

ARIMA in R

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R Markdown

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When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
#Setting up pull dates and obtaining stock information

start <- as.Date("2010-05-27")
end <- as.Date("2020-05-27")

getSymbols("AAPL",src = "yahoo",from = start, to = end)

## 'getSymbols' currently uses auto.assign=TRUE by default, but will
## use auto.assign=FALSE in 0.5-0. You will still be able to use
## 'loadSymbols' to automatically load data. getOption("getSymbols.env")
## and getOption("getSymbols.auto.assign") will still be checked for
## alternate defaults.
##
## This message is shown once per session and may be disabled by setting
## options("getSymbols.warning4.0"=FALSE). See ?getSymbols for details.

## [1] "AAPL"

class(AAPL)

## [1] "xts" "zoo"

head(AAPL)

##          AAPL.Open AAPL.High AAPL.Low AAPL.Close AAPL.Volume AAPL.Adjusted
## 2010-05-27    35.80000   36.27000  35.58714    36.19286   166570600     31.33206
## 2010-05-28    37.05571   37.05714  36.19286    36.69714   203903700     31.76862
## 2010-06-01    37.09857   37.99143  36.99429    37.26143   219118200     32.25713
## 2010-06-02    37.79143   37.82857  37.19000    37.70714   172137000     32.64297
## 2010-06-03    37.88286   37.93572  37.20143    37.58857   162526700     32.54033
## 2010-06-04    36.88714   37.41429  36.37571    36.56572   189576100     31.65483
```

```
getSymbols(c("MSFT", "GOOG", "AMZN", "NDAQ"), src = "yahoo", from = start, to = end)
```

```
## [1] "MSFT" "GOOG" "AMZN" "NDAQ"
```

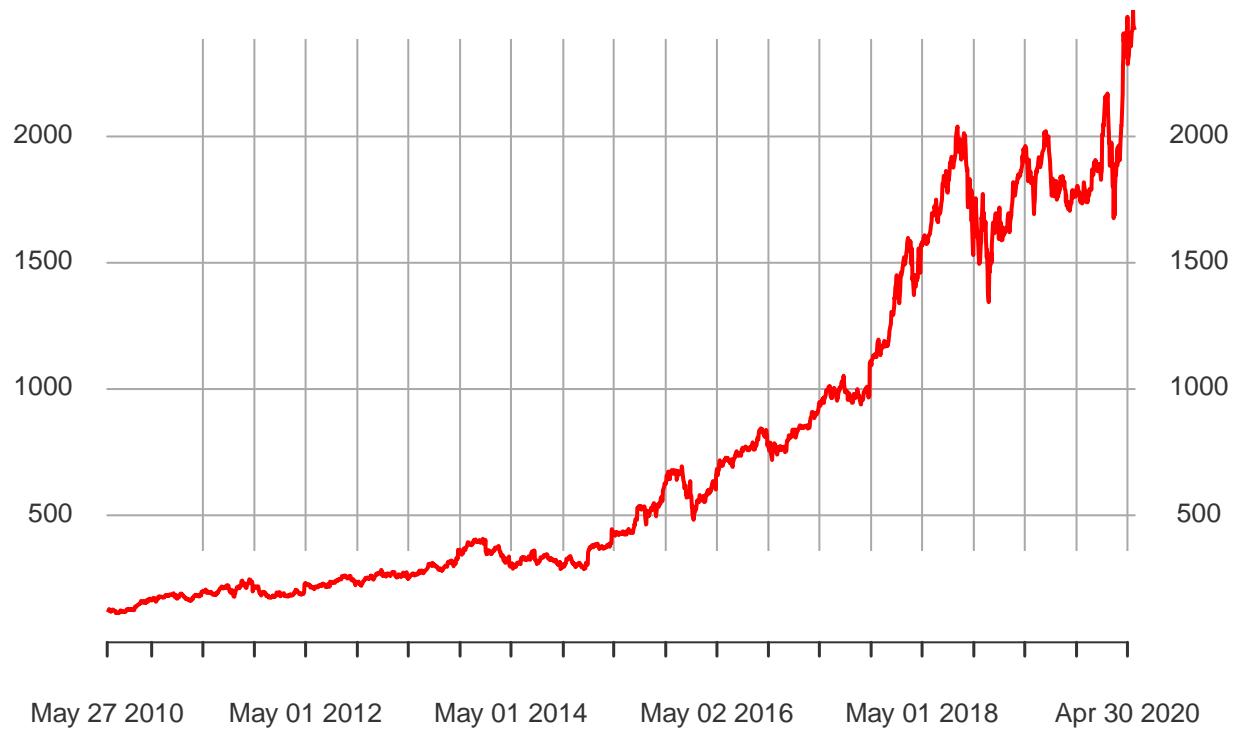
```
plot(AAPL[, "AAPL.Close"], main = "AAPL", col = "red" )
```



```
plot(AMZN[, "AMZN.Close"], main = "AMZN", col = "red")
```

AMZN

2010–05–27 / 2020–05–26



```
plot(GOOG[, "GOOG.Close"], main = "GOOG", col = "red")
```

GOOG

2010–05–27 / 2020–05–26



```
plot(MSFT[, "MSFT.Close"], main = "MSFT", col = "red")
```

MSFT

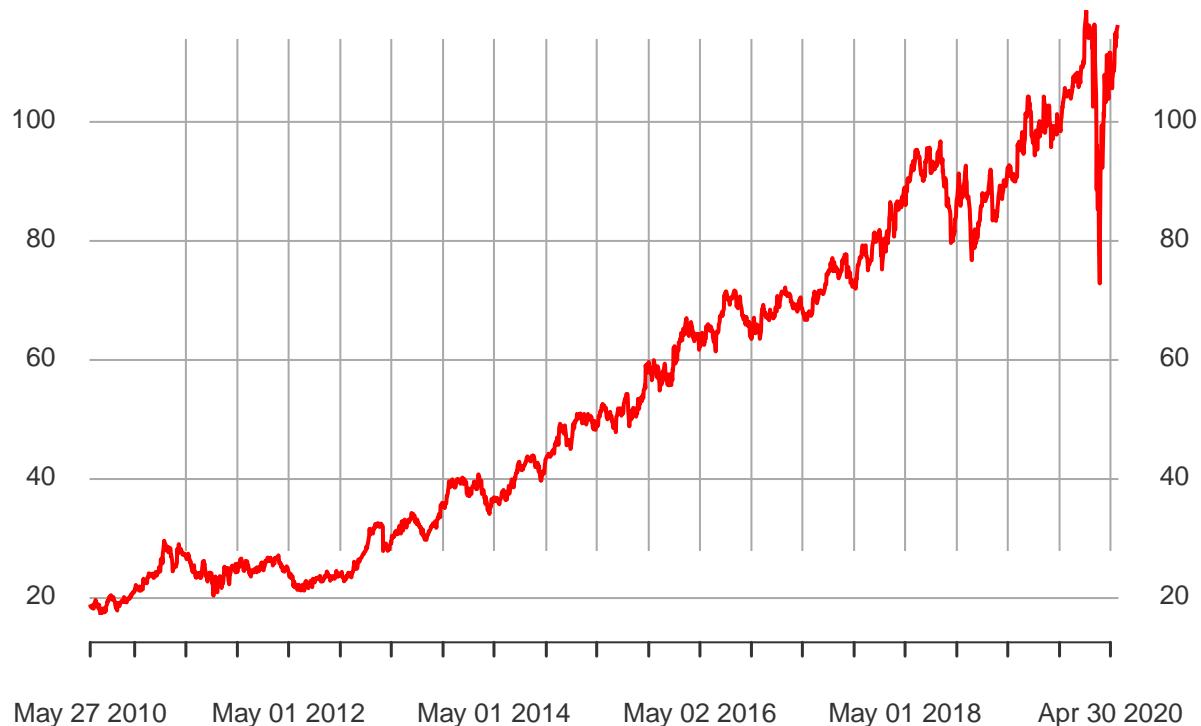
2010–05–27 / 2020–05–26



```
plot(NDAQ[, "NDAQ.Close"], main = "NDAQ", col = "red")
```

NDAQ

2010–05–27 / 2020–05–26



```
candleChart(AAPL, up.col = "red", dn.col = "white", theme = "white")
```

AAPL

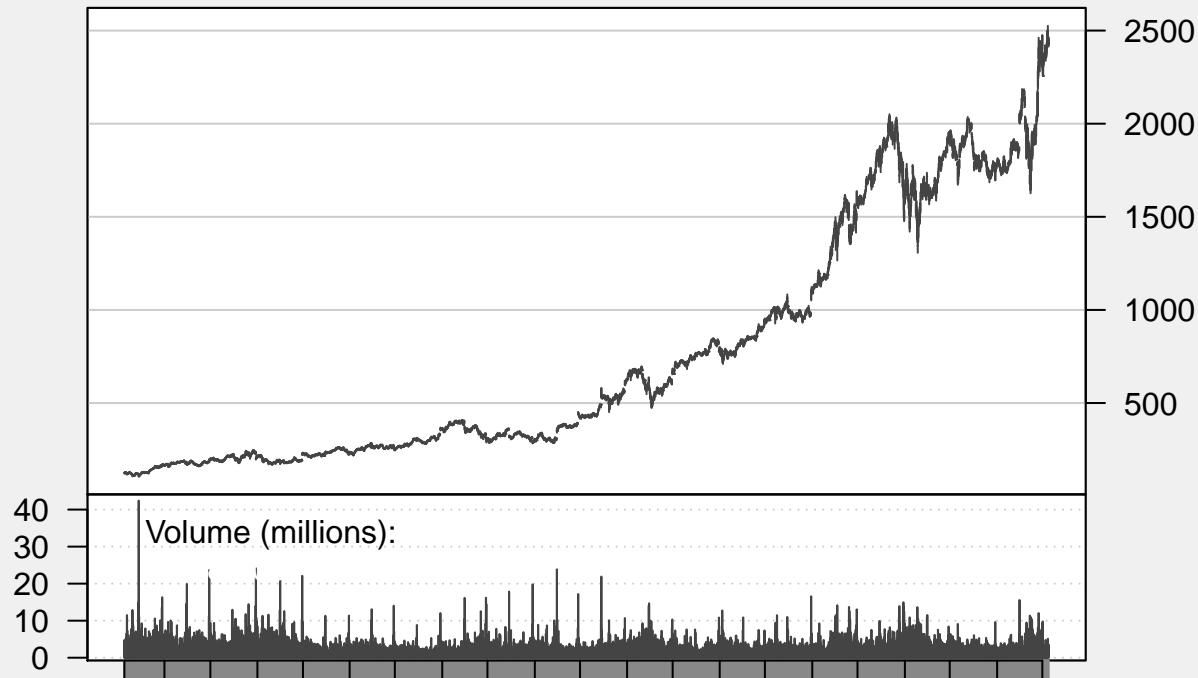
[2010-05-27/2020-05-26]



```
candleChart(AMZN, up.col = "red", dn.col = "white", theme = "white")
```

AMZN

[2010-05-27/2020-05-26]



May 27 2010 Nov 01 2012 May 01 2015 Nov 01 2017 Apr 30 2020

```
candleChart(GOOG, up.col = "black", dn.col = "red", theme = "white")
```

GOOG

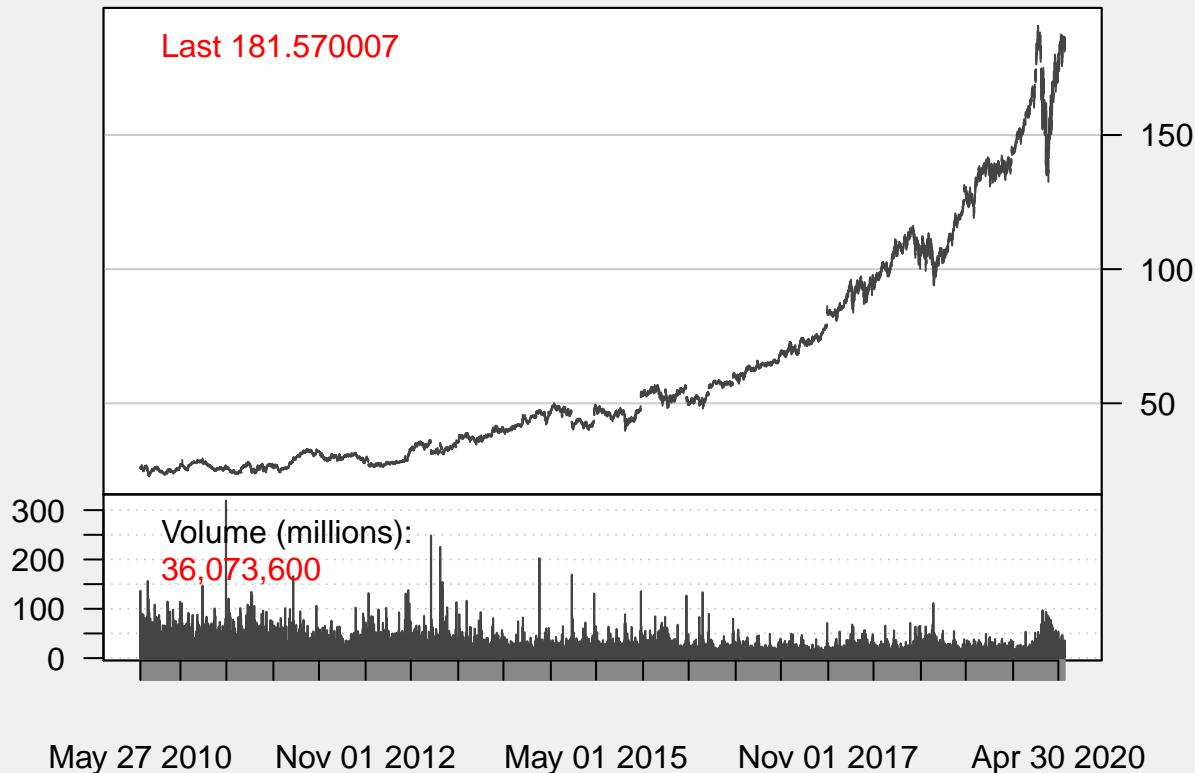
[2010-05-27/2020-05-26]



```
candleChart(MSFT, up.col = "black", dn.col = "red", theme = "white")
```

MSFT

[2010-05-27/2020-05-26]



```
candleChart(NDAQ, up.col = "black", dn.col = "red", theme = "white")
```



```
summary(AAPL)
```

```
##      Index          AAPL.Open        AAPL.High        AAPL.Low
## Min.   :2010-05-27   Min.   : 34.01   Min.   : 34.66   Min.   : 33.65
## 1st Qu.:2012-11-25  1st Qu.: 72.23   1st Qu.: 72.79   1st Qu.: 71.60
## Median :2015-05-27  Median :106.64   Median :107.61   Median :105.55
## Mean   :2015-05-26  Mean   :120.60   Mean   :121.77   Mean   :119.47
## 3rd Qu.:2017-11-21  3rd Qu.:160.41   3rd Qu.:162.13   3rd Qu.:159.07
## Max.   :2020-05-26  Max.   :324.74   Max.   :327.85   Max.   :323.35
##      AAPL.Close       AAPL.Volume       AAPL.Adjusted
## Min.   : 34.28   Min.   :11362000   Min.   : 29.67
## 1st Qu.: 72.25   1st Qu.:30370325   1st Qu.: 63.91
## Median :106.49   Median : 51044200   Median : 99.07
## Mean   :120.67   Mean   : 70013248   Mean   :113.99
## 3rd Qu.:160.59   3rd Qu.: 95160450   3rd Qu.:154.79
## Max.   :327.20   Max.   :470249500  Max.   :326.32
```

```
summary(AMZN)
```

```
##      Index          AMZN.Open        AMZN.High        AMZN.Low
## Min.   :2010-05-27   Min.   : 105.9    Min.   : 111.3    Min.   : 105.8
## 1st Qu.:2012-11-25  1st Qu.: 253.1    1st Qu.: 255.5    1st Qu.: 250.1
## Median :2015-05-27  Median : 429.7    Median : 432.8    Median : 426.2
## Mean   :2015-05-26  Mean   : 753.5    Mean   : 761.1    Mean   : 745.1
## 3rd Qu.:2017-11-21  3rd Qu.:1134.1    3rd Qu.:1144.0    3rd Qu.:1128.0
```

```

## Max.    :2020-05-26   Max.    :2500.0   Max.    :2525.4   Max.    :2467.3
## AMZN.Close      AMZN.Volume      AMZN.Adjusted
## Min.    : 108.6   Min.    : 881300   Min.    : 108.6
## 1st Qu.: 252.5   1st Qu.: 2773975  1st Qu.: 252.5
## Median  : 429.5   Median : 3739050  Median : 429.5
## Mean    : 753.5   Mean   : 4382792  Mean   : 753.5
## 3rd Qu.:1137.8   3rd Qu.: 5168100  3rd Qu.:1137.8
## Max.    :2497.9   Max.    :42421100  Max.    :2497.9

```

```
summary(GOOG)
```

	Index	GOOG.Open	GOOG.High	GOOG.Low
##	Min. :2010-05-27	Min. : 218.3	Min. : 220.3	Min. : 216.0
##	1st Qu.:2012-11-25	1st Qu.: 355.9	1st Qu.: 358.0	1st Qu.: 352.2
##	Median :2015-05-27	Median : 588.0	Median : 592.5	Median : 582.8
##	Mean :2015-05-26	Mean : 685.9	Mean : 692.0	Mean : 679.8
##	3rd Qu.:2017-11-21	3rd Qu.:1016.6	3rd Qu.:1029.9	3rd Qu.:1001.4
##	Max. :2020-05-26	Max. :1525.1	Max. :1532.1	Max. :1521.4
##	GOOG.Close GOOG.Volume GOOG.Adjusted			
##	Min. : 217.2	Min. : 7900	Min. : 217.2	
##	1st Qu.: 354.2	1st Qu.: 1403400	1st Qu.: 354.2	
##	Median : 587.8	Median : 2167350	Median : 587.8	
##	Mean : 686.1	Mean : 3087344	Mean : 686.1	
##	3rd Qu.:1017.6	3rd Qu.: 4181050	3rd Qu.:1017.6	
##	Max. :1526.7	Max. :29760600	Max. :1526.7	

```
summary(MSFT)
```

	Index	MSFT.Open	MSFT.High	MSFT.Low
##	Min. :2010-05-27	Min. : 23.09	Min. : 23.32	Min. : 22.73
##	1st Qu.:2012-11-25	1st Qu.: 30.33	1st Qu.: 30.64	1st Qu.: 30.15
##	Median :2015-05-27	Median : 46.66	Median : 47.05	Median : 46.27
##	Mean :2015-05-26	Mean : 61.83	Mean : 62.39	Mean : 61.24
##	3rd Qu.:2017-11-21	3rd Qu.: 83.72	3rd Qu.: 84.38	3rd Qu.: 83.19
##	Max. :2020-05-26	Max. :190.65	Max. :190.70	Max. :186.47
##	MSFT.Close MSFT.Volume MSFT.Adjusted			
##	Min. : 23.01	Min. : 7425600	Min. : 18.18	
##	1st Qu.: 30.39	1st Qu.: 24135600	1st Qu.: 25.26	
##	Median : 46.70	Median : 33598250	Median : 41.96	
##	Mean : 61.85	Mean : 39225748	Mean : 57.95	
##	3rd Qu.: 83.90	3rd Qu.: 49103425	3rd Qu.: 80.56	
##	Max. :188.70	Max. :319317900	Max. :187.66	

```
summary(NDAQ)
```

	Index	NDAQ.Open	NDAQ.High	NDAQ.Low
##	Min. :2010-05-27	Min. : 17.46	Min. : 17.75	Min. : 17.18
##	1st Qu.:2012-11-25	1st Qu.: 27.25	1st Qu.: 27.58	1st Qu.: 27.01
##	Median :2015-05-27	Median : 50.59	Median : 50.94	Median : 50.22
##	Mean :2015-05-26	Mean : 54.80	Mean : 55.32	Mean : 54.29
##	3rd Qu.:2017-11-21	3rd Qu.: 77.05	3rd Qu.: 77.39	3rd Qu.: 76.22
##	Max. :2020-05-26	Max. :119.24	Max. :120.23	Max. :118.46

```

##      NDAQ.Close      NDAQ.Volume      NDAQ.Adjusted
##  Min.   : 17.30   Min.   : 217900   Min.   : 14.90
##  1st Qu.: 27.31   1st Qu.: 749375   1st Qu.: 23.60
##  Median : 50.59   Median : 1053400   Median : 45.84
##  Mean   : 54.83   Mean   : 1342232   Mean   : 51.28
##  3rd Qu.: 76.81   3rd Qu.: 1595925   3rd Qu.: 73.02
##  Max.   :118.67   Max.   :18263200   Max.   :117.63

```

#computing rates of change

#Apple

```

ROCapple <- ROC(AAPL[, "AAPL.Close"], n=1)
head(ROCapple)

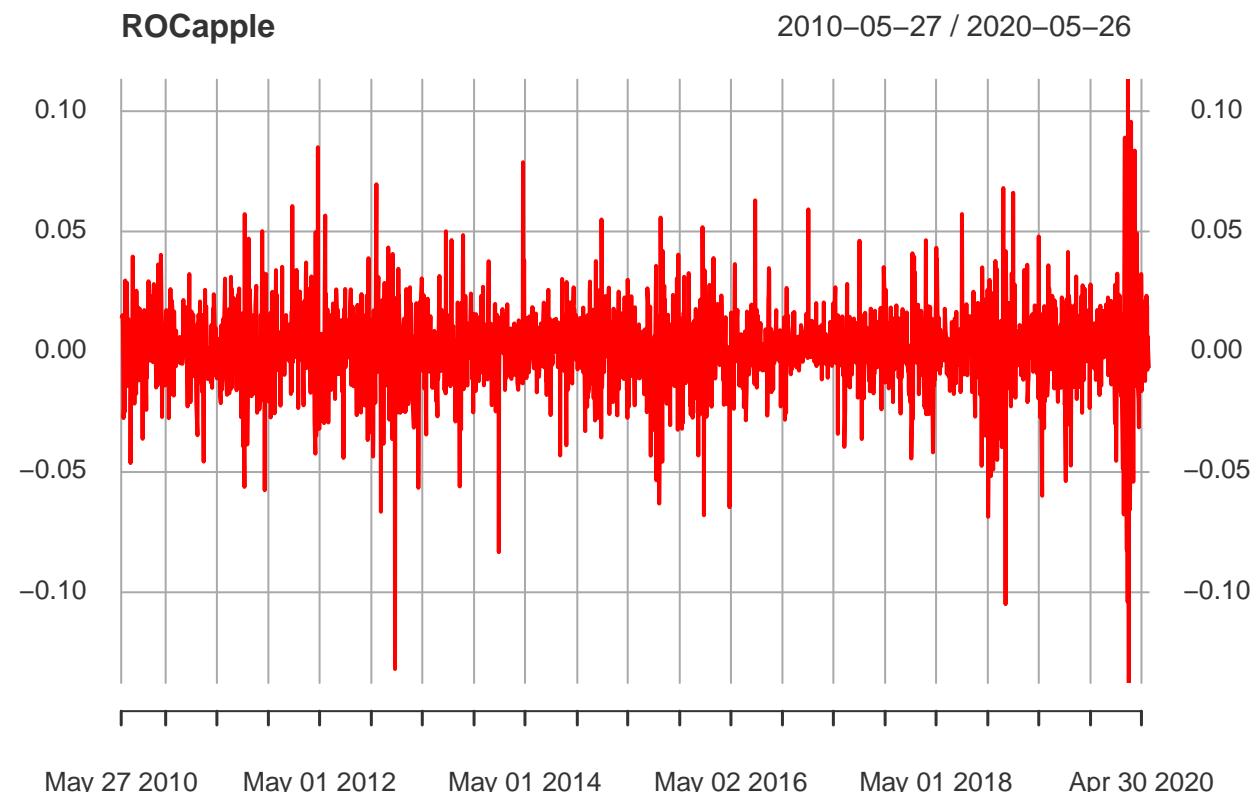
```

```

##          AAPL.Close
## 2010-05-27      NA
## 2010-05-28  0.013837181
## 2010-06-01  0.015259785
## 2010-06-02  0.011890803
## 2010-06-03 -0.003149505
## 2010-06-04 -0.027588935

```

```
plot(ROCapple, col="red")
```

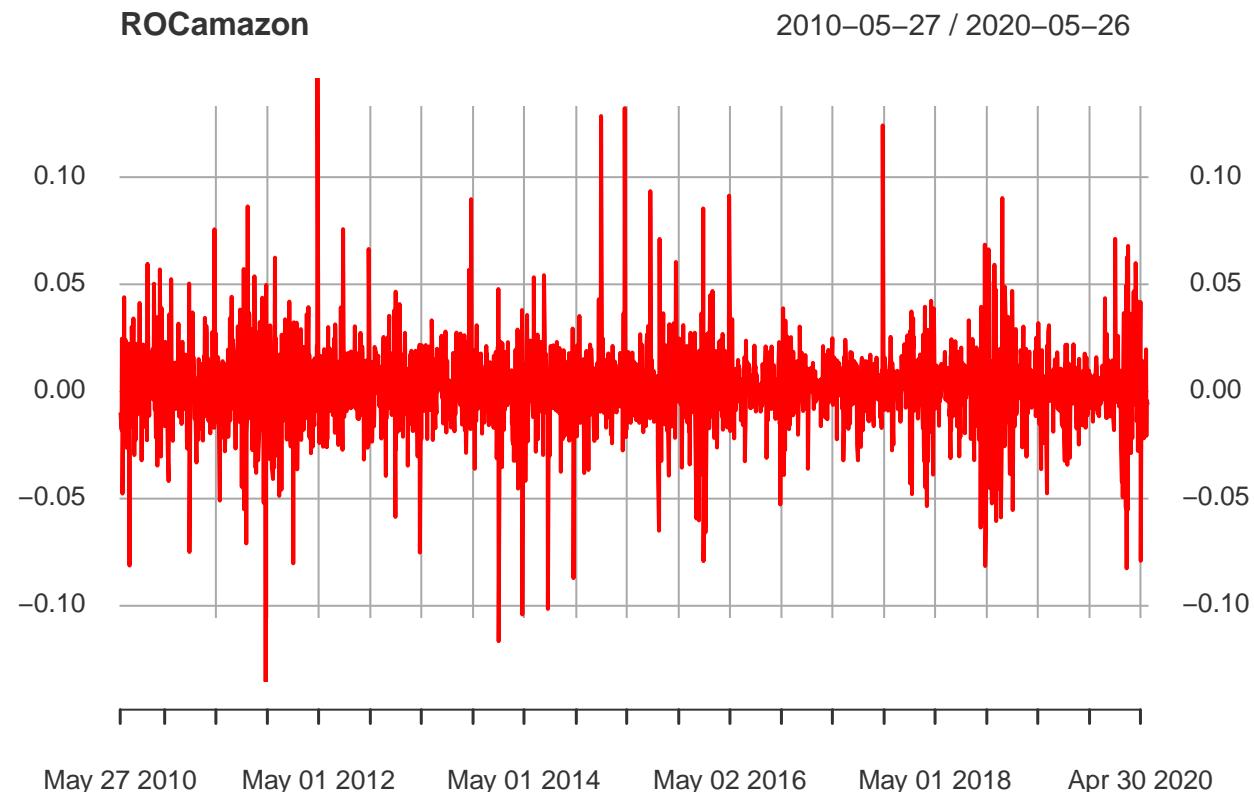


```
#amazon

ROCamazon <- ROC(AMZN[, "AMZN.Close"], n=1, )
head(ROCamazon)
```

```
##          AMZN.Close
## 2010-05-27      NA
## 2010-05-28 -0.009835089
## 2010-06-01 -0.017853317
## 2010-06-02  0.024605529
## 2010-06-03  0.019210981
## 2010-06-04 -0.047637506
```

```
plot(ROCamazon, col="red")
```



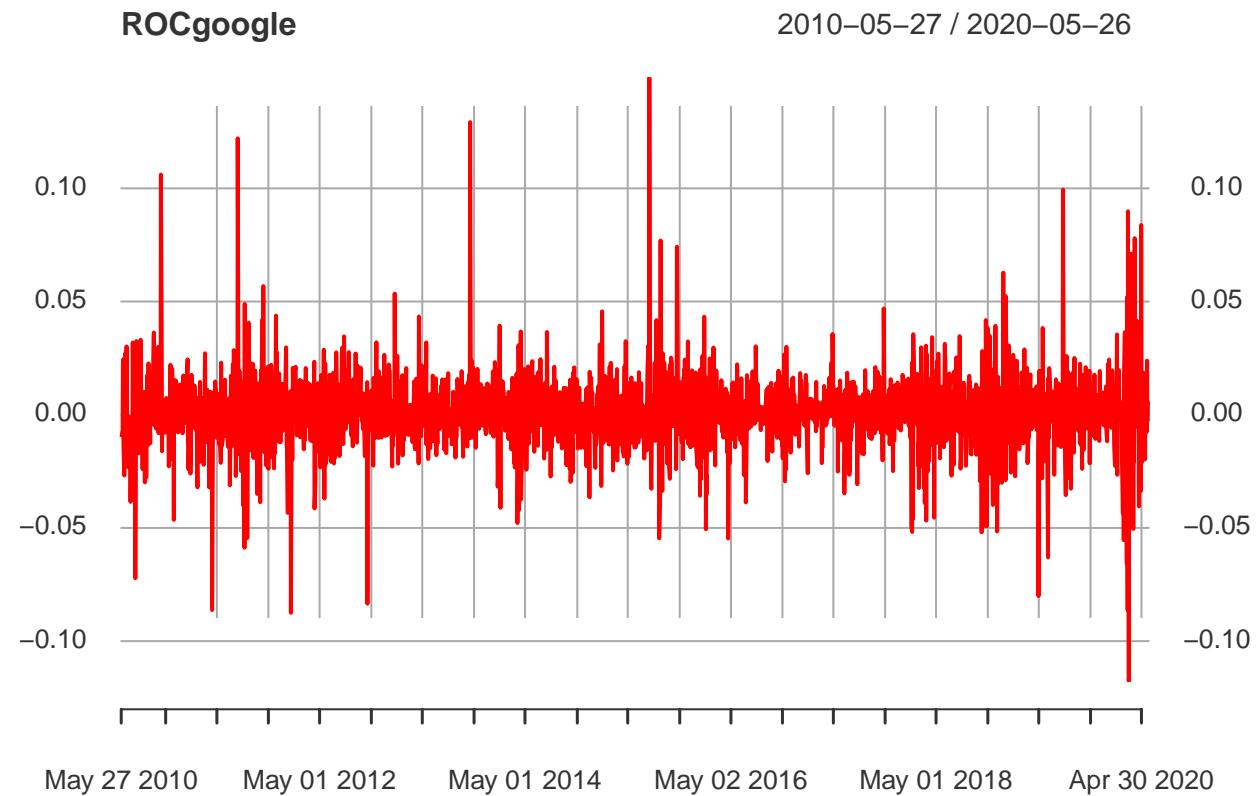
```
#google

ROCgoogle <- ROC(GOOG[, "GOOG.Close"], n=1, )
head(ROCgoogle)
```

```
##          GOOG.Close
## 2010-05-27      NA
## 2010-05-28 -0.009896747
## 2010-06-01 -0.006735512
```

```
## 2010-06-02 0.022547942  
## 2010-06-03 0.024486438  
## 2010-06-04 -0.013701030
```

```
plot(ROCgoogle, col="red")
```



```
#microsoft
```

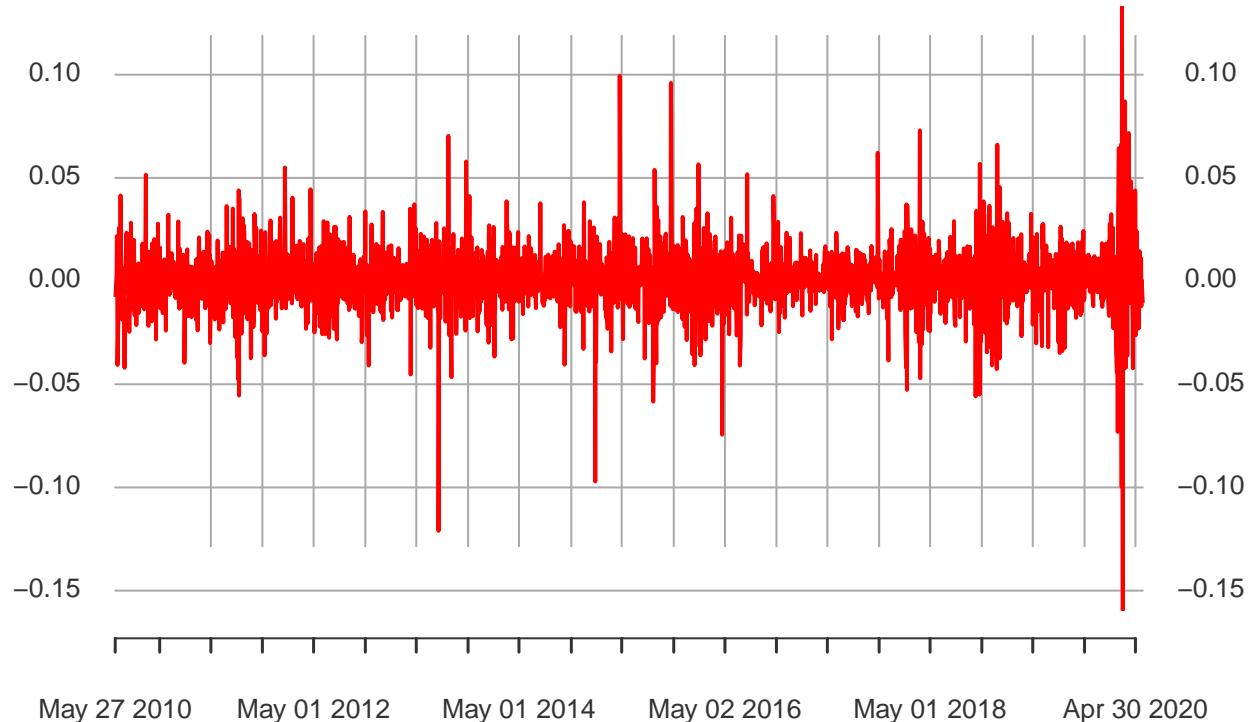
```
ROCmicrosoft <- ROC(MSFT[, "MSFT.Close"], n=1,)  
head(ROCmicrosoft)
```

```
## MSFT.Close  
## 2010-05-27 NA  
## 2010-05-28 -0.007722085  
## 2010-06-01 0.003482302  
## 2010-06-02 0.021777366  
## 2010-06-03 0.015004107  
## 2010-06-04 -0.040651370
```

```
plot(ROCmicrosoft, col="red")
```

ROCmicrosoft

2010–05–27 / 2020–05–26



#*NASDAQ*

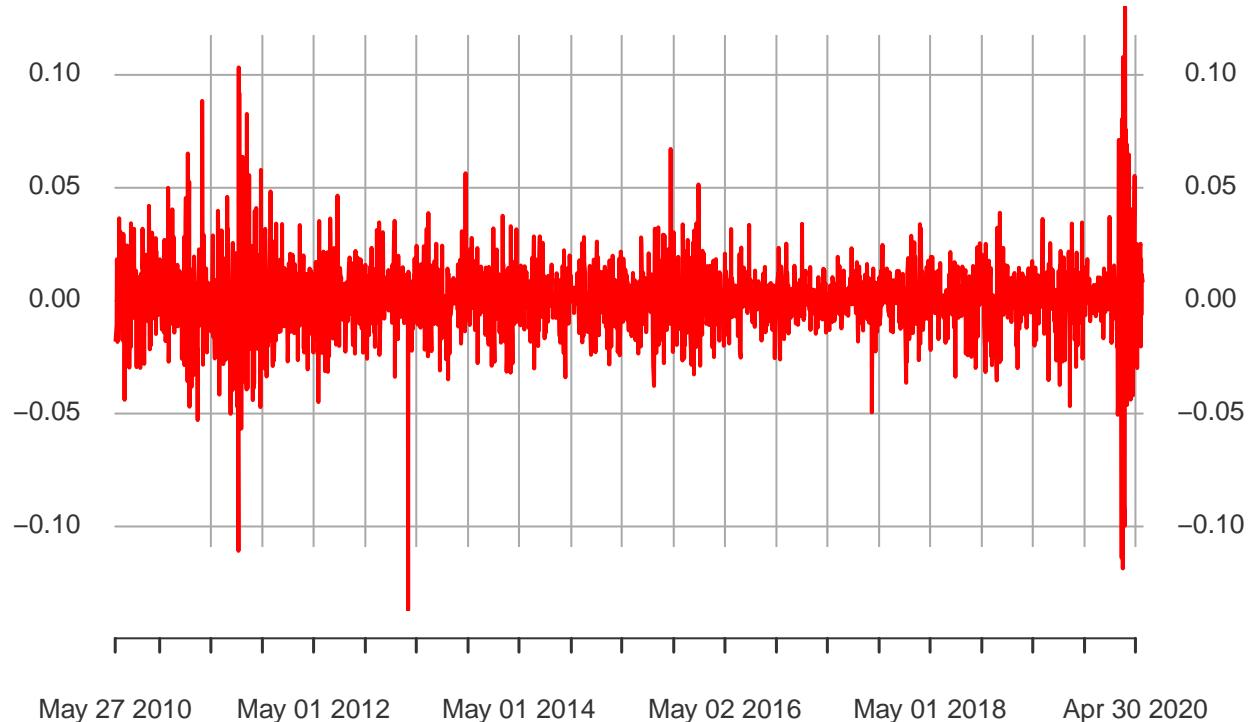
```
ROCnasdaq <- ROC(NDAQ[, "NDAQ.Close"], n=1,)  
head(ROCnasdaq)
```

```
## NDAQ.Close  
## 2010-05-27 NA  
## 2010-05-28 -0.018124163  
## 2010-06-01 -0.010816817  
## 2010-06-02 0.018319532  
## 2010-06-03 0.002133334  
## 2010-06-04 -0.018280079
```

```
plot(ROCnasdaq, col="red")
```

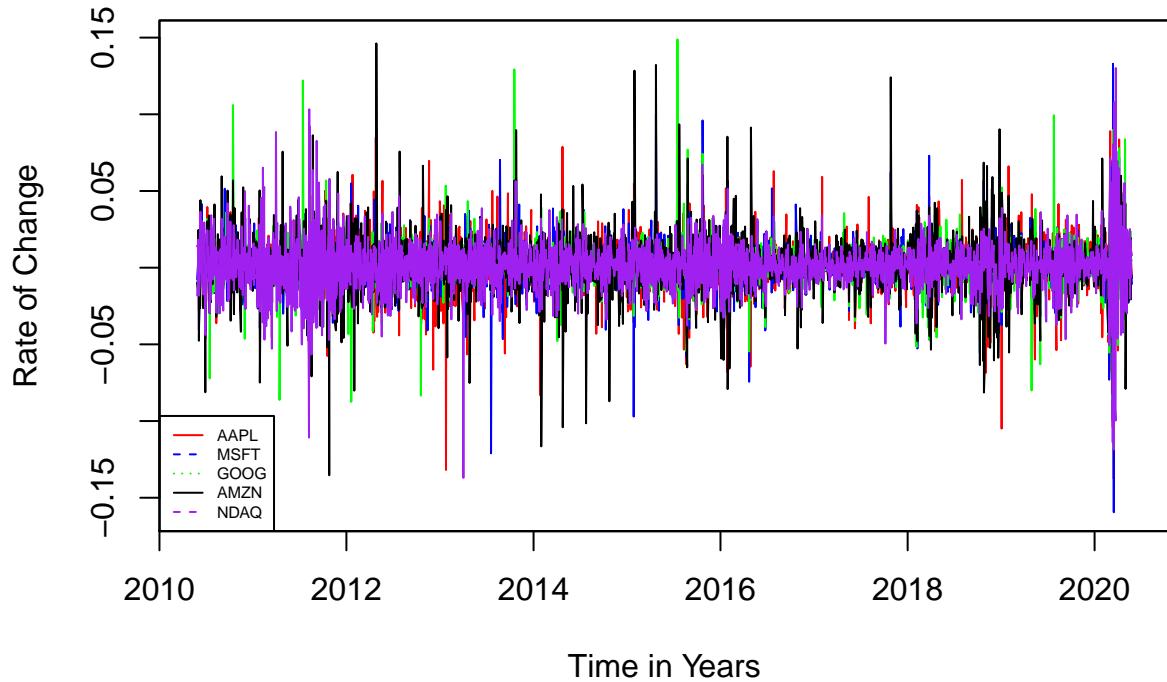
ROCnasdaq

2010–05–27 / 2020–05–26



