Stock Prediction

OK paper but DO NOT print pages and pages of raw data in a paper.

1.Background

Abstract: Predicting stock price using machine learning techniques

Stock market prediction is the act of trying to determine the future value of a company stock or other financial instrument traded on an exchange. Everybody wants to know the prediction. In the past, many people had used support vector machine (SVM), which is a very specific type of learning algorithms characterized by the capacity control of the decision function, to do predict. But it is not very precisely. In my project, I will combine some other regression models on this method and try to do some more changes. A good prediction of stock price is which can help people to do right decision, and just help.

Background

We always confused and interested with that if we can predict the stock market accurately? If the answer is yes, many people will cheer. But in actual, we are not sure about that. The changes of the price of stock is just a time-varying sequence. We can express it by Price=Market(t). But what is the function of Market? We can try many models, like linear regression, nonlinear regression, logistic regression or other probability models. But there is no model can match the trend exactly. Some models can only do some not very accurate predictions in a specific range.So my purpose is to use different machine learning methods to do a much more accurate prediction of stock price.

In particular, numerous studies have been conducted to predict the movement of stock market using machine learning algorithms such as support vector machine (SVM). In my project, I propose a new way to predict the price of the stock, just like: collecting different models as a whole to do prediction. In my project, I will just predict some particular stocks.

In conclusion, combined methods are preferred because they can combine the methods advantages to do predict. Such as Linear Regression and Naive Bayes. In addition, SVM (Support Vector Machine) and LRMC (Logistic Regression/ Markov Chain) models are also mentioned a lot of studies. However if we want to do prediction, there will be many difficulties. Because in actual, there are so many factors will influence the price, just like: maybe someday one company's CEO has been reported some sex scandals, and this will influence it's company's stock price sharply. And these factors are those which we can't predict. The prediction process will be very interesting because history is always surprisingly similar with now.

2.Data Description

I plan to use dataset of S&P500, Dow30,and NASDAQ stock price from 2006-1-1 till 2016-1-1 to do my analysis and prediction. For each day information is given on the Open, High, Low and Close prices, and also for the Volume and Adjusted close price. I hope that by my ananlysis, I can help people to do decision on the time to sell, buy or keep the stock price to make the maximum profit.

*Open Price:The price of a security at the beginning of a day of trading on the stock market. When a stock exchange opens, each security has an initial trading price at which it is bought (and sold) on the first trade of the day. Quite often, the security's open price will differ from its closing price of the day before.

High Price: One day's highest price. Low Price: One day's lowest price. Close Price:The price of a security at the ending of a day of trading on the stock market. Volume:Volume is the number of shares or contracts traded in a security or an entire market during a given period of time. Adjusted Close Price:The adjusted closing price is a useful tool when examining historical returns because it gives analysts an accurate representation of the firm's equity value beyond the simple market price.

```
#Load data
sp500<-read.csv(file="/Users/auroracongo/Desktop/S&P500.csv",header=T)
dow30<-read.csv(file="/Users/auroracongo/Desktop/Dow30.csv",header=T)
nasdaq<-read.csv(file="/Users/auroracongo/Desktop/NASDAQ.csv",header=T)
```

```
class(sp500$Date)
```

```
## [1] "factor"
```

```
date1.sp500<-strsplit(as.character(sp500$Date),split = "-")
date2.sp500<-matrix(unlist(date1.sp500),nrow=2517,ncol=3,byrow=T)
date3.sp500<-data.frame(date2.sp500)
sp500.n<-cbind("sp500",date3.sp500,sp500[,-1])
summary(sp500.n)
```

```
##   "sp500"            X1              X2              X3
##  sp500:2517   2008   : 253   10     : 221   09     :  87
##               2009   : 252   08     : 220   10     :  86
##               2010   : 252   03     : 218   11     :  86
##               2011   : 252   06     : 214   13     :  86
##               2013   : 252   07     : 213   23     :  86
##               2014   : 252   12     : 212   12     :  85
##               (Other):1004   (Other):1219   (Other):2001
##       Open             High              Low             Close
##  Min.   : 679.3   Min.   : 695.3   Min.   : 666.8   Min.   : 676.5
##  1st Qu.:1224.5   1st Qu.:1237.7   1st Qu.:1215.2   1st Qu.:1224.6
##  Median :1367.4   Median :1375.1   Median :1361.0   Median :1367.7
##  Mean   :1437.6   Mean   :1446.3   Mean   :1428.3   Mean   :1437.9
##  3rd Qu.:1649.1   3rd Qu.:1656.6   3rd Qu.:1639.8   3rd Qu.:1650.5
##  Max.   :2130.4   Max.   :2134.7   Max.   :2126.1   Max.   :2130.8
##
```

```
##      Volume              Adj.Close
##  Min.   :5.362e+08   Min.   : 676.5
##  1st Qu.:3.073e+09   1st Qu.:1224.6
##  Median :3.687e+09   Median :1367.7
##  Mean   :3.891e+09   Mean   :1437.9
##  3rd Qu.:4.447e+09   3rd Qu.:1650.5
##  Max.   :1.146e+10   Max.   :2130.8
##
```

```
colnames(sp500.n)<-
c("Stockname","Year","Month","Day","Open","High","Low","Close","Volume"
,"Adj.Close")
```

```
class(dow30$Date)
```

```
## [1] "factor"
```

```
date1.dow30<-strsplit(as.character(dow30$Date),split = "-")
date2.dow30<-matrix(unlist(date1.dow30),nrow=2517,ncol=3,byrow=T)
date3.dow30<-data.frame(date2.dow30)
dow30.n<-cbind("dow30",date3.dow30,dow30[,-1])
summary(dow30.n)
```

```
##   "dow30"           X1              X2              X3              Open
##  dow30:2517   2008   : 253   10     : 221   09     :  87   Min.   :
6547
##                2009   : 252   08     : 220   10     :  86   1st
Qu.:11113
##                2010   : 252   03     : 218   11     :  86   Median
:12566
##                2011   : 252   06     : 214   13     :  86   Mean
:12965
##                2013   : 252   07     : 213   23     :  86   3rd
Qu.:15106
##                2014   : 252   12     : 212   12     :  85   Max.
:18315
##                (Other):1004   (Other):1219   (Other):2001
##       High            Low             Close            Volume
##  Min.   : 6710   Min.   : 6470   Min.   : 6547   Min.   :  8410000
##  1st Qu.:11180   1st Qu.:11030   1st Qu.:11114   1st Qu.:113740000
##  Median :12612   Median :12481   Median :12570   Median :171770000
##  Mean   :13044   Mean   :12883   Mean   :12968   Mean   :190861665
##  3rd Qu.:15183   3rd Qu.:15045   3rd Qu.:15112   3rd Qu.:242870000
##  Max.   :18351   Max.   :18273   Max.   :18312   Max.   :738440000
##
##    Adj.Close
##  Min.   : 6547
##  1st Qu.:11114
##  Median :12570
##  Mean   :12968
##  3rd Qu.:15112
```

```
## Max.    :18312
##

colnames(dow30.n)<-
c("Stockname","Year","Month","Day","Open","High","Low","Close","Volume"
,"Adj.Close")

class(nasdaq$Date)

## [1] "factor"

date1.nasdaq<-strsplit(as.character(nasdaq$Date),split = "-")
date2.nasdaq<-matrix(unlist(date1.nasdaq),nrow=2517,ncol=3,byrow=T)
date3.nasdaq<-data.frame(date2.nasdaq)
nasdaq.n<-cbind("nasdaq",date3.nasdaq,nasdaq[,-1])
summary(nasdaq.n)

##   "nasdaq"          X1              X2              X3
Open
##  nasdaq:2517   2008   : 253   10     : 221   09     :  87   Min.
:1285
##                2009   : 252   08     : 220   10     :  86   1st
Qu.:2300
##                2010   : 252   03     : 218   11     :  86   Median
:2637
##                2011   : 252   06     : 214   13     :  86   Mean
:2970
##                2013   : 252   07     : 213   23     :  86   3rd
Qu.:3495
##                2014   : 252   12     : 212   12     :  85   Max.
:5223
##                (Other):1004   (Other):1219   (Other):2001
##       High           Low            Close          Volume
##  Min.   :1316   Min.   :1266   Min.   :1269   Min.   :2.214e+08
##  1st Qu.:2314   1st Qu.:2282   1st Qu.:2303   1st Qu.:1.745e+09
##  Median :2652   Median :2614   Median :2636   Median :1.944e+09
##  Mean   :2988   Mean   :2950   Mean   :2970   Mean   :1.991e+09
##  3rd Qu.:3509   3rd Qu.:3475   3rd Qu.:3496   3rd Qu.:2.178e+09
##  Max.   :5232   Max.   :5201   Max.   :5219   Max.   :4.554e+09
##
##    Adj.Close
##  Min.   :1269
##  1st Qu.:2303
##  Median :2636
##  Mean   :2970
##  3rd Qu.:3496
##  Max.   :5219
##

colnames(nasdaq.n)<-
c("Stockname","Year","Month","Day","Open","High","Low","Close","Volume"
,"Adj.Close")
```

I will combine all three datasets into one dataset and to do other analysis.

```
stock<-rbind(sp500.n,dow30.n,nasdaq.n)
summary(stock)
```

```
##   Stockname        Year           Month            Day
##  sp500 :2517   2008   : 759   10     : 663   09     : 261
##  dow30 :2517   2009   : 756   08     : 660   10     : 258
##  nasdaq:2517   2010   : 756   03     : 654   11     : 258
##                2011   : 756   06     : 642   13     : 258
##                2013   : 756   07     : 639   23     : 258
##                2014   : 756   12     : 636   12     : 255
##                (Other):3012   (Other):3657   (Other):6003
##       Open              High              Low              Close
##  Min.   :  679.3   Min.   :  695.3   Min.   :  666.8   Min.   :
676.5
##  1st Qu.: 1552.3   1st Qu.: 1563.5   1st Qu.: 1542.7   1st Qu.:
1552.5
##  Median : 2637.4   Median : 2652.4   Median : 2613.7   Median :
2635.7
##  Mean   : 5790.8   Mean   : 5826.1   Mean   : 5753.8   Mean   :
5792.2
##  3rd Qu.:11109.9   3rd Qu.:11179.8   3rd Qu.:11029.2   3rd
Qu.:11111.6
##  Max.   :18315.1   Max.   :18351.4   Max.   :18272.6   Max.
:18312.4
##
##      Volume            Adj.Close
##  Min.   :8.410e+06   Min.   :  676.5
##  1st Qu.:2.428e+08   1st Qu.: 1552.5
##  Median :1.931e+09   Median : 2635.7
##  Mean   :2.024e+09   Mean   : 5792.2
##  3rd Qu.:3.120e+09   3rd Qu.:11111.6
##  Max.   :1.146e+10   Max.   :18312.4
##
```

3.Linear Regression Model

The first model I choose to do analysis is linear regression model. From reading literature, I know we can calculate the average stock price using this function:

$$\overline{P}_i = \frac{C_i + H_i + L_i}{3}$$

```
average<-(stock$Close+stock$High+stock$Low)/3
stock.new<-cbind(stock,average)
```

Linear regression using average price

In this dataset, we can do a simple linear regression to see the relationships between different variables.

```
stock.lm.1<-lm(average~Volume,data=stock.new)
summary(stock.lm.1)

##
## Call:
## lm(formula = average ~ Volume, data = stock.new)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8107.0 -2790.7  -470.4  2074.8 18718.4
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.086e+04  5.908e+01   183.8   <2e-16 ***
## Volume      -2.504e-06  2.236e-08  -112.0   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3299 on 7549 degrees of freedom
## Multiple R-squared:  0.6242, Adjusted R-squared:  0.6241
## F-statistic: 1.254e+04 on 1 and 7549 DF,  p-value: < 2.2e-16

stock.lm.2<-lm(average~Open,data=stock.new)
summary(stock.lm.2)

##
## Call:
## lm(formula = average ~ Open, data = stock.new)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -558.89  -11.80    0.84   12.57  630.38
##
## Coefficients:
##                 Estimate Std. Error  t value Pr(>|t|)
## (Intercept) -0.0207395  0.9391662   -0.022    0.982
## Open         0.9999779  0.0001188 8416.932   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 55.55 on 7549 degrees of freedom
## Multiple R-squared:  0.9999, Adjusted R-squared:  0.9999
## F-statistic: 7.084e+07 on 1 and 7549 DF,  p-value: < 2.2e-16

cor(stock.new$Open,stock.new$average)

## [1] 0.9999467
```

Because we use Close, High and Low price to calculate the average price. And the average price have strong collinearity with Open price. That means the average price and the Open price are very similar. So we can't find some statistical significance between them. So I try another analysis. I use the next day's average price and todat's average price to do linear regression.

Linear regression using average price and future average price

My object is to see if we can use those already existing stock price to predict the unknown furture. So I will do some different analysis.

```
#change data order,I will add the next day's price to the current day row.

average.f<-average[2:7550]
stock.1<-cbind(stock.new[1:7549,],average.f)
stock.1.lm1<-lm(average.f~Open+average,data=stock.1)
summary(stock.1.lm1)
```

```
##
## Call:
## lm(formula = average.f ~ Open + average, data = stock.1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5692.3   -11.0    -3.4     5.8 16227.5
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  3.72569    3.38701   1.100    0.271
## Open         0.98041    0.04150  23.623   <2e-16 ***
## average      0.01893    0.04150   0.456    0.648
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 200.3 on 7546 degrees of freedom
## Multiple R-squared:  0.9986, Adjusted R-squared:  0.9986
## F-statistic: 2.721e+06 on 2 and 7546 DF,  p-value: < 2.2e-16
```

```
cor(stock.1$Open,stock.1$Close)
```

```
## [1] 0.99989
```

This result is either not very desirable. Because all price columns have strong collinearity. And by this, I can conduct that the stock won't change very sharply day by day. The changing of the stock price is always very smoothly. We can also do another analysis to test this conculsion.

