Forecasting Methods

In this pre-read, we are going to get a brief idea about some of the time series models that are available to model the time series data.

Simple Moving Average: In this method, we forecast the next value(s) in a time series based on the average of a fixed finite number m of the previous values. Thus, for all $i > m$,

$$\hat{y}_i = \frac{1}{m} \sum_{j=i-m}^{i-1} y_j = \frac{(y_{i-m} + \cdots + y_{i-1})}{m}$$

This is a naïve approach to time series modeling. This model simply states that the next observation is the mean of all past m observations.

Weighted Moving Average: In the simple moving average, the weights given to the previous m values were all equal. We now consider the case where these weights can be different. This type of forecasting is called weighted moving average. Here, we assign m weights w_1, …, w_m, where $w_1 + \ldots + w_m$ = 1, and define the forecasted values as follows:

$$\hat{y}_i = w_m y_{i-m} + \cdots + w_1 y_{i-1}$$

Autoregressive (AR) Model: The Auto-Regressive Model popularly known as the AR model is one of the simplest models for solving time series forecasting problems. The value of y at time t depends on the previous values of the same time series. The order (p) of an autoregression is the number of previous values in the series that are used to predict the value at the present time.

$$AR(p) : y_t = f(y_{t-1}, y_{t-2}, \ldots y_{t-p})$$

Moving Average (MA) Model: While the Auto-Regressive model considers the past values of the target variable for prediction, the Moving Average model makes use of the past error terms instead, as opposed to the past values themselves. A Moving Average model of order (q) can be represented as follows:

$$Y_t = \beta_0 + \epsilon_t + \phi_1 \epsilon_{t-1} + \phi_2 \epsilon_{t-2} + \phi_3 \epsilon_{t-3} + \cdots + \phi_q \epsilon_{t-q}$$

Where, $\epsilon_t, \epsilon_{t-1}, \cdots, \epsilon_{t-q}$ are the past error terms.

Auto-Regressive Moving Average (ARMA) Model: The Auto-Regressive Moving Average (ARMA) model is a combination of the Auto-Regressive (AR) model and the Moving Average (MA) model, thereby using both the past values as well as the past error terms to forecast Time Series.

ARMA can be mathematically expressed as follows:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \cdots + \beta_p Y_{t-p} + \epsilon_t + \phi_1 \epsilon_{t-1} + \phi_2 \epsilon_{t-2} + \phi_3 \epsilon_{t-3} + \cdots + \phi_q \epsilon_{t-q}$$

Auto-Regressive Integrated Moving Average (ARIMA) Model: The Auto-Regressive Integrated Moving Average (ARIMA) is a very popular model used in time series forecasting. The model is a generalization of the ARMA model that uses integration for attaining stationarity.

The ARIMA model makes use of 3 parameters as given below:

p: Lag order or the number of past orders to be included in the model, i.e., the order of AutoRegression

d: The degree of differencing to be applied (the number of times the data has had past values subtracted).

q: The order of Moving Average

Some examples of ARIMA(p, d, q) are

- $ARIMA(1, 0, 0)$

  $y_t = a_1 y_{t-1} + \epsilon_t$

- $ARIMA(2, 0, 0)$

  $y_t = a_1 y_{t-1} + a_2 y_{t-2} + \epsilon_t$

- $ARIMA(2, 1, 1)$

$\Delta y_t = a_1 \Delta y_{t-1} + a_2 \Delta y_{t-2} + b_1 \epsilon_{t-1} \, where \, \Delta y_t = y_t - y_{t-1}$

Happy Learning!

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