APPLY ANALYTICS FOR FORECASTING AND INVENTORY PLANNING FOR A LARGE RETAILER

May 14, 2023

```
[1]: library(dplyr)      # data wrangling
     library(lubridate)  # date manipulation
     library(forecast)   # time series library
     library(MLmetrics)  # calculate error
     library(ggplot2)    # Beautify the graph
     library(tidyr)      # Tidy the data
     library(zoo)        # Order index observations
     library(tseries)    # adf.test
```

Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union

Loading required package: timechange

Attaching package: 'lubridate'

The following objects are masked from 'package:base':

    date, intersect, setdiff, union

Warning message:
"package 'forecast' was built under R version 4.2.3"
Registered S3 method overwritten by 'quantmod':

```
  method               from
  as.zoo.data.frame zoo
```

Warning message:
"package 'MLmetrics' was built under R version 4.2.3"

Attaching package: 'MLmetrics'

The following object is masked from 'package:base':

    Recall

Attaching package: 'zoo'

The following objects are masked from 'package:base':

    as.Date, as.Date.numeric

Warning message:
"package 'tseries' was built under R version 4.2.3"

[2]: ```r
AAPL<-read.csv('AAPL.csv')
```

[3]: ```r
AAPL
```

	Date	Open	High	Low	Close	Adj.Close	Volume
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<int>
	2014-09-29	100.59	100.69	98.04	99.62	93.51429	142718700
	2014-10-06	99.95	102.38	98.31	100.73	94.55624	280258200
	2014-10-13	101.33	101.78	95.18	97.67	91.68379	358539800
	2014-10-20	98.32	105.49	98.22	105.22	98.77104	358532900
	2014-10-27	104.85	108.04	104.70	108.00	101.38068	220230600
	2014-11-03	108.22	110.30	107.72	109.01	102.32877	199952900
	2014-11-10	109.02	114.19	108.40	114.18	107.64668	205166700
	2014-11-17	114.27	117.57	113.30	116.47	109.80563	233414700
	2014-11-24	116.85	119.75	116.62	118.93	112.12486	181873900
	2014-12-01	118.81	119.25	111.27	115.00	108.41975	266589700
	2014-12-08	114.10	114.85	109.35	109.73	103.45129	259868000
	2014-12-15	110.70	113.24	106.26	111.78	105.38398	328856600
	2014-12-22	112.16	114.52	111.97	113.99	107.46753	119396500
	2014-12-29	113.79	114.77	107.35	109.33	103.07418	152088400
	2015-01-05	108.29	113.25	104.63	112.01	105.60083	283252500
	2015-01-12	112.60	112.80	105.20	105.99	99.92529	303607000
	2015-01-19	107.84	113.75	106.50	112.98	106.51534	198737000
	2015-01-26	113.74	120.00	109.03	117.16	110.45615	465842700
	2015-02-02	118.05	120.51	116.08	118.93	112.12486	270757300
	2015-02-09	118.55	127.48	118.43	127.08	120.28137	303206800
	2015-02-16	127.49	129.50	126.92	129.50	122.57192	194354900
	2015-02-23	130.02	133.60	126.61	128.46	121.58755	368216200
	2015-03-02	129.25	130.28	125.76	126.60	119.82704	246938500
	2015-03-09	127.96	129.57	121.63	123.59	116.97807	326514100
	2015-03-16	123.88	129.25	122.87	125.90	119.16451	266672900
	2015-03-23	127.12	128.04	122.60	123.25	116.65627	209326300
	2015-03-30	124.05	126.49	123.10	125.32	118.61552	162031800
	2015-04-06	124.47	128.12	124.33	127.10	120.30030	182207500
	2015-04-13	128.37	128.57	124.46	124.75	118.07602	171186100
A data.frame: 184 × 7	2015-04-20	125.57	130.63	125.17	130.28	123.31015	207440700
	2017-09-11	160.500	163.96	157.91	159.88	158.6604	220582600
	2017-09-18	160.110	160.50	150.56	151.89	150.7314	186188500
	2017-09-25	149.990	154.72	149.16	154.12	152.9444	154856800
	2017-10-02	154.260	155.49	152.46	155.30	154.1154	93784300
	2017-10-09	155.810	158.00	155.10	156.99	155.7925	81304800
	2017-10-16	157.900	160.87	155.02	156.25	155.0581	126051300
	2017-10-23	156.890	163.60	155.27	163.05	161.8063	122403300
	2017-10-30	163.890	174.26	163.72	172.50	171.1842	215177400
	2017-11-06	172.370	176.24	171.72	174.67	173.3376	138425400
	2017-11-13	173.500	174.50	168.38	170.15	169.4591	116459700
	2017-11-20	170.290	175.50	169.56	174.97	174.2595	81009300
	2017-11-27	175.050	175.08	167.16	171.05	170.3554	170098500
	2017-12-04	172.480	172.62	166.46	169.37	168.6823	137481100
	2017-12-11	169.200	174.17	168.79	173.97	173.2636	139147200
	2017-12-18	174.880	177.20	173.25	175.01	174.2994	117632400
	2017-12-25	170.800	171.85	169.22	169.23	168.5428	97163800
	2018-01-01	170.160	175.37	169.26	175.00	174.2894	101168400
	2018-01-08	174.350	177.36	173.00	177.09	176.3709	110197500
	2018-01-15	177.900	180.10	175.07	178.46	177.7354	127571200
	2018-01-22	177.300	179.44	170.06	171.51	170.8136	191574800

```
[4]: head(AAPL)
```

