



Syllabus

BST 467: Applied Statistics in the Biomedical Sciences

Spring 2018

Monday and Wednesday, 10:30 – 11:45

Helen Wood Hall (HWH): 1W-502 Collins & Wilson Classroom

Instructor(s): Xueya Cai, Ph.D.

Office Hours: Wednesday 11:45 – 12:45 pm or by appointment

TA office hours:

Luoying Yang, Thursday 9:50-10:50 am, SRB 4.165D

William Consagra-Francis, Tuesday 12:40-1:40, SRB 4121

Course website, course email list: Blackboard

Prerequisites: One semester of undergraduate statistics is required. Students with insufficient statistics preparation are expected to remedy the deficiency on their own.

Instructor and Teaching Assistants

Instructor: **Xueya Cai, PhD**

Research Associate Professor

Department of Biostatistics and Computational Biology

University of Rochester School of Medicine and Dentistry

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Teaching Assistants:

Luoying Yang, William Consagra-Francis

PhD students

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Course Description

BST 467 is an introductory level biostatistics course designed for PhD students in the biomedical sciences. This course will cover the topics on probability and probability distributions, sampling distributions, statistical inferences from small and large samples, analysis of categorical data, analysis of variance, correlation and simple linear and non-linear regression analysis. **All analytical topics will be illustrated using examples from biomedical sciences areas.**

Course Aims and Objectives

The primary objectives of this course are to:



- Provide a basic foundation of probability and probability distributions
- Provide instruction on how to formulate an appropriate hypothesis and make relevant inferences from quantitative and qualitative data
- Provide instruction on how to apply modeling to real life data in order to identify the associated significant predictors to response variables.

Upon completion of the course, students will understand and be able to apply basic techniques in inferential statistics.

Course Policies and Expectations

Students are required to attend the class. Students are encouraged to participate in discussions on course materials and homework assignments **but the final solutions to homework assignments are expected to be written independently by each student.**

Materials and Access

Textbook: Pagano M and Gauvreau K. Principles of Biostatistics. Second Edition. 2000. Duxbury

Assignments and Grading Procedures

Class materials and homework assignments will be posted on Blackboard and homework will be collected in class the following week. No late homework will be accepted. JMP output without highlights or without relevant interpretation will not be given credit. The final homework grade will be based on the best 10 homework assignments. Make-up examinations will be given only in extraordinary situations (such as serious illness) and can be arranged after receiving prior consent from the instructor. The class has an open book in-class midterm exam and an open book in-class final exam. Students are also required to present and discuss papers as teams during the journal club sessions. The final course grade will be determined using the following weighing scheme:

Homework	25%
Midterm exam	25%
Final exam	30%
Journal club participation	20%

Exam 2 will test all the material covered in this class although the emphasis will be on the contents after Exam 1. Letter grades will be assigned based on the distribution of the total score.

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 visit the following website:

http://www.rochester.edu/college/honesty/docs/Academic_Honesty.pdf



Accommodations for Students with Disabilities

Students needing academic adjustments or accommodations because of a documented disability must contact the Disability Resource Coordinator for the school in which they are enrolled:

<http://www.rochester.edu/eoc/DisabilityCoordinators.html>

Course Schedule

Lecture 1. (Wednesday, January 17)

Class and course introduction

Chapter 2. Data Presentation. 2.1 Type of data, 2.2 Frequency tables, 2.4 Graphs

Lecture 2. (Monday, January 22)

Chapter 2 Data Presentation. 2.3 Graphs

Chapter 3 Numerical Summary Measures. 3.1 Measures of central tendency, 3.2 Measures of dispersion

Homework #1 is assigned (Chapters 2, 3, 6)

Lecture 3. (Wednesday, January 24)

Chapter 6 Probability: 6.1 Basic idea of probability, 6.2 Conditional probability, 6.7 Exercises

Lab

Lecture 4. (Monday, January 29)

Chapter 6. Probability: 6.3 Bayes' theorem, 6.4 Diagnostic tests 6.5 The relative risk and the odds ratio

Homework #2 is assigned (Chapter 6, 7)

Homework #1 is due

Lecture 5. (Wednesday, January 31)