```
#combining all roc plots
```

```
roc <- as.xts(data.frame(AAPL = ROCapple, MSFT = ROCmicrosoft, GOOG = ROCgoogle, AMZN = ROCamazon, NDAQ
```



```

# Create an xts object (xts is loaded with quantmod) that contains closing
# prices for AAPL, MSFT, and GOOG
stocks <- as.xts(data.frame(AAPL = AAPL[, "AAPL.Close"], MSFT = MSFT[, "MSFT.Close"],
                             GOOG = GOOG[, "GOOG.Close"], AMZN = AMZN[, "AMZN.Close"], NDAQ = NDAQ[, "ND
head(stocks)

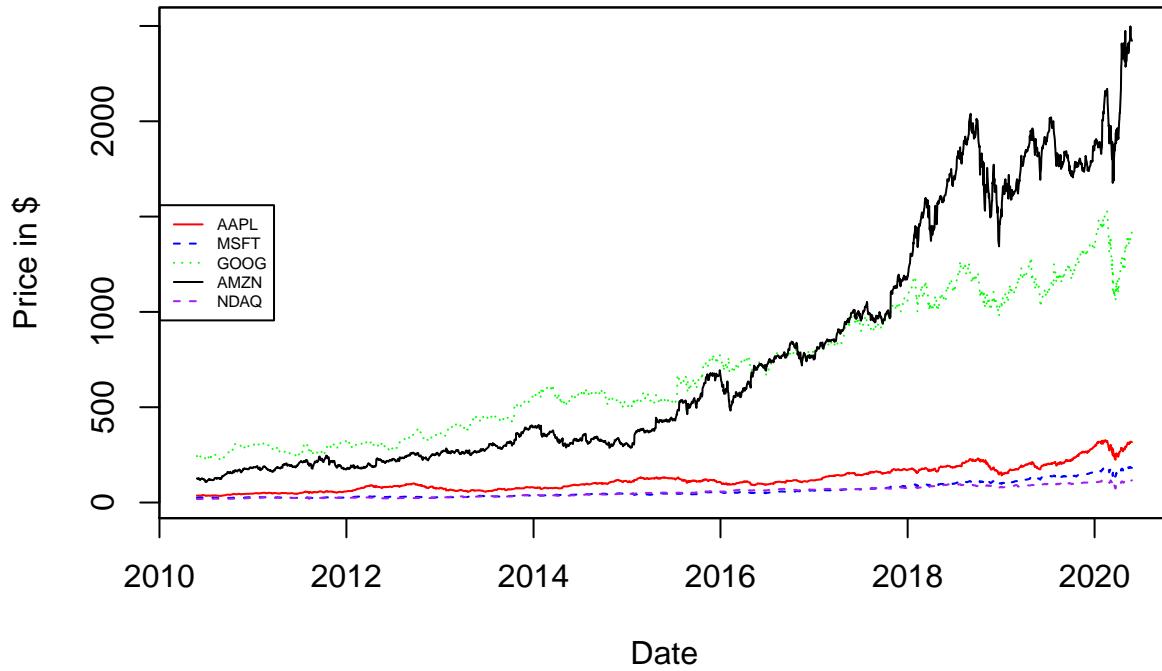
##          AAPL.Close MSFT.Close GOOG.Close AMZN.Close NDAQ.Close
## 2010-05-27    36.19286     26.00   244.3143    126.70    18.93
## 2010-05-28    36.69714     25.80   241.9083    125.46    18.59
## 2010-06-01    37.26143     25.89   240.2844    123.24    18.39
## 2010-06-02    37.70714     26.46   245.7638    126.31    18.73
## 2010-06-03    37.58857     26.86   251.8560    128.76    18.77
## 2010-06-04    36.56572     25.79   248.4288    122.77    18.43

#Saving into CSV
write.csv(stocks, file = "stocks.csv", row.names = FALSE)
setwd("C:/Users/ziyad/Desktop/Data Analytics capstone")

# Create a plot showing all series as lines; must use as.zoo to use the zoo
# method for plot, which allows for multiple series to be plotted on same
# plot

plot(as.zoo(stocks), screens = 1, lty = 1:3,col = c("red","blue","green","black","Purple"), xlab = "Date"
legend("left", c("AAPL", "MSFT", "GOOG", "AMZN", "NDaq"), col=c("red","blue","green","black","Purple"),

```



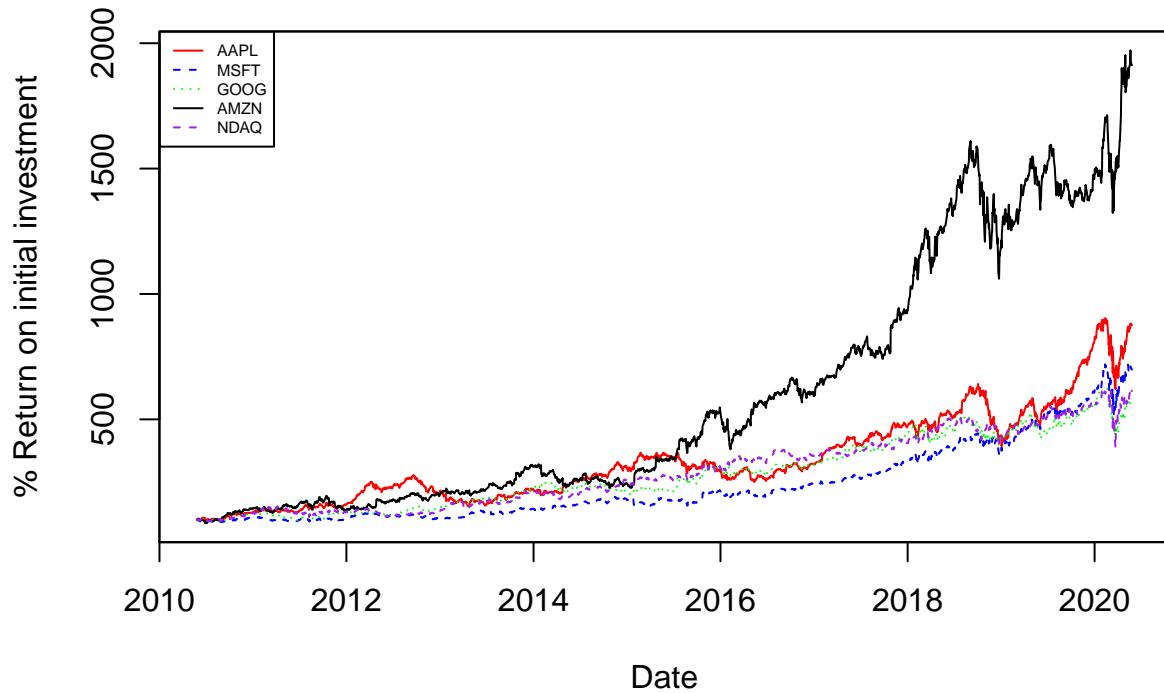
```
#compute and plot nominal returns
```

```
nominal_return = apply(stocks, 1, function(x) {x / stocks[1,]*100}) %>%
  t %>% as.xts
```

```
head(nominal_return)
```

```
##          AAPL.Close MSFT.Close GOOG.Close AMZN.Close NDAQ.Close
## 2010-05-27    100.0000  100.00000  100.00000  100.00000  100.00000
## 2010-05-28    101.3933   99.23077   99.01521   99.02131   98.20391
## 2010-06-01    102.9524   99.57692   98.35053   97.26914   97.14738
## 2010-06-02    104.1839   101.76923   100.59332   99.69219   98.94348
## 2010-06-03    103.8563   103.30770   103.08690   101.62589   99.15478
## 2010-06-04    101.0302   99.19231   101.68413   96.89818   97.35869
```

```
plot(as.zoo(nominal_return), screens = 1, lty = 1:3, xlab = "Date", ylab = "% Return on initial investment")
legend("topleft", c("AAPL", "MSFT", "GOOG", "AMZN", "NDAQ"), col = c("red", "blue", "green", "black", "purple"))
```



```
#Testing out ARIMA models with closing value on Y axis and Date on x axis
```

```
#1) Apple
```

```
class(AAPL)
```

```
## [1] "xts" "zoo"
```

```
AAPL_close_price <- (AAPL[,4])
plot((AAPL_close_price))
```



```

class(AAPL_close_price)

## [1] "xts" "zoo"

par(mfrow = c(1,1))
print(adf.test(AAPL_close_price)) #P-value > 0.05 indicates non stationary data

## 
##  Augmented Dickey-Fuller Test
## 
## data: AAPL_close_price
## Dickey-Fuller = -1.4497, Lag order = 13, p-value = 0.8113
## alternative hypothesis: stationary

auto.arima(AAPL_close_price, seasonal = FALSE)

## Series: AAPL_close_price
## ARIMA(1,1,0) with drift
## 
## Coefficients:
##             ar1     drift
##           -0.1774   0.1115
## s.e.      0.0196   0.0456
## 
```

```

## sigma^2 estimated as 7.252: log likelihood=-6059.04
## AIC=12124.08    AICc=12124.09    BIC=12141.57

par(mfrow = c(2,2))
pacf(AAPL_close_price)
acf(AAPL_close_price)

#Translating Raw price into logarithmic form to obtain returns

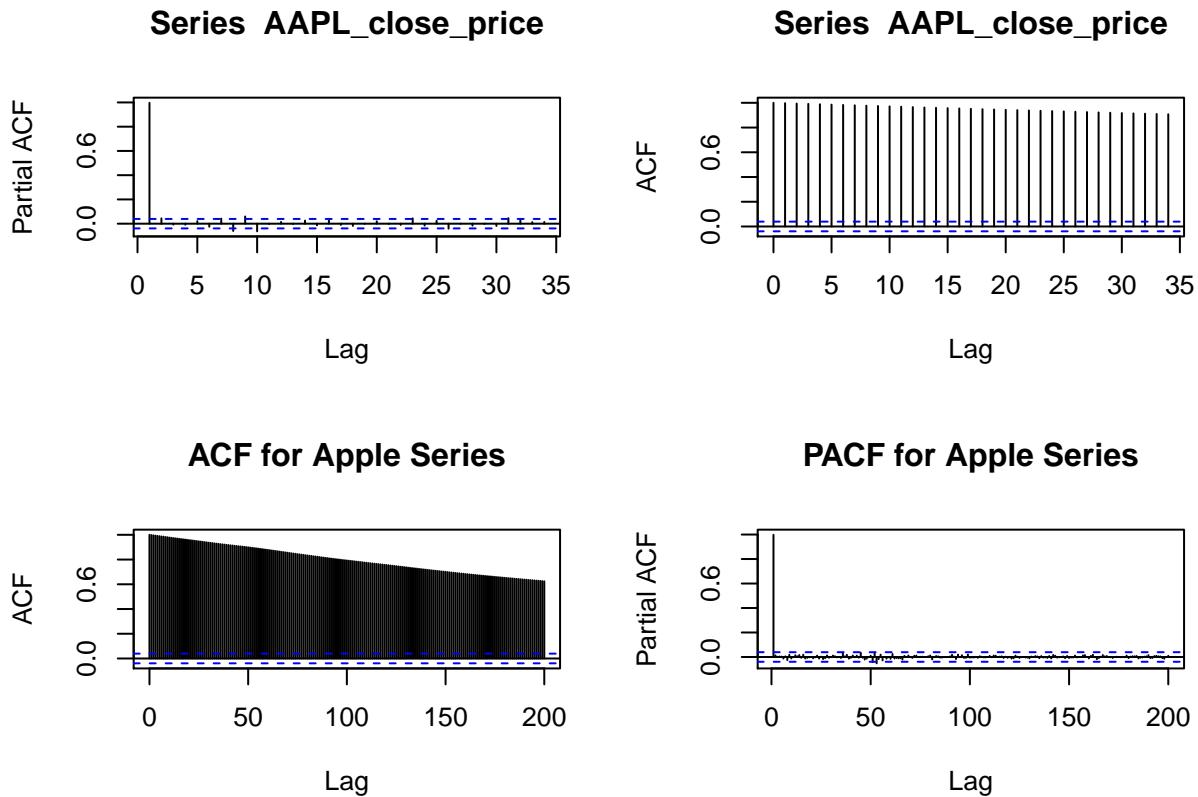
lnapple = log(AAPL_close_price)
print(lnapple[1:10])

##          AAPL.Close
## 2010-05-27  3.588862
## 2010-05-28  3.602699
## 2010-06-01  3.617959
## 2010-06-02  3.629850
## 2010-06-03  3.626700
## 2010-06-04  3.599111
## 2010-06-07  3.579304
## 2010-06-08  3.572867
## 2010-06-09  3.547974
## 2010-06-10  3.577589

#Checking for stationarity

acf(lnapple, lag.max = 200, main = "ACF for Apple Series")
pacf(lnapple, lag.max = 200, main = "PACF for Apple Series")

```



```
print(adf.test(lnapple)) #P-value > 0.05 indicates non stationary data
```

```
##  
## Augmented Dickey-Fuller Test  
##  
## data: lnapple  
## Dickey-Fuller = -2.6024, Lag order = 13, p-value = 0.3233  
## alternative hypothesis: stationary
```

#Differencing the data to turn into stationary data

```
difflnapple = diff(lnapple,)  
head(difflnapple)
```

```
## AAPL.Close  
## 2010-05-27      NA  
## 2010-05-28  0.013837181  
## 2010-06-01  0.015259785  
## 2010-06-02  0.011890803  
## 2010-06-03 -0.003149505  
## 2010-06-04 -0.027588935
```

```
adf.test(lnapple)
```

```

##  

## Augmented Dickey-Fuller Test  

##  

## data: lnapple  

## Dickey-Fuller = -2.6024, Lag order = 13, p-value = 0.3233  

## alternative hypothesis: stationary

adf.test(difflnapple[2:1259,]) # p-value < 0.05 indication stationary data. Model fitting to continue

## Warning in adf.test(difflnapple[2:1259,]): p-value smaller than printed p-value

##  

## Augmented Dickey-Fuller Test  

##  

## data: difflnapple[2:1259, ]  

## Dickey-Fuller = -12.088, Lag order = 10, p-value = 0.01  

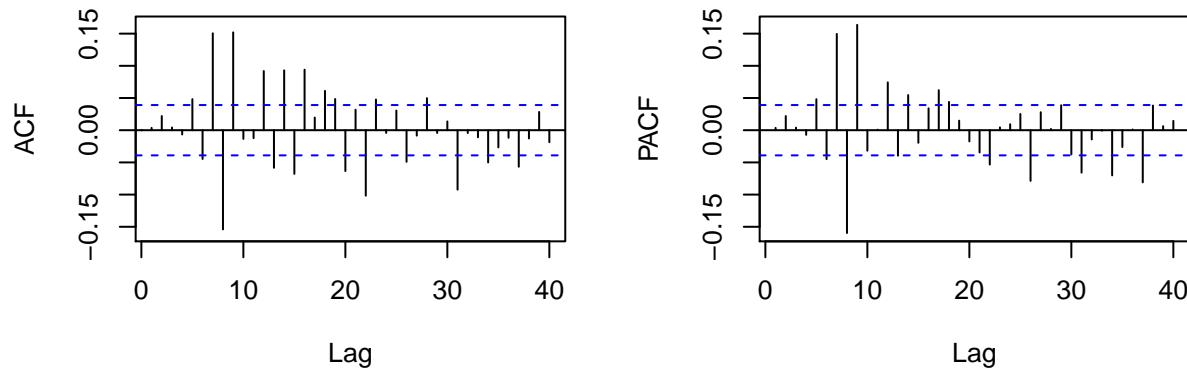
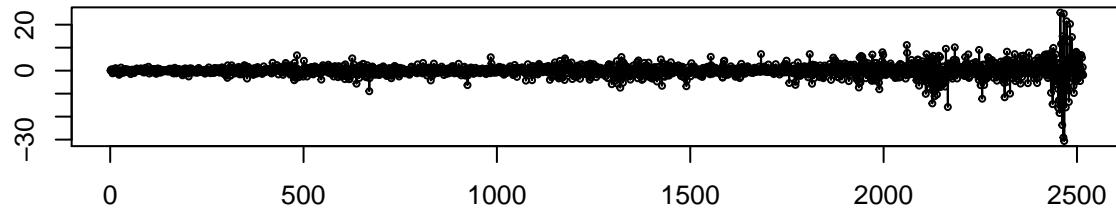
## alternative hypothesis: stationary

#Trying different fits

fitA = auto.arima(AAPL_close_price, seasonal = FALSE)
tsdisplay(residuals(fitA), lag.max = 40, main = '1,1,0 Model Residuals')

```

1,1,0 Model Residuals



```

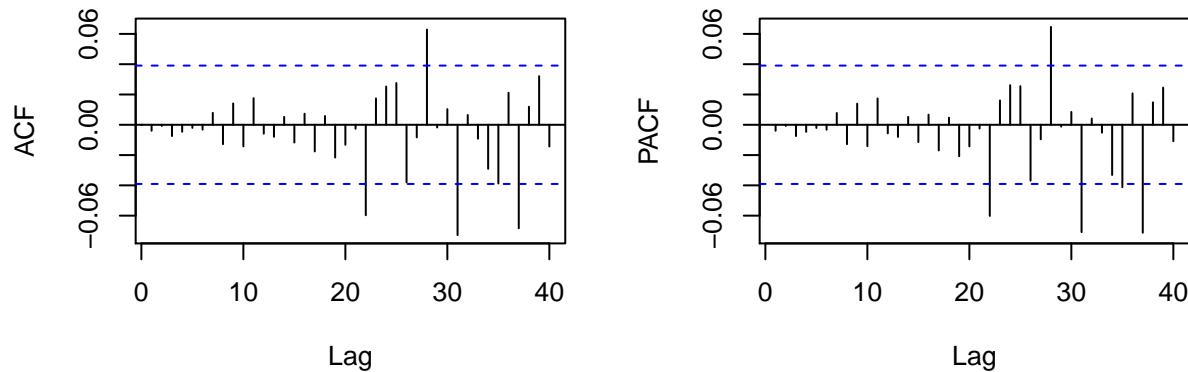
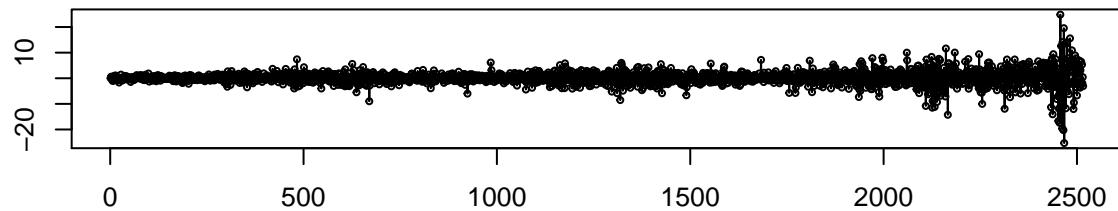
auto.arima(AAPL_close_price, seasonal = FALSE)

## Series: AAPL_close_price
## ARIMA(1,1,0) with drift
##
## Coefficients:
##             ar1     drift
##          -0.1774   0.1115
##  s.e.    0.0196   0.0456
##
## sigma^2 estimated as 7.252:  log likelihood=-6059.04
## AIC=12124.08   AICc=12124.09   BIC=12141.57

fitB = arima(AAPL_close_price, order = c(1,1,19))
tsdisplay(residuals(fitB), lag.max = 40, main = '(1,1,19) Model Residuals')

```

(1,1,19) Model Residuals

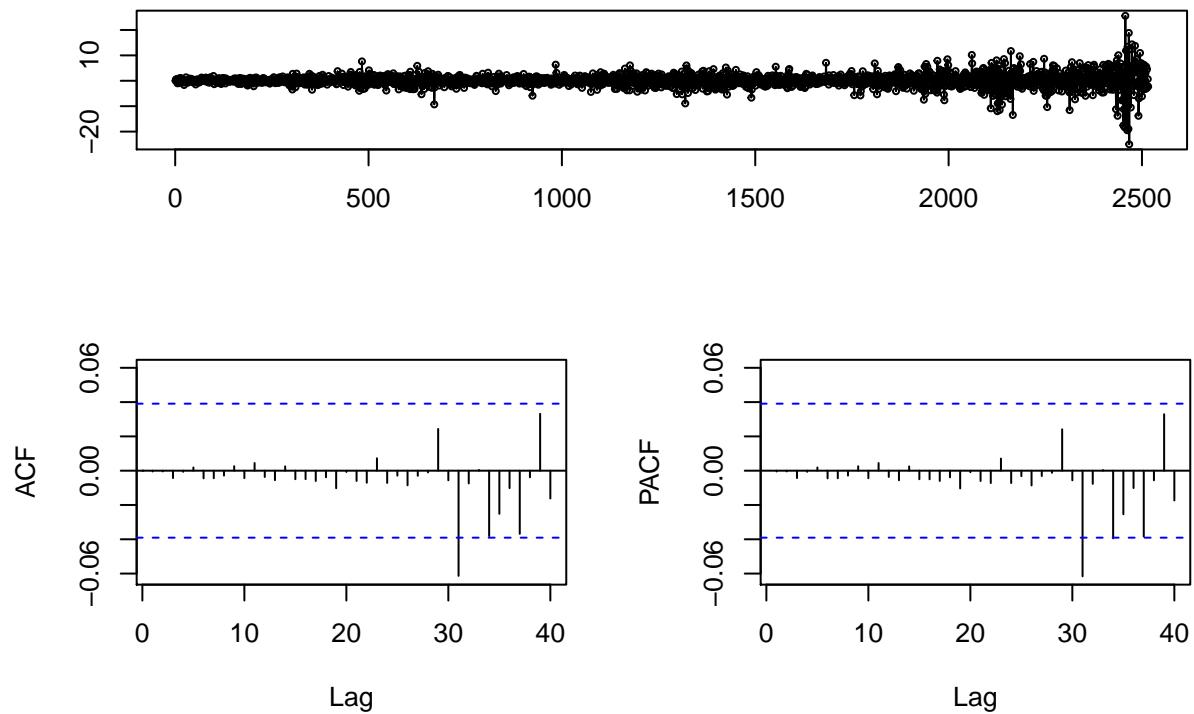


```

fitC = arima(AAPL_close_price, order = c(1,1,28))
tsdisplay(residuals(fitC), lag.max = 40, main = '(1,1,28) Model Residuals')

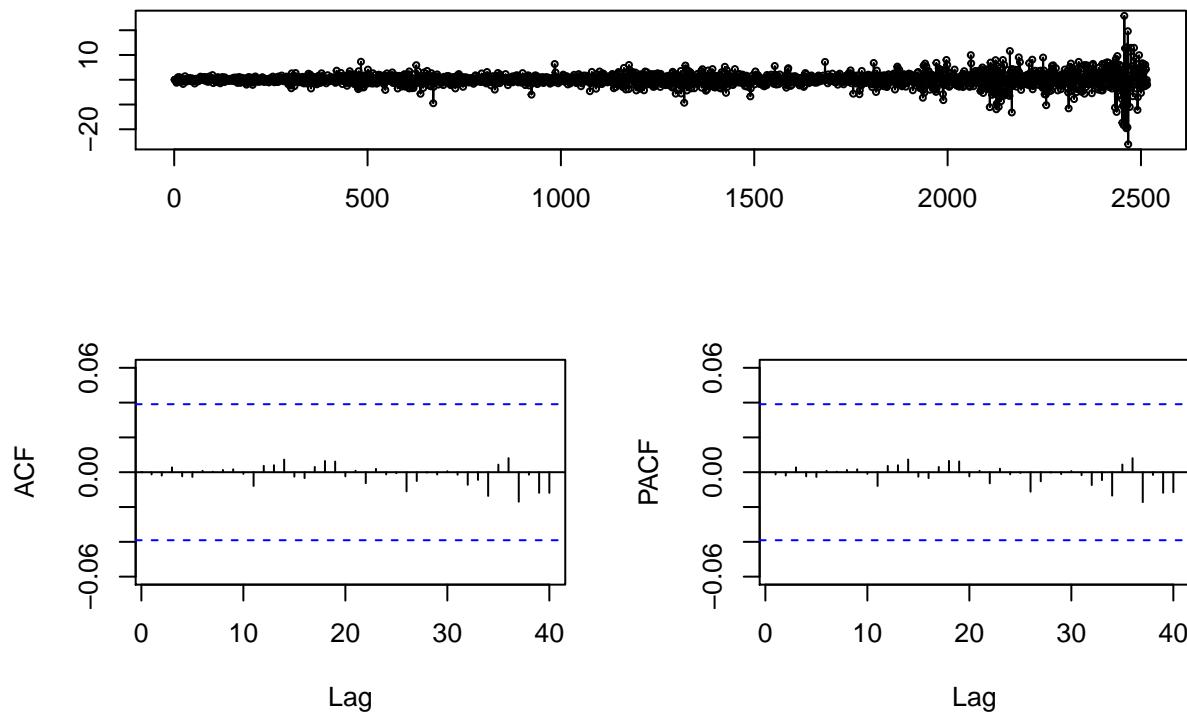
```

(1,1,28) Model Residuals



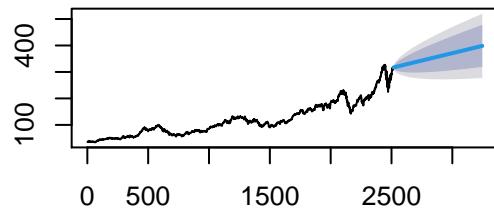
```
fitD = arima(AAPL_close_price, order = c(1,2,40))
tsdisplay(residuals(fitD), lag.max = 40, main = '(1,2,40) Model Residuals')
```

(1,2,40) Model Residuals

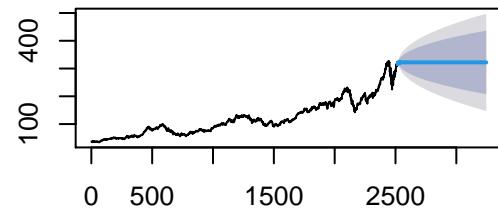


```
par(mfrow = c(2,2))
term <- 730
fcast1 <- forecast(fitA, h = term)
plot(fcast1)
fcast2 <- forecast(fitB, h = term)
plot(fcast2)
fcast3 <- forecast(fitC, h = term)
plot(fcast3)
fcast4 <- forecast(fitD, h = term)
plot(fcast4)
```

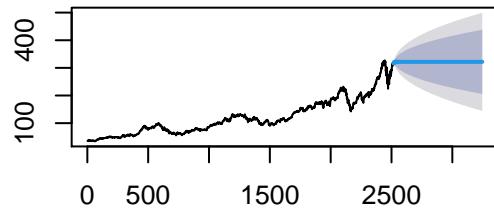
Forecasts from ARIMA(1,1,0) with drift



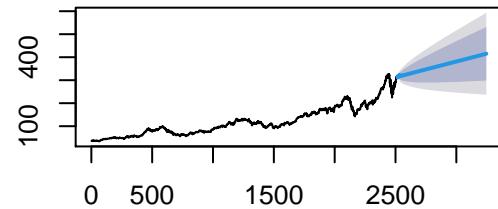
Forecasts from ARIMA(1,1,19)



Forecasts from ARIMA(1,1,28)



Forecasts from ARIMA(1,2,40)



```
print(fcast4)
```

```
##      Point Forecast     Lo 80     Hi 80     Lo 95     Hi 95
## 2517    314.8170 311.5904 318.0437 309.8824 319.7517
## 2518    316.1997 311.8598 320.5397 309.5624 322.8371
## 2519    312.1398 306.9324 317.3472 304.1758 320.1038
## 2520    315.6240 309.6557 321.5924 306.4962 324.7518
## 2521    313.7070 307.0645 320.3495 303.5481 323.8658
## 2522    317.1991 309.9095 324.4887 306.0507 328.3475
## 2523    318.1448 310.2975 325.9920 306.1434 330.1461
## 2524    317.2591 308.7282 325.7900 304.2123 330.3059
## 2525    317.8926 308.9084 326.8769 304.1524 331.6328
## 2526    317.5074 307.9299 327.0848 302.8599 332.1548
## 2527    320.0622 309.9451 330.1794 304.5894 335.5350
## 2528    319.6926 309.0822 330.3029 303.4654 335.9197
## 2529    320.4477 309.2747 331.6206 303.3601 337.5352
## 2530    319.2804 307.6432 330.9176 301.4828 337.0780
## 2531    319.5633 307.4029 331.7237 300.9656 338.1610
## 2532    319.7945 307.1930 332.3961 300.5221 339.0670
## 2533    319.1800 306.0656 332.2944 299.1232 339.2368
## 2534    320.6022 306.9642 334.2402 299.7447 341.4597
## 2535    318.8652 304.6985 333.0318 297.1992 340.5311
## 2536    319.1417 304.4132 333.8703 296.6164 341.6671
## 2537    318.6959 303.4921 333.8997 295.4437 341.9481
## 2538    319.3175 303.6094 335.0255 295.2940 343.3409
```

