# 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(zoo)
     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]: AAPL<-read.csv('AAPL.csv')

[3]: AAPL
```

ckirs         ckirs <th< th=""><th></th><th>Date</th><th>Open</th><th>High</th><th>Low</th><th>Close</th><th>Adj.Close</th><th>Volume</th></th<>		Date	Open	High	Low	Close	Adj.Close	Volume
			_					
2014-10-06   99.95   102.38   98.31   100.73   94.55624   280258200   2014-10-20   98.32   105.49   98.22   105.22   98.77104   358539800   2014-10-27   104.85   108.04   104.70   108.00   101.38068   220230690   2014-11-40   109.02   114.19   108.40   114.18   107.64668   205166700   2014-11-14   114.27   117.57   113.30   116.47   109.0563   233414700   2014-11-24   116.85   119.75   116.62   118.93   112.12486   181873900   2014-12-15   118.81   119.25   111.27   115.00   103.34195   266589700   2014-12-15   114.10   114.85   109.35   109.73   103.45129   259688000   2014-12-24   116.70   113.24   106.26   111.78   103.8398   328856600   2014-12-25   113.79   114.77   107.35   109.33   103.07418   152088400   2015-01-51   68.29   113.25   104.63   112.01   60.56083   23832500   2015-01-51   68.29   113.55   104.63   112.01   60.56083   23832500   2015-01-52   68.29   113.75   106.50   112.98   105.51334   198737000   2015-01-26   118.74   120.00   109.03   117.16   110.45615   46842700   2015-02-02   118.05   127.48   118.43   127.08   122.8137   303206800   2015-02-16   118.55   127.48   118.43   127.08   122.8137   303206800   2015-02-36   217.49   129.50   129.50   129.50   129.579   2015-03-20   2015-03-20   123.55   127.63   129.50   129.50   129.579   2015-03-30   217.96   129.57   121.63   123.55   116.65627   209326300   2015-03-30   217.96   129.57   121.63   123.55   116.65627   209326300   2015-03-30   124.05   128.04   123.25   116.65627   209326300   2015-03-30   124.05   126.49   123.10   125.52   118.05152   162031800   2015-04-13   124.80   158.90   158.50   158.90   159.7914   169.680   2017-00-18   160.80   163.96   153.91   159.88   158.6604   2015-03-30   2015-03-10   125.57   130.63   125.17   130.28   123.3015   2017400-00   155.80   156.00   155.00   156.99   156.792   156.05   156.95   156.051   126031300   2017-10-20   156.890   163.890   156.791   159.88   158.6604   2005-000   2017-10-20   156.890   163.60   155.00   156.99   155.792   130.480   156.50   156.90   156.792   156.05	-							
2014-10-27   104.85   108.04   104.70   108.00   101.38068   220230600   2014-11-10   109.02   114.19   108.40   114.18   107.646668   205166700   2014-11-17   114.27   117.57   113.30   116.47   109.80563   233414700   2014-11-14   116.85   119.75   116.62   118.93   112.12486   181873900   2014-12-08   118.81   119.75   116.62   118.93   112.12486   181873900   2014-12-15   110.70   113.24   106.26   111.78   105.38398   328856600   2014-12-29   113.70   114.85   109.35   109.73   103.45129   259868000   2014-12-29   113.79   114.77   107.35   109.33   103.07418   152088400   2014-12-29   113.79   114.77   107.35   109.33   103.07418   152088400   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   28325800   2015-01-05   108.29   113.25   104.63   112.01   105.60083   28325800   2015-01-06   108.29   113.75   106.50   112.98   106.51534   198737000   2015-01-06   118.05   120.51   116.08   118.93   112.12486   270757300   2015-02-09   118.55   127.48   118.43   127.08   122.28137   30326800   2015-02-09   118.55   127.48   118.43   127.08   122.28137   30326800   2015-02-09   118.55   127.48   