Chapter 7. Theoretical Probability Distributions: 7.2 Binomial, 7.3. The Poisson distribution, 7.4 Normal

Chapter 8. Sampling Distribution of the Mean: 8.1 Normal distribution of the sample mean

Lecture 6. (Monday, February 5)

Chapter 8. Sampling Distribution of the Mean: 8.2 Central limit theorem, 8.4 Application of the central limit theorem, problems solving), 9.3 Student's t distribution

Discussion on Homework #1

Homework #3 is assigned (Chapters 8, 9, 10)

Homework #2 is due

Lecture 7. (Wednesday, February 7)

Chapter 10. Hypothesis Testing: 10.1 General concepts 10.2 Two-sided tests of hypotheses, 10.3 One-sided and two-sided tests of hypotheses



Lecture 8. (Monday, February 12)

Chapter 10. Hypothesis Testing: 10.4 Types of error, 10.5 Power, 10.6 Sample size calculation

Lecture notes: Study design

Lab

Discussion on Homework #2

Homework #4 is assigned (Chapter 10, 11)

Homework #3 is due

Lecture 9. (Wednesday, February 14)

Journal club reading (15 min for each team)

Tettamanti S, Marin V, Pizzitola I, et. al. Targeting of acute myeloid leukaemia by cytokine-induced killer cells redirected with a novel CD123-specific chimeric antigen receptor. *Br J Haematol.* 2013 May;161(3):389-401. doi: 10.1111/bjh.12282. Epub 2013 Feb 25.

Naiker S, Connolly C, Wiesner L, et. al. Randomized pharmacokinetic evaluation of different rifabutin doses in African HIV-infected tuberculosis patients on lopinavir/ritonavir-based antiretroviral therapy. *BMC Pharmacol Toxicol.* 2014 Nov 19;15(1): 61

Granberg T, Fan Q, Treaba CA, et. al. In vivo characterization of cortical and white matter neuroaxonal pathology in early multiple sclerosis. *Brain* 2017(140): 2912-26

Lecture 10. (Monday, February 19)

Chapter 9. Confidence Intervals of a Single Mean: 9.1 Two-sided confidence intervals, 9.2 One-sided confidence intervals, Confidence Intervals of a Single Mean

Discussion on Homework #3

Homework #5 is assigned (Chapter 9)

Homework #4 is due

Lecture 11. (Wednesday, February 21)

Chapter 11. Comparison of Two Means: 11.1 Paired samples 11.2 Independent samples

Chapter 9 Confidence interval on difference of two means

Lab

Lecture 12. (Monday, February 26)

Chapter 12. Analysis of Variance: 12.1 One-way analysis of variance

Discussion on Homework #4

Homework #6 is assigned (Chapter 12)

Homework #5 is due

Lecture 13. (Wednesday, February 28)

Chapter 12. Analysis of Variance: 12.2 Multiple comparisons procedures, ANOVA with interaction

Lab



Lecture 14. (Monday, March 5)

Chapter 13. Nonparametric Methods: 13.1 The Sign test, 13.2 The Wilcoxon Signed-Rank test, 13.3. The Wilcoxon rank sum test

Homework #7 is assigned (Chapter 13, 14)

Homework #6 is due

Lab

Lecture 15. (Wednesday, March 7)

Journal club reading

Wang HC, Lin CC, Cheung R, Zhang-Hooks YX, Agarwal A, Ellis-Davies G, Rock J, Bergles DE. Spontaneous activity of Cochlear hair cells triggered by fluid secretion mechanism in adjacent support cells. Cell 2015

Rowena S, Kaihara KA, Paolino M, ..., Dixit VM. β -cell insulin secretion requires the ubiquitin ligase COP1. Cell 2015 (in press)

Additional reading

Na J, Yang H, Bae S, Lim KM. Analysis of Statistical Methods Currently used in Toxicology Journals.

Toxicol Res. 2014 Sep;30(3):185-92. doi: 10.5487/TR.2014.30.3.185.