Linear regression using average price and dual future average prices

I will use the average price of the day after tomorrow and the price of tomorrow and today's price to do linear regression.

```
#change data order,I will add the next day's price to the current day row.
average.f<-average[2:7550]
average.f2<-average[3:7551]
stock.2<-cbind(stock.new[1:7549,],average.f,average.f2)
stock.2.lm1<-lm(average.f2~average+average.f,data=stock.2)
summary(stock.2.lm1)
```

```
##
## Call:
## lm(formula = average.f2 ~ average + average.f, data = stock.2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5768.1   -18.7    -4.3    12.1 16214.2
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  4.47511    3.50864   1.275  0.20219
## average     -0.03048    0.01151  -2.649  0.00808 **
## average.f    1.02971    0.01151  89.490  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 207.5 on 7546 degrees of freedom
## Multiple R-squared:  0.9985, Adjusted R-squared:  0.9985
## F-statistic: 2.535e+06 on 2 and 7546 DF,  p-value: < 2.2e-16
```

From the summary you can see that, the average price of tomorrow and the average price of the day after tomorrow are also have very little impact on the price of today. That can prove our previous conclusion:the stock won't change very sharply day by day. The changing of the stock price is always very smoothly. But I review my data, I find that: I need to scale my data to expand the difference between the price.

Logistic regression by analyzing rise or fall

I find maybe I can do the analysis of stock rise or fall, rathar than the specific difference between the price.

```
di<-stock.1$average.f-stock.1$average
diff<-ifelse(di>0,1,0)
stock.diff<-cbind(stock.1,diff)
stock.diff.lm<-lm(as.numeric(diff)~Open+average,data=stock.1)
stock.diff.log<-glm(diff~Open+average,data=stock.1)
summary(stock.diff.log)
```

```
##
## Call:
## glm(formula = diff ~ Open + average, data = stock.1)
##
## Deviance Residuals:
```

```
##     Min       1Q   Median       3Q      Max  
## -1.7326  -0.4281  -0.1630   0.4890   2.1211  
## 
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)    
## (Intercept)  4.597e-01  7.498e-03   61.32   <2e-16 ***
## Open         4.085e-03  9.187e-05   44.46   <2e-16 ***
## average     -4.086e-03  9.187e-05  -44.47   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## (Dispersion parameter for gaussian family taken to be 0.1966241)
## 
##     Null deviance: 1872.7  on 7548  degrees of freedom
## Residual deviance: 1483.7  on 7546  degrees of freedom
## AIC: 9150
## 
## Number of Fisher Scoring iterations: 2
```

```r
summary(stock.diff.lm)
```

```
## 
## Call:
## lm(formula = as.numeric(diff) ~ Open + average, data = stock.1)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max 
## -1.7326 -0.4281 -0.1630  0.4890  2.1211 
## 
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)    
## (Intercept)  4.597e-01  7.498e-03   61.32   <2e-16 ***
## Open         4.085e-03  9.187e-05   44.46   <2e-16 ***
## average     -4.086e-03  9.187e-05  -44.47   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.4434 on 7546 degrees of freedom
## Multiple R-squared:  0.2077, Adjusted R-squared:  0.2075 
## F-statistic: 989.1 on 2 and 7546 DF,  p-value: < 2.2e-16
```

From the summary you can see that R^2 is only 20.75%, that means, the model only expalin 20% of all data. This is very inaccurate.

Conclusion:

From all the analyses I have done before, I find the most importatnt conclusion is that: the changing of the stock price day by day is very tiny, in most situations, it won't change sharply. And that also tell us it is very difficult to predict the stock price's trend. And this also match our daily life common sense.

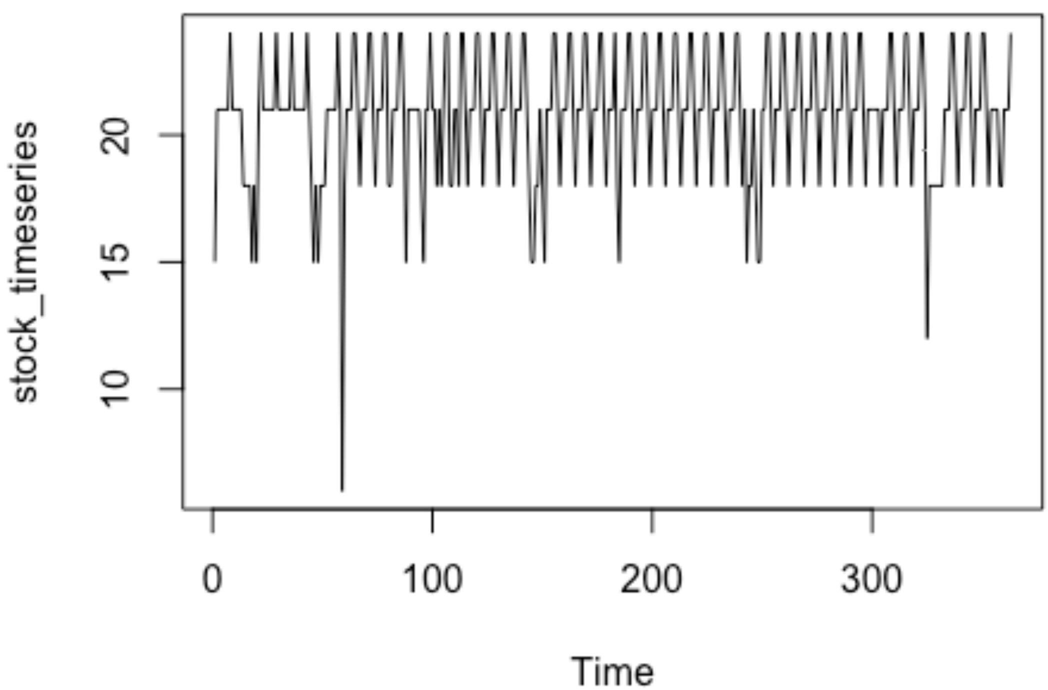
But this model is only one algorithm, I will also try other algorithms to do further analysis.

4.Time Series Analysis

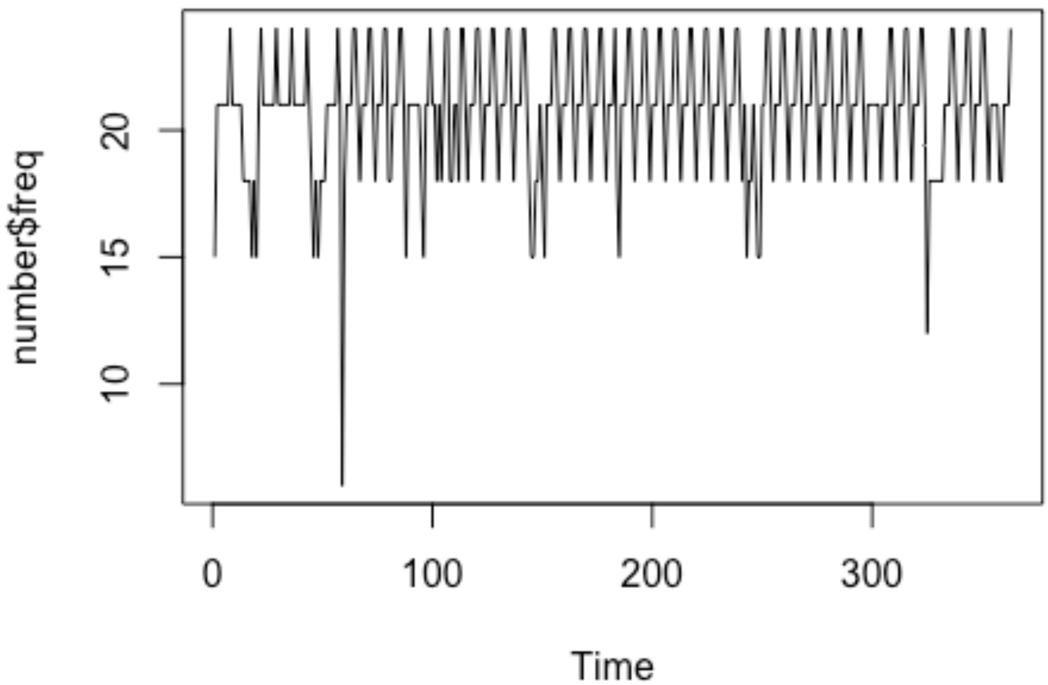
```
library(RCurl)

## Warning: package 'RCurl' was built under R version 3.2.4

## Loading required package: bitops

library(plyr)
library(forecast)

## Loading required package: zoo

##
## Attaching package: 'zoo'

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

## Loading required package: timeDate

## This is forecast 6.2

require(graphics)

number <- count(stock, c("Month", "Day"))
stock$Month<-as.numeric(stock$Month)
stock$Day<-as.numeric(stock$Day)
stock_timeseries <- ts(number$freq, start = c(1,1),frequency = 1)
stock_timeseries

## Time Series:
## Start = 1
## End = 363
## Frequency = 1
##   [1] 15 21 21 21 21 21 21 24 21 21 21 21 21 18 18 18 18 15 18 15 21
24 21
##  [24] 21 21 21 21 21 24 21 21 21 21 21 21 24 21 21 21 21 21 21 24 21
18 15
##  [47] 18 15 18 18 18 21 21 21 21 21 24 21  6 18 21 21 21 24 24 21 18
21 21
##  [70] 21 24 24 21 18 21 21 21 24 24 18 18 21 21 21 24 24 21 15 21 21
21 21
##  [93] 21 21 18 15 21 21 24 21 21 18 21 18 21 24 24 18 18 21 21 18 24
24 21
## [116] 18 21 21 21 24 24 21 18 21 21 21 24 24 21 18 21 21 21 24 24 21
18 21
## [139] 21 21 24 24 21 18 15 15 18 18 21 18 15 21 21 21 24 24 21 18 21
21 21
```

```
## [162] 24 24 21 18 21 21 21 24 24 21 18 21 21 21 24 24 21 18 21 21 21
24 18
## [185] 15 21 21 21 24 24 21 18 21 21 21 24 24 21 18 21 21 21 24 24 21
18 21
## [208] 21 21 24 24 21 18 21 21 21 24 24 21 18 21 21 21 24 24 21 18 21
21 21
## [231] 24 24 21 18 21 21 21 24 24 21 18 21 15 18 18 21 18 15 15 21 21
24 24
## [254] 21 18 21 21 21 24 24 21 18 21 21 21 24 24 21 18 21 21 21 24 24
21 18
## [277] 21 21 21 24 24 21 18 21 21 21 24 24 21 18 21 21 21 24 24 21 18
21 21
## [300] 21 21 21 21 18 21 21 21 24 24 21 18 21 21 21 24 24 21 18 21 21
21 24
## [323] 24 21 12 18 18 18 18 18 18 18 21 21 21 24 24 21 18 21 21 21 24
24 21
## [346] 18 21 21 21 24 24 21 18 21 21 21 21 18 18 21 21 21 24
```

```
plot(stock_timeseries)
```




```
ts.plot(number$freq)
```



From time series analysis, you can conclude that the price of the stock is changeing very smoothly, and there is no dramatic changes as time flows. So we can conclude that the price of stock changes smoothly.

5.Support Vector Machines

We assume V_i to represent future k days average price. And this value will tell us to analysis in the next k days we can get p% changes. V_i represents the future k days average price changing percentage comparing of today's closing price.

$$V_i = \frac{\overline{P}_{i+j} - C_i^{\ k}}{C_i}$$

We assume T as an indicator variable, which represents the total grand of the absolute value of the dynamic changes exceed p% of the target revenue.

Why we need to quote T-value, because in our dataset, we don't have any indenpent to do analysis. So we need to find some relationship between those existing data. So I find that we can find the cumulative amount of change as our variable. But this variable is calculated by ourselves and this variable can predicted by a specfic function. We can't use this as our indenpent variable to do SVM analysis. Because we need to find the variable which we don't know the specific formula. And we need the machine help us to do calculation and do prediction.

```
#This function is from literature.
library(quantmod)

## Loading required package: xts

## Loading required package: TTR

## Warning: package 'TTR' was built under R version 3.2.4

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

T.ind = function(quotes, tgt.margin=0.025, n.days=10){
    v = apply(HLC(quotes), 1, mean)
    r = matrix(NA, ncol=n.days, nrow=NROW(quotes))
    for(x in 1:n.days){
        r[, x] = Next(Delt(v, k=x), x)
    }
    x = apply(r, 1, function(x) sum(x[x > tgt.margin | x < -
tgt.margin]))
    if(is.xts(quotes)){ xts(x, time(quotes))}
    else{x}
}

tvalue<-T.ind(stock)
stock.t<-cbind(stock,tvalue)
summary(stock.t)

##    Stockname         Year           Month             Day
##   sp500 :2517   2008    : 759   Min.   : 1.000   Min.   : 1.00
##   dow30 :2517   2009    : 756   1st Qu.: 4.000   1st Qu.: 8.00
##   nasdaq:2517   2010    : 756   Median : 7.000   Median :16.00
##                 2011    : 756   Mean   : 6.548   Mean   :15.74
##                 2013    : 756   3rd Qu.:10.000   3rd Qu.:23.00
##                 2014    : 756   Max.   :12.000   Max.   :31.00
##                 (Other):3012
##       Open              High              Low               Close
##   Min.   :  679.3   Min.   :  695.3   Min.   :  666.8   Min.   :
676.5
##   1st Qu.: 1552.3   1st Qu.: 1563.5   1st Qu.: 1542.7   1st Qu.:
1552.5
##   Median : 2637.4   Median : 2652.4   Median : 2613.7   Median :
2635.7
##   Mean   : 5790.8   Mean   : 5826.1   Mean   : 5753.8   Mean   :
5792.2
##   3rd Qu.:11109.9   3rd Qu.:11179.8   3rd Qu.:11029.2   3rd
Qu.:11111.6
##   Max.   :18315.1   Max.   :18351.4   Max.   :18272.6   Max.
:18312.4
##
```

```
##      Volume              Adj.Close            tvalue
##  Min.   :8.410e+06   Min.   :  676.5   Min.   : -5.35330
##  1st Qu.:2.428e+08   1st Qu.: 1552.5   1st Qu.: -0.04450
##  Median :1.931e+09   Median : 2635.7   Median :  0.00000
##  Mean   :2.024e+09   Mean   : 5792.2   Mean   :  0.09752
##  3rd Qu.:3.120e+09   3rd Qu.:11111.6   3rd Qu.:  0.00000
##  Max.   :1.146e+10   Max.   :18312.4   Max.   :128.36165
##                                        NA's   :10
```

We need to find a variable to do SVM. So I think the best variable is we can assume an element and this element can help us to calculate the stockholder's behavior's earnings.