```

## 2539      319.0925 302.9729 335.2121 294.4397 343.7453
## 2540      318.2572 301.6923 334.8221 292.9234 343.5910
## 2541      318.5250 301.5332 335.5168 292.5383 344.5118
## 2542      318.1598 300.7182 335.6014 291.4852 344.8344
## 2543      318.7186 300.8681 336.5691 291.4186 346.0186
## 2544      318.4094 300.1537 336.6652 290.4897 346.3292
## 2545      319.1737 300.4724 337.8750 290.5725 347.7748
## 2546      318.6517 299.5310 337.7724 289.4091 347.8943
## 2547      318.9176 299.3717 338.4635 289.0248 348.8105
## 2548      318.9176 299.0239 338.8113 288.4928 349.3424
## 2549      318.8696 298.6173 339.1219 287.8963 349.8429
## 2550      319.3877 298.7879 339.9876 287.8830 350.8925
## 2551      319.3471 298.4176 340.2766 287.3382 351.3560
## 2552      319.8839 298.6546 341.1132 287.4165 352.3513
## 2553      319.9285 298.4126 341.4445 287.0227 352.8344
## 2554      320.1125 298.3305 341.8944 286.7999 353.4251
## 2555      320.1106 298.0672 342.1540 286.3982 353.8230
## 2556      320.2880 297.9535 342.6226 286.1303 354.4458
## 2557      320.4138 297.8009 343.0266 285.8304 354.9972
## 2558      320.5544 297.6635 343.4453 285.5458 355.5629
## 2559      320.6907 297.5256 343.8558 285.2628 356.1187
## 2560      320.8283 297.3916 344.2650 284.9850 356.6716
## 2561      320.9655 297.2600 344.6710 284.7111 357.2199
## 2562      321.1028 297.1312 345.0744 284.4414 357.7642
## 2563      321.2401 297.0050 345.4752 284.1757 358.3045
## 2564      321.3774 296.8813 345.8736 283.9138 358.8410
## 2565      321.5147 296.7600 346.2695 283.6556 359.3738
## 2566      321.6520 296.6410 346.6630 283.4010 359.9030
## 2567      321.7893 296.5243 347.0543 283.1499 360.4288
## 2568      321.9266 296.4099 347.4434 282.9021 360.9511
## 2569      322.0639 296.2975 347.8303 282.6576 361.4702
## 2570      322.2012 296.1873 348.2151 282.4163 361.9861
## 2571      322.3385 296.0790 348.5980 282.1781 362.4989
## 2572      322.4758 295.9728 348.9788 281.9429 363.0087
## 2573      322.6131 295.8684 349.3578 281.7106 363.5155
## 2574      322.7504 295.7659 349.7348 281.4812 364.0196
## 2575      322.8877 295.6652 350.1101 281.2545 364.5208
## 2576      323.0250 295.5663 350.4836 281.0305 365.0194
## 2577      323.1623 295.4691 350.8554 280.8092 365.5153
## 2578      323.2996 295.3736 351.2256 280.5904 366.0087
## 2579      323.4369 295.2797 351.5941 280.3741 366.4996
## 2580      323.5741 295.1873 351.9610 280.1603 366.9880
## 2581      323.7114 295.0966 352.3263 279.9488 367.4741
## 2582      323.8487 295.0074 352.6901 279.7396 367.9578
## 2583      323.9860 294.9196 353.0525 279.5328 368.4393
## 2584      324.1233 294.8333 353.4134 279.3281 368.9186
## 2585      324.2606 294.7484 353.7729 279.1256 369.3957
## 2586      324.3979 294.6649 354.1310 278.9252 369.8707
## 2587      324.5352 294.5827 354.4877 278.7268 370.3436
## 2588      324.6725 294.5019 354.8431 278.5305 370.8145
## 2589      324.8098 294.4224 355.1973 278.3362 371.2834
## 2590      324.9471 294.3441 355.5501 278.1438 371.7504
## 2591      325.0844 294.2670 355.9018 277.9533 372.2155
## 2592      325.2217 294.1912 356.2522 277.7647 372.6787

```

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## 2593      325.3590 294.1166 356.6014 277.5778 373.1402
## 2594      325.4963 294.0431 356.9495 277.3928 373.5998
## 2595      325.6336 293.9708 357.2964 277.2095 374.0577
## 2596      325.7709 293.8996 357.6422 277.0279 374.5139
## 2597      325.9082 293.8294 357.9869 276.8480 374.9684
## 2598      326.0455 293.7604 358.3306 276.6697 375.4212
## 2599      326.1828 293.6924 358.6731 276.4930 375.8725
## 2600      326.3201 293.6254 359.0147 276.3180 376.3222
## 2601      326.4574 293.5595 359.3552 276.1444 376.7703
## 2602      326.5947 293.4946 359.6947 275.9724 377.2169
## 2603      326.7320 293.4306 360.0333 275.8019 377.6620
## 2604      326.8692 293.3676 360.3709 275.6329 378.1056
## 2605      327.0065 293.3055 360.7076 275.4653 378.5478
## 2606      327.1438 293.2444 361.0433 275.2991 378.9886
## 2607      327.2811 293.1842 361.3781 275.1343 379.4280
## 2608      327.4184 293.1248 361.7120 274.9709 379.8660
## 2609      327.5557 293.0664 362.0451 274.8088 380.3026
## 2610      327.6930 293.0088 362.3773 274.6481 380.7380
## 2611      327.8303 292.9520 362.7086 274.4886 381.1720
## 2612      327.9676 292.8961 363.0391 274.3304 381.6048
## 2613      328.1049 292.8410 363.3688 274.1735 382.0363
## 2614      328.2422 292.7868 363.6976 274.0178 382.4666
## 2615      328.3795 292.7333 364.0257 273.8633 382.8957
## 2616      328.5168 292.6806 364.3530 273.7100 383.3236
## 2617      328.6541 292.6286 364.6795 273.5579 383.7503
## 2618      328.7914 292.5774 365.0053 273.4070 384.1758
## 2619      328.9287 292.5270 365.3303 273.2571 384.6002
## 2620      329.0660 292.4773 365.6546 273.1084 385.0235
## 2621      329.2033 292.4283 365.9782 272.9609 385.4457
## 2622      329.3406 292.3801 366.3011 272.8144 385.8668
## 2623      329.4779 292.3325 366.6232 272.6689 386.2868
## 2624      329.6152 292.2856 366.9447 272.5245 386.7058
## 2625      329.7525 292.2394 367.2655 272.3812 387.1237
## 2626      329.8898 292.1939 367.5856 272.2389 387.5406
## 2627      330.0270 292.1490 367.9051 272.0976 387.9565
## 2628      330.1643 292.1048 368.2239 271.9573 388.3714
## 2629      330.3016 292.0612 368.5421 271.8180 388.7853
## 2630      330.4389 292.0183 368.8596 271.6796 389.1983
## 2631      330.5762 291.9759 369.1765 271.5422 389.6103
## 2632      330.7135 291.9342 369.4928 271.4057 390.0213
## 2633      330.8508 291.8931 369.8085 271.2701 390.4315
## 2634      330.9881 291.8526 370.1236 271.1355 390.8407
## 2635      331.1254 291.8127 370.4381 271.0018 391.2490
## 2636      331.2627 291.7733 370.7521 270.8689 391.6565
## 2637      331.4000 291.7346 371.0654 270.7370 392.0631
## 2638      331.5373 291.6964 371.3782 270.6058 392.4688
## 2639      331.6746 291.6587 371.6905 270.4756 392.8736
## 2640      331.8119 291.6216 372.0022 270.3462 393.2776
## 2641      331.9492 291.5851 372.3133 270.2176 393.6808
## 2642      332.0865 291.5490 372.6239 270.0898 394.0831
## 2643      332.2238 291.5135 372.9340 269.9629 394.4847
## 2644      332.3611 291.4786 373.2436 269.8367 394.8854
## 2645      332.4984 291.4441 373.5526 269.7113 395.2854
## 2646      332.6357 291.4102 373.8611 269.5867 395.6846

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## 2647      332.7730 291.3767 374.1692 269.4629 396.0830
## 2648      332.9103 291.3438 374.4767 269.3398 396.4807
## 2649      333.0476 291.3113 374.7838 269.2175 396.8776
## 2650      333.1848 291.2794 375.0903 269.0959 397.2738
## 2651      333.3221 291.2479 375.3964 268.9751 397.6692
## 2652      333.4594 291.2168 375.7020 268.8550 398.0639
## 2653      333.5967 291.1863 376.0072 268.7355 398.4579
## 2654      333.7340 291.1562 376.3119 268.6168 398.8512
## 2655      333.8713 291.1265 376.6161 268.4988 399.2438
## 2656      334.0086 291.0973 376.9199 268.3815 399.6357
## 2657      334.1459 291.0686 377.2232 268.2648 400.0270
## 2658      334.2832 291.0403 377.5261 268.1489 400.4176
## 2659      334.4205 291.0124 377.8286 268.0336 400.8075
## 2660      334.5578 290.9850 378.1306 267.9189 401.1967
## 2661      334.6951 290.9579 378.4322 267.8049 401.5853
## 2662      334.8324 290.9313 378.7334 267.6915 401.9733
## 2663      334.9697 290.9052 379.0342 267.5788 402.3606
## 2664      335.1070 290.8794 379.3346 267.4667 402.7473
## 2665      335.2443 290.8540 379.6346 267.3552 403.1334
## 2666      335.3816 290.8290 379.9341 267.2443 403.5188
## 2667      335.5189 290.8045 380.2333 267.1341 403.9037
## 2668      335.6562 290.7803 380.5321 267.0244 404.2879
## 2669      335.7935 290.7565 380.8305 266.9153 404.6716
## 2670      335.9308 290.7331 381.1285 266.8068 405.0547
## 2671      336.0681 290.7100 381.4261 266.6989 405.4372
## 2672      336.2054 290.6874 381.7233 266.5916 405.8191
## 2673      336.3426 290.6651 382.0202 266.4848 406.2005
## 2674      336.4799 290.6431 382.3167 266.3786 406.5813
## 2675      336.6172 290.6216 382.6129 266.2730 406.9615
## 2676      336.7545 290.6004 382.9087 266.1678 407.3412
## 2677      336.8918 290.5795 383.2041 266.0633 407.7204
## 2678      337.0291 290.5590 383.4992 265.9593 408.0990
## 2679      337.1664 290.5389 383.7939 265.8558 408.4771
## 2680      337.3037 290.5191 384.0883 265.7528 408.8546
## 2681      337.4410 290.4996 384.3824 265.6504 409.2317
## 2682      337.5783 290.4805 384.6761 265.5484 409.6082
## 2683      337.7156 290.4617 384.9695 265.4470 409.9842
## 2684      337.8529 290.4433 385.2625 265.3461 410.3597
## 2685      337.9902 290.4251 385.5553 265.2457 410.7347
## 2686      338.1275 290.4073 385.8477 265.1458 411.1092
## 2687      338.2648 290.3898 386.1397 265.0464 411.4832
## 2688      338.4021 290.3727 386.4315 264.9474 411.8568
## 2689      338.5394 290.3558 386.7230 264.8490 412.2298
## 2690      338.6767 290.3393 387.0141 264.7510 412.6024
## 2691      338.8140 290.3230 387.3049 264.6535 412.9745
## 2692      338.9513 290.3071 387.5954 264.5564 413.3461
## 2693      339.0886 290.2915 387.8857 264.4598 413.7173
## 2694      339.2259 290.2761 388.1756 264.3637 414.0880
## 2695      339.3632 290.2611 388.4652 264.2680 414.4583
## 2696      339.5004 290.2463 388.7545 264.1728 414.8281
## 2697      339.6377 290.2319 389.0436 264.0780 415.1975
## 2698      339.7750 290.2177 389.3323 263.9837 415.5664
## 2699      339.9123 290.2039 389.6208 263.8898 415.9349
## 2700      340.0496 290.1903 389.9090 263.7963 416.3030

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## 2701      340.1869 290.1769 390.1969 263.7033 416.6706
## 2702      340.3242 290.1639 390.4845 263.6106 417.0378
## 2703      340.4615 290.1511 390.7719 263.5184 417.4046
## 2704      340.5988 290.1387 391.0590 263.4267 417.7710
## 2705      340.7361 290.1264 391.3458 263.3353 418.1369
## 2706      340.8734 290.1145 391.6323 263.2443 418.5025
## 2707      341.0107 290.1028 391.9186 263.1538 418.8676
## 2708      341.1480 290.0914 392.2046 263.0636 419.2324
## 2709      341.2853 290.0802 392.4904 262.9739 419.5967
## 2710      341.4226 290.0693 392.7759 262.8845 419.9607
## 2711      341.5599 290.0586 393.0611 262.7955 420.3242
## 2712      341.6972 290.0482 393.3461 262.7069 420.6874
## 2713      341.8345 290.0381 393.6309 262.6187 421.0502
## 2714      341.9718 290.0282 393.9154 262.5309 421.4126
## 2715      342.1091 290.0185 394.1996 262.4435 421.7747
## 2716      342.2464 290.0091 394.4836 262.3564 422.1363
## 2717      342.3837 290.0000 394.7674 262.2697 422.4976
## 2718      342.5210 289.9910 395.0509 262.1834 422.8585
## 2719      342.6582 289.9823 395.3342 262.0974 423.2191
## 2720      342.7955 289.9739 395.6172 262.0118 423.5793
## 2721      342.9328 289.9657 395.9000 261.9265 423.9391
## 2722      343.0701 289.9577 396.1826 261.8416 424.2986
## 2723      343.2074 289.9499 396.4649 261.7571 424.6578
## 2724      343.3447 289.9424 396.7471 261.6729 425.0166
## 2725      343.4820 289.9351 397.0290 261.5890 425.3750
## 2726      343.6193 289.9280 397.3106 261.5055 425.7331
## 2727      343.7566 289.9211 397.5921 261.4224 426.0909
## 2728      343.8939 289.9145 397.8733 261.3395 426.4483
## 2729      344.0312 289.9081 398.1543 261.2570 426.8054
## 2730      344.1685 289.9019 398.4351 261.1749 427.1621
## 2731      344.3058 289.8959 398.7157 261.0930 427.5186
## 2732      344.4431 289.8901 398.9961 261.0115 427.8747
## 2733      344.5804 289.8845 399.2762 260.9303 428.2305
## 2734      344.7177 289.8792 399.5562 260.8494 428.5859
## 2735      344.8550 289.8740 399.8359 260.7689 428.9411
## 2736      344.9923 289.8691 400.1154 260.6887 429.2959
## 2737      345.1296 289.8644 400.3948 260.6087 429.6504
## 2738      345.2669 289.8598 400.6739 260.5291 430.0046
## 2739      345.4042 289.8555 400.9528 260.4498 430.3585
## 2740      345.5415 289.8514 401.2315 260.3708 430.7121
## 2741      345.6788 289.8474 401.5101 260.2921 431.0654
## 2742      345.8160 289.8437 401.7884 260.2137 431.4184
## 2743      345.9533 289.8402 402.0665 260.1356 431.7711
## 2744      346.0906 289.8368 402.3445 260.0578 432.1235
## 2745      346.2279 289.8336 402.6222 259.9803 432.4756
## 2746      346.3652 289.8307 402.8998 259.9031 432.8274
## 2747      346.5025 289.8279 403.1772 259.8262 433.1789
## 2748      346.6398 289.8253 403.4543 259.7495 433.5301
## 2749      346.7771 289.8229 403.7313 259.6732 433.8811
## 2750      346.9144 289.8207 404.0081 259.5971 434.2317
## 2751      347.0517 289.8186 404.2848 259.5213 434.5821
## 2752      347.1890 289.8168 404.5612 259.4458 434.9322
## 2753      347.3263 289.8151 404.8375 259.3705 435.2821
## 2754      347.4636 289.8136 405.1136 259.2956 435.6316

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## 2755      347.6009 289.8123 405.3895 259.2209 435.9809
## 2756      347.7382 289.8111 405.6652 259.1464 436.3299
## 2757      347.8755 289.8102 405.9408 259.0723 436.6787
## 2758      348.0128 289.8094 406.2162 258.9984 437.0272
## 2759      348.1501 289.8088 406.4914 258.9247 437.3754
## 2760      348.2874 289.8083 406.7664 258.8514 437.7234
## 2761      348.4247 289.8080 407.0413 258.7783 438.0711
## 2762      348.5620 289.8079 407.3160 258.7054 438.4185
## 2763      348.6993 289.8080 407.5905 258.6328 438.7657
## 2764      348.8366 289.8082 407.8649 258.5605 439.1127
## 2765      348.9738 289.8086 408.1391 258.4884 439.4593
## 2766      349.1111 289.8091 408.4132 258.4165 439.8058
## 2767      349.2484 289.8098 408.6871 258.3449 440.1520
## 2768      349.3857 289.8107 408.9608 258.2736 440.4979
## 2769      349.5230 289.8117 409.2343 258.2025 440.8436
## 2770      349.6603 289.8129 409.5077 258.1316 441.1891
## 2771      349.7976 289.8143 409.7810 258.0610 441.5343
## 2772      349.9349 289.8158 410.0541 257.9906 441.8792
## 2773      350.0722 289.8174 410.3270 257.9204 442.2240
## 2774      350.2095 289.8192 410.5998 257.8505 442.5685
## 2775      350.3468 289.8212 410.8724 257.7809 442.9127
## 2776      350.4841 289.8233 411.1449 257.7114 443.2568
## 2777      350.6214 289.8256 411.4172 257.6422 443.6006
## 2778      350.7587 289.8280 411.6894 257.5732 443.9442
## 2779      350.8960 289.8306 411.9614 257.5045 444.2875
## 2780      351.0333 289.8333 412.2333 257.4359 444.6306
## 2781      351.1706 289.8361 412.5050 257.3676 444.9735
## 2782      351.3079 289.8391 412.7766 257.2995 445.3162
## 2783      351.4452 289.8423 413.0481 257.2317 445.6587
## 2784      351.5825 289.8456 413.3194 257.1640 446.0009
## 2785      351.7198 289.8490 413.5905 257.0966 446.3429
## 2786      351.8571 289.8526 413.8615 257.0294 446.6847
## 2787      351.9944 289.8563 414.1324 256.9624 447.0263
## 2788      352.1316 289.8602 414.4031 256.8956 447.3677
## 2789      352.2689 289.8642 414.6737 256.8291 447.7088
## 2790      352.4062 289.8683 414.9442 256.7627 448.0498
## 2791      352.5435 289.8726 415.2145 256.6966 448.3905
## 2792      352.6808 289.8770 415.4847 256.6306 448.7310
## 2793      352.8181 289.8815 415.7547 256.5649 449.0714
## 2794      352.9554 289.8862 416.0247 256.4994 449.4115
## 2795      353.0927 289.8910 416.2944 256.4340 449.7514
## 2796      353.2300 289.8959 416.5641 256.3689 450.0911
## 2797      353.3673 289.9010 416.8336 256.3040 450.4306
## 2798      353.5046 289.9062 417.1030 256.2393 450.7700
## 2799      353.6419 289.9115 417.3723 256.1747 451.1091
## 2800      353.7792 289.9170 417.6414 256.1104 451.4480
## 2801      353.9165 289.9226 417.9104 256.0463 451.7867
## 2802      354.0538 289.9283 418.1793 255.9823 452.1253
## 2803      354.1911 289.9341 418.4480 255.9186 452.4636
## 2804      354.3284 289.9401 418.7166 255.8550 452.8017
## 2805      354.4657 289.9462 418.9851 255.7916 453.1397
## 2806      354.6030 289.9524 419.2535 255.7285 453.4775
## 2807      354.7403 289.9587 419.5218 255.6655 453.8150
## 2808      354.8776 289.9652 419.7899 255.6027 454.1524

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## 2809      355.0149 289.9718 420.0579 255.5401 454.4897
## 2810      355.1522 289.9785 420.3258 255.4776 454.8267
## 2811      355.2894 289.9853 420.5936 255.4154 455.1635
## 2812      355.4267 289.9922 420.8612 255.3533 455.5002
## 2813      355.5640 289.9993 421.1288 255.2914 455.8367
## 2814      355.7013 290.0065 421.3962 255.2297 456.1730
## 2815      355.8386 290.0138 421.6635 255.1682 456.5091
## 2816      355.9759 290.0212 421.9307 255.1068 456.8450
## 2817      356.1132 290.0287 422.1978 255.0456 457.1808
## 2818      356.2505 290.0363 422.4647 254.9846 457.5164
## 2819      356.3878 290.0441 422.7316 254.9238 457.8518
## 2820      356.5251 290.0519 422.9983 254.8631 458.1871
## 2821      356.6624 290.0599 423.2649 254.8026 458.5222
## 2822      356.7997 290.0680 423.5314 254.7423 458.8571
## 2823      356.9370 290.0762 423.7978 254.6822 459.1918
## 2824      357.0743 290.0845 424.0641 254.6222 459.5264
## 2825      357.2116 290.0929 424.3303 254.5624 459.8608
## 2826      357.3489 290.1014 424.5964 254.5027 460.1950
## 2827      357.4862 290.1100 424.8623 254.4433 460.5291
## 2828      357.6235 290.1188 425.1282 254.3839 460.8630
## 2829      357.7608 290.1276 425.3939 254.3248 461.1968
## 2830      357.8981 290.1366 425.6596 254.2658 461.5304
## 2831      358.0354 290.1456 425.9251 254.2069 461.8638
## 2832      358.1727 290.1548 426.1905 254.1483 462.1970
## 2833      358.3100 290.1640 426.4559 254.0898 462.5302
## 2834      358.4472 290.1734 426.7211 254.0314 462.8631
## 2835      358.5845 290.1829 426.9862 253.9732 463.1959
## 2836      358.7218 290.1924 427.2513 253.9151 463.5285
## 2837      358.8591 290.2021 427.5162 253.8573 463.8610
## 2838      358.9964 290.2119 427.7810 253.7995 464.1933
## 2839      359.1337 290.2217 428.0457 253.7419 464.5255
## 2840      359.2710 290.2317 428.3103 253.6845 464.8575
## 2841      359.4083 290.2418 428.5749 253.6272 465.1894
## 2842      359.5456 290.2519 428.8393 253.5701 465.5211
## 2843      359.6829 290.2622 429.1036 253.5131 465.8527
## 2844      359.8202 290.2726 429.3678 253.4563 466.1841
## 2845      359.9575 290.2830 429.6320 253.3996 466.5154
## 2846      360.0948 290.2936 429.8960 253.3430 466.8466
## 2847      360.2321 290.3042 430.1600 253.2866 467.1775
## 2848      360.3694 290.3150 430.4238 253.2304 467.5084
## 2849      360.5067 290.3258 430.6876 253.1743 467.8391
## 2850      360.6440 290.3367 430.9512 253.1183 468.1696
## 2851      360.7813 290.3477 431.2148 253.0625 468.5001
## 2852      360.9186 290.3589 431.4783 253.0068 468.8303
## 2853      361.0559 290.3701 431.7417 252.9513 469.1605
## 2854      361.1932 290.3814 432.0050 252.8959 469.4905
## 2855      361.3305 290.3928 432.2682 252.8406 469.8203
## 2856      361.4678 290.4042 432.5313 252.7855 470.1500
## 2857      361.6050 290.4158 432.7943 252.7305 470.4796
## 2858      361.7423 290.4275 433.0572 252.6756 470.8090
## 2859      361.8796 290.4392 433.3201 252.6209 471.1384
## 2860      362.0169 290.4510 433.5828 252.5663 471.4675
## 2861      362.1542 290.4630 433.8455 252.5119 471.7966
## 2862      362.2915 290.4750 434.1081 252.4576 472.1255

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## 2863      362.4288 290.4871 434.3706 252.4034 472.4542
## 2864      362.5661 290.4992 434.6330 252.3493 472.7829
## 2865      362.7034 290.5115 434.8953 252.2954 473.1114
## 2866      362.8407 290.5239 435.1576 252.2416 473.4398
## 2867      362.9780 290.5363 435.4197 252.1880 473.7680
## 2868      363.1153 290.5488 435.6818 252.1344 474.0962
## 2869      363.2526 290.5614 435.9438 252.0810 474.4242
## 2870      363.3899 290.5741 436.2057 252.0277 474.7520
## 2871      363.5272 290.5869 436.4675 251.9746 475.0798
## 2872      363.6645 290.5997 436.7292 251.9216 475.4074
## 2873      363.8018 290.6126 436.9909 251.8687 475.7349
## 2874      363.9391 290.6257 437.2525 251.8159 476.0623
## 2875      364.0764 290.6387 437.5140 251.7632 476.3895
## 2876      364.2137 290.6519 437.7754 251.7107 476.7166
## 2877      364.3510 290.6652 438.0367 251.6583 477.0436
## 2878      364.4883 290.6785 438.2980 251.6060 477.3705
## 2879      364.6256 290.6919 438.5592 251.5538 477.6973
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## 2882      365.0374 290.7326 439.3423 251.3980 478.6769
## 2883      365.1747 290.7463 439.6031 251.3463 479.0032
## 2884      365.3120 290.7601 439.8639 251.2947 479.3293
## 2885      365.4493 290.7740 440.1247 251.2433 479.6554
## 2886      365.5866 290.7879 440.3853 251.1919 479.9813
## 2887      365.7239 290.8020 440.6459 251.1407 480.3071
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## 2890      366.1358 290.8445 441.4271 250.9877 481.2839
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## 2892      366.4104 290.8732 441.9476 250.8862 481.9346
## 2893      366.5477 290.8877 442.2077 250.8357 482.2597
## 2894      366.6850 290.9022 442.4678 250.7852 482.5848
## 2895      366.8223 290.9168 442.7278 250.7349 482.9097
## 2896      366.9596 290.9315 442.9877 250.6847 483.2345
## 2897      367.0969 290.9462 443.2475 250.6345 483.5592
## 2898      367.2342 290.9611 443.5073 250.5845 483.8838
## 2899      367.3715 290.9760 443.7670 250.5346 484.2083
## 2900      367.5088 290.9909 444.0266 250.4848 484.5327
## 2901      367.6461 291.0059 444.2862 250.4351 484.8570
## 2902      367.7834 291.0210 444.5457 250.3855 485.1812
## 2903      367.9206 291.0362 444.8051 250.3361 485.5052
## 2904      368.0579 291.0515 445.0644 250.2867 485.8292
## 2905      368.1952 291.0668 445.3237 250.2374 486.1531
## 2906      368.3325 291.0821 445.5829 250.1882 486.4768
## 2907      368.4698 291.0976 445.8421 250.1392 486.8005
## 2908      368.6071 291.1131 446.1012 250.0902 487.1240
## 2909      368.7444 291.1286 446.3602 250.0413 487.4475
## 2910      368.8817 291.1443 446.6191 249.9926 487.7709
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## 2912      369.1563 291.1758 447.1369 249.8954 488.4173
## 2913      369.2936 291.1916 447.3956 249.8469 488.7403
## 2914      369.4309 291.2075 447.6543 249.7985 489.0633
## 2915      369.5682 291.2235 447.9129 249.7503 489.3861
## 2916      369.7055 291.2395 448.1715 249.7021 489.7089

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## 2917      369.8428 291.2556 448.4300 249.6540 490.0316
## 2918      369.9801 291.2717 448.6884 249.6060 490.3541
## 2919      370.1174 291.2879 448.9468 249.5582 490.6766
## 2920      370.2547 291.3042 449.2051 249.5104 490.9990
## 2921      370.3920 291.3206 449.4634 249.4627 491.3213
## 2922      370.5293 291.3370 449.7216 249.4151 491.6434
## 2923      370.6666 291.3534 449.9797 249.3676 491.9655
## 2924      370.8039 291.3700 450.2378 249.3202 492.2875
## 2925      370.9412 291.3865 450.4958 249.2729 492.6094
## 2926      371.0784 291.4032 450.7537 249.2257 492.9312
## 2927      371.2157 291.4199 451.0116 249.1785 493.2530
## 2928      371.3530 291.4367 451.2694 249.1315 493.5746
## 2929      371.4903 291.4535 451.5272 249.0845 493.8961
## 2930      371.6276 291.4704 451.7849 249.0377 494.2176
## 2931      371.7649 291.4873 452.0425 248.9909 494.5389
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## 2947      373.9617 291.7661 456.1572 248.2545 499.6688
## 2948      374.0990 291.7840 456.4139 248.2092 499.9887
## 2949      374.2362 291.8020 456.6705 248.1639 500.3086
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## 2954      374.9227 291.8925 457.9529 247.9390 501.9065
## 2955      375.0600 291.9108 458.2093 247.8942 502.2258
## 2956      375.1973 291.9291 458.4655 247.8496 502.5451
## 2957      375.3346 291.9475 458.7218 247.8050 502.8642
## 2958      375.4719 291.9659 458.9779 247.7605 503.1833
## 2959      375.6092 291.9844 459.2341 247.7160 503.5024
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## 2962      376.0211 292.0401 460.0021 247.5832 504.4590
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## 2964      376.2957 292.0774 460.5139 247.4950 505.0964
## 2965      376.4330 292.0962 460.7698 247.4510 505.4149
## 2966      376.5703 292.1150 461.0255 247.4071 505.7334
## 2967      376.7076 292.1339 461.2813 247.3633 506.0519
## 2968      376.8449 292.1528 461.5369 247.3195 506.3702
## 2969      376.9822 292.1718 461.7926 247.2758 506.6885
## 2970      377.1195 292.1908 462.0482 247.2322 507.0067

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## 2971      377.2568 292.2098 462.3037 247.1887 507.3248
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## 2973      377.5313 292.2481 462.8146 247.1018 507.9609
## 2974      377.6686 292.2673 463.0700 247.0585 508.2788
## 2975      377.8059 292.2865 463.3254 247.0152 508.5966
## 2976      377.9432 292.3058 463.5807 246.9721 508.9144
## 2977      378.0805 292.3251 463.8359 246.9289 509.2321
## 2978      378.2178 292.3445 464.0911 246.8859 509.5497
## 2979      378.3551 292.3639 464.3463 246.8429 509.8673
## 2980      378.4924 292.3834 464.6014 246.8000 510.1848
## 2981      378.6297 292.4029 464.8565 246.7572 510.5022
## 2982      378.7670 292.4225 465.1115 246.7144 510.8196
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## 2989      379.7281 292.5606 466.8955 246.4170 513.0392
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## 2994      380.4146 292.6606 468.1685 246.2065 514.6226
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## 2999      381.1010 292.7616 469.4404 245.9976 516.2045
## 3000      381.2383 292.7819 469.6947 245.9560 516.5207
## 3001      381.3756 292.8023 469.9489 245.9144 516.8368
## 3002      381.5129 292.8227 470.2031 245.8730 517.1529
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## 3018      383.7096 293.1546 474.2647 245.2176 522.2017
## 3019      383.8469 293.1757 474.5182 245.1772 522.5167
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## 3036      386.1810 293.5392 478.8227 244.4977 527.8643
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## 3076      391.6728 294.4317 488.9139 242.9554 540.3902
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## 3079      392.0847 294.5005 489.6688 242.8426 541.3268
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## 3090      393.5949 294.7549 492.4350 242.4322 544.7577
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## 3099      394.8306 294.9654 494.6958 242.0999 547.5613
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## 3102      395.2425 295.0360 495.4490 241.9898 548.4951
## 3103      395.3798 295.0595 495.7000 241.9532 548.8063
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## 3109      396.2036 295.2015 497.2056 241.7343 550.6728
## 3110      396.3408 295.2253 497.4564 241.6979 550.9838
## 3111      396.4781 295.2490 497.7073 241.6616 551.2947
## 3112      396.6154 295.2728 497.9581 241.6253 551.6056
## 3113      396.7527 295.2966 498.2088 241.5890 551.9165
## 3114      396.8900 295.3205 498.4596 241.5528 552.2273
## 3115      397.0273 295.3443 498.7103 241.5166 552.5381
## 3116      397.1646 295.3682 498.9611 241.4804 552.8488
## 3117      397.3019 295.3921 499.2117 241.4443 553.1595
## 3118      397.4392 295.4160 499.4624 241.4082 553.4702
## 3119      397.5765 295.4400 499.7131 241.3721 553.7809
## 3120      397.7138 295.4639 499.9637 241.3361 554.0915
## 3121      397.8511 295.4879 500.2143 241.3001 554.4021
## 3122      397.9884 295.5119 500.4649 241.2642 554.7126
## 3123      398.1257 295.5360 500.7154 241.2282 555.0231
## 3124      398.2630 295.5600 500.9660 241.1924 555.3336
## 3125      398.4003 295.5841 501.2165 241.1565 555.6441
## 3126      398.5376 295.6082 501.4670 241.1207 555.9545
## 3127      398.6749 295.6323 501.7174 241.0849 556.2649
## 3128      398.8122 295.6564 501.9679 241.0491 556.5752
## 3129      398.9495 295.6806 502.2183 241.0134 556.8856
## 3130      399.0868 295.7048 502.4687 240.9777 557.1958
## 3131      399.2241 295.7290 502.7191 240.9420 557.5061
## 3132      399.3614 295.7532 502.9695 240.9064 557.8163

```

```

## 3133      399.4986 295.7775 503.2198 240.8708 558.1265
## 3134      399.6359 295.8017 503.4702 240.8352 558.4367
## 3135      399.7732 295.8260 503.7205 240.7997 558.7468
## 3136      399.9105 295.8503 503.9708 240.7641 559.0569
## 3137      400.0478 295.8746 504.2210 240.7287 559.3670
## 3138      400.1851 295.8990 504.4713 240.6932 559.6770
## 3139      400.3224 295.9233 504.7215 240.6578 559.9871
## 3140      400.4597 295.9477 504.9717 240.6224 560.2970
## 3141      400.5970 295.9721 505.2219 240.5870 560.6070
## 3142      400.7343 295.9965 505.4721 240.5517 560.9169
## 3143      400.8716 296.0210 505.7222 240.5164 561.2268
## 3144      401.0089 296.0454 505.9724 240.4811 561.5367
## 3145      401.1462 296.0699 506.2225 240.4459 561.8465
## 3146      401.2835 296.0944 506.4726 240.4107 562.1563
## 3147      401.4208 296.1189 506.7226 240.3755 562.4661
## 3148      401.5581 296.1435 506.9727 240.3403 562.7758
## 3149      401.6954 296.1680 507.2227 240.3052 563.0855
## 3150      401.8327 296.1926 507.4728 240.2701 563.3952
## 3151      401.9700 296.2172 507.7228 240.2350 563.7049
## 3152      402.1073 296.2418 507.9727 240.2000 564.0145
## 3153      402.2446 296.2664 508.2227 240.1650 564.3241
## 3154      402.3819 296.2911 508.4726 240.1300 564.6337
## 3155      402.5192 296.3157 508.7226 240.0950 564.9433
## 3156      402.6564 296.3404 508.9725 240.0601 565.2528
## 3157      402.7937 296.3651 509.2224 240.0252 565.5623
## 3158      402.9310 296.3898 509.4722 239.9903 565.8717
## 3159      403.0683 296.4146 509.7221 239.9555 566.1812
## 3160      403.2056 296.4393 509.9719 239.9207 566.4906
## 3161      403.3429 296.4641 510.2218 239.8859 566.8000
## 3162      403.4802 296.4889 510.4716 239.8511 567.1093
## 3163      403.6175 296.5137 510.7213 239.8164 567.4187
## 3164      403.7548 296.5385 510.9711 239.7816 567.7280
## 3165      403.8921 296.5634 511.2209 239.7470 568.0373
## 3166      404.0294 296.5882 511.4706 239.7123 568.3465
## 3167      404.1667 296.6131 511.7203 239.6777 568.6557
## 3168      404.3040 296.6380 511.9700 239.6430 568.9649
## 3169      404.4413 296.6629 512.2197 239.6085 569.2741
## 3170      404.5786 296.6878 512.4694 239.5739 569.5833
## 3171      404.7159 296.7128 512.7190 239.5394 569.8924
## 3172      404.8532 296.7377 512.9686 239.5049 570.2015
## 3173      404.9905 296.7627 513.2182 239.4704 570.5106
## 3174      405.1278 296.7877 513.4678 239.4359 570.8196
## 3175      405.2651 296.8127 513.7174 239.4015 571.1286
## 3176      405.4024 296.8377 513.9670 239.3671 571.4376
## 3177      405.5397 296.8628 514.2165 239.3327 571.7466
## 3178      405.6770 296.8878 514.4661 239.2983 572.0556
## 3179      405.8142 296.9129 514.7156 239.2640 572.3645
## 3180      405.9515 296.9380 514.9651 239.2297 572.6734
## 3181      406.0888 296.9631 515.2146 239.1954 572.9823
## 3182      406.2261 296.9882 515.4641 239.1611 573.2911
## 3183      406.3634 297.0133 515.7135 239.1269 573.6000
## 3184      406.5007 297.0385 515.9630 239.0927 573.9088
## 3185      406.6380 297.0637 516.2124 239.0585 574.2176
## 3186      406.7753 297.0888 516.4618 239.0243 574.5263

```

```

## 3187      406.9126 297.1140 516.7112 238.9902 574.8351
## 3188      407.0499 297.1392 516.9606 238.9561 575.1438
## 3189      407.1872 297.1645 517.2099 238.9220 575.4525
## 3190      407.3245 297.1897 517.4593 238.8879 575.7611
## 3191      407.4618 297.2150 517.7086 238.8538 576.0698
## 3192      407.5991 297.2402 517.9579 238.8198 576.3784
## 3193      407.7364 297.2655 518.2073 238.7858 576.6870
## 3194      407.8737 297.2908 518.4565 238.7518 576.9956
## 3195      408.0110 297.3161 518.7058 238.7178 577.3041
## 3196      408.1483 297.3415 518.9551 238.6839 577.6127
## 3197      408.2856 297.3668 519.2043 238.6500 577.9212
## 3198      408.4229 297.3922 519.4536 238.6161 578.2297
## 3199      408.5602 297.4175 519.7028 238.5822 578.5381
## 3200      408.6975 297.4429 519.9520 238.5483 578.8466
## 3201      408.8348 297.4683 520.2012 238.5145 579.1550
## 3202      408.9720 297.4937 520.4504 238.4807 579.4634
## 3203      409.1093 297.5192 520.6995 238.4469 579.7718
## 3204      409.2466 297.5446 520.9487 238.4131 580.0802
## 3205      409.3839 297.5701 521.1978 238.3794 580.3885
## 3206      409.5212 297.5955 521.4469 238.3456 580.6968
## 3207      409.6585 297.6210 521.6960 238.3119 581.0051
## 3208      409.7958 297.6465 521.9451 238.2782 581.3134
## 3209      409.9331 297.6720 522.1942 238.2446 581.6217
## 3210      410.0704 297.6975 522.4433 238.2109 581.9299
## 3211      410.2077 297.7231 522.6923 238.1773 582.2381
## 3212      410.3450 297.7486 522.9414 238.1437 582.5463
## 3213      410.4823 297.7742 523.1904 238.1101 582.8545
## 3214      410.6196 297.7998 523.4394 238.0765 583.1626
## 3215      410.7569 297.8253 523.6884 238.0430 583.4708
## 3216      410.8942 297.8509 523.9374 238.0095 583.7789
## 3217      411.0315 297.8766 524.1864 237.9760 584.0870
## 3218      411.1688 297.9022 524.4354 237.9425 584.3951
## 3219      411.3061 297.9278 524.6843 237.9090 584.7031
## 3220      411.4434 297.9535 524.9333 237.8756 585.0112
## 3221      411.5807 297.9791 525.1822 237.8421 585.3192
## 3222      411.7180 298.0048 525.4311 237.8087 585.6272
## 3223      411.8553 298.0305 525.6800 237.7753 585.9352
## 3224      411.9926 298.0562 525.9289 237.7419 586.2432
## 3225      412.1298 298.0819 526.1778 237.7086 586.5511
## 3226      412.2671 298.1076 526.4266 237.6753 586.8590
## 3227      412.4044 298.1334 526.6755 237.6419 587.1669
## 3228      412.5417 298.1591 526.9243 237.6086 587.4748
## 3229      412.6790 298.1849 527.1732 237.5753 587.7827
## 3230      412.8163 298.2107 527.4220 237.5421 588.0906
## 3231      412.9536 298.2364 527.6708 237.5088 588.3984
## 3232      413.0909 298.2622 527.9196 237.4756 588.7062
## 3233      413.2282 298.2880 528.1684 237.4424 589.0140
## 3234      413.3655 298.3139 528.4172 237.4092 589.3218
## 3235      413.5028 298.3397 528.6659 237.3760 589.6296
## 3236      413.6401 298.3655 528.9147 237.3429 589.9373
## 3237      413.7774 298.3914 529.1634 237.3097 590.2451
## 3238      413.9147 298.4173 529.4121 237.2766 590.5528
## 3239      414.0520 298.4431 529.6609 237.2435 590.8605
## 3240      414.1893 298.4690 529.9096 237.2104 591.1682

```

```

## 3241      414.3266 298.4949 530.1583 237.1773 591.4758
## 3242      414.4639 298.5208 530.4069 237.1443 591.7835
## 3243      414.6012 298.5467 530.6556 237.1112 592.0911
## 3244      414.7385 298.5727 530.9043 237.0782 592.3987
## 3245      414.8758 298.5986 531.1529 237.0452 592.7063
## 3246      415.0131 298.6246 531.4016 237.0122 593.0139

```

#2) Amazon

```
class(AMZN)
```

```
## [1] "xts" "zoo"
```

```
AMZN_close_price <- (AMZN[,4])
plot((AMZN_close_price))
```



```
class(AMZN_close_price)
```

```
## [1] "xts" "zoo"
```

```
print(adf.test(AMZN_close_price)) #P-value > 0.05 indicates non stationary data
```

```
##
```

```

##  Augmented Dickey-Fuller Test
##
## data: AMZN_close_price
## Dickey-Fuller = -1.004, Lag order = 13, p-value = 0.9381
## alternative hypothesis: stationary

auto.arima(AMZN_close_price, seasonal = FALSE)

## Series: AMZN_close_price
## ARIMA(0,1,1) with drift
##
## Coefficients:
##             ma1     drift
##           -0.0739  0.9127
## s.e.    0.0193  0.3541
##
## sigma^2 estimated as 368: log likelihood=-10996.96
## AIC=21999.93   AICc=21999.94   BIC=22017.42

par(mfrow = c(2,2))
pacf(AMZN_close_price)
acf(AMZN_close_price)

#Translating Raw price into logarithmic form to obtain returns

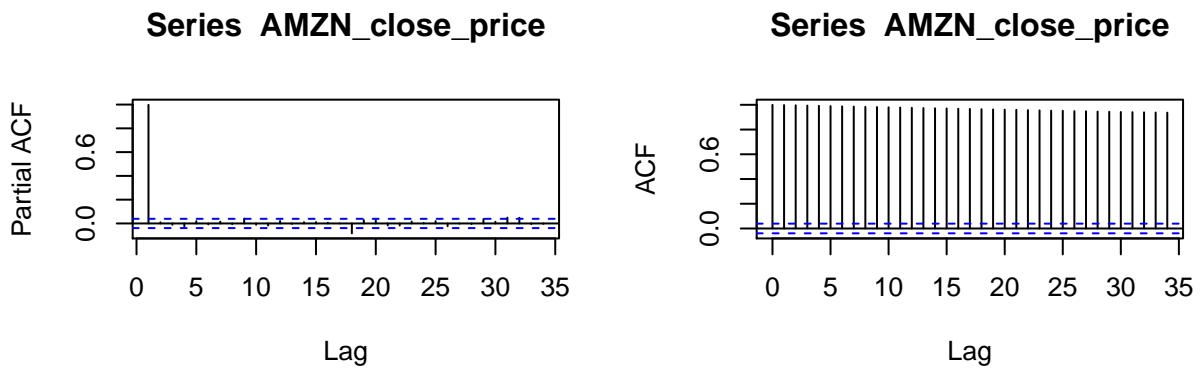
lnamzn = log(AMZN_close_price)
head(lnamzn)

##          AMZN.Close
## 2010-05-27  4.841822
## 2010-05-28  4.831987
## 2010-06-01  4.814134
## 2010-06-02  4.838739
## 2010-06-03  4.857950
## 2010-06-04  4.810313

#Checking for stationarity

par(mfrow = c(2,2))

```



```
acf(lnamzn, lag.max = 200, main = "ACF for Amazon Series")
pacf(lnamzn, lag.max = 200, main = "PACF for Amazon Series")
print(adf.test(lnamzn)) #P-value > 0.05 indicates non stationary data
```

```
##
## Augmented Dickey-Fuller Test
##
## data: lnamzn
## Dickey-Fuller = -2.7387, Lag order = 13, p-value = 0.2656
## alternative hypothesis: stationary
```

#Differencing the data to turn into stationary data

```
difflnamzn = diff(lnamzn)
head(difflnamzn)
```

```
##          AMZN.Close
## 2010-05-27      NA
## 2010-05-28 -0.009835089
## 2010-06-01 -0.017853317
## 2010-06-02  0.024605529
## 2010-06-03  0.019210981
## 2010-06-04 -0.047637506
```

```

adf.test(lnamzn)

##
##  Augmented Dickey-Fuller Test
##
## data: lnamzn
## Dickey-Fuller = -2.7387, Lag order = 13, p-value = 0.2656
## alternative hypothesis: stationary

adf.test(difflnamzn[2:1259]) # p-value < 0.05 indication stationary data. Model fitting to continue

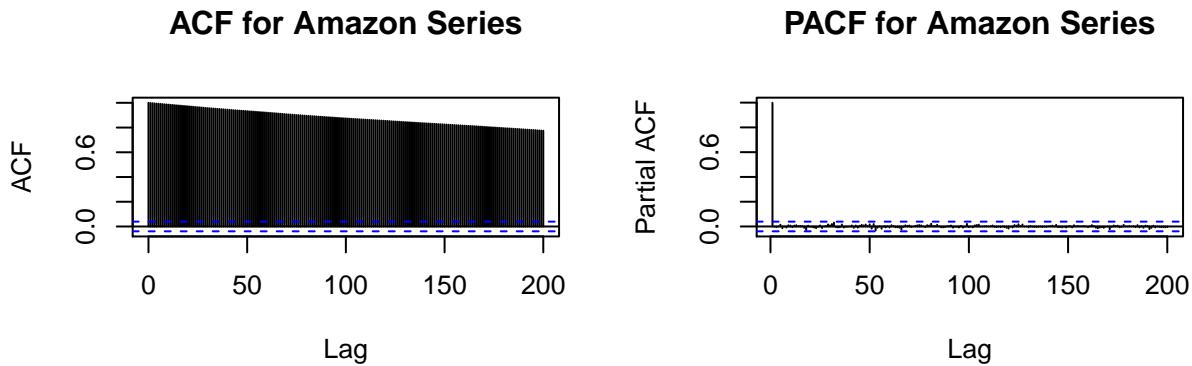
## Warning in adf.test(difflnamzn[2:1259, ]): p-value smaller than printed p-value

##
##  Augmented Dickey-Fuller Test
##
## data: difflnamzn[2:1259, ]
## Dickey-Fuller = -11.195, Lag order = 10, p-value = 0.01
## alternative hypothesis: stationary

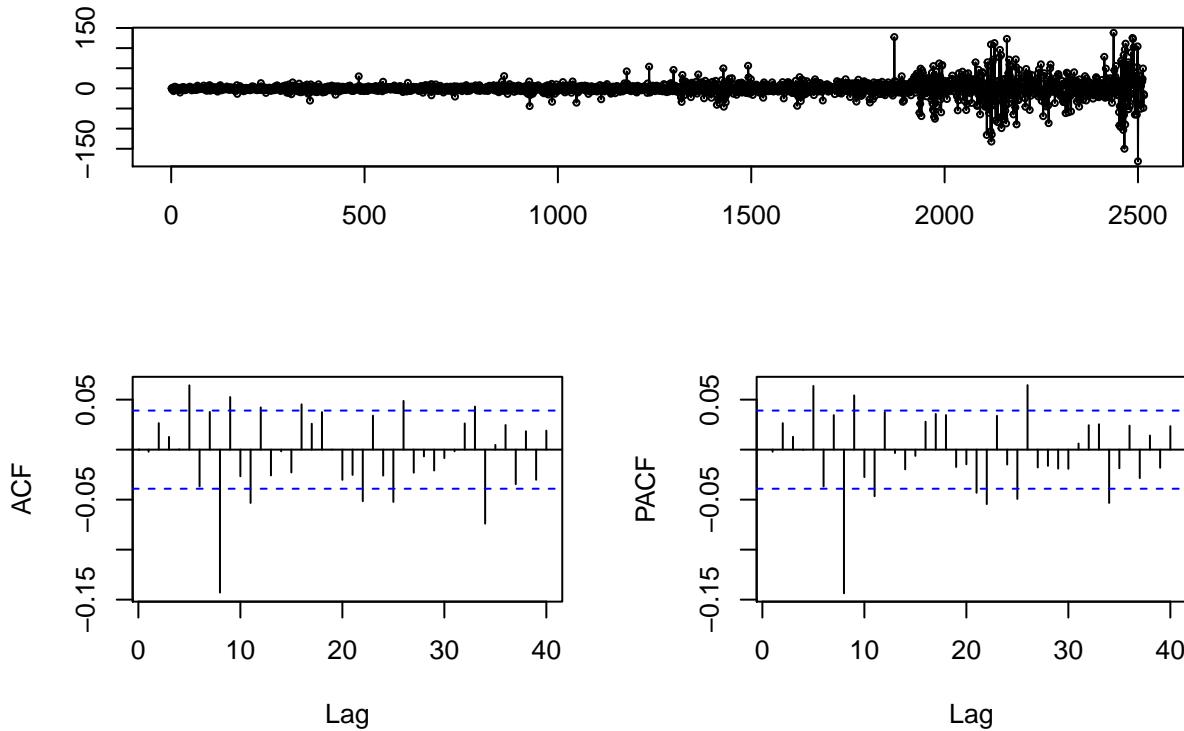
#Trying different fits

fitA = auto.arima(AMZN_close_price, seasonal = FALSE)
tsdisplay(residuals(fitA), lag.max = 40, main = '0,1,1 Model Residuals')

