

Time Series Modeling

Lecture 1d: Time Series Terminology

stats24x7.com

1

Prediction of a time series into future is called forecasting.

Examples:

- Marketing departments/production scheduling need to forecast DEMAND
- In finance, interest rates must be predicted so that new capital acquisitions can be planned.
- In HR, forecasts of #(workers) is needed.

stats24x7.com

2

Components of a time series are:

1. Trend
2. Cycle
3. Seasonal Variations
4. Irregular Variations

stats24x7.com

3

1. Trend= up/down movement of a time series

- Trend may be due to: technology, consumer tastes, increase in per capita income, increase in population, inflation, etc.

stats24x7.com

4

2. Cycle= up/down movement of a time series around trend; a cycle can have a duration from 2-10 years (or even longer), measured from peak to peak or trough to trough.

- Examples: Business cycle, caused by periods of prosperity and recession: expansion ends at the peak of the business cycle (boom), followed by contraction (bust) ending at trough

stats24x7.com

5

3. Seasonal Variations= periodic pattern that completes within one year, and is repeated each year.

- Examples:
 - time series of daily temperature of a place is seasonal (meaning changes in the weather)
 - Monthly sales volume in a department store may have seasonal component due to various holidays.

stats24x7.com

6

4. Irregular Fluctuations= erratic movements in a time series that follow no recognizable pattern.

These could be caused by unusual events such as earthquakes, hurricanes, wars, strikes, etc.

stats24x7.com 7

Methods of Forecasting

- Qualitative Methods
- Quantitative or Empirical Methods
- Box-Jenkins Methodology

Qualitative Methods - Generally based on expert opinions, used when historical data is not available or is scarce.

stats24x7.com 8

Quantitative or Empirical Methods

(a) Univariate models predict future values based solely on past; historical data is analyzed in an attempt to find a pattern, then time series is predicted assuming the pattern will sustain.

(b) Causal forecasting involves using other variables that are related to the variable of interest; historical data is used.

Example:

Sales of a product	=	f	(price of product, ad campaign cost, competitor's price of same product)
↑			↑
dependent variable			independent variable

stats24x7.com 9

Box-Jenkins Methodology

Steps are:

1. Identification of a model, done by looking at Sample Autocorrelation (SAC) or Sample Partial Autocorrelation (SPAC)
2. Parameter Estimation
3. Diagnostic Checking
4. Forecasting

Note that the Box-Jenkins method is iterative- the model may be modified after diagnostic checking

- Box-Jenkins method can be used to forecast discrete/continuous variables.
- Box-Jenkins method can be used to forecast both nonseasonal/seasonal data.

stats24x7.com 10

Measuring Forecast Errors

- y_i = observed value at time i
- \hat{y}_i = predicted value at time I
- error= $e_i = y_i - \hat{y}_i$
- Methods that minimize MAD or MSE are sought:

(a) Mean Absolute Deviation (MAD) = $\frac{\sum |e_i|}{n}$

(b) Mean Squared Error (MSE) = $\frac{\sum e_i^2}{n}$

stats24x7.com 11

(c) Mean Absolute Percentage Error (MAPE) =

$$\frac{\sum_{i=1}^n \frac{|y_i - \hat{y}_i|}{y_i}}{n} \times 100$$

(assuming $y_i > 0$)

stats24x7.com 12