We can set a level as 0.1 for behavior. If the T value <-0.1, we can assume that people will sell the stock and we assume this behavior number is -1.If the T value is between -0.1 and 0.1, we can assume that people will keep the stock in hand and we assume this behavior number is 0.If the T value is bigger than 0.1, we can assume that people will buy other stocks and we assume this behavior number is 1.

```
behavior<-NULL
stock.t2<-na.omit(stock.t)
for (i in 1:7541){
  if (stock.t2$tvalue[i]< (-0.1)){
    behavior[i]<-(-1)
  }
  else if (stock.t2$tvalue[i]>0.1){
    behavior[i]<-1
  }else{
    behavior[i]<-0
  }
}
behavior<-na.omit(behavior)
```

And the most important variabl we need to set is the stockholder's behavior's earnings. We can think, if today's behavior is -1, that means we need to sell our in hand stock, but if tomorrow's diff is 1, that means the stock increases the price. So by this two condition, we can conclude that diff=1,behavior=-1 that means we sell the stock early and we lose money so we made false desicion. By this rule, we can summary all the rules. And then we can use SVM method to do analysis.

S&P 500

```
sp500.new<-cbind(stock.diff$diff[2:2500],behavior[1:2499])
sp500.new<-as.data.frame(sp500.new)
colnames(sp500.new)<-c("diff","behavior")
decision<-NULL
for (i in 1:2499){
  if (sp500.new$diff[i]==0 && sp500.new$behavior[i]==-1){
    decision[i]="R"
  }
```

```
  else if (sp500.new$diff[i]==0 && sp500.new$behavior[i]==0){
    decision[i]="F"
  }
  else if (sp500.new$diff[i]==0 && sp500.new$behavior[i]==1){
    decision[i]="F"
  }
  else if (sp500.new$diff[i]==1 && sp500.new$behavior[i]==-1){
    decision[i]="F"
  }
  else if (sp500.new$diff[i]==1 && sp500.new$behavior[i]==0){
    decision[i]="R"
  }
  else if (sp500.new$diff[i]==1 && sp500.new$behavior[i]==1){
    decision[i]="R"
  }
}
sp500.ana<-data.frame(sp500.new,decision)
library(e1071)

##
## Attaching package: 'e1071'

## The following objects are masked from 'package:timeDate':
##
##     kurtosis, skewness

sp500.train<-sp500.ana[1:1249,]
ysp500.train<-sp500.ana[1:1249,3]
sp500.test<-sp500.ana[1251:2499,-3]
ysp500.test<-sp500.ana[1251:2499,3]


costvalues <- 10^seq(-3,2,1)
tuned.svm.s <- tune(svm,decision~., data=sp500.train,
ranges=list(cost=costvalues), kernel="radial")
summary(tuned.svm.s)

##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost
##   0.1
##
## - best performance: 0
##
## - Detailed performance results:
##    cost      error dispersion
## 1 1e-03 0.46362581 0.04444443
## 2 1e-02 0.03681935 0.01562291
```

```
## 3 1e-01 0.00000000 0.00000000
## 4 1e+00 0.00000000 0.00000000
## 5 1e+01 0.00000000 0.00000000
## 6 1e+02 0.00000000 0.00000000
```

```
sp500.svm<-
svm(decision~.,kernel="radial",cost=0.01,gamma=0.5,data=sp500.train)
summary(sp500.svm)
```

```
##
## Call:
## svm(formula = decision ~ ., data = sp500.train, kernel = "radial",
##     cost = 0.01, gamma = 0.5)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  0.01
##       gamma:  0.5
##
## Number of Support Vectors:  412
##
##  ( 207 205 )
##
##
## Number of Classes:  2
##
## Levels:
##  F R
```

```
sp500.prd<-predict(sp500.svm,sp500.test)
table(sp500.prd,ysp500.test)
```

```
##          ysp500.test
## sp500.prd   F   R
##         F 442   0
##         R  87 720
```

From the result we can see this method is relatively accurate to our data. Because the accuracy of the prediction is (442+720)/(442+87+720)=93%.

Dow 30

```
dow30.new<-cbind(stock.diff$diff[2518:5016],behavior[2517:5015])
dow30.new<-as.data.frame(dow30.new)
colnames(dow30.new)<-c("diff","behavior")
decision<-NULL
for (i in 1:2499){
  if (dow30.new$diff[i]==0 && dow30.new$behavior[i]==-1){
    decision[i]="R"
  }
```

```
  else if (dow30.new$diff[i]==0 && dow30.new$behavior[i]==0){
    decision[i]="F"
  }
  else if (dow30.new$diff[i]==0 && dow30.new$behavior[i]==1){
    decision[i]="F"
  }
  else if (dow30.new$diff[i]==1 && dow30.new$behavior[i]==-1){
    decision[i]="F"
  }
  else if (dow30.new$diff[i]==1 && dow30.new$behavior[i]==0){
    decision[i]="R"
  }
  else if (dow30.new$diff[i]==1 && dow30.new$behavior[i]==1){
    decision[i]="R"
  }
}
dow30.ana<-data.frame(dow30.new,decision)
library(e1071)
dow30.train<-dow30.ana[1:1249,]
ydow30.train<-dow30.ana[1:1249,3]
dow30.test<-dow30.ana[1251:2499,-3]
ydow30.test<-dow30.ana[1251:2499,3]

costvalues <- 10^seq(-3,2,1)
tuned.svm.d <- tune(svm,decision~., data=dow30.train,
ranges=list(cost=costvalues), kernel="radial")
summary(tuned.svm.d)

##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost
##   0.1
##
## - best performance: 0
##
## - Detailed performance results:
##    cost      error dispersion
## 1 1e-03 0.47717419 0.04208775
## 2 1e-02 0.02884516 0.01479621
## 3 1e-01 0.00000000 0.00000000
## 4 1e+00 0.00000000 0.00000000
## 5 1e+01 0.00000000 0.00000000
## 6 1e+02 0.00000000 0.00000000
```

```
dow30.svm<-
svm(decision~.,kernel="radial",cost=0.01,gamma=0.5,data=dow30.train)
summary(dow30.svm)
```

```
##
## Call:
## svm(formula = decision ~ ., data = dow30.train, kernel = "radial",
##     cost = 0.01, gamma = 0.5)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  0.01
##       gamma:  0.5
##
## Number of Support Vectors:  392
##
##  ( 197 195 )
##
##
## Number of Classes:  2
##
## Levels:
##  F R
```

```
dow30.prd<-predict(dow30.svm,dow30.test)
table(dow30.prd,ydow30.test)
```

```
##          ydow30.test
## dow30.prd   F   R
##         F 458   0
##         R  80 711
```

From the result we can see this method is relatively accurate to our data. Because the accuracy of the prediction is (456+709)/(456+84+709)=93%.

nasdaq

```
nasdaq.new<-cbind(stock.diff$diff[5035:7533],behavior[5034:7532])
nasdaq.new<-as.data.frame(nasdaq.new)
colnames(nasdaq.new)<-c("diff","behavior")
decision<-NULL
for (i in 1:2499){
  if (nasdaq.new$diff[i]==0 && nasdaq.new$behavior[i]==-1){
    decision[i]="R"
  }
  else if (nasdaq.new$diff[i]==0 && nasdaq.new$behavior[i]==0){
    decision[i]="F"
  }
  else if (nasdaq.new$diff[i]==0 && nasdaq.new$behavior[i]==1){
```

```
    decision[i]="F"
  }
  else if (nasdaq.new$diff[i]==1 && nasdaq.new$behavior[i]==-1){
    decision[i]="F"
  }
  else if (nasdaq.new$diff[i]==1 && nasdaq.new$behavior[i]==0){
    decision[i]="R"
  }
  else if (nasdaq.new$diff[i]==1 && nasdaq.new$behavior[i]==1){
    decision[i]="R"
  }
}
nasdaq.ana<-data.frame(nasdaq.new,decision)
library(e1071)
nasdaq.train<-nasdaq.ana[1:1249,]
ynasdaq.train<-nasdaq.ana[1:1249,3]
nasdaq.test<-nasdaq.ana[1251:2499,-3]
ynasdaq.test<-nasdaq.ana[1251:2499,3]

costvalues <- 10^seq(-3,2,1)
tuned.svm.n <- tune(svm,decision~., data=nasdaq.train,
ranges=list(cost=costvalues), kernel="radial")
summary(tuned.svm.n)

##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost
##   0.1
##
## - best performance: 0
##
## - Detailed performance results:
##    cost      error dispersion
## 1 1e-03 0.45157419 0.04634891
## 2 1e-02 0.03285806 0.01878364
## 3 1e-01 0.00000000 0.00000000
## 4 1e+00 0.00000000 0.00000000
## 5 1e+01 0.00000000 0.00000000
## 6 1e+02 0.00000000 0.00000000

nasdaq.svm<-
svm(decision~.,kernel="radial",cost=0.01,gamma=0.5,data=nasdaq.train)
summary(nasdaq.svm)

##
## Call:
## svm(formula = decision ~ ., data = nasdaq.train, kernel = "radial",
```

```
##     cost = 0.01, gamma = 0.5)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  0.01
##       gamma:  0.5
##
## Number of Support Vectors:  462
##
##  ( 231 231 )
##
##
## Number of Classes:  2
##
## Levels:
##  F R
```

```
nasdaq.prd<-predict(nasdaq.svm,nasdaq.test)
table(nasdaq.prd,ynasdaq.test)
```

```
##           ynasdaq.test
## nasdaq.prd   F   R
##          F 433   0
##          R  61 755
```

The accuracy of the prediction is (433+755)/(433+61+755)=95%.

Use all data to do predict(only use S&P 500 as example)

When we use all the numeric to do analysis, we need to explict the future data. Like tomorrow data or the diff. Because we don't need to tell the machine about the future data. And only by current data and some relationship, maybe machine can give us some good guidances. But maybe sometimes, machine can't. So that need us to analyze the result.

```
c<-stock.diff[2:2500,-12]
sp500.new2<-data.frame(c,behavior[1:2499])
colnames(sp500.new2)<-
c("Stockname","Year","Month","Day","Open","High","Low","Close","Volume"
,"Adj.Close","average","diff","behavior")
decision<-NULL
for (i in 1:2499){
  if (sp500.new2$diff[i]==0 && sp500.new2$behavior[i]==-1){
    decision[i]="R"
  }
  else if (sp500.new2$diff[i]==0 && sp500.new2$behavior[i]==0){
    decision[i]="F"
  }
  else if (sp500.new2$diff[i]==0 && sp500.new2$behavior[i]==1){
```

```
    decision[i]="F"
  }
  else if (sp500.new2$diff[i]==1 && sp500.new2$behavior[i]==-1){
    decision[i]="F"
  }
  else if (sp500.new2$diff[i]==1 && sp500.new2$behavior[i]==0){
    decision[i]="R"
  }
  else if (sp500.new2$diff[i]==1 && sp500.new2$behavior[i]==1){
    decision[i]="R"
  }
}
sp500.ana2<-data.frame(sp500.new2,decision)
library(e1071)
sp500.train2<-sp500.ana2[1:1249,-13]
ysp500.train2<-sp500.ana2[1:1249,14]
sp500.test2<-sp500.ana2[1251:2499,1:12]
ysp500.test2<-sp500.ana2[1251:2499,14]

costvalues <- 10^seq(-3,2,1)
tuned.svm.s2 <- tune(svm,decision~., data=sp500.train2,
ranges=list(cost=costvalues), kernel="radial")
summary(tuned.svm.s2)

##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost
##   100
##
## - best performance: 0.1209032
##
## - Detailed performance results:
##    cost     error dispersion
## 1 1e-03 0.4635161 0.06196812
## 2 1e-02 0.4635161 0.06196812
## 3 1e-01 0.1257161 0.02703567
## 4 1e+00 0.1257161 0.02703567
## 5 1e+01 0.1281161 0.02593662
## 6 1e+02 0.1209032 0.02342227

sp500.svm2<-
svm(decision~.,kernel="radial",cost=0.01,gamma=0.5,data=sp500.train2)
summary(sp500.svm2)

##
## Call:
## svm(formula = decision ~ ., data = sp500.train2, kernel = "radial",
```

```
##     cost = 0.01, gamma = 0.5)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  0.01
##       gamma:  0.5
##
## Number of Support Vectors:  1203
##
##  ( 624 579 )
##
##
## Number of Classes:  2
##
## Levels:
##  F R
```

```
sp500.prd2<-predict(sp500.svm2,sp500.test2)
table(sp500.prd2,ysp500.test2)
```

```
##           ysp500.test2
## sp500.prd2   F   R
##          F   0   0
##          R 529 720
```

This result means, the machine make all the result as right. That means no matter what behavior you have, machine suggests you to follow your choice. That is the smart area of the machine. Because the probability of "Right" is a little bigger than"False", the machine can't conclude any other suggestions. So it will suggest you to keep your choice because it always hold a higher probability.

