School of Public Health
Syllabus and Course Information

UNIVERSITY OF MINNESOTA
Driven to Discover℠

PubH 7401: Fundamentals of Biostatistical Inference
Fall 2018

Meeting Days: Tuesdays and Thursdays

Meeting Time: 12:20-2:15 PM

Meeting Place: Weaver-Densford Hall W2-110

Credits: 4 credits

Instructor: Eric Lock

Office Address: Mayo A467

Office Phone: 612-625-0651

Fax: 612-626-0660

E-mail: elock@umn.edu

Office Hours: Thursday 2:30- 3:30 PM

TA: Tushar Patni

E-mail: patni006@umn.edu

TA Office Hours: Wednesday 1-2pm (Mayo A446)

Course website: http://ericfrazerlock.com/pubh7401.html

COURSE DESCRIPTION

PubH 7401: *Fundamentals of Biostatistical Inference* is part of a two-course sequence in advanced biostatistical theory and methods. It presents a rigorous approach to probability and statistical inference with applications to research in public health and other health science fields. These courses are aimed at doctoral students in public health and health science fields other than Biostatistics.

Fundamentals of Biostatistical Inference covers the topics of

- probability,
- random variables: distribution functions, expectation, variance

- statistical estimation,
- sampling distributions and the Central Limit Theorem,
- hypothesis testing, and
- confidence intervals.

This course uses the statistical software of R, a freely available statistical software package, to illustrate a variety of theoretical concepts.

COURSE PREREQUISITES

The course requires students to have a background in scalar calculus (e.g., Calculus I and II). We understand that it may have been a long time since you've last had calculus, so here are a few resources to refresh your calculus knowledge:

- Khan Academy: AP Calculus AB
- Garrett P., "Calculus Refresher." From Math Insight. http://mathinsight.org/calculus_refresher
- Fischer, I., "Basic Calculus Refresher." http://www.stat.wisc.edu/~ifischer/calculus.pdf

COURSE GOALS AND OBJECTIVES

Upon completion of this course, students should understand and be able to apply the concepts of probability, distributions, the central limit theorem, likelihood theory, statistical estimation, hypothesis testing, and confidence interval construction to statistical applications in their field of interest. In particular, this course should prepare students to implement and understand advanced statistical methods in their dissertations.

METHODS OF INSTRUCTION AND WORK EXPECTATIONS

Instruction: This format of this course will be a combination of the traditional lecture style and opportunities for you to work out examples and investigate concepts during class. Therefore, you should come prepared to actively participate in class. You can access the course content and assignments via the course website: http://ericfrazerlock.com/pubh7401.html.

Work Expectation:

Class Time and Preparation for Class You are expected to attend class, participate in class discussions, and complete the assigned homework and exams. You should read through the assigned reading prior to coming to class. We certainly do not expect you to be experts on the assigned reading before class, but you should have at least skimmed the material before class. From an educational research perspective, the benefits to reading the book before class is creating context to help you better make sense of the new material during class.

Homework There will be approximately 10 homework assignments. These assignments are intended to keep you actively engaged with the material. You can expect the homework to consist of exercises from the textbook and additional problems that may involve simulation and exploration through the use of statistical software.

In general, homework will be assigned each week and students will have **one week** to complete the assignment. Try to work through the assignments throughout the week (rather than waiting until near the due date) in order to receive feedback from the instructors and the TA. You can expect homework to be returned within a week of the due date. Each homework assignment contributes equally in the final grade.

Working together on homework assignments is permitted, but copying the work of another student is a violation of course policy.

Late Policy Late assignments are not accepted unless approved in advance by the instructors or for a documented reason (such as illness).

Exams There will be two midterm exams and a final exam. **All exams will be take-home exams.** Students may use any resources, including any textbook and class notes, but may NOT consult with any other people, including the TA. The final exam will be cumulative but will be weighted more heavily towards material from the latter portion of the course.

Course Communication You must use your U of M email address! All course communications will be sent to your University of Minnesota email account. If you have not yet initiated your U of M email account, you will need to do so at: http://www.umn.edu/initiate.