118.43   127.08   122.57192   194854900   2015-03-09   127.96   129.57   126.03   123.59   116.97807   326514000   2015-03-09   127.96   129.57   121.03   123.59   116.97807   326514000   2015-03-09   127.96   129.57   121.63   123.59   116.97807   326514000   2015-03-03   124.05   126.49   123.10   125.32   118.61552   16607200   2015-04-03   124.05   128.57   124.60   123.52   118.61552   16203100   2015-04-03   124.05   126.49   123.10   125.32   118.61552   16203100   2017-04-04   124.47   128.12   124.33   127.10   120.30031   12207500   2017-00-18   160.10   160.50   150.56   151.89   150.7314   186188500   2017-00-28   160.90   155.80   150.56   150.59   155.795   81304800   2017-00-24   154.60   155.40   155.00   155.09   155.795   81304800   2017-10-03   163.80   174.50   163.83   170.15   169.451   174.850   100.00   100.00								
2014-11-03   108.22   110.30   107.72   109.01   102.32877   199952900   2014-11-11   109.02   114.19   108.40   114.18   107.64668   205166709   2014-11-24   116.85   119.75   116.62   118.93   112.12466   181873900   2014-12-01   118.81   119.25   111.27   115.00   108.41975   266889700   2014-12-01   118.81   119.25   111.27   115.00   108.41975   266889700   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   2014-12-29   113.79   114.77   107.35   109.33   103.07418   152088400   2015-01-10   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   2015-01-20   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   112.12486   270757300   2015-02-03   118.55   127.48   118.43   112.12486   270757300   2015-02-33   130.02   133.60   126.61   128.46   121.58755   368216200   2015-03-30   127.79   129.57   121.63   123.59   116.97807   326514100   2015-03-31   127.12   128.04   122.60   123.25   116.65627   209326800   2015-03-33   127.12   128.04   122.60   123.25   116.65627   209326810   2015-03-32   127.12   128.04   122.60   123.25   116.65627   209326810   2015-03-30   124.05   126.49   123.10   125.35   118.61552   209326810   2015-03-25   149.99   154.72   149.16   154.12   152.9444   154856800   2017-09-25   149.990   154.72   149.16   154.12   152.9444   154856800   2017-09-25   149.990   154.72   149.16   154.12   152.9444   154856800   2017-09-25   149.990   154.72   149.16   154.12   152.9444   154856800   2017-10-03   156.890   164.87   155.02   156.25   155.0581   126051300   2017-10-13   156.890   154.72   149.16   154.12   152.9444   154856800   2017-10-13   156.890   155.70   163.50   155.09   155.795   139.800   2017-10-13   156.890								
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   2014-12-08   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   2014-12-29   112.16   114.52   111.97   113.99   107.46753   119396500   2014-12-29   113.79   114.77   107.35   109.33   103.07418   152085400   2015-01-05   108.29   113.25   104.63   112.01   105.60083   283252500   2015-01-12   112.60   112.80   105.50   112.98   106.51534   198737000   2015-01-12   112.60   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   112.12466   2707300   2015-02-02   118.05   120.51   116.08   118.93   112.12466   2707300   2015-02-03   130.02   133.60   126.61   128.46   121.87575   368216200   2015-03-09   129.25   130.28   125.57   212.63   123.59   116.97807   326514100   2015-03-03   127.12   128.04   122.87   125.00   119.6451   266672900   2015-03-03   124.05   126.49   123.10   123.55   116.65627   209326300   2015-03-30   124.05   126.49   123.10   123.55   116.65627   209326300   2015-03-30   124.05   