6.Decision tree

Decision tree

To make more precise prediction, we can use decision tree to do analysis to see which elements have effect on the dealing decision. First, we randomly choose two dataset: one as train dataset, another one as test dataset. We use C5.0 method to do predict.

```
set.seed(123)
train<-sample(1:2499,2000)
sp500.train3<-sp500.ana2[train,]
sp500.test3<-sp500.ana2[-train,]
#check the proportion of class variable
prop.table(table(sp500.train3$decision))
```

```
##
##      F      R
## 0.4435 0.5565

prop.table(table(sp500.test3$decision))

##
##         F         R
## 0.4448898 0.5551102

#C5.0 model
library(C50)
model <- C5.0(sp500.train3[,c(1:11,13)], sp500.train3$decision)
model

##
## Call:
## C5.0.default(x = sp500.train3[, c(1:11, 13)], y =
sp500.train3$decision)
##
## Classification Tree
## Number of samples: 2000
## Number of predictors: 12
##
## Tree size: 3
##
## Non-standard options: attempt to group attributes

summary(model)

##
## Call:
## C5.0.default(x = sp500.train3[, c(1:11, 13)], y =
sp500.train3$decision)
##
##
## C5.0 [Release 2.07 GPL Edition]      Thu Apr 28 10:53:33 2016
## -------------------------------
##
## Class specified by attribute `outcome'
##
## Read 2000 cases (13 attributes) from undefined.data
##
## Decision tree:
##
## behavior <= -1: R (288/48)
## behavior > -1:
## :...behavior <= 0: F (1418/632)
##     behavior > 0: R (294/53)
##
##
## Evaluation on training data (2000 cases):
```

```
## 
##      Decision Tree
##    ----------------
##    Size      Errors
## 
##       3  733(36.6%)   <<
## 
## 
##     (a)   (b)    <-classified as
##    ----  ----
##     786   101    (a): class F
##     632   481    (b): class R
## 
## 
##  Attribute usage:
## 
##  100.00% behavior
## 
## 
## Time: 0.0 secs
```

From the summary, you can see the decision tree make the best decision need follow those conditions: if behavior <= -1, the decision is right; and if behavior > -1, the decision is also right; and if behavior <= 0: the decision is false; and if behavior > 0: the decision is right. And the error is 36.6%. This is very match my hypothesis in the previous question. The behavior can effect the total revenue of the stockholder.

```r
library(gmodels)
#Evaluating model performance
sp500_prep <- predict(model, sp500.test3)
CrossTable(sp500.test3$decision,sp500_prep, prop.chisq=FALSE,
prop.c=FALSE,prop.r=FALSE, dnn=c('actual decision', 'predicted
decision'))
```

```
## 
## 
##    Cell Contents
## |-------------------------|
## |                       N |
## |         N / Table Total |
## |-------------------------|
## 
## 
## Total Observations in Table:  499
## 
## 
##                 | predicted decision
## actual decision |         F |         R | Row Total |
## ----------------|-----------|-----------|-----------|
##               F |       190 |        32 |       222 |
```

```
##                  |     0.381 |     0.064 |           |
## -----------------|-----------|-----------|-----------|
##                R |       160 |       117 |       277 |
##                  |     0.321 |     0.234 |           |
## -----------------|-----------|-----------|-----------|
##     Column Total |       350 |       149 |       499 |
## -----------------|-----------|-----------|-----------|
##
##
```

Cut Branches

As we see in the previous question, the behavior is a very imortant element in the decision making process. So if we want to know the relationship between the result and other attributes, we need to cut the behavior column and then to do analysis to see which element have relationship with our indenpentdent.

```
set.seed(123)
train<-sample(1:2499,2000)
sp500.train4<-sp500.ana2[train,-13]
sp500.test4<-sp500.ana2[-train,-13]
#check the proportion of class variable

#C5.0 model

model2 <- C5.0(sp500.train4[,c(1:11)], sp500.train4$decision)
model2

##
## Call:
## C5.0.default(x = sp500.train4[, c(1:11)], y = sp500.train4$decision)
##
## Classification Tree
## Number of samples: 2000
## Number of predictors: 11
##
## Tree size: 3
##
## Non-standard options: attempt to group attributes

summary(model2)

##
## Call:
## C5.0.default(x = sp500.train4[, c(1:11)], y = sp500.train4$decision)
##
##
## C5.0 [Release 2.07 GPL Edition]      Thu Apr 28 10:53:34 2016
## -------------------------------
##
## Class specified by attribute `outcome'
```

```
##
## Read 2000 cases (12 attributes) from undefined.data
##
## Decision tree:
##
## Volume > 3.78835e+09: R (908/314)
## Volume <= 3.78835e+09:
## :...Close <= 1272.43: R (119/41)
##     Close > 1272.43: F (973/441)
##
##
## Evaluation on training data (2000 cases):
##
##      Decision Tree
##    ----------------
##    Size      Errors
##
##       3  796(39.8%)   <<
##
##
##     (a)   (b)    <-classified as
##    ----  ----
##     532   355    (a): class F
##     441   672    (b): class R
##
##
##  Attribute usage:
##
##  100.00% Volume
##   54.60% Close
##
##
## Time: 0.0 secs
```

So from the model you can see that The volume and the close price are also important elements on making decision. And the error is 39.8%. This result is also very desirable.

```
library(gmodels)
#Evaluating model performance
sp500_prep2 <- predict(model2, sp500.test4)
CrossTable(sp500.test4$decision,sp500_prep2, prop.chisq=FALSE,
prop.c=FALSE,prop.r=FALSE, dnn=c('actual decision', 'predicted
decision'))

##
##
##    Cell Contents
## |-------------------------|
## |                       N |
```

```
## |         N / Table Total |
## |-------------------------|
##
##
## Total Observations in Table:  499
##
##
##                 | predicted decision
## actual decision |         F |         R | Row Total |
## ----------------|-----------|-----------|-----------|
##               F |       112 |       110 |       222 |
##                 |     0.224 |     0.220 |           |
## ----------------|-----------|-----------|-----------|
##               R |       114 |       163 |       277 |
##                 |     0.228 |     0.327 |           |
## ----------------|-----------|-----------|-----------|
##    Column Total |       226 |       273 |       499 |
## ----------------|-----------|-----------|-----------|
##
##
```

7.Unsupervised learning

K-means

I plan to use K-means to do unsupervised learning analysis. To see how the centers distributed.

```
library(cluster)
k<-3
stock.k1<-stock[,5:10]
stock.k2<-stock.1[,5:12]
stock.k1.cluster<-kmeans(stock.k1,k)
stock.k2.cluster<-kmeans(stock.k2,k)
stock.k1.cluster$centers
```

```
##        Open      High       Low     Close     Volume Adj.Close
## 1  1390.868  1401.521  1379.108  1390.836 4516237818  1390.836
## 2  2595.925  2610.844  2579.437  2596.373 2194107583  2596.373
## 3 12770.633 12848.171 12690.531 12774.075  204572825 12774.075
```

```
table(stock.k1.cluster$cluster,stock$Stockname)
```

```
##
##     sp500 dow30 nasdaq
##   1  1617     0     29
##   2   894     0   2445
##   3     6  2517     43
```

```
str(stock.k2.cluster)
```

```
## List of 9
##  $ cluster     : Named int [1:7549] 3 3 3 3 3 2 2 2 2 2 ...
##   ..- attr(*, "names")= chr [1:7549] "1" "2" "3" "4" ...
##  $ centers     : num [1:3, 1:8] 12771 1391 2596 12848 1402 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:3] "1" "2" "3"
##   .. ..$ : chr [1:8] "Open" "High" "Low" "Close" ...
##  $ totss       : num 2.18e+22
##  $ withinss    : num [1:3] 5.16e+19 2.05e+21 8.50e+20
##  $ tot.withinss: num 2.95e+21
##  $ betweenss   : num 1.88e+22
##  $ size        : int [1:3] 2566 1646 3337
##  $ iter        : int 3
##  $ ifault      : int 0
##  - attr(*, "class")= chr "kmeans"
```

From the table, we can see the result concluded by the k-means method is very credible. Because we only give the all the numeric elements to do k-means, and this method helps us to put all the data into three categories which is our original classification.

