STAT 576 Bayesian Analysis

Fall 2024

Time:	Tu/Th 12:05 PM – 1:20 PM	**Location:**	SLOAN 7
Instructor:	Chencheng Cai	**Email:**	chencheng.cai@wsu.edu
Prerequisites:	STAT 556, STAT 536	**Credit Hours:**	3
Office Hours:	Tu/Wed 1:30-3:30 PM or by appointment	**Office Location:**	Neill Hall 405

Course Materials

1. **Lecture Notes**:
   available on both Canvas and the course website (https://www.math.wsu.edu/faculty/ccai/stat576.html)

2. **Textbook**:
   Bayesian Data Analysis, 3rd Edition. Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari and Donald B. Rubin. Chapman & Hall. 2013.
   Free online access from the book website (http://www.stat.columbia.edu/ gelman/book/)

3. **Recommended Reading:**
   The Bayesian Choice: From Decision-Theoretic Foundations to Computational Implementation, 2nd Edition. Christian P. Robert. Springer. 2007.

   Monte Carlo Methods for Scientific Computing. Jun S. Liu. Springer. 2008.

Course Description

The course will focus on Bayesian statistics including the methodologies and practices in a programming language (R or Python). Specifically, the following topics will be covered in the course.

- Bayesian inference
- Prior elicitation
- Hierachical models
- Bayesian computation
- Markov chain Monte Carlo and Gibbs sampler
- Bayesian regression
- State-space models

Learning Outcomes

Week 1	Overview the topic and review prerequisites on linear algebra and regression theories
Week 2-6	Master the foundations for Bayesian statistics
Week 7-10	Master the computation methodologies in Bayesian inference
Week 11-12	Master the application of Bayesian statistics in regression and nonparametric models
Week 13-14	Master the state-space model and sequential Monte Carlo methods

Assessment

The grading of this course will be assessed based on (1) Homework, (2) Exams, and (3) Final project according to the following allocations.

Homework	40%
Mid-term Exams	30%
Project	30%
Total	100%

The grading scale table is as follows.

A	93% - 100%	C+	77%-79.99%
A-	90% - 92.99%	C	73% - 76.99%
B+	87% - 89.99%	C-	70% - 72.99%
B	83% - 86.99%	D+	66% - 69.99%
B-	80% - 82.99%	D	60% - 65.99%
		F	0% - 59.99%

Homework

There are approximately six homework to be assigned throughout the semester. These will come from problems provided by the textbook or materials discussed in the lectures. Homework assignments will primarily consist of methodological exercises and programming exercises, and both the two parts of the exercises need to be completed. Please organize the methodological part (either typed or scanned) and the codes (including outputs) into one PDF file and submit them through Canvas. Late homework without exemption from the instructor will be graded 0 points.

Mid-term Exams

The mid-term exam is scheduled to Week 8. The problems will be developed from materials presented in lecture notes. These will primarily consist of concept checks, methodological questions and calculations. The mid-term exam is closed-book and closed-notes.

Project

In the final project, the students will be asked to apply Bayesian methods discussed in the class to a dataset. The project must involve Bayesian methods in the sense of both methodological development and computations. The project will be graded based on both the report and presentation.

Class Participation

To properly gain a working knowledge of the material, attendance and participation in class are necessary. While this will not be graded, enrolled students are highly encouraged to attend the class.

Policies

Students with Disabilities

Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center at 509-335-3417 to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist on your home campus. Provide disability Specialist contact information: Pullman or WSU Online: 509-335-3417, Washington Building 217; http://accesscenter.wsu.edu, Access.Center@wsu.edu

Academic Integrity Statement

You are responsible for reading WSU's Academic Integrity Policy, which is based on Washington State law. If you cheat in your work in this class you will:

- Fail the course.
- Be reported to the Center for Community Standards.
- Have the right to appeal my decision.
- Not be able to drop the course or withdraw from the course until the appeals process is finished.

If you have any questions about what you can and cannot do in this course, ask me.
If you want to ask for a change in my decision about academic integrity, use the form at the Center for Community Standards website. You must submit this request within 21 calendar days of the decision.

Expectations for Classroom Conduct

Respect each other and treat others how you want to be treated. Please silence your cell phones and all other electronics and refrain from using these items during class. Do not disrupt the class, students are here to learn and cannot do so if others are being disruptive. If I feel you are disrupting the class or are disrespectful of anyone, I reserve the right to ask you to leave class for the day. Success in class requires reading the textbook, listening and asking questions in lectures, and doing all assigned work. Only you choose whether or not to succeed by doing these things.

Workload Expectations

This course meets for a total of 2.5 hours per week. For each hour of lecture equivalent, students should expect to have a minimum of two hours of work outside of class.

Artificial Intelligence (AI) Policy: AI Use only with acknowledgment

Students are allowed to use advanced automated tools (artificial intelligence or machine learning tools such as ChatGPT, Co-Pilot, or Dall-E) on assignments in this course if that use is properly documented and credited. For example, text generated using ChatGPT-3 should include a citation such as: "Chat-GPT-3. (YYYY, Month DD of query). "Text of your query." Generated using OpenAI. https://chat.openai.com/" Material generated using other tools should follow a similar citation convention.

University Syllabus

Students are responsible for reading and understanding all university-wide policies and resources pertaining to all courses (for instance: accommodations, care resources, policies on discrimination or harassment), which can be found in the **university syllabus**.

Tentative Schedule

Week 1	Aug 20, Aug 22	Introduction and review
Week 2	Aug 27, Aug 29	Bayesian Inference
Week 3	Sept 3, Sept 5	
Week 4	Sept 10, Sept 12	Asymptotics
Week 5	Sept 17, Sept 19	Hierachical Bayes
Week 6	Sept 24, Sept 26	Model Checking
Week 7	Oct 1, Oct 3	Bayesian Computation
Week 8	Oct 8, Oct 10	**Mid-term Exam**
Week 9	Oct 15, Oct 17	MCMC and Gibbs Sampler
Week 10	Oct 22, Oct 24	
Week 11	Oct 29, Oct 31	Bayesian Regression and Nonparametric Models
Week 12	Nov 5, Nov 7	
Week 13	Nov 12, Nov 14	State-space Models and Sequential Monte Carlo
Week 14	Nov 19, Nov 21	
Week 15	Nov 26, Nov 28	**Thanksgiving Break**
Week 16	Dec 3, Dec 5	Presentation
Week 17	Dec 9 – Dec 14	**Exam Week**