Biostatistics 830:
General State Space MCMC
and
Advanced Bayesian Modeling/Computing
Winter 2017

Instructor: Timothy D. Johnson
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Lecture: Tuesday/Thursday 11:40 am–1:00 pm, SPH II, M4318

Grading:	**Participation:**	(10%)
	Homework:	(20%)
	Course Lecture:	(30%)
	Term Project:	(40%)

Text: No Text Required. Recommended Text: Markov Chains and Stochastic Stability, 2nd ed. Sean Meyn and Richard Tweedie, Cambridge University Press. 2009. We will be reading several manuscripts which will be posted on the Course CTools website.

Course Requirements: PhD standing, Biostatistics 682 (Applied Bayesian Inference) or equivalent. Master's students need my consent. A knowledge of basic stochastic processes and measure theory is strongly recommended. Good programming skills are highly recommended. No auditing allowed. Biostatistics 830 is a special topics course and is variable unit. For this particular course, 3 units are required.

Course Description: The course is broken up into four sections: 1) general state space MC theory 2) MCMC 3) Bayesian model choice and 4) student lectures. The first part will take up about half the course. In 1) we will lay the foundations of Markov chain theory necessary to have a deep understanding of the theory underlying MCMC algorithms. In 2) we turn our attention to specific MCMC algorithms (specifically the Metropolis-Hastings algorithm and Gibbs sampling) and study their convergence properties along with LLN and CLT for Markov chains. In 3) we discuss various model selections methods within the Bayesian paradigm, including DIC, Bayes factors, bridge sampling, model averaging and trans-dimensional MCMC. In 4) students will select, with instructor approval, a Bayesian modeling topic that they will study in depth, based on literature, and present a lecture to the class. Topics can include, but are not limited to Approximate Bayesian Computation (ABC), Bayesian hypothesis testing, Bayesian false discovery rate, nonparametric regression/infinite mixture models, generalized non-linear models, ordinal regression, Bayesian CART, survival analysis, imaging models, spatial models and dynamic linear models. In the past some of the topics included spatial-temporal modeling, Bayesian survival modeling, spatial Poisson modeling for RNA-seq data, pattern mixture modeling (missing data) and non-linear modeling. Students are encouraged to select topics that are related to their dissertation, but not part

of their dissertation. The term project is an analysis of a data set (students are encouraged to use data from their dissertation) and will consist of a 10 page paper. Students are to turn in an abstract for their project and the project must be approved by the instructor. Homework will be minimal throughout the first half of the semester. There will be a few homework assignments that will require coding in the second half of the semester.

Competencies covered in this course:

Core Competencies:

1. Develop written and oral presentations based on statistical analyses for both public health professionals and educated lay audiences.

Biostatistics:

1. Understand the theoretical foundations of statistical methods, including probability theory, distribution theory, risk and decision theory, mathematics of probability and statistics, and stochastic processes.

2. Develop written and oral presentation skills and other scientific reporting skills, based on statistical analyses for public health, medical and basic scientists and educated lay audiences.

3. Statistical techniques: Applications of stochastic processes and Bayesian inference techniques

4. Mathematical foundation.

5. Communication of results.

Academic Integrity: The faculty of the School of Public Health believes 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, 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. The preparation of reports, papers, and examinations, assigned on an individual basis, must represent each students own effort. Reference sources should be indicated clearly. The use of assistance from other students or aids of any kind during a written examination, except when the use of aids such as electronic devices, books or notes has been approved by an instructor, is a violation of the standard of academic conduct (Standard of Academic Conduct, University of Michigan School of Public Health).