We can also do k=4 to see the result.

```
k<-4
stock.k1.2<-stock[,5:10]
stock.k2.2<-stock.1[,5:12]
stock.k1.2.cluster<-kmeans(stock.k1,k)
stock.k2.2.cluster<-kmeans(stock.k2,k)
str(stock.k1.2.cluster)
```

```
## List of 9
##  $ cluster     : Named int [1:7551] 4 4 4 4 4 2 2 2 3 2 ...
##   ..- attr(*, "names")= chr [1:7551] "1" "2" "3" "4" ...
##  $ centers     : num [1:4, 1:6] 12803 1575 1088 2723 12881 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:4] "1" "2" "3" "4"
##   .. ..$ : chr [1:6] "Open" "High" "Low" "Close" ...
##  $ totss       : num 2.18e+22
##  $ withinss    : num [1:4] 4.42e+19 4.34e+20 4.85e+20 3.91e+20
##  $ tot.withinss: num 1.36e+21
##  $ betweenss   : num 2.04e+22
##  $ size        : int [1:4] 2558 1655 439 2899
##  $ iter        : int 3
##  $ ifault      : int 0
##  - attr(*, "class")= chr "kmeans"
```

```
str(stock.k2.2.cluster)
```

```
## List of 9
##  $ cluster     : Named int [1:7549] 2 2 2 2 2 1 1 1 4 1 ...
##   ..- attr(*, "names")= chr [1:7549] "1" "2" "3" "4" ...
```

```
##  $ centers     : num [1:4, 1:8] 1577 2724 12803 1092 1586 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:4] "1" "2" "3" "4"
##   .. ..$ : chr [1:8] "Open" "High" "Low" "Close" ...
##  $ totss       : num 2.18e+22
##  $ withinss    : num [1:4] 4.25e+20 3.89e+20 4.42e+19 4.97e+20
##  $ tot.withinss: num 1.36e+21
##  $ betweenss   : num 2.04e+22
##  $ size        : int [1:4] 1649 2894 2558 448
##  $ iter        : int 3
##  $ ifault      : int 0
##  - attr(*, "class")= chr "kmeans"
```

```
stock.k2.2.cluster
```

```
## K-means clustering with 4 clusters of sizes 1649, 2894, 2558, 448
##
## Cluster means:
##        Open      High       Low     Close     Volume Adj.Close
average
## 1  1576.576  1586.260  1566.169  1576.992 3733722444  1576.992
1576.474
## 2  2723.964  2739.723  2706.496  2724.319 2045135529  2724.319
2723.513
## 3 12802.983 12880.747 12722.672 12806.460  201558456 12806.460
12803.293
## 4  1091.941  1104.801  1076.814  1091.090 6003981290  1091.090
1090.902
##   average.f
## 1  1576.929
## 2  2727.460
## 3 12798.313
## 4  1092.629
##
## Clustering vector:
##    1    2    3    4    5    6    7    8    9   10   11   12   13
14   15
##    2    2    2    2    2    1    1    1    4    1    1    1    1
1    1
##   16   17   18   19   20   21   22   23   24   25   26   27   28
29   30
##    1    1    1    1    1    1    1    1    2    2    1    1    1
1    1
##   31   32   33   34   35   36   37   38   39   40   41   42   43
44   45
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##   46   47   48   49   50   51   52   53   54   55   56   57   58
59   60
##    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
1    1
##   61   62   63   64   65   66   67   68   69   70   71   72   73
74   75
##    1    1    1    1    1    1    1    1    1    1    1    1    4
1    1
##   76   77   78   79   80   81   82   83   84   85   86   87   88
89   90
##    1    1    1    1    1    1    1    1    1    1    1    1    4
4    4
##   91   92   93   94   95   96   97   98   99  100  101  102  103
104  105
##    4    4    1    1    1    2    2    1    1    1    1    1    1
1    1
##  106  107  108  109  110  111  112  113  114  115  116  117  118
119  120
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  121  122  123  124  125  126  127  128  129  130  131  132  133
134  135
##    1    1    1    1    1    1    1    1    1    1    4    1    1
1    1
##  136  137  138  139  140  141  142  143  144  145  146  147  148
149  150
##    1    1    1    1    1    2    1    1    1    1    1    1    1
1    1
##  151  152  153  154  155  156  157  158  159  160  161  162  163
164  165
##    1    1    1    1    2    1    1    1    2    1    1    1    1
1    1
##  166  167  168  169  170  171  172  173  174  175  176  177  178
179  180
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  181  182  183  184  185  186  187  188  189  190  191  192  193
194  195
##    1    1    1    1    3    1    1    1    1    1    1    1    1
1    1
##  196  197  198  199  200  201  202  203  204  205  206  207  208
209  210
##    1    1    1    4    1    1    1    1    1    1    1    1    1
1    1
##  211  212  213  214  215  216  217  218  219  220  221  222  223
224  225
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  226  227  228  229  230  231  232  233  234  235  236  237  238
239  240
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  241  242  243  244  245  246  247  248  249  250  251  252  253
```

```
254  255
##    1    1    1    1    1    1    1    1    1    1    1    2    2
2    2
##  256  257  258  259  260  261  262  263  264  265  266  267  268
269  270
##    2    2    1    1    4    1    4    4    1    1    1    1    1
1    1
##  271  272  273  274  275  276  277  278  279  280  281  282  283
284  285
##    1    1    1    1    2    2    1    1    1    1    1    1    1
1    1
##  286  287  288  289  290  291  292  293  294  295  296  297  298
299  300
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  301  302  303  304  305  306  307  308  309  310  311  312  313
314  315
##    1    1    1    1    4    4    1    1    1    1    1    1    1
1    1
##  316  317  318  319  320  321  322  323  324  325  326  327  328
329  330
##    1    1    1    1    1    1    1    1    4    1    1    1    2
1    1
##  331  332  333  334  335  336  337  338  339  340  341  342  343
344  345
##    1    2    2    2    1    2    2    2    2    2    2    2    2
2    2
##  346  347  348  349  350  351  352  353  354  355  356  357  358
359  360
##    2    2    1    2    2    2    2    1    1    1    1    1    1
1    1
##  361  362  363  364  365  366  367  368  369  370  371  372  373
374  375
##    1    2    2    1    2    1    2    1    1    1    1    2    2
1    2
##  376  377  378  379  380  381  382  383  384  385  386  387  388
389  390
##    1    2    2    2    1    1    1    2    1    1    2    1    1
1    1
##  391  392  393  394  395  396  397  398  399  400  401  402  403
404  405
##    1    2    1    2    2    2    2    1    2    2    2    1    2
1    1
##  406  407  408  409  410  411  412  413  414  415  416  417  418
419  420
##    2    2    2    1    2    1    1    2    1    1    1    1    1
1    2
##  421  422  423  424  425  426  427  428  429  430  431  432  433
434  435
##    1    1    1    1    1    1    1    1    1    2    1    1    1
```

```
1    1
##  436  437  438  439  440  441  442  443  444  445  446  447  448 
449  450 
##    1    1    1    1    1    1    1    1    1    1    1    1    1 
1    4 
##  451  452  453  454  455  456  457  458  459  460  461  462  463 
464  465 
##    1    1    1    2    1    1    1    1    1    1    1    1    1 
1    1 
##  466  467  468  469  470  471  472  473  474  475  476  477  478 
479  480 
##    1    1    1    1    1    1    1    1    1    1    1    1    1 
1    1 
##  481  482  483  484  485  486  487  488  489  490  491  492  493 
494  495 
##    1    1    1    1    1    1    1    1    1    1    1    1    1 
1    1 
##  496  497  498  499  500  501  502  503  504  505  506  507  508 
509  510 
##    1    1    1    1    1    1    1    2    1    2    2    2    2 
2    2 
##  511  512  513  514  515  516  517  518  519  520  521  522  523 
524  525 
##    4    1    1    1    1    1    1    1    1    1    1    1    1 
1    1 
##  526  527  528  529  530  531  532  533  534  535  536  537  538 
539  540 
##    2    2    1    1    1    1    1    1    1    1    1    1    1 
2    1 
##  541  542  543  544  545  546  547  548  549  550  551  552  553 
554  555 
##    1    1    1    1    1    1    1    1    1    1    1    1    1 
1    1 
##  556  557  558  559  560  561  562  563  564  565  566  567  568 
569  570 
##    1    1    1    2    1    1    1    1    2    2    1    1    1 
1    1 
##  571  572  573  574  575  576  577  578  579  580  581  582  583 
584  585 
##    2    1    1    1    4    1    1    2    1    2    1    1    1 
1    1 
##  586  587  588  589  590  591  592  593  594  595  596  597  598 
599  600 
##    1    1    1    2    2    2    1    2    2    2    1    1    1 
1    1 
##  601  602  603  604  605  606  607  608  609  610  611  612  613 
614  615 
##    2    1    2    1    1    1    1    2    1    1    1    1    2 
2    1 
##  616  617  618  619  620  621  622  623  624  625  626  627  628
```

```
629  630
##    1    1    2    1    1    1    1    2    1    1    1    1    1
2    2
##  631  632  633  634  635  636  637  638  639  640  641  642  643
644  645
##    1    1    4    1    1    1    1    4    1    1    1    1    1
1    1
##  646  647  648  649  650  651  652  653  654  655  656  657  658
659  660
##    1    1    1    1    1    1    1    1    1    1    1    2    1
1    1
##  661  662  663  664  665  666  667  668  669  670  671  672  673
674  675
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  676  677  678  679  680  681  682  683  684  685  686  687  688
689  690
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  691  692  693  694  695  696  697  698  699  700  701  702  703
704  705
##    2    1    1    1    1    2    1    1    2    1    1    1    1
1    1
##  706  707  708  709  710  711  712  713  714  715  716  717  718
719  720
##    4    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  721  722  723  724  725  726  727  728  729  730  731  732  733
734  735
##    1    1    1    1    1    1    1    1    2    1    1    1    1
1    1
##  736  737  738  739  740  741  742  743  744  745  746  747  748
749  750
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  751  752  753  754  755  756  757  758  759  760  761  762  763
764  765
##    1    1    1    1    1    1    1    2    2    2    2    4    1
1    1
##  766  767  768  769  770  771  772  773  774  775  776  777  778
779  780
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  781  782  783  784  785  786  787  788  789  790  791  792  793
794  795
##    1    2    2    1    1    1    1    1    1    2    1    1    1
1    1
##  796  797  798  799  800  801  802  803  804  805  806  807  808
809  810
##    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
1    1
##  811  812  813  814  815  816  817  818  819  820  821  822  823
824  825
##    1    1    2    1    1    1    1    1    1    1    1    1    1
1    1
##  826  827  828  829  830  831  832  833  834  835  836  837  838
839  840
##    1    1    1    4    1    1    1    1    1    1    1    1    1
2    2
##  841  842  843  844  845  846  847  848  849  850  851  852  853
854  855
##    2    2    2    1    1    1    2    1    1    2    1    2    2
1    1
##  856  857  858  859  860  861  862  863  864  865  866  867  868
869  870
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  871  872  873  874  875  876  877  878  879  880  881  882  883
884  885
##    1    2    1    1    1    1    1    2    1    2    1    1    1
1    1
##  886  887  888  889  890  891  892  893  894  895  896  897  898
899  900
##    1    4    1    1    1    1    1    1    1    1    1    1    1
1    1
##  901  902  903  904  905  906  907  908  909  910  911  912  913
914  915
##    1    1    1    1    1    2    1    1    1    1    1    1    1
1    1
##  916  917  918  919  920  921  922  923  924  925  926  927  928
929  930
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  931  932  933  934  935  936  937  938  939  940  941  942  943
944  945
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  946  947  948  949  950  951  952  953  954  955  956  957  958
959  960
##    1    1    1    1    1    1    1    1    1    4    1    1    1
1    1
##  961  962  963  964  965  966  967  968  969  970  971  972  973
974  975
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  976  977  978  979  980  981  982  983  984  985  986  987  988
989  990
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
##  991  992  993  994  995  996  997  998  999 1000 1001 1002 1003
```

```
1004 1005
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018
1019 1020
##    1    2    2    2    2    2    1    1    1    1    4    1    1
1    1
## 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033
1034 1035
##    1    1    1    1    1    1    1    4    1    1    2    1    1
1    1
## 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048
1049 1050
##    1    1    1    1    1    1    1    1    1    1    1    1    4
1    1
## 1051 1052 1053 1054 1055 1056 1057 1058 1059 1060 1061 1062 1063
1064 1065
##    4    4    1    1    4    4    1    1    1    1    1    4    1
1    4
## 1066 1067 1068 1069 1070 1071 1072 1073 1074 1075 1076 1077 1078
1079 1080
##    4    2    1    4    1    4    1    4    1    4    4    1    1
1    4
## 1081 1082 1083 1084 1085 1086 1087 1088 1089 1090 1091 1092 1093
1094 1095
##    1    4    1    4    1    1    1    4    1    1    4    1    1
4    4
## 1096 1097 1098 1099 1100 1101 1102 1103 1104 1105 1106 1107 1108
1109 1110
##    4    4    4    4    1    1    4    1    4    1    4    2    2
4    1
## 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122 1123
1124 1125
##    4    4    4    4    4    1    1    1    1    1    1    1    1
1    1
## 1126 1127 1128 1129 1130 1131 1132 1133 1134 1135 1136 1137 1138
1139 1140
##    1    1    1    1    1    1    1    1    1    1    1    1    1
4    1
## 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151 1152 1153
1154 1155
##    1    1    4    1    1    1    1    1    1    1    1    1    1
1    1
## 1156 1157 1158 1159 1160 1161 1162 1163 1164 1165 1166 1167 1168
1169 1170
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1171 1172 1173 1174 1175 1176 1177 1178 1179 1180 1181 1182 1183
1184 1185
##    1    1    1    1    1    1    1    1    1    1    2    1    1
```

```
1    1
## 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195 1196 1197 1198
1199 1200
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1201 1202 1203 1204 1205 1206 1207 1208 1209 1210 1211 1212 1213
1214 1215
##    1    1    1    1    1    1    1    4    4    1    1    1    1
1    1
## 1216 1217 1218 1219 1220 1221 1222 1223 1224 1225 1226 1227 1228
1229 1230
##    1    1    3    2    2    1    2    2    2    2    2    2    1
1    1
## 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240 1241 1242 1243
1244 1245
##    1    1    1    1    1    1    1    4    1    4    1    1    1
1    4
## 1246 1247 1248 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258
1259 1260
##    4    1    4    1    1    1    1    1    4    1    1    1    1
2    2
## 1261 1262 1263 1264 1265 1266 1267 1268 1269 1270 1271 1272 1273
1274 1275
##    2    2    2    2    2    1    1    1    1    1    1    1    1
1    1
## 1276 1277 1278 1279 1280 1281 1282 1283 1284 1285 1286 1287 1288
1289 1290
##    4    1    1    4    1    1    1    2    1    1    1    1    1
1    4
## 1291 1292 1293 1294 1295 1296 1297 1298 1299 1300 1301 1302 1303
1304 1305
##    1    1    1    1    1    1    4    4    1    1    1    1    1
1    1
## 1306 1307 1308 1309 1310 1311 1312 1313 1314 1315 1316 1317 1318
1319 1320
##    1    1    1    4    4    1    4    4    4    1    2    1    1
1    1
## 1321 1322 1323 1324 1325 1326 1327 1328 1329 1330 1331 1332 1333
1334 1335
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1336 1337 1338 1339 1340 1341 1342 1343 1344 1345 1346 1347 1348
1349 1350
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1351 1352 1353 1354 1355 1356 1357 1358 1359 1360 1361 1362 1363
1364 1365
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1366 1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378
```

```
1379 1380
##    1    1    1    1    1    1    1    1    1    1    4    1    1
1    1
## 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391 1392 1393
1394 1395
##    1    1    4    1    1    4    4    4    1    4    1    1    1
1    1
## 1396 1397 1398 1399 1400 1401 1402 1403 1404 1405 1406 1407 1408
1409 1410
##    1    4    1    1    1    4    4    4    4    4    4    4    4
4    4
## 1411 1412 1413 1414 1415 1416 1417 1418 1419 1420 1421 1422 1423
1424 1425
##    1    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1426 1427 1428 1429 1430 1431 1432 1433 1434 1435 1436 1437 1438
1439 1440
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1441 1442 1443 1444 1445 1446 1447 1448 1449 1450 1451 1452 1453
1454 1455
##    4    4    1    1    1    4    1    1    1    1    1    1    1
4    1
## 1456 1457 1458 1459 1460 1461 1462 1463 1464 1465 1466 1467 1468
1469 1470
##    1    1    4    1    4    1    1    4    1    4    4    1    1
1    1
## 1471 1472 1473 1474 1475 1476 1477 1478 1479 1480 1481 1482 1483
1484 1485
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    4
## 1486 1487 1488 1489 1490 1491 1492 1493 1494 1495 1496 1497 1498
1499 1500
##    1    4    4    1    1    1    4    4    4    1    1    4    4
1    1
## 1501 1502 1503 1504 1505 1506 1507 1508 1509 1510 1511 1512 1513
1514 1515
##    1    1    1    1    1    1    4    4    2    1    2    2    2
2    2
## 1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528
1529 1530
##    1    1    1    4    4    1    4    1    1    1    1    1    1
4    1
## 1531 1532 1533 1534 1535 1536 1537 1538 1539 1540 1541 1542 1543
1544 1545
##    1    1    1    2    1    1    1    1    1    1    1    1    1
1    1
## 1546 1547 1548 1549 1550 1551 1552 1553 1554 1555 1556 1557 1558
1559 1560
##    1    1    1    1    4    4    4    4    4    4    4    4    1
```

```
4    4
## 1561 1562 1563 1564 1565 1566 1567 1568 1569 1570 1571 1572 1573
1574 1575
##    4    1    4    4    4    1    1    1    4    1    4    1    4
4    4
## 1576 1577 1578 1579 1580 1581 1582 1583 1584 1585 1586 1587 1588
1589 1590
##    4    1    1    4    4    4    1    4    4    4    4    4    4
4    4
## 1591 1592 1593 1594 1595 1596 1597 1598 1599 1600 1601 1602 1603
1604 1605
##    4    1    1    4    4    4    4    4    4    4    4    4    4
1    1
## 1606 1607 1608 1609 1610 1611 1612 1613 1614 1615 1616 1617 1618
1619 1620
##    1    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1621 1622 1623 1624 1625 1626 1627 1628 1629 1630 1631 1632 1633
1634 1635
##    1    1    4    1    4    1    4    4    4    1    1    1    1
4    1
## 1636 1637 1638 1639 1640 1641 1642 1643 1644 1645 1646 1647 1648
1649 1650
##    1    1    1    1    1    4    4    1    4    4    4    1    4
4    1
## 1651 1652 1653 1654 1655 1656 1657 1658 1659 1660 1661 1662 1663
1664 1665
##    1    4    4    1    1    4    4    4    4    4    4    4    4
4    4
## 1666 1667 1668 1669 1670 1671 1672 1673 1674 1675 1676 1677 1678
1679 1680
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1681 1682 1683 1684 1685 1686 1687 1688 1689 1690 1691 1692 1693
1694 1695
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1696 1697 1698 1699 1700 1701 1702 1703 1704 1705 1706 1707 1708
1709 1710
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1711 1712 1713 1714 1715 1716 1717 1718 1719 1720 1721 1722 1723
1724 1725
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1726 1727 1728 1729 1730 1731 1732 1733 1734 1735 1736 1737 1738
1739 1740
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1741 1742 1743 1744 1745 1746 1747 1748 1749 1750 1751 1752 1753
```

```
1754 1755
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1756 1757 1758 1759 1760 1761 1762 1763 1764 1765 1766 1767 1768
1769 1770
##    1    1    4    1    4    4    1    1    1    1    2    2    1
4    4
## 1771 1772 1773 1774 1775 1776 1777 1778 1779 1780 1781 1782 1783
1784 1785
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    2
## 1786 1787 1788 1789 1790 1791 1792 1793 1794 1795 1796 1797 1798
1799 1800
##    4    4    4    4    4    4    4    4    4    4    4    4    1
4    4
## 1801 1802 1803 1804 1805 1806 1807 1808 1809 1810 1811 1812 1813
1814 1815
##    4    4    1    4    4    4    4    4    4    4    4    4    4
4    4
## 1816 1817 1818 1819 1820 1821 1822 1823 1824 1825 1826 1827 1828
1829 1830
##    4    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1831 1832 1833 1834 1835 1836 1837 1838 1839 1840 1841 1842 1843
1844 1845
##    1    4    4    4    4    4    4    4    4    4    4    4    4
4    4
## 1846 1847 1848 1849 1850 1851 1852 1853 1854 1855 1856 1857 1858
1859 1860
##    4    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1861 1862 1863 1864 1865 1866 1867 1868 1869 1870 1871 1872 1873
1874 1875
##    1    4    4    4    4    2    1    1    4    4    4    1    1
4    4
## 1876 1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888
1889 1890
##    4    1    4    4    4    4    4    4    4    4    4    4    1
4    4
## 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903
1904 1905
##    4    4    4    1    1    1    4    1    1    1    1    1    1
1    1
## 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918
1919 1920
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933
1934 1935
##    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
1    1
## 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948
1949 1950
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963
1964 1965
##    1    1    1    1    1    1    1    1    1    1    4    4    4
4    4
## 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978
1979 1980
##    4    1    4    1    1    1    1    1    1    1    1    1    1
1    1
## 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993
1994 1995
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    4
## 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
2009 2010
##    1    1    1    4    4    1    4    4    4    4    1    1    1
4    4
## 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
2024 2025
##    1    1    1    1    1    2    2    2    2    2    1    1    1
1    1
## 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038
2039 2040
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    1
## 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053
2054 2055
##    2    1    4    1    1    1    1    1    1    1    4    1    1
1    1
## 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068
2069 2070
##    1    1    1    1    1    1    1    1    1    1    1    1    1
1    2
## 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083
2084 2085
##    1    1    1    2    1    2    1    1    1    1    2    1    1
1    1
## 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098
2099 2100
##    1    1    1    2    2    2    2    1    2    1    2    1    2
2    2
## 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113
2114 2115
##    2    1    2    2    1    1    1    1    1    4    1    1    1
4    4
## 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128
```

```
2129 2130
##    4    4    4    1    1    4    1    1    1    1    1    1    1
1    1
## 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143
2144 2145
##    1    1    2    2    1    1    1    2    2    2    2    2    1
1    1
## 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158
2159 2160
##    1    1    1    1    1    2    2    1    2    1    1    2    1
1    1
## 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173
2174 2175
##    1    2    1    1    1    2    2    1    1    2    1    1    2
1    1
## 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188
2189 2190
##    2    2    1    1    2    2    2    1    1    1    1    2    1
1    1
## 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203
2204 2205
##    2    1    1    1    1    2    2    2    1    2    2    2    2
1    2
## 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218
2219 2220
##    1    2    1    2    2    2    1    1    2    2    1    2    1
1    2
## 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233
2234 2235
##    2    1    1    1    1    1    1    1    1    2    2    2    2
2    2
## 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248
2249 2250
##    2    2    2    2    1    2    2    2    2    2    1    1    2
2    2
## 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263
2264 2265
##    1    2    1    2    2    2    2    2    2    2    2    1    2
1    1
## 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278
2279 2280
##    1    2    2    2    2    2    2    2    2    2    1    2    2
2    2
## 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293
2294 2295
##    2    2    2    2    2    2    1    2    2    2    3    2    2
2    2
## 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308
2309 2310
##    2    2    1    2    2    1    2    2    2    2    2    2    2
```

```
2    2
## 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323
2324 2325
##    2    1    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338
2339 2340
##    2    1    2    2    2    2    2    2    2    2    2    2    2
2    1
## 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353
2354 2355
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368
2369 2370
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383
2384 2385
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398
2399 2400
##    2    2    2    2    2    2    3    1    2    2    2    2    2
2    2
## 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413
2414 2415
##    2    2    2    2    2    1    2    2    1    2    2    2    2
2    2
## 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428
2429 2430
##    2    2    2    1    2    2    1    2    2    2    2    2    2
2    2
## 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443
2444 2445
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458
2459 2460
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473
2474 2475
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488
2489 2490
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503
```

```
2504 2505
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518
2519 2520
##    2    2    2    2    2    2    2    2    2    2    2    2    3
3    3
## 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533
2534 2535
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548
2549 2550
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563
2564 2565
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578
2579 2580
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593
2594 2595
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608
2609 2610
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623
2624 2625
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638
2639 2640
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653
2654 2655
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668
2669 2670
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683
2684 2685
##    3    3    3    3    3    3    3    3    3    3    3    3    3
```

```
3    3
## 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698
2699 2700
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713
2714 2715
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728
2729 2730
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743
2744 2745
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2746 2747 2748 2749 2750 2751 2752 2753 2754 2755 2756 2757 2758
2759 2760
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2761 2762 2763 2764 2765 2766 2767 2768 2769 2770 2771 2772 2773
2774 2775
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2776 2777 2778 2779 2780 2781 2782 2783 2784 2785 2786 2787 2788
2789 2790
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2791 2792 2793 2794 2795 2796 2797 2798 2799 2800 2801 2802 2803
2804 2805
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2806 2807 2808 2809 2810 2811 2812 2813 2814 2815 2816 2817 2818
2819 2820
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2821 2822 2823 2824 2825 2826 2827 2828 2829 2830 2831 2832 2833
2834 2835
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2836 2837 2838 2839 2840 2841 2842 2843 2844 2845 2846 2847 2848
2849 2850
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2851 2852 2853 2854 2855 2856 2857 2858 2859 2860 2861 2862 2863
2864 2865
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2866 2867 2868 2869 2870 2871 2872 2873 2874 2875 2876 2877 2878
```

```
2879 2880
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2881 2882 2883 2884 2885 2886 2887 2888 2889 2890 2891 2892 2893
2894 2895
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2896 2897 2898 2899 2900 2901 2902 2903 2904 2905 2906 2907 2908
2909 2910
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2911 2912 2913 2914 2915 2916 2917 2918 2919 2920 2921 2922 2923
2924 2925
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2926 2927 2928 2929 2930 2931 2932 2933 2934 2935 2936 2937 2938
2939 2940
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2941 2942 2943 2944 2945 2946 2947 2948 2949 2950 2951 2952 2953
2954 2955
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2956 2957 2958 2959 2960 2961 2962 2963 2964 2965 2966 2967 2968
2969 2970
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2971 2972 2973 2974 2975 2976 2977 2978 2979 2980 2981 2982 2983
2984 2985
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 2986 2987 2988 2989 2990 2991 2992 2993 2994 2995 2996 2997 2998
2999 3000
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3001 3002 3003 3004 3005 3006 3007 3008 3009 3010 3011 3012 3013
3014 3015
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3016 3017 3018 3019 3020 3021 3022 3023 3024 3025 3026 3027 3028
3029 3030
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3031 3032 3033 3034 3035 3036 3037 3038 3039 3040 3041 3042 3043
3044 3045
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3046 3047 3048 3049 3050 3051 3052 3053 3054 3055 3056 3057 3058
3059 3060
##    3    3    3    3    3    3    3    3    3    3    3    3    3
```

```
3    3
## 3061 3062 3063 3064 3065 3066 3067 3068 3069 3070 3071 3072 3073
3074 3075
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3076 3077 3078 3079 3080 3081 3082 3083 3084 3085 3086 3087 3088
3089 3090
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3091 3092 3093 3094 3095 3096 3097 3098 3099 3100 3101 3102 3103
3104 3105
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3106 3107 3108 3109 3110 3111 3112 3113 3114 3115 3116 3117 3118
3119 3120
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3121 3122 3123 3124 3125 3126 3127 3128 3129 3130 3131 3132 3133
3134 3135
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3136 3137 3138 3139 3140 3141 3142 3143 3144 3145 3146 3147 3148
3149 3150
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3151 3152 3153 3154 3155 3156 3157 3158 3159 3160 3161 3162 3163
3164 3165
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3166 3167 3168 3169 3170 3171 3172 3173 3174 3175 3176 3177 3178
3179 3180
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3181 3182 3183 3184 3185 3186 3187 3188 3189 3190 3191 3192 3193
3194 3195
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3196 3197 3198 3199 3200 3201 3202 3203 3204 3205 3206 3207 3208
3209 3210
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3211 3212 3213 3214 3215 3216 3217 3218 3219 3220 3221 3222 3223
3224 3225
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3226 3227 3228 3229 3230 3231 3232 3233 3234 3235 3236 3237 3238
3239 3240
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3241 3242 3243 3244 3245 3246 3247 3248 3249 3250 3251 3252 3253
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3254 3255
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3256 3257 3258 3259 3260 3261 3262 3263 3264 3265 3266 3267 3268
3269 3270
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3271 3272 3273 3274 3275 3276 3277 3278 3279 3280 3281 3282 3283
3284 3285
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3286 3287 3288 3289 3290 3291 3292 3293 3294 3295 3296 3297 3298
3299 3300
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3301 3302 3303 3304 3305 3306 3307 3308 3309 3310 3311 3312 3313
3314 3315
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3316 3317 3318 3319 3320 3321 3322 3323 3324 3325 3326 3327 3328
3329 3330
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3331 3332 3333 3334 3335 3336 3337 3338 3339 3340 3341 3342 3343
3344 3345
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## 3346 3347 3348 3349 3350 3351 3352 3353 3354 3355 3356 3357 3358
3359 3360
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3361 3362 3363 3364 3365 3366 3367 3368 3369 3370 3371 3372 3373
3374 3375
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3376 3377 3378 3379 3380 3381 3382 3383 3384 3385 3386 3387 3388
3389 3390
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## 3391 3392 3393 3394 3395 3396 3397 3398 3399 3400 3401 3402 3403
3404 3405
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3406 3407 3408 3409 3410 3411 3412 3413 3414 3415 3416 3417 3418
3419 3420
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3421 3422 3423 3424 3425 3426 3427 3428 3429 3430 3431 3432 3433
3434 3435
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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3    3
## 3436 3437 3438 3439 3440 3441 3442 3443 3444 3445 3446 3447 3448
3449 3450
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## 3451 3452 3453 3454 3455 3456 3457 3458 3459 3460 3461 3462 3463
3464 3465
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3466 3467 3468 3469 3470 3471 3472 3473 3474 3475 3476 3477 3478
3479 3480
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## 3481 3482 3483 3484 3485 3486 3487 3488 3489 3490 3491 3492 3493
3494 3495
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## 3496 3497 3498 3499 3500 3501 3502 3503 3504 3505 3506 3507 3508
3509 3510
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3511 3512 3513 3514 3515 3516 3517 3518 3519 3520 3521 3522 3523
3524 3525
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3526 3527 3528 3529 3530 3531 3532 3533 3534 3535 3536 3537 3538
3539 3540
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## 3541 3542 3543 3544 3545 3546 3547 3548 3549 3550 3551 3552 3553
3554 3555
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 3556 3557 3558 3559 3560 3561 3562 3563 3564 3565 3566 3567 3568
3569 3570
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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3584 3585
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## 3586 3587 3588 3589 3590 3591 3592 3593 3594 3595 3596 3597 3598
3599 3600
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3601 3602 3603 3604 3605 3606 3607 3608 3609 3610 3611 3612 3613
3614 3615
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3616 3617 3618 3619 3620 3621 3622 3623 3624 3625 3626 3627 3628
```

