Time Series Analysis using ARIMA model in R Programming

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In R programming, data analysis and visualization is so easy to learn the behaviour of the data. Moreover, the R language is used mostly in the data science field after Python. Time series analysis is a type of analysis of data used to check the behaviour of data over a period of time. The data is collected over time sequentially by the `ts()` function along with some parameters. It helps in analyzing the pattern of the data over a graph. There are many techniques used to forecast the time series object over the plot graph but the **ARIMA model** is the most widely used approach out of them.

Time Series Forecasting

Time series forecasting is a process of predicting future values with the help of some statistical tools and methods used on a data set with historical data. Some of the applications of time series forecasting are:

- Predicting stock prices
- Forecast weather
- Forecast the sales of a product

ARIMA model

ARIMA stands for AutoRegressive Integrated Moving Average and is specified by three order parameters: *(p, d, q).*

- **AR(*p*) Autoregression:** A regression model that utilizes the dependent relationship between a current observation and observations over a previous period.An auto regressive (*AR(p)*) component refers to the use of past values in the regression equation for the time series.
- **I(*d*) Integration:** Uses differencing of observations (subtracting an observation from observation at the previous time step) in order to make the time series stationary.

Differencing involves the subtraction of the current values of a series with its previous values d number of times.

- **MA(*q*) Moving Average:** A model that uses the dependency between an observation and a residual error from a moving average model applied to lagged observations. A moving average component depicts the error of the model as a combination of previous error terms. The order *q* represents the number of terms to be included in the model.

Types of ARIMA Model

- **ARIMA:** Non-seasonal Autoregressive Integrated Moving Averages
- **SARIMA:** Seasonal ARIMA
- **SARIMAX:** Seasonal ARIMA with exogenous variables

Implementation of ARIMA model in R

In R programming, **`arima()`** function is used to perform this technique. ARIMA model is used to fit a univariate data. **`auto.arima()`** function returns the best ARIMA model by searching over many models.

Syntax:

auto.arima(x)

Parameters:

x: *represents univariate time series object*

To know about more optional parameters, use below command in the console: help("auto.arima")

Example 1:

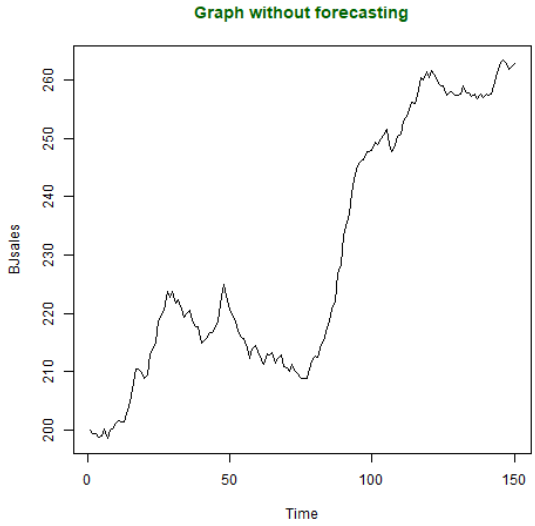
In this example, let's predict the next 10 sale values by using **BJsales** dataset present in R packages. This dataset is already a time series object, so there is no need to apply **`ts()`** function.

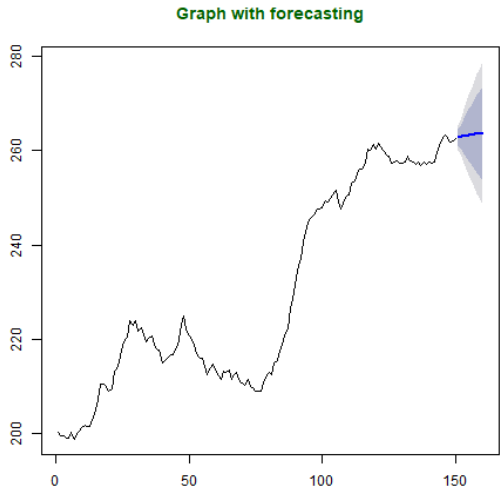
```
# R program to illustrate
# Time Series Analysis
# Using ARIMA model in R

# Install the library for forecast()
install.packages("forecast")

# library required for forecasting
library(forecast)

# Output to be created as png file
png(file = "TimeSeriesGFG.png")

# Plotting graph without forecasting
plot(BJsales, main = "Graph without forecasting",
col.main = "darkgreen")

# Saving the file
dev.off()

# Output to be created as png file
png(file = "TimeSeriesARIMAGFG.png")

# Fitting model using arima model
fit <- auto.arima(BJsales)

# Next 10 forecasted values
```

```
forecastedValues <- forecast(fit, 10)

# Print forecasted values
print(forecastedValues)

plot(forecastedValues, main = "Graph with forecasting",
col.main = "darkgreen")

# saving the file
dev.off()
```

