Time Series Analysis

Basics of Time Series Analysis

Nicoleta Serban, Ph.D.
Professor
Stewart School of Industrial and Systems Engineering

Overview

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About This Lesson

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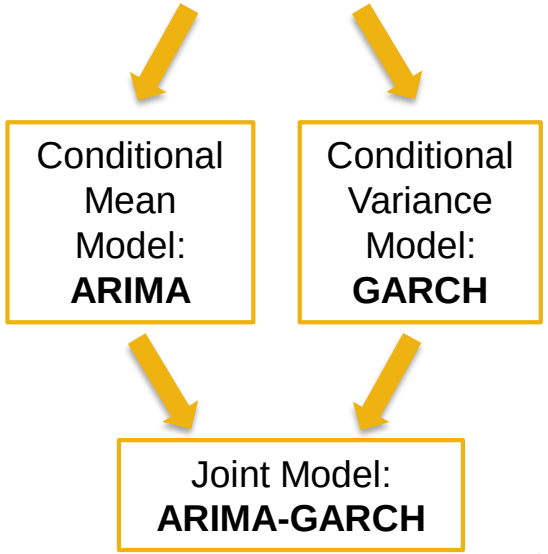
Course Road Map

Pre-requisite: Basic Statistical Modeling & Inference

Basic Time Series Modeling

- Trend
- Seasonality
- Serial Dependence
- Prediction

Univariate Analysis



Multivariate Analysis

- Correlation between & within time series
- Multivariate AR model (VAR)

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Course Road Map: Pre-requisite

Pre-requisite: Basic Statistical Modeling & Inference

- *Distribution of a Random Variable*
- *Statistical Estimation*
- *Statistical Inference*
- *Regression Analysis*

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Model Estimation in Time Series Analysis

Approaches:

1. Method of Moments (MOM)
   - Durbin-Levinson Algorithm (Linear Prediction)
   - Yule-Walker Algorithm (AR model estimation
   - Innovation Algorithm (Linear Prediction & ARMA model estimation)

2. Maximum Likelihood Estimation
   - Most common approach in time series model estimation
   - ARMA, GARCH, VAR

Why important?

Statistical properties and statistical inference of the estimated model are different depending on the estimation approach.

Statistical Inference in Time Series Analysis

Approaches:

1. Confidence & Prediction Intervals
    - Evaluate statistical significance of model coefficients
    - Provide prediction bands for time series forecasts

2. Hypothesis Testing
    - Evaluate statistical significance of model coefficients
    - Evaluate whether data follows a prescribed distribution (e.g. normal)
    - Evaluate model goodness of fit

Why important?

Statistical inference is used in model interpretation and evaluation.

Regression Analysis in Time Series Analysis

General Regression model:

Data: $\{y_1, (x_{1,1}, \dots, x_{1,p})\}, \dots, \{y_n, (x_{n,1}, \dots, x_{n,p})\}$

Model: $Y_i = \beta_0 + \beta_1 x_{i,1} + \beta_2 x_{i,2} + \cdots + \beta_p x_{i,p} + \varepsilon_i, \ i = 1, \dots, n$

Time Series Regression models:

Data: $\{y_1, t_1\}, \dots, \{y_n, t_n\}$

Model:

- Basic model decomposition: $Y_t = m_t + s_t + X_t$
- ARMA, GARCH, VAR

Why important?

Regression modeling is at the basis of all models discussed in this course.

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Course Road Map: Basic Concepts

Basic Time Series Modeling

- Trend
- Seasonality
- Serial Dependence
- Prediction

- *Time Series Definitions*
- *Basic Decomposition: Trend & Seasonality analysis*
- *Stationarity: The basic concept for all time series models*
- *Prediction: Best Linear Predictor*

Basics of Time Series Analysis

What will this module cover?

1. Basic time series modeling
    - Definition of a time series
    - Simple decomposition of a time series into trend & seasonality
    - Approaches for estimating trend and seasonality

2. Fundamental time series concepts
    - Stationarity
    - Linear Process
    - Prediction

Why important?

The concepts introduced in this module are at the basis of all time series models introduced in this course.

Data Examples using R Statistical Software

1. Data Examples
   - Average monthly temperature records starting in 1879 until 2016
   - Emergency Department Volume
   - Bitcoin Price

2. R Statistical Software
   - Visual analytics
   - Evaluating properties and characteristics of a time series
   - Fitting linear regression models for seasonality
   - Fitting parametric and non-parametric trends

Why important?

Fundamentals of time series modeling are best understood by illustrating them using data examples.

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Summary

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