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3629 3630
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## 3631 3632 3633 3634 3635 3636 3637 3638 3639 3640 3641 3642 3643
3644 3645
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3646 3647 3648 3649 3650 3651 3652 3653 3654 3655 3656 3657 3658
3659 3660
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3661 3662 3663 3664 3665 3666 3667 3668 3669 3670 3671 3672 3673
3674 3675
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3689 3690
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3704 3705
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3719 3720
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3721 3722 3723 3724 3725 3726 3727 3728 3729 3730 3731 3732 3733
3734 3735
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3736 3737 3738 3739 3740 3741 3742 3743 3744 3745 3746 3747 3748
3749 3750
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3764 3765
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3    3
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3779 3780
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## 3781 3782 3783 3784 3785 3786 3787 3788 3789 3790 3791 3792 3793
3794 3795
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3796 3797 3798 3799 3800 3801 3802 3803 3804 3805 3806 3807 3808
3809 3810
##    3    3    3    3    3    3    3    3    3    3    3    3    3
```

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3824 3825
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## 3826 3827 3828 3829 3830 3831 3832 3833 3834 3835 3836 3837 3838
3839 3840
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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3854 3855
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3869 3870
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3884 3885
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3899 3900
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3914 3915
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3916 3917 3918 3919 3920 3921 3922 3923 3924 3925 3926 3927 3928
3929 3930
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3931 3932 3933 3934 3935 3936 3937 3938 3939 3940 3941 3942 3943
3944 3945
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3946 3947 3948 3949 3950 3951 3952 3953 3954 3955 3956 3957 3958
3959 3960
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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3974 3975
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## 3976 3977 3978 3979 3980 3981 3982 3983 3984 3985 3986 3987 3988
3989 3990
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 3991 3992 3993 3994 3995 3996 3997 3998 3999 4000 4001 4002 4003
```