Output:

Point	Forecast	Lo 80	Hi 80	Lo 95	Hi 95
151	262.8620	261.1427	264.5814	260.2325	265.4915
152	263.0046	260.2677	265.7415	258.8189	267.1903
153	263.1301	259.4297	266.8304	257.4709	268.7893
154	263.2405	258.5953	267.8857	256.1363	270.3447
155	263.3377	257.7600	268.9153	254.8074	271.8680
156	263.4232	256.9253	269.9211	253.4855	273.3608
157	263.4984	256.0941	270.9028	252.1744	274.8224
158	263.5647	255.2691	271.8602	250.8778	276.2516
159	263.6229	254.4529	272.7930	249.5986	277.6473
160	263.6742	253.6474	273.7011	248.3395	279.0089





Explanation:

Following output is produced by executing the above code. 10 next values are predicted by using **`forecast()`** function based on ARIMA model of BJsales dataset. First graph shows the visuals of BJsales without forecasting and second graphs shows the visuals of BJsales with forecasted values.

Example 2:

In this example, let's predict next 50 values of **DAX** in **EuStockMarkets** dataset present in R base package. It can take longer time than usual as the dataset is large enough as compared to BJsales dataset. This dataset is already a time series object, so there is no need to apply **`ts()`** function.

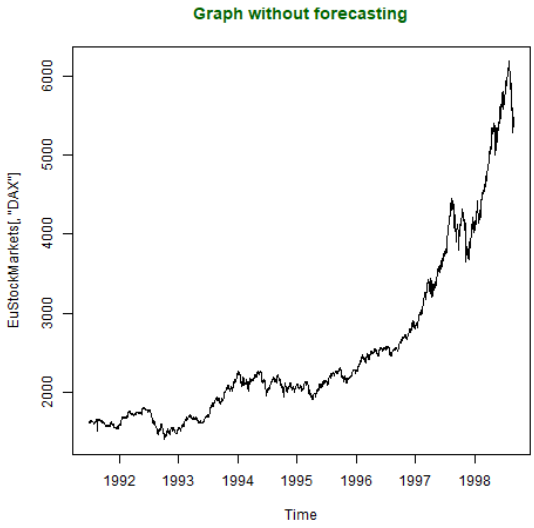
```
# R program to illustrate
# Time Series Analysis
# Using ARIMA model in R

# Install the library for forecast()
install.packages("forecast")

# library required for forecasting
library(forecast)

# Output to be created as png file
png(file = "TimeSeries2GFG.png")

# Plotting graph without forecasting
plot(EuStockMarkets[, "DAX"],
main = "Graph without forecasting",
col.main = "darkgreen")

# Saving the file
```

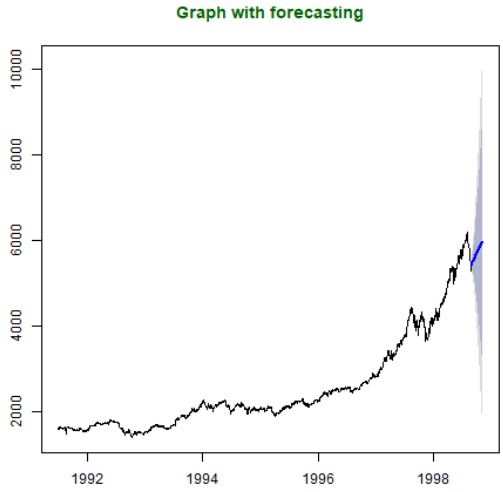
```
dev.off()

# Output to be created as png file
png(file = "TimeSeriesARIMA2GFG.png")

# Fitting model using arima model
fit <- auto.arima(EuStockMarkets[, "DAX"])

# Next 50 forecasted values
forecastedValues <- forecast(fit, 50)

# Print forecasted values
print(forecastedValues)

plot(forecastedValues, main = "Graph with forecasting",
col.main = "darkgreen")

# saving the file
dev.off()
```

