HARVARD T.H. CHAN | SCHOOL OF PUBLIC HEALTH

BST 241/ BIOSTAT 241: Inference II
Spring 2024 – Tue and Thu, 9:45-11:15 am, FXB G10

Instructor Information

Faculty: Rajarshi Mukherjee, Assistant Professor, Department of Biostatistics, Harvard T.H. Chan School of Public Health

Office: Building II, Room 415

Email: ram521@mail.harvard.edu

Office Hours: Building II, Room 415, Tuesdays 12 - 1 pm

Teaching Assistants

Parker Knight, Department of Biostatistics, Harvard T.H. Chan School of Public Health

Email: pknight@g.harvard.edu

Office hours: TBD

Credits: 5 credits

Course Description

This course considers several advanced topics in statistical inference. Topics include optimal asymptotic inference under regular parametric models through maximum likelihood estimation, semiparametric optimality theory and the geometry of influence functions, introduction to empirical processes and application to the theory of estimating equations, and asymptotically minimax estimation of nonparametric functions.

- **Pre-Requisites**
  BST231 and preferably BST240 (previously BIO 250) or permission of instructor If you are unsure of the prerequisites for your course, please contact your Academic Administrator.

Learning Objectives
Upon successful completion of this course, you should be able to:

- Learn a framework of constructing optimal inferential tools for both parametric and nonparametric *functionals* using classical and state of the art methods in semiparametric and nonparametric theory.

  Specific Topics*: Parametric Optimality Theory (Asymptotics of Maximum Likelihood Estimator, Parametric Tangent Spaces and Geometry of Influence Functions, Asymptotic Local Minimax Theory); Nonparametric Functional Estimation (Non-Parametric Fisher Information, Nonparametric Tangent Spaces and Efficient Influence Functions, Aspects of Empirical Process Theory and Theory of Estimating Equations).*

- Learn a framework of constructing estimators for nonparametric functions.

  Specific Topics*: Nonparametric Density Estimation and Nonparametric Regression (Asymptotic Minimax Decision Theory and Construction of Optimal Estimators)*

References: The course does not have a fixed text book. Over the course of time we will use materials from and across the following sources:

1. **(Required)** Scribe Notes on the Canvas course website.
2. Semiparametric Theory and Missing Data *by* Alexander Tsiatis
3. Asymptotic Statistics *by* Aad van der Vaart
4. Mathematical Theory of Infinite Dimensional Statistical Models *by* Everist Gine and Richard Nickl
5. A Distribution Free Theory of Nonparametric Regression *by* Laszlo Gyorfi, Michael Kohler, Adam Krzyzak, Harro Walk
6. Introduction to Nonparametric Estimation *by* Alexander Tsybakov
7. All of Nonparametric Statistics *by* Larry Wasserman

Course Structure

The course is an advanced graduate level course and will be based on weekly lectures, scribing lectures, biweekly homework, one midterm, and a final project. Please find more details of the course structure below.

Canvas Course Website: *The Canvas site is an important learning tool for this course where students will access required articles, submit course assignments and share other resources with the class. Course announcements will be posted on the site and students will be required to check the course website on a weekly basis.*

Technical Information: *Any information on software or hardware students will need. Also include any emails or phone numbers students would need for tech support related to required software or hardware.*

Grading, Progress and Assessment

This course assumes substantial and informed student participation. General discussion of theory and practice is encouraged and expected of all students. At a minimum, being informed requires class attendance, completion of assigned readings and homework, and scribing lectures (schedule to be described during Lecture 1). The course also includes a midterm exam (time and structure TBD) and a final project. The grade division will be as follows:

The final grade for this course will be based on:

- Bi-weekly Homework: 30%
- Midterm: 30%
- Final Project: 40%

More details about each aspect of the grading component are provided below.

Bi-weekly Homework (30%)

Homework for this course is designed to help students get a hand on practice with the asymptotic theory of statistical inference and work out specific examples using the theory discussed in class. The homework should be typed in LaTeX.

Midterm Exam (30%)
Midterm will be designed to explore the materials covered during the first 8 weeks of class. The date and structure of the exam is yet TBD and will be discussed during the first week of class.

Final Project (40%)
The final project will involve reading and presenting state-of-the-art papers in nonparametric inference. The project will be explored in groups of 3-4 and will involve reading papers, writing a report, and a class presentation.

