STP 598: TIME SERIES
Spring 2023
Arizona State University

INSTRUCTOR: HEDIBERT F. LOPES hedibert.lopes@asu.edu
http://hedibert.org/current-teaching
Lectures: Tuesdays and Thursdays, from 10:30am to 11:45am (January 10th to April 27th)
Office hours: Wednesday, from 11am to 12pm (by appointment only)
Classroom: Social Sciences 205 (Tempe)

Course Description

Attention: this is an advanced time series course! A strong background in calculus, probability, statistics and matrix algebra is highly beneficial. The main goal of the course is to make the student familiar with and able to implement univariate and multivariate modern time series models. Univariate time series models we will consider include the family of autoregressive (fractionally) integrated moving average (ARIMA) models, dynamic linear models (aka state-space) models, Markov switching models, generalized autoregressive conditionally heteroskedastic (GARCH) and stochastic volatility (SV) models. Multivariate time series models we will consider include vector autoregressive (VAR) models, factor-augmented VARs, dynamic factor models and various time-varying covariance models. The inferential approach of this course is predominantly Bayesian, so we will briefly introduce key ingredients of Bayesian inference, model selection and criticism. An introduction to the main Monte Carlo methods for Bayesian inference, such as MC integration, sampling-importance-resampling (SIR), Markov chain Monte Carlo (MCMC) and sequential MC (SMC), will also be introduced. All classroom examples and implementations as well as projects will be carried out by the open-source statistical software R.

Key topics covered will be:

- PART I: Basic univariate time series models: AR, MA and ARMA models; unit-root non-stationarity and long-memory processes; seasonal models.
- PART II: Bayesian ingredients (prior, likelihood, posterior, predictive, Bayes factor and posterior model probability); Monte Carlo (MC) methods (MC integration, sampling importance resampling (SIR)) and Markov chain Monte Carlo (MCMC) methods (Gibbs sampler and Metropolis-Hastings (MH) algorithms).
- PART III: More univariate time series: ARCH/GARCH models; EGARCH, GARCH-M, TGARCH; Bayesian GARCH; Bayesian inference in the local level model; Dynamic models; Stochastic volatility models. We will use MCMC as well as sequential Monte Carlo (SMC) schemes to perform batch and online posterior inference.
- PART IV: Multivariate time series models: Vector autoregressive (VAR) models; Large Bayesian VAR (BVAR) models, factor augmented VAR (FAVAR) models, time-varying parameter BVAR (TVP-BVAR) models, Bayesian FAVAR (BFAVAR) models; Factor models and time-varying covariance models.

Books

- Gamerman and Lopes (2006) MCMC: Stochastic Simulation for Bayesian Inference, Second Edition. Chapman & Hall/CRC. http://www.dme.ufrj.br/mcmc
- Prado, Ferreira and West (2021) Time Series: Modeling, Computation & Inference, Second Edition. Chapman & Hall/CRC.
- Shumway and Stoffer (2011) Time Series Analysis and Its Applications with R Examples, Third Edition. Springer. http://www.stat.pitt.edu/stoffer/tsa4

- Tsay (2010) Analysis of Financial Time Series, Third Edition. Wiley-Interscience, Probability and Statistics. http://faculty.chicagobooth.edu/ruey.tsay/teaching/fts3
- Tsay (2014) Multivariate Time Series Analysis with R and Financial Applications. Wiley. http://faculty.chicagobooth.edu/ruey.tsay/teaching/mtsbk

Course Materials

Course materials (including as much of the slides as I can) will be available on my professional page at http://hedibert.org/current-teaching and under the folder Time Series-PhD-ASU.

Software

All classroom examples and implementations as well as projects will be carried out by the open-source statistical software R.