STA422/2162H1: Theory of Statistical Inference

Fall, 2015

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Lectures: Mondays 12-2pm in SS2105
Office hours: Mondays 10-11am in SS5106H, or by appointment
Course website: Available through https://portal.utoronto.ca

Course Goal:

This course introduces the asymptotic likelihood theory from first-order to higher order for non-Bayesian inference. Three commonly used likelihood-based inference approaches will be examined: signed likelihood root, the standardized maximum likelihood estimate departure, and the standardized score. Improvements over classical asymptotic theory will be followed. Edgeworth and saddlepoint approximation to the density as well as the distribution functions will be introduced. The Lugannani-Rice formula and the modified likelihood root will be investigated and numerical study will be conducted. Finally, some recent approaches to likelihood-based inference in the presence of nuisance parameter will be outlined. Orthogonal parameters, modified profiled likelihood, and tangent exponential model will be discussed.

Recommend reference:

- D.A.S. Fraser, *Probability and Statistics: theory and applications* (1976), Duxbury.
- John E. Kolassa, *Series Approximation methods in statistics*, 3rd Edition, Springer, 2005. PP31-62.
- Ronald W. Butler, *Saddlepoint approximation with applications*, Cambrideg, 2007. PP151-156.
- Bradley Efron & David V. Hinkley, *Assessing the Accuracy of the Maximum Likelihood Estimator: Observed Versus Expected Fisher Information*, Biometrika, Vol. 65, No. 3 (Dec., 1978), pp. 457-482

- Nancy, Reid, *Saddlepoint methods and statistical inference*. With comments and a rejoinder by the author, Statistical Science (Impact Factor: 2.74). 01/1988; 3(2). DOI: 10.1214/ss/1177012906.
- Reid, N. and Fraser, D.A.S (2003), *Likelihood inference in the presence of nuisance parameters*, SLAC,8-11,2003.

Computing

R language. R is free software and can be downloaded (for Windows, Mac, and Linux operating systems) from

http://cran.r-project.org.

Documentation for R can also be found at www.r-project.org and this site also lists some books related to R.

Evaluation

The course grade will be based on three problem sets (15% each for a total of 30%), attendance (10%), course projection (10% for presentation, 15% for final report), and a written exam in class (20%).

- Problem sets will involve both mathematical exercise as well as some computing using R. Two problem sets will be handled in before **Nov. 7**.
- The project presentation is scheduled on **Monday, Nov. 16,** 2015 from **12-1:20pm**. The **report for your project** is due on Monday, **Nov. 23**, 2015.
- The 1-2 **hours in class exam** will be held on **Wednesday, Dec, 9, 2015**.

Academic Integrity Policy

Students should familiarize themselves with the University's policies on academic integrity, which can be found at

www.artsci.utoronto.ca/osai/students.

Accessibility Needs

The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns a bout the course, the classrooms, or course materials, please contact Accessibility Services as soon as possible: disability.services@utoronto.ca or http://studentlife.utoronto.ca/accessibility.

Syllabus

The following topics will be covered in the course:

1. Asymptotic theory for classical likelihood based inference: likelihood ratio, likelihood root, standardized maximum likelihood estimate departure, standardized score function.
2. Higher order approximations for non-Bayesian inference: Edgeworth and saddlepoint approximation to density and distribution function. Lugannani-Rice formula and the modified likelihood root will be investigated and numerical study will be conducted.
3. Likelihood inference in the presence of nuisance parameters: orthogonal parameter, profile likelihood, modified likelihood, marginal and conditional likelihood.
4. Sample space differentiation and approximate ancillary, tangent exponential model will be discussed.