BIOSTAT815: ADVANCED TOPICS IN COMPUTATIONAL STATISTICS

Monday, Wednesday / 3:00-4:30pm / M4318 SPH II

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Office Hours: TBA

Course Description: Biostatistics 815 is intended to provide students with deep understanding of computational issues related to the implementation of statistical methods, from basics of programming language to inner workings of sophisticated statistical methods. C++ and R languages will be used throughout the course.

Canvas website: https://umich.instructure.com/courses/90360

Pre-requisites: Biostatistics 615 or equivalent for basic understandings of statistical computing is required. Students should be comfortable with basic programming (in R and C++), simple algebra, and basic statistics including probability distribution, linear model, and hypothesis testing. Students are encouraged to take Biostatistics 601 and 602 or equivalent classes prior to taking Biostatistics 815.

Course Goals: Biostatistics 815 is intended to provide students with advanced understanding of computational algorithms for statistical inference. Statistical computing is of critical importance for statisticians to efficiently process data and organize information so to delivery adequate solutions to substantive questions. This course will cover computational algorithms for graphical models and numerical optimization. It will also cover basic principles and skills for parallel computing, high-performance computing, and cloud computing.

Competencies: The Council for Education in Public Health recommends every course document in the Public Health competencies covered in its subject syllabus. This is the list of competencies covered by Biostatistics 815.

- Biostatistics
  - Describe basic concepts of probability, random variation, and commonly used statistical probability distributions.
  - Describe preferred methodological alternatives to commonly used statistical methods when assumptions are not met.
  - Apply common statistical methods for inference.
Apply basic informatics techniques with vital statistics and public health records in the description of public health characteristics and in public health research and evaluation.

Course Requirements:

Homework assignments will be given out on every other Wednesday and due on coming Wednesday in class. Late submission will not be accepted unless the student obtains permission from the instructor. You may discuss homework problems with fellow students; however, you must write up the assignment based on your own understanding. Plagiarism will not be tolerated. Please carefully read the Standards of Academic Acts below for more details.

Course Evaluation will be based on the following criteria:

- Homework 20% (6 homework assignments + Canvas quizzes)
- Mid-term 40% (Tentative schedule: Nov 21)
- Final Project 40% 100%

Classroom Expectations/Etiquette:

Before each lecture, lecture slides will be uploaded to the Canvas site. The lecture will follow the slides and document camera will be used to fill in the gaps between the slides. After each lecture, students are required to complete online review quizzes that will be available on the Canvas sites. The online quiz scores are used for feedbacks to the instructor and will not affect the grades. Students are expected to regularly attend the lectures, complete online quizzes before next lecture, and submit homework every other week. Students are strongly encouraged to complete homework assignment independently, but are permitted to discuss homework assignments with colleagues. However, they are never allowed to share any part of their draft or submitted homework. Plagiarism will not be tolerated. Students are strongly encouraged to utilize office hours to interact with the instructor. They are also encouraged to utilize the anonymous Google form to provide feedbacks or requests anonymously. Laptops will be allowed during the class, and questions during the lecture are strongly encouraged.

Academic Integrity:

The faculty and staff of the School of Public Health believe that the conduct of a student registered or taking courses in the School should be consistent with that of a professional person. Courtesy, honesty, and respect should be shown by students toward faculty members, guest lecturers, administrative support staff, community partners, and fellow students. Similarly, students should expect faculty to treat them fairly, showing respect for their ideas and opinions and striving to help them achieve maximum benefits from their experience in the School.

Student academic misconduct refers to behavior that may include plagiarism, cheating, fabrication, falsification of records or official documents, intentional misuse of equipment or materials (including library materials), and aiding and abetting the perpetration of such acts. Please visit http://sph.umich.edu/student-resources/mph-mhsa.html for the full Policy on Student Academic Conduct Standards and Procedures.

Student Well-Being:
SPH faculty and staff believe it is important to support the physical and emotional well-being of our students. If you have a physical or mental health issue that is affecting your performance or participation in any course, and/or if you need help connecting with University services, please contact the instructor or the Office of Academic Affairs. Please visit http://sph.umich.edu/student-life/wellness.html for information on wellness resources available to you.

Student Accommodations:
Students should speak with their instructors before or during the first week of classes regarding any special needs. Students can also visit the Office of Academic Affairs for assistance in coordinating communications around accommodations. Students seeking academic accommodations should register with Services for Students with Disabilities (SSD). SSD arranges reasonable and appropriate academic accommodations for students with disabilities. Please visit https://ssd.umich.edu/topic/our-services for more information on student accommodations. Students who expect to miss classes, examinations, or other assignments as a consequence of their religious observance shall be provided with a reasonable alternative opportunity to complete such academic responsibilities. It is the obligation of students to provide faculty with reasonable notice of the dates of religious holidays on which they will be absent. Please visit http://www.provost.umich.edu/calendar/religious_holidays.html#conflicts for the complete University policy.

Course Topics/Reading List:

- Numerical methods (Week 1-5)
  - Review: Golden search & Nelder-Mead algorithms
  - Expectation-Maximization (E-M) algorithm
  - Simulated Annealing
  - Markov-chain Monte carlo (MCMC)
  - Gibbs sampling
  - Brief overview of linear/quadratic programming

- Data structure and algorithms for statistical inference (Week 6-11)
  - Binary search trees and heaps
  - Hashes
  - Graphs
  - Dynamic programming
  - Dijkstra’s algorithms
  - Hidden Markov models
  - Conditional Random Fields
  - Message passing algorithms

- Skills for high-performance computing (Week 12-15)
  - Matrix programming with BLAS/LAPACK
  - Multithreading
  - High-performance computing
  - Cloud computing