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4004 4005
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4019 4020
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4034 4035
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## 4036 4037 4038 4039 4040 4041 4042 4043 4044 4045 4046 4047 4048
4049 4050
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4051 4052 4053 4054 4055 4056 4057 4058 4059 4060 4061 4062 4063
4064 4065
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4066 4067 4068 4069 4070 4071 4072 4073 4074 4075 4076 4077 4078
4079 4080
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4081 4082 4083 4084 4085 4086 4087 4088 4089 4090 4091 4092 4093
4094 4095
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4096 4097 4098 4099 4100 4101 4102 4103 4104 4105 4106 4107 4108
4109 4110
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4111 4112 4113 4114 4115 4116 4117 4118 4119 4120 4121 4122 4123
4124 4125
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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4139 4140
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4154 4155
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4169 4170
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## 4171 4172 4173 4174 4175 4176 4177 4178 4179 4180 4181 4182 4183
4184 4185
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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4199 4200
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4201 4202 4203 4204 4205 4206 4207 4208 4209 4210 4211 4212 4213
4214 4215
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4216 4217 4218 4219 4220 4221 4222 4223 4224 4225 4226 4227 4228
4229 4230
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4231 4232 4233 4234 4235 4236 4237 4238 4239 4240 4241 4242 4243
4244 4245
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4246 4247 4248 4249 4250 4251 4252 4253 4254 4255 4256 4257 4258
4259 4260
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## 4261 4262 4263 4264 4265 4266 4267 4268 4269 4270 4271 4272 4273
4274 4275
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4276 4277 4278 4279 4280 4281 4282 4283 4284 4285 4286 4287 4288
4289 4290
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## 4291 4292 4293 4294 4295 4296 4297 4298 4299 4300 4301 4302 4303
4304 4305
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4306 4307 4308 4309 4310 4311 4312 4313 4314 4315 4316 4317 4318
4319 4320
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333
4334 4335
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4349 4350
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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4364 4365
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4366 4367 4368 4369 4370 4371 4372 4373 4374 4375 4376 4377 4378
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4394 4395
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## 4396 4397 4398 4399 4400 4401 4402 4403 4404 4405 4406 4407 4408
4409 4410
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4411 4412 4413 4414 4415 4416 4417 4418 4419 4420 4421 4422 4423
4424 4425
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4426 4427 4428 4429 4430 4431 4432 4433 4434 4435 4436 4437 4438
4439 4440
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## 4441 4442 4443 4444 4445 4446 4447 4448 4449 4450 4451 4452 4453
4454 4455
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4456 4457 4458 4459 4460 4461 4462 4463 4464 4465 4466 4467 4468
4469 4470
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4471 4472 4473 4474 4475 4476 4477 4478 4479 4480 4481 4482 4483
4484 4485
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4486 4487 4488 4489 4490 4491 4492 4493 4494 4495 4496 4497 4498
4499 4500
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4501 4502 4503 4504 4505 4506 4507 4508 4509 4510 4511 4512 4513
4514 4515
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4516 4517 4518 4519 4520 4521 4522 4523 4524 4525 4526 4527 4528
4529 4530
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4531 4532 4533 4534 4535 4536 4537 4538 4539 4540 4541 4542 4543
4544 4545
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4546 4547 4548 4549 4550 4551 4552 4553 4554 4555 4556 4557 4558
4559 4560
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4561 4562 4563 4564 4565 4566 4567 4568 4569 4570 4571 4572 4573
4574 4575
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## 4576 4577 4578 4579 4580 4581 4582 4583 4584 4585 4586 4587 4588
4589 4590
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4591 4592 4593 4594 4595 4596 4597 4598 4599 4600 4601 4602 4603
4604 4605
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## 4606 4607 4608 4609 4610 4611 4612 4613 4614 4615 4616 4617 4618
4619 4620
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4621 4622 4623 4624 4625 4626 4627 4628 4629 4630 4631 4632 4633
4634 4635
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## 4636 4637 4638 4639 4640 4641 4642 4643 4644 4645 4646 4647 4648
4649 4650
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## 4651 4652 4653 4654 4655 4656 4657 4658 4659 4660 4661 4662 4663
4664 4665
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4666 4667 4668 4669 4670 4671 4672 4673 4674 4675 4676 4677 4678
4679 4680
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## 4696 4697 4698 4699 4700 4701 4702 4703 4704 4705 4706 4707 4708
4709 4710
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4711 4712 4713 4714 4715 4716 4717 4718 4719 4720 4721 4722 4723
4724 4725
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## 4726 4727 4728 4729 4730 4731 4732 4733 4734 4735 4736 4737 4738
4739 4740
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## 4741 4742 4743 4744 4745 4746 4747 4748 4749 4750 4751 4752 4753
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4769 4770
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## 4771 4772 4773 4774 4775 4776 4777 4778 4779 4780 4781 4782 4783
4784 4785
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4786 4787 4788 4789 4790 4791 4792 4793 4794 4795 4796 4797 4798
4799 4800
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4801 4802 4803 4804 4805 4806 4807 4808 4809 4810 4811 4812 4813
4814 4815
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4816 4817 4818 4819 4820 4821 4822 4823 4824 4825 4826 4827 4828
4829 4830
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## 4831 4832 4833 4834 4835 4836 4837 4838 4839 4840 4841 4842 4843
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## 4846 4847 4848 4849 4850 4851 4852 4853 4854 4855 4856 4857 4858
4859 4860
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4861 4862 4863 4864 4865 4866 4867 4868 4869 4870 4871 4872 4873
4874 4875
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4876 4877 4878 4879 4880 4881 4882 4883 4884 4885 4886 4887 4888
4889 4890
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## 4891 4892 4893 4894 4895 4896 4897 4898 4899 4900 4901 4902 4903
4904 4905
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## 4906 4907 4908 4909 4910 4911 4912 4913 4914 4915 4916 4917 4918
4919 4920
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## 4921 4922 4923 4924 4925 4926 4927 4928 4929 4930 4931 4932 4933
4934 4935
##    3    3    3    3    3    3    3    3    3    3    3    3    3
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## 4951 4952 4953 4954 4955 4956 4957 4958 4959 4960 4961 4962 4963
4964 4965
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4979 4980
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## 4981 4982 4983 4984 4985 4986 4987 4988 4989 4990 4991 4992 4993
4994 4995
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 4996 4997 4998 4999 5000 5001 5002 5003 5004 5005 5006 5007 5008
5009 5010
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 5011 5012 5013 5014 5015 5016 5017 5018 5019 5020 5021 5022 5023
5024 5025
##    3    3    3    3    3    3    3    3    3    3    3    3    3
3    3
## 5026 5027 5028 5029 5030 5031 5032 5033 5034 5035 5036 5037 5038
5039 5040
##    3    3    3    3    3    3    3    3    3    2    2    2    2
3    2
## 5041 5042 5043 5044 5045 5046 5047 5048 5049 5050 5051 5052 5053
5054 5055
##    2    2    1    2    2    2    2    2    2    2    2    2    2
2    2
## 5056 5057 5058 5059 5060 5061 5062 5063 5064 5065 5066 5067 5068
5069 5070
##    2    2    3    2    2    2    2    2    2    2    2    2    2
2    2
## 5071 5072 5073 5074 5075 5076 5077 5078 5079 5080 5081 5082 5083
5084 5085
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5086 5087 5088 5089 5090 5091 5092 5093 5094 5095 5096 5097 5098
5099 5100
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5101 5102 5103 5104 5105 5106 5107 5108 5109 5110 5111 5112 5113
5114 5115
##    2    2    2    2    2    2    1    2    2    2    2    2    2
2    2
## 5116 5117 5118 5119 5120 5121 5122 5123 5124 5125 5126 5127 5128
```

```
5129 5130
##    2    2    2    2    2    2    2    2    2    1    2    2    2
2    2
## 5131 5132 5133 5134 5135 5136 5137 5138 5139 5140 5141 5142 5143
5144 5145
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5146 5147 5148 5149 5150 5151 5152 5153 5154 5155 5156 5157 5158
5159 5160
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5161 5162 5163 5164 5165 5166 5167 5168 5169 5170 5171 5172 5173
5174 5175
##    2    2    2    2    1    2    2    2    2    2    2    2    2
2    2
## 5176 5177 5178 5179 5180 5181 5182 5183 5184 5185 5186 5187 5188
5189 5190
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5191 5192 5193 5194 5195 5196 5197 5198 5199 5200 5201 5202 5203
5204 5205
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5206 5207 5208 5209 5210 5211 5212 5213 5214 5215 5216 5217 5218
5219 5220
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5221 5222 5223 5224 5225 5226 5227 5228 5229 5230 5231 5232 5233
5234 5235
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5236 5237 5238 5239 5240 5241 5242 5243 5244 5245 5246 5247 5248
5249 5250
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5251 5252 5253 5254 5255 5256 5257 5258 5259 5260 5261 5262 5263
5264 5265
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5266 5267 5268 5269 5270 5271 5272 5273 5274 5275 5276 5277 5278
5279 5280
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5281 5282 5283 5284 5285 5286 5287 5288 5289 5290 5291 5292 5293
5294 5295
##    2    2    2    2    2    2    2    2    2    3    3    2    2
1    2
## 5296 5297 5298 5299 5300 5301 5302 5303 5304 5305 5306 5307 5308
5309 5310
##    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
3    2
## 5311 5312 5313 5314 5315 5316 5317 5318 5319 5320 5321 5322 5323
5324 5325
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5326 5327 5328 5329 5330 5331 5332 5333 5334 5335 5336 5337 5338
5339 5340
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    1
## 5341 5342 5343 5344 5345 5346 5347 5348 5349 5350 5351 5352 5353
5354 5355
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5356 5357 5358 5359 5360 5361 5362 5363 5364 5365 5366 5367 5368
5369 5370
##    2    2    1    2    2    2    2    2    2    2    2    2    2
2    2
## 5371 5372 5373 5374 5375 5376 5377 5378 5379 5380 5381 5382 5383
5384 5385
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5386 5387 5388 5389 5390 5391 5392 5393 5394 5395 5396 5397 5398
5399 5400
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5401 5402 5403 5404 5405 5406 5407 5408 5409 5410 5411 5412 5413
5414 5415
##    2    2    2    2    2    2    2    2    2    2    2    3    2
2    2
## 5416 5417 5418 5419 5420 5421 5422 5423 5424 5425 5426 5427 5428
5429 5430
##    1    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5431 5432 5433 5434 5435 5436 5437 5438 5439 5440 5441 5442 5443
5444 5445
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5446 5447 5448 5449 5450 5451 5452 5453 5454 5455 5456 5457 5458
5459 5460
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5461 5462 5463 5464 5465 5466 5467 5468 5469 5470 5471 5472 5473
5474 5475
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5476 5477 5478 5479 5480 5481 5482 5483 5484 5485 5486 5487 5488
5489 5490
##    2    2    2    2    2    2    2    2    1    2    2    2    2
2    2
## 5491 5492 5493 5494 5495 5496 5497 5498 5499 5500 5501 5502 5503
```

```
5504 5505
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5506 5507 5508 5509 5510 5511 5512 5513 5514 5515 5516 5517 5518
5519 5520
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5521 5522 5523 5524 5525 5526 5527 5528 5529 5530 5531 5532 5533
5534 5535
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5536 5537 5538 5539 5540 5541 5542 5543 5544 5545 5546 5547 5548
5549 5550
##    2    2    2    2    2    2    2    3    2    1    2    2    2
2    2
## 5551 5552 5553 5554 5555 5556 5557 5558 5559 5560 5561 5562 5563
5564 5565
##    2    2    2    2    2    2    2    2    2    3    2    2    2
2    2
## 5566 5567 5568 5569 5570 5571 5572 5573 5574 5575 5576 5577 5578
5579 5580
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5581 5582 5583 5584 5585 5586 5587 5588 5589 5590 5591 5592 5593
5594 5595
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5596 5597 5598 5599 5600 5601 5602 5603 5604 5605 5606 5607 5608
5609 5610
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5611 5612 5613 5614 5615 5616 5617 5618 5619 5620 5621 5622 5623
5624 5625
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5626 5627 5628 5629 5630 5631 5632 5633 5634 5635 5636 5637 5638
5639 5640
##    2    2    2    3    2    2    2    2    2    2    2    2    2
2    2
## 5641 5642 5643 5644 5645 5646 5647 5648 5649 5650 5651 5652 5653
5654 5655
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5656 5657 5658 5659 5660 5661 5662 5663 5664 5665 5666 5667 5668
5669 5670
##    2    2    2    2    2    2    2    2    3    2    2    1    2
2    2
## 5671 5672 5673 5674 5675 5676 5677 5678 5679 5680 5681 5682 5683
5684 5685
##    2    1    2    2    2    2    2    2    2    2    2    2    2
```

```
2    2
## 5686 5687 5688 5689 5690 5691 5692 5693 5694 5695 5696 5697 5698
5699 5700
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5701 5702 5703 5704 5705 5706 5707 5708 5709 5710 5711 5712 5713
5714 5715
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5716 5717 5718 5719 5720 5721 5722 5723 5724 5725 5726 5727 5728
5729 5730
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5731 5732 5733 5734 5735 5736 5737 5738 5739 5740 5741 5742 5743
5744 5745
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5746 5747 5748 5749 5750 5751 5752 5753 5754 5755 5756 5757 5758
5759 5760
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5761 5762 5763 5764 5765 5766 5767 5768 5769 5770 5771 5772 5773
5774 5775
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5776 5777 5778 5779 5780 5781 5782 5783 5784 5785 5786 5787 5788
5789 5790
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5791 5792 5793 5794 5795 5796 5797 5798 5799 5800 5801 5802 5803
5804 5805
##    2    2    2    3    3    2    2    2    2    2    2    2    2
2    2
## 5806 5807 5808 5809 5810 5811 5812 5813 5814 5815 5816 5817 5818
5819 5820
##    2    2    2    2    2    2    2    2    2    2    3    2    2
2    2
## 5821 5822 5823 5824 5825 5826 5827 5828 5829 5830 5831 5832 5833
5834 5835
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5836 5837 5838 5839 5840 5841 5842 5843 5844 5845 5846 5847 5848
5849 5850
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5851 5852 5853 5854 5855 5856 5857 5858 5859 5860 5861 5862 5863
5864 5865
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5866 5867 5868 5869 5870 5871 5872 5873 5874 5875 5876 5877 5878
```

```
5879 5880
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5881 5882 5883 5884 5885 5886 5887 5888 5889 5890 5891 5892 5893
5894 5895
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5896 5897 5898 5899 5900 5901 5902 5903 5904 5905 5906 5907 5908
5909 5910
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5911 5912 5913 5914 5915 5916 5917 5918 5919 5920 5921 5922 5923
5924 5925
##    2    2    2    3    2    2    2    2    2    2    1    2    2
2    2
## 5926 5927 5928 5929 5930 5931 5932 5933 5934 5935 5936 5937 5938
5939 5940
##    2    2    2    2    2    2    2    2    2    2    2    2    2
3    2
## 5941 5942 5943 5944 5945 5946 5947 5948 5949 5950 5951 5952 5953
5954 5955
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5956 5957 5958 5959 5960 5961 5962 5963 5964 5965 5966 5967 5968
5969 5970
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5971 5972 5973 5974 5975 5976 5977 5978 5979 5980 5981 5982 5983
5984 5985
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 5986 5987 5988 5989 5990 5991 5992 5993 5994 5995 5996 5997 5998
5999 6000
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6001 6002 6003 6004 6005 6006 6007 6008 6009 6010 6011 6012 6013
6014 6015
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6016 6017 6018 6019 6020 6021 6022 6023 6024 6025 6026 6027 6028
6029 6030
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6031 6032 6033 6034 6035 6036 6037 6038 6039 6040 6041 6042 6043
6044 6045
##    2    2    2    2    2    2    2    2    2    2    3    3    3
3    3
## 6046 6047 6048 6049 6050 6051 6052 6053 6054 6055 6056 6057 6058
6059 6060
##    2    2    2    2    2    2    2    2    2    2    2    2    2
```

```
2    2
## 6061 6062 6063 6064 6065 6066 6067 6068 6069 6070 6071 6072 6073
6074 6075
##    2    2    2    2    3    2    2    2    2    2    2    2    2
2    2
## 6076 6077 6078 6079 6080 6081 6082 6083 6084 6085 6086 6087 6088
6089 6090
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6091 6092 6093 6094 6095 6096 6097 6098 6099 6100 6101 6102 6103
6104 6105
##    2    2    2    2    2    2    2    2    2    2    2    1    2
2    2
## 6106 6107 6108 6109 6110 6111 6112 6113 6114 6115 6116 6117 6118
6119 6120
##    2    2    2    2    1    2    2    2    2    2    2    2    2
2    2
## 6121 6122 6123 6124 6125 6126 6127 6128 6129 6130 6131 6132 6133
6134 6135
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6136 6137 6138 6139 6140 6141 6142 6143 6144 6145 6146 6147 6148
6149 6150
##    2    2    2    1    1    1    1    1    1    2    2    2    2
2    2
## 6151 6152 6153 6154 6155 6156 6157 6158 6159 6160 6161 6162 6163
6164 6165
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6166 6167 6168 6169 6170 6171 6172 6173 6174 6175 6176 6177 6178
6179 6180
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6181 6182 6183 6184 6185 6186 6187 6188 6189 6190 6191 6192 6193
6194 6195
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6196 6197 6198 6199 6200 6201 6202 6203 6204 6205 6206 6207 6208
6209 6210
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6211 6212 6213 6214 6215 6216 6217 6218 6219 6220 6221 6222 6223
6224 6225
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6226 6227 6228 6229 6230 6231 6232 6233 6234 6235 6236 6237 6238
6239 6240
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6241 6242 6243 6244 6245 6246 6247 6248 6249 6250 6251 6252 6253
```

