STAT 153 - Introduction to Time Series
Fall 2021

- Instructor: Ruoqi Yu, email: ruoqiyu@berkeley.edu*.
  Lectures: Wednesday 3:10 - 6 pm, Birge 50.
  *For private concerns or logistic issues, otherwise please go to office hours.

- GSI: Tyler Maltba, email: tyler_maltba@berkeley.edu.
  Lab*: Friday Sections: 1:10 - 3 pm in Evans 332, 3:10 - 5 pm in Evans 332
  GSI: Zihao Chen, email: zihaochen@berkeley.edu.
  Lab*: Friday Sections: 9:10 - 11 am in Evans 332, 11:10 am - 1 pm in Evans 332
  *Labs will start from 9/3/2021.

- Office Hours (starting from 8/25/2021, zoom link available at bCourses):
  Ruoqi Yu: Wednesday 9 - 11 am or by appointment.
  Tyler Maltba: Tuesday/Thursday 12 - 2 pm or by appointment.
  Zihao Chen: TBA
  Due to the large size of this class, responding to emails may be slow. The best way to get help is to go to office hours. The GSIs and I have office hours almost every day each week.

1 Course Description

A time series is a set of numerical observations, each one being recorded at a specific time. Such data arise everywhere. It's probably incorrect to assume independence, so we look at ways to deal with how the data interact with time. This course aims to teach you how to analyze time series data in the time domain and spectral domain (we will focus mostly on univariate time series data).

2 Topics

We will generally follow the topics presented in the textbook. Our tentative list of topics:

- Weak and strong stationarity.
- Trend and seasonality models.
- Moving average (MA), autoregressive (AR), and ARMA models.
- Best linear prediction.
- Estimation: method of moments, least squares, maximum likelihood.
- ARIMA and SARIMA models.
- Diagnostics and model selection (AIC/BIC, crossvalidation).
- (Discrete) Fourier transform and spectral density.
- Time invariant filters and power transfer function.

3 Course Prerequisites

This course is intended for students who have taken at least one elementary statistics course at the level of STAT 135 (some basic data analysis experience and familiarity with statistical notions such as correlation, maximum likelihood estimation, method of moments estimation, least squares, confidence intervals etc. is required) and one elementary probability course at the level of STAT 134 (familiarity is required with random variables, distribution functions, independence, uncorrelatedness, joint distributions etc). For the second part of the class (on frequency domain methods) some background on complex numbers is required. Basic programming skills in R are required.

4 Textbook

Time Series Analysis and its Applications by Shumway and Stoffer, fourth edition. An electronic PDF version is available for free via the library website. One thing to note: as stated on page vii, "this book is designed to be useful as a text for courses in time series on several different levels". Thus, part of the book are applicable to our class (mostly chapters 1-4), and others are for graduate-level classes. We will follow this book but not too closely.

5 bCourses

bCourses will be the hub for class material, grades, and announcements. All lecture slides, sample R code, homework, etc. will be posted there.

6 Assignments

- Homework. There will be approximately 6 homework in total. Homework should be submitted via bCourses and will be due on Wednesdays at 3 pm (before the lectures). No late homework will be accepted, but the lowest homework grade will be dropped. You are welcome and encouraged to work in small groups on the assignments. However, as listed in the academic honesty section below, you are expected to write up your own solutions and/or code.

- Exams. There will be two exams: one midterm and one final. The exams will be cumulative. Exams, of course, are worked on independently. If your score on the final exam is higher than your midterm score, it will replace them! So, if you struggle at the beginning but work hard and do well on the final, your grade in the course will reflect your hard work! There will be no make-up midterms. If you have to miss the midterm, weights will be shifted to the final exam with valid evidences for absence such as a doctor's note. If you do not take the final exam, it is policy that you fail the course. Please drop this class if you are taking another class whose final exam is also from 7 - 10 pm on Tuesday 12/14/2021.

- Project. Please get together in groups of 3-5 students. Groups with less than 3 or more than 5 students will not be accepted. There won't be individual grades for the group project, but each group will receive a single grade.

7 Grading

For all grading we will be using bCourses. After grading has been published, regrade requests should be submitted within one week. After one week, no regrade requests would be considered. Regrade requests are for handling grading errors, not for arguing with the grading rubric. Keep in mind, that there is a possibility that you might get a lower score after the regrade. Please use the following communication channels for regrade requests (remember to state which question(s) you would like to be regraded and explain clearly why you feel it is graded incorrectly):

- Homework: Please first contact the Reader (Laura Li, cylaura@berkeley.edu). If you still have a complaint, send me a written request through email explaining your case clearly.
- Midterms: Please send a written regrade request to me through email.
- Final: Due to time constraints, we cannot consider any regrade request or complaints for the Final. I will make sure that your final grade is invariant under a potential small change in your Final's score.