```



0,1,1 Model Residuals

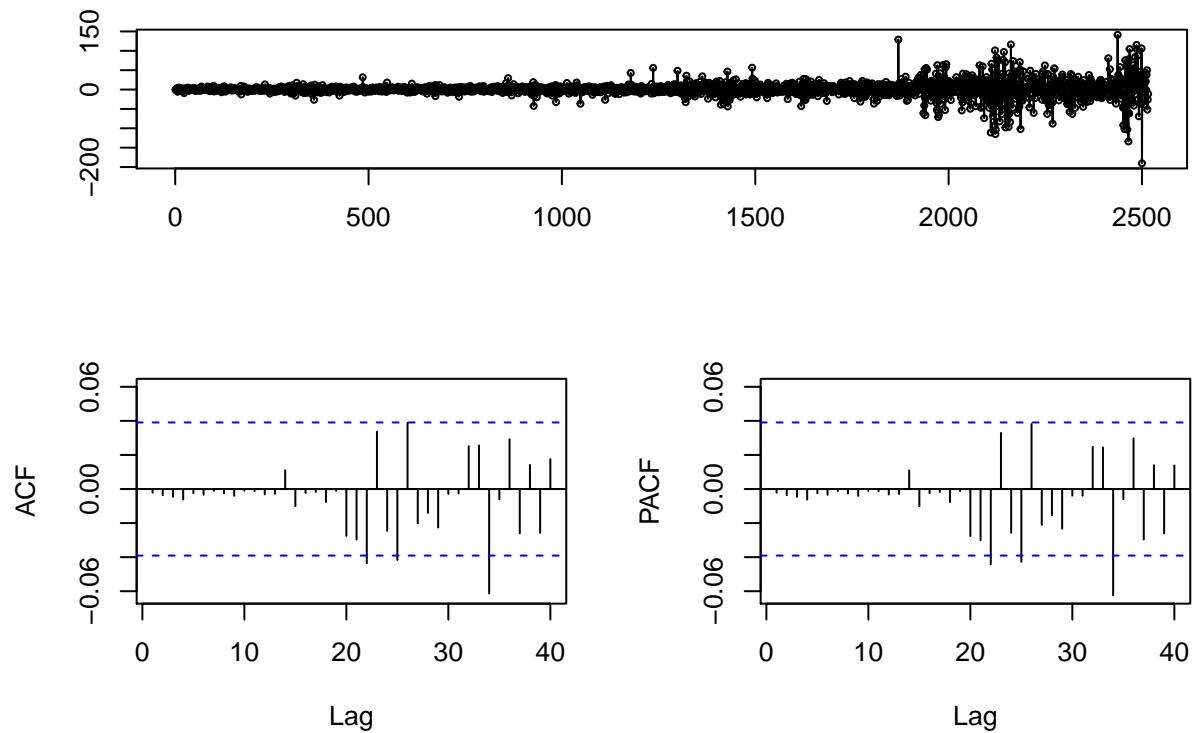


```
auto.arima(AMZN_close_price, seasonal = FALSE)

## Series: AMZN_close_price
## ARIMA(0,1,1) with drift
##
## Coefficients:
##          ma1    drift
##        -0.0739  0.9127
##  s.e.  0.0193  0.3541
##
## sigma^2 estimated as 368: log likelihood=-10996.96
## AIC=21999.93   AICc=21999.94   BIC=22017.42

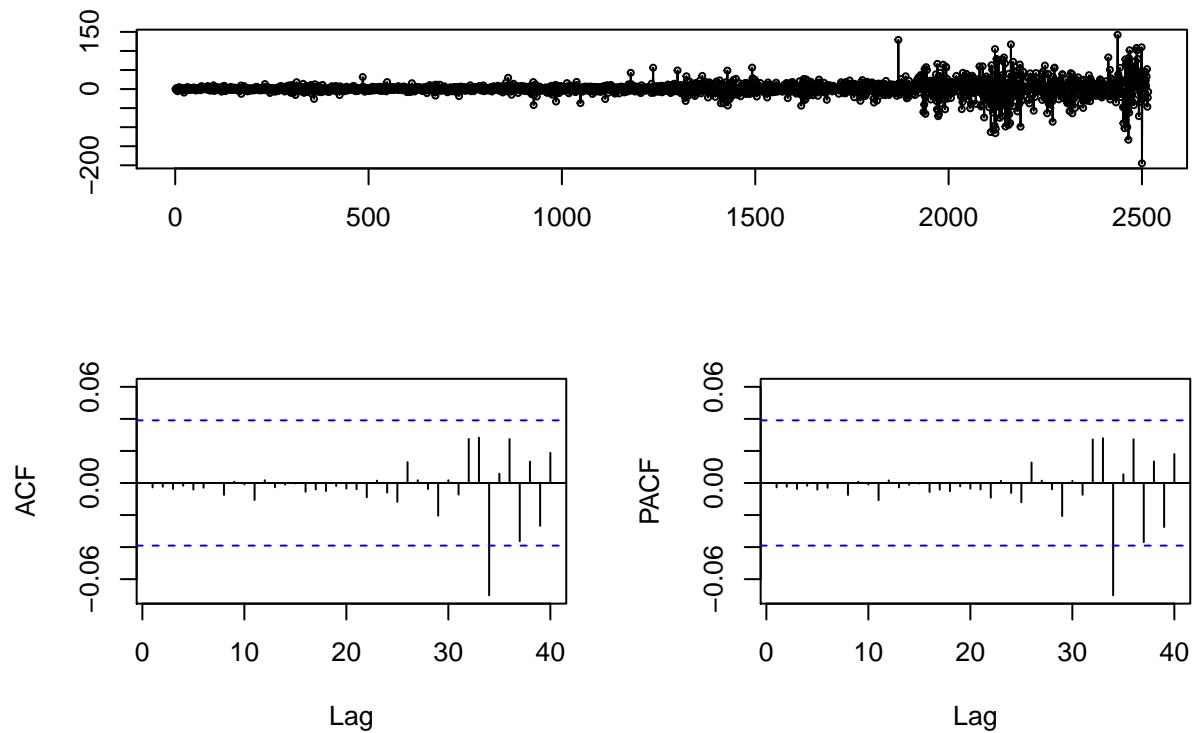
fitB = arima(AMZN_close_price, order = c(1,1,19))
tsdisplay(residuals(fitB), lag.max = 40, main = '(1,1,19) Model Residuals')
```

(1,1,19) Model Residuals



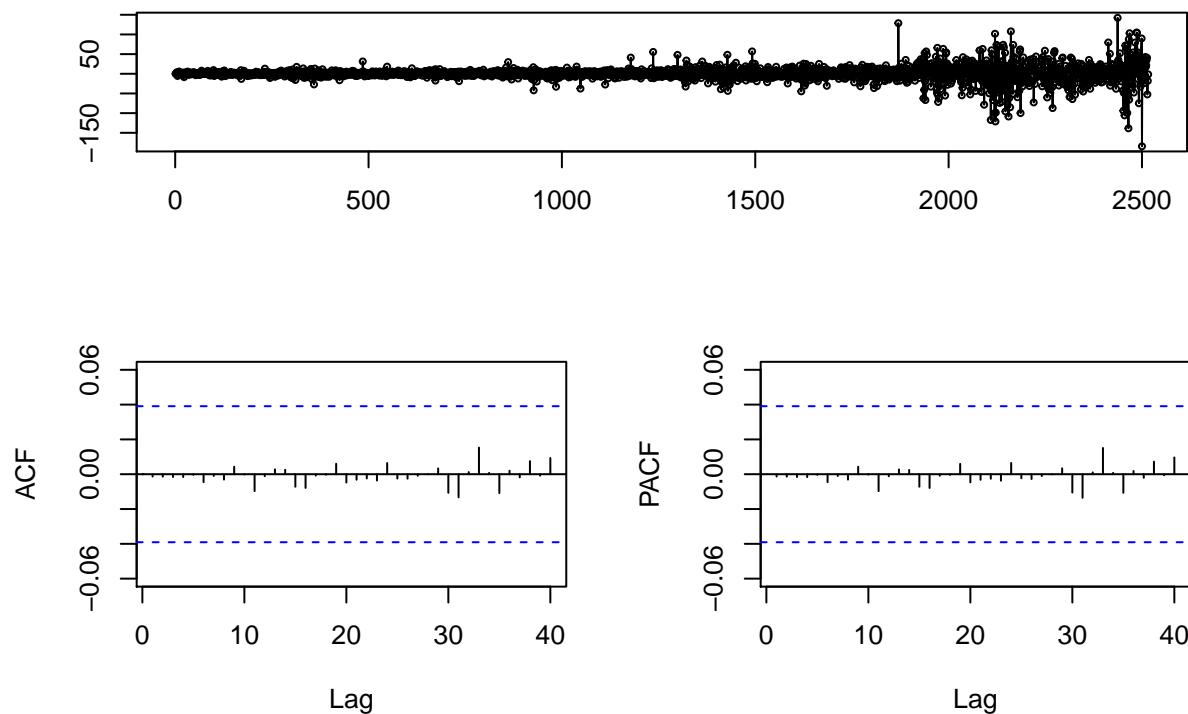
```
fitC = arima(AMZN_close_price, order = c(1,1,28))
tsdisplay(residuals(fitC), lag.max = 40, main = '(1,1,28) Model Residuals')
```

(1,1,28) Model Residuals



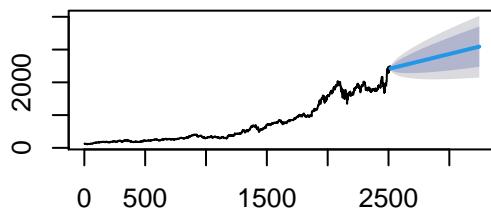
```
fitD = arima(AMZN_close_price, order = c(1,2,40))
tsdisplay(residuals(fitD), lag.max = 40, main = '(1,2,40) Model Residuals')
```

(1,2,40) Model Residuals

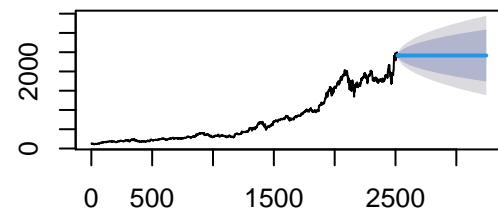


```
par(mfrow = c(2,2))
term <- 730
fcast1 <- forecast(fitA, h = term)
plot(fcast1)
fcast2 <- forecast(fitB, h = term)
plot(fcast2)
fcast3 <- forecast(fitC, h = term)
plot(fcast3)
fcast4 <- forecast(fitD, h = term)
plot(fcast4)
```

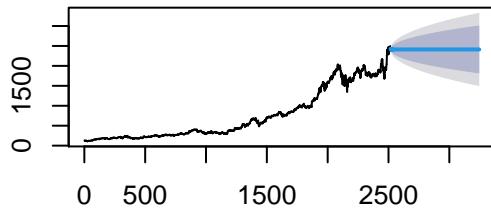
Forecasts from ARIMA(0,1,1) with drift



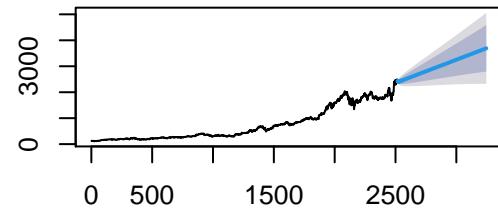
Forecasts from ARIMA(1,1,19)



Forecasts from ARIMA(1,1,28)



Forecasts from ARIMA(1,2,40)



```
print(fcast4)
```

```
##      Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## 2517     2424.683 2400.863 2448.502 2388.253 2461.112
## 2518     2422.232 2389.448 2455.016 2372.093 2472.371
## 2519     2422.756 2382.685 2462.827 2361.473 2484.040
## 2520     2413.059 2366.683 2459.435 2342.133 2483.985
## 2521     2413.796 2361.760 2465.833 2334.213 2493.380
## 2522     2432.720 2374.957 2490.483 2344.379 2521.061
## 2523     2405.989 2343.274 2468.704 2310.075 2501.904
## 2524     2412.001 2344.379 2479.624 2308.582 2515.421
## 2525     2423.832 2352.708 2494.955 2315.058 2532.605
## 2526     2414.770 2339.907 2489.633 2300.278 2529.263
## 2527     2415.986 2337.785 2494.187 2296.388 2535.584
## 2528     2412.952 2331.775 2494.128 2288.803 2537.100
## 2529     2434.238 2349.899 2518.578 2305.252 2563.224
## 2530     2429.824 2342.667 2516.982 2296.528 2563.120
## 2531     2430.387 2340.660 2520.114 2293.162 2567.613
## 2532     2417.769 2325.587 2509.952 2276.788 2558.751
## 2533     2408.854 2313.913 2503.794 2263.655 2554.053
## 2534     2427.452 2329.721 2525.184 2277.984 2576.920
## 2535     2427.139 2326.430 2527.848 2273.118 2581.160
## 2536     2422.993 2319.520 2526.466 2264.745 2581.241
## 2537     2427.584 2321.513 2533.655 2265.363 2589.805
## 2538     2426.233 2317.751 2534.715 2260.324 2592.142
```

```

## 2539      2437.237 2326.608 2547.866 2268.045 2606.430
## 2540      2427.842 2314.863 2540.821 2255.056 2600.629
## 2541      2435.707 2320.652 2550.761 2259.745 2611.668
## 2542      2437.385 2320.471 2554.299 2258.581 2616.190
## 2543      2438.111 2319.147 2557.074 2256.171 2620.050
## 2544      2440.909 2320.033 2561.786 2256.044 2625.774
## 2545      2443.233 2320.501 2565.965 2255.531 2630.935
## 2546      2440.513 2316.104 2564.922 2250.246 2630.780
## 2547      2438.810 2312.673 2564.946 2245.900 2631.719
## 2548      2445.039 2317.132 2572.947 2249.422 2640.657
## 2549      2446.607 2316.831 2576.384 2248.131 2645.083
## 2550      2444.010 2312.357 2575.663 2242.664 2645.356
## 2551      2447.061 2313.887 2580.235 2243.390 2650.732
## 2552      2448.481 2313.684 2583.279 2242.327 2654.636
## 2553      2452.537 2316.030 2589.044 2243.767 2661.307
## 2554      2453.641 2315.601 2591.681 2242.527 2664.755
## 2555      2455.860 2316.287 2595.434 2242.402 2669.319
## 2556      2457.407 2316.424 2598.389 2241.792 2673.021
## 2557      2459.332 2316.886 2601.777 2241.480 2677.183
## 2558      2461.044 2317.180 2604.907 2241.023 2681.064
## 2559      2462.875 2317.583 2608.168 2240.670 2685.081
## 2560      2464.640 2317.938 2611.342 2240.279 2689.001
## 2561      2466.442 2318.333 2614.551 2239.929 2692.955
## 2562      2468.223 2318.719 2617.727 2239.577 2696.870
## 2563      2470.016 2319.123 2620.909 2239.245 2700.787
## 2564      2471.802 2319.529 2624.076 2238.920 2704.685
## 2565      2473.593 2319.946 2627.239 2238.610 2708.575
## 2566      2475.380 2320.368 2630.393 2238.309 2712.452
## 2567      2477.170 2320.798 2633.541 2238.020 2716.319
## 2568      2478.958 2321.235 2636.681 2237.741 2720.175
## 2569      2480.747 2321.678 2639.815 2237.473 2724.021
## 2570      2482.535 2322.128 2642.942 2237.214 2727.857
## 2571      2484.324 2322.585 2646.063 2236.965 2731.683
## 2572      2486.113 2323.048 2649.178 2236.726 2735.499
## 2573      2487.901 2323.517 2652.286 2236.496 2739.306
## 2574      2489.690 2323.991 2655.389 2236.276 2743.105
## 2575      2491.479 2324.472 2658.486 2236.064 2746.894
## 2576      2493.268 2324.958 2661.577 2235.860 2750.675
## 2577      2495.056 2325.450 2664.663 2235.665 2754.447
## 2578      2496.845 2325.947 2667.743 2235.479 2758.211
## 2579      2498.634 2326.449 2670.818 2235.300 2761.967
## 2580      2500.422 2326.956 2673.888 2235.129 2765.715
## 2581      2502.211 2327.469 2676.953 2234.966 2769.456
## 2582      2504.000 2327.986 2680.013 2234.810 2773.189
## 2583      2505.788 2328.508 2683.069 2234.661 2776.915
## 2584      2507.577 2329.034 2686.119 2234.520 2780.634
## 2585      2509.366 2329.566 2689.166 2234.385 2784.346
## 2586      2511.154 2330.101 2692.207 2234.258 2788.051
## 2587      2512.943 2330.641 2695.245 2234.136 2791.750
## 2588      2514.732 2331.185 2698.278 2234.022 2795.442
## 2589      2516.520 2331.734 2701.307 2233.914 2799.127
## 2590      2518.309 2332.286 2704.332 2233.812 2802.807
## 2591      2520.098 2332.843 2707.353 2233.716 2806.480
## 2592      2521.886 2333.403 2710.370 2233.626 2810.147

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## 2593 2523.675 2333.967 2713.383 2233.541 2813.809
## 2594 2525.464 2334.535 2716.393 2233.463 2817.465
## 2595 2527.252 2335.106 2719.399 2233.390 2821.115
## 2596 2529.041 2335.681 2722.401 2233.323 2824.760
## 2597 2530.830 2336.260 2725.400 2233.261 2828.399
## 2598 2532.619 2336.842 2728.395 2233.204 2832.033
## 2599 2534.407 2337.427 2731.387 2233.152 2835.662
## 2600 2536.196 2338.016 2734.376 2233.105 2839.286
## 2601 2537.985 2338.607 2737.362 2233.064 2842.906
## 2602 2539.773 2339.202 2740.344 2233.027 2846.520
## 2603 2541.562 2339.801 2743.323 2232.994 2850.129
## 2604 2543.351 2340.402 2746.300 2232.967 2853.734
## 2605 2545.139 2341.006 2749.273 2232.944 2857.335
## 2606 2546.928 2341.613 2752.243 2232.925 2860.930
## 2607 2548.717 2342.223 2755.211 2232.911 2864.522
## 2608 2550.505 2342.835 2758.175 2232.901 2868.109
## 2609 2552.294 2343.451 2761.137 2232.896 2871.692
## 2610 2554.083 2344.069 2764.096 2232.894 2875.271
## 2611 2555.871 2344.690 2767.053 2232.897 2878.846
## 2612 2557.660 2345.313 2770.007 2232.903 2882.417
## 2613 2559.449 2345.939 2772.958 2232.914 2885.984
## 2614 2561.237 2346.567 2775.907 2232.928 2889.547
## 2615 2563.026 2347.198 2778.854 2232.946 2893.106
## 2616 2564.815 2347.832 2781.798 2232.968 2896.662
## 2617 2566.603 2348.467 2784.740 2232.993 2900.214
## 2618 2568.392 2349.105 2787.679 2233.022 2903.762
## 2619 2570.181 2349.746 2790.616 2233.054 2907.307
## 2620 2571.970 2350.388 2793.551 2233.090 2910.849
## 2621 2573.758 2351.033 2796.484 2233.129 2914.387
## 2622 2575.547 2351.680 2799.414 2233.172 2917.922
## 2623 2577.336 2352.329 2802.342 2233.217 2921.454
## 2624 2579.124 2352.980 2805.269 2233.266 2924.982
## 2625 2580.913 2353.633 2808.193 2233.318 2928.508
## 2626 2582.702 2354.288 2811.115 2233.373 2932.030
## 2627 2584.490 2354.945 2814.035 2233.431 2935.549
## 2628 2586.279 2355.604 2816.954 2233.492 2939.066
## 2629 2588.068 2356.265 2819.870 2233.556 2942.579
## 2630 2589.856 2356.928 2822.785 2233.623 2946.090
## 2631 2591.645 2357.593 2825.697 2233.693 2949.597
## 2632 2593.434 2358.259 2828.608 2233.765 2953.102
## 2633 2595.222 2358.927 2831.517 2233.840 2956.605
## 2634 2597.011 2359.597 2834.425 2233.918 2960.104
## 2635 2598.800 2360.269 2837.331 2233.998 2963.601
## 2636 2600.588 2360.942 2840.235 2234.081 2967.095
## 2637 2602.377 2361.617 2843.137 2234.167 2970.587
## 2638 2604.166 2362.294 2846.038 2234.255 2974.077
## 2639 2605.954 2362.972 2848.937 2234.345 2977.564
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## 2641 2609.532 2364.333 2854.730 2234.533 2984.530
## 2642 2611.321 2365.016 2857.625 2234.631 2988.010
## 2643 2613.109 2365.701 2860.518 2234.731 2991.488
## 2644 2614.898 2366.387 2863.409 2234.833 2994.963
## 2645 2616.687 2367.074 2866.299 2234.937 2998.436
## 2646 2618.475 2367.763 2869.188 2235.043 3001.907

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## 2647 2620.264 2368.453 2872.075 2235.152 3005.376
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## 2649 2623.841 2369.837 2877.846 2235.375 3012.307
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## 2651 2627.419 2371.227 2883.611 2235.607 3019.231
## 2652 2629.207 2371.923 2886.491 2235.725 3022.689
## 2653 2630.996 2372.621 2889.371 2235.846 3026.146
## 2654 2632.785 2373.320 2892.249 2235.968 3029.601
## 2655 2634.573 2374.021 2895.126 2236.093 3033.054
## 2656 2636.362 2374.723 2898.002 2236.219 3036.505
## 2657 2638.151 2375.425 2900.876 2236.347 3039.955
## 2658 2639.939 2376.129 2903.749 2236.477 3043.402
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## 2662 2647.094 2378.956 2915.232 2237.013 3057.175
## 2663 2648.883 2379.666 2918.100 2237.151 3060.615
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## 2665 2652.460 2381.088 2923.832 2237.432 3067.488
## 2666 2654.249 2381.801 2926.697 2237.575 3070.923
## 2667 2656.038 2382.514 2929.561 2237.720 3074.355
## 2668 2657.826 2383.229 2932.424 2237.866 3077.787
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## 2671 2663.192 2385.378 2941.006 2238.312 3088.072
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## 2673 2666.770 2386.816 2946.724 2238.617 3094.922
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## 2679 2677.502 2391.149 2963.855 2239.563 3115.441
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## 2681 2681.079 2392.600 2969.558 2239.888 3122.270
## 2682 2682.868 2393.327 2972.409 2240.053 3125.683
## 2683 2684.656 2394.054 2975.259 2240.218 3129.095
## 2684 2686.445 2394.782 2978.108 2240.385 3132.505
## 2685 2688.234 2395.511 2980.957 2240.553 3135.915
## 2686 2690.022 2396.241 2983.804 2240.722 3139.323
## 2687 2691.811 2396.971 2986.651 2240.892 3142.730
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## 2692 2700.755 2400.633 3000.876 2241.758 3159.751
## 2693 2702.543 2401.367 3003.719 2241.934 3163.152
## 2694 2704.332 2402.102 3006.562 2242.111 3166.553
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## 2696 2707.909 2403.574 3012.245 2242.468 3173.350
## 2697 2709.698 2404.311 3015.085 2242.648 3176.748
## 2698 2711.487 2405.048 3017.925 2242.829 3180.144
## 2699 2713.275 2405.786 3020.765 2243.011 3183.540
## 2700 2715.064 2406.525 3023.604 2243.194 3186.935

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## 2702      2718.641 2408.003 3029.280 2243.561 3193.722
## 2703      2720.430 2408.743 3032.117 2243.746 3197.114
## 2704      2722.219 2409.484 3034.954 2243.932 3200.505
## 2705      2724.007 2410.225 3037.790 2244.119 3203.896
## 2706      2725.796 2410.967 3040.625 2244.306 3207.286
## 2707      2727.585 2411.709 3043.461 2244.495 3210.675
## 2708      2729.373 2412.452 3046.295 2244.684 3214.063
## 2709      2731.162 2413.195 3049.129 2244.873 3217.451
## 2710      2732.951 2413.939 3051.963 2245.064 3220.838
## 2711      2734.740 2414.683 3054.796 2245.255 3224.224
## 2712      2736.528 2415.427 3057.629 2245.447 3227.610
## 2713      2738.317 2416.172 3060.462 2245.639 3230.995
## 2714      2740.106 2416.918 3063.294 2245.832 3234.379
## 2715      2741.894 2417.663 3066.125 2246.026 3237.763
## 2716      2743.683 2418.410 3068.956 2246.220 3241.145
## 2717      2745.472 2419.156 3071.787 2246.415 3244.528
## 2718      2747.260 2419.903 3074.617 2246.611 3247.909
## 2719      2749.049 2420.651 3077.447 2246.807 3251.290
## 2720      2750.838 2421.399 3080.277 2247.004 3254.671
## 2721      2752.626 2422.147 3083.106 2247.202 3258.051
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## 2723      2756.204 2423.645 3088.763 2247.598 3264.809
## 2724      2757.992 2424.394 3091.591 2247.798 3268.187
## 2725      2759.781 2425.144 3094.419 2247.997 3271.565
## 2726      2761.570 2425.894 3097.246 2248.197 3274.942
## 2727      2763.358 2426.644 3100.073 2248.398 3278.319
## 2728      2765.147 2427.395 3102.900 2248.599 3281.695
## 2729      2766.936 2428.146 3105.726 2248.801 3285.071
## 2730      2768.724 2428.897 3108.552 2249.003 3288.446
## 2731      2770.513 2429.649 3111.378 2249.206 3291.820
## 2732      2772.302 2430.401 3114.203 2249.409 3295.195
## 2733      2774.091 2431.153 3117.028 2249.613 3298.568
## 2734      2775.879 2431.905 3119.853 2249.817 3301.942
## 2735      2777.668 2432.658 3122.678 2250.021 3305.315
## 2736      2779.457 2433.411 3125.502 2250.226 3308.687
## 2737      2781.245 2434.165 3128.326 2250.431 3312.059
## 2738      2783.034 2434.918 3131.150 2250.637 3315.431
## 2739      2784.823 2435.672 3133.973 2250.843 3318.802
## 2740      2786.611 2436.426 3136.796 2251.049 3322.173
## 2741      2788.400 2437.180 3139.619 2251.256 3325.544
## 2742      2790.189 2437.935 3142.442 2251.463 3328.914
## 2743      2791.977 2438.690 3145.265 2251.671 3332.284
## 2744      2793.766 2439.445 3148.087 2251.879 3335.653
## 2745      2795.555 2440.200 3150.909 2252.087 3339.023
## 2746      2797.343 2440.956 3153.731 2252.295 3342.391
## 2747      2799.132 2441.711 3156.553 2252.504 3345.760
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## 2749      2802.709 2443.223 3162.195 2252.923 3352.496
## 2750      2804.498 2443.980 3165.017 2253.133 3355.863
## 2751      2806.287 2444.736 3167.837 2253.343 3359.231
## 2752      2808.075 2445.493 3170.658 2253.553 3362.598
## 2753      2809.864 2446.250 3173.479 2253.764 3365.965
## 2754      2811.653 2447.007 3176.299 2253.975 3369.331

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## 2755      2813.442 2447.764 3179.119 2254.186 3372.697
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## 2757      2817.019 2449.279 3184.759 2254.609 3379.429
## 2758      2818.808 2450.036 3187.579 2254.821 3382.795
## 2759      2820.596 2450.794 3190.398 2255.033 3386.160
## 2760      2822.385 2451.552 3193.218 2255.245 3389.525
## 2761      2824.174 2452.310 3196.037 2255.457 3392.890
## 2762      2825.962 2453.068 3198.856 2255.670 3396.254
## 2763      2827.751 2453.827 3201.675 2255.883 3399.619
## 2764      2829.540 2454.585 3204.494 2256.096 3402.983
## 2765      2831.328 2455.344 3207.313 2256.309 3406.347
## 2766      2833.117 2456.102 3210.132 2256.523 3409.711
## 2767      2834.906 2456.861 3212.950 2256.736 3413.075
## 2768      2836.694 2457.620 3215.769 2256.950 3416.439
## 2769      2838.483 2458.379 3218.587 2257.164 3419.802
## 2770      2840.272 2459.138 3221.405 2257.378 3423.165
## 2771      2842.060 2459.897 3224.224 2257.592 3426.528
## 2772      2843.849 2460.657 3227.042 2257.807 3429.892
## 2773      2845.638 2461.416 3229.860 2258.021 3433.254
## 2774      2847.426 2462.175 3232.678 2258.236 3436.617
## 2775      2849.215 2462.935 3235.495 2258.450 3439.980
## 2776      2851.004 2463.694 3238.313 2258.665 3443.342
## 2777      2852.793 2464.454 3241.131 2258.880 3446.705
## 2778      2854.581 2465.214 3243.949 2259.095 3450.067
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## 2781      2859.947 2467.493 3252.401 2259.741 3460.154
## 2782      2861.736 2468.253 3255.219 2259.956 3463.516
## 2783      2863.525 2469.013 3258.036 2260.172 3466.878
## 2784      2865.313 2469.773 3260.853 2260.387 3470.240
## 2785      2867.102 2470.533 3263.671 2260.603 3473.601
## 2786      2868.891 2471.293 3266.488 2260.818 3476.963
## 2787      2870.679 2472.054 3269.305 2261.034 3480.325
## 2788      2872.468 2472.814 3272.122 2261.249 3483.687
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## 2792      2879.623 2475.854 3283.391 2262.112 3497.133
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## 2795      2884.989 2478.135 3291.842 2262.760 3507.218
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## 2797      2888.566 2479.656 3297.477 2263.191 3513.941
## 2798      2890.355 2480.416 3300.294 2263.407 3517.302
## 2799      2892.144 2481.176 3303.111 2263.623 3520.664
## 2800      2893.932 2481.936 3305.928 2263.839 3524.026
## 2801      2895.721 2482.696 3308.745 2264.054 3527.387
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## 2803      2899.298 2484.217 3314.380 2264.486 3534.111
## 2804      2901.087 2484.977 3317.197 2264.701 3537.473
## 2805      2902.876 2485.737 3320.014 2264.917 3540.834
## 2806      2904.664 2486.497 3322.832 2265.132 3544.196
## 2807      2906.453 2487.257 3325.649 2265.348 3547.558
## 2808      2908.242 2488.017 3328.466 2265.563 3550.920

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## 2809 2910.030 2488.777 3331.284 2265.779 3554.282
## 2810 2911.819 2489.537 3334.101 2265.994 3557.644
## 2811 2913.608 2490.296 3336.919 2266.209 3561.006
## 2812 2915.396 2491.056 3339.736 2266.424 3564.369
## 2813 2917.185 2491.816 3342.554 2266.639 3567.731
## 2814 2918.974 2492.576 3345.372 2266.854 3571.093
## 2815 2920.762 2493.335 3348.190 2267.069 3574.456
## 2816 2922.551 2494.095 3351.007 2267.284 3577.818
## 2817 2924.340 2494.854 3353.825 2267.498 3581.181
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## 2820 2929.706 2497.132 3362.279 2268.142 3591.270
## 2821 2931.495 2497.892 3365.097 2268.356 3594.633
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## 2826 2940.438 2501.686 3379.189 2269.425 3611.450
## 2827 2942.227 2502.445 3382.008 2269.639 3614.814
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## 2829 2945.804 2503.962 3387.646 2270.066 3621.542
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## 2831 2949.381 2505.479 3393.284 2270.491 3628.271
## 2832 2951.170 2506.237 3396.103 2270.704 3631.636
## 2833 2952.959 2506.995 3398.922 2270.917 3635.001
## 2834 2954.747 2507.754 3401.741 2271.129 3638.365
## 2835 2956.536 2508.511 3404.561 2271.342 3641.731
## 2836 2958.325 2509.269 3407.380 2271.554 3645.096
## 2837 2960.113 2510.027 3410.200 2271.766 3648.461
## 2838 2961.902 2510.785 3413.020 2271.977 3651.827
## 2839 2963.691 2511.542 3415.840 2272.189 3655.193
## 2840 2965.479 2512.299 3418.660 2272.400 3658.559
## 2841 2967.268 2513.057 3421.480 2272.611 3661.925
## 2842 2969.057 2513.814 3424.300 2272.823 3665.291
## 2843 2970.846 2514.571 3427.120 2273.033 3668.658
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## 2846 2976.212 2516.841 3435.582 2273.665 3678.758
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## 2854 2990.521 2522.889 3458.153 2275.339 3705.703
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## 2856 2994.098 2524.399 3463.798 2275.755 3712.441
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## 2997.676 2525.909 3469.442 2276.171 3719.181
## 2999.464 2526.664 3472.265 2276.378 3722.551
## 2999.253 2527.418 3475.088 2276.585 3725.921
## 2999.042 2528.173 3477.911 2276.792 3729.291
## 2999.830 2528.927 3480.734 2276.999 3732.662

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## 2863      3006.619 2529.681 3483.557 2277.205 3736.033
## 2864      3008.408 2530.435 3486.381 2277.411 3739.404
## 2865      3010.196 2531.189 3489.204 2277.617 3742.776
## 2866      3011.985 2531.942 3492.028 2277.823 3746.148
## 2867      3013.774 2532.696 3494.852 2278.028 3749.520
## 2868      3015.563 2533.449 3497.676 2278.233 3752.892
## 2869      3017.351 2534.202 3500.501 2278.438 3756.264
## 2870      3019.140 2534.955 3503.325 2278.643 3759.637
## 2871      3020.929 2535.707 3506.150 2278.847 3763.010
## 2872      3022.717 2536.460 3508.975 2279.051 3766.384
## 2873      3024.506 2537.212 3511.800 2279.255 3769.757
## 2874      3026.295 2537.964 3514.625 2279.458 3773.131
## 2875      3028.083 2538.716 3517.450 2279.661 3776.505
## 2876      3029.872 2539.468 3520.276 2279.864 3779.880
## 2877      3031.661 2540.220 3523.102 2280.067 3783.255
## 2878      3033.449 2540.971 3525.927 2280.269 3786.630
## 2879      3035.238 2541.722 3528.754 2280.471 3790.005
## 2880      3037.027 2542.474 3531.580 2280.673 3793.381
## 2881      3038.815 2543.224 3534.406 2280.874 3796.757
## 2882      3040.604 2543.975 3537.233 2281.075 3800.133
## 2883      3042.393 2544.725 3540.060 2281.276 3803.509
## 2884      3044.181 2545.476 3542.887 2281.477 3806.886
## 2885      3045.970 2546.226 3545.714 2281.677 3810.263
## 2886      3047.759 2546.976 3548.542 2281.877 3813.641
## 2887      3049.547 2547.725 3551.370 2282.077 3817.018
## 2888      3051.336 2548.475 3554.198 2282.276 3820.396
## 2889      3053.125 2549.224 3557.026 2282.475 3823.775
## 2890      3054.914 2549.973 3559.854 2282.674 3827.153
## 2891      3056.702 2550.722 3562.683 2282.872 3830.532
## 2892      3058.491 2551.471 3565.511 2283.070 3833.912
## 2893      3060.280 2552.219 3568.340 2283.268 3837.291
## 2894      3062.068 2552.967 3571.169 2283.465 3840.671
## 2895      3063.857 2553.715 3573.999 2283.662 3844.051
## 2896      3065.646 2554.463 3576.828 2283.859 3847.432
## 2897      3067.434 2555.211 3579.658 2284.056 3850.813
## 2898      3069.223 2555.958 3582.488 2284.252 3854.194
## 2899      3071.012 2556.705 3585.318 2284.448 3857.576
## 2900      3072.800 2557.452 3588.149 2284.643 3860.958
## 2901      3074.589 2558.199 3590.979 2284.838 3864.340
## 2902      3076.378 2558.945 3593.810 2285.033 3867.722
## 2903      3078.166 2559.691 3596.641 2285.227 3871.105
## 2904      3079.955 2560.437 3599.473 2285.422 3874.489
## 2905      3081.744 2561.183 3602.304 2285.615 3877.872
## 2906      3083.532 2561.929 3605.136 2285.809 3881.256
## 2907      3085.321 2562.674 3607.968 2286.002 3884.641
## 2908      3087.110 2563.419 3610.800 2286.194 3888.025
## 2909      3088.898 2564.164 3613.633 2286.387 3891.410
## 2910      3090.687 2564.909 3616.465 2286.579 3894.796
## 2911      3092.476 2565.653 3619.298 2286.770 3898.181
## 2912      3094.265 2566.398 3622.131 2286.962 3901.567
## 2913      3096.053 2567.142 3624.965 2287.153 3904.954
## 2914      3097.842 2567.885 3627.798 2287.343 3908.341
## 2915      3099.631 2568.629 3630.632 2287.533 3911.728
## 2916      3101.419 2569.372 3633.466 2287.723 3915.115

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## 2917      3103.208 2570.115 3636.301 2287.913 3918.503
## 2918      3104.997 2570.858 3639.135 2288.102 3921.891
## 2919      3106.785 2571.600 3641.970 2288.291 3925.280
## 2920      3108.574 2572.343 3644.805 2288.479 3928.669
## 2921      3110.363 2573.085 3647.641 2288.667 3932.058
## 2922      3112.151 2573.827 3650.476 2288.855 3935.448
## 2923      3113.940 2574.568 3653.312 2289.042 3938.838
## 2924      3115.729 2575.309 3656.148 2289.229 3942.229
## 2925      3117.517 2576.051 3658.984 2289.415 3945.619
## 2926      3119.306 2576.791 3661.821 2289.601 3949.011
## 2927      3121.095 2577.532 3664.658 2289.787 3952.402
## 2928      3122.883 2578.272 3667.495 2289.973 3955.794
## 2929      3124.672 2579.012 3670.332 2290.158 3959.187
## 2930      3126.461 2579.752 3673.169 2290.342 3962.579
## 2931      3128.249 2580.492 3676.007 2290.526 3965.973
## 2932      3130.038 2581.231 3678.845 2290.710 3969.366
## 2933      3131.827 2581.970 3681.684 2290.894 3972.760
## 2934      3133.616 2582.709 3684.522 2291.077 3976.154
## 2935      3135.404 2583.447 3687.361 2291.259 3979.549
## 2936      3137.193 2584.186 3690.200 2291.441 3982.944
## 2937      3138.982 2584.924 3693.039 2291.623 3986.340
## 2938      3140.770 2585.662 3695.879 2291.805 3989.736
## 2939      3142.559 2586.399 3698.719 2291.986 3993.132
## 2940      3144.348 2587.136 3701.559 2292.166 3996.529
## 2941      3146.136 2587.873 3704.399 2292.347 3999.926
## 2942      3147.925 2588.610 3707.240 2292.527 4003.323
## 2943      3149.714 2589.346 3710.081 2292.706 4006.721
## 2944      3151.502 2590.083 3712.922 2292.885 4010.120
## 2945      3153.291 2590.819 3715.763 2293.064 4013.518
## 2946      3155.080 2591.554 3718.605 2293.242 4016.918
## 2947      3156.868 2592.290 3721.447 2293.420 4020.317
## 2948      3158.657 2593.025 3724.289 2293.597 4023.717
## 2949      3160.446 2593.760 3727.132 2293.774 4027.117
## 2950      3162.234 2594.494 3729.975 2293.951 4030.518
## 2951      3164.023 2595.228 3732.818 2294.127 4033.919
## 2952      3165.812 2595.962 3735.661 2294.302 4037.321
## 2953      3167.600 2596.696 3738.505 2294.478 4040.723
## 2954      3169.389 2597.430 3741.349 2294.653 4044.126
## 2955      3171.178 2598.163 3744.193 2294.827 4047.529
## 2956      3172.967 2598.896 3747.037 2295.001 4050.932
## 2957      3174.755 2599.629 3749.882 2295.175 4054.336
## 2958      3176.544 2600.361 3752.727 2295.348 4057.740
## 2959      3178.333 2601.093 3755.572 2295.521 4061.144
## 2960      3180.121 2601.825 3758.418 2295.693 4064.549
## 2961      3181.910 2602.556 3761.263 2295.865 4067.955
## 2962      3183.699 2603.288 3764.110 2296.037 4071.361
## 2963      3185.487 2604.019 3766.956 2296.208 4074.767
## 2964      3187.276 2604.749 3769.803 2296.378 4078.174
## 2965      3189.065 2605.480 3772.650 2296.549 4081.581
## 2966      3190.853 2606.210 3775.497 2296.718 4084.988
## 2967      3192.642 2606.940 3778.344 2296.888 4088.396
## 2968      3194.431 2607.669 3781.192 2297.057 4091.805
## 2969      3196.219 2608.399 3784.040 2297.225 4095.214
## 2970      3198.008 2609.128 3786.889 2297.393 4098.623

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## 2971      3199.797 2609.856 3789.737 2297.561 4102.033
## 2972      3201.585 2610.585 3792.586 2297.728 4105.443
## 2973      3203.374 2611.313 3795.435 2297.894 4108.854
## 2974      3205.163 2612.041 3798.285 2298.061 4112.265
## 2975      3206.951 2612.768 3801.135 2298.226 4115.676
## 2976      3208.740 2613.495 3803.985 2298.392 4119.088
## 2977      3210.529 2614.222 3806.835 2298.557 4122.501
## 2978      3212.318 2614.949 3809.686 2298.721 4125.914
## 2979      3214.106 2615.675 3812.537 2298.885 4129.327
## 2980      3215.895 2616.401 3815.388 2299.049 4132.741
## 2981      3217.684 2617.127 3818.240 2299.212 4136.155
## 2982      3219.472 2617.853 3821.092 2299.375 4139.570
## 2983      3221.261 2618.578 3823.944 2299.537 4142.985
## 2984      3223.050 2619.303 3826.796 2299.699 4146.401
## 2985      3224.838 2620.027 3829.649 2299.860 4149.817
## 2986      3226.627 2620.752 3832.502 2300.021 4153.233
## 2987      3228.416 2621.476 3835.355 2300.181 4156.650
## 2988      3230.204 2622.200 3838.209 2300.341 4160.067
## 2989      3231.993 2622.923 3841.063 2300.501 4163.485
## 2990      3233.782 2623.646 3843.917 2300.660 4166.904
## 2991      3235.570 2624.369 3846.772 2300.818 4170.322
## 2992      3237.359 2625.091 3849.627 2300.976 4173.742
## 2993      3239.148 2625.814 3852.482 2301.134 4177.161
## 2994      3240.936 2626.535 3855.337 2301.291 4180.582
## 2995      3242.725 2627.257 3858.193 2301.448 4184.002
## 2996      3244.514 2627.978 3861.049 2301.604 4187.423
## 2997      3246.302 2628.699 3863.906 2301.760 4190.845
## 2998      3248.091 2629.420 3866.762 2301.915 4194.267
## 2999      3249.880 2630.140 3869.619 2302.070 4197.689
## 3000      3251.669 2630.861 3872.476 2302.225 4201.112
## 3001      3253.457 2631.580 3875.334 2302.379 4204.536
## 3002      3255.246 2632.300 3878.192 2302.532 4207.960
## 3003      3257.035 2633.019 3881.050 2302.685 4211.384
## 3004      3258.823 2633.738 3883.909 2302.838 4214.809
## 3005      3260.612 2634.456 3886.768 2302.990 4218.234
## 3006      3262.401 2635.175 3889.627 2303.141 4221.660
## 3007      3264.189 2635.892 3892.486 2303.292 4225.086
## 3008      3265.978 2636.610 3895.346 2303.443 4228.513
## 3009      3267.767 2637.327 3898.206 2303.593 4231.940
## 3010      3269.555 2638.044 3901.066 2303.743 4235.368
## 3011      3271.344 2638.761 3903.927 2303.892 4238.796
## 3012      3273.133 2639.477 3906.788 2304.041 4242.225
## 3013      3274.921 2640.193 3909.649 2304.189 4245.654
## 3014      3276.710 2640.909 3912.511 2304.337 4249.084
## 3015      3278.499 2641.625 3915.373 2304.484 4252.514
## 3016      3280.287 2642.340 3918.235 2304.631 4255.944
## 3017      3282.076 2643.055 3921.098 2304.777 4259.375
## 3018      3283.865 2643.769 3923.961 2304.923 4262.807
## 3019      3285.653 2644.483 3926.824 2305.068 4266.239
## 3020      3287.442 2645.197 3929.687 2305.213 4269.671
## 3021      3289.231 2645.911 3932.551 2305.357 4273.104
## 3022      3291.020 2646.624 3935.415 2305.501 4276.538
## 3023      3292.808 2647.337 3938.280 2305.645 4279.972
## 3024      3294.597 2648.049 3941.145 2305.788 4283.406

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## 3025      3296.386 2648.761 3944.010 2305.930 4286.841
## 3026      3298.174 2649.473 3946.875 2306.072 4290.277
## 3027      3299.963 2650.185 3949.741 2306.213 4293.712
## 3028      3301.752 2650.896 3952.607 2306.354 4297.149
## 3029      3303.540 2651.607 3955.473 2306.495 4300.586
## 3030      3305.329 2652.318 3958.340 2306.635 4304.023
## 3031      3307.118 2653.028 3961.207 2306.774 4307.461
## 3032      3308.906 2653.738 3964.074 2306.913 4310.899
## 3033      3310.695 2654.448 3966.942 2307.052 4314.338
## 3034      3312.484 2655.157 3969.810 2307.190 4317.778
## 3035      3314.272 2655.866 3972.678 2307.327 4321.218
## 3036      3316.061 2656.575 3975.547 2307.464 4324.658
## 3037      3317.850 2657.283 3978.416 2307.601 4328.099
## 3038      3319.638 2657.991 3981.285 2307.737 4331.540
## 3039      3321.427 2658.699 3984.155 2307.872 4334.982
## 3040      3323.216 2659.407 3987.025 2308.007 4338.424
## 3041      3325.004 2660.114 3989.895 2308.142 4341.867
## 3042      3326.793 2660.820 3992.766 2308.276 4345.310
## 3043      3328.582 2661.527 3995.637 2308.409 4348.754
## 3044      3330.370 2662.233 3998.508 2308.542 4352.199
## 3045      3332.159 2662.939 4001.380 2308.675 4355.643
## 3046      3333.948 2663.644 4004.252 2308.807 4359.089
## 3047      3335.737 2664.349 4007.124 2308.938 4362.535
## 3048      3337.525 2665.054 4009.996 2309.069 4365.981
## 3049      3339.314 2665.759 4012.869 2309.200 4369.428
## 3050      3341.103 2666.463 4015.742 2309.330 4372.875
## 3051      3342.891 2667.167 4018.616 2309.459 4376.323
## 3052      3344.680 2667.870 4021.490 2309.588 4379.771
## 3053      3346.469 2668.573 4024.364 2309.717 4383.220
## 3054      3348.257 2669.276 4027.239 2309.845 4386.670
## 3055      3350.046 2669.978 4030.114 2309.972 4390.120
## 3056      3351.835 2670.681 4032.989 2310.099 4393.570
## 3057      3353.623 2671.382 4035.864 2310.226 4397.021
## 3058      3355.412 2672.084 4038.740 2310.352 4400.472
## 3059      3357.201 2672.785 4041.616 2310.477 4403.924
## 3060      3358.989 2673.486 4044.493 2310.602 4407.377
## 3061      3360.778 2674.186 4047.370 2310.726 4410.830
## 3062      3362.567 2674.886 4050.247 2310.850 4414.283
## 3063      3364.355 2675.586 4053.125 2310.974 4417.737
## 3064      3366.144 2676.286 4056.003 2311.097 4421.192
## 3065      3367.933 2676.985 4058.881 2311.219 4424.647
## 3066      3369.721 2677.684 4061.759 2311.341 4428.102
## 3067      3371.510 2678.382 4064.638 2311.462 4431.558
## 3068      3373.299 2679.080 4067.518 2311.583 4435.015
## 3069      3375.088 2679.778 4070.397 2311.703 4438.472
## 3070      3376.876 2680.475 4073.277 2311.823 4441.929
## 3071      3378.665 2681.173 4076.157 2311.942 4445.387
## 3072      3380.454 2681.869 4079.038 2312.061 4448.846
## 3073      3382.242 2682.566 4081.919 2312.179 4452.305
## 3074      3384.031 2683.262 4084.800 2312.297 4455.765
## 3075      3385.820 2683.958 4087.682 2312.414 4459.225
## 3076      3387.608 2684.653 4090.564 2312.531 4462.686
## 3077      3389.397 2685.348 4093.446 2312.647 4466.147
## 3078      3391.186 2686.043 4096.329 2312.763 4469.609

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## 3079      3392.974 2686.737 4099.211 2312.878 4473.071
## 3080      3394.763 2687.431 4102.095 2312.992 4476.534
## 3081      3396.552 2688.125 4104.978 2313.107 4479.997
## 3082      3398.340 2688.818 4107.862 2313.220 4483.461
## 3083      3400.129 2689.511 4110.747 2313.333 4486.925
## 3084      3401.918 2690.204 4113.631 2313.446 4490.390
## 3085      3403.706 2690.896 4116.516 2313.558 4493.855
## 3086      3405.495 2691.588 4119.402 2313.669 4497.321
## 3087      3407.284 2692.280 4122.287 2313.780 4500.788
## 3088      3409.072 2692.971 4125.173 2313.891 4504.254
## 3089      3410.861 2693.662 4128.060 2314.000 4507.722
## 3090      3412.650 2694.353 4130.947 2314.110 4511.190
## 3091      3414.439 2695.043 4133.834 2314.219 4514.658
## 3092      3416.227 2695.733 4136.721 2314.327 4518.127
## 3093      3418.016 2696.423 4139.609 2314.435 4521.597
## 3094      3419.805 2697.112 4142.497 2314.542 4525.067
## 3095      3421.593 2697.801 4145.385 2314.649 4528.538
## 3096      3423.382 2698.490 4148.274 2314.755 4532.009
## 3097      3425.171 2699.178 4151.163 2314.861 4535.481
## 3098      3426.959 2699.866 4154.053 2314.966 4538.953
## 3099      3428.748 2700.553 4156.943 2315.070 4542.426
## 3100      3430.537 2701.241 4159.833 2315.174 4545.899
## 3101      3432.325 2701.927 4162.723 2315.278 4549.373
## 3102      3434.114 2702.614 4165.614 2315.381 4552.847
## 3103      3435.903 2703.300 4168.505 2315.484 4556.322
## 3104      3437.691 2703.986 4171.397 2315.586 4559.797
## 3105      3439.480 2704.671 4174.289 2315.687 4563.273
## 3106      3441.269 2705.356 4177.181 2315.788 4566.750
## 3107      3443.057 2706.041 4180.074 2315.888 4570.227
## 3108      3444.846 2706.726 4182.967 2315.988 4573.704
## 3109      3446.635 2707.410 4185.860 2316.087 4577.182
## 3110      3448.423 2708.093 4188.754 2316.186 4580.661
## 3111      3450.212 2708.777 4191.648 2316.284 4584.140
## 3112      3452.001 2709.460 4194.542 2316.382 4587.620
## 3113      3453.790 2710.142 4197.437 2316.479 4591.100
## 3114      3455.578 2710.825 4200.332 2316.576 4594.580
## 3115      3457.367 2711.507 4203.227 2316.672 4598.062
## 3116      3459.156 2712.188 4206.123 2316.768 4601.544
## 3117      3460.944 2712.870 4209.019 2316.863 4605.026
## 3118      3462.733 2713.550 4211.915 2316.957 4608.509
## 3119      3464.522 2714.231 4214.812 2317.051 4611.992
## 3120      3466.310 2714.911 4217.709 2317.145 4615.476
## 3121      3468.099 2715.591 4220.607 2317.237 4618.961
## 3122      3469.888 2716.271 4223.505 2317.330 4622.446
## 3123      3471.676 2716.950 4226.403 2317.422 4625.931
## 3124      3473.465 2717.629 4229.302 2317.513 4629.417
## 3125      3475.254 2718.307 4232.200 2317.604 4632.904
## 3126      3477.042 2718.985 4235.100 2317.694 4636.391
## 3127      3478.831 2719.663 4237.999 2317.783 4639.879
## 3128      3480.620 2720.340 4240.899 2317.873 4643.367
## 3129      3482.408 2721.017 4243.800 2317.961 4646.856
## 3130      3484.197 2721.694 4246.700 2318.049 4650.345
## 3131      3485.986 2722.370 4249.601 2318.137 4653.835
## 3132      3487.774 2723.046 4252.503 2318.224 4657.325

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## 3133      3489.563 2723.722 4255.404 2318.310 4660.816
## 3134      3491.352 2724.397 4258.307 2318.396 4664.308
## 3135      3493.141 2725.072 4261.209 2318.481 4667.800
## 3136      3494.929 2725.747 4264.112 2318.566 4671.292
## 3137      3496.718 2726.421 4267.015 2318.650 4674.786
## 3138      3498.507 2727.095 4269.918 2318.734 4678.279
## 3139      3500.295 2727.768 4272.822 2318.817 4681.773
## 3140      3502.084 2728.441 4275.727 2318.900 4685.268
## 3141      3503.873 2729.114 4278.631 2318.982 4688.764
## 3142      3505.661 2729.787 4281.536 2319.063 4692.259
## 3143      3507.450 2730.459 4284.441 2319.144 4695.756
## 3144      3509.239 2731.130 4287.347 2319.225 4699.253
## 3145      3511.027 2731.802 4290.253 2319.304 4702.750
## 3146      3512.816 2732.473 4293.159 2319.384 4706.248
## 3147      3514.605 2733.143 4296.066 2319.463 4709.747
## 3148      3516.393 2733.814 4298.973 2319.541 4713.246
## 3149      3518.182 2734.484 4301.881 2319.619 4716.746
## 3150      3519.971 2735.153 4304.788 2319.696 4720.246
## 3151      3521.759 2735.822 4307.697 2319.772 4723.746
## 3152      3523.548 2736.491 4310.605 2319.848 4727.248
## 3153      3525.337 2737.160 4313.514 2319.924 4730.750
## 3154      3527.125 2737.828 4316.423 2319.999 4734.252
## 3155      3528.914 2738.496 4319.333 2320.073 4737.755
## 3156      3530.703 2739.163 4322.243 2320.147 4741.258
## 3157      3532.492 2739.830 4325.153 2320.221 4744.763
## 3158      3534.280 2740.497 4328.064 2320.293 4748.267
## 3159      3536.069 2741.163 4330.975 2320.366 4751.772
## 3160      3537.858 2741.829 4333.886 2320.437 4755.278
## 3161      3539.646 2742.495 4336.798 2320.508 4758.784
## 3162      3541.435 2743.160 4339.710 2320.579 4762.291
## 3163      3543.224 2743.825 4342.622 2320.649 4765.798
## 3164      3545.012 2744.490 4345.535 2320.718 4769.306
## 3165      3546.801 2745.154 4348.448 2320.787 4772.815
## 3166      3548.590 2745.818 4351.362 2320.856 4776.324
## 3167      3550.378 2746.481 4354.276 2320.924 4779.833
## 3168      3552.167 2747.144 4357.190 2320.991 4783.343
## 3169      3553.956 2747.807 4360.104 2321.058 4786.854
## 3170      3555.744 2748.469 4363.019 2321.124 4790.365
## 3171      3557.533 2749.131 4365.935 2321.189 4793.877
## 3172      3559.322 2749.793 4368.850 2321.254 4797.389
## 3173      3561.110 2750.454 4371.766 2321.319 4800.902
## 3174      3562.899 2751.115 4374.683 2321.383 4804.415
## 3175      3564.688 2751.776 4377.600 2321.446 4807.929
## 3176      3566.476 2752.436 4380.517 2321.509 4811.444
## 3177      3568.265 2753.096 4383.434 2321.572 4814.959
## 3178      3570.054 2753.756 4386.352 2321.633 4818.474
## 3179      3571.843 2754.415 4389.270 2321.695 4821.991
## 3180      3573.631 2755.073 4392.189 2321.755 4825.507
## 3181      3575.420 2755.732 4395.108 2321.815 4829.024
## 3182      3577.209 2756.390 4398.027 2321.875 4832.542
## 3183      3578.997 2757.048 4400.947 2321.934 4836.061
## 3184      3580.786 2757.705 4403.867 2321.992 4839.580
## 3185      3582.575 2758.362 4406.787 2322.050 4843.099
## 3186      3584.363 2759.019 4409.708 2322.107 4846.619

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## 3187      3586.152 2759.675 4412.629 2322.164 4850.140
## 3188      3587.941 2760.331 4415.551 2322.220 4853.661
## 3189      3589.729 2760.986 4418.472 2322.276 4857.183
## 3190      3591.518 2761.641 4421.395 2322.331 4860.705
## 3191      3593.307 2762.296 4424.317 2322.386 4864.228
## 3192      3595.095 2762.951 4427.240 2322.440 4867.751
## 3193      3596.884 2763.605 4430.163 2322.493 4871.275
## 3194      3598.673 2764.258 4433.087 2322.546 4874.799
## 3195      3600.461 2764.912 4436.011 2322.598 4878.324
## 3196      3602.250 2765.565 4438.936 2322.650 4881.850
## 3197      3604.039 2766.217 4441.860 2322.701 4885.376
## 3198      3605.827 2766.870 4444.785 2322.752 4888.903
## 3199      3607.616 2767.521 4447.711 2322.802 4892.430
## 3200      3609.405 2768.173 4450.637 2322.852 4895.958
## 3201      3611.194 2768.824 4453.563 2322.901 4899.486
## 3202      3612.982 2769.475 4456.490 2322.949 4903.015
## 3203      3614.771 2770.125 4459.416 2322.997 4906.545
## 3204      3616.560 2770.775 4462.344 2323.044 4910.075
## 3205      3618.348 2771.425 4465.271 2323.091 4913.605
## 3206      3620.137 2772.074 4468.199 2323.137 4917.137
## 3207      3621.926 2772.723 4471.128 2323.183 4920.668
## 3208      3623.714 2773.372 4474.057 2323.228 4924.201
## 3209      3625.503 2774.020 4476.986 2323.272 4927.734
## 3210      3627.292 2774.668 4479.915 2323.316 4931.267
## 3211      3629.080 2775.316 4482.845 2323.360 4934.801
## 3212      3630.869 2775.963 4485.775 2323.403 4938.335
## 3213      3632.658 2776.609 4488.706 2323.445 4941.871
## 3214      3634.446 2777.256 4491.637 2323.487 4945.406
## 3215      3636.235 2777.902 4494.568 2323.528 4948.942
## 3216      3638.024 2778.548 4497.500 2323.568 4952.479
## 3217      3639.812 2779.193 4500.432 2323.608 4956.016
## 3218      3641.601 2779.838 4503.364 2323.648 4959.554
## 3219      3643.390 2780.482 4506.297 2323.687 4963.093
## 3220      3645.178 2781.127 4509.230 2323.725 4966.632
## 3221      3646.967 2781.770 4512.164 2323.763 4970.171
## 3222      3648.756 2782.414 4515.098 2323.800 4973.711
## 3223      3650.545 2783.057 4518.032 2323.837 4977.252
## 3224      3652.333 2783.700 4520.967 2323.873 4980.793
## 3225      3654.122 2784.342 4523.902 2323.909 4984.335
## 3226      3655.911 2784.984 4526.837 2323.944 4987.878
## 3227      3657.699 2785.626 4529.773 2323.978 4991.421
## 3228      3659.488 2786.267 4532.709 2324.012 4994.964
## 3229      3661.277 2786.908 4535.645 2324.045 4998.508
## 3230      3663.065 2787.548 4538.582 2324.078 5002.053
## 3231      3664.854 2788.189 4541.519 2324.110 5005.598
## 3232      3666.643 2788.828 4544.457 2324.142 5009.144
## 3233      3668.431 2789.468 4547.395 2324.173 5012.690
## 3234      3670.220 2790.107 4550.333 2324.203 5016.237
## 3235      3672.009 2790.746 4553.272 2324.233 5019.784
## 3236      3673.797 2791.384 4556.211 2324.263 5023.332
## 3237      3675.586 2792.022 4559.150 2324.291 5026.881
## 3238      3677.375 2792.660 4562.090 2324.320 5030.430
## 3239      3679.163 2793.297 4565.030 2324.347 5033.980
## 3240      3680.952 2793.934 4567.971 2324.374 5037.530

