

# colorado school of public health

## BIOS 7717 BAYESIAN INFERENCE SPRING 2018

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COLORADO SCHOOL OF PUBLIC HEALTH  
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Course website: <http://www.johnhughes.org/bios7717.html>  
Credits: 3  
Meeting days: Monday and Wednesday  
Meeting time: 9–10:20 AM  
Meeting place: Ed 2 South, Room 2201  
Office hours: 10:30–11:30 AM on Wednesday, or by appointment

### 1. OVERVIEW

#### 1.1. Description.

BIOS 7717 Bayesian Inference, 3.0 cr.

(Spring, Fall) Prereq: BIOS 6612 and BIOS 6632 or permission of instructor. Restrictions: Instructor consent required. Offered variable term and year.

This course will introduce students to modern Bayesian statistical modeling and inference. Topics include a comparison of frequentist and Bayesian approaches, Markov chain Monte Carlo (MCMC) methods for simulating from posterior distributions, regression inference, hierarchical models, and mixed models.

1.2. **Learning Objectives.** Students who successfully complete this course will be able to

- understand and apply Bayesian theory, methods, and software to analyze data; and
- compare and contrast the frequentist and Bayesian approaches to statistical inference.

1.3. **Competencies Addressed by This Course.**

- Compare and contrast the frequentist and Bayesian approaches to inference.

- Perform basic derivations of posterior and predictive distributions for standard statistical models.
- Carry out Bayesian analyses, and interpret and report the results.
- Understand and be able to discuss standard MCMC algorithms for simulation from posterior distributions, including Gibbs sampling and the Metropolis–Hastings algorithm.
- Be able to use JAGS and/or R to do MCMC for Bayesian inference.
- Appreciate that the discipline of statistics is not free of controversies.

**1.4. Methods of Instruction and Work Expectations.** Class meetings will comprise lecture and discussion. Students are expected to attend class, participate in class discussions, and complete all homework assignments and the capstone project. Students are also expected to complete reading assignments.

**1.5. Text and Materials.** Lecture notes and other materials will be available on the course website. There is no required text. You may find useful one or more of the books listed at the end of this syllabus: Brooks et al. (2011); Gelman et al. (2014); Hoff (2009); Kadane (2011); McElreath (2016); Robert (2007); Savage (1972); Bruckner et al. (1997); Robert and Casella (1999); Norris (1998); Ravishanker and Dey (2001).

**1.6. Outline/Schedule.**

- (1) Introduction
- (2) Decision-Theoretic Foundations
- (3) Markov Chain Monte Carlo (MCMC)
- (4) Frasian Inference
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## 2. ASSESSMENT

**2.1. Homework Assignments.** There will be several homework assignments during the semester. Students are encouraged to discuss the homework problems and to work together on the computing. However, each student is expected to write his/her submission independently. Hand in only relevant computer output. Note that submitted code should generally be commented and placed in an appendix.

You will have two weeks to complete each assignment. Late homework will not be accepted without prior approval from the instructor. Handwritten work will not be accepted.

**2.2. Capstone Project.** There will be a final project and presentation. Details will be handed out in February.

**2.3. Grading.** The project will be worth 40% of your semester grade, homework 60%. Each student's percentage grade will be converted to a letter grade according to the following table.

A	94–100%	B <sup>+</sup>	87–89%	C <sup>+</sup>	77–79%	D <sup>+</sup>	67–69%	F	0–59%
A <sup>–</sup>	90–93%	B	84–86%	C	74–76%	D	64–66%		
		B <sup>–</sup>	80–83%	C <sup>–</sup>	70–73%	D <sup>–</sup>	60–63%		

### 3. POLICIES

**3.1. Incomplete Grades.** The current university policy concerning incomplete grades will be followed in this course. Incomplete grades are given only in situations where unexpected emergencies prevent a student from completing the course; students have up to one year (three semesters) to complete course requirements. Your instructor is the final authority on whether you qualify for an incomplete. Incomplete work must be finished within the time allowed or an F will appear on your transcript.

