Term Information

Effective Term	Autumn 2023
Previous Value	*Autumn 2014*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

This is based on the previous STAT 7303 course; removes utility theory, exchangeability and de Finetti's Theorem; adds computation of Bayesian analysis, Gibbs sampler and Metropolis-Hastings algorithms, Bayesian model assessment and robustness.

What is the rationale for the proposed change(s)?

The current STAT 7302 is no a longer required for the Ph.D. program in Statistics. Adding material on computation, fitting and assessing Bayesian models, Bayesian model assessment, will better prepare students for their dissertation research.

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

Stat 7303 will no longer be offered. This course replaces it.

Is approval of the requrest contingent upon the approval of other course or curricular program request? Yes

Please identify the pending request and explain its relationship to the proposed changes(s) for this course (e.g. cross listed courses, new or revised program)

This course change is part of a revision in the Ph.D. program in Statistics. This will also affect the content of courses taught in the interdisciplinary Ph.D. program in Biostatistics.

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Statistics
Fiscal Unit/Academic Org	Statistics - D0694
College/Academic Group	Arts and Sciences
Level/Career	Graduate
Course Number/Catalog	7302
Course Title	Bayesian Analysis and Decision Theory
Previous Value	*Advanced Statistical Theory II*
Transcript Abbreviation	Bayesian Analysis
Previous Value	*Adv Stat Theory 2*
Course Description	Decision theory, loss functions, priors, posteriors, Bayesian inference, empirical Bayes, hierarchical modeling, computation, and Bayesian model assessment and robustness. Intended primarily for PhD students in Statistics or Biostatistics.
Previous Value	*Hypothesis testing: likelihood ratio tests, resampling and permutation based tests, sequential tests, multiple testing, asymptotic distributions of test statistics. Intended primarily for PhD students in Statistics or Biostatistics.*
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week, 12 Week, 8 Week, 7 Week, 6 Week, 4 Week
Previous Value	*14 Week, 12 Week, 8 Week, 7 Week, 6 Week*

Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq: Stat 7301, or permission of instructor.
Previous Value	*Prereq: 7301, or permission of instructor.*
Exclusions	
Previous Value	Not open to students with credit for 822.
Electronically Enforced	No

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	27.0501
Subsidy Level	Doctoral Course
Intended Rank	Masters, Doctoral

Requirement/Elective Designation

Required for this unit's degrees, majors, and/or minors
The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Understand central elements of decision theory
- Compute Bayes risk and frequentist risk and derive Bayes rules
- Understand important statistical principles that motivate various modes of inference
- Build realistic Bayesian models and specify appropriate prior distributions using a variety of approaches
- Fit Bayesian models to data using numerical techniques, including Gibbs sampling and Markov chain Monte Carlo
- Assess and validate the assumptions underlying empirical Bayes and hierarchical Bayes models

Previous Value

- *Hypothesis testing: likelihood ratio tests, resampling and permutation based tests, sequential tests, multiple testing, asymptotic distributions of test statistics. Intended primarily for PhD students in Statistics or Biostatistics.*

Content Topic List

- Bayesian Expected Loss, Frequentist Risk, Bayes Risk
- Decision Principles (Bayesian, Frequentist, Likelihood)
- Loss Functions
- Prior Distributions (Subjective, Noninformative, Improper, Empirical, Hierarchical)
- Posterior Distributions
- Bayes Inference (Estimation, Credible Sets, Hypothesis Testing, prediction)
- Empirical Bayes Analysis and Hierarchical Bayes Models
- Computation of Bayesian analysis. Gibbs Sampler and Metropolis-Hasting Algorithms.
- Bayesian Model Assessment and Robustness

Previous Value

- *Neyman-Pearson lemma*
- *Monotone likelihood ratio*
- *UMP, UMPU tests*
- *Confidence regions*
- *Bootstrap/permutation tests*
- *Sequential tests*
- *Multiple testing*
- *Chi-square tests*
- *Asymptotic distributions of test statistics*
- *Asymptotics of maximum likelihood estimators*

Sought Concurrence

No

Attachments

- STAT7302_syllabus.pdf: Syllabus

  (Syllabus. Owner: Craigmile,Peter F)

- SP20-STAT-7302-Xu.pdf: Old syllabus

  (Syllabus. Owner: Craigmile,Peter F)

Comments

- Ditto *(by Vankeerbergen,Bernadette Chantal on 12/03/2022 09:18 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Craigmile,Peter F	12/02/2022 08:32 AM	Submitted for Approval
Approved	Craigmile,Peter F	12/02/2022 05:27 PM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	12/03/2022 09:18 PM	College Approval
Submitted	Craigmile,Peter F	12/03/2022 09:29 PM	Submitted for Approval
Approved	Craigmile,Peter F	12/03/2022 09:30 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	12/04/2022 05:46 PM	College Approval
Pending Approval	Cody,Emily Kathryn Jenkins,Mary Ellen Bigler Hanlin,Deborah Kay Hilty,Michael Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	12/04/2022 05:46 PM	ASCCAO Approval

THE OHIO STATE UNIVERSITY

College of Arts & Sciences
Department of Statistics

SYLLABUS: STAT 7302

BAYESIAN ANALYSIS AND DECISION THEORY

Spring 2024 (full semester)
3 credit hours

COURSE OVERVIEW

Instructor

<NAME TO BE ANNOUNCED>

Email address: <TO BE ANNOUNCED>

Lectures: This class will meet 3 days a week for 55 minutes each lecture. <LOCATION TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Graduate teaching assistant

<NAME>

Email address: <TO BE ANNOUNCED>

Office hours: <TO BE ANNOUNCED>

Prerequisites

STAT 7301 or permission of instructor

Course description

This course explores basic elements of decision theory and Bayesian inference. During the semester we will cover the following core topics:

- Bayesian Expected Loss, Frequentist Risk, Bayes Risk

- Decision Principles (Bayesian, Frequentist, Likelihood)
- Loss Functions
- Prior Distributions (Subjective, Noninformative, Improper, Empirical, Hierarchical)
- Posterior Distributions
- Bayes Inference (Estimation, Credible Sets, Hypothesis Testing, prediction)
- Empirical Bayes Analysis and Hierarchical Bayes Models
- Computation of Bayesian analysis. