Applied Time-Series Analysis

ABOUT THE COURSE

The course introduces the concepts and methods of time-series analysis. Specifically, the topics include (i) stationarity and ergodicity (ii) auto-, cross- and partial-correlation functions (iii) linear random processes - definitions (iv) auto-regressive, moving average, ARIMA and seasonal ARIMA models (v) spectral (Fourier) analysis and periodicity detection and (vi) parameter estimation concepts and methods. Practical implementations in R are illustrated at each stage of the course.

The subject of time-series analysis is of fundamental interest to data analysts in all fields of engineering, econometrics, climatology, humanities and medicine. Only few universities across the globe include this course on this topic despite its importance. This subject is foundational to all researchers interested in modelling uncertainties, developing models from data and multivariate data analysis.

COURSE LAYOUT

Week 1: Introduction & Overview; Review of Probability & Statistics – Parts 1 & 2
Week 2: Introduction to Random Processes; Stationarity & Ergodicity
Week 3: Auto- and cross-correlation functions; Partial correlation functions
Week 4: Linear random processes; Auto-regressive, Moving average and ARMA models
Week 5: Models for non-stationary processes; Trends, heteroskedasticity and ARIMA models
Week 6: Fourier analysis of deterministic signals; DFT and periodogram
Week 7: Spectral densities and representations; Wiener-Khinchin theorem; Harmonic processes; SARIMA models
Week 8: Introduction to estimation theory; Goodness of estimators; Fisher's information
Week 9: Properties of estimators; bias, variance, efficiency; C-R bound; consistency
Week 10: Least squares, WLS and non-linear LS estimators
Week 11: Maximum likelihood and Bayesian estimators.
Week 12: Estimation of signal properties, time-series models; Case studies