A data.frame: 6 × 7

	Date <chr>	Open <dbl>	High <dbl>	Low <dbl>	Close <dbl>	Adj.Close <dbl>	Volume <int>
1	2014-09-29	100.59	100.69	98.04	99.62	93.51429	142718700
2	2014-10-06	99.95	102.38	98.31	100.73	94.55624	280258200
3	2014-10-13	101.33	101.78	95.18	97.67	91.68379	358539800
4	2014-10-20	98.32	105.49	98.22	105.22	98.77104	358532900
5	2014-10-27	104.85	108.04	104.70	108.00	101.38068	220230600
6	2014-11-03	108.22	110.30	107.72	109.01	102.32877	199952900

```
[5]: AAPL <- mutate(AAPL, Date = ymd(Date))
     AAPL <- select(AAPL, c(Date, Close))
     AAPL <- complete(AAPL, Date = seq.Date(min(AAPL$Date), max(AAPL$Date),␣
       ↪by="day"))
     AAPL <- arrange(AAPL)
```

```
[6]: tail(AAPL)
```

A tibble: 6 × 2

Date <date>	Close <dbl>
2018-03-24	NA
2018-03-25	NA
2018-03-26	167.78
2018-03-27	NA
2018-03-28	NA
2018-03-29	167.78

```
[7]: colSums(is.na(AAPL))
```