**3.2. Civility.** My commitment is to create a climate for learning characterized by respect for each other and the contributions each person makes to class. I ask that you make a similar commitment.

**3.3. Professionalism.** Mobile devices must be silenced during all class meetings. Those not heeding this rule will be asked to leave the classroom immediately so as to not disrupt the learning environment.

**3.4. Academic Conduct.** All students are expected to abide by the Honor Code of the Colorado School of Public Health. Unless otherwise instructed, all of your work in this course should represent completely independent work. Students are expected to familiarize themselves with the Student Honor Code, which can be found at [http://www.ucdenver.edu/academics/colleges/PublicHealth/Academics/academics/Documents/PoliciesHandbooks/CSPH\\_Honor\\_Code.pdf](http://www.ucdenver.edu/academics/colleges/PublicHealth/Academics/academics/Documents/PoliciesHandbooks/CSPH_Honor_Code.pdf) or in the Student Resources section of the CSPH website. Any student found to have committed acts of misconduct (including, but not limited to, cheating, plagiarism, research misconduct, breach of confidentiality, or illegal acts) will be subject to the procedures outlined in the CSPH Honor Code.

**3.5. Accommodations for Disabilities.** Any student requesting accommodations for a disability must contact one of the following persons.

Sherry Holden | Coordinator  
University of Colorado Anschutz Medical Campus Disability Resources and Services  
Building 500, Room Q20-EG 305A  
Phone: (303) 724-5640  
Fax: (303) 724-5641  
Monday, Tuesday, and Thursday only  
[sherry.holden@ucdenver.edu](mailto:sherry.holden@ucdenver.edu)

Selim Özi | Assistive Technology Specialist, Accommodation Coordinator  
University of Colorado Anschutz Medical Campus Disability Resources and Services  
Mail Stop A010, Building 500, Room Q20-EG 306  
Phone: (303) 724-8428  
Fax: (303) 724-5641  
[selim.oz@ucdenver.edu](mailto:selim.oz@ucdenver.edu)

Be aware that the determination of accommodations can take a long time. No accommodations will be made for the course until written documentation is provided to the course director(s) by Disability Resources and Services. It is the student's responsibility to coordinate approved accommodations with Disability Resources and Services in advance.

Further information regarding disability accommodations can be found at <http://www.ucdenver.edu/student-services/resources/disability-resources-services/accommodations/Pages/accommodations.aspx>.

Students can schedule appointments at <http://www.ucdenver.edu/student-services/resources/disability-resources-services/about-office/contact-us-CUAnschutz/Pages/form.aspx>.

#### REFERENCES

- [1] Brooks, S., Gelman, A., Jones, G., and Meng, X.-L. (2011). *Handbook of Markov Chain Monte Carlo*. CRC Press.
- [2] Bruckner, A. M., Bruckner, J. B., and Thomson, B. S. (1997). *Real Analysis*. ClassicalRealAnalysis.com.
- [3] Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., and Rubin, D. B. (2014). *Bayesian Data Analysis*, volume 2. CRC press Boca Raton, FL.
- [4] Hoff, P. D. (2009). *A First Course in Bayesian Statistical Methods*. Springer Science & Business Media.
- [5] Kadane, J. B. (2011). *Principles of Uncertainty*. CRC Press.
- [6] McElreath, R. (2016). *Statistical Rethinking: A Bayesian Course with Examples in R and Stan*. Chapman & Hall/CRC Texts in Statistical Science. CRC Press.
- [7] Norris, J. R. (1998). *Markov Chains*. Cambridge University Press.
- [8] Ravishanker, N. and Dey, D. K. (2001). *A First Course in Linear Model Theory*. CRC Press.
- [9] Robert, C. (2007). *The Bayesian Choice: From Decision-Theoretic Foundations to Computational Implementation*. Springer Science & Business Media.
- [10] Robert, C. P. and Casella, G. (1999). *Monte Carlo Statistical Methods*. Springer New York.
- [11] Savage, L. J. (1972). *The Foundations of Statistics*. Dover.