JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Syllabus
Bayesian Statistics
553.432/632 Fall 2023
(3 credits, EQ)
2nd Draft Aug 30, 2023

Instructor

Dr Sergey Kushnarev, skushna1@jhu.edu
Office: Wyman N453
Office hours: Tues, 2-3pm

Teaching Assistants:

Lang, Lang	llang7@jhu.edu
Wu, Yue	ywu166@jhu.edu
Kan, Shuwen	skan2@jhu.edu
McPherson, Ian Oliver	imcpher1@jhu.edu

Weekly Office hours: see Canvas for office hours
Location: S425 Wyman (AMS TA room) or on Zoom

Lectures

Class #	Title	Lecture
EN.553.432 (01)	Bayesian Statistics	Krieger 180 MW 12:00PM - 1:15PM
EN.553.632 (01)	Bayesian Statistics	Krieger 180 MW 12:00PM - 1:15PM
EN.553.632 (02)	Bayesian Statistics	Remsen Hall 101 MW 4:30PM - 5:45PM

Textbook

Lecture notes will be made available online after the lecture. Skeleton lecture notes and R notebooks will be available before the lecture.

Required

- Peter D. Hoff, *A First Course in Bayesian Statistical Methods*, Springer (2009).

Recommended:

- Ronald Christensen, Wesley Johnson, Adam Branscum, and Timothy E.Hanson, *Bayesian Ideas and Data Analysis*, CRC Press (2010).
- Bradley P. Carlin and Thomas A. Louis, *Bayesian Methods for Data Analysis, Third Edition*, Taylor & Francis (2008).

Online Resources

Please log in to Canvas for all materials related to this course. Homework assignments will be submitted via Gradescope. Access Gradescope via the Canvas course website as well.

Course Information

The course will cover Bayesian methods for exploratory data analysis. The emphasis will be on applied data analysis in various disciplines. We will consider a variety of topics, including introduction to Bayesian inference, prior and posterior distribution, hierarchical models, spatial models, longitudinal models, models for categorical data and missing data, model checking and selection, computational methods by Markov Chain Monte Carlo using R. We will also cover some nonparametric Bayesian models if time allows, such as Gaussian processes.

Prerequisites 553.630 (recommended) or 553.430 or permission by instructor.

Computing: the programming language R will be used for demonstration in the class. For homework and exams, you can use either Python or R.

Course Goals

(1) Ability to understand the basic concepts underlying the Bayesian approach to statistical thinking.
(2) Ability to use the Bayesian computing techniques for the practical application of Bayesian models to data analysis.

Tentative Course Schedule

See Canvas

Key Dates

Check in the Course Schedule on Canvas.

Assignments & Midterm Exam & Final Project

Homework will be posted on the Canvas course website. *You can submit the HW up to 24 hours late with a 20% penalty*. Illness and family emergencies will be dealt with on an individual basis. Graded homeworks will be returned timely. There will be one **in-class midterm exam** and one **final individual/group project with class presentation and report**.

The project can be on any topic related to Bayesian theory, methods, and applications. If you decide to have a group final project, the group can have at most **three** students. The report should include the following:

- Purpose of the project. Description of the problem you are studying and the purpose of and rationale of the project.
- Literature Review. Preliminary outline of the literature related to the proposed project.
- Proposed "Method". A written description of the project plan including the research question, the Bayesian model you are going to use to solve the problem, and computational solutions

related (MCMC details).
- Simulation studies on synthetic data if necessary.
- Data analysis and interpretation.

When you submit your homework and final project, you will need to include your code with the data used (well documented and runnable so that TAs can reproduce your results). Results that cannot be reproduced with the submitted code will not be scored.

All homework should be submitted via *Gradescope.*

Grading

Homework: 40%
Midterm: 30%
Final project presentation: 5%
Final project report: 25%.