Date 0 **Close** 1094
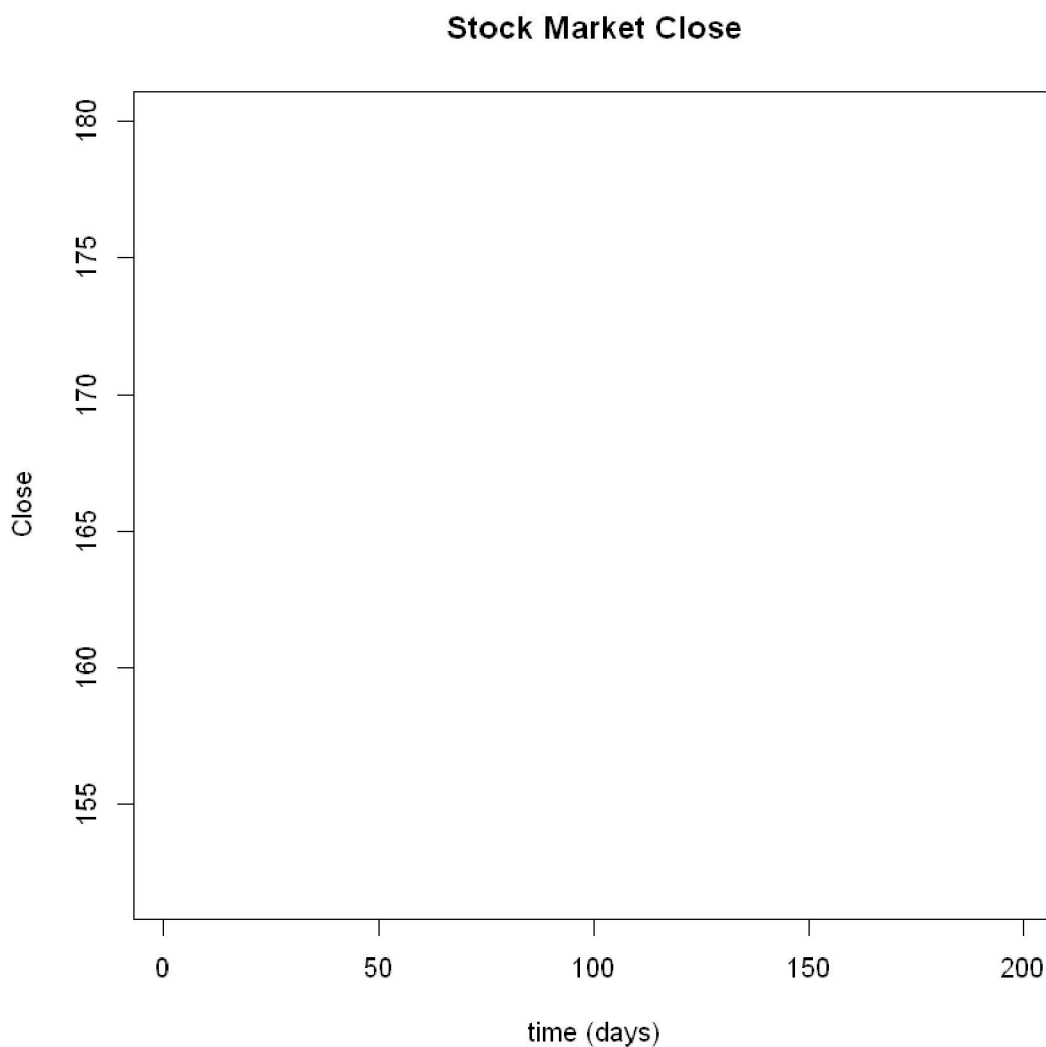
```
[8]: tail(AAPL$Close, 200)
```

