum $R(f|x)$, i.e. $\min R(f)$.

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Problem 3

1

First I copied the chart in Wiki with all their symbols to Excel.Then I copied the symbol column and paste with transpose. Finally I get longstring here.

```
options("getSymbols.yahoo.warning"=FALSE)
options("getSymbols.warning4.0"=FALSE)
options(warn = F)
library(quantmod,warn.conflicts = F)
```

```
## Loading required package: xts
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: TTR
```

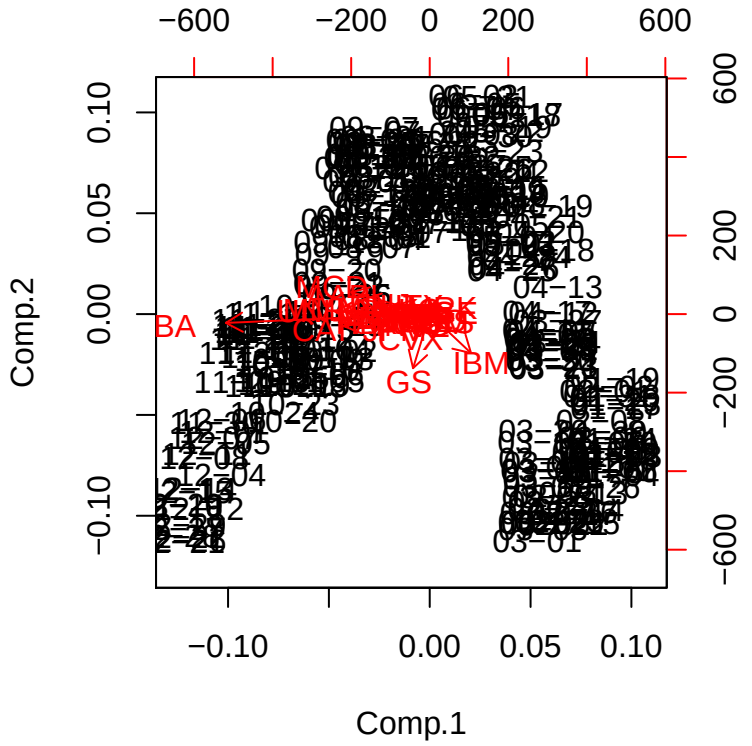
```
## Version 0.4-0 included new data defaults. See ?getSymbols.
```

```
longstring="AAPL    AXP BA  CAT CSCO    CVX DIS DWDP    GE  GS  HD  IBM INTC    JNJ JPM KO  MCD MMM MRK
"
DJIname <- strsplit(longstring,split = "\t")
DJIname <- DJIname[[1]]#unlist it
DJIname[30] <- "XOM"#final term has a \n
data <- getSymbols("AAPL", auto.assign = F, from = "2017-01-01", to = "2018-01-01")
#initialize data to get number of columns
data <- data[,4]
#since I only use the close price,I pick it up manually

for(i in 2:30){
  datatemp <- getSymbols(DJIname[i], auto.assign = F,
              from = "2017-01-01", to = "2018-01-01")
  #since we only take use of close price,I think to get it first is better
  datatemp <- datatemp[,4]
  data <- cbind.data.frame(data,datatemp)
}
#A for-loop to get other data and put to them into one dataframe.

colnames(data) <- DJIname
for(i in 1:nrow(data)){
  tempname <- substr(rownames(data)[i],start = 6,stop=nchar(rownames(data)[i]))
  rownames(data)[i] <- tempname
```

```
}
#rename colunms and rows
```