126.49   123.10   125.32   118.61552   162031800   2015-03-40   125.57   126.3   123.15   118.07602   171.0760   125.57   126.50   155.88   158.6604   2203800   2015-03-30   124.05   126.49   123.10   125.32   118.61552   162031800   1207-09-25   149.99   154.72   149.16   154.12   152.944   15485800   2017-09-25   149.99   154.72   149.16   154.12   152.944   15485800   2017-10-10   152.80   155.80   150.56   155.89   150.7314   186188500   2017-10-10   155.80   163.60   155.74   163.05   156.99   155.7925   81304800   2017-10-10   155.80   163.60   155.74   163.05   156.99   155.7925   81304800   2017-10-10   170.290   175.50   160.64   169.37   174.259   100.3300   100.3300   100.3300   100.3300   100.3300   100.3300   100.3300   100.3300   100.3300   100.3300   1								
16.85   119.75   116.62   118.93   112.12486   181873900   2014-12-01   118.81   119.25   111.27   115.00   108.41975   265887000   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   99.9529   303607000   2015-01-19   107.84   113.75   106.50   112.98   106.51534   198737000   2015-01-02   118.05   120.50   100.33   117.12486   270757300   2015-02-09   118.05   120.51   116.08   118.93   112.12486   270757300   2015-02-09   118.55   127.48   118.43   127.08   120.28137   303208500   2015-02-09   127.49   129.50   126.61   128.46   121.58755   368216200   2015-03-02   219.25   130.28   125.66   128.46   121.58755   368216200   2015-03-03   127.12   128.04   122.60   123.25   116.07807   326514100   2015-03-33   124.05   126.95   123.25   116.65627   209326300   2015-03-33   124.05   126.49   123.05   125.57   118.06502   2015-03-04   124.47   128.12   124.33   127.10   120.30030   182207500   2015-04-02   124.47   128.12   124.33   127.10   120.30030   1266672900   2015-04-03   124.45   124.64   124.75   118.07602   171186100   100.50   100.50   150.56   151.89   150.7314   186188500   100.50   100.50   150.50   151.89   150.7314   186188500   100.50   100.50   150.50   151.89   150.7314   186188500   100.50   100.50   150.50   151.89   150.7314   186188500   100.50   100.50   150.50   151.89   150.7314   186188500   100.50   100.50   150.50   151.89   150.7314   186188500   100.50   100.50   150.50   151.89   150.7314   186188500   100.50   100.50   150.50   151.89   150.7314   186188500   100.50   100.50   150.5								
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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   2014-12-29   113.79   114.77   107.35   109.33   103.07418   152088400   2015-01-05   108.29   113.75   104.63   112.01   105.60083   283252500   2015-01-12   112.60   112.80   105.20   105.99   99.95259   30607000   2015-01-06   113.74   120.00   109.03   117.16   110.45615   465842700   2015-02-02   118.05   127.48   118.03   112.12486   270757300   2015-02-09   118.55   127.48   118.43   127.08   120.28137   303206800   2015-02-09   118.55   127.48   118.43   127.08   120.28137   303206800   2015-03-02   129.50   129.50   122.57192   194354900   2015-03-02   129.50   129.50   122.57192   194354900   2015-03-03   129.95   130.28   125.76   126.60   119.82704   246938500   2015-03-03   127.09   129.55   122.63   123.59   116.97807   36614100   2015-03-03   124.05   129.57   126.49   125.50   119.82704   246938500   2015-03-03   124.05   126.49   123.00   123.25   116.65627   209326300   2015-03-30   124.05   126.49   123.00   125.55   126.45   125.05   116.65627   209326300   2015-03-30   124.05   126.49   123.00   125.55   126.40   124.75   180.7602   171186100   