COURSE TEXT AND READINGS

The textbook for this course is

Devore and Beck's Modern Mathematical Statistics with Applications (Springer, 2nd ed., 2012).

The hard copy of the book is available through the University of Minnesota bookstore. However, a free PDF is available via the University of Minnesota Library website.

Other useful textbooks about advanced statistical theory and methods include

- Diez, Barr, and Çetinkaya-Rundel's OpenIntro Statistics (https://www.openintro.org/stat/textbook.php?stat_book=os) ← Free to download. A gentle introduction.
- Jeff Gill's Essential Mathematics for Political and Social Science Research (Cambridge University Press, 2006) ← Good review of mathematical concepts.
- Wackerly, Mendenhall, and Scheaffer's Mathematical Statistics with Applications (Cengage Learning, 7th ed., 2008) ←Equivalent difficulty.
- DeGroot and Schervish's Probability and Statistics (Pearson, 4th ed., 2012) ← Equivalent difficulty.
- Casella and Berger's Statistical Inference (Cengage Learning, 2nd ed., 2002) ← More advanced approach.

TENTATIVE COURSE OUTLINE/WEEKLY SCHEDULE

Date	Lecture Title & Topics	Textbook Readings	Exams
Sept. 4 – Sept. 6 (2 days)	**Introduction to PubH 7401** • Introduction to course • Review of common statistical procedures • Introduction to R computing environment	Review of Introductory Statistics Material	
Sept. 11 – Sept. 13 (2 days)	**Introduction to Probability** • Conditional, marginal, and joint probability • Bayes' Theorem • Independence	Chapters 2.1-2.5	
Sept. 18 (1 day)	**Conditional Probability Examples** • Lifetables and Kaplan-Meier • k-Nearest Neighbor	Lecture slides	
Sept. 20 – Sept. 27 (3 days)	**Random Variables, Discrete Distributions, Expectation, and Variance** • Random variables • Probability mass functions • Expectation and variance • Discrete distributions (Binomial, Poisson, Hypergeometric)	Chapters 3.1-3.3 & Chapters 3.5-3.7	
Oct. 2 – Oct. 4 (2 days)	**Continuous Random Variables** • Continuous random variables • pdf and cdf • Expectation and variance • Continuous distributions (Normal, Exponential, Gamma, Beta)	Chapters 4.1-4.2 & Chapters 4.3-4.5	

Oct. 9 – Oct. 16 (3 days)	**Multivariate Distributions** • Joint and marginal pmf and pdf • Covariance & correlation • Conditional distributions • Conditional expectation and variance • Introduction to random effects models and hierarchical modeling	Chapters 5.1-5.2 & Chapters 5.3; 6.3	Take-Home Exam 1 **(Due Oct. 16)**
Oct. 18 – Oct. 23 (2 days)	**Statistics and Their Sampling Distributions** • Sampling distributions • Introduction to Bootstrap • Central Limit Theorem	Chapters 6.1-6.2	
Oct. 25 (1 days)	**Point Estimators** • Point estimators • Criteria for evaluating point estimators	Chapters 7.1-7.2	
Oct. 30 – Nov. 1 (2 days)	**Maximum Likelihood Estimators** • Likelihood construction • Fisher Information • Asymptotic relative efficiency • Bootstrap standard errors	Chapter 7.2 & Chapter 7.4 & Chapters 12.1-12.2	
Nov. 6 – Nov. 8 (2 days)	**Maximum Likelihood Examples** • MLE and (generalized) linear model • Delta theorem	Lecture slides	
Nov. 13 (1 day)	**Method of Moments and Estimating Equations** • Method of moments estimators • Least squares estimator • Generalized estimating equations	Lecture slides	

