BIOSTAT602 : BIOSTATISTICAL INFERENCE

Tuesday, Thursday / 1:00-3:00pm / 1230 USB

Primary Instructor: **Hyun Min Kang**
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Office Hours : Tuesday 4:00-5:30pm

Graduate Student Instructor: **Anita Pandit**
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Course Description: Biostatistics 602 is intended to provide students with deep understanding of key concepts and analytics of statistical inference. Statistical inference methods are of critical importance for statisticians to properly process data and organize information to quantify uncertainty so to delivery adequate solutions to substantive questions. This course will cover both statistical estimation and inference, including point estimation, confidence interval estimation, hypothesis testing and basic asymptotic theory. The primary focus will be on the frequentist's school of statistical estimation and inference, while some basics of Bayesian inference will be discussed.

Course Materials: Required Textbook : Statistical Inference, 2nd Edition, by Casella and Berger
Optional Textbook : Statistical Inference, by Garthwaite, Jolliffe and Jones
Canvas website : https://umich.instructure.com/courses/54730

Pre-requisites: Biostatistics 601 or equivalent as well as knowledge of basic calculus and matrix algebra. In particular, students are expected to have acquaintance of the following subjects:

- random variables
- independence
- expectation, moments, and moment generating functions
- common discrete and continuous distributions
- random sampling

(i.e. approximately chapters 1-5.5 of Casella and Berger.)

Course Goals: Biostatistics 602 is intended to provide students with deep understanding of key concepts and analytics of statistical inference. Statistical inference methods are of critical importance for statisticians to properly process data and organize information to quantify uncertainty so to delivery adequate solutions to substantive questions. This course will cover both statistical estimation and inference, including point estimation, confidence interval estimation, hypothesis testing and basic asymptotic theory. The primary focus will be on the

frequentist's school of statistical estimation and inference, while some basics of Bayesian inference will be discussed.

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 602.

- **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.
  - Distinguish among the different measurement scales and the implications for selection of statistical methods to be used based on these distinctions.
  - Apply common statistical methods for inference.
  - Apply descriptive and inferential methodologies according to the type of study design for answering a particular research question.
  - Interpret results of statistical analyses found in public health studies.
- **Epidemiology**
  - Draw appropriate inferences from epidemiologic data.
  - Evaluate the strengths and limitations of epidemiologic reports.
- **Health Behavior and Health Education (Social and Behavioral Sciences)**
  - Apply evidence-based approaches in the development and evaluation of social and behavioral science interventions.
- **Cross-Cutting Competencies**
  - Apply evidence-based principles and the scientific knowledge base to critical evaluation and decision making in public health.

Course Requirements: Homework assignments will be given out on every Thursday and due on coming Thursday 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% (12 homework assignments + Canvas quizzes)
Mid-term	40%
Final Exam	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 each 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 and the GSI. They are also encouraged to utilize the anonymous Google form to provide with 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:

We will be primarily focusing on Chapter 6-10 of Casella and Berger. In particular, we will cover the following topics:

- Data Reduction (Week 1-4)
    - Sufficiency principle (6.2)
        - Sufficient statistics
        - Complete statistics
        - Ancillary stati stics
        - The exponential family of distributions
        - Likelihood principle (6.3)
- Point Estimation (Week 5-10)
    - Estimator construction (7.2)
        - Moment estimator
        - Maximum likelihood estimator
        - Bayes estimator
        - E-M algorithm
    - Evaluation of estimators (7.3)
        - Unbiasedness
        - Sufficiency
    - Asymptotic properties (10.1)
        - Consistency
        - Efficiency
- Hypothesis Testing (Week 11-13)
    - Tests construction (8.2)
        - Null and alternative hypotheses
        - Composite hypotheses
        - Likelihood ratio test
        - Wald Test
        - P-values
    - Evaluation of tests (8.3)
        - Neyman-Pearson Lemma
        - Karlin-Rubin Theorem
    - Asymptotic properties (10.3)
- Interval Estimation (Week 14-16)
    - Interval construction (9.2)
    - Evaluation of intervals (9.3)
    - Asymptotic properties (10.4)