Adata.frame: 184 × 7   2015-04-13   128.37   128.57   124.66   124.75   180.7602   171186100   Adata.frame: 184 × 7   2015-04-13   128.37   128.57   124.66   124.75   180.7602   171186100   Adata.frame: 184 × 7   2015-04-13   128.37   128.57   124.66   124.75   180.7602   171186100   Adata.frame: 184 × 7   2015-04-13   128.37   128.57   124.66   124.75   130.28   123.31015   207440700   124.77   124.96   124.75   130.28   123.31015   207440700   124.77   124.96   124.75   130.28   123.31015   207440700   124.77   124.96   124.75   130.28   123.31015   207440700   124.75   124.66   124.75   124.66   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124.46   124.75   124								
2014-12-15   110.70   113.24   106.26   111.78   105.38398   328856600   2014-12-22   113.79   114.77   173.99   107.46753   113996500   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   2015-02-02   118.05   120.51   116.08   118.93   112.12486   270757300   2015-02-03   13.02   133.60   126.61   128.46   121.58755   368216200   2015-02-33   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   2015-03-03   127.96   129.57   121.63   123.59   116.97807   326514100   2015-03-33   124.05   128.84   122.60   123.25   116.65627   209326300   2015-03-33   124.05   126.49   123.30   125.32   118.61552   626031800   2015-04-06   124.47   128.12   124.33   127.10   120.30030   182207500   2015-04-06   124.47   128.12   124.33   127.10   120.30030   182207500   2015-04-06   124.47   128.12   124.33   127.10   120.30030   182207500   2015-04-06   125.57   130.63   125.17   130.28   123.31015   207440700   125.50   149.09   155.79   159.88   158.6604   220582600   2017-09-18   160.110   160.50   150.56   151.89   150.7314   186188500   2017-09-18   160.110   160.50   150.56   151.89   150.7314   15488800   2017-10-16   157.90   154.72   149.16   155.30   155.105   155.09   155.7925   81304800   2017-10-16   157.80   160.87   155.02   156.05   155.081   126.051300   2017-10-16   157.80   160.87   155.02   156.05   151.081   126051300   2017-10-16   172.370   174.26   163.72   174.57   174.67   173.3376   138425400   2017-11-20   175.50   175.08   167.40   174.57   174.67   173.3376   138425400   2017-11-20   172.480   174.50   166.69   174.97   174.2595   81003300   2017-11-20   174.240   174.50   166.69   174.97   174.2595   81003300								
114.52   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   2015-01-12   112.60   112.80   105.90   99.95259   303607000   2015-01-19   107.84   113.75   106.50   112.98   106.51534   198737000   2015-01-20   118.05   120.51   116.08   118.03   112.1246   270757300   2015-02-09   118.55   127.48   118.43   127.08   120.28137   303206800   2015-02-20   118.05   125.05   126.61   128.46   121.58755   368216200   2015-02-23   130.02   133.60   126.61   128.46   121.58755   368216200   2015-03-09   127.96   129.57   121.63   123.59   116.97807   326514100   2015-03-03   127.96   129.57   121.63   123.59   116.65627   2035-03-03   127.05   122.57   121.63   123.59   116.65627   2035-03-03   124.05   126.49   125.35   116.65627   20326300   2015-03-03   124.05   126.49   125.35   116.65627   20326300   2015-03-03   124.05   126.49   125.35   116.65627   20326300   2015-03-03   124.05   126.49   125.35   118.61552   162031800   2015-04-06   124.47   128.12   124.33   127.10   120.30030   182207500   12015-04-06   124.47   128.12   124.33   127.10   120.30030   182207500   12015-04-13   128.37   128.57   124.46   124.75   118.07602   171186100   12017-09-18   