```

```

## 3241      3682.741 2794.570 4570.911 2324.401 5041.081
## 3242      3684.529 2795.206 4573.853 2324.427 5044.632
## 3243      3686.318 2795.842 4576.794 2324.452 5048.184
## 3244      3688.107 2796.477 4579.736 2324.477 5051.736
## 3245      3689.895 2797.112 4582.679 2324.502 5055.289
## 3246      3691.684 2797.747 4585.621 2324.525 5058.843

```

#3) Google

```
class(GOOG)
```

```
## [1] "xts" "zoo"
```

```
GOOG_close_price <- (GOOG[,4])
plot((GOOG_close_price))
```



```
class(GOOG_close_price)
```

```
## [1] "xts" "zoo"
```

```
print(adf.test(GOOG_close_price)) #P-value < 0.05 indicates stationary data
```

```
##
```

```

##  Augmented Dickey-Fuller Test
##
## data: GOOG_close_price
## Dickey-Fuller = -3.6475, Lag order = 13, p-value = 0.02809
## alternative hypothesis: stationary

auto.arima(GOOG_close_price, seasonal = FALSE)

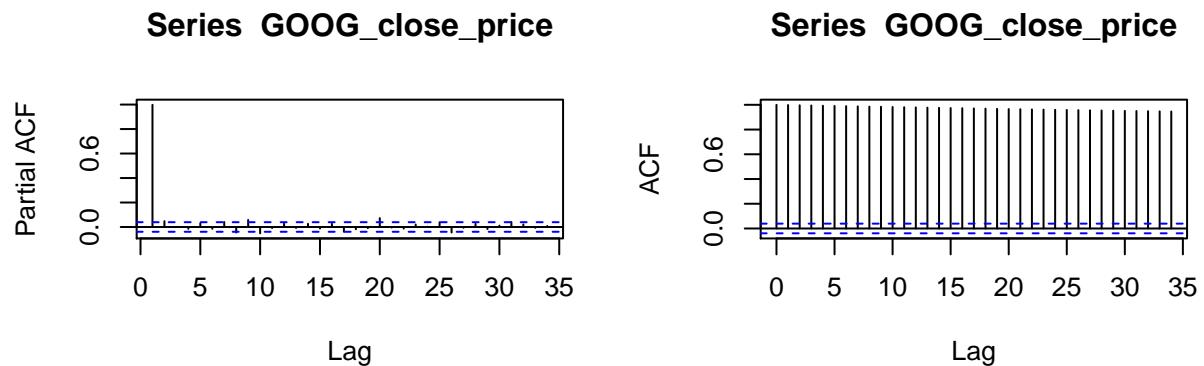
## Series: GOOG_close_price
## ARIMA(0,1,1) with drift
##
## Coefficients:
##             ma1     drift
##           -0.1210  0.4663
## s.e.    0.0194  0.2285
##
## sigma^2 estimated as 170: log likelihood=-10025.93
## AIC=20057.87   AICc=20057.88   BIC=20075.36

par(mfrow = c(2,2))
pacf(GOOG_close_price)
acf(GOOG_close_price)

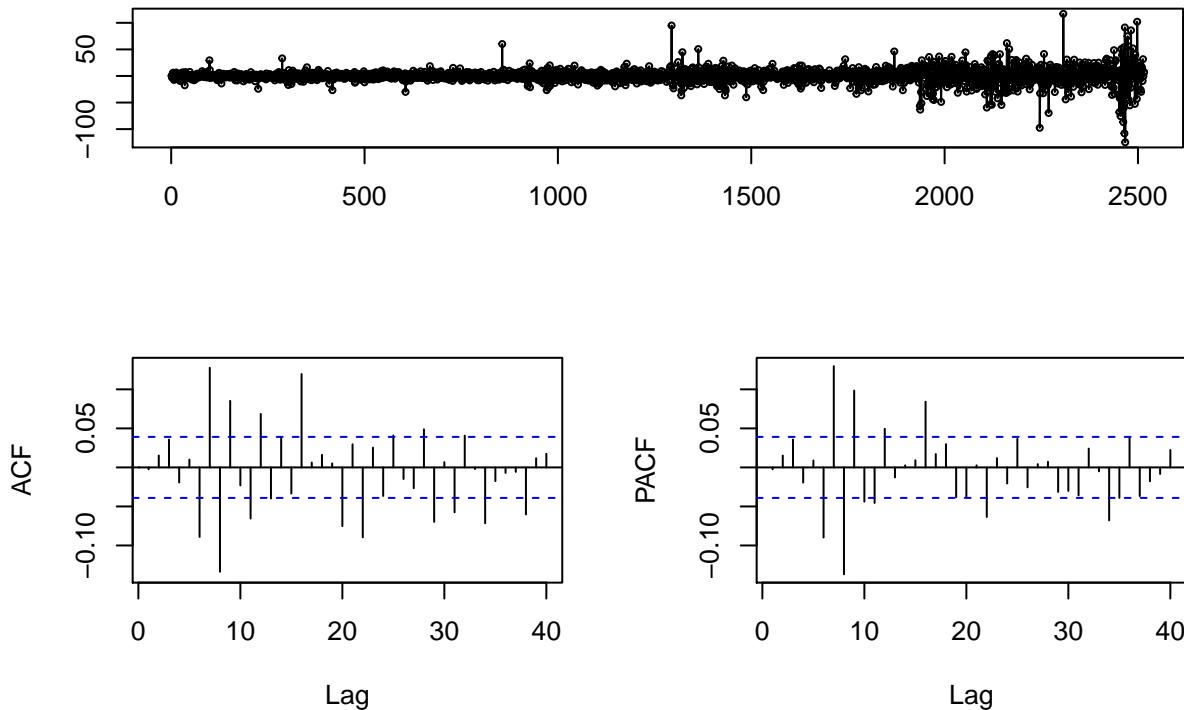
#Trying different fits

fitA = auto.arima(GOOG_close_price, seasonal = FALSE)
tsdisplay(residuals(fitA), lag.max = 40, main = '0,1,1 Model Residuals')

```



0,1,1 Model Residuals

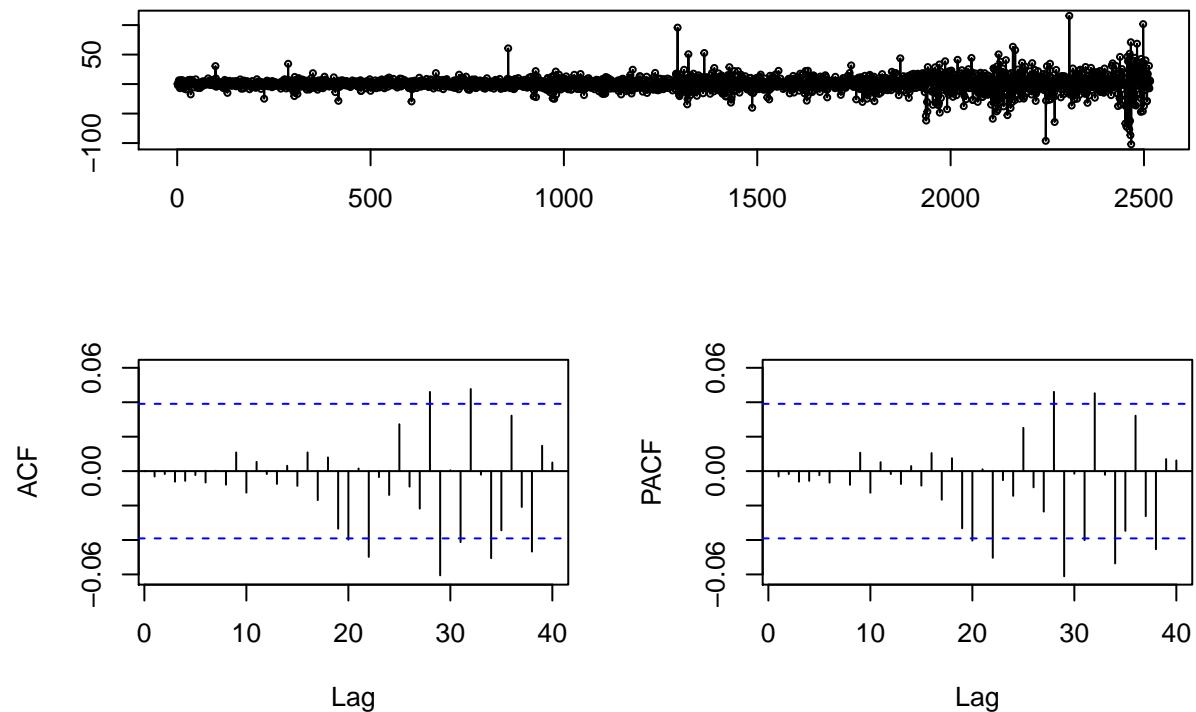


```
auto.arima(GOOG_close_price, seasonal = FALSE)

## Series: GOOG_close_price
## ARIMA(0,1,1) with drift
##
## Coefficients:
##          ma1    drift
##        -0.1210  0.4663
##  s.e.   0.0194  0.2285
##
## sigma^2 estimated as 170: log likelihood=-10025.93
## AIC=20057.87   AICc=20057.88   BIC=20075.36

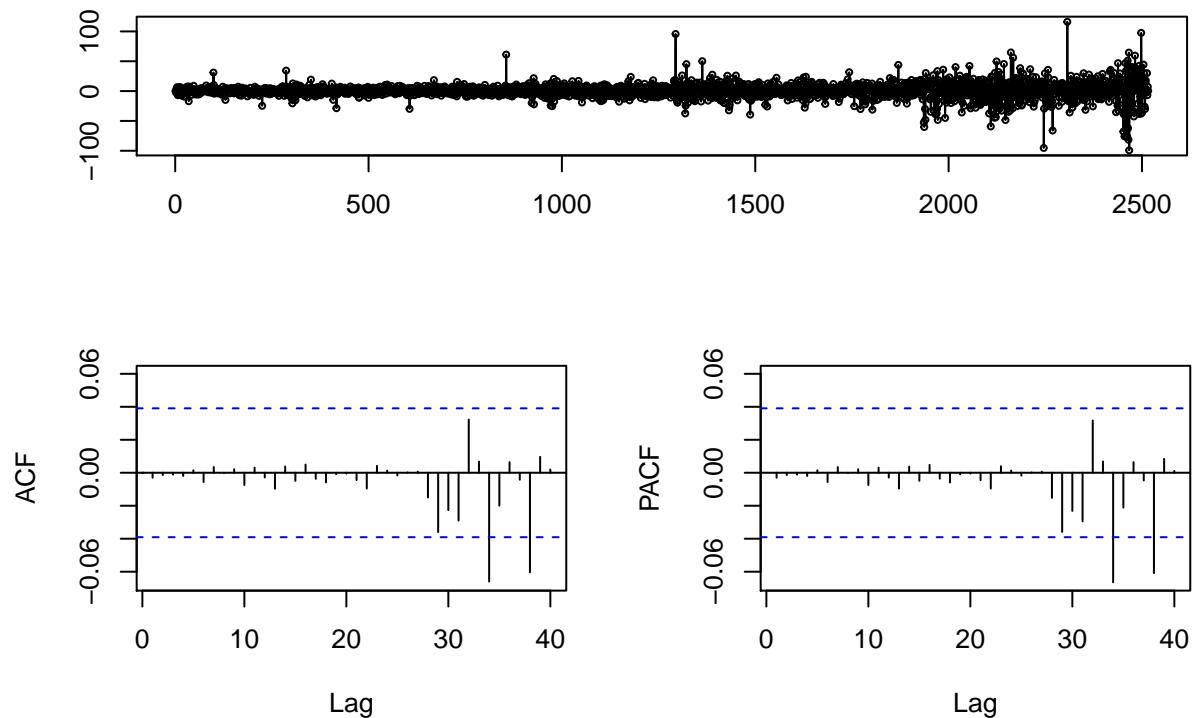
fitB = arima(GOOG_close_price, order = c(1,1,19))
tsdisplay(residuals(fitB), lag.max = 40, main = '(1,1,19) Model Residuals')
```

(1,1,19) Model Residuals



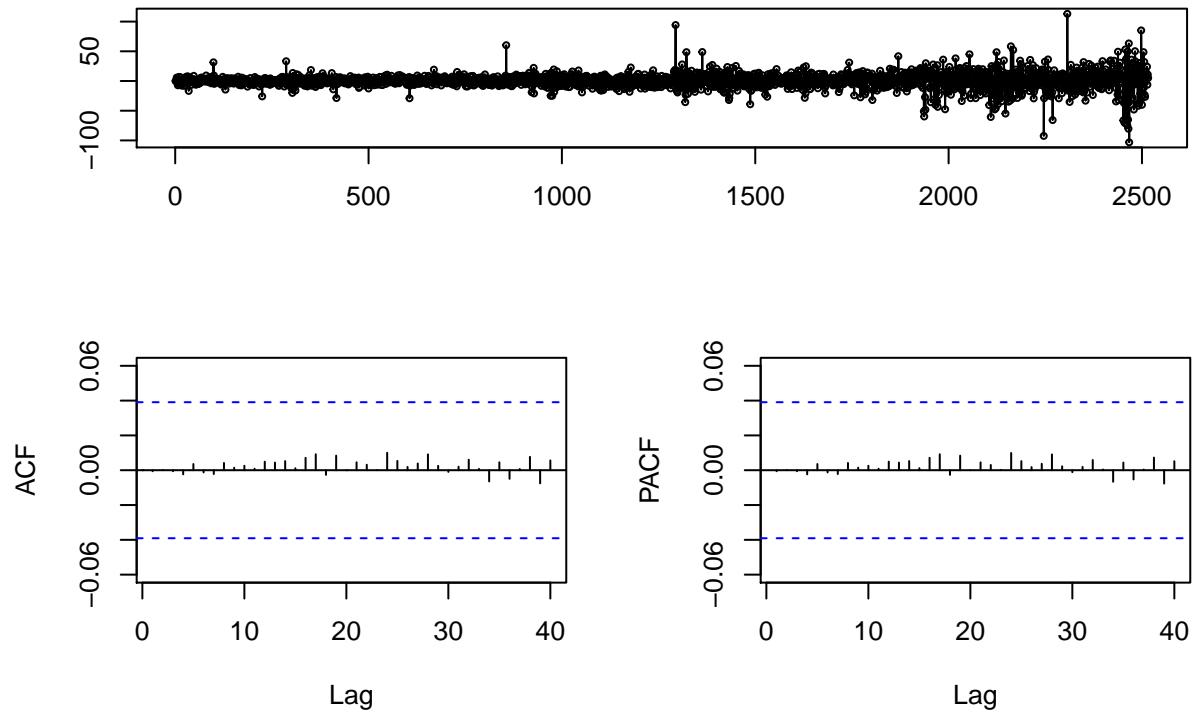
```
fitC = arima(GOOG_close_price, order = c(1,1,28))
tsdisplay(residuals(fitC), lag.max = 40, main = '(1,1,28) Model Residuals')
```

(1,1,28) Model Residuals



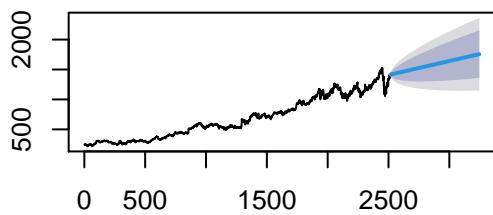
```
fitD = arima(GOOG_close_price, order = c(1,2,40))
tsdisplay(residuals(fitD), lag.max = 40, main = '(1,2,40) Model Residuals')
```

(1,2,40) Model Residuals

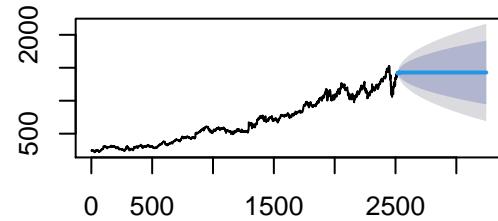


```
par(mfrow = c(2,2))
term <- 730
fcast1 <- forecast(fitA, h = term)
plot(fcast1)
fcast2 <- forecast(fitB, h = term)
plot(fcast2)
fcast3 <- forecast(fitC, h = term)
plot(fcast3)
fcast4 <- forecast(fitD, h = term)
plot(fcast4)
```

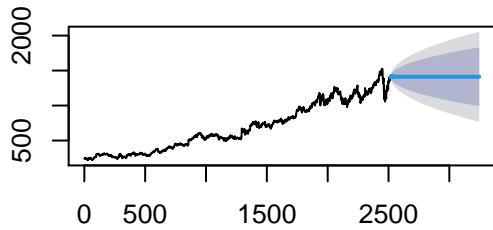
Forecasts from ARIMA(0,1,1) with drift



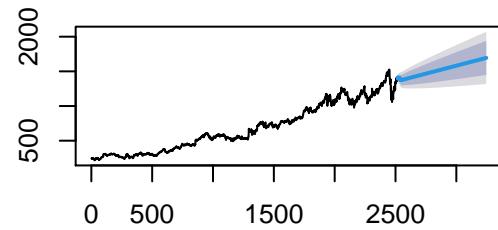
Forecasts from ARIMA(1,1,19)



Forecasts from ARIMA(1,1,28)



