Forecasting Models with R

Section 1: Course Overview

Course Disclaimer

- This course has an educational and informational purpose and doesn´t constitute ant type of forecasting or investment advice. All conclusions reflect solely the instructor's opinions based on historical data and calculations with the possibility of future outliers not previously observed within this time series. Past performance doesn´t guarantee future returns. Investment risk and uncertainty can possibly lead to its total loss for unleveraged products and even larger for leveraged ones.
- Therefore, the instructor is not responsible for any damages caused by using data, information, forecasts, opinions or conclusions for investment decisions; exclusively transferring all this responsibility to the student. Recommending that the student does own due-diligence based on several scenarios and assumptions before taking any forecasting or investment decision.

Course Overview

- Practical course is divided into **four sections** and **bibliography**.
- In **first section** forecasting models' applications and time series decomposition are defined.
- Next, R statistical software downloading options, data file reading and R script files statistical computing instructions are explained.
- In **second section** simple forecasting methods are used as initial forecasting comparison benchmarks while exploring:
  - Arithmetic mean method.
  - Naïve or random walk method.
  - Seasonal random walk method.
  - Random walk with drift methods.
- After that, methods' predicting accuracy is tested by comparing forecasting errors metrics such as:
  - Scale-dependent mean absolute error and root mean squared error. Scale-independent mean absolute percentage error.

Course Overview

- In **third section** moving averages and exponential smoothing methods are used for forecasting by flattening time series while exploring:
  - Simple moving average method.
  - Brown's simple exponential smoothing method.
  - Holt's linear and exponential trend methods.
  - Gardner's additive and Taylor's multiplicative damped trend methods.
  - Holt-Winters additive, multiplicative and damped seasonal methods.
- Next, best method is automatically selected by comparing information loss criteria.
- After that, methods' predicting accuracy is tested by comparing previously studied forecasting errors metrics and introducing:
  - Scale-independent mean absolute scaled error.

Course Overview

- In **fourth section** auto regressive integrated moving average models are used for forecasting by estimating the conditional mean of a process with prerequisite of achieving a first order trend stationary time series.
- This will be tested with:
  - Augmented Dickey-Fuller unit root test for the mean and Kwiatkowski-Phillips-Schmidt-Shin test.
- Next, model specification will be done through autocorrelation and partial autocorrelation functions while exploring:
  - Geometric random walk without and with drift models.
  - Level and differentiated first order autoregressive models.
  - Brown's simple exponential smoothing and simple exponential smoothing with growth models.
  - Holt's linear trend and Gardner's additive damped trend models.
  - Seasonal random walk with drift and seasonal random trend models.
  - General seasonal and general first order autoregressive seasonal models.
  - Seasonally differentiated first order autoregressive and Holt-Winters additive seasonality models.
- After that, best model is automatically selected by comparing information loss criteria:
  - Akaike, corrected Akaike and Schwarz Bayesian information criteria.
- Then, models' predicting accuracy is tested by comparing previously studied forecasting errors metrics.
- Finally, best model's forecasting errors or residuals randomness is evaluated with Ljung-Box autocorrelation test to asses if they don't contain any forecasting information.

Forecasting Models

- **Forecasting models** are extensively used for time series data prediction. They are applied in several fields for purposes such as sales forecasting, inventory optimization, demand & operations planning, financial forecasting, and cash flow management among many others.

Forecasting Models

- **Time series decomposition** consists of identifying its trend, seasonal and cyclical patterns. Its trend pattern corresponds to long-term linear or non-linear increase or decrease in the data. Its seasonal pattern corresponds to fixed and known periodic influence such as weekly, monthly, or quarterly. Its cyclical pattern corresponds to non-fixed periodic influence of at least two years.

$$\boldsymbol{additive\ model}:\ \boldsymbol{y_t = b_t + s_t + \varepsilon_t}$$

$$\boldsymbol{multiplicative\ model}:\ \boldsymbol{y_t = b_t * s_t * \varepsilon_t : ln(y_t)} \\ \boldsymbol{= ln(b_t) + ln(s_t) + ln(\varepsilon_t)}$$

Forecasting Models

- **Forecasting Models calculations** are made in *R (64-bit) statistical software* which can be downloaded in *R-Project* website.

Forecasting Models Data

- **Forecasting models data** is based on Apple Inc.'s daily stock prices (ticker: AAPL) for one business calendar year (October 1st, 2014 to September 30th, 2015 : 252 observations) and one month prediction interval (October 1st, 2015 to October 31st, 2015 : 22 observations). It was obtained from *Yahoo! Finance*.
- You can download .CSV file in **Course Data File** Lecture.

Forecasting Models Data

- **Forecasting models scripts** are R code files with instructions for performing statistical computing operations on previously read .CSV data file within software's console. Commonly used formats are .R and .txt plain text files.
- They can be downloaded at the beginning of each section in **Section N Script File** Lectures.