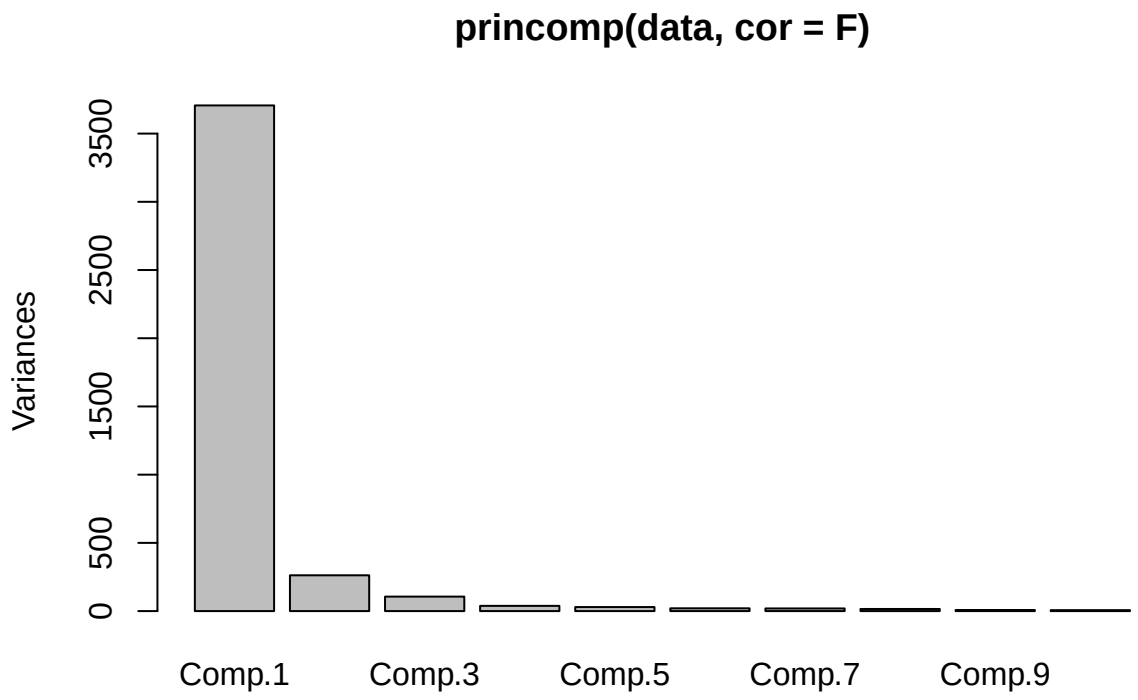
2

```
biplot(princomp(data,cor=F))
```



The biplot here is not very informative since all vectors are very condensed in the picture.

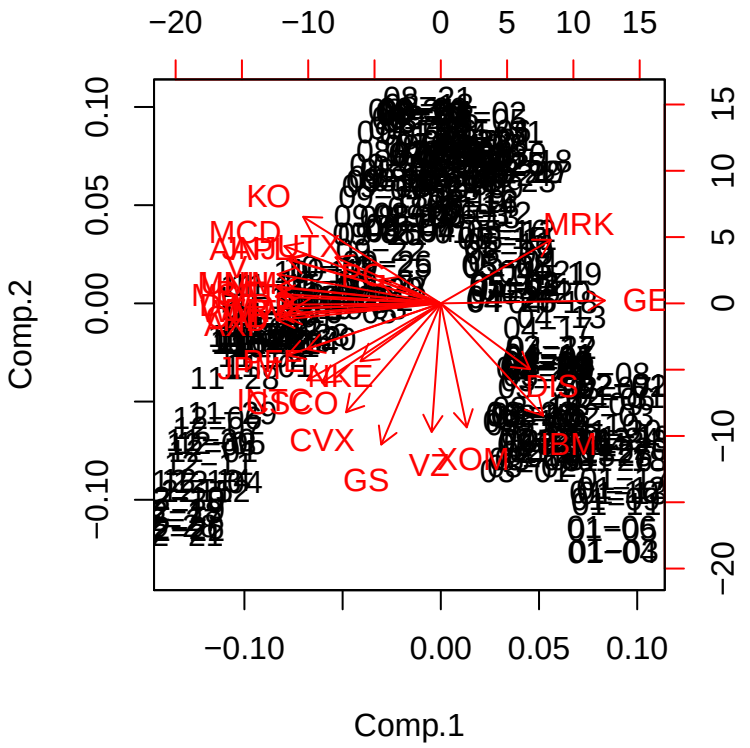
```
screeplot(princomp(data,cor=F))
```



The screeplot here shows that component 1 takes most of variance. I think only one component is really important.

