STATISTC 697TS – Time Series Analysis and Applications

University of Massachusetts Amherst, Spring 2022

About This Course

Description: This course will cover several workhorse models for analysis of time series data. The course will begin with a thorough and careful review of linear and general linear regression models, with a focus on model selection and uncertainty quantification. Basic time series concepts will then be introduced. Having built a strong foundation to work from, we will delve into several foundational time series models: autoregressive and vector autoregressive models. We will then introduce the state-space modeling framework, which generalizes the foundational time series models and offers greater flexibility. Time series models are especially computationally challenging to work with - throughout the course we will explore and implement the specialized algorithms that make computation feasible in R and/or STAN. Weekly problem sets, two-to-three short exams, and a final project will be required.

Objectives: After this course, students should be able to:

- Perform exploratory time series data analysis;
- Understand, explain and know the relative merits of several classical time series models, including but not limited to AR, MA, ARMA, ARIMA, and state-space models;
- Fit several series models to data using `R`;
- Interpret time series analysis results.

Prerequisites: STAT 607/608 or strong performance in STAT 515/516 for familiarity with maximum likelihood estimation. STAT 625 or 705 or strong performance in STAT 525 for familiarity with linear algebra, specifically in the context of regression, recommended but not required.

Class Location and Times

Lederle Graduate Research Tower (LGRT) 171, M/W/F, 12:20PM - 1:10PM

Instructor

Maryclare Griffin (maryclaregri@umass.edu)
Physical Office: LGRT 1342 Zoom Room: `https://umass-amherst.zoom.us/j/8484275519`
Office Hours: Weds. 3:30PM-4:30PM/Thurs. 3:00PM-4:00PM/By Appointment.

Course Page and Related Pages

Learning Management System: `https://umass.moonami.com`

Lecture Notes and Textbooks

Course notes will be posted on the LMS as the progresses. You will be responsible for any material that has been covered in the course notes for exams, homeworks, and projects. The course notes will be based on the following textbooks, which are available for free to download via the University of Massachusetts Amherst Library.

- Shumway and Stoffer (2006), *Time Series Analysis and Its Applications With R Examples, 2nd Ed.*
- Chan (2010), *Time Series: Applications to Finance with R and S−Plus®, 2nd Ed.*
- Cowpertwait and Metcalfe (2009), *Introductory Time Series with R.*
- Tsay (2010), *Analysis of Financial Time Series, 3rd Ed.*

Tentative Schedule

Week 1	Regression Review	-	1/26	1/28	
Week 2	Modeling Time Trends, Minimizing Prediction Error, Stationarity	1/31	2/2	2/4	
Week 3	Autoregressive Models	2/7	2/9	2/11	
Week 4	Autoregressive Models, Moving Average Models	2/14	2/16	2/18	
Week 5	Moving Average Models	2/22	2/23	2/25	
Week 6	ARIMA Models	2/28	3/2	**3/4**	**Quiz 1 Fri.**
Week 7	State-Space Models	3/7	3/9	3/11	
Spring Break	Spring Break - Spring Break - Spring Break- Spring Break- Spring Break- Spring Break- Spring Break- Spring Break				
Week 8	State-Space Models	3/21	3/23	3/25	
Week 9	State-Space Models	3/28	**3/30**	4/1	**Quiz 2 Weds.**
Week 10	Spectral Models	4/4	4/6	4/8	
Week 11	Spectral Models	4/11	4/13	4/15	
Week 12	Multivariate Models	No class!	4/20	4/22	
Week 13	Multivariate Models	4/25	4/27	4/29	
Week 14	Multivariate Models	5/2	**5/4**	No class!	**Quiz 3 Weds.**

Grading Policy

Grades will be computed according to:

Quizzes	30%
Homeworks (lowest grade dropped)	30%
Project	30%
Reflections	10%

Students are encouraged to work together on homeworks and the project, but each student must independently write up and submit their own homework or project in their own words. Students must list any students they worked with in homeworks or the project, and must cite any references used. Written regrading requests must be submitted to the instructor via emails within one week of the grade being received. If granted, a complete re-grade will be performed and the new grade can be higher or lower.

Exams

Quizzes will be completed independently. Preliminary exam dates are:

- Friday, 3/4/2022;
- Wednesday, 3/30/2022;
- Wednesday, 5/4/2022.

Exams will be focused on the most recently covered material, but will be cumulative insofar as the material builds on itself throughout the semester. No make-up exams will be considered, unless a student misses an exam due to a documented illness or family emergency. Please notify the instructor via email if you may miss an exam as soon as promptly as possible.

Homeworks

Completed homeworks must be submitted on the LMS by the beginning of class (12:20PM) on Fridays unless otherwise indicated, and will be posted by 11:59PM two Thursdays before they are due. Late homework will not be accepted. This will let the instructor draw on completed homeworks for Friday lectures.

Solutions to problems that require use of `R` must be written up using `R` Markdown, and all relevant code for replication must be included. When `R` is used, raw `R` output alone will not constitute a complete solution. Instead, students will be expected to translate `R` output into words, possibly accompanied by well-annotated graphics and tables.

Project

Students will be asked to select one of several approved datasets and independently complete a five page writeup containing:

- Exploratory data analysis;
- Application of two methods learned in class;
- Discussions of the methods' appropriateness.

`R` code reproducing all results must be submitted with the writeup. A final draft of the entire project will be due Thursday, 5/12/2022 by 5:00PM, submitted online via the LMS.

Parts of the project will also be woven into homeworks. The final draft will count towards the 30% of your grade based on the project, whereas parts woven into homeworks will count towards the corresponding homework grade.

Reflections

Starting in Week 2, a weekly reflection will be due on the LMS by the end of class (1:10PM) on Fridays unless otherwise indicated, and will be graded as complete (full credit) or incomplete (no credit). A complete weekly reflection will consist of at least three complete sentences describing a concept from the course that you are struggling to understand, feel like you've mastered, or are interested in learning more about. The last five minutes of Friday lectures will be spent on reflections, however submissions will be accepted throughout the week leading up to the due date and time. The 10% of your grade based on reflections will reflect the proportion of complete reflections submitted on time.

Computing and Typesetting

This course will use `R` for all computing:

`http://cran.r-project.org`

Students must typeset homeworks and the project using `R` Markdown:

`http://rmarkdown.rstudio.com`

`R` Markdown is easily used from within RStudio:

`https://www.rstudio.com/products/rstudio`

Emails

- Include 697 in the email subject line. The instructor cannot guarantee that emails that do not contain either 697 in the email subject line will be read and responded to.
- The instructor will respond to emails at her discretion.

Students with Disabilities

The University of Massachusetts Amherst is committed to making reasonable, effective and appropriate accommodations to meet the needs of students with disabilities and help create a barrier-free campus. If you have a disability and require accommodations, please register with Disability Services (161 Whitmore Administration building; phone 413-545-0892) to have an accommodation letter sent to your faculty. Information on services and materials for registering are also available on their website `www.umass.edu/disability`.