Discussion on Homework 5 and 6

Spring Break: March 10 – March 18

No Class

Monday, March 19

Midterm examination

Lecture 16. (Wednesday, March 21)

Chapter 14. Inference on Proportions: 14.1 Normal approximation to the Binomial distribution 14.2

Sampling distribution of a proportion

Lecture 17. (Monday, March 26)

Chapter 14. Inference on Proportions: 14.3 Confidence intervals, 14.4 Hypothesis testing, 14.5 Sample size estimation, 14.6 Comparison of two proportions

Lab

Homework #8 is assigned (Chapter 14)

Homework #7 is due

Lecture 18. (Wednesday, March 28)

Real data example

Lecture 19. (Monday, April 2)

Journal club reading



Nieh EH, Matthews GA, Allsop SA, Presbrey KN, Leppla CA, Wichmann R, Neve R, Wildes CP, Tye KM. Decoding neural circuits that control compulsive sucrose seeking. *Cell*. 2015 Jan 29;160(3):528-41

Benayoun BA, Pollina EA, Ucar D, Mahmoudi S, Karra K, Wong ED, Devarajan K, Daugherty AC, Kundaje AB, Mancini E, Hitz BC, Gupta R, Rando TA, Baker JC, Snyder MP, Cherry JM, Brunet A. H3K4me3 breadth is linked to cell identity and transcriptional consistency. *Cell*. 2014 Jul 31;158(3):673-88. doi: 10.1016/j.cell.2014.06.027.

And it's correction:

Benayoun BA1, Pollina EA2, Ucar D3, Mahmoudi S3, Karra K3, Wong ED3, Devarajan K3, Daugherty AC3, Kundaje AB3, Mancini E3, Hitz BC3, Gupta R3, Rando TA4, Baker JC3, Snyder MP3, Cherry JM3, Brunet A5. H3K4me3 breadth is linked to cell identity and transcriptional consistency. *Cell*. 2015 November 19;163: 1281-86

Lecture 20. (Wednesday, April 4)

Chapter 15. Contingency Tables: 15.1 Chi-Square test for 2×2 tables, 15.2 McNemar's test
Homework #9 is assigned (Chapter 15, 17)
Homework #8 is due
Discussion on Homework 7

Lecture 21. (Monday, April 9)

Chapter 15. Contingency Tables: 15.1 Chi-Square test for $r \times c$ tables
Lecture notes: Multiple proportions and comparisons

Lecture 22. (Wednesday, April 11)

Chapter 17. Correlation: 17.1 The two-way scatter plot, 17.2 Pearson's correlation coefficient
Lab

Lecture 23. (Monday, April 16)

Chapter 18. Simple Linear Regression: 18.1 Linear regression concepts, 18.2 Fittings of a regression line by the method of least squares, 18.4 Some applications
Homework # 10 is assigned (Chapters 18, 19)
Homework # 9 is due
Discussion of Homework #8

Lecture 24. (Wednesday, April 18)

Chapter 19: Multiple regression

Lecture 25. (Monday, April 23)

Chapter 20: Logistic Regression: 20.1 The model, 20.2 Multiple Logistic regression, 20.3 Indicator variables
Homework # 11 is assigned (Chapter 20)
Homework # 10 is due
Discussion of Homework #9



Lecture 26. (Wednesday, April 25) SRB 1412

Non-linear Regression Models (Lecture notes)

Lecture 27. (Monday, April 30)

Journal club reading

Sadeghi S, Fooladi E, Malekaneh M. A nanocomposite/crude extract enzyme-based xanthine biosensor. *Anal Biochem.* 2014 Nov 1;464:51-9. doi: 10.1016/j.ab.2014.07.013. Epub 2014 Jul 22.

Ming J, Harms MP, Morris JC, et. al. Integrated cortical structural marker for Alzheimer's disease. *Neurobiol Aging.* 2014 Oct 12. pii: S0197-4580(14)00553-3. doi: 10.1016/j.neurobiolaging.2014.03.042. [Epub ahead of print]

Thion MS, Low D, Silvin A, et. al. Microbiome influences prenatal and adult microglia in a sex-specific manner. *Cell.* 2018(172): 1-17.

Additional reading:

Genser B, Cooper PJ, Yazdanbakhsh M, et. Al. A guide to modern statistical analysis of immunological data. *BMC Immunology* 2007, 8:27 doi:10.1186/1471-2172-8-27.

5/6 – 5/13 final exam