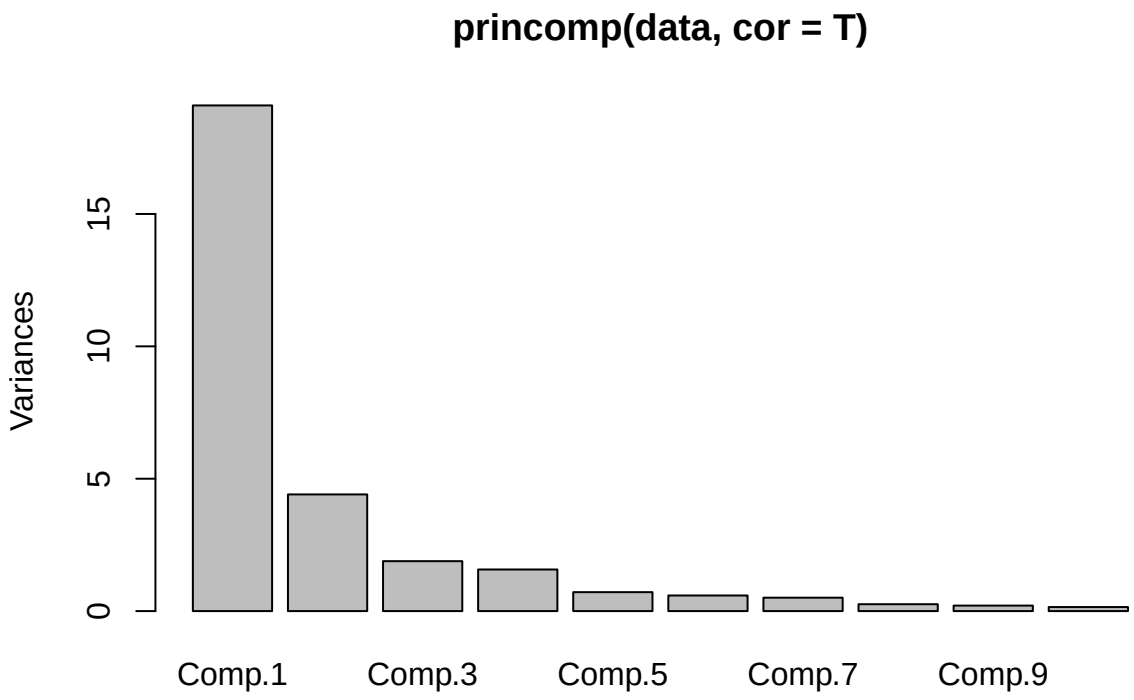
3

```
biplot(princomp(data,cor=T))
```



After modification of scale,I think this time the biplot is much more informatice. I noticed that McDonald and Coca-Cola are very closed to each and they are all food companies.Also,most finacial companies like JPMorgan,Travelers and Visa are of negative component 2 and are closed to each. Maybe Goldman Sachs veries here.

