COURSE OUTLINE
STATISTICS 153: INTRODUCTION TO TIME SERIES
SPRING 2019

UNIVERSITY OF CALIFORNIA, BERKELEY

- **Instructor**: Merle Behr. Email: `behr@berkeley.edu`
- **Lectures**: 2:00 - 3:30 pm on Tuesdays and Thursdays at Hearst Mining 390.
- **Office Hours**: 3:45 - 5:00 pm on Tuesdays and Thursdays at Evans 399.
- **GSI 1**: Frank Qiu. Email: `frankqiu@berkeley.edu`
- **GSI 2**: Runjing (Bryan) Liu. Email: `runjing_liu@berkeley.edu`
- **GSI Discussion Section**: Fri, 9-11am (Evans 332), 11am-1pm (Evans 344), 12-2pm (Etcheverry 3109), 2-4pm (Evans 3), starting 1/25/19.
- **GSIs Office Hours**: TBA

Short Description: A time series is a set of numerical observations, each one being recorded at a specific time. Such data arise everywhere. This course aims to teach you how to analyze time series data (we will focus mostly on univariate time series data). There exist two main approaches to time series analysis: *Time Domain* approach and *Frequency Domain* approach. Approximately, about 60% of the course will be on time domain methods and 40% on frequency domain methods.

Tentative List of Topics:

(1) Trend and seasonality models.
(2) Weak and strong stationarity.
(3) Moving average (MA), autoregressive (AR), and ARMA models.
(4) Best linear prediction.
(5) Estimation: method of moments, least squares, maximum likelihood.
(6) ARIMA and SARIMA models.
(7) Diagnostics and model selection (AIC/BIC, cross validation).
(8) (Discrete) Fourier transform and spectral density.
(9) Time invariant filters and power transfer function.

Prerequisite: 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.

Date: January 18, 2019.

Textbook: *Time Series Analysis and its Applications* by Shumway and Stoffer. It is available for free via the library website. We will follow this book but not too closely.

Other textbooks you can look at:

(1) *Introduction to Time Series and Forecasting* by Brockwell and Davis. This is a very standard introductory time series textbook.
(2) *Time Series: Theory and Methods* by Brockwell and Davis. More focused on the theoretical background. Many proofs which we might not have time to cover in class can be found here.
(3) *Time Series Analysis with Applications in R* by Cryer and Chan. A more elementary text than Shumway and Stoffer. Available for free online through the library website.
(4) *Fourier Analysis of Time Series* by Bloomfield. This book only covers the frequency domain approach. Available for free online.

bCourses: We will post all lecture material (lecture notes, sample R code, homework, etc.) on bCourses. Your assignment grades will also be posted on bCourses. We will also use bCourses for course-related announcements.

Piazza: For Q & A we will be using Piazza. I have created a site for this class, please sign up for the class at `piazza.com/berkeley/spring2019/stat153`. The GSIs and I cannot monitor Piazza 24/7, so please help your fellow classmates. Do not post your entire homework solutions on Piazza and try to be specific in your questions.

Lecture Notes and R code: There will be typed lecture notes, which I upload chapter-wise, shortly after each lecture. I will also upload some data analysis examples in R for most chapters.

Homework assignments: These will involve a mix of theoretical (pen and paper) and computer exercises. We will post them roughly once every two weeks. Due date of homework will be (at the earliest) one week after it got posted. All homework needs to be submitted via Gradescope. Late assignments will not be accepted! You will be allowed to drop one of the homework assignments for your final assessment.

Midterms: There will be two in-class midterm exams whose tentative dates are Thursday 03/07/19 and 04/25/19. All electronic devices are prohibited during Midterm 1 and 2. Try not to ask many questions during exams, as this is quite disruptive to other students; make your best attempt and move on. In case you cannot attend one of the in-class exams because of unexpected illness, you need to hand in a doctor's certificate so that we can accommodate you.

Final project: The Final will be a group project. To this end, please get together in groups of 3-5 students. Groups with less than 3 or more than 5 students will not be accepted. The final project will get posted during the last week of instruction and will be due on Monday 5/13/19 (the first day of the final exam week). There won't be individual grades for the group project, but each group will receive a single grade.

Assessment: Your final grade will be a weighted average of your homework (20%), Midterm 1 (25%), Midterm 2 (35%), and Final Project (20%).

Bonus point for participation in lab section: Every student presenting at least one worksheet problem during lab session receives a small bonus point for the final grade.

Grading: For all grading we will be using Gradescope, which allows us to provide fast and accurate feedback on your work. As soon as grades are posted, you will be notified immediately so that you can log in and see your feedback. Your Gradescope login is your university email, and your password can be changed at `https://www.gradescope.com/reset_password`. The same link can be used if you need to set your password for the first time.

Grade Complaints: 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 if I do the regrade. Please send all regrade request via Gradescope. Due to time constraints, we cannot consider any regrade request or complaints for the Final project. I will make sure that your final grade is invariant under a potential small change in your Final project's score.

Enrollment issues: All Concurrent Enrollment (CE) students need to wait until the waiting list gets cleared. Switching sections: There is no easy way for me to switch your section. Enrolled students can only switch their sections, using CalCentral, when there is room in the section they wish to enroll in. If there is no room in the section you wish to enroll in, you have the option to add yourself to the top of waiting list but this does essentially drop you from the course. You should only attend the section where you are enrolled in. You can find all deadlines regarding adding/dropping courses on `https://registrar.berkeley.edu/calendar`.

Academic Integrity: You are encouraged to work in small groups on homework problems. However, you must write up the solutions on your own, and you must never read or copy the solutions of other students. Similarly, you may use books or online resources to help solve homework problems, but you must credit all such sources in your writeup and you must never copy material verbatim. Any student found to be cheating risks automatically failing the class and being referred to the Office of Student Conduct. In particular, copying solutions, in whole or in part, from other students in the class or any other source without acknowledgment constitutes cheating. Please also read carefully through the UC Berkeley Honor Code which can be found at `https://teaching.berkeley.edu/berkeley-honor-code`.

Students with disabilities: If you need accommodations for any physical, psychological, or learning disability, please get in touch with me so that we can make the necessary arrangements.

Bomb Threats/Fire Alarms: In case of a fire alarm or bomb threat you should grab your belongings and exit silently, but immediately. When the alarm takes place during an exam, you should leave your exam and scantron unless told to bring them with you. Depending upon the timing of the alarm we may continue the exam outside or in the exam room, when and if we are allowed to re-enter. This decision will be made at the time of the alarm (if there is one). Sorry but any talking or looking at material during this

time will be considered cheating. A zero will be given on the exam. A truly annoying bad habit is the pulling of fire alarms by ill-prepared and selfish students who foolishly think their entire future rests on the grade on one exam. This is a felony crime, punishable by a fine and time in jail. In addition, anyone caught pulling the alarm will fail the course and is subject to expulsion from the University.

Scheduling Conflicts: Please notify me in writing 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 any case, you will need to provide proofs (like medical documents) whenever you cannot take an exam.

Please note that this syllabus might be subject to change.