```
6254 6255
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6256 6257 6258 6259 6260 6261 6262 6263 6264 6265 6266 6267 6268
6269 6270
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6271 6272 6273 6274 6275 6276 6277 6278 6279 6280 6281 6282 6283
6284 6285
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6286 6287 6288 6289 6290 6291 6292 6293 6294 6295 6296 6297 6298
6299 6300
##    2    2    2    2    2    2    2    3    3    3    2    3    2
2    2
## 6301 6302 6303 6304 6305 6306 6307 6308 6309 6310 6311 6312 6313
6314 6315
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6316 6317 6318 6319 6320 6321 6322 6323 6324 6325 6326 6327 6328
6329 6330
##    2    3    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6331 6332 6333 6334 6335 6336 6337 6338 6339 6340 6341 6342 6343
6344 6345
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6346 6347 6348 6349 6350 6351 6352 6353 6354 6355 6356 6357 6358
6359 6360
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6361 6362 6363 6364 6365 6366 6367 6368 6369 6370 6371 6372 6373
6374 6375
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6376 6377 6378 6379 6380 6381 6382 6383 6384 6385 6386 6387 6388
6389 6390
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6391 6392 6393 6394 6395 6396 6397 6398 6399 6400 6401 6402 6403
6404 6405
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6406 6407 6408 6409 6410 6411 6412 6413 6414 6415 6416 6417 6418
6419 6420
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6421 6422 6423 6424 6425 6426 6427 6428 6429 6430 6431 6432 6433
6434 6435
##    2    2    2    1    2    2    2    2    2    2    2    2    2
```

```
2    2
## 6436 6437 6438 6439 6440 6441 6442 6443 6444 6445 6446 6447 6448
6449 6450
##    2    2    2    2    2    2    2    2    2    1    1    2    1
1    2
## 6451 6452 6453 6454 6455 6456 6457 6458 6459 6460 6461 6462 6463
6464 6465
##    2    2    2    2    2    2    2    1    1    1    1    2    2
1    2
## 6466 6467 6468 6469 6470 6471 6472 6473 6474 6475 6476 6477 6478
6479 6480
##    2    2    2    2    2    2    2    1    2    1    2    2    2
2    1
## 6481 6482 6483 6484 6485 6486 6487 6488 6489 6490 6491 6492 6493
6494 6495
##    2    2    2    2    2    2    2    2    2    2    2    1    2
2    2
## 6496 6497 6498 6499 6500 6501 6502 6503 6504 6505 6506 6507 6508
6509 6510
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6511 6512 6513 6514 6515 6516 6517 6518 6519 6520 6521 6522 6523
6524 6525
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6526 6527 6528 6529 6530 6531 6532 6533 6534 6535 6536 6537 6538
6539 6540
##    1    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6541 6542 6543 6544 6545 6546 6547 6548 6549 6550 6551 6552 6553
6554 6555
##    2    2    2    2    2    2    2    2    3    2    2    2    2
2    2
## 6556 6557 6558 6559 6560 6561 6562 6563 6564 6565 6566 6567 6568
6569 6570
##    2    2    2    2    2    2    2    2    2    2    2    2    3
2    2
## 6571 6572 6573 6574 6575 6576 6577 6578 6579 6580 6581 6582 6583
6584 6585
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6586 6587 6588 6589 6590 6591 6592 6593 6594 6595 6596 6597 6598
6599 6600
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6601 6602 6603 6604 6605 6606 6607 6608 6609 6610 6611 6612 6613
6614 6615
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6616 6617 6618 6619 6620 6621 6622 6623 6624 6625 6626 6627 6628
```

```
6629 6630
##    2    1    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6631 6632 6633 6634 6635 6636 6637 6638 6639 6640 6641 6642 6643
6644 6645
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6646 6647 6648 6649 6650 6651 6652 6653 6654 6655 6656 6657 6658
6659 6660
##    2    2    2    2    2    2    2    2    2    2    2    1    2
2    2
## 6661 6662 6663 6664 6665 6666 6667 6668 6669 6670 6671 6672 6673
6674 6675
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    1
## 6676 6677 6678 6679 6680 6681 6682 6683 6684 6685 6686 6687 6688
6689 6690
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6691 6692 6693 6694 6695 6696 6697 6698 6699 6700 6701 6702 6703
6704 6705
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6706 6707 6708 6709 6710 6711 6712 6713 6714 6715 6716 6717 6718
6719 6720
##    2    2    2    1    1    1    2    2    2    2    2    2    2
2    2
## 6721 6722 6723 6724 6725 6726 6727 6728 6729 6730 6731 6732 6733
6734 6735
##    2    2    1    2    2    2    2    2    2    2    2    2    2
2    2
## 6736 6737 6738 6739 6740 6741 6742 6743 6744 6745 6746 6747 6748
6749 6750
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6751 6752 6753 6754 6755 6756 6757 6758 6759 6760 6761 6762 6763
6764 6765
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6766 6767 6768 6769 6770 6771 6772 6773 6774 6775 6776 6777 6778
6779 6780
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6781 6782 6783 6784 6785 6786 6787 6788 6789 6790 6791 6792 6793
6794 6795
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6796 6797 6798 6799 6800 6801 6802 6803 6804 6805 6806 6807 6808
6809 6810
##    2    2    2    2    3    3    2    2    2    2    2    2    2
```

```
2    2
## 6811 6812 6813 6814 6815 6816 6817 6818 6819 6820 6821 6822 6823
6824 6825
##    2    2    2    2    2    2    2    2    3    2    2    2    1
1    2
## 6826 6827 6828 6829 6830 6831 6832 6833 6834 6835 6836 6837 6838
6839 6840
##    2    2    2    1    2    2    2    2    2    2    2    2    2
2    2
## 6841 6842 6843 6844 6845 6846 6847 6848 6849 6850 6851 6852 6853
6854 6855
##    2    2    2    1    2    2    2    2    1    2    1    2    1
2    1
## 6856 6857 6858 6859 6860 6861 6862 6863 6864 6865 6866 6867 6868
6869 6870
##    2    1    2    2    2    2    2    2    2    2    2    2    1
1    1
## 6871 6872 6873 6874 6875 6876 6877 6878 6879 6880 6881 6882 6883
6884 6885
##    1    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6886 6887 6888 6889 6890 6891 6892 6893 6894 6895 6896 6897 6898
6899 6900
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6901 6902 6903 6904 6905 6906 6907 6908 6909 6910 6911 6912 6913
6914 6915
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6916 6917 6918 6919 6920 6921 6922 6923 6924 6925 6926 6927 6928
6929 6930
##    2    2    2    2    2    2    2    2    2    2    1    2    2
2    2
## 6931 6932 6933 6934 6935 6936 6937 6938 6939 6940 6941 6942 6943
6944 6945
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6946 6947 6948 6949 6950 6951 6952 6953 6954 6955 6956 6957 6958
6959 6960
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6961 6962 6963 6964 6965 6966 6967 6968 6969 6970 6971 6972 6973
6974 6975
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6976 6977 6978 6979 6980 6981 6982 6983 6984 6985 6986 6987 6988
6989 6990
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 6991 6992 6993 6994 6995 6996 6997 6998 6999 7000 7001 7002 7003
```

```
7004 7005
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7006 7007 7008 7009 7010 7011 7012 7013 7014 7015 7016 7017 7018
7019 7020
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7021 7022 7023 7024 7025 7026 7027 7028 7029 7030 7031 7032 7033
7034 7035
##    2    2    2    1    2    2    2    1    2    2    2    2    2
1    1
## 7036 7037 7038 7039 7040 7041 7042 7043 7044 7045 7046 7047 7048
7049 7050
##    1    1    2    1    2    2    2    2    2    2    2    2    2
2    2
## 7051 7052 7053 7054 7055 7056 7057 7058 7059 7060 7061 7062 7063
7064 7065
##    2    2    2    3    2    2    2    2    2    2    2    2    2
2    2
## 7066 7067 7068 7069 7070 7071 7072 7073 7074 7075 7076 7077 7078
7079 7080
##    2    2    2    2    2    2    2    2    2    3    2    2    2
2    2
## 7081 7082 7083 7084 7085 7086 7087 7088 7089 7090 7091 7092 7093
7094 7095
##    2    2    2    1    1    2    2    2    2    2    2    2    2
2    2
## 7096 7097 7098 7099 7100 7101 7102 7103 7104 7105 7106 7107 7108
7109 7110
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7111 7112 7113 7114 7115 7116 7117 7118 7119 7120 7121 7122 7123
7124 7125
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7126 7127 7128 7129 7130 7131 7132 7133 7134 7135 7136 7137 7138
7139 7140
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7141 7142 7143 7144 7145 7146 7147 7148 7149 7150 7151 7152 7153
7154 7155
##    2    2    2    1    2    2    2    1    1    1    2    2    2
2    1
## 7156 7157 7158 7159 7160 7161 7162 7163 7164 7165 7166 7167 7168
7169 7170
##    2    2    2    1    2    2    2    2    2    2    2    2    2
2    2
## 7171 7172 7173 7174 7175 7176 7177 7178 7179 7180 7181 7182 7183
7184 7185
##    2    2    2    2    3    2    2    2    2    2    2    1    2
```

```
2    2
## 7186 7187 7188 7189 7190 7191 7192 7193 7194 7195 7196 7197 7198
7199 7200
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7201 7202 7203 7204 7205 7206 7207 7208 7209 7210 7211 7212 7213
7214 7215
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7216 7217 7218 7219 7220 7221 7222 7223 7224 7225 7226 7227 7228
7229 7230
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7231 7232 7233 7234 7235 7236 7237 7238 7239 7240 7241 7242 7243
7244 7245
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7246 7247 7248 7249 7250 7251 7252 7253 7254 7255 7256 7257 7258
7259 7260
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7261 7262 7263 7264 7265 7266 7267 7268 7269 7270 7271 7272 7273
7274 7275
##    2    2    1    2    2    2    2    2    2    2    2    2    2
2    2
## 7276 7277 7278 7279 7280 7281 7282 7283 7284 7285 7286 7287 7288
7289 7290
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7291 7292 7293 7294 7295 7296 7297 7298 7299 7300 7301 7302 7303
7304 7305
##    2    2    2    2    2    2    2    2    2    2    2    2    2
3    2
## 7306 7307 7308 7309 7310 7311 7312 7313 7314 7315 7316 7317 7318
7319 7320
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7321 7322 7323 7324 7325 7326 7327 7328 7329 7330 7331 7332 7333
7334 7335
##    2    2    2    2    3    2    2    2    2    2    2    2    2
2    2
## 7336 7337 7338 7339 7340 7341 7342 7343 7344 7345 7346 7347 7348
7349 7350
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7351 7352 7353 7354 7355 7356 7357 7358 7359 7360 7361 7362 7363
7364 7365
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7366 7367 7368 7369 7370 7371 7372 7373 7374 7375 7376 7377 7378
```

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7379 7380
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7381 7382 7383 7384 7385 7386 7387 7388 7389 7390 7391 7392 7393
7394 7395
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7396 7397 7398 7399 7400 7401 7402 7403 7404 7405 7406 7407 7408
7409 7410
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7411 7412 7413 7414 7415 7416 7417 7418 7419 7420 7421 7422 7423
7424 7425
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7426 7427 7428 7429 7430 7431 7432 7433 7434 7435 7436 7437 7438
7439 7440
##    3    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7441 7442 7443 7444 7445 7446 7447 7448 7449 7450 7451 7452 7453
7454 7455
##    2    2    1    2    2    2    2    2    2    2    2    2    2
2    2
## 7456 7457 7458 7459 7460 7461 7462 7463 7464 7465 7466 7467 7468
7469 7470
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7471 7472 7473 7474 7475 7476 7477 7478 7479 7480 7481 7482 7483
7484 7485
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7486 7487 7488 7489 7490 7491 7492 7493 7494 7495 7496 7497 7498
7499 7500
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7501 7502 7503 7504 7505 7506 7507 7508 7509 7510 7511 7512 7513
7514 7515
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7516 7517 7518 7519 7520 7521 7522 7523 7524 7525 7526 7527 7528
7529 7530
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7531 7532 7533 7534 7535 7536 7537 7538 7539 7540 7541 7542 7543
7544 7545
##    2    2    2    2    2    2    2    2    2    2    2    2    2
2    2
## 7546 7547 7548 7549
##    2    2    2    2
##
```

```
## Within cluster sum of squares by cluster:
## [1] 4.247770e+20 3.891342e+20 4.418188e+19 4.970017e+20
##  (between_SS / total_SS =  93.8 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
## [5] "tot.withinss" "betweenss"    "size"         "iter"
## [9] "ifault"
```

From the result, we can see that the percentage $between_SS/total_SS$ is 93.8 %. It is relatively high. So k-means is a good predict method we can use in this type question.

8.Conclusion

In linear model, I have tried so mant method. Because in the beginning of the projet I don't know how to do analysis. But I try many different combinations, and finally, I find I can use tomorrow and today's diff as indenpendent to do analysis. And I can also use the day after tomorrow and today's diff to do analysis and find some useful information.

As my data is continuous by time, I use time series wo do analysis. By this analysis, I only find the conclusion that the stock's price won't change sharply and it always changes very smoothly. And this is also match our daily common sense.

Next step, I do the SVM analysis. First important thing I need to face is to find the indenpendent which I can do analysis. I think abou the numeric I don't know how to do. So I find the literature, it tells me that I need to add an variable whcih can help you to calcluate the changes by numberic. So I set the t-value. And then, I find I can't use this value to make the machine to do supervise learning. Because this value is calculated by specific funtion. We need to give the machine such data that they don't have specific funtion. We can't find the specific relationship between them but we want find the relation. We can use SVM to help us. So I find another variable: behavior's earnings. Use the diff between today and tomorrow and the behavior made by to stockholder to conduct the stockhold's earning situtaion. And use training dataset to set rules and use test dataset to test.

Then I use decision trees to see except the earning variable and how other variables influencing the trend.

Then I have done k-means to see how the number cluster's situation. I can see that those number can be clustered relatively clearly. So unsuperviesd learning is a guidance to my data.

Above all, the prediction of the time when we can buy or when we need to seel our stocks is very hard to predict. We can only do qualitative analysis, but not quantitative analysis. Although some model can predict results for a period, future is always uncertain. It is just like our life, liek: you never know what will happen in the next minute. This is my final project in my student life, and I will also need to face to my uncertain future. Prediction of life is very similar with prediction of stock, it is filled with uncertainties. But this is also the interesting part of our life. Thanks machine learning tells me so many methods to solve the problems in our daily life.

9.References

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[4] www.wikiposit.org

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