SCHOOL OF MEDICINE & DENTISTRY
UNIVERSITY of ROCHESTER MEDICAL CENTER

Statistical Inference II – BST412

Spring 2021
TTh 1:30p – 3:10p

Instructors: Brent A. Johnson, Ph.D. and Robert L. Strawderman, Sc.D.
Office Hours: 12:30-1:30 T and by appt. (tentative)
Course website, course email list: TBA
Prerequisites: BST 401, 411

Instructional Staff

There is no TA for this course. Office hours will be held by Zoom.

Course Description

The course topic is advanced statistical inference and is a foundational course for doctoral students in statistics and biostatistics. This course leans toward the theoretical side but the topics covered are largely motivated by modern statistical thinking and needs for estimation and inference with real data.

Course Aims and Objectives

This course begins by expanding on the topical coverage of BST411, beginning with an introduction to some key ideas in asymptotics for sequences of random variables and its applications to developing the properties of estimators and associated statistical inference; we will then move on to some more advanced coverage of topics in likelihood-based inference initially covered in BST411 for univariate parameter models. The course then departs from BST411, and moves on to cover estimation and inference from a perspective that significantly generalizes the so-called 'method of moments' (e.g., generalized estimating equations, generalized method of moments). As time permits, other useful tools in inference, such as resampling methods, are introduced from the perspective of standard error estimation, statistical testing and especially confidence interval formation.

By the end of the course the student should be able to (i) understand the similarities and differences between the univariate and multiparameter approaches to likelihood-based estimation and inference; (ii) understand the similarities and differences between likelihood-based and other approaches to statistical estimation and inference; (iii) understand the role and importance of asymptotic theory in estimation, testing and confidence interval formation; and, (iv) be able to use the many tools available in establishing the asymptotic behavior of various statistical estimators, tests, and confidence intervals.

Course Policies and Expectations

Homework: You are encouraged to work in small teams with your classroom peers but the write-up of the solution set and any related coding must be in your own words, per the departmental policy:

https://www.urmc.rochester.edu/biostat/courses/studentcollaboration.aspx

Homework assignments will involve a combination of theory and computing (preferably in R), and possibly data analysis. It will generally be due 14 days after the day assigned (due dates will be noted on the assignment and announced in class). Homework must be submitted electronically through Blackboard before the class period where it is due. Late assignments will only be permitted in the case of emergency or serious illness; at our discretion, extensions may be provided in other circumstances, but only with sufficient notice (please do not ask for an extension on the day it is due).

Attendance/Participation: Student engagement keeps the learning active and stimulates the classroom environment. Although attendance will not formally be taken, you are expected to attend every class, and our impressions of attendance/participation will figure into your final grade (see Grading Procedures). All lectures will be offered via Zoom – your video is expected to be on for the entire class period, and cell phones should be off or otherwise silenced as appropriate. There is a possibility that some classes may be held with the option of in-person instruction depending on the Covid-19 situation in Monroe County, university rules and regulations; such lectures will be recorded or available on Zoom, with attendance not being mandatory (i.e., dependent on your own personal health situation and comfort level).

Enrollment: Standard university procedures and dates will govern the successful dropping/adding of courses, changing from a letter grade to pass/fail, and auditing the course.

Materials and Access

Course website and materials:
Blackboard site for course.

Required Text
None.

Recommended Textbooks
Boos DD and Stefanski LA (2013) *Essential Statistical Inference*. Springer: New York.
Casella G and Berger RL (1990) *Statistical Inference*. Duxbury: Belmont, CA.
Lehmann EL and Casella G (1998) *Theory of Point Estimation*. Springer: New York.
Shao J (2003) *Mathematical Statistics*. Springer: New York.