Harvard Chan Policies and Expectations

Inclusivity Statement

Diversity and inclusiveness are fundamental to public health education and practice. Students are encouraged to have an open mind and respect differences of all kinds. I share responsibility with you for creating a learning climate that is hospitable to all perspectives and cultures; please contact me if you have any concerns or suggestions.

Bias Related Incident Reporting

The Harvard Chan School believes all members of our community should be able to study and work in an environment where they feel safe and respected. As a mechanism to promote an inclusive community, we have created an anonymous bias-related incident reporting system. If you have experienced bias, please submit a report here so that the administration can track and address concerns as they arise and to better support members of the Harvard Chan community.

Title IX

The following policy applies to all Harvard University students, faculty, staff, appointees, or third parties: Harvard University Sexual and Gender-Based Harassment Policy. Procedures For Complaints Against a Faculty Member Procedures For Complaints Against Non-Faculty Academic Appointees

Academic Integrity

Each student in this course is expected to abide by the Harvard University and the Harvard T.H. Chan School of Public Health School's standards of Academic Integrity. All work submitted to meet course requirements is expected to be a student's own work. In the preparation of work submitted to meet course requirements, students

should always take great care to distinguish their own ideas and knowledge from information derived from sources.

Students must assume that collaboration in the completion of assignments is prohibited unless explicitly specified. Students must acknowledge any collaboration and its extent in all submitted work. This requirement applies to collaboration on editing as well as collaboration on substance.

Should academic misconduct occur, the student(s) may be subject to disciplinary action as outlined in the Student Handbook. See the Student Handbook for additional policies related to academic integrity and disciplinary actions.

Accommodations for Students with Disabilities
Harvard University provides academic accommodations to students with disabilities. Any requests for academic accommodations should ideally be made before the first week of the semester, except for unusual circumstances, so arrangements can be made. Students must register with the Local Disability Coordinator in the Office for Student Affairs to verify their eligibility for appropriate accommodations. Contact Colleen Cronin ccronin@hsph.harvard.edu in all cases, including temporary disabilities.

Religious Holidays, Absence Due to
According to Chapter 151c, Section 2B, of the General Laws of Massachusetts, any student in an educational or vocational training institution, other than a religious or denominational training institution, who is unable, because of his or her religious beliefs, to attend classes or to participate in any examination, study, or work requirement on a particular day shall be excused from any such examination or requirement which he or she may have missed because of such absence on any particular day, provided that such makeup examination or work shall not create an unreasonable burden upon the School. See the student handbook for more information.

Grade of Absence from Examination
A student who cannot attend a regularly scheduled examination must request permission for an alternate examination from the instructor in advance of the examination. See the student handbook for more information.

Final Examination Policy
No student should be required to take more than two examinations during any one day of finals week. Students who have more than two examinations scheduled during a particular day during the final examination period may take their class schedules to the director for student affairs for assistance in arranging for an alternate time for all exams in excess of two. Please refer to the student handbook for the policy.

Course Evaluations
Constructive feedback from students is a valuable resource for improving teaching. The feedback should be specific, focused and respectful. It should also address aspects of the course and teaching that are positive as well as those which need improvement.

Completion of the evaluation is a requirement for each course. Your grade will not be available until you submit the evaluation. In addition, registration for future terms will be blocked until you have completed evaluations for courses in prior terms.

Academic Continuity Policy

Social Isolation: In case one or more of us need to socially isolate we will follow the following rubric

(a) **Student:** If you have been exposed to the virus and have to quarantine:
  (i) Kindly let both Madhav and me know.
  (ii) Please include “BST/BIOSTATS 241 Isolation" in the email subject line so they receive prompt attention.
  (iii) We will maintain an active (private) list of students currently in isolation, and will explore other options (e.g., virtual lectures) if a significant fraction of the class is simultaneously unable to attend in-person.
(b) **Teaching Staff:** In case the instructor is exposed and has to isolate:
  (i) Miss less than 2 lectures: Separate make-up lectures will be scheduled at times that are convenient for the majority of the class .
  (ii) Miss more than 2 lectures: Subsequent lectures will be held over Zoom.
  (iii) Office hours/sections might be held either over Zoom or rescheduled.

Academic Progress:

(a) **Homework:** If you are in isolation, and unable to submit your homework, send us an email, and we can work out an appropriate extension.

(b) **Mid-Term:** If you are in isolation and unable to take the mid-term within the designated time window, send us an email, and we can work out an appropriate extension.
(c) **Study Partners:** We encourage you to have (at least one, if not more) study partners for this course.