Output:

Point	Forecast	Lo 80	Hi 80	Lo 95	Hi 95
1998.650	5477.071	5432.030	5522.113	5408.186	5545.957
1998.654	5455.437	5385.726	5525.148	5348.823	5562.051
1998.658	5438.930	5345.840	5532.020	5296.561	5581.299
1998.662	5470.902	5353.454	5588.349	5291.281	5650.522
1998.665	5478.529	5334.560	5622.498	5258.347	5698.710
1998.669	5505.691	5333.182	5678.199	5241.862	5769.519
1998.673	5512.314	5306.115	5718.513	5196.960	5827.669
1998.677	5517.260	5276.482	5758.037	5149.022	5885.497
1998.681	5524.894	5248.363	5801.426	5101.976	5947.813
1998.685	5540.523	5226.767	5854.279	5060.675	6020.371
1998.688	5551.386	5198.746	5904.026	5012.070	6090.702
1998.692	5564.652	5171.572	5957.732	4963.488	6165.815
1998.696	5574.519	5139.172	6009.867	4908.713	6240.326
1998.700	5584.631	5105.761	6063.500	4852.263	6316.998
1998.704	5595.439	5071.763	6119.116	4794.545	6396.333
1998.708	5607.468	5037.671	6177.265	4736.039	6478.897
1998.712	5618.547	5001.313	6235.781	4674.569	6562.524
1998.715	5629.916	4963.981	6295.852	4611.456	6648.377
1998.719	5640.767	4924.864	6356.669	4545.888	6735.645
1998.723	5651.753	4884.718	6418.789	4478.674	6824.833
1998.727	5662.881	4843.558	6482.203	4409.835	6915.926

1998.731	5674.177	4801.426	6546.928	4339.419	7008.934
1998.735	5685.286	4757.984	6612.588	4267.100	7103.472
1998.738	5696.434	4713.486	6679.383	4193.144	7199.725
1998.742	5707.511	4667.838	6747.183	4117.468	7297.553
1998.746	5718.625	4621.180	6816.069	4040.228	7397.022
1998.750	5729.763	4573.514	6886.012	3961.433	7498.093
1998.754	5740.921	4524.851	6956.990	3881.103	7600.739
1998.758	5752.044	4475.153	7028.934	3799.208	7704.879
1998.762	5763.173	4424.479	7101.867	3715.817	7810.528
1998.765	5774.293	4372.828	7175.758	3630.938	7917.649
1998.769	5785.422	4320.235	7250.610	3544.611	8026.233
1998.773	5796.554	4266.706	7326.403	3456.853	8136.256
1998.777	5807.688	4212.254	7403.123	3367.682	8247.695
1998.781	5818.816	4156.883	7480.749	3277.109	8360.523
1998.785	5829.945	4100.614	7559.276	3185.162	8474.729
1998.788	5841.073	4043.457	7638.690	3091.856	8590.291
1998.792	5852.203	3985.425	7718.982	2997.212	8707.195
1998.796	5863.333	3926.528	7800.139	2901.245	8825.422
1998.800	5874.464	3866.776	7882.152	2803.970	8944.957
1998.804	5885.593	3806.178	7965.007	2705.402	9065.783
1998.808	5896.722	3744.746	8048.698	2605.559	9187.886
1998.812	5907.852	3682.489	8133.214	2504.453	9311.250
1998.815	5918.981	3619.416	8218.547	2402.100	9435.863
1998.819	5930.111	3555.536	8304.686	2298.512	9561.710
1998.823	5941.241	3490.857	8391.624	2193.702	9688.779
1998.827	5952.370	3425.388	8479.352	2087.684	9817.056
1998.831	5963.500	3359.137	8567.862	1980.470	9946.529
1998.835	5974.629	3292.111	8657.147	1872.072	10077.186
1998.838	5985.759	3224.319	8747.198	1762.502	10209.016





Explanation:

The following output is produced by executing the above code. 50 future stock price of DAX is predicted by using `forecast()` function based on the ARIMA model of DAX of EuStockMarkets dataset. The first graph shows the visuals of DAX of EuStockMarkets dataset without forecasting and second graphs show the visuals of DAX of EuStockMarkets dataset with forecasted values.

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2

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