160.110   160.50   150.56   151.89   150.7314   18618500   2017-09-18   160.110   160.50   150.56   151.89   150.7314   18618500   2017-09-18   160.110   160.50   150.56   151.89   150.7314   18618500   2017-10-09   154.70   158.00   155.49   155.30   154.154   39784300   2017-10-10   154.20   155.40   155.27   160.95   155.94   150.3300   12071-10-10   154.20   155.40   155.27   160.95   155.95   130.4800   2017-10-13   158.80   174.26   163.72   172.50   171.1842   215177400   2017-10-10   172.30   163.890   174.26   163.50   155.49   150.3316   1304800   2017-10-10   172.30   176.24   171.20   172.50   171.1842   215177400   2017-11-10   172.40   174.25   166.85   174.07   173.3376   138425400   2017-11-20   172.40   175.50   175.50   166.86   174.07   173.3376   138425400   201								
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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   2015-01-02   118.05   120.51   116.08   118.93   112.12486   270757300   2015-02-02   118.05   120.51   116.08   118.93   112.12486   270757300   2015-02-16   127.49   129.50   126.60   129.50   122.57192   194354900   2015-02-23   30.02   133.60   126.61   128.46   121.58755   368216200   2015-03-09   127.96   129.57   121.63   123.59   116.97807   246938500   2015-03-09   127.96   129.57   121.63   123.59   116.97807   236514100   2015-03-30   127.12   128.04   122.60   123.25   116.65627   209326300   2015-03-30   124.05   128.04   122.60   123.25   116.65627   209326300   2015-03-30   124.05   128.04   122.60   123.25   116.65627   209326300   2015-03-40   128.37   128.57   124.66   124.75   118.07602   171186100   2015-04-13   128.37   128.57   124.66   124.75   118.07602   171186100   2017-09-18   160.110   160.50   150.56   151.89   150.7314   1861850   2017-09-25   149.990   154.72   149.16   154.12   152.9444   154856800   2017-10-09   155.810   155.06   155.99   155.7925   8130480   2017-10-09   155.810   155.00   155.00   156.99   155.7925   8130480   2017-10-09   158.80   163.60   155.07   171.842   215177400   2017-10-10   167.390   160.87   155.02   156.59   155.0581   126051300   2017-10-20   156.890   163.60   155.27   163.05   151.890   1240500   2017-10-20   156.890   175.50   166.36   174.50   174.50   169.4901   1464500   2017-11-20   170.290   175.50   166.36   174.50   174.50   169.4901   1464500   2017-11-20   170.290   175.50   168.38   170.15   169.4901   1464500   2017-11-20   170.290   175.50   168.38   170.15   169.4901   1464500   2017-11-20   170.290   175.50   168.36   170.50   174.50   168.36   174.2994   174.2994   17632400   2017-11-20   170.290   175.50   166.66   174.07   173.256   139147200   2017-11-20   170.290   175.50   166.66   174.07   174.2595   810030								
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$\begin{array}{c ccccccccccccccccccccccccccccccccccc$								270757300
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		2015-02-09		127.48			120.28137	303206800
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		2015-02-16		129.50			122.57192	194354900
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		2015-02-23						
$\begin{array}{c} 2015-03-16 \\ 2015-03-23 \\ 2015-03-23 \\ 2015-03-23 \\ 2015-03-30 \\ 2015-04-06 \\ 2015-04-06 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-12 $		2015-03-02	129.25	130.28	125.76	126.60	119.82704	246938500
$\begin{array}{c} 2015-03-16 \\ 2015-03-23 \\ 2015-03-23 \\ 2015-03-23 \\ 2015-03-30 \\ 2015-03-30 \\ 2015-04-06 \\ 2015-04-06 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-12 \\ 2015-04-13 \\ 2015-04-12 $		2015-03-09	127.96	129.57	121.63	123.59	116.97807	326514100
