STP 598: TIME SERIES
Spring 2023
Arizona State University

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

ATTENTION!!!
This is an advanced time series course (see the course description below!)
A strong background in calculus, statistics and matrix algebra is highly beneficial.

Course Description

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.

Grades

This is an advanced time series course (see the course description above!) and a strong background in calculus, statistics and matrix algebra is highly beneficial. Grades will be based on homework and final projects which may (should!!) be done in groups. By far the most important thing is your project. Mostly the homework will be applied things you will do in R. Grading Students can expect to get at least a B+ if an honest attempt is made to engage with the material. Students who complete all assigned problems with correct answers for most of them will get an A. Students who distinguish themselves in class participation or give particularly thorough solutions can earn an A+.

Academic Dishonesty

Academic honesty is expected of all students in all examinations, papers, laboratory work, academic transactions and records. The possible sanctions include, but are not limited to, appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification and dismissal. For more information, see http://provost.asu.edu/academicintegrity.

Students with Disabilities

Disability Accommodations: Qualified students with disabilities who will require disability accommodations in this class are encouraged to make their requests to me at the beginning of the semester either during office hours or by appointment. Note: Prior to receiving disability accommodations, verification of eligibility from the Disability Resource Center (DRC) is required. Disability information is confidential.

Establishing Eligibility for Disability Accommodations

Students who feel they will need disability accommodations in this class but have not registered with the Disability Resource Center (DRC) should contact DRC immediately. Their office is located on the first floor of the Matthews Center Building. DRC staff can also be reached at: 480-965-1234 (V), 480-965-9000 (TTY). For additional information, visit: www.asu.edu/studentaffairs/ed/drc. Their hours are 8:00 AM to 5:00 PM, Monday through Friday.

Policy on Threatening Behavior

All incidents and allegations of violent or threatening conduct by an ASU student (whether on- or off campus) must be reported to the ASU Police Department (ASU PD) and the Office of the Dean of Students. If either office determines that the behavior poses or has posed a serious threat to personal safety or to the welfare of the campus, the student will not be permitted to return to campus or reside in any ASU residence hall until an appropriate threat assessment has been completed and, if necessary, conditions for return are imposed. ASU PD, the Office of the Dean of Students, and other appropriate offices will coordinate the assessment in light of the relevant circumstances.

Classroom behavior: Make sure you arrive on time for class

Excessive tardiness will be subject to sanctions. Under no circumstances should you allow your cell phone to ring during class. Any disruptive behavior, which includes ringing cell phones, listening to your mp3/iPod player, text messaging, constant talking, eating food noisily, reading a newspaper will not be tolerated. The use of laptops (unless for lecture note taking), cell phones, MP3, IPOD, etc are strictly prohibited during class. Students who engage in disruptive classroom behavior may be subject to various sanctions. The procedures for initiating a disruptive behavior withdrawal can be found at https://clas.asu.edu/resources/disruptive-behavior.

Absences related to religious observances/practices

If you will be absent from class due to a religious observance or practice, it is your responsibility to inform the instructor during the first week of class. Your instructor will work with you on alternative and reasonable arrangements for any time missed.

Absences related to university sanctioned events and activities

If you will be absent from class due to participation in a university sanctioned event/activity, it is your responsibility to inform the instructor during the first week of class. Your instructor will work with you on alternative and reasonable arrangements for any time missed.

Inclusion

The School of Mathematical and Statistical Sciences encourages faculty to address and refer to students by their preferred name and gender pronoun. If your preferred name is different than what appears on the class roster, or you would like to be addressed using a specific pronoun, please let your instructor know.

Policy on Sexual Discrimination

Arizona State University is committed to providing an environment free of discrimination, harassment, or retaliation for the entire university community, including all students, faculty members, staff employees, and guests. ASU expressly prohibits discrimination, harassment, and retaliation by employees, students, contractors, or agents of the university based on any protected status: race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, and genetic information.

Title IX

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at `https://sexualviolenceprevention.asu.edu/faqs`.

Note

As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, `https://eoss.asu.edu/counseling`, is available if you wish discuss any concerns confidentially and privately.