BUSINESS ANALYTICS

Forecasting

- Time series Analysis

    - Analyse the changes happened in one variables over period of time

    - More suitable for short-term projections (ie. 5 to 6 year time series data)

    - Should have clear trend, pattern and stability

- Component of time series:

    - Trend

    - Seasonal

    - Cyclical

    - Irregular

Note: Data should be in time series format

Component of time series

- Trend:
    - Long term pattern
    - Can be positive or negative depends on pattern
    - If it is not showing decreasing or increasing pattern, called stationary
- Cyclical
    - Required minimum 8 years of data
    - Ups and downs around the given trend in cyclical pattern
    - Duration depends on the type of business

- Seasonal:

  - Required minimum 2 years of data

  - Seasonally occurs, when there is a regular fluctuation during the same month of every year

- Irregular component:

  - Irregular data is unpredictable

  - Picks random variable for analysis

Decomposition of components

- Before forecasting, have to do decompose
- When we decompose the time series data we will get all the time series components
- Two methods of decomposing:

     - Time series additive model (Follow the constant pattern)

      (ie. Trend + Seasonality + Regular)

     - Multiplicative model (Do not follow constant pattern)

      (ie. Trend x Seasonality x Irregular)

Techniques/method of forecasting

- **Simple Moving Average**

  - Simple way to predict the future

  - Useful for long term trends

  - Prediction is done based on average (mean)

  - Example:

    8 7 5 6 8 9 6 7 5 ?

    Lets take 5 previous year data to find average

    (8 +9+ 6 +7 +5) /5 = 7

- **Weighted Moving Average**

  - Derived from simple moving average with different weightage to our previous data

  - Weightage will be assigned manually

  - Weightage will be decreased towards old data

  - Example:

  8 7 5 6 8 9 6 7 5 ?

  Lets take 6 previous year data and weightage will be given to find average

  {6(1/6)+8(2/6)+9(3/6)+6 (4/6)+7(5/6)+5 (6/6)}/6 = 3

- **Exponential Smoothing**
  - Also called, Exponential Moving Average
  - More advanced method from weighted moving average
  - Damping factor will be decreasing exponentially towards the older data
  - To forecast the data:

    $F_{(t+1)} = \alpha d_t + (1-\alpha)F_t$

    α = Smoothing constant or Damping factor

    d = Actual value (demand)

    F = Fitted value (forecast)

- In most cases, the default value of α will be 0.2, over all range will be 0 to 1
- Value with least Mean Square Error (MSE) will be Alpha value
- If d(mean) is equal to f(mean), the MSE will be 0 (Prefect prediction)
- Has limitation that it cannot capture trend and seasonality from the data

- **Holt's Exponential Smoothing**
  - It capture trend in data
  - Smoothing will happen twice:
    - First smooths the actual data and the forecast data
    - Secondly smooths between last two forecasted valued and find the trend the data
  - Also called Double exponential Smoothing
  - To forecast and to calculate the trend

    $F_{(t+1)} = \alpha d_t + (1-\alpha)(F_t - T_t)$

    $T_{(t+1)} = \beta(F_{(t+1)} - F_t) + (1-\beta)T_t$

    $H_{(t+1)} = F_{(t+1)} + T_{(t+1)}$
  - Has limitation that it cannot capture seasonality from the data

- **Holt's Winter Model**
  - Captures both trend and seasonal component in the data
  - As well as capture both addictive and multiplicative seasonality
  - To forecast along with trend and seasonality:

    $F_t = \alpha * Y_t/S_{t-p} + (1-\alpha)(F_{t-1}-T_{t-1})$

    $S_t = \beta * Y_t/F_t + (1-\beta) * S_{t-p}$

    $T_t = \gamma * (F_t-F_{t-1}) + (1-\gamma) * T_{t-1}$

    $W_{t+m} = (F_{t+1} + mT_{t+1})S_{t+m-p}$

  - To de seasonality, need minimum 2 years of data to forecast

- **Autoregressive Integrated Moving Average (ARIMA)**
  - General class of models for forecasting time series of non-stationary models
  - Non-stationary data will be converted into stationary models using logging or differentiating
  - Model includes an explicit statistical model for irregular component to allow non-zero auto-correction
  - Also have:
    - AR Process (Autoregressive Process)
    - MA Process (Moving Average Process)
    - ARMA Process (Autoregressive Moving Average Process)

Key points

- Moving and weighted average methods can be done only in R Programmer
- Need to download package for forecast in R Programmer
- To do time series, data should be in time series format
- Before forecasting, have to decompose the data

- Forecasting in R & SAS