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$								
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$								
$ \begin{array}{c} 2015\text{-}04\text{-}06 \\ 2015\text{-}04\text{-}13 \\ 2015\text{-}04\text{-}13 \\ 2015\text{-}04\text{-}20 \\ 2017\text{-}09\text{-}11 \\ 2017\text{-}09\text{-}18 \\ 2017\text{-}09\text{-}18 \\ 2017\text{-}09\text{-}25 \\ 2017\text{-}09\text{-}25 \\ 2017\text{-}09\text{-}25 \\ 2017\text{-}10\text{-}02 \\ 2017\text{-}10\text{-}02 \\ 2017\text{-}10\text{-}02 \\ 2017\text{-}10\text{-}02 \\ 2017\text{-}10\text{-}03 \\ 2017\text{-}10\text{-}04 \\ 2017\text{-}10\text{-}05 \\ 2017\text$								
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		2015-04-06				127.10	120.30030	182207500
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		2015-04-13	128.37	128.57	124.46	124.75	118.07602	171186100
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	A data.frame: $184 \times 7$	2015-04-20	125.57	130.63	125.17	130.28	123.31015	207440700
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		2015 00 11	100 500	100.00	15501	150.00	150 0001	22050200
$\begin{array}{cccccccccccccccccccccccccccccccccccc$								
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2017-12-25  170.800  171.85  169.22  169.23  168.5428  97163800								
		2017-12-23	170.300 $170.160$		169.22 $169.26$	109.23 $175.00$	174.2894	101168400
2018-01-08 174.350 177.36 173.00 177.09 176.3709 110197500				175.37 $177.36$				
2018-01-08 174.300 177.30 173.00 177.09 170.3709 110197300 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)

```
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
                                                         98.31
                     2
                         2014-10-06
                                      99.95
                                                102.38
                                                                  100.73
                                                                            94.55624
                                                                                        280258200
A data.frame: 6 \times 7
                                      101.33
                                               101.78
                                                                  97.67
                     3
                         2014-10-13
                                                         95.18
                                                                            91.68379
                                                                                        358539800
                         2014-10-20
                                      98.32
                                                105.49
                                                         98.22
                                                                  105.22
                                                                            98.77104
                     4
                                                                                        358532900
                     5
                         2014-10-27
                                      104.85
                                                108.04
                                                         104.70
                                                                  108.00
                                                                            101.38068