Forecasts from ARIMA(1,2,40)



```
print(fcast4)
```

```
##      Point Forecast     Lo 80     Hi 80     Lo 95     Hi 95
## 2517    1405.057 1389.173 1420.941 1380.765 1429.349
## 2518    1410.976 1389.308 1432.644 1377.837 1444.115
## 2519    1407.811 1381.806 1433.816 1368.040 1447.582
## 2520    1409.917 1379.843 1439.991 1363.923 1455.910
## 2521    1401.559 1368.076 1435.043 1350.350 1452.768
## 2522    1406.975 1370.413 1443.536 1351.059 1462.891
## 2523    1410.135 1371.159 1449.110 1350.527 1469.743
## 2524    1396.256 1354.327 1438.185 1332.132 1460.381
## 2525    1397.105 1353.129 1441.082 1329.850 1464.361
## 2526    1399.631 1353.407 1445.855 1328.937 1470.325
## 2527    1403.348 1355.017 1451.679 1329.432 1477.264
## 2528    1392.548 1342.583 1442.514 1316.132 1468.965
## 2529    1401.252 1349.433 1453.071 1322.002 1480.503
## 2530    1402.777 1349.347 1456.208 1321.062 1484.492
## 2531    1403.695 1348.651 1458.738 1319.513 1487.876
## 2532    1398.781 1342.286 1455.277 1312.379 1485.184
## 2533    1386.412 1328.165 1444.659 1297.331 1475.493
## 2534    1398.568 1338.603 1458.532 1306.859 1490.276
## 2535    1390.892 1329.258 1452.525 1296.632 1485.152
## 2536    1384.969 1321.717 1448.221 1288.233 1481.705
## 2537    1385.807 1321.244 1450.370 1287.067 1484.548
## 2538    1389.663 1323.734 1455.593 1288.833 1490.493
```

```

## 2539 1384.465 1317.462 1451.469 1281.993 1486.938
## 2540 1381.735 1313.628 1449.841 1277.574 1485.895
## 2541 1383.165 1314.122 1452.208 1277.573 1488.758
## 2542 1379.244 1309.179 1449.309 1272.088 1486.400
## 2543 1382.798 1311.806 1453.789 1274.225 1491.370
## 2544 1376.249 1304.436 1448.063 1266.421 1486.078
## 2545 1380.741 1307.999 1453.482 1269.492 1491.989
## 2546 1380.848 1307.411 1454.286 1268.535 1493.162
## 2547 1377.789 1303.635 1451.944 1264.380 1491.199
## 2548 1377.382 1302.647 1452.116 1263.085 1491.679
## 2549 1377.621 1302.227 1453.015 1262.315 1492.926
## 2550 1376.648 1300.619 1452.676 1260.372 1492.923
## 2551 1375.407 1298.875 1451.938 1258.362 1492.452
## 2552 1377.357 1300.368 1454.346 1259.613 1495.101
## 2553 1376.469 1298.999 1453.940 1257.988 1494.951
## 2554 1376.969 1299.035 1454.903 1257.779 1496.159
## 2555 1377.593 1299.336 1455.849 1257.909 1497.276
## 2556 1378.037 1299.397 1456.677 1257.768 1498.307
## 2557 1378.497 1299.481 1457.513 1257.653 1499.342
## 2558 1378.956 1299.565 1458.347 1257.537 1500.375
## 2559 1379.415 1299.650 1459.180 1257.425 1501.405
## 2560 1379.874 1299.736 1460.011 1257.314 1502.433
## 2561 1380.332 1299.824 1460.841 1257.205 1503.459
## 2562 1380.791 1299.913 1461.669 1257.099 1504.484
## 2563 1381.250 1300.004 1462.496 1256.994 1505.506
## 2564 1381.709 1300.096 1463.322 1256.892 1506.525
## 2565 1382.168 1300.189 1464.146 1256.792 1507.543
## 2566 1382.626 1300.283 1464.970 1256.693 1508.559
## 2567 1383.085 1300.379 1465.791 1256.597 1509.573
## 2568 1383.544 1300.476 1466.612 1256.503 1510.585
## 2569 1384.003 1300.574 1467.431 1256.410 1511.596
## 2570 1384.462 1300.674 1468.249 1256.319 1512.604
## 2571 1384.920 1300.775 1469.066 1256.230 1513.610
## 2572 1385.379 1300.877 1469.882 1256.143 1514.615
## 2573 1385.838 1300.980 1470.696 1256.058 1515.618
## 2574 1386.297 1301.084 1471.510 1255.975 1516.619
## 2575 1386.756 1301.189 1472.322 1255.893 1517.618
## 2576 1387.214 1301.296 1473.133 1255.813 1518.615
## 2577 1387.673 1301.404 1473.943 1255.735 1519.611
## 2578 1388.132 1301.512 1474.752 1255.659 1520.605
## 2579 1388.591 1301.622 1475.559 1255.584 1521.598
## 2580 1389.050 1301.733 1476.366 1255.511 1522.588
## 2581 1389.508 1301.845 1477.171 1255.439 1523.577
## 2582 1389.967 1301.959 1477.976 1255.370 1524.565
## 2583 1390.426 1302.073 1478.779 1255.301 1525.551
## 2584 1390.885 1302.188 1479.582 1255.235 1526.535
## 2585 1391.344 1302.304 1480.383 1255.170 1527.518
## 2586 1391.802 1302.421 1481.183 1255.106 1528.499
## 2587 1392.261 1302.540 1481.983 1255.044 1529.478
## 2588 1392.720 1302.659 1482.781 1254.984 1530.457
## 2589 1393.179 1302.779 1483.578 1254.925 1531.433
## 2590 1393.638 1302.900 1484.375 1254.867 1532.408
## 2591 1394.096 1303.023 1485.170 1254.811 1533.382
## 2592 1394.555 1303.146 1485.965 1254.756 1534.354

```

```

## 2593 1395.014 1303.270 1486.758 1254.703 1535.325
## 2594 1395.473 1303.395 1487.551 1254.651 1536.294
## 2595 1395.932 1303.520 1488.343 1254.601 1537.262
## 2596 1396.390 1303.647 1489.134 1254.552 1538.229
## 2597 1396.849 1303.775 1489.924 1254.504 1539.194
## 2598 1397.308 1303.903 1490.713 1254.458 1540.158
## 2599 1397.767 1304.033 1491.501 1254.413 1541.121
## 2600 1398.226 1304.163 1492.288 1254.370 1542.082
## 2601 1398.684 1304.294 1493.075 1254.327 1543.042
## 2602 1399.143 1304.426 1493.860 1254.286 1544.000
## 2603 1399.602 1304.559 1494.645 1254.246 1544.958
## 2604 1400.061 1304.693 1495.429 1254.208 1545.914
## 2605 1400.520 1304.827 1496.212 1254.171 1546.868
## 2606 1400.978 1304.963 1496.994 1254.135 1547.822
## 2607 1401.437 1305.099 1497.776 1254.100 1548.774
## 2608 1401.896 1305.236 1498.557 1254.067 1549.725
## 2609 1402.355 1305.373 1499.336 1254.034 1550.675
## 2610 1402.814 1305.512 1500.116 1254.003 1551.624
## 2611 1403.272 1305.651 1500.894 1253.973 1552.572
## 2612 1403.731 1305.791 1501.671 1253.945 1553.518
## 2613 1404.190 1305.932 1502.448 1253.917 1554.463
## 2614 1404.649 1306.073 1503.224 1253.891 1555.407
## 2615 1405.108 1306.216 1504.000 1253.865 1556.350
## 2616 1405.566 1306.359 1504.774 1253.841 1557.292
## 2617 1406.025 1306.502 1505.548 1253.818 1558.232
## 2618 1406.484 1306.647 1506.321 1253.796 1559.172
## 2619 1406.943 1306.792 1507.094 1253.775 1560.110
## 2620 1407.402 1306.938 1507.865 1253.756 1561.048
## 2621 1407.860 1307.085 1508.636 1253.737 1561.984
## 2622 1408.319 1307.232 1509.407 1253.719 1562.919
## 2623 1408.778 1307.380 1510.176 1253.703 1563.853
## 2624 1409.237 1307.529 1510.945 1253.687 1564.786
## 2625 1409.696 1307.678 1511.714 1253.673 1565.718
## 2626 1410.155 1307.828 1512.481 1253.659 1566.650
## 2627 1410.613 1307.979 1513.248 1253.647 1567.580
## 2628 1411.072 1308.130 1514.014 1253.636 1568.509
## 2629 1411.531 1308.282 1514.780 1253.625 1569.437
## 2630 1411.990 1308.435 1515.545 1253.616 1570.364
## 2631 1412.449 1308.588 1516.309 1253.607 1571.290
## 2632 1412.907 1308.742 1517.073 1253.600 1572.215
## 2633 1413.366 1308.896 1517.836 1253.593 1573.139
## 2634 1413.825 1309.051 1518.598 1253.588 1574.062
## 2635 1414.284 1309.207 1519.360 1253.583 1574.984
## 2636 1414.743 1309.364 1520.121 1253.579 1575.906
## 2637 1415.201 1309.521 1520.882 1253.577 1576.826
## 2638 1415.660 1309.678 1521.642 1253.575 1577.745
## 2639 1416.119 1309.836 1522.401 1253.574 1578.664
## 2640 1416.578 1309.995 1523.160 1253.574 1579.581
## 2641 1417.037 1310.155 1523.918 1253.575 1580.498
## 2642 1417.495 1310.315 1524.676 1253.577 1581.414
## 2643 1417.954 1310.475 1525.433 1253.579 1582.329
## 2644 1418.413 1310.636 1526.190 1253.583 1583.243
## 2645 1418.872 1310.798 1526.945 1253.587 1584.156
## 2646 1419.331 1310.960 1527.701 1253.593 1585.068

```

```

## 2647 1419.789 1311.123 1528.456 1253.599 1585.980
## 2648 1420.248 1311.287 1529.210 1253.606 1586.891
## 2649 1420.707 1311.450 1529.963 1253.614 1587.800
## 2650 1421.166 1311.615 1530.717 1253.622 1588.709
## 2651 1421.625 1311.780 1531.469 1253.632 1589.617
## 2652 1422.083 1311.945 1532.221 1253.642 1590.525
## 2653 1422.542 1312.112 1532.973 1253.653 1591.431
## 2654 1423.001 1312.278 1533.724 1253.665 1592.337
## 2655 1423.460 1312.445 1534.474 1253.678 1593.242
## 2656 1423.919 1312.613 1535.224 1253.691 1594.146
## 2657 1424.377 1312.781 1535.974 1253.706 1595.049
## 2658 1424.836 1312.950 1536.723 1253.721 1595.952
## 2659 1425.295 1313.119 1537.471 1253.737 1596.853
## 2660 1425.754 1313.289 1538.219 1253.753 1597.754
## 2661 1426.213 1313.459 1538.966 1253.771 1598.655
## 2662 1426.671 1313.629 1539.713 1253.789 1599.554
## 2663 1427.130 1313.801 1540.460 1253.808 1600.453
## 2664 1427.589 1313.972 1541.206 1253.827 1601.351
## 2665 1428.048 1314.144 1541.951 1253.848 1602.248
## 2666 1428.507 1314.317 1542.696 1253.869 1603.144
## 2667 1428.965 1314.490 1543.441 1253.891 1604.040
## 2668 1429.424 1314.664 1544.185 1253.913 1604.935
## 2669 1429.883 1314.838 1544.928 1253.937 1605.829
## 2670 1430.342 1315.012 1545.671 1253.961 1606.723
## 2671 1430.801 1315.187 1546.414 1253.985 1607.616
## 2672 1431.259 1315.363 1547.156 1254.011 1608.508
## 2673 1431.718 1315.539 1547.898 1254.037 1609.399
## 2674 1432.177 1315.715 1548.639 1254.064 1610.290
## 2675 1432.636 1315.892 1549.380 1254.091 1611.180
## 2676 1433.095 1316.069 1550.120 1254.119 1612.070
## 2677 1433.553 1316.247 1550.860 1254.148 1612.958
## 2678 1434.012 1316.425 1551.600 1254.178 1613.847
## 2679 1434.471 1316.603 1552.339 1254.208 1614.734
## 2680 1434.930 1316.782 1553.077 1254.239 1615.621
## 2681 1435.389 1316.962 1553.815 1254.270 1616.507
## 2682 1435.847 1317.142 1554.553 1254.303 1617.392
## 2683 1436.306 1317.322 1555.290 1254.335 1618.277
## 2684 1436.765 1317.503 1556.027 1254.369 1619.161
## 2685 1437.224 1317.684 1556.764 1254.403 1620.045
## 2686 1437.683 1317.865 1557.500 1254.438 1620.927
## 2687 1438.141 1318.047 1558.236 1254.473 1621.810
## 2688 1438.600 1318.230 1558.971 1254.509 1622.691
## 2689 1439.059 1318.412 1559.706 1254.546 1623.572
## 2690 1439.518 1318.595 1560.440 1254.583 1624.453
## 2691 1439.977 1318.779 1561.174 1254.621 1625.332
## 2692 1440.435 1318.963 1561.908 1254.659 1626.211
## 2693 1440.894 1319.147 1562.641 1254.698 1627.090
## 2694 1441.353 1319.332 1563.374 1254.738 1627.968
## 2695 1441.812 1319.517 1564.106 1254.778 1628.845
## 2696 1442.271 1319.703 1564.838 1254.819 1629.722
## 2697 1442.729 1319.889 1565.570 1254.861 1630.598
## 2698 1443.188 1320.075 1566.301 1254.903 1631.474
## 2699 1443.647 1320.262 1567.032 1254.945 1632.349
## 2700 1444.106 1320.449 1567.763 1254.988 1633.223

```

```

## 2701      1444.565 1320.636 1568.493 1255.032 1634.097
## 2702      1445.023 1320.824 1569.223 1255.077 1634.970
## 2703      1445.482 1321.012 1569.952 1255.121 1635.843
## 2704      1445.941 1321.201 1570.681 1255.167 1636.715
## 2705      1446.400 1321.389 1571.410 1255.213 1637.587
## 2706      1446.859 1321.579 1572.139 1255.259 1638.458
## 2707      1447.317 1321.768 1572.867 1255.307 1639.328
## 2708      1447.776 1321.958 1573.594 1255.354 1640.198
## 2709      1448.235 1322.149 1574.321 1255.402 1641.068
## 2710      1448.694 1322.339 1575.048 1255.451 1641.936
## 2711      1449.153 1322.530 1575.775 1255.501 1642.805
## 2712      1449.611 1322.722 1576.501 1255.550 1643.673
## 2713      1450.070 1322.913 1577.227 1255.601 1644.540
## 2714      1450.529 1323.105 1577.953 1255.652 1645.407
## 2715      1450.988 1323.298 1578.678 1255.703 1646.273
## 2716      1451.447 1323.491 1579.403 1255.755 1647.138
## 2717      1451.905 1323.684 1580.127 1255.807 1648.004
## 2718      1452.364 1323.877 1580.851 1255.860 1648.868
## 2719      1452.823 1324.071 1581.575 1255.914 1649.732
## 2720      1453.282 1324.265 1582.299 1255.968 1650.596
## 2721      1453.741 1324.459 1583.022 1256.022 1651.459
## 2722      1454.199 1324.654 1583.745 1256.077 1652.322
## 2723      1454.658 1324.849 1584.467 1256.132 1653.184
## 2724      1455.117 1325.045 1585.189 1256.188 1654.046
## 2725      1455.576 1325.240 1585.911 1256.245 1654.907
## 2726      1456.035 1325.436 1586.633 1256.302 1655.767
## 2727      1456.493 1325.633 1587.354 1256.359 1656.628
## 2728      1456.952 1325.829 1588.075 1256.417 1657.487
## 2729      1457.411 1326.026 1588.796 1256.475 1658.347
## 2730      1457.870 1326.224 1589.516 1256.534 1659.205
## 2731      1458.329 1326.421 1590.236 1256.594 1660.064
## 2732      1458.787 1326.619 1590.956 1256.653 1660.921
## 2733      1459.246 1326.817 1591.675 1256.714 1661.779
## 2734      1459.705 1327.016 1592.394 1256.774 1662.636
## 2735      1460.164 1327.215 1593.113 1256.836 1663.492
## 2736      1460.623 1327.414 1593.832 1256.897 1664.348
## 2737      1461.081 1327.613 1594.550 1256.959 1665.204
## 2738      1461.540 1327.813 1595.268 1257.022 1666.059
## 2739      1461.999 1328.013 1595.985 1257.085 1666.913
## 2740      1462.458 1328.213 1596.703 1257.148 1667.767
## 2741      1462.917 1328.414 1597.420 1257.212 1668.621
## 2742      1463.375 1328.615 1598.136 1257.277 1669.474
## 2743      1463.834 1328.816 1598.853 1257.341 1670.327
## 2744      1464.293 1329.017 1599.569 1257.407 1671.180
## 2745      1464.752 1329.219 1600.285 1257.472 1672.032
## 2746      1465.211 1329.421 1601.000 1257.538 1672.883
## 2747      1465.669 1329.623 1601.716 1257.605 1673.734
## 2748      1466.128 1329.826 1602.431 1257.672 1674.585
## 2749      1466.587 1330.029 1603.145 1257.739 1675.435
## 2750      1467.046 1330.232 1603.860 1257.807 1676.285
## 2751      1467.505 1330.435 1604.574 1257.875 1677.134
## 2752      1467.963 1330.639 1605.288 1257.944 1677.983
## 2753      1468.422 1330.843 1606.002 1258.013 1678.832
## 2754      1468.881 1331.047 1606.715 1258.082 1679.680

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## 2755      1469.340 1331.252 1607.428 1258.152 1680.528
## 2756      1469.799 1331.456 1608.141 1258.222 1681.375
## 2757      1470.257 1331.661 1608.854 1258.293 1682.222
## 2758      1470.716 1331.867 1609.566 1258.364 1683.068
## 2759      1471.175 1332.072 1610.278 1258.436 1683.914
## 2760      1471.634 1332.278 1610.990 1258.508 1684.760
## 2761      1472.093 1332.484 1611.701 1258.580 1685.605
## 2762      1472.551 1332.691 1612.412 1258.653 1686.450
## 2763      1473.010 1332.897 1613.123 1258.726 1687.295
## 2764      1473.469 1333.104 1613.834 1258.799 1688.139
## 2765      1473.928 1333.311 1614.545 1258.873 1688.983
## 2766      1474.387 1333.518 1615.255 1258.947 1689.826
## 2767      1474.846 1333.726 1615.965 1259.022 1690.669
## 2768      1475.304 1333.934 1616.675 1259.097 1691.512
## 2769      1475.763 1334.142 1617.384 1259.172 1692.354
## 2770      1476.222 1334.350 1618.094 1259.248 1693.196
## 2771      1476.681 1334.559 1618.803 1259.324 1694.037
## 2772      1477.140 1334.768 1619.511 1259.401 1694.878
## 2773      1477.598 1334.977 1620.220 1259.478 1695.719
## 2774      1478.057 1335.186 1620.928 1259.555 1696.559
## 2775      1478.516 1335.396 1621.636 1259.632 1697.399
## 2776      1478.975 1335.606 1622.344 1259.710 1698.239
## 2777      1479.434 1335.816 1623.051 1259.789 1699.078
## 2778      1479.892 1336.026 1623.759 1259.868 1699.917
## 2779      1480.351 1336.236 1624.466 1259.947 1700.756
## 2780      1480.810 1336.447 1625.173 1260.026 1701.594
## 2781      1481.269 1336.658 1625.879 1260.106 1702.432
## 2782      1481.728 1336.869 1626.586 1260.186 1703.269
## 2783      1482.186 1337.081 1627.292 1260.266 1704.106
## 2784      1482.645 1337.292 1627.998 1260.347 1704.943
## 2785      1483.104 1337.504 1628.704 1260.429 1705.779
## 2786      1483.563 1337.716 1629.409 1260.510 1706.615
## 2787      1484.022 1337.929 1630.114 1260.592 1707.451
## 2788      1484.480 1338.141 1630.819 1260.674 1708.286
## 2789      1484.939 1338.354 1631.524 1260.757 1709.122
## 2790      1485.398 1338.567 1632.229 1260.840 1709.956
## 2791      1485.857 1338.780 1632.933 1260.923 1710.791
## 2792      1486.316 1338.994 1633.637 1261.007 1711.625
## 2793      1486.774 1339.208 1634.341 1261.090 1712.458
## 2794      1487.233 1339.421 1635.045 1261.175 1713.292
## 2795      1487.692 1339.636 1635.748 1261.259 1714.125
## 2796      1488.151 1339.850 1636.452 1261.344 1714.957
## 2797      1488.610 1340.064 1637.155 1261.429 1715.790
## 2798      1489.068 1340.279 1637.857 1261.515 1716.622
## 2799      1489.527 1340.494 1638.560 1261.601 1717.453
## 2800      1489.986 1340.709 1639.262 1261.687 1718.285
## 2801      1490.445 1340.925 1639.965 1261.774 1719.116
## 2802      1490.904 1341.140 1640.667 1261.861 1719.947
## 2803      1491.362 1341.356 1641.368 1261.948 1720.777
## 2804      1491.821 1341.572 1642.070 1262.035 1721.607
## 2805      1492.280 1341.788 1642.771 1262.123 1722.437
## 2806      1492.739 1342.005 1643.473 1262.211 1723.266
## 2807      1493.198 1342.222 1644.174 1262.300 1724.095
## 2808      1493.656 1342.438 1644.874 1262.388 1724.924

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## 2809 1494.115 1342.655 1645.575 1262.477 1725.753
## 2810 1494.574 1342.873 1646.275 1262.567 1726.581
## 2811 1495.033 1343.090 1646.975 1262.656 1727.409
## 2812 1495.492 1343.308 1647.675 1262.746 1728.237
## 2813 1495.950 1343.526 1648.375 1262.837 1729.064
## 2814 1496.409 1343.744 1649.075 1262.927 1729.891
## 2815 1496.868 1343.962 1649.774 1263.018 1730.718
## 2816 1497.327 1344.180 1650.473 1263.109 1731.544
## 2817 1497.786 1344.399 1651.172 1263.201 1732.370
## 2818 1498.244 1344.618 1651.871 1263.293 1733.196
## 2819 1498.703 1344.837 1652.570 1263.385 1734.022
## 2820 1499.162 1345.056 1653.268 1263.477 1734.847
## 2821 1499.621 1345.275 1653.966 1263.570 1735.672
## 2822 1500.080 1345.495 1654.664 1263.663 1736.497
## 2823 1500.538 1345.715 1655.362 1263.756 1737.321
## 2824 1500.997 1345.935 1656.060 1263.849 1738.145
## 2825 1501.456 1346.155 1656.757 1263.943 1738.969
## 2826 1501.915 1346.375 1657.455 1264.037 1739.792
## 2827 1502.374 1346.596 1658.152 1264.132 1740.616
## 2828 1502.832 1346.816 1658.849 1264.226 1741.439
## 2829 1503.291 1347.037 1659.545 1264.321 1742.261
## 2830 1503.750 1347.258 1660.242 1264.416 1743.084
## 2831 1504.209 1347.479 1660.938 1264.512 1743.906
## 2832 1504.668 1347.701 1661.634 1264.608 1744.728
## 2833 1505.126 1347.922 1662.330 1264.704 1745.549
## 2834 1505.585 1348.144 1663.026 1264.800 1746.370
## 2835 1506.044 1348.366 1663.722 1264.897 1747.191
## 2836 1506.503 1348.588 1664.417 1264.993 1748.012
## 2837 1506.962 1348.811 1665.113 1265.091 1748.833
## 2838 1507.420 1349.033 1665.808 1265.188 1749.653
## 2839 1507.879 1349.256 1666.503 1265.286 1750.473
## 2840 1508.338 1349.479 1667.197 1265.384 1751.292
## 2841 1508.797 1349.702 1667.892 1265.482 1752.112
## 2842 1509.256 1349.925 1668.586 1265.580 1752.931
## 2843 1509.714 1350.148 1669.281 1265.679 1753.750
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## 2845 1510.632 1350.595 1670.669 1265.877 1755.387
## 2846 1511.091 1350.819 1671.362 1265.977 1756.205
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## 2848 1512.008 1351.267 1672.749 1266.176 1757.840
## 2849 1512.467 1351.492 1673.443 1266.277 1758.658
## 2850 1512.926 1351.716 1674.136 1266.377 1759.475
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## 2852 1513.844 1352.166 1675.521 1266.579 1761.108
## 2853 1514.302 1352.391 1676.214 1266.680 1761.925
## 2854 1514.761 1352.616 1676.906 1266.782 1762.741
## 2855 1515.220 1352.842 1677.599 1266.884 1763.557
## 2856 1515.679 1353.067 1678.291 1266.986 1764.372
## 2857 1516.138 1353.293 1678.983 1267.088 1765.187
## 2858 1516.596 1353.519 1679.674 1267.190 1766.003
## 2859 1517.055 1353.745 1680.366 1267.293 1766.817
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## 2862 1518.432 1354.423 1682.440 1267.603 1769.260

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## 2863 1518.890 1354.650 1683.131 1267.707 1770.074
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## 2865 1519.808 1355.104 1684.512 1267.915 1771.701
## 2866 1520.267 1355.331 1685.203 1268.019 1772.515
## 2867 1520.726 1355.558 1685.893 1268.124 1773.327
## 2868 1521.184 1355.786 1686.583 1268.229 1774.140
## 2869 1521.643 1356.013 1687.273 1268.334 1774.953
## 2870 1522.102 1356.241 1687.963 1268.439 1775.765
## 2871 1522.561 1356.469 1688.653 1268.545 1776.577
## 2872 1523.020 1356.697 1689.343 1268.651 1777.389
## 2873 1523.478 1356.925 1690.032 1268.757 1778.200
## 2874 1523.937 1357.153 1690.721 1268.863 1779.011
## 2875 1524.396 1357.382 1691.410 1268.970 1779.823
## 2876 1524.855 1357.610 1692.099 1269.076 1780.633
## 2877 1525.314 1357.839 1692.788 1269.183 1781.444
## 2878 1525.772 1358.068 1693.477 1269.290 1782.254
## 2879 1526.231 1358.297 1694.166 1269.398 1783.065
## 2880 1526.690 1358.526 1694.854 1269.506 1783.875
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## 2883 1528.066 1359.215 1696.918 1269.830 1786.303
## 2884 1528.525 1359.444 1697.606 1269.938 1787.112
## 2885 1528.984 1359.674 1698.294 1270.047 1787.921
## 2886 1529.443 1359.904 1698.981 1270.156 1788.730
## 2887 1529.902 1360.134 1699.669 1270.265 1789.538
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## 2889 1530.819 1360.595 1701.043 1270.484 1791.154
## 2890 1531.278 1360.826 1701.730 1270.594 1791.962
## 2891 1531.737 1361.057 1702.417 1270.704 1792.770
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## 2894 1533.113 1361.750 1704.477 1271.035 1795.191
## 2895 1533.572 1361.981 1705.163 1271.146 1795.998
## 2896 1534.031 1362.212 1705.849 1271.257 1796.804
## 2897 1534.490 1362.444 1706.535 1271.369 1797.611
## 2898 1534.948 1362.676 1707.221 1271.480 1798.417
## 2899 1535.407 1362.908 1707.907 1271.592 1799.223
## 2900 1535.866 1363.140 1708.593 1271.704 1800.028
## 2901 1536.325 1363.372 1709.278 1271.816 1800.834
## 2902 1536.784 1363.604 1709.963 1271.928 1801.639
## 2903 1537.242 1363.836 1710.649 1272.041 1802.444
## 2904 1537.701 1364.069 1711.334 1272.153 1803.249
## 2905 1538.160 1364.301 1712.019 1272.266 1804.054
## 2906 1538.619 1364.534 1712.704 1272.379 1804.858
## 2907 1539.078 1364.767 1713.388 1272.493 1805.663
## 2908 1539.536 1365.000 1714.073 1272.606 1806.467
## 2909 1539.995 1365.233 1714.757 1272.720 1807.271
## 2910 1540.454 1365.467 1715.442 1272.834 1808.074
## 2911 1540.913 1365.700 1716.126 1272.948 1808.878
## 2912 1541.372 1365.934 1716.810 1273.062 1809.681
## 2913 1541.831 1366.167 1717.494 1273.177 1810.484
## 2914 1542.289 1366.401 1718.178 1273.291 1811.287
## 2915 1542.748 1366.635 1718.861 1273.406 1812.090
## 2916 1543.207 1366.869 1719.545 1273.521 1812.892

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## 2917 1543.666 1367.103 1720.228 1273.637 1813.695
## 2918 1544.125 1367.337 1720.912 1273.752 1814.497
## 2919 1544.583 1367.572 1721.595 1273.868 1815.299
## 2920 1545.042 1367.806 1722.278 1273.983 1816.101
## 2921 1545.501 1368.041 1722.961 1274.099 1816.902
## 2922 1545.960 1368.276 1723.644 1274.216 1817.704
## 2923 1546.419 1368.511 1724.326 1274.332 1818.505
## 2924 1546.877 1368.746 1725.009 1274.449 1819.306
## 2925 1547.336 1368.981 1725.691 1274.565 1820.107
## 2926 1547.795 1369.216 1726.374 1274.682 1820.907
## 2927 1548.254 1369.452 1727.056 1274.799 1821.708
## 2928 1548.713 1369.687 1727.738 1274.917 1822.508
## 2929 1549.171 1369.923 1728.420 1275.034 1823.308
## 2930 1549.630 1370.158 1729.102 1275.152 1824.108
## 2931 1550.089 1370.394 1729.784 1275.270 1824.908
## 2932 1550.548 1370.630 1730.465 1275.388 1825.708
## 2933 1551.007 1370.866 1731.147 1275.506 1826.507
## 2934 1551.465 1371.103 1731.828 1275.624 1827.306
## 2935 1551.924 1371.339 1732.509 1275.743 1828.105
## 2936 1552.383 1371.575 1733.190 1275.862 1828.904
## 2937 1552.842 1371.812 1733.871 1275.981 1829.703
## 2938 1553.301 1372.049 1734.552 1276.100 1830.501
## 2939 1553.759 1372.285 1735.233 1276.219 1831.300
## 2940 1554.218 1372.522 1735.914 1276.338 1832.098
## 2941 1554.677 1372.759 1736.594 1276.458 1832.896
## 2942 1555.136 1372.997 1737.275 1276.578 1833.694
## 2943 1555.595 1373.234 1737.955 1276.698 1834.491
## 2944 1556.053 1373.471 1738.636 1276.818 1835.289
## 2945 1556.512 1373.709 1739.316 1276.938 1836.086
## 2946 1556.971 1373.946 1739.996 1277.059 1836.883
## 2947 1557.430 1374.184 1740.676 1277.179 1837.680
## 2948 1557.889 1374.422 1741.355 1277.300 1838.477
## 2949 1558.347 1374.660 1742.035 1277.421 1839.274
## 2950 1558.806 1374.898 1742.715 1277.542 1840.070
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## 2953 1560.183 1375.612 1744.753 1277.907 1842.458
## 2954 1560.641 1375.851 1745.432 1278.029 1843.254
## 2955 1561.100 1376.089 1746.111 1278.151 1844.050
## 2956 1561.559 1376.328 1746.790 1278.273 1844.845
## 2957 1562.018 1376.567 1747.469 1278.395 1845.641
## 2958 1562.477 1376.806 1748.147 1278.517 1846.436
## 2959 1562.935 1377.045 1748.826 1278.640 1847.231
## 2960 1563.394 1377.284 1749.505 1278.763 1848.025
## 2961 1563.853 1377.523 1750.183 1278.886 1848.820
## 2962 1564.312 1377.762 1750.861 1279.009 1849.615
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## 2964 1565.229 1378.241 1752.218 1279.256 1851.203
## 2965 1565.688 1378.481 1752.896 1279.379 1851.997
## 2966 1566.147 1378.721 1753.573 1279.503 1852.791
## 2967 1566.606 1378.960 1754.251 1279.627 1853.585
## 2968 1567.065 1379.200 1754.929 1279.751 1854.378
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## 2970 1567.982 1379.680 1756.284 1279.999 1855.965

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## 2971      1568.441 1379.921 1756.961 1280.124 1856.758
## 2972      1568.900 1380.161 1757.639 1280.249 1857.551
## 2973      1569.359 1380.401 1758.316 1280.374 1858.344
## 2974      1569.817 1380.642 1758.993 1280.499 1859.136
## 2975      1570.276 1380.883 1759.670 1280.624 1859.929
## 2976      1570.735 1381.123 1760.347 1280.749 1860.721
## 2977      1571.194 1381.364 1761.023 1280.874 1861.513
## 2978      1571.653 1381.605 1761.700 1281.000 1862.305
## 2979      1572.111 1381.846 1762.377 1281.126 1863.097
## 2980      1572.570 1382.087 1763.053 1281.252 1863.889
## 2981      1573.029 1382.328 1763.730 1281.378 1864.680
## 2982      1573.488 1382.570 1764.406 1281.504 1865.472
## 2983      1573.947 1382.811 1765.082 1281.630 1866.263
## 2984      1574.405 1383.053 1765.758 1281.757 1867.054
## 2985      1574.864 1383.294 1766.434 1281.883 1867.845
## 2986      1575.323 1383.536 1767.110 1282.010 1868.636
## 2987      1575.782 1383.778 1767.786 1282.137 1869.427
## 2988      1576.241 1384.020 1768.462 1282.264 1870.217
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## 2994      1578.993 1385.473 1772.514 1283.030 1874.957
## 2995      1579.452 1385.716 1773.189 1283.158 1875.747
## 2996      1579.911 1385.958 1773.864 1283.286 1876.536
## 2997      1580.370 1386.201 1774.539 1283.414 1877.325
## 2998      1580.829 1386.444 1775.213 1283.543 1878.115
## 2999      1581.287 1386.687 1775.888 1283.671 1878.904
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## 3001      1582.205 1387.173 1777.237 1283.929 1880.481
## 3002      1582.664 1387.416 1777.912 1284.058 1881.270
## 3003      1583.123 1387.659 1778.586 1284.187 1882.058
## 3004      1583.581 1387.903 1779.260 1284.317 1882.846
## 3005      1584.040 1388.146 1779.934 1284.446 1883.634
## 3006      1584.499 1388.390 1780.608 1284.576 1884.422
## 3007      1584.958 1388.633 1781.282 1284.705 1885.210
## 3008      1585.417 1388.877 1781.956 1284.835 1885.998
## 3009      1585.875 1389.121 1782.630 1284.965 1886.786
## 3010      1586.334 1389.365 1783.304 1285.095 1887.573
## 3011      1586.793 1389.609 1783.977 1285.226 1888.360
## 3012      1587.252 1389.853 1784.651 1285.356 1889.148
## 3013      1587.711 1390.097 1785.324 1285.487 1889.935
## 3014      1588.169 1390.341 1785.998 1285.617 1890.722
## 3015      1588.628 1390.586 1786.671 1285.748 1891.508
## 3016      1589.087 1390.830 1787.344 1285.879 1892.295
## 3017      1589.546 1391.074 1788.017 1286.010 1893.082
## 3018      1590.005 1391.319 1788.690 1286.141 1893.868
## 3019      1590.463 1391.564 1789.363 1286.273 1894.654
## 3020      1590.922 1391.808 1790.036 1286.404 1895.440
## 3021      1591.381 1392.053 1790.709 1286.536 1896.227
## 3022      1591.840 1392.298 1791.381 1286.667 1897.012
## 3023      1592.299 1392.543 1792.054 1286.799 1897.798
## 3024      1592.757 1392.788 1792.727 1286.931 1898.584

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## 3025 1593.216 1393.034 1793.399 1287.063 1899.369
## 3026 1593.675 1393.279 1794.071 1287.195 1900.155
## 3027 1594.134 1393.524 1794.744 1287.328 1900.940
## 3028 1594.593 1393.770 1795.416 1287.460 1901.725
## 3029 1595.051 1394.015 1796.088 1287.593 1902.510
## 3030 1595.510 1394.261 1796.760 1287.726 1903.295
## 3031 1595.969 1394.506 1797.432 1287.858 1904.080
## 3032 1596.428 1394.752 1798.104 1287.991 1904.864
## 3033 1596.887 1394.998 1798.775 1288.125 1905.649
## 3034 1597.345 1395.244 1799.447 1288.258 1906.433
## 3035 1597.804 1395.490 1800.119 1288.391 1907.217
## 3036 1598.263 1395.736 1800.790 1288.525 1908.002
## 3037 1598.722 1395.982 1801.462 1288.658 1908.786
## 3038 1599.181 1396.228 1802.133 1288.792 1909.569
## 3039 1599.639 1396.475 1802.804 1288.926 1910.353
## 3040 1600.098 1396.721 1803.475 1289.060 1911.137
## 3041 1600.557 1396.968 1804.147 1289.194 1911.920
## 3042 1601.016 1397.214 1804.818 1289.328 1912.704
## 3043 1601.475 1397.461 1805.489 1289.462 1913.487
## 3044 1601.933 1397.707 1806.160 1289.597 1914.270
## 3045 1602.392 1397.954 1806.830 1289.731 1915.053
## 3046 1602.851 1398.201 1807.501 1289.866 1915.836
## 3047 1603.310 1398.448 1808.172 1290.001 1916.619
## 3048 1603.769 1398.695 1808.842 1290.136 1917.402
## 3049 1604.227 1398.942 1809.513 1290.271 1918.184
## 3050 1604.686 1399.189 1810.183 1290.406 1918.967
## 3051 1605.145 1399.437 1810.854 1290.541 1919.749
## 3052 1605.604 1399.684 1811.524 1290.676 1920.531
## 3053 1606.063 1399.931 1812.194 1290.812 1921.313
## 3054 1606.522 1400.179 1812.864 1290.948 1922.095
## 3055 1606.980 1400.426 1813.534 1291.083 1922.877
## 3056 1607.439 1400.674 1814.204 1291.219 1923.659
## 3057 1607.898 1400.922 1814.874 1291.355 1924.441
## 3058 1608.357 1401.169 1815.544 1291.491 1925.222
## 3059 1608.816 1401.417 1816.214 1291.627 1926.004
## 3060 1609.274 1401.665 1816.883 1291.764 1926.785
## 3061 1609.733 1401.913 1817.553 1291.900 1927.566
## 3062 1610.192 1402.161 1818.223 1292.037 1928.347
## 3063 1610.651 1402.409 1818.892 1292.173 1929.128
## 3064 1611.110 1402.658 1819.561 1292.310 1929.909
## 3065 1611.568 1402.906 1820.231 1292.447 1930.690
## 3066 1612.027 1403.154 1820.900 1292.584 1931.471
## 3067 1612.486 1403.403 1821.569 1292.721 1932.251
## 3068 1612.945 1403.651 1822.238 1292.858 1933.032
## 3069 1613.404 1403.900 1822.907 1292.995 1933.812
## 3070 1613.862 1404.148 1823.576 1293.133 1934.592
## 3071 1614.321 1404.397 1824.245 1293.270 1935.372
## 3072 1614.780 1404.646 1824.914 1293.408 1936.152
## 3073 1615.239 1404.895 1825.583 1293.545 1936.932
## 3074 1615.698 1405.144 1826.251 1293.683 1937.712
## 3075 1616.156 1405.393 1826.920 1293.821 1938.491
## 3076 1616.615 1405.642 1827.588 1293.959 1939.271
## 3077 1617.074 1405.891 1828.257 1294.097 1940.050
## 3078 1617.533 1406.140 1828.925 1294.236 1940.830

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## 3079 1617.992 1406.389 1829.594 1294.374 1941.609
## 3080 1618.450 1406.639 1830.262 1294.513 1942.388
## 3081 1618.909 1406.888 1830.930 1294.651 1943.167
## 3082 1619.368 1407.138 1831.598 1294.790 1943.946
## 3083 1619.827 1407.387 1832.266 1294.929 1944.725
## 3084 1620.286 1407.637 1832.934 1295.068 1945.504
## 3085 1620.744 1407.887 1833.602 1295.207 1946.282
## 3086 1621.203 1408.136 1834.270 1295.346 1947.061
## 3087 1621.662 1408.386 1834.938 1295.485 1947.839
## 3088 1622.121 1408.636 1835.605 1295.624 1948.617
## 3089 1622.580 1408.886 1836.273 1295.764 1949.396
## 3090 1623.038 1409.136 1836.941 1295.903 1950.174
## 3091 1623.497 1409.386 1837.608 1296.043 1950.952
## 3092 1623.956 1409.636 1838.276 1296.182 1951.730
## 3093 1624.415 1409.887 1838.943 1296.322 1952.507
## 3094 1624.874 1410.137 1839.610 1296.462 1953.285
## 3095 1625.332 1410.387 1840.278 1296.602 1954.063
## 3096 1625.791 1410.638 1840.945 1296.742 1954.840
## 3097 1626.250 1410.888 1841.612 1296.882 1955.617
## 3098 1626.709 1411.139 1842.279 1297.023 1956.395
## 3099 1627.168 1411.389 1842.946 1297.163 1957.172
## 3100 1627.626 1411.640 1843.613 1297.304 1957.949
## 3101 1628.085 1411.891 1844.280 1297.444 1958.726
## 3102 1628.544 1412.142 1844.946 1297.585 1959.503
## 3103 1629.003 1412.392 1845.613 1297.726 1960.280
## 3104 1629.462 1412.643 1846.280 1297.867 1961.056
## 3105 1629.920 1412.894 1846.946 1298.008 1961.833
## 3106 1630.379 1413.145 1847.613 1298.149 1962.609
## 3107 1630.838 1413.397 1848.279 1298.290 1963.386
## 3108 1631.297 1413.648 1848.946 1298.431 1964.162
## 3109 1631.756 1413.899 1849.612 1298.573 1964.938
## 3110 1632.214 1414.150 1850.278 1298.714 1965.715
## 3111 1632.673 1414.402 1850.945 1298.856 1966.491
## 3112 1633.132 1414.653 1851.611 1298.998 1967.266
## 3113 1633.591 1414.905 1852.277 1299.139 1968.042
## 3114 1634.050 1415.156 1852.943 1299.281 1968.818
## 3115 1634.508 1415.408 1853.609 1299.423 1969.594
## 3116 1634.967 1415.660 1854.275 1299.565 1970.369
## 3117 1635.426 1415.911 1854.941 1299.707 1971.145
## 3118 1635.885 1416.163 1855.606 1299.850 1971.920
## 3119 1636.344 1416.415 1856.272 1299.992 1972.695
## 3120 1636.802 1416.667 1856.938 1300.134 1973.470
## 3121 1637.261 1416.919 1857.603 1300.277 1974.246
## 3122 1637.720 1417.171 1858.269 1300.420 1975.020
## 3123 1638.179 1417.423 1858.934 1300.562 1975.795
## 3124 1638.638 1417.675 1859.600 1300.705 1976.570
## 3125 1639.096 1417.928 1860.265 1300.848 1977.345
## 3126 1639.555 1418.180 1860.931 1300.991 1978.120
## 3127 1640.014 1418.432 1861.596 1301.134 1978.894
## 3128 1640.473 1418.685 1862.261 1301.277 1979.668
## 3129 1640.932 1418.937 1862.926 1301.420 1980.443
## 3130 1641.390 1419.190 1863.591 1301.564 1981.217
## 3131 1641.849 1419.442 1864.256 1301.707 1981.991
## 3132 1642.308 1419.695 1864.921 1301.851 1982.765