Nov. 15 – Nov. 20 (2 days)	**Confidence Intervals and Hypothesis Testing** • Coverage and average length • CI for maximum likelihood estimators • Bootstrap confidence intervals	Chapter 6.4 & Chapters 8.1-8.3 & Chapters 9.1-9.2 & Chapter 9.4	Take-Home Exam 2 **(Due Nov. 20)**
Nov. 27 – Nov. 29 (2 days)	**Hypothesis Testing** • Type I and II Errors & Size and Power • Power and size • Rejection region and p-values • Permutation tests • Wald, score, and likelihood ratio tests		
Dec. 4 – Dec. 11 (3 days)	**Introduction to Bayesian Inference** • Prior, likelihood, and posterior • Incorporating prior information • Inference and hypothesis testing • Credible intervals • Conjugate priors	Lecture slides	
Dec. 12	Final Exam assigned		
Dec. 19	Final Exam Due before 10am		

EVALUATION AND GRADING

A student's final grade will be calculated by weighting assessments (homework, Midterm Exams 1 & 2, and Final Exam) as follows:

- Homework (25%)
- Exams (75%)
  - Exam 1 (20%)
  - Exam 2 (25%)
  - Final Exam (30%)

Academic Integrity Policy: We expect that students will complete all exams **INDEPENDENTLY,** without assistance from any other people. If we have any reason to suspect that a student gave assistance on an exam to another student or received assistance on an exam from another student or a person outside the class, we will file a claim with the Office of Student Conduct and Academic Integrity.

A/F letter grade will be determined by total effort as follows:

A = 93-100%	(4.000) Represents achievement that is outstanding relative to the level necessary to meet course requirements.
A- = 90-92%	(3.667)
B+ = 87-89%	(3.333)
B = 83-86%	(3.000) Represents achievement that is significantly above the level necessary to meet course requirements.
B- = 80-82%	(2.667)
C+ = 77-79%	(2.333)
C = 73-76%	(2.000) Represents achievement that meets the minimum course requirements.
C- = 70-72%	(1.667)
D+ = 67-69%	(1.333)
D = 63-66%	(1.000) Represents achievement that is worthy of credit even though it fails to meet fully the course requirements.
F = 62% or less	Represents failure (or no credit) and signifies that the work was either (1) completed but at a level of achievement that is not worthy of credit or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I.
For those enrolled S/N, a letter grade of C or better must be achieved to receive an S.	

The instructor reserves the right to adjust the scale downward (so that it requires a lower percentage to achieve a certain letter grade) but never higher.

If you would like to switch grading options (e.g., A/F to S/N), it must be done within the first two weeks of the semester.

For additional information, please refer to:
http://policy.umn.edu/Policies/Education/Education/GRADINGTRANSCRIPTS.html.

Course Evaluation*:* The SPH will collect student course evaluations electronically using a software system called CoursEval: www.sph.umn.edu/courseval. The system will send email notifications to students when they can access and complete their course evaluations. Students who complete their course evaluations promptly will be able to access their final

grades just as soon as the faculty member renders the grade in SPHGrades: www.sph.umn.edu/grades. All students will have access to their final grades through OneStop two weeks after the last day of the semester regardless of whether they completed their course evaluation or not. Student feedback on course content and faculty teaching skills are an important means for improving our work. Please take the time to complete a course evaluation for each of the courses for which you are registered.

Incomplete Contracts: A grade of incomplete "I" shall be assigned at the discretion of the instructor when, due to extraordinary circumstances (e.g., documented illness or hospitalization, death in family, etc.), the student was prevented from completing the work of the course on time. The assignment of an "I" requires that a contract be initiated and completed by the student before the last official day of class, and signed by both the student and instructor. If an incomplete is deemed appropriate by the instructor, the student in consultation with the instructor, will specify the time and manner in which the student will complete course requirements. Extension for completion of the work will not exceed one year (or earlier if designated by the student's college). For more information and to initiate an incomplete contract, students should go to SPHGrades at: www.sph.umn.edu/grades.

University of Minnesota Uniform Grading and Transcript Policy: A link to the policy can be found at onestop.umn.edu.

