

## STA 5934: Topics in multiple testing (and causal inference)

**Course description:** This course focuses on statistical inference in high-dimensional settings where there may be as many, or more, variables than observations. Our focus is motivated by always newer technologies, which now produce extremely large datasets, often with huge number of measurements on each of a comparatively small number of experimental units. Topics include testing problems in high dimensions: sparse alternatives (needle in a haystack) and non-sparse alternatives, Bonferroni's method, Fisher's test, ANOVA, higher criticism; multiple testing problems: familywise error rate (FWER), procedures for controlling FWER, false discovery rate (FDR), procedures for controlling FDR, empirical Bayes view of FDR, local FDR; James-Stein estimation, Cauchy combination rules, and recent development in spatial transcriptomic data analysis; among others. If time permits, I would like to cover basics in causal inference. A fundamental difficulty in causal inference is that we are not simply interested in measuring what happened in the past or predicting what will happen in the future, but rather need to understand what could have happened in a counterfactual universe where agents chose to act differently.

**Prerequisite courses:** Stats 5334 and 5440. Knowledge of probability theory and limiting distributions.

**Lecture:** Mondays and Wednesdays, 3:05–4:20 PM OSB 204

**Instructor:** Prof. Hongyuan Cao

**Email:** [hcao@fsu.edu](mailto:hcao@fsu.edu)

**Office Hour:** Mondays 2:00-3:00 PM or by appointment in OSB 319

**Class Website:** <https://canvas.fsu.edu>

**Textbook:** We do not have a textbook for this course

**References:** *Large-Scale Inference: Empirical Bayes Methods for Estimation, Testing, and Prediction* by Bradley Efron, IMS Monographs, Cambridge University Press, <https://www.cambridge.org/core/books/largescale-inference/A0B183B0080A92966497F12CE5D12589>

*Weak Convergence and Empirical Processes-with applications to statistics*, by Aad W. van der Vaart and Jon A. Wellner, Springer, <https://link.springer.com/book/10.1007/978-1-4757-2545-2>

*Causal Inference* by Miguel A. Hernan and James M. Robins, Chapman & Hall/CRC 2020 [https://cdn1.sph.harvard.edu/wp-content/uploads/sites/1268/2021/03/ciwhatif\\_hernanrobins\\_30mar21.pdf](https://cdn1.sph.harvard.edu/wp-content/uploads/sites/1268/2021/03/ciwhatif_hernanrobins_30mar21.pdf)

**Homework:** The homework assignments will be posted regularly. You are encouraged to discuss with each other, but should write down the answers independently. Please also indicate your collaborators if you discuss with other people.

**Exams:** There is no final exam. Students will present research papers and/or a take home final project

**Final grade:** It will be determined by a weighted average of the following items: (1) homework 60%, and (2) final project 40%.

### **Course Policies**

- **Classroom policies:** The classroom environment is an important factor for effective learning. In order to not distract other students' attention please follow these classroom policies. The first one of these is the university policy. Remember that no food or drinks are allowed. Turn off all audible alarms (cell phones, pagers, calculators, watches etc.) Do not use cell phones in the class. Come to the class on time.
- **Attendance:** You are required to attend all classes. The class activities will help you assimilate the lessons more easily, giving you an opportunity for active learning. Do not let this opportunity slip away. Any foreseen absence must be cleared with the instructor. If the absence is due to emergencies, it is the student's responsibility to notify the instructor at the earliest opportunity of the emergency.
- **Homework and exams:** Homework is due at the beginning of the class. It is the student's responsibility to retrieve his or her homework/exam whenever they are returned and to check grades on the class website. If you notice any mistake in recording grades, please inform the instructor about it as soon as possible but no later than one week from grades being posted online.
- **Contacting the instructor outside the class:** You are strongly encouraged to come to the instructor during the office hours. If your schedule conflicts with the office hours, you can make an appointment. You may ask the instructor brief questions by e-mail, but you may be asked to come to office hours if the instructor thinks that the questions are better answered this way. When you send e-mails remember the following: always send e-mails from your FSU accounts. The e-mails from non-FSU accounts may not reach me due to filters. Always write your full name at the end of each e-mail message you send.
- **Academic honor policy:** The Florida State University Academic Honor Policy outlines the University expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "... be honest and truthful and ... [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy)
- **Students with disabilities:** Students with disabilities in need of academic accommodation should: 1. Register with and provide documentation to the Student Disability Resource Center; 2. Bring a letter to the instructor indicating the type of accommodation needed. This should be done during the first week of class. See <https://dos.fsu.edu/sdrc/> for more information.