```

```

## 3133 1642.767 1419.948 1865.586 1301.994 1983.539
## 3134 1643.226 1420.200 1866.251 1302.138 1984.313
## 3135 1643.684 1420.453 1866.916 1302.282 1985.087
## 3136 1644.143 1420.706 1867.580 1302.426 1985.861
## 3137 1644.602 1420.959 1868.245 1302.570 1986.634
## 3138 1645.061 1421.212 1868.910 1302.714 1987.408
## 3139 1645.520 1421.465 1869.574 1302.858 1988.181
## 3140 1645.978 1421.718 1870.239 1303.002 1988.955
## 3141 1646.437 1421.971 1870.903 1303.146 1989.728
## 3142 1646.896 1422.225 1871.567 1303.291 1990.501
## 3143 1647.355 1422.478 1872.232 1303.435 1991.274
## 3144 1647.814 1422.731 1872.896 1303.580 1992.047
## 3145 1648.272 1422.985 1873.560 1303.725 1992.820
## 3146 1648.731 1423.238 1874.224 1303.869 1993.593
## 3147 1649.190 1423.492 1874.888 1304.014 1994.366
## 3148 1649.649 1423.745 1875.552 1304.159 1995.139
## 3149 1650.108 1423.999 1876.216 1304.304 1995.911
## 3150 1650.566 1424.252 1876.880 1304.449 1996.684
## 3151 1651.025 1424.506 1877.544 1304.594 1997.456
## 3152 1651.484 1424.760 1878.208 1304.740 1998.229
## 3153 1651.943 1425.014 1878.872 1304.885 1999.001
## 3154 1652.402 1425.268 1879.536 1305.030 1999.773
## 3155 1652.860 1425.522 1880.199 1305.176 2000.545
## 3156 1653.319 1425.776 1880.863 1305.321 2001.317
## 3157 1653.778 1426.030 1881.526 1305.467 2002.089
## 3158 1654.237 1426.284 1882.190 1305.613 2002.861
## 3159 1654.696 1426.538 1882.853 1305.759 2003.633
## 3160 1655.154 1426.792 1883.517 1305.905 2004.404
## 3161 1655.613 1427.047 1884.180 1306.051 2005.176
## 3162 1656.072 1427.301 1884.843 1306.197 2005.947
## 3163 1656.531 1427.555 1885.507 1306.343 2006.719
## 3164 1656.990 1427.810 1886.170 1306.489 2007.490
## 3165 1657.448 1428.064 1886.833 1306.635 2008.262
## 3166 1657.907 1428.319 1887.496 1306.782 2009.033
## 3167 1658.366 1428.573 1888.159 1306.928 2009.804
## 3168 1658.825 1428.828 1888.822 1307.075 2010.575
## 3169 1659.284 1429.083 1889.485 1307.221 2011.346
## 3170 1659.742 1429.337 1890.148 1307.368 2012.117
## 3171 1660.201 1429.592 1890.810 1307.515 2012.888
## 3172 1660.660 1429.847 1891.473 1307.662 2013.658
## 3173 1661.119 1430.102 1892.136 1307.809 2014.429
## 3174 1661.578 1430.357 1892.799 1307.956 2015.199
## 3175 1662.036 1430.612 1893.461 1308.103 2015.970
## 3176 1662.495 1430.867 1894.124 1308.250 2016.740
## 3177 1662.954 1431.122 1894.786 1308.397 2017.511
## 3178 1663.413 1431.377 1895.449 1308.545 2018.281
## 3179 1663.872 1431.632 1896.111 1308.692 2019.051
## 3180 1664.330 1431.888 1896.773 1308.840 2019.821
## 3181 1664.789 1432.143 1897.436 1308.987 2020.591
## 3182 1665.248 1432.398 1898.098 1309.135 2021.361
## 3183 1665.707 1432.654 1898.760 1309.283 2022.131
## 3184 1666.166 1432.909 1899.422 1309.431 2022.901
## 3185 1666.624 1433.165 1900.084 1309.578 2023.671
## 3186 1667.083 1433.420 1900.746 1309.726 2024.440

```

```

## 3187 1667.542 1433.676 1901.408 1309.874 2025.210
## 3188 1668.001 1433.931 1902.070 1310.023 2025.979
## 3189 1668.460 1434.187 1902.732 1310.171 2026.749
## 3190 1668.918 1434.443 1903.394 1310.319 2027.518
## 3191 1669.377 1434.699 1904.056 1310.467 2028.287
## 3192 1669.836 1434.955 1904.718 1310.616 2029.056
## 3193 1670.295 1435.210 1905.379 1310.764 2029.826
## 3194 1670.754 1435.466 1906.041 1310.913 2030.595
## 3195 1671.213 1435.722 1906.703 1311.061 2031.364
## 3196 1671.671 1435.978 1907.364 1311.210 2032.132
## 3197 1672.130 1436.235 1908.026 1311.359 2032.901
## 3198 1672.589 1436.491 1908.687 1311.508 2033.670
## 3199 1673.048 1436.747 1909.349 1311.657 2034.439
## 3200 1673.507 1437.003 1910.010 1311.806 2035.207
## 3201 1673.965 1437.259 1910.671 1311.955 2035.976
## 3202 1674.424 1437.516 1911.333 1312.104 2036.744
## 3203 1674.883 1437.772 1911.994 1312.253 2037.513
## 3204 1675.342 1438.028 1912.655 1312.402 2038.281
## 3205 1675.801 1438.285 1913.316 1312.552 2039.049
## 3206 1676.259 1438.541 1913.977 1312.701 2039.817
## 3207 1676.718 1438.798 1914.638 1312.851 2040.585
## 3208 1677.177 1439.055 1915.299 1313.000 2041.354
## 3209 1677.636 1439.311 1915.960 1313.150 2042.121
## 3210 1678.095 1439.568 1916.621 1313.300 2042.889
## 3211 1678.553 1439.825 1917.282 1313.449 2043.657
## 3212 1679.012 1440.082 1917.943 1313.599 2044.425
## 3213 1679.471 1440.338 1918.603 1313.749 2045.193
## 3214 1679.930 1440.595 1919.264 1313.899 2045.960
## 3215 1680.389 1440.852 1919.925 1314.049 2046.728
## 3216 1680.847 1441.109 1920.585 1314.199 2047.495
## 3217 1681.306 1441.366 1921.246 1314.350 2048.263
## 3218 1681.765 1441.623 1921.907 1314.500 2049.030
## 3219 1682.224 1441.880 1922.567 1314.650 2049.797
## 3220 1682.683 1442.138 1923.228 1314.801 2050.564
## 3221 1683.141 1442.395 1923.888 1314.951 2051.332
## 3222 1683.600 1442.652 1924.548 1315.102 2052.099
## 3223 1684.059 1442.909 1925.209 1315.252 2052.866
## 3224 1684.518 1443.167 1925.869 1315.403 2053.633
## 3225 1684.977 1443.424 1926.529 1315.554 2054.399
## 3226 1685.435 1443.681 1927.189 1315.705 2055.166
## 3227 1685.894 1443.939 1927.849 1315.855 2055.933
## 3228 1686.353 1444.196 1928.510 1316.006 2056.700
## 3229 1686.812 1444.454 1929.170 1316.157 2057.466
## 3230 1687.271 1444.711 1929.830 1316.308 2058.233
## 3231 1687.729 1444.969 1930.490 1316.460 2058.999
## 3232 1688.188 1445.227 1931.150 1316.611 2059.765
## 3233 1688.647 1445.485 1931.809 1316.762 2060.532
## 3234 1689.106 1445.742 1932.469 1316.913 2061.298
## 3235 1689.565 1446.000 1933.129 1317.065 2062.064
## 3236 1690.023 1446.258 1933.789 1317.216 2062.830
## 3237 1690.482 1446.516 1934.448 1317.368 2063.596
## 3238 1690.941 1446.774 1935.108 1317.519 2064.362
## 3239 1691.400 1447.032 1935.768 1317.671 2065.128
## 3240 1691.859 1447.290 1936.427 1317.823 2065.894

```

```

## 3241      1692.317 1447.548 1937.087 1317.975 2066.660
## 3242      1692.776 1447.806 1937.746 1318.127 2067.426
## 3243      1693.235 1448.064 1938.406 1318.278 2068.191
## 3244      1693.694 1448.322 1939.065 1318.430 2068.957
## 3245      1694.153 1448.581 1939.725 1318.583 2069.723
## 3246      1694.611 1448.839 1940.384 1318.735 2070.488

```

#4) Microsoft

```
class(MSFT)
```

```
## [1] "xts" "zoo"
```

```
MSFT_close_price <- (MSFT[,4])
plot((MSFT_close_price))
```



```
class(MSFT_close_price)
```

```
## [1] "xts" "zoo"
```

```
print(adf.test(MSFT_close_price)) #P-value > 0.05 indicates non stationary data
```

```
## Warning in adf.test(MSFT_close_price): p-value greater than printed p-value
```

```

##  

##  Augmented Dickey-Fuller Test  

##  

## data: MSFT_close_price  

## Dickey-Fuller = -0.18412, Lag order = 13, p-value = 0.99  

## alternative hypothesis: stationary

auto.arima(MSFT_close_price, seasonal = FALSE)

## Series: MSFT_close_price
## ARIMA(5,2,0)
##  

## Coefficients:
##          ar1      ar2      ar3      ar4      ar5
##     -1.1345  -0.8642  -0.5125  -0.2833  -0.0585
## s.e.    0.0199   0.0296   0.0327   0.0296   0.0199
##  

## sigma^2 estimated as 2.291: log likelihood=-4607.53
## AIC=9227.06   AICc=9227.1   BIC=9262.04

par(mfrow = c(2,2))
pacf(MSFT_close_price)
acf(MSFT_close_price)

#Translating Raw price into logarithmic form to obtain returns

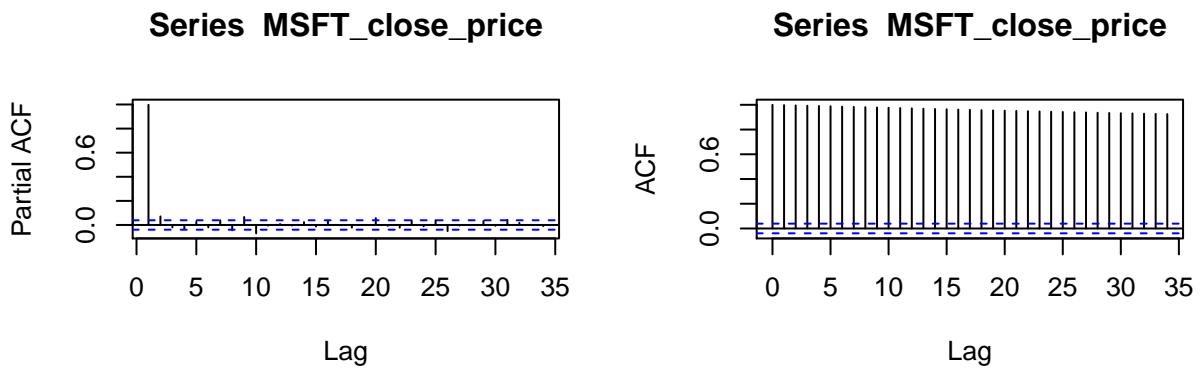
lnMSFT = log(MSFT_close_price)
head(lnMSFT)

##          MSFT.Close
## 2010-05-27  3.258097
## 2010-05-28  3.250374
## 2010-06-01  3.253857
## 2010-06-02  3.275634
## 2010-06-03  3.290638
## 2010-06-04  3.249987

#Checking for stationarity

par(mfrow = c(2,2))

```



```
acf(lnMSFT, lag.max = 200, main = "ACF for Microsoft Series")
pacf(lnMSFT, lag.max = 200, main = "PACF for Microsoft Series")
print(adf.test(lnMSFT)) #P-value > 0.05 indicates non stationary data
```

```
##
## Augmented Dickey-Fuller Test
##
## data: lnMSFT
## Dickey-Fuller = -2.4475, Lag order = 13, p-value = 0.3888
## alternative hypothesis: stationary
```

#Differencing the data to turn into stationary data

```
diffLnMSFT = diff(lnMSFT,)
head(diffLnMSFT)
```

```
##               MSFT.Close
## 2010-05-27      NA
## 2010-05-28 -0.007722085
## 2010-06-01  0.003482302
## 2010-06-02  0.021777366
## 2010-06-03  0.015004107
## 2010-06-04 -0.040651370
```

```

adf.test(lnMSFT)

##
##  Augmented Dickey-Fuller Test
##
## data: lnMSFT
## Dickey-Fuller = -2.4475, Lag order = 13, p-value = 0.3888
## alternative hypothesis: stationary

adf.test(diffLnMSFT[2:1259]) # p-value < 0.05 indication stationary data. Model fitting to continue

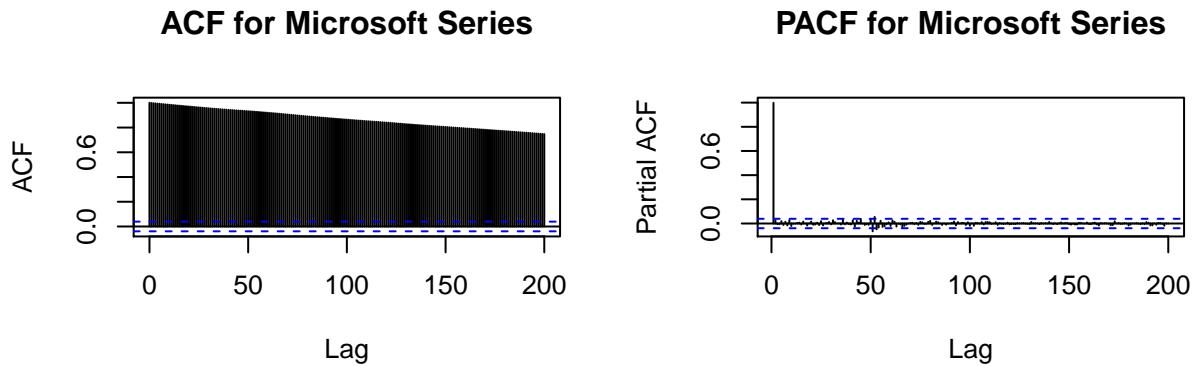
## Warning in adf.test(diffLnMSFT[2:1259, ]): p-value smaller than printed p-value

##
##  Augmented Dickey-Fuller Test
##
## data: diffLnMSFT[2:1259, ]
## Dickey-Fuller = -11.475, Lag order = 10, p-value = 0.01
## alternative hypothesis: stationary

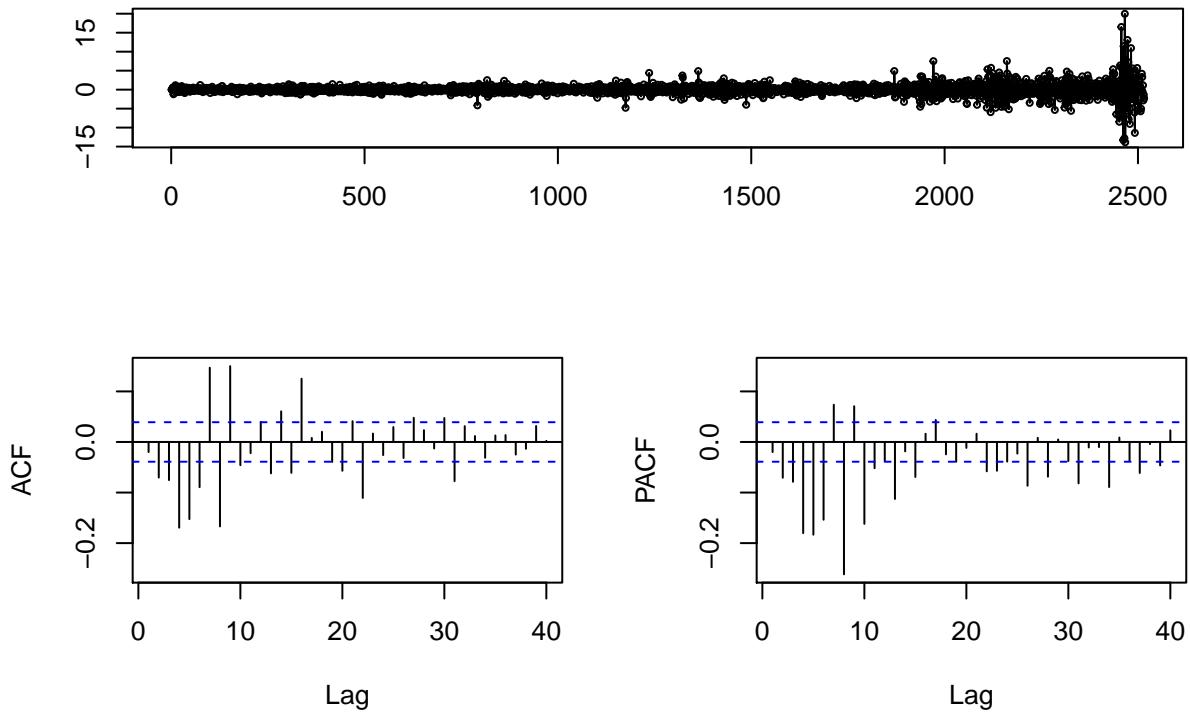
#Trying different fits

fitA = auto.arima(MSFT_close_price, seasonal = FALSE)
tsdisplay(residuals(fitA), lag.max = 40, main = '3,1,1 Model Residuals')

```



3,1,1 Model Residuals

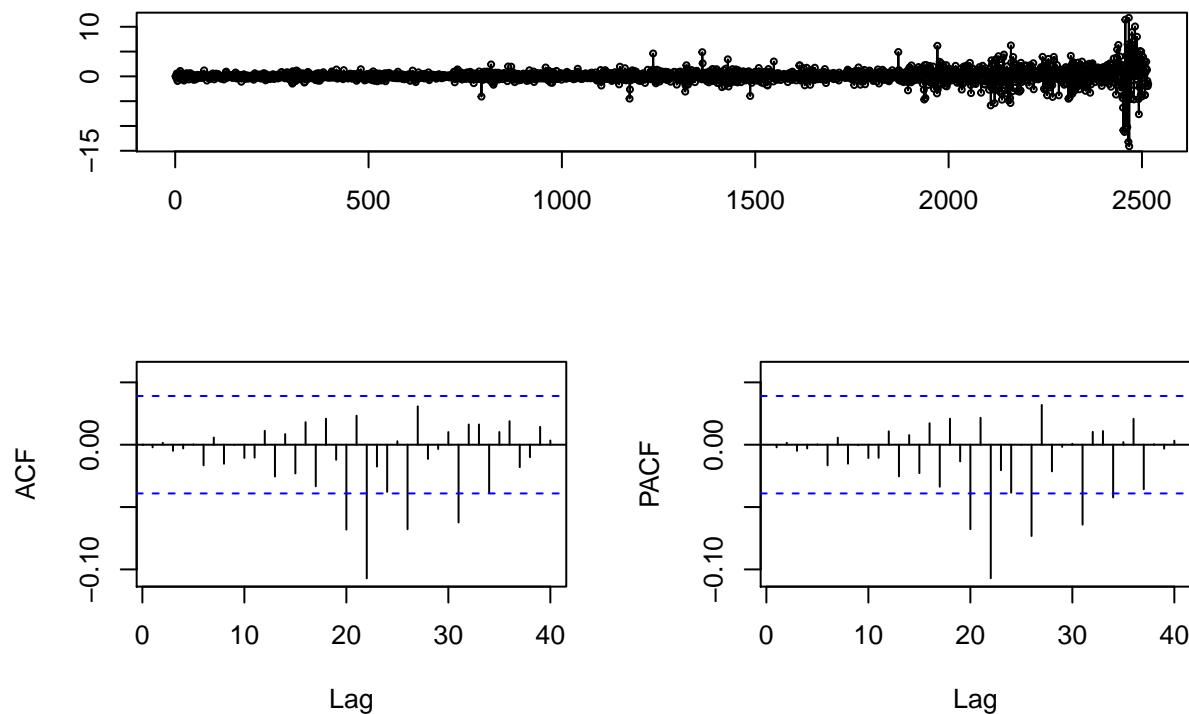


```
auto.arima(MSFT_close_price, seasonal = FALSE)

## Series: MSFT_close_price
## ARIMA(5,2,0)
##
## Coefficients:
##          ar1      ar2      ar3      ar4      ar5
##        -1.1345  -0.8642  -0.5125  -0.2833  -0.0585
##  s.e.    0.0199   0.0296   0.0327   0.0296   0.0199
##
## sigma^2 estimated as 2.291:  log likelihood=-4607.53
## AIC=9227.06  AICc=9227.1  BIC=9262.04

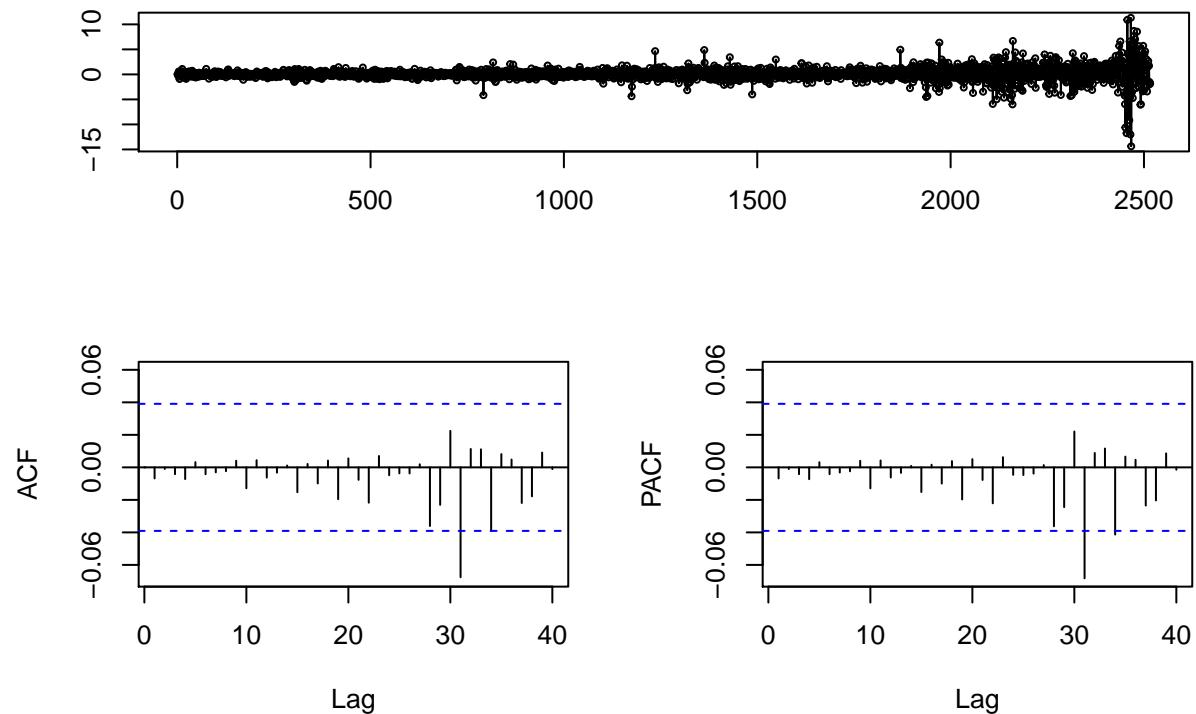
fitB = arima(MSFT_close_price, order = c(1,1,19))
tsdisplay(residuals(fitB), lag.max = 40, main = '(1,1,19) Model Residuals')
```

(1,1,19) Model Residuals



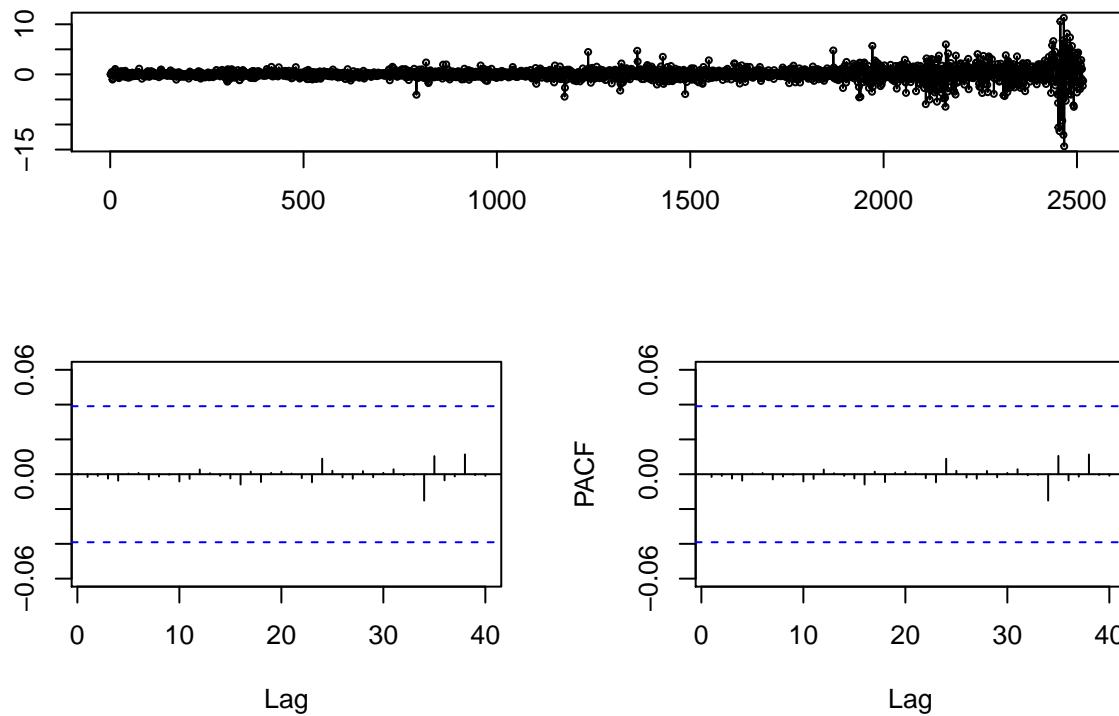
```
fitC = arima(MSFT_close_price, order = c(1,1,28))
tsdisplay(residuals(fitC), lag.max = 40, main = '(1,1,28) Model Residuals')
```

(1,1,28) Model Residuals



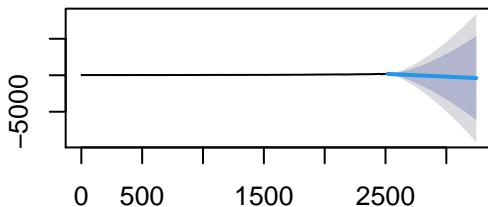
```
fitD = arima(MSFT_close_price, order = c(1,2,40))
tsdisplay(residuals(fitD), lag.max = 40, main = '(1,2,40) Model Residuals')
```

(1,2,40) Model Residuals

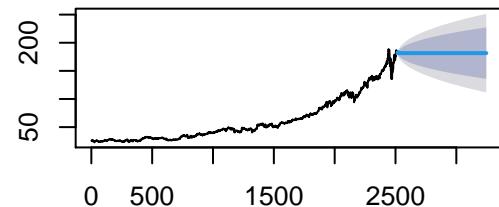


```
par(mfrow = c(2,2))
term <- 730
fcast1 <- forecast(fitA, h = term)
plot(fcast1)
fcast2 <- forecast(fitB, h = term)
plot(fcast2)
fcast3 <- forecast(fitC, h = term)
plot(fcast3)
fcast4 <- forecast(fitD, h = term)
plot(fcast4)
```

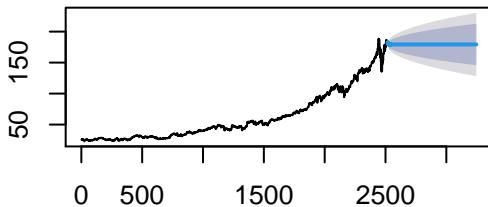
Forecasts from ARIMA(5,2,0)



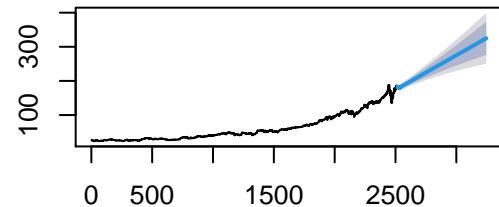
Forecasts from ARIMA(1,1,19)



Forecasts from ARIMA(1,1,28)



Forecasts from ARIMA(1,2,40)



```
print(fcast4)
```

```
##      Point Forecast     Lo 80     Hi 80     Lo 95     Hi 95
## 2517    182.5733 180.9323 184.2143 180.0637 185.0830
## 2518    182.5177 180.4626 184.5727 179.3748 185.6605
## 2519    181.4292 179.0064 183.8519 177.7238 185.1345
## 2520    183.0628 180.2421 185.8835 178.7489 187.3766
## 2521    180.7688 177.6704 183.8671 176.0302 185.5073
## 2522    182.8971 179.5412 186.2531 177.7646 188.0296
## 2523    182.0705 178.5150 185.6260 176.6328 187.5082
## 2524    180.9297 177.0957 184.7637 175.0662 186.7933
## 2525    180.4250 176.4374 184.4126 174.3266 186.5234
## 2526    180.5899 176.3670 184.8129 174.1315 187.0484
## 2527    180.7540 176.3414 185.1666 174.0055 187.5025
## 2528    180.6504 176.0687 185.2320 173.6433 187.6574
## 2529    180.8940 176.1157 185.6724 173.5862 188.2019
## 2530    180.6052 175.6793 185.5311 173.0717 188.1387
## 2531    181.1314 176.0282 186.2347 173.3267 188.9362
## 2532    180.0810 174.8443 185.3177 172.0722 188.0899
## 2533    180.2081 174.7917 185.6245 171.9245 188.4918
## 2534    180.7593 175.1765 186.3422 172.2211 189.2976
## 2535    180.4211 174.6923 186.1498 171.6597 189.1825
## 2536    180.6162 174.7483 186.4841 171.6420 189.5904
## 2537    180.4972 174.5286 186.4658 171.3690 189.6254
## 2538    181.5842 175.4980 187.6705 172.2761 190.8924
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## 2539 181.4406 175.2809 187.6002 172.0202 190.8609
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## 2551 183.9150 177.1914 190.6385 173.6321 194.1978
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## 2564 186.8118 179.7315 193.8921 175.9834 197.6401
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## 2663 206.8654 196.2824 217.4485 190.6801 223.0508
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## 2712      216.7910 203.9974 229.5847 197.2249 236.3572
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## 2838      242.3140 222.7715 261.8565 212.4263 272.2017
## 2839      242.5166 222.9153 262.1179 212.5389 272.4942
## 2840      242.7191 223.0589 262.3793 212.6514 272.7868
## 2841      242.9217 223.2025 262.6409 212.7638 273.0796
## 2842      243.1243 223.3460 262.9025 212.8761 273.3725
## 2843      243.3268 223.4895 263.1642 212.9882 273.6654
## 2844      243.5294 223.6328 263.4259 213.1002 273.9585
## 2845      243.7319 223.7761 263.6878 213.2121 274.2517
## 2846      243.9345 223.9193 263.9497 213.3239 274.5451
## 2847      244.1371 224.0625 264.2117 213.4356 274.8385
## 2848      244.3396 224.2055 264.4737 213.5472 275.1321
## 2849      244.5422 224.3485 264.7359 213.6587 275.4257
## 2850      244.7448 224.4915 264.9981 213.7700 275.7195
## 2851      244.9473 224.6343 265.2604 213.8812 276.0134
## 2852      245.1499 224.7771 265.5227 213.9924 276.3074
## 2853      245.3525 224.9198 265.7851 214.1034 276.6015
## 2854      245.5550 225.0624 266.0476 214.2142 276.8958
## 2855      245.7576 225.2049 266.3102 214.3250 277.1901
## 2856      245.9601 225.3474 266.5729 214.4357 277.4846
## 2857      246.1627 225.4898 266.8356 214.5463 277.7792
## 2858      246.3653 225.6321 267.0984 214.6567 278.0738
## 2859      246.5678 225.7744 267.3613 214.7670 278.3686
## 2860      246.7704 225.9166 267.6242 214.8772 278.6635
## 2861      246.9730 226.0587 267.8872 214.9874 278.9586
## 2862      247.1755 226.2007 268.1503 215.0974 279.2537

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## 2863      247.3781 226.3427 268.4135 215.2072 279.5489
## 2864      247.5806 226.4846 268.6767 215.3170 279.8443
## 2865      247.7832 226.6264 268.9400 215.4267 280.1397
## 2866      247.9858 226.7682 269.2034 215.5362 280.4353
## 2867      248.1883 226.9098 269.4668 215.6457 280.7310
## 2868      248.3909 227.0515 269.7303 215.7550 281.0268
## 2869      248.5935 227.1930 269.9939 215.8643 281.3227
## 2870      248.7960 227.3344 270.2576 215.9734 281.6187
## 2871      248.9986 227.4758 270.5213 216.0824 281.9148
## 2872      249.2012 227.6172 270.7851 216.1913 282.2110
## 2873      249.4037 227.7584 271.0490 216.3001 282.5074
## 2874      249.6063 227.8996 271.3130 216.4088 282.8038
## 2875      249.8088 228.0407 271.5770 216.5173 283.1004
## 2876      250.0114 228.1817 271.8411 216.6258 283.3970
## 2877      250.2140 228.3227 272.1053 216.7341 283.6938
## 2878      250.4165 228.4636 272.3695 216.8424 283.9907
## 2879      250.6191 228.6044 272.6338 216.9505 284.2877
## 2880      250.8217 228.7452 272.8982 217.0586 284.5848
## 2881      251.0242 228.8858 273.1626 217.1665 284.8820
## 2882      251.2268 229.0264 273.4271 217.2743 285.1793
## 2883      251.4293 229.1670 273.6917 217.3820 285.4767
## 2884      251.6319 229.3075 273.9564 217.4896 285.7742
## 2885      251.8345 229.4479 274.2211 217.5971 286.0718
## 2886      252.0370 229.5882 274.4859 217.7045 286.3696
## 2887      252.2396 229.7285 274.7507 217.8118 286.6674
## 2888      252.4422 229.8686 275.0157 217.9189 286.9654
## 2889      252.6447 230.0088 275.2807 218.0260 287.2634
## 2890      252.8473 230.1488 275.5458 218.1330 287.5616
## 2891      253.0499 230.2888 275.8109 218.2398 287.8599
## 2892      253.2524 230.4287 276.0761 218.3466 288.1582
## 2893      253.4550 230.5686 276.3414 218.4532 288.4567
## 2894      253.6575 230.7083 276.6067 218.5598 288.7553
## 2895      253.8601 230.8481 276.8722 218.6662 289.0540
## 2896      254.0627 230.9877 277.1376 218.7725 289.3528
## 2897      254.2652 231.1273 277.4032 218.8788 289.6517
## 2898      254.4678 231.2668 277.6688 218.9849 289.9507
## 2899      254.6704 231.4062 277.9345 219.0909 290.2498
## 2900      254.8729 231.5456 278.2003 219.1968 290.5490
## 2901      255.0755 231.6849 278.4661 219.3026 290.8484
## 2902      255.2780 231.8241 278.7320 219.4083 291.1478
## 2903      255.4806 231.9632 278.9980 219.5139 291.4473
## 2904      255.6832 232.1023 279.2640 219.6194 291.7470
## 2905      255.8857 232.2414 279.5301 219.7248 292.0467
## 2906      256.0883 232.3803 279.7963 219.8301 292.3465
## 2907      256.2909 232.5192 280.0625 219.9353 292.6465
## 2908      256.4934 232.6580 280.3288 220.0403 292.9465
## 2909      256.6960 232.7968 280.5952 220.1453 293.2467
## 2910      256.8986 232.9355 280.8616 220.2502 293.5469
## 2911      257.1011 233.0741 281.1281 220.3550 293.8473
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## 2913      257.5062 233.3511 281.6614 220.5642 294.4483
## 2914      257.7088 233.4895 281.9281 220.6686 294.7490
## 2915      257.9114 233.6279 282.1948 220.7730 295.0497
## 2916      258.1139 233.7662 282.4617 220.8773 295.3506

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## 2917      258.3165 233.9044 282.7286 220.9814 295.6516
## 2918      258.5191 234.0426 282.9956 221.0855 295.9526
## 2919      258.7216 234.1806 283.2626 221.1894 296.2538
## 2920      258.9242 234.3187 283.5297 221.2933 296.5551
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## 2922      259.3293 234.5945 284.0641 221.5007 297.1579
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## 2924      259.7344 234.8701 284.5988 221.7077 297.7612
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## 2931      261.1524 235.8325 286.4723 222.4290 299.8758
## 2932      261.3549 235.9697 286.7402 222.5316 300.1783
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## 2935      261.9626 236.3810 287.5442 222.8389 301.0863
## 2936      262.1652 236.5180 287.8124 222.9412 301.3892
## 2937      262.3678 236.6549 288.0806 223.0433 301.6922
## 2938      262.5703 236.7917 288.3489 223.1454 301.9953
## 2939      262.7729 236.9285 288.6173 223.2473 302.2985
## 2940      262.9754 237.0652 288.8857 223.3492 302.6017
## 2941      263.1780 237.2019 289.1542 223.4509 302.9051
## 2942      263.3806 237.3384 289.4227 223.5526 303.2086
## 2943      263.5831 237.4750 289.6913 223.6541 303.5122
## 2944      263.7857 237.6114 289.9600 223.7556 303.8158
## 2945      263.9883 237.7478 290.2287 223.8569 304.1196
## 2946      264.1908 237.8841 290.4975 223.9582 304.4235
## 2947      264.3934 238.0204 290.7664 224.0593 304.7274
## 2948      264.5960 238.1566 291.0353 224.1604 305.0315
## 2949      264.7985 238.2927 291.3043 224.2614 305.3357
## 2950      265.0011 238.4288 291.5734 224.3622 305.6399
## 2951      265.2036 238.5648 291.8425 224.4630 305.9443
## 2952      265.4062 238.7007 292.1117 224.5637 306.2487
## 2953      265.6088 238.8366 292.3810 224.6642 306.5533
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## 2971      269.2549 241.2716 297.2383 226.4581 312.0518
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## 2973      269.6600 241.5409 297.7792 226.6555 312.6646
## 2974      269.8626 241.6754 298.0498 226.7540 312.9712
## 2975      270.0652 241.8099 298.3204 226.8525 313.2778
## 2976      270.2677 241.9443 298.5911 226.9509 313.5846
## 2977      270.4703 242.0787 298.8619 227.0491 313.8914
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## 2979      270.8754 242.3473 299.4035 227.2454 314.5054
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## 2982      271.4831 242.7497 300.2166 227.5391 315.4271
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## 2984      271.8882 243.0176 300.7589 227.7344 316.0420
## 2985      272.0908 243.1515 301.0301 227.8319 316.3497
## 2986      272.2934 243.2853 301.3014 227.9294 316.6573
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## 2992      273.5087 244.0869 302.9305 228.5120 318.5055
## 2993      273.7113 244.2203 303.2023 228.6088 318.8138
## 2994      273.9139 244.3537 303.4741 228.7054 319.1223
## 2995      274.1164 244.4869 303.7459 228.8020 319.4308
## 2996      274.3190 244.6201 304.0178 228.8985 319.7394
## 2997      274.5216 244.7533 304.2898 228.9949 320.0482
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## 2999      274.9267 245.0194 304.8339 229.1875 320.6659
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## 3001      275.3318 245.2853 305.3783 229.3796 321.2840
## 3002      275.5344 245.4181 305.6506 229.4756 321.5931
## 3003      275.7369 245.5509 305.9229 229.5714 321.9024
## 3004      275.9395 245.6837 306.1953 229.6672 322.2118
## 3005      276.1421 245.8163 306.4678 229.7629 322.5212
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## 3014      277.9651 247.0077 308.9226 230.6198 325.3104
## 3015      278.1677 247.1398 309.1956 230.7146 325.6208
## 3016      278.3703 247.2718 309.4687 230.8092 325.9313
## 3017      278.5728 247.4037 309.7419 230.9038 326.2418
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## 3022      279.5856 248.0626 311.1086 231.3754 327.7959
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## 3024      279.9908 248.3258 311.6557 231.5634 328.4181

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## 3025      280.1933 248.4573 311.9294 231.6572 328.7294
## 3026      280.3959 248.5887 312.2031 231.7510 329.0408
## 3027      280.5984 248.7201 312.4768 231.8447 329.3522
## 3028      280.8010 248.8514 312.7506 231.9383 329.6638
## 3029      281.0036 248.9826 313.0245 232.0318 329.9754
## 3030      281.2061 249.1138 313.2984 232.1252 330.2871
## 3031      281.4087 249.2450 313.5724 232.2185 330.5989
## 3032      281.6113 249.3760 313.8465 232.3117 330.9108
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## 3036      282.4215 249.8998 314.9433 232.6838 332.1592
## 3037      282.6241 250.0306 315.2176 232.7766 332.4716
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## 3054      286.0677 252.2451 319.8902 234.3406 337.7947
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## 3057      286.6753 252.6342 320.7165 234.6139 338.7367
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## 3059      287.0805 252.8933 321.2676 234.7958 339.3652
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## 3086      292.5497 256.3693 328.7300 237.2166 347.8827
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## 3130      301.4625 261.9480 340.9769 241.0303 361.8946
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## 3144      304.2983 263.7012 344.8955 242.2104 366.3863
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## 3149      305.3112 264.3248 346.2975 242.6280 367.9943
## 3150      305.5137 264.4494 346.5780 242.7113 368.3162
## 3151      305.7163 264.5739 346.8586 242.7945 368.6381
## 3152      305.9188 264.6984 347.1393 242.8776 368.9601
## 3153      306.1214 264.8228 347.4200 242.9607 369.2822
## 3154      306.3240 264.9472 347.7008 243.0436 369.6043
## 3155      306.5265 265.0715 347.9816 243.1265 369.9266
## 3156      306.7291 265.1957 348.2625 243.2093 370.2489
## 3157      306.9317 265.3199 348.5434 243.2920 370.5713
## 3158      307.1342 265.4441 348.8243 243.3747 370.8938
## 3159      307.3368 265.5682 349.1054 243.4572 371.2163
## 3160      307.5393 265.6922 349.3865 243.5397 371.5390
## 3161      307.7419 265.8162 349.6676 243.6221 371.8617
## 3162      307.9445 265.9402 349.9488 243.7045 372.1845
## 3163      308.1470 266.0641 350.2300 243.7867 372.5074
## 3164      308.3496 266.1879 350.5113 243.8689 372.8303
## 3165      308.5522 266.3117 350.7926 243.9510 373.1534
## 3166      308.7547 266.4354 351.0740 244.0330 373.4765
## 3167      308.9573 266.5591 351.3554 244.1149 373.7997
## 3168      309.1599 266.6828 351.6369 244.1968 374.1230
## 3169      309.3624 266.8064 351.9185 244.2785 374.4463
## 3170      309.5650 266.9299 352.2001 244.3602 374.7697
## 3171      309.7675 267.0534 352.4817 244.4418 375.0933
## 3172      309.9701 267.1768 352.7634 244.5234 375.4168
## 3173      310.1727 267.3002 353.0452 244.6048 375.7405
## 3174      310.3752 267.4235 353.3270 244.6862 376.0643
## 3175      310.5778 267.5468 353.6088 244.7675 376.3881
## 3176      310.7804 267.6700 353.8907 244.8487 376.7120
## 3177      310.9829 267.7932 354.1727 244.9299 377.0360
## 3178      311.1855 267.9163 354.4547 245.0109 377.3600
## 3179      311.3881 268.0393 354.7368 245.0919 377.6842
## 3180      311.5906 268.1624 355.0189 245.1728 378.0084
## 3181      311.7932 268.2853 355.3010 245.2537 378.3327
## 3182      311.9957 268.4082 355.5832 245.3344 378.6571
## 3183      312.1983 268.5311 355.8655 245.4151 378.9815
## 3184      312.4009 268.6539 356.1478 245.4957 379.3061
## 3185      312.6034 268.7767 356.4302 245.5762 379.6307
## 3186      312.8060 268.8994 356.7126 245.6566 379.9554