Other Useful Sources and References
Billingsley P (1995) *Probability and Measure*. Wiley: New York.
Serfling R (1980) *Approximation Theorems of Mathematical Statistics*. Wiley: New York.
Van der Vaart AA (1998). *Asymptotic Statistics.* Cambridge University Press: UK.
Lehmann EL and Romano J (2005) *Testing Statistical Hypotheses*. Springer: New York.
Newey WK, McFadden D (1994) Large sample estimation and hypothesis testing.
Handbook of Econometrics, Chapter 36.

Assignments and Grading Procedures
There will be approximately 4 homework assignments (60%) and a take-home final (35%); attendance with your video on (or in person, if available) and class participation round out the remainder of the semester grade (5%).

Academic Integrity
Academic integrity is a core value of the University of Rochester. Students who violate the University of Rochester University Policy on Academic Honesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since academic dishonesty harms the individual, other students, and the integrity of the University, policies on academic dishonesty are strictly enforced. For further information on the University of Rochester Policy on Academic Honesty, please see the *Jurisdiction and Responsibility for Academic and Nonacademic Misconduct* section in the **Regulations and University Polices Concerning Graduate Studies** *http://www.rochester.edu/GradBulletin/PDFbulletin/Regulations.pdf*

Accommodations for Students with Disabilities
Students needing academic adjustments or accommodations because of a documented disability must contact the Access Services Coordinator. For information regarding access services and support at SMD, please refer to our webpage:
https://www.urmc.rochester.edu/education/graduate/current-students/disability-supports-services.aspx

Policy Against Discrimination and Harassment
http://www.rochester.edu/president/assets/pdf/attachment-student-policy-against-harrassment-and-discrimination-4.26.16.pdf

Center for Student Conflict Management (CSCM): 585-275-4085 or
Conflict.management@rochester.edu

Anonymous Disclosure: see Bias-related Incident Report Form

At any time, students are encouraged to privately raise any concerns they might have with either or both professors, related to this class or otherwise, during or after the semester.

Important Dates:
14 January 2021: first class.
2 March 2021: no class.
4 March 2021: no class.
30 March 2021: no class.
29 April 2021: last class.

Topics to be Covered (tentative and subject to change)

Introductory Material/ Some Review

Topic 1. Basic concepts in advanced probability; little "oh" and big "Oh" notation; sample moments, types of convergence, generating functions.
Topic 2. Asymptotic expansions; asymptotic linearity; influence functions; Delta method.

Likelihood-based statistical inference

Topic 3. Review of likelihood and one-parameter MLEs; asymptotic theory: existence; strong and weak consistency; asymptotic normality (AN); efficiency and the Cramer-Rao lower bound; asymptotic relative efficiency (ARE).

Topic 4. Multi-parameter MLEs: multiparameter likelihood; information identity; methods for computing MLEs (eg, Fisher-scoring, Newton-Raphson, optimization); large-sample theory and conditions for consistency and AN of MLEs; extension of efficiency concepts and the Cramer-Rao lower bound to the multivariate setting; one-step estimation. Examples of exceptions to usual assumptions/conditions.

Topic 5. Basic hypothesis testing: likelihood ratio, Wald, and score tests. Associated methods for confidence interval construction.

Topic 6. Inference with nuisance parameters: (a) estimation: conditional likelihood, marginal likelihood, profile likelihood; (b) testing: generalized Neyman-Pearson lemma, generalized likelihood ratio tests, generalized Wald and score (i.e., tests for parameter subsets and partitions of the variance-covariance matrix). Associated methods for confidence interval construction.

Semi-parametric methods for estimation and testing

Topic 7. Review of multivariate method of moments; M-estimation; Z-estimation; GEE-1 and GEE-2; GMM and quadratic inference functions (QIF).

Miscellaneous topics (as time permits, not necessarily in order)

Topic 8. Bootstrap, perturbation methods and related resampling plans.

Topic 9. Decision theory, loss, minimax, admissibility, shrinkage estimation.

Topic 10. Quantile estimation, Bahadur's representation theorem, X-statistics (X = R, U, or L).