Semester composite scores are calculated according to the breakdown shown below.

- Homework: 30%
- Midterm: 20%, date: Wednesday, October 13, in class.
- Project: 10%, due date: Tuesday, 11/23/2021.
- Final Exam: 40%, assigned time: Tuesday 12/14/2021, 7 - 10 pm, location TBA.

Semester letter grades will be assigned based on your percentage of total points, broken down below:

- $[99, 100] = A+$
- $[94, 99) = A$
- $[90, 94) = A-$
- $[87, 90) = B+$
- $[83, 87) = B$
- $[80, 83) = B-$
- $[77, 80) = C+$
- $[73, 77) = C$
- $[70, 73) = C-$
- $[67, 70) = D+$
- $[63, 67) = D$
- $[60, 63) = D-$
- $[0, 60) = F$

8 Notifications

8.1 Accommodation

Students requesting accommodations due to a disability should contact me (the professor) at the start of the semester (or as soon as they become eligible for accommodations) in order to provide you with ample time to meet the required accommodations.

8.2 Scheduling Conflicts

Please notify me in email by the second week of the term about any known or potential extracurricular conflicts (such as religious observances, graduate or medical school interviews, or team activities). I will try my best to help you with making accommodations, but cannot promise them in all cases. In the event there is no mutually-workable solution, you may be dropped from the class. In regards to emergencies (i.e., sudden conflicts), see the previous section on exams.

- Statement on Classroom Climate:
  We are all responsible for creating a learning environment that is welcoming, inclusive, equitable, and respectful. The expectation in this class is that we all live up to this responsibility, even during vigorous debate or disagreement, and that we will intervene if exclusionary or harassing behavior occurs. If you feel that these expectations are not being met, you can consult your instructors or seek assistance from campus resources.

- Academic Accommodations:
  The purpose of academic accommodations is to ensure that all students have a fair chance at academic success. If you have Letters of Accommodations from the Disabled Students' Program or another authorized office, please share them with me as soon as possible, and we will work out the necessary arrangements. While individual circumstances can vary, requests for accommodations often fall into the categories listed on the Academic Calendar and Accommodations website. The campus has well-developed processes in place for students to request accommodations, and you are encouraged to contact the relevant campus offices listed on the Academic Accommodations Hub(link is external). These offices, some of which are confidential, can offer support, answer questions about your eligibility and rights, and request accommodations on your behalf, while maintaining your privacy.

8.3 Academic Integrity

One of the most important skills you can learn is how to find information you need. Even more than remembering the material in this course, I hope you remember where/how to access the material when you need to use again! With that in mind, one of the most important values of an academic community is the balance between the free ow of ideas and the respect for the intellectual property of others. Researchers don't use one another's research without permission; scholars and students always use proper citations in papers; professors may not circulate or publish student papers without the writer's permission; and students may not circulate or post materials (handouts, exams, syllabi – any class materials) from their classes without the written permission of the instructor.

Any test, paper or report submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course unless you obtain prior written approval to do so from your instructor. In all of your assignments, including your homework or drafts of papers, you may use words or ideas written by other individuals in publications, web sites, or other sources, but only with proper attribution. Acknowledge any help received on your assignments. If you are not clear about the expectations for completing an assignment or taking a test or examination, be sure to seek clarification from your instructor or GSI beforehand. Finally, you should keep in mind that as a member of the campus community, you are expected to demonstrate integrity in all of your academic endeavors and will be evaluated on your own merits. The consequences of cheating and academic dishonesty—including a formal discipline file, possible loss of future internship, scholarship, or employment opportunities, and denial of admission to graduate school—are simply not worth it.

Cheating on exams and blatantly copying homework will result in a 0 on said assignments and will be reported to the appropriate office. Posting any course material on public sites like coursehero etc or making any course material available to other students is considered cheating and plagiarism. Please do not do it. Serious action will be taken.

In the event that an exam is disturbed via bomb threat, fire alarm, or other severe classroom disruption, I will announce to the class to grab your belongings and exit silently but immediately, leaving your exam behind in the classroom unless instructed otherwise. The decision on how to proceed with the exam will be made at the time of the alarm. Any talk about or looking at exam material before the exam is finished, without instructor permission, will constitute cheating and your exam will be graded as a zero. Use common sense and honesty and we'll all be fine!

8.4 Enrollment Issues

Once enrolled, please only attend the lab section you are actually enrolled in, to make sure we have enough seats. Before enrollment, you are welcome to attend Friday labs, but only if there is room in the lab for the enrolled students. If you'd like to switch sections, use CalCentral. If there is no room in section you'd like to be in, you can add yourself to the top of waiting list, but this does essentially drop you from the course. For add/drop deadlines, see https://registrar.berkeley.edu/calendar. I must wait to enroll Concurrent Enrollment (CE) students until after the waiting list gets cleared.