                                                                                        220230600
                                                                                        199952900
                         2014-11-03
                                      108.22
                                                110.30
                                                         107.72
                                                                  109.01
                                                                            102.32877
```

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

	Date	Close
	< date >	<dbl $>$
	2018-03-24	NA
A tibble: $6 \times 2$	2018-03-25	NA
A tibble: $0 \times 2$	2018-03-26	167.78
	2018-03-27	NA
	2018-03-28	NA
	2018-03-29	167.78

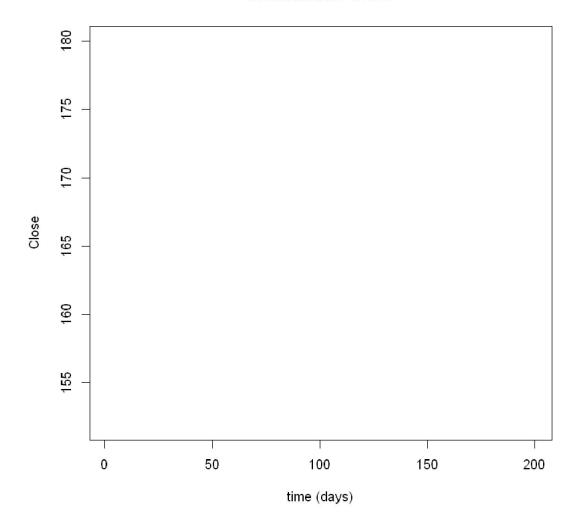
#### [7]: colSums(is.na(AAPL))

Date 0 Close 1094

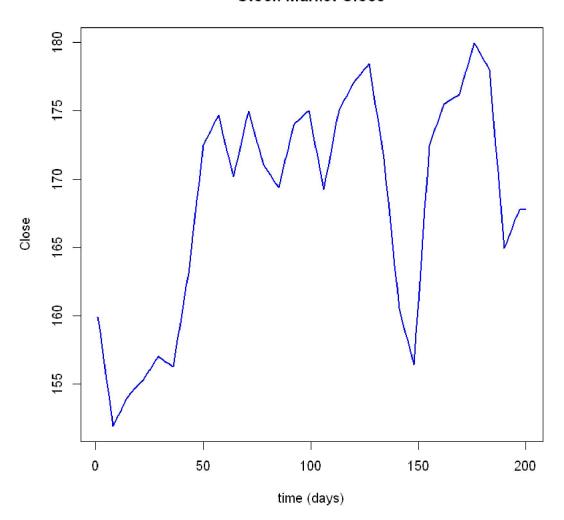
#### [8]: tail(AAPL\$Close, 200)

 $\begin{array}{c} 1.\ 159.880005\ 2.\ < \text{NA} >\ 3.\ < \text{NA} >\ 4.\ < \text{NA} >\ 5.\ < \text{NA} >\ 6.\ < \text{NA} >\ 7.\ < \text{NA} >\ 8.\ 151.889999\ 9.\ < \text{NA} >\ 10.\ < \text{NA} >\ 11.\ < \text{NA} >\ 12.\ < \text{NA} >\ 13.\ < \text{NA} >\ 14.\ < \text{NA} >\ 15.\ 154.119995\ 16.\ < \text{NA} >\ 17.\ < \text{NA} >\ 18.\ < \text{NA} >\ 19.\ < \text{NA} >\ 20.\ < \text{NA} >\ 21.\ < \text{NA} >\ 22.\ 155.300003\ 23.\ < \text{NA} >\ 24.\ < \text{NA} >\ 25.\ < \text{NA} >\ 26.\ < \text{NA} >\ 27.\ < \text{NA} >\ 28.\ < \text{NA} >\ 29.\ 156.990005\ 30.\ < \text{NA} >\ 31.\ < \text{NA} >\ 32.\ < \text{NA} >\ 33.\ < \text{NA} >\ 34.\ < \text{NA} >\ 35.\ < \text{NA} >\ 36.\ 156.25\ 37.\ < \text{NA} >\ 38.\ < \text{NA} >\ 39.\ < \text{NA} >\ 40.\ < \text{NA} >\ 41.\ < \text{NA} >\ 42.\ < \text{NA} >\ 44.\ < \text{NA} >\ 45.\ < \text{NA} >\ 46.\ < \text{NA} >\ 47.\ < \text{NA} >\ 48.\ < \text{NA} >\ 49.\ < \text{NA} >$ 

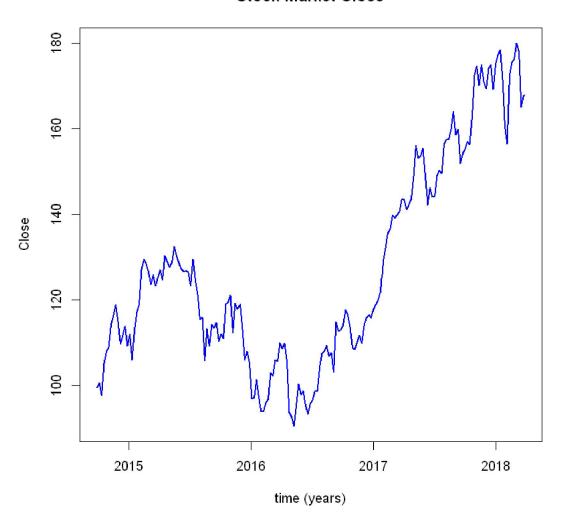
```
121. <NA> 122. <NA> 123. <NA> 124. <NA> 125. <NA> 126. <NA> 126. <NA> 127. 178.460007 128. <NA> 129. <NA> 130. <NA> 131. <NA> 131. <NA> 132. <NA> 133. <NA> 134. 171.509995 135. <NA> 136. <NA> 136. <NA> 137. <NA> 138. <NA> 139. <NA> 140. <NA> 141. 160.5 142. <NA> 143. <NA> 144. <NA> 145. <NA> 146. <NA> 147. <NA> 148. 156.410004 149. <NA> 150. <NA> 151. <NA> 151. <NA> 152. <NA> 153. <NA> 154. <NA> 155. 172.42993 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> 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> 196. <NA> 197. 167.779999 198. <NA> 199. <NA> 190. 167.779999
```



```
[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" \)
```



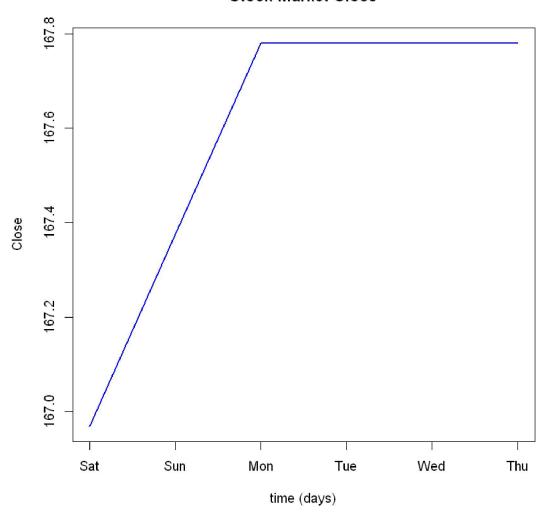
```
[11]: plot(AAPL_new$Date, AAPL_new$Close, type = "l", col = "blue", lwd = 2, xlab = "time (years)", ylab = 'Close', main = "Stock Market Close")
```



```
[12]: tail_values <- tail(AAPL_new)

plot(tail_values$Date, tail_values$Close, type = "1", col = "blue", lwd = 2,__

Axlab = "time (days)", ylab = 'Close', main = "Stock Market Close")
```



```
Close
                    month
                    <date>
                                    <dbl>
                    2014-09-01
                                   99.69929
                    2014 \text{-} 10 \text{-} 01
                                   102.89885
A tibble: 6 \times 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'



```
[17]: AAPL_test <- tail(AAPL_new, 24)
[18]: AAPL_train <- head(AAPL_new, -length(AAPL_test))
[20]: plot(AAPL_train)</pre>
```