```

```

## 3187      313.0086 269.0220 356.9951 245.7370 380.2801
## 3188      313.2111 269.1446 357.2776 245.8173 380.6050
## 3189      313.4137 269.2672 357.5602 245.8975 380.9299
## 3190      313.6162 269.3897 357.8428 245.9776 381.2549
## 3191      313.8188 269.5122 358.1255 246.0576 381.5800
## 3192      314.0214 269.6346 358.4082 246.1376 381.9051
## 3193      314.2239 269.7569 358.6910 246.2175 382.2304
## 3194      314.4265 269.8792 358.9738 246.2973 382.5557
## 3195      314.6291 270.0015 359.2567 246.3770 382.8811
## 3196      314.8316 270.1237 359.5396 246.4567 383.2065
## 3197      315.0342 270.2458 359.8226 246.5363 383.5321
## 3198      315.2368 270.3679 360.1056 246.6158 383.8577
## 3199      315.4393 270.4900 360.3887 246.6952 384.1834
## 3200      315.6419 270.6120 360.6718 246.7746 384.5092
## 3201      315.8444 270.7339 360.9550 246.8538 384.8350
## 3202      316.0470 270.8558 361.2382 246.9330 385.1610
## 3203      316.2496 270.9777 361.5215 247.0122 385.4870
## 3204      316.4521 271.0995 361.8048 247.0912 385.8131
## 3205      316.6547 271.2212 362.0882 247.1702 386.1392
## 3206      316.8573 271.3429 362.3716 247.2491 386.4655
## 3207      317.0598 271.4645 362.6551 247.3279 386.7918
## 3208      317.2624 271.5861 362.9386 247.4066 387.1182
## 3209      317.4649 271.7077 363.2222 247.4853 387.4446
## 3210      317.6675 271.8292 363.5058 247.5638 387.7712
## 3211      317.8701 271.9506 363.7895 247.6423 388.0978
## 3212      318.0726 272.0720 364.0733 247.7208 388.4245
## 3213      318.2752 272.1934 364.3570 247.7991 388.7513
## 3214      318.4778 272.3147 364.6409 247.8774 389.0781
## 3215      318.6803 272.4359 364.9247 247.9556 389.4051
## 3216      318.8829 272.5571 365.2087 248.0337 389.7321
## 3217      319.0855 272.6782 365.4927 248.1117 390.0592
## 3218      319.2880 272.7993 365.7767 248.1897 390.3863
## 3219      319.4906 272.9204 366.0608 248.2676 390.7135
## 3220      319.6931 273.0414 366.3449 248.3454 391.0409
## 3221      319.8957 273.1623 366.6291 248.4232 391.3682
## 3222      320.0983 273.2832 366.9133 248.5008 391.6957
## 3223      320.3008 273.4041 367.1976 248.5784 392.0232
## 3224      320.5034 273.5249 367.4819 248.6559 392.3509
## 3225      320.7060 273.6456 367.7663 248.7334 392.6786
## 3226      320.9085 273.7663 368.0507 248.8107 393.0063
## 3227      321.1111 273.8869 368.3352 248.8880 393.3342
## 3228      321.3136 274.0075 368.6197 248.9652 393.6621
## 3229      321.5162 274.1281 368.9043 249.0423 393.9901
## 3230      321.7188 274.2486 369.1890 249.1194 394.3181
## 3231      321.9213 274.3690 369.4736 249.1964 394.6463
## 3232      322.1239 274.4894 369.7584 249.2733 394.9745
## 3233      322.3265 274.6098 370.0431 249.3501 395.3028
## 3234      322.5290 274.7301 370.3280 249.4269 395.6312
## 3235      322.7316 274.8503 370.6128 249.5035 395.9596
## 3236      322.9342 274.9705 370.8978 249.5801 396.2882
## 3237      323.1367 275.0907 371.1827 249.6567 396.6168
## 3238      323.3393 275.2108 371.4678 249.7331 396.9454
## 3239      323.5418 275.3309 371.7528 249.8095 397.2742
## 3240      323.7444 275.4509 372.0379 249.8858 397.6030

```

```

## 3241      323.9470 275.5708 372.3231 249.9620 397.9319
## 3242      324.1495 275.6907 372.6083 250.0382 398.2609
## 3243      324.3521 275.8106 372.8936 250.1143 398.5899
## 3244      324.5547 275.9304 373.1789 250.1903 398.9191
## 3245      324.7572 276.0502 373.4643 250.2662 399.2483
## 3246      324.9598 276.1699 373.7497 250.3420 399.5775

```

#5) Nasdaq

```
class(NDAQ)
```

```
## [1] "xts" "zoo"
```

```
NDAQ_close_price <- (NDAQ[,4])
plot((NDAQ_close_price))
```



```
class(NDAQ_close_price)
```

```
## [1] "xts" "zoo"
```

```
print(adf.test(NDAQ_close_price)) #P-value < 0.05 indicates stationary data
```

```
##
```

```

##  Augmented Dickey-Fuller Test
##
## data: NDAQ_close_price
## Dickey-Fuller = -3.4999, Lag order = 13, p-value = 0.04229
## alternative hypothesis: stationary

auto.arima(NDAQ_close_price, seasonal = FALSE)

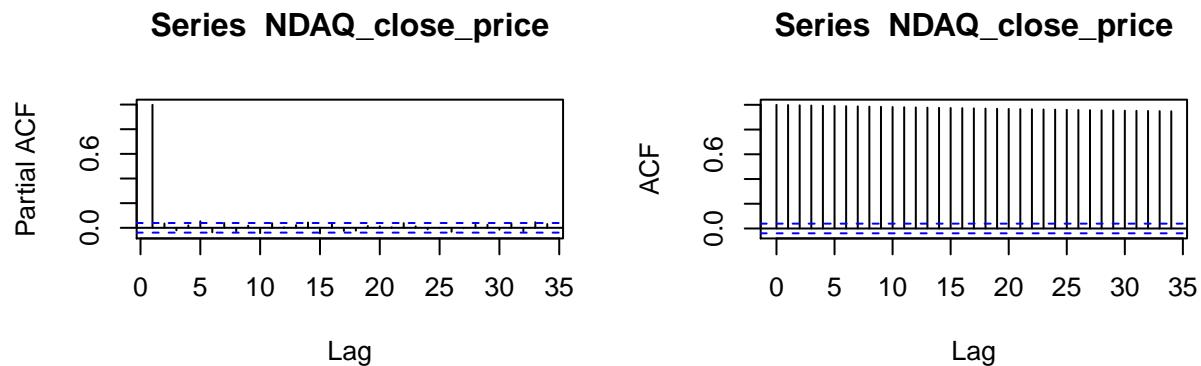
## Series: NDAQ_close_price
## ARIMA(4,1,4) with drift
##
## Coefficients:
##          ar1      ar2      ar3      ar4      ma1      ma2      ma3      ma4
##         -0.4556   0.4208  -0.4570  -0.7842   0.3934  -0.3814   0.4492   0.6070
##  s.e.    0.0362   0.0422   0.0493   0.0393   0.0453   0.0516   0.0610   0.0491
##          drift
##         0.0388
##  s.e.   0.0174
##
## sigma^2 estimated as 0.9233: log likelihood=-3464.02
## AIC=6948.03   AICc=6948.12   BIC=7006.33

par(mfrow = c(2,2))
pacf(NDAQ_close_price)
acf(NDAQ_close_price)

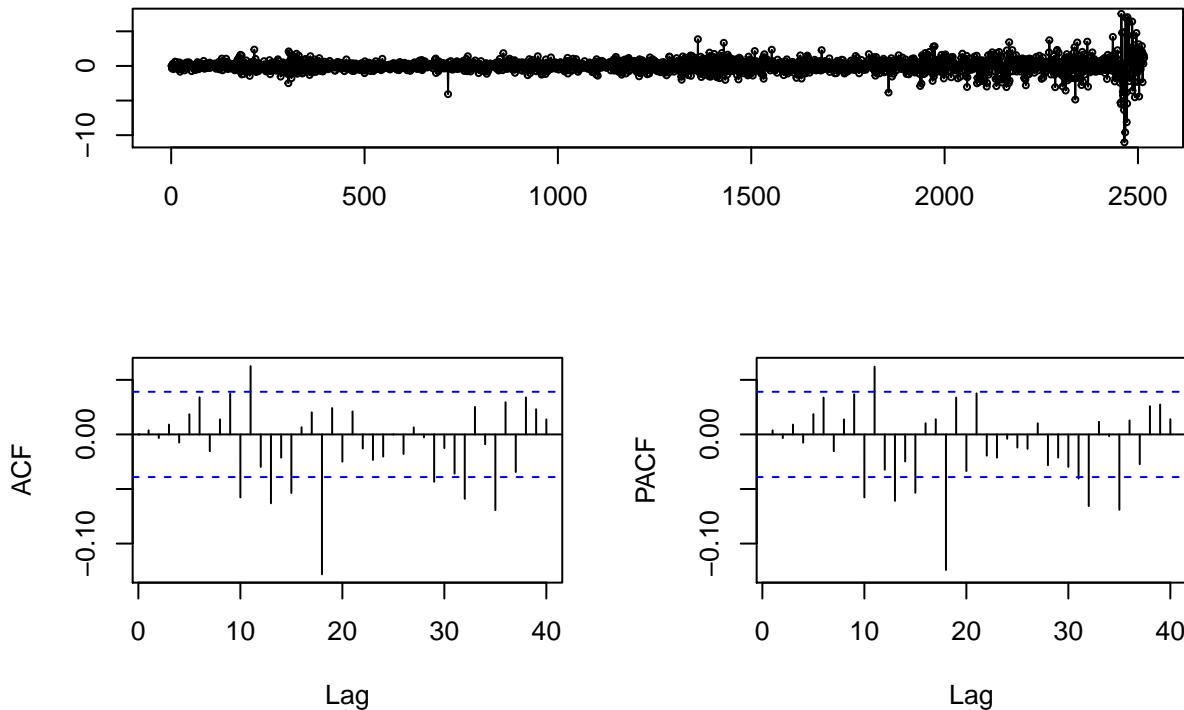
#Trying different fits

fitA = auto.arima(NDAQ_close_price, seasonal = FALSE)
tsdisplay(residuals(fitA), lag.max = 40, main = '4,1,4 Model Residuals')

```



4,1,4 Model Residuals

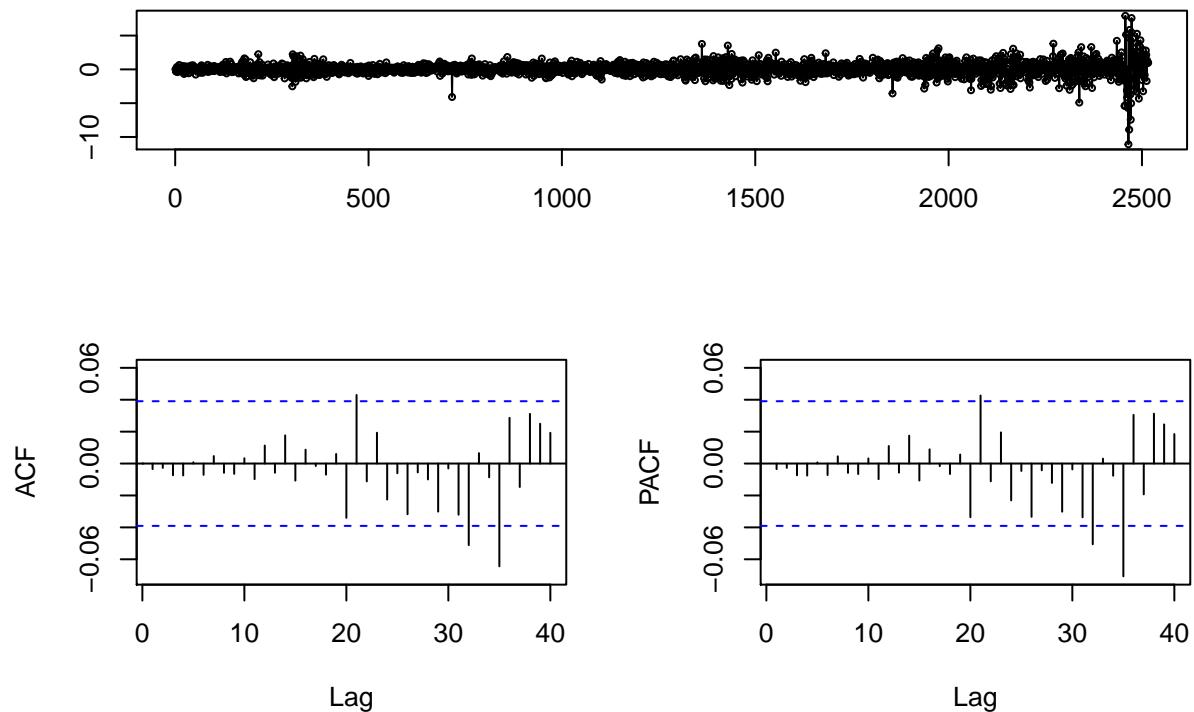


```
auto.arima(NDAQ_close_price, seasonal = FALSE)

## Series: NDAQ_close_price
## ARIMA(4,1,4) with drift
##
## Coefficients:
##      ar1     ar2     ar3     ar4     ma1     ma2     ma3     ma4
##     -0.4556   0.4208  -0.4570  -0.7842   0.3934  -0.3814   0.4492   0.6070
##  s.e.    0.0362   0.0422   0.0493   0.0393   0.0453   0.0516   0.0610   0.0491
##      drift
##     0.0388
##  s.e.  0.0174
##
## sigma^2 estimated as 0.9233: log likelihood=-3464.02
## AIC=6948.03   AICc=6948.12   BIC=7006.33

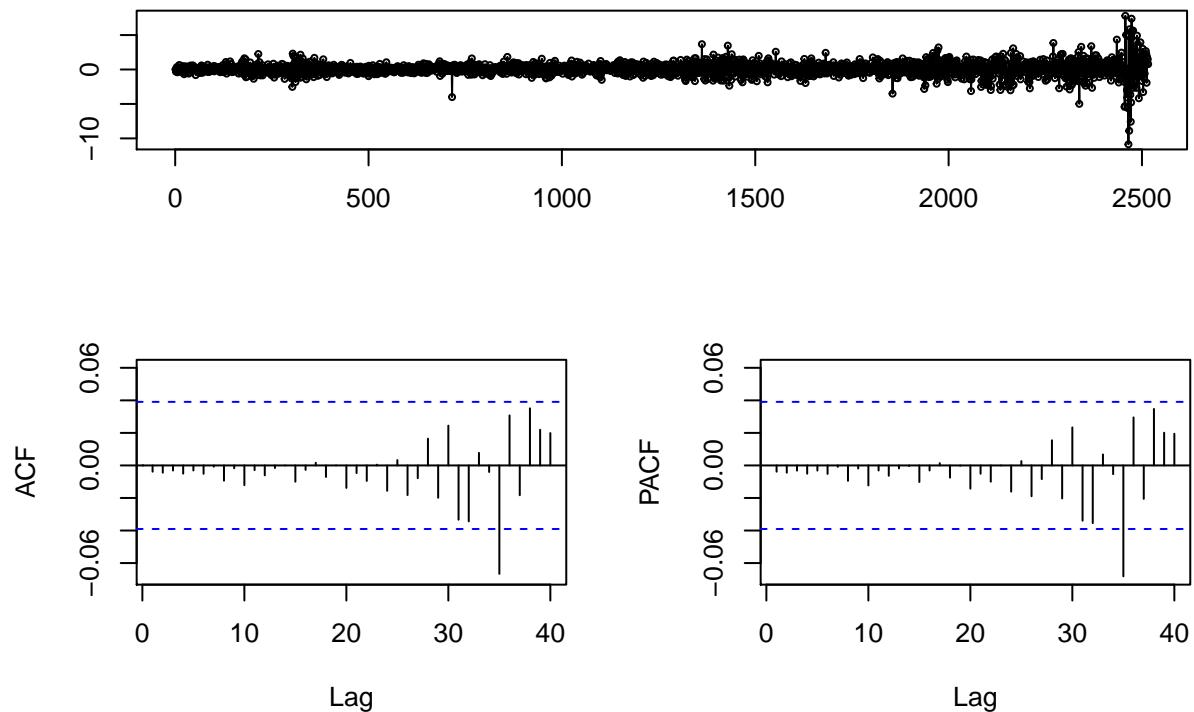
fitB = arima(NDAQ_close_price, order = c(1,1,19))
tsdisplay(residuals(fitB), lag.max = 40, main = '(1,1,19) Model Residuals')
```

(1,1,19) Model Residuals



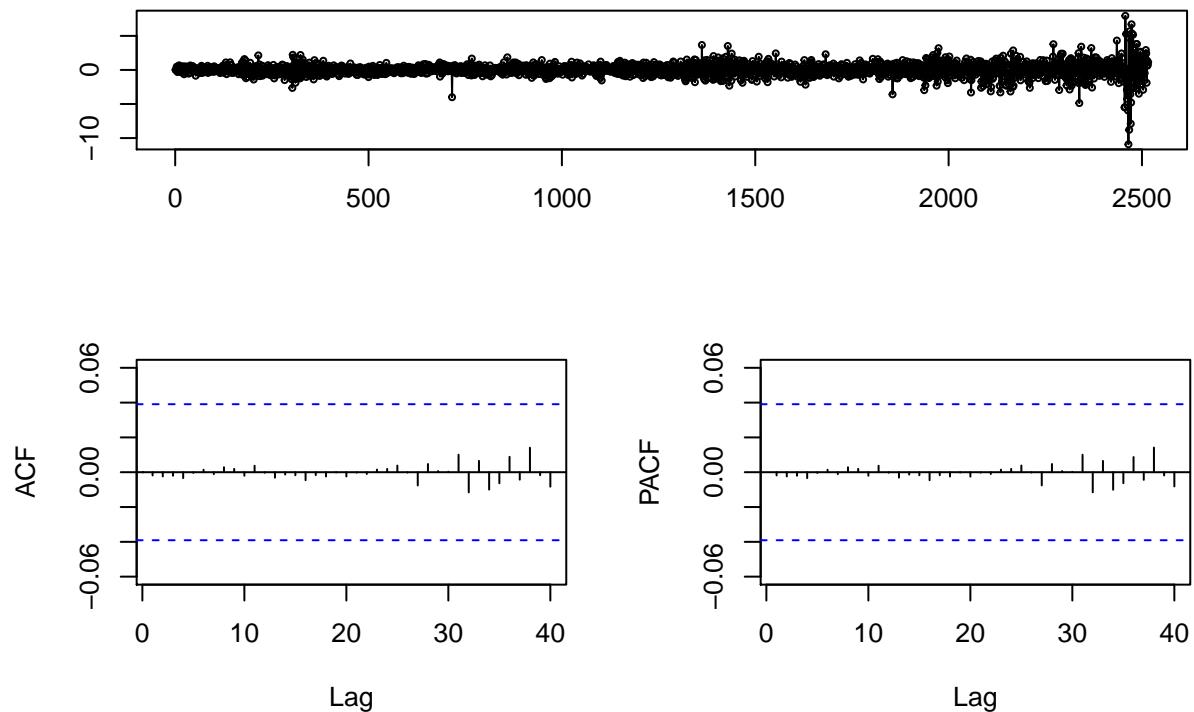
```
fitC = arima(NDAQ_close_price, order = c(1,1,28))
tsdisplay(residuals(fitC), lag.max = 40, main = '(1,1,28) Model Residuals')
```

(1,1,28) Model Residuals



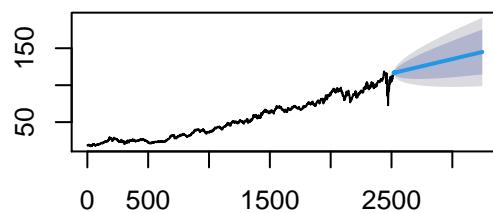
```
fitD = arima(NDAQ_close_price, order = c(1,2,40))
tsdisplay(residuals(fitD), lag.max = 40, main = '(1,2,40) Model Residuals')
```

(1,2,40) Model Residuals

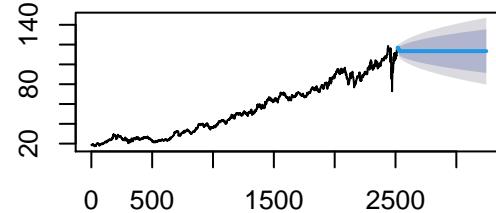


```
par(mfrow = c(2,2))
term <- 730
fcast1 <- forecast(fitA, h = term)
plot(fcast1)
fcast2 <- forecast(fitB, h = term)
plot(fcast2)
fcast3 <- forecast(fitC, h = term)
plot(fcast3)
fcast4 <- forecast(fitD, h = term)
plot(fcast4)
```

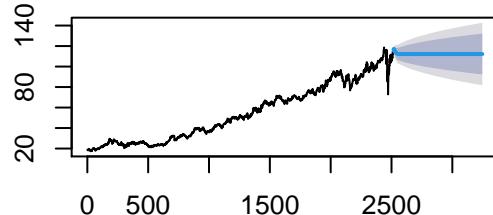
Forecasts from ARIMA(4,1,4) with drift



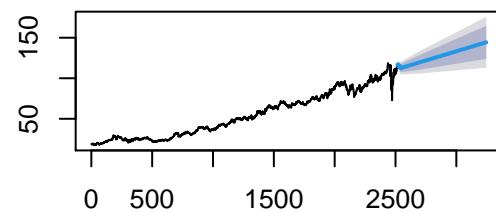
Forecasts from ARIMA(1,1,19)



Forecasts from ARIMA(1,1,28)



Forecasts from ARIMA(1,2,40)



```
print(fcast4)
```

```
##      Point Forecast     Lo 80     Hi 80     Lo 95     Hi 95
## 2517    116.7115 115.5169 117.9060 114.8846 118.5383
## 2518    117.2365 115.5894 118.8836 114.7175 119.7555
## 2519    116.3650 114.3283 118.4017 113.2501 119.4799
## 2520    116.2553 113.9312 118.5795 112.7009 119.8098
## 2521    115.9227 113.3903 118.4552 112.0497 119.7958
## 2522    115.9039 113.1646 118.6432 111.7144 120.0933
## 2523    115.7409 112.8303 118.6516 111.2894 120.1924
## 2524    115.6430 112.5155 118.7704 110.8599 120.4260
## 2525    115.7996 112.4844 119.1147 110.7294 120.8697
## 2526    115.3866 111.8444 118.9289 109.9693 120.8040
## 2527    115.6976 111.9908 119.4043 110.0286 121.3666
## 2528    114.6597 110.7861 118.5333 108.7355 120.5838
## 2529    114.8619 110.8511 118.8727 108.7279 120.9959
## 2530    114.6482 110.5340 118.7623 108.3561 120.9402
## 2531    114.3738 110.1470 118.6005 107.9095 120.8380
## 2532    114.7196 110.4035 119.0357 108.1187 121.3205
## 2533    114.2192 109.7901 118.6483 107.4455 120.9929
## 2534    114.3677 109.8397 118.8958 107.4427 121.2928
## 2535    114.3390 109.7401 118.9380 107.3055 121.3725
## 2536    114.2966 109.6321 118.9611 107.1628 121.4304
## 2537    113.8438 109.1248 118.5629 106.6267 121.0610
## 2538    113.9981 109.2140 118.7823 106.6814 121.3149
```

```

## 2539      113.4899 108.6457 118.3341 106.0814 120.8984
## 2540      113.2136 108.3042 118.1230 105.7054 120.7218
## 2541      113.0009 108.0335 117.9684 105.4038 120.5981
## 2542      112.5918 107.5686 117.6149 104.9095 120.2741
## 2543      112.5015 107.4295 117.5736 104.7445 120.2585
## 2544      112.5022 107.3821 117.6223 104.6717 120.3327
## 2545      112.3418 107.1746 117.5090 104.4393 120.2444
## 2546      112.2586 107.0518 117.4653 104.2956 120.2216
## 2547      112.4189 107.1700 117.6678 104.3914 120.4464
## 2548      112.3755 107.0946 117.6564 104.2991 120.4519
## 2549      112.5986 107.2895 117.9077 104.4790 120.7182
## 2550      112.7007 107.3650 118.0364 104.5404 120.8610
## 2551      112.6810 107.3189 118.0432 104.4804 120.8817
## 2552      112.7933 107.4119 118.1748 104.5631 121.0236
## 2553      112.8729 107.4699 118.2759 104.6097 121.1361
## 2554      112.9789 107.5560 118.4018 104.6852 121.2725
## 2555      113.0835 107.6391 118.5279 104.7570 121.4099
## 2556      113.1504 107.6804 118.6204 104.7847 121.5160
## 2557      113.2035 107.7063 118.7007 104.7963 121.6107
## 2558      113.2516 107.7267 118.7765 104.8020 121.7012
## 2559      113.2979 107.7451 118.8506 104.8057 121.7901
## 2560      113.3435 107.7629 118.9241 104.8087 121.8783
## 2561      113.3889 107.7805 118.9973 104.8116 121.9662
## 2562      113.4341 107.7980 119.0702 104.8144 122.0538
## 2563      113.4794 107.8156 119.1431 104.8174 122.1413
## 2564      113.5246 107.8333 119.2159 104.8205 122.2287
## 2565      113.5698 107.8510 119.2886 104.8237 122.3160
## 2566      113.6150 107.8688 119.3612 104.8270 122.4031
## 2567      113.6603 107.8867 119.4338 104.8304 122.4901
## 2568      113.7055 107.9047 119.5063 104.8339 122.5770
## 2569      113.7507 107.9227 119.5787 104.8376 122.6638
## 2570      113.7959 107.9408 119.6510 104.8413 122.7505
## 2571      113.8411 107.9590 119.7233 104.8452 122.8371
## 2572      113.8864 107.9773 119.7955 104.8492 122.9235
## 2573      113.9316 107.9956 119.8676 104.8533 123.0099
## 2574      113.9768 108.0140 119.9396 104.8574 123.0961
## 2575      114.0220 108.0324 120.0116 104.8617 123.1823
## 2576      114.0672 108.0510 120.0835 104.8661 123.2683
## 2577      114.1125 108.0696 120.1554 104.8706 123.3543
## 2578      114.1577 108.0882 120.2271 104.8752 123.4401
## 2579      114.2029 108.1069 120.2988 104.8799 123.5259
## 2580      114.2481 108.1257 120.3705 104.8847 123.6115
## 2581      114.2933 108.1446 120.4421 104.8896 123.6970
## 2582      114.3386 108.1635 120.5136 104.8946 123.7825
## 2583      114.3838 108.1825 120.5851 104.8997 123.8679
## 2584      114.4290 108.2015 120.6565 104.9048 123.9531
## 2585      114.4742 108.2206 120.7278 104.9101 124.0383
## 2586      114.5194 108.2397 120.7991 104.9155 124.1234
## 2587      114.5646 108.2589 120.8704 104.9209 124.2084
## 2588      114.6099 108.2782 120.9415 104.9264 124.2933
## 2589      114.6551 108.2975 121.0127 104.9320 124.3782
## 2590      114.7003 108.3169 121.0837 104.9377 124.4629
## 2591      114.7455 108.3363 121.1547 104.9435 124.5476
## 2592      114.7907 108.3558 121.2257 104.9494 124.6321

```

```

## 2593      114.8360 108.3753 121.2966 104.9553 124.7166
## 2594      114.8812 108.3949 121.3674 104.9613 124.8011
## 2595      114.9264 108.4146 121.4382 104.9674 124.8854
## 2596      114.9716 108.4343 121.5090 104.9736 124.9696
## 2597      115.0168 108.4540 121.5797 104.9799 125.0538
## 2598      115.0621 108.4738 121.6503 104.9862 125.1379
## 2599      115.1073 108.4937 121.7209 104.9926 125.2220
## 2600      115.1525 108.5135 121.7915 104.9991 125.3059
## 2601      115.1977 108.5335 121.8620 105.0057 125.3898
## 2602      115.2429 108.5535 121.9324 105.0123 125.4736
## 2603      115.2882 108.5735 122.0028 105.0190 125.5573
## 2604      115.3334 108.5936 122.0732 105.0258 125.6410
## 2605      115.3786 108.6137 122.1435 105.0326 125.7246
## 2606      115.4238 108.6339 122.2137 105.0395 125.8081
## 2607      115.4690 108.6541 122.2840 105.0465 125.8916
## 2608      115.5143 108.6744 122.3541 105.0536 125.9750
## 2609      115.5595 108.6947 122.4243 105.0607 126.0583
## 2610      115.6047 108.7150 122.4944 105.0679 126.1415
## 2611      115.6499 108.7354 122.5644 105.0751 126.2247
## 2612      115.6951 108.7559 122.6344 105.0824 126.3079
## 2613      115.7404 108.7763 122.7044 105.0898 126.3909
## 2614      115.7856 108.7969 122.7743 105.0972 126.4739
## 2615      115.8308 108.8174 122.8442 105.1047 126.5568
## 2616      115.8760 108.8380 122.9140 105.1123 126.6397
## 2617      115.9212 108.8586 122.9838 105.1199 126.7225
## 2618      115.9665 108.8793 123.0536 105.1276 126.8053
## 2619      116.0117 108.9000 123.1233 105.1354 126.8880
## 2620      116.0569 108.9208 123.1930 105.1432 126.9706
## 2621      116.1021 108.9416 123.2626 105.1510 127.0532
## 2622      116.1473 108.9624 123.3322 105.1590 127.1357
## 2623      116.1926 108.9833 123.4018 105.1669 127.2182
## 2624      116.2378 109.0042 123.4714 105.1750 127.3006
## 2625      116.2830 109.0251 123.5409 105.1831 127.3829
## 2626      116.3282 109.0461 123.6103 105.1912 127.4652
## 2627      116.3734 109.0671 123.6797 105.1994 127.5475
## 2628      116.4187 109.0882 123.7491 105.2077 127.6297
## 2629      116.4639 109.1093 123.8185 105.2160 127.7118
## 2630      116.5091 109.1304 123.8878 105.2243 127.7939
## 2631      116.5543 109.1515 123.9571 105.2327 127.8759
## 2632      116.5995 109.1727 124.0264 105.2412 127.9579
## 2633      116.6448 109.1939 124.0956 105.2497 128.0398
## 2634      116.6900 109.2152 124.1648 105.2583 128.1217
## 2635      116.7352 109.2365 124.2339 105.2669 128.2035
## 2636      116.7804 109.2578 124.3030 105.2755 128.2853
## 2637      116.8256 109.2791 124.3721 105.2842 128.3670
## 2638      116.8708 109.3005 124.4412 105.2930 128.4487
## 2639      116.9161 109.3219 124.5102 105.3018 128.5303
## 2640      116.9613 109.3434 124.5792 105.3107 128.6119
## 2641      117.0065 109.3648 124.6482 105.3196 128.6934
## 2642      117.0517 109.3863 124.7171 105.3285 128.7749
## 2643      117.0969 109.4079 124.7860 105.3375 128.8564
## 2644      117.1422 109.4294 124.8549 105.3465 128.9378
## 2645      117.1874 109.4510 124.9238 105.3556 129.0191
## 2646      117.2326 109.4726 124.9926 105.3648 129.1005

```

```

## 2647 117.2778 109.4943 125.0614 105.3739 129.1817
## 2648 117.3230 109.5160 125.1301 105.3831 129.2630
## 2649 117.3683 109.5377 125.1989 105.3924 129.3441
## 2650 117.4135 109.5594 125.2676 105.4017 129.4253
## 2651 117.4587 109.5812 125.3363 105.4110 129.5064
## 2652 117.5039 109.6029 125.4049 105.4204 129.5874
## 2653 117.5491 109.6248 125.4735 105.4298 129.6684
## 2654 117.5944 109.6466 125.5421 105.4393 129.7494
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