Resources:

Slides: Canvas/Files/Slides

There are two subfolders. The Updating subfolder contains tentative versions, which will be uploaded before the Monday/Wednesday classes for students to preview. The Final Version subfolder contains the final versions of slides, which will be uploaded after we complete each lecture (each lecture usually takes 1-2 weeks).

Textbook: Canvas/Files/Textbook

This folder contains the PDF of our textbook. (It is still strongly recommended to get a hard copy of the textbook.)

All of the R code in the textbook can be found at https://www.stat.pitt.edu/stoffer/tsa4/

Reading materials: Ed (https://edstem.org/us/courses/54744/discussion/4159280)

The reading materials will be posted from time to time. Some remarks of slides will also be posted there.

Solutions to homework and quizzes: Canvas/Files/Assignments and Canvas/Files/Quizzes

For homework, detailed solutions will be uploaded. For quizzes, only the correct answers will be uploaded (shortly after the quiz), but no detailed explanations are included. Please feel free to ask questions about the quiz during Friday sessions. Our TF will also go over the past homework during Friday sessions.

Q&A: Canvas/Ed Discussion

You are welcome to attend office hours. Ed is the online platform to ask questions. You can choose to ask questions anonymously. Please allow 24-48 hours for Instructor and TF to respond.

Materials to study for midterm/final:

It is recommended to read the slides carefully. Some details not mentioned on the slides can be found in the reading materials. The midterm/final has two parts. Part 1 contains multiple choice questions. The quizzes serve as good material to practice for Part 1. Part 2 contains some longer questions. The homework problems are good material to study.

Syllabus:

Term: Spring 2024

Course Instructor: Tracy Ke <zke@fas.harvard.edu> [Please do NOT use zke@g.harvard.edu]

Teaching Fellows: TBD

Meeting Time: 3-4:15pm, Monday and Wednesday

Office Hours: TBD

TF Office Hours: TBD

Weekly TF Sessions: Friday (exact time will be determined after the first week of Spring 2024)

Grading: Homework (30%), midterm (25%), written final (25%), final project (10%), attendance & quizzes (10%)

Attendance & quizzes (open-book and open-note): There will be a short quiz (usually 10 minutes) in the beginning of each Monday's lecture (starting from Week 2).

The quiz serves as both a check-in of attendance and a test of basic things taught in class. It is open-book and open-note. You can read textbooks and check slides/notes. Sample quiz can be found under Canvas/Files. In both the Midterm & Final, part 1 contains variants of the questions in quizzes. Hence, taking the quizzes is also a good practice for the Midterm & Final.

Policy of Quiz.pdf

Midterm: Close-book in-class exam (1 cheatsheet allowed). No R coding.

Written final: In the exam period. No R coding. 2 cheatsheet allowed.

Project: Students form groups to complete a final project. The goal of this project is to use the time series techniques learnt in class to analyze a real-world data set.

Homework: A mix of mathematical statistics (how to formalize real problems, come up with an estimator, prove consistency, etc.) and implementation of the methods introduced in lecture (using R or the language of your choice; solutions will be provided in R).

Late Homework Policy: Late assignments will automatically receive a grade of zero.

Course collaboration policy:

For quizzes: No collaboration is allowed.

For homework: You are allowed and in fact encouraged to discuss homework with other students, but all of your final answers should be in your own words. Copying or simply paraphrasing other studentsâ€™ homework is not allowed. Please list all the the other students that you have discussed your assignment with at the front of your submitted homework (or as a comment to your online submission). In particular, you can ask questions and seek help from each other, but you are not allowed to copy others' code/plots/proofs.

Scenario 1: Student A asks Student B how to use an R function. Later, A implements it by himself/herself and generates the results/plots needed for the homework. [This is Okay.]

Scenario 2: Student A takes the homework of Student B, copies the lines of code and/or the results/plots. [This is not allowed.]

Scenario 3: Students A&B discuss about how to prove something in the homework. They figure out the answers together. Later, each of them writes down the solutions independently. [This is Okay.]

Scenario 4: Students A&B discuss about how to prove something in the homework. They figure out the answers. Student B writes down all steps. Student A copies his/her answers. [This is not allowed.]

For general course materials: You are encouraged to discuss lecture materials with other students or form study groups.

For exams: All exams (including the midterm and finals) should be your independent work - no collaboration is allowed.

Course Description: This course is an introduction to time series with an emphasis on models, methods, and algorithms. Time series techniques are used to understand data which may be observed over time and in which time plays an important role.

We will begin with simple models such as autoregressive, moving average, and ARIMA models, which involve linearity and Gaussianity assumptions. With these models in mind, we discuss statistical questions such as parameter inference, model choice, and forecasting in the presence of uncertainty.

In the second part of the course we will cover more sophisticated time series models such as hidden Markov and state space models, which are used extensively in science and industry. In turn, these suggest interesting computational questions, and we will cover classic algorithms such as the Kalman filter and particle filter.

Course Requirements: No previous knowledge of time series methods is required, but we assume knowledge of statistical inference and probability at the level of STAT 110, 111, and 139, or the equivalent in other departments. For example, we will frequently use concepts such as *likelihood*, *estimators*, *asymptotics*, *variance and covariance*, *method of moments*, *conditional distributions*, etc.

Some reminders on calculus and probability, written by Prof. Neil Shephard who previously taught this course, are available in Files/Reading Material. The topics mentioned above are also covered in the first seven chapters of *All of Statistics* by Larry Wasserman. If you plan to take the course, these should not look too scary to you.

Text: We will upload slides and lecture notes regularly, so a textbook is not strictly necessary.

For reference, the closest book for the first part of the course will be *Time Series Analysis and Its Applications* by Shumway and Stoffer (*PDF can be found under STAT131/Files*). For the second part the course will follow the themes of *Nonlinear Time Series* by Douc, Moulines, and Stoffer, without being as heavy on the math side.

Other standard books on time series include *Introduction to Time Series and Forecasting* by Brockwell and Davis (1991), *Financial Time Series* by Tsay (2010), and *Time Series Analysis with Applications in R*, by J.D. Cryer and Kung-Sik Chan (2008).

Goals

- Foundations: Specificities of dependent data (i.e. what makes time series special?); the logic underlying statistical inference in this setting; interpretation of parameters, model criticism; asymptotic properties in the limit of the number of data points.
- Skills: Calibration and prediction of time series; implementation in R on various examples; uncertainty quantification; algorithms and computational methods for hidden Markov models and state space models.

Weekly agenda:

Please find attached the weekly agenda from Spring 2022. We will roughly follow the same agenda this semester (except that there will be data-analysis final).

Agenda-Spring-2022.pdf