OTHER COURSE INFORMATION AND POLICIES

Grade Option Change (if applicable)
For full-semester courses, students may change their grade option, if applicable, through the second week of the semester. Grade option change deadlines for other terms (i.e. summer and half-semester courses) can be found at onestop.umn.edu.

Course Withdrawal
Students should refer to the Refund and Drop/Add Deadlines for the particular term at onestop.umn.edu for information and deadlines for withdrawing from a course. As a courtesy, students should notify their instructor and, if applicable, advisor of their intent to withdraw.
Students wishing to withdraw from a course after the noted final deadline for a particular term must contact the School of Public Health Office of Admissions and Student Resources at sph-ssc@umn.edu for further information.

Student Conduct Code
The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.
As a student at the University you are expected adhere to Board of Regents Policy: Student Conduct Code. To review the Student Conduct Code, please see: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf.
Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach or student learning. The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities."

Use of Personal Electronic Devices in the Classroom
Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also for other students in the class. To this end, the University establishes the right of each faculty member to determine if and how personal electronic devices are allowed to be used in the classroom. For complete information, please reference: http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html.

Scholastic Dishonesty
You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. (Student Conduct Code: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf) If it is determined that a student has cheated, he or she may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please see: http://policy.umn.edu/Policies/Education/Education/INSTRUCTORRESP.html.

The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: http://www1.umn.edu/oscai/integrity/student/index.html. If you have additional questions, please clarify with your instructor for the course. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class-e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam.

Makeup Work for Legitimate Absences
Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see: http://policy.umn.edu/Policies/Education/Education/MAKEUPWORK.html.

Appropriate Student Use of Class Notes and Course Materials
Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please see:
http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html.

Sexual Harassment
"Sexual harassment" means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Such conduct has the purpose or effect of unreasonably interfering with an individual's work or academic performance or creating an intimidating, hostile, or offensive working or academic environment in any University activity or program. Such behavior is not acceptable in the University setting. For additional information, please consult Board of Regents Policy: http://regents.umn.edu/sites/default/files/policies/SexHarassment.pdf.

Equity, Diversity, Equal Opportunity, and Affirmative Action
The University will provide equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult Board of Regents Policy:
http://regents.umn.edu/sites/default/files/policies/Equity_Diversity_EO_AA.pdf.

Disability Accommodations
The University of Minnesota is committed to providing equitable access to learning opportunities for all students. Disability Services (DS) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.
If you have, or think you may have, a disability (e.g., mental health, attentional, learning, chronic health, sensory, or physical), please contact DS at 612-626-1333 to arrange a confidential discussion regarding equitable access and reasonable accommodations.
If you are registered with DS and have a current letter requesting reasonable accommodations, please contact your instructor as early in the semester as possible to discuss how the accommodations will be applied in the course.
For more information, please see the DS website, https://diversity.umn.edu/disability/.

Mental Health and Stress Management
As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University of Minnesota services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website:
http://www.mentalhealth.umn.edu.

The Office of Student Affairs at the University of Minnesota
The Office for Student Affairs provides services, programs, and facilities that advance student success, inspire students to make life-long positive contributions to society, promote an inclusive environment, and enrich the University of Minnesota community.

Units within the Office for Student Affairs include, the Aurora Center for Advocacy & Education, Boynton Health Service, Central Career Initiatives (CCE, CDes, CFANS), Leadership Education and Development –Undergraduate Programs (LEAD-

UP), the Office for Fraternity and Sorority Life, the Office for Student Conduct and Academic Integrity, the Office for Student Engagement, the Parent Program, Recreational Sports, Student and Community Relations, the Student Conflict Resolution Center, the Student Parent HELP Center, Student Unions & Activities, University Counseling & Consulting Services, and University Student Legal Service.

For more information, please see the Office of Student Affairs at http://www.osa.umn.edu/index.html.

Academic Freedom and Responsibility: for courses that do not involve students in research
Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.*

Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor, the Department Chair, your adviser, the associate dean of the college, or the Vice Provost for Faculty and Academic Affairs in the Office of the Provost.

**Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".*