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.
Report any violations you witness to the instructor. Report any violations you witness to the instructor. You can also contact:

- For undergraduates: the director of student conduct (or designee) by calling the Office of Student Conduct at 410-516-2509 or via email at studentconduct@jhu.edu
- For KSAS Graduate Students; rseitz5@jh.edu
- For WSE Graduate Students: christinekavanagh@jhu.edu

Personal Wellbeing

- Because of ongoing COVID-19 concerns, special requirements may be in effect this term, and these may vary during the term. Please keep updated with these at the following sites:
  - University information: https://covidinfo.jhu.edu/
  - Whiting School of Engineering information: https://engineering.jhu.edu/covid-19/
- COVID-19 vaccination a required unless an exception has been granted by the university for health or religious reasons.
- If you are sick please notify me by email so that we can make appropriate accommodations should this affect your ability to attend class, complete assignments, or participate in assessments. The Student Health and Wellness Center is open and operational for primary care needs. If you would like to speak with a medical provider, please call 410-516-8270, and staff will determine an appropriate course of action. See also https://studentaffairs.jhu.edu/student-life/student-outreach-support/absences-from-class/illness-note-policy/
- Johns Hopkins University values diversity and inclusion. We are committed to providing welcoming, equitable, and accessible educational experiences for all students. Students with disabilities (including those with psychological conditions, medical conditions, and temporary disabilities) can request accommodations for this course by providing an Accommodation Letter issued by Student Disability Services (SDS). Please request accommodations for this course as early as possible to provide time for effective communication and arrangements.
  For further information or to start the process of requesting accommodations, please contact Student Disability Services at Homewood Campus, Shaffer Hall #101, call: 410-516-4720 and email:

studentdisabilityservices@jhu.edu or visit the website https://studentaffairs.jhu.edu/disabilities/.

- If you are struggling with anxiety, stress, depression, or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out their services. The Counseling Center is located at 3003 North Charles Street in Suite S-200 and can be reached at 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/
- Student Outreach & Support helps students manage physical and mental health concerns, personal and family emergencies, financial issues, and other obstacles that may arise during their college experience. Students can self-refer or refer a friend who may need extra support or help getting connected to resources. To connect with SOS, please visit this website: https://studentaffairs.jhu.edu/student-life/student-outreach-support/ or email deanofstudents@jhu.edu, call 410-516-7857, or students can schedule to meet with a Case Manager by visiting the Student Outreach & Support website and filling out a referral form online.

Classroom Climate

I am committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. I believe fostering an inclusive climate is important because research and my experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me, the TAs, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.
If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share directly with me or the TAs. I promise that we will take your communication seriously and seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the department chair ([Chair's Name and Email]), the Director of Undergraduate Studies ([DUS Name and Email]), the WSE Assistant Dean for Diversity and Inclusion (Darlene Saporu, dsaporu@jhu.edu), the KSAS Assistant Dean for Diversity and Inclusion (Araceli Frias, afrias3@jhu.edu) or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g., sexual harassment).

Family Accommodations Policy
You are welcome to bring a family member to class on occasional days when your responsibilities require it (for example, if emergency child care is unavailable, or for health needs of a relative). In fact, you may see my children in class on days when their school is closed. Please be sensitive to the classroom environment, and if your family member becomes uncomfortably disruptive, you may leave the classroom and return as needed.

Policy on Incomplete Grades:

The full policy is available here:
https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/grading-policies/

The significant component of this policy is that there is an Incomplete Grade Contract available to students in SIS to request an incomplete grade. This is how all incomplete grades must be initiated. Another significant component is the timeline for completion of an incomplete grade for undergraduate students, which is **45 calendar days after the last day of classes**. For graduate students, the deadline is the end of the third week of classes of the following semester. See the full catalogue entry for considerations for students on academic probation and graduating students.

Deadlines for Adding, Dropping and Withdrawing from Courses
https://studentaffairs.jhu.edu/registrar/students/registration/

Students may add a course up to **noon on September 8, 2023** (customized academic learning, formerly called independent academic work, such as research may be added until **October 8, 2023**). They may drop courses up until **October 8, 2023** provided they remain registered for a minimum of 12 credits. Between **October 9, 2023 and November 10, 2023,** a student may withdraw from a course with a W on their academic record. A record of the course will remain on the academic record with a W appearing in the grade column to indicate that the student registered and then withdrew from the course.

For more information on these and other academic policies, see
https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/grading-policies/