1. 159.880005 2. <NA> 3. <NA> 4. <NA> 5. <NA> 6. <NA> 7. <NA> 8. 151.889999 9. <NA>
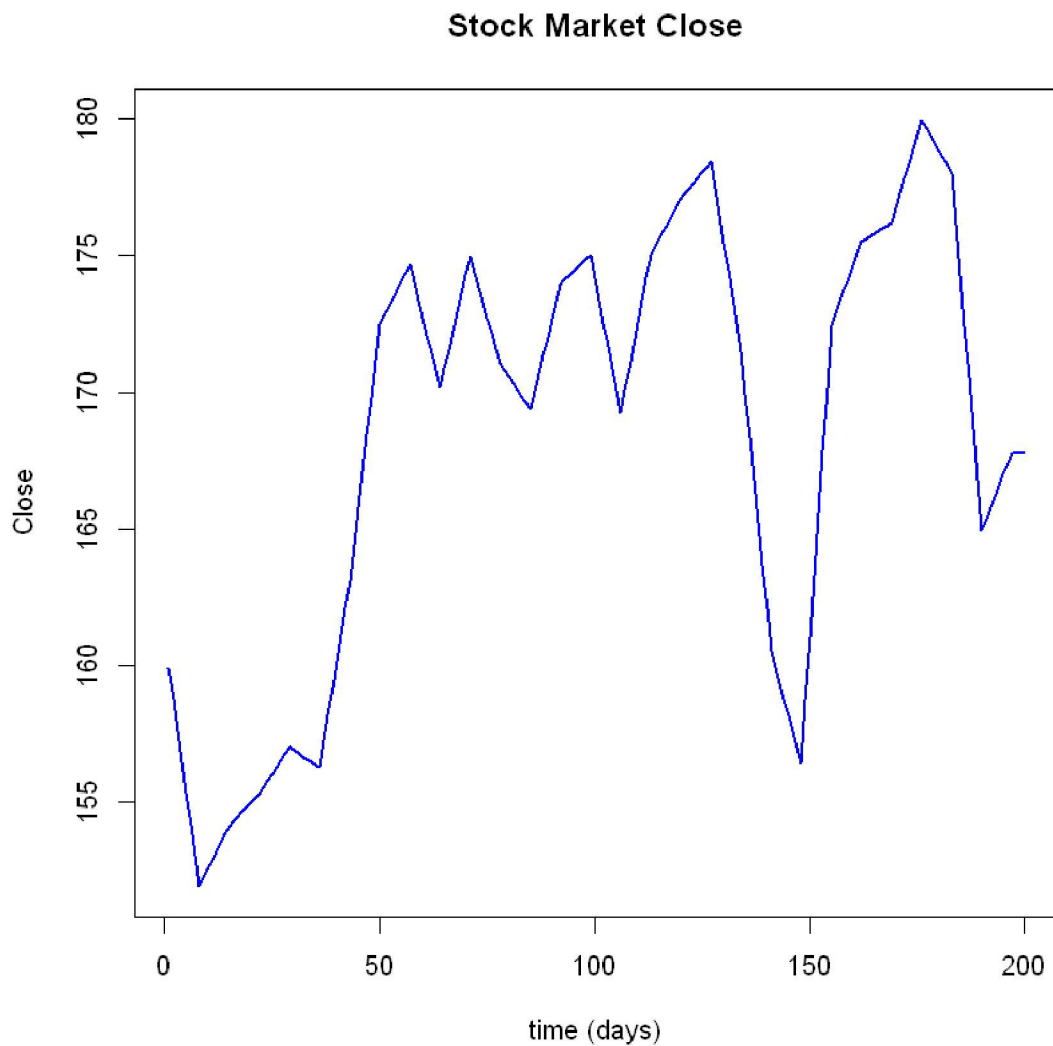10. <NA> 11. <NA> 12. <NA> 13. <NA> 14. <NA> 15. 154.119995 16. <NA> 17. <NA>
18. <NA> 19. <NA> 20. <NA> 21. <NA> 22. 155.300003 23. <NA> 24. <NA> 25. <NA>
26. <NA> 27. <NA> 28. <NA> 29. 156.990005 30. <NA> 31. <NA> 32. <NA> 33. <NA>
34. <NA> 35. <NA> 36. 156.25 37. <NA> 38. <NA> 39. <NA> 40. <NA> 41. <NA>
42. <NA> 43. 163.050003 44. <NA> 45. <NA> 46. <NA> 47. <NA> 48. <NA> 49. <NA>
50. 172.5 51. <NA> 52. <NA> 53. <NA> 54. <NA> 55. <NA> 56. <NA> 57. 174.669998
58. <NA> 59. <NA> 60. <NA> 61. <NA> 62. <NA> 63. <NA> 64. 170.149994 65. <NA>
66. <NA> 67. <NA> 68. <NA> 69. <NA> 70. <NA> 71. 174.970001 72. <NA> 73. <NA>
74. <NA> 75. <NA> 76. <NA> 77. <NA> 78. 171.050003 79. <NA> 80. <NA> 81. <NA>
82. <NA> 83. <NA> 84. <NA> 85. 169.369995 86. <NA> 87. <NA> 88. <NA> 89. <NA>
90. <NA> 91. <NA> 92. 173.970001 93. <NA> 94. <NA> 95. <NA> 96. <NA> 97. <NA>
98. <NA> 99. 175.009995 100. <NA> 101. <NA> 102. <NA> 103. <NA> 104. <NA> 105. <NA>
106. 169.229996 107. <NA> 108. <NA> 109. <NA> 110. <NA> 111. <NA> 112. <NA> 113. 175
114. <NA> 115. <NA> 116. <NA> 117. <NA> 118. <NA> 119. <NA> 120. 177.089996