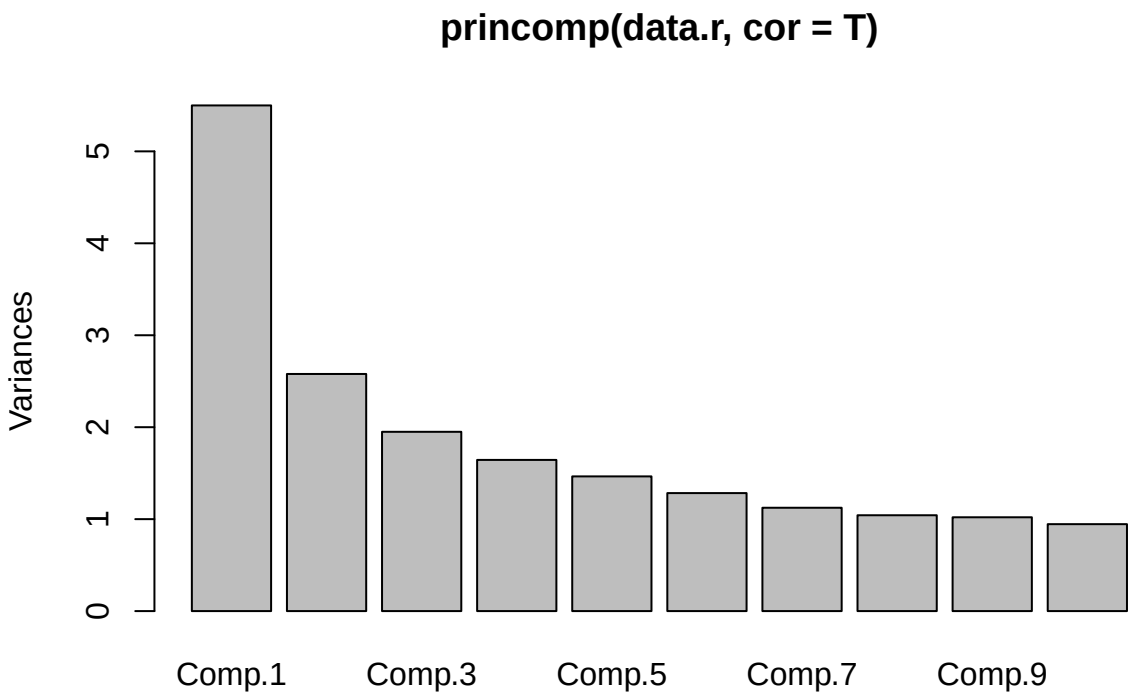
```
screeplot(princomp(data,cor=T))
```



This time,the screelot shows that Component 2 may count for something,too.

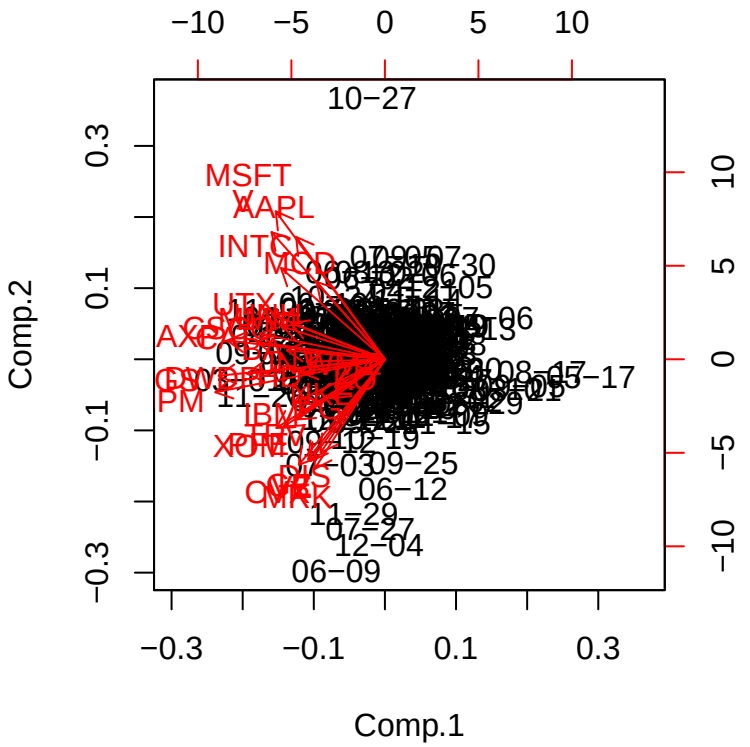
4

```
data <- as.matrix(data)
data.lag <- diff(data,lag=1,differences = 1)
data <- data[-1,]
data.r <- data.lag/data
screeplot(princomp(data.r,cor=T))
```



The screeplot here shows that only component 1 and 2 could not explain all variance.Many other components do make sense.

```
biplot(princomp(data.r,cor=T))
```



The biplot show that all stocks are of negative component 1. I think this tell us some information about the whole market trend since they are all in one direction.

If the stocks fluctuate randomly and independent to each,I think the direction of each stock vector should distribute more uniform, just like a circle.