TIME SERIES ANALYSIS

STAT 4440/8446

Course Description:

The objective of this course is to learn and apply statistical methods for the analysis of data that have been observed over time. Topics covered include: Models for Stationary and Non-Stationary Time Series, Model Specification, Parameter Estimation, Model Diagnostics, Forecasting, Seasonal Models, Time Series Regression, and Spectral Analysis. Statistical software will be used. **3 credits**

Prerequisites:

Undergraduate and Graduate: MATH 4750/8756 with a C- or better or STAT 3800/8005 with a C- or better or another introductory probability/statistics course with a C- or better, or permission of instructor.

Overview of content and purpose of the course:

In introductory statistics courses, most data analysis is based on the concept of random samples, where it can be assumed that each observation is independent of all other observations. While there are many such real-world examples of this phenomenon, there are also many real-world scenarios in which there is correlation among the data. Time Series are one such example in which the time dependency creates correlation between observations. There are several families of statistical models that are useful for modeling time series data, ARIMA and GARCH are two particularly useful examples. ARIMA models can also be extended to SARIMA models if the data shows seasonality. All these topics will be covered in the course. The course will make heavy use of statistical software.

Anticipated audience/demand:

Undergraduate and Graduate students in Mathematics, Engineering, Business, and Computer Science who are interested in the analysis of time-dependent data.

Major topics:

1) Introduction to Time Series: Examples, Approaches

2) Fundamental Concepts of Time Series: Stochastic Processes, Means, Variances, Covariances, Stationarity

3) Trends in Time Series: Deterministic vs Stochastic Trends, Regression Methods

4) Models for Stationary Time Series: General Linear Processes, Moving Average Processes, Autoregressive Processes, ARMA Models

5) Models for Nonstationary Time Series: Differencing, ARIMA Models

6) Model Specification: Sample Autocorrelation, Partial Autocorrelation Function, Extended Autocorrelation Function, Specification techniques

7) Parameter Estimation: Method of Moments, Least Squares, Maximum Likelihood, Properties of Estimators

8) Model Diagnostics: Residual Analysis, Overfitting

9) Forecasting: ARIMA forecasting, Prediction Limits

10) Seasonal Models: Seasonal ARIMA, Specification, Fitting, Diagnostics

11) Time Series Regression Models: Intervention Analysis, Outliers, Spurious Correlation, Prewhitening

12) Models of Heteroscedasticity: ARCH Models, GARCH Models

13) Spectral Analysis: Periodogram, Spectral Density

Methods:

The class will be presented primarily in lecture form with student discussion encouraged. Questions are encouraged in class and out.

Student Role:

Students must attend and participate in class in addition to completing course requirements. Students are expected to do reading and assignments as they are assigned.

Textbook:

Cryer, J.D., and Chan, K.S. (2010). *Time Series Analysis: With Applications in R* (2nd ed.), Springer: New York.

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