121. <NA> 122. <NA> 123. <NA> 124. <NA> 125. <NA> 126. <NA> 127. 178.460007
128. <NA> 129. <NA> 130. <NA> 131. <NA> 132. <NA> 133. <NA> 134. 171.509995
135. <NA> 136. <NA> 137. <NA> 138. <NA> 139. <NA> 140. <NA> 141. 160.5 142. <NA>
143. <NA> 144. <NA> 145. <NA> 146. <NA> 147. <NA> 148. 156.410004 149. <NA>
150. <NA> 151. <NA> 152. <NA> 153. <NA> 154. <NA> 155. 172.429993 156. <NA>
157. <NA> 158. <NA> 159. <NA> 160. <NA> 161. <NA> 162. 175.5 163. <NA> 164. <NA>
165. <NA> 166. <NA> 167. <NA> 168. <NA> 169. 176.210007 170. <NA> 171. <NA>
172. <NA> 173. <NA> 174. <NA> 175. <NA> 176. 179.979996 177. <NA> 178. <NA>
179. <NA> 180. <NA> 181. <NA> 182. <NA> 183. 178.020004 184. <NA> 185. <NA>
186. <NA> 187. <NA> 188. <NA> 189. <NA> 190. 164.940002 191. <NA> 192. <NA>
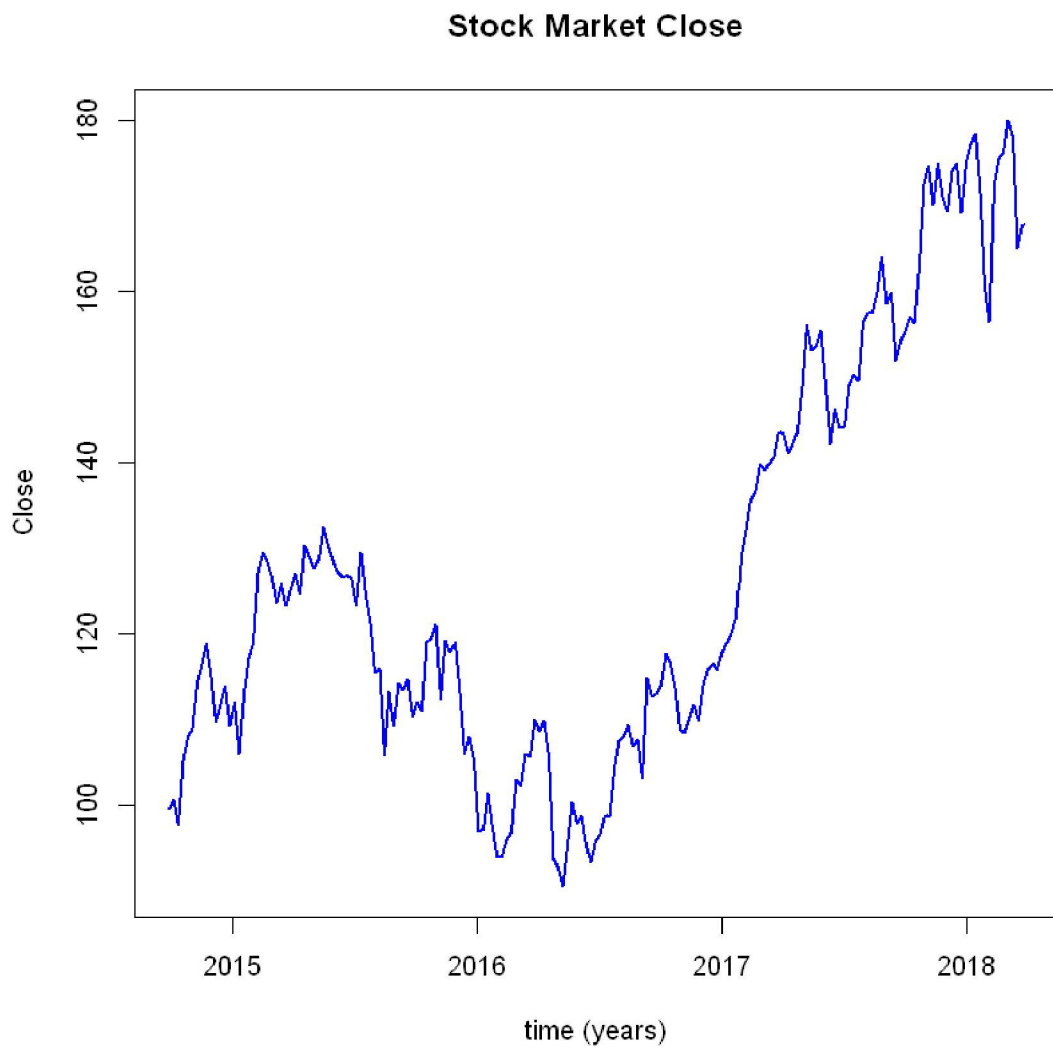193. <NA> 194. <NA> 195. <NA> 196. <NA> 197. 167.779999 198. <NA> 199. <NA>
200. 167.779999

```
[9]:  close_values <- tail(AAPL$Close, 200)
      plot(close_values, type = "l", col = "blue", lwd = 2, xlab = "time (days)",
        ↪ylab = 'Close', main = "Stock Market Close")
```
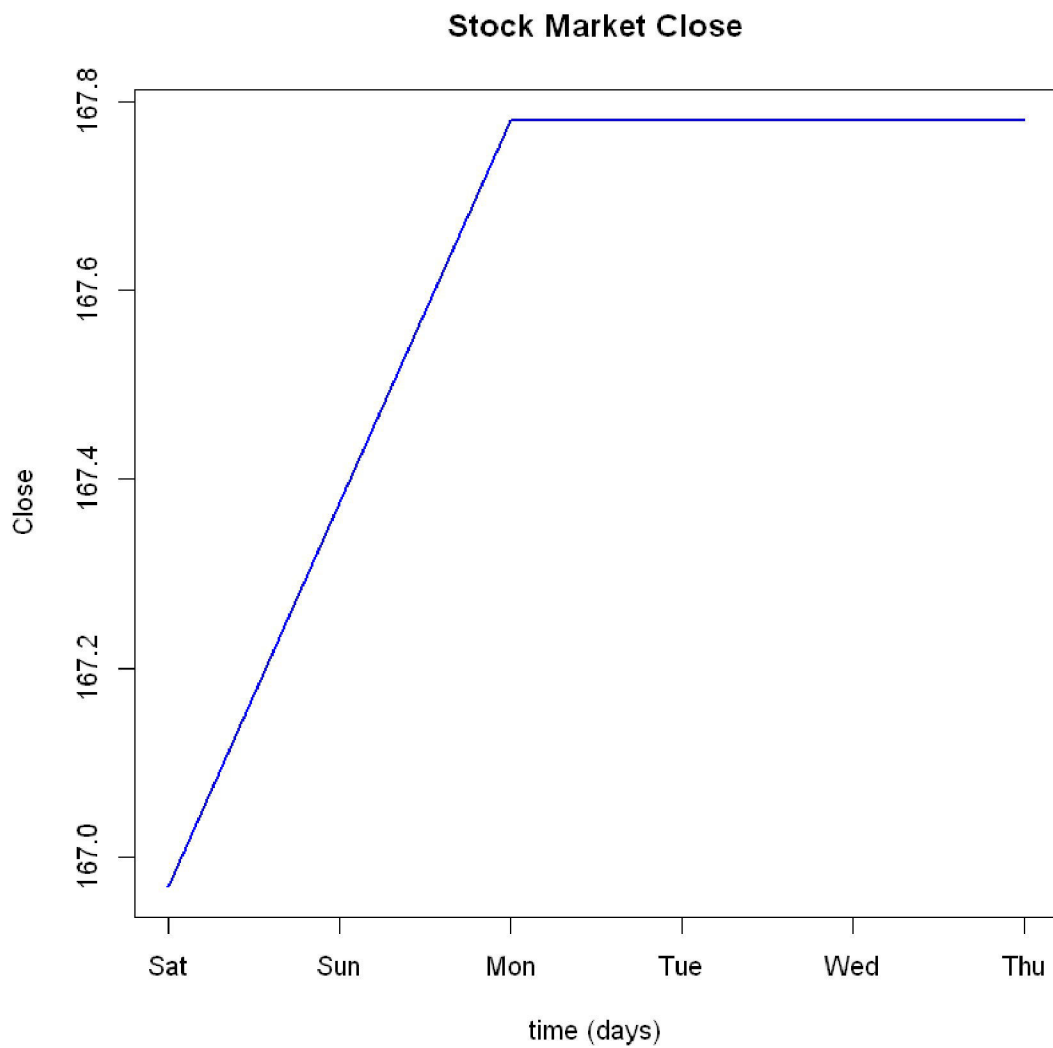
```
[10]:  AAPL_new <- mutate(AAPL, Close = na.fill(Close, "extend"))
       close_values <- tail(AAPL_new, 200)
       plot(close_values$Close, type = "l", col = "blue", lwd = 2, xlab = "time␣
        ↪(days)", ylab = 'Close', main = "Stock Market Close")
```


Stock Market Close

```
[11]:  plot(AAPL_new$Date, AAPL_new$Close, type = "l", col = "blue", lwd = 2, xlab =␣
        ↪"time (years)", ylab = 'Close', main = "Stock Market Close")
```

Stock Market Close


```
[12]:  tail_values <- tail(AAPL_new)
       plot(tail_values$Date, tail_values$Close, type = "l", col = "blue", lwd = 2,␣
         ↪xlab = "time (days)", ylab = 'Close', main = "Stock Market Close")
```

Stock Market Close


```
[13]: class(AAPL_new)
```

1. 'tbl_df' 2. 'tbl' 3. 'data.frame'

```
[14]: APPL_m <- summarize(group_by(AAPL_new, month = lubridate::floor_date(Date,
      ↪"month")), Close = mean(Close))
      head(APPL_m)
```

| | month | Close |
	<date>	<dbl>
	2014-09-01	99.69929
	2014-10-01	102.89885
A tibble: 6 × 2	2014-11-01	114.85624
	2014-12-01	111.79447
	2015-01-01	112.36369
	2015-02-01	126.52184

```
[15]: AAPL_ts <- ts( data = APPL_m$Close, start = c(1980,12,01), frequency = 12)
      class(AAPL_ts)
```

'ts'

```
[16]: plot(AAPL_ts)
```

```
[17]: AAPL_test <- tail(AAPL_new, 24)
```

```
[18]: AAPL_train <- head(AAPL_new, -length(AAPL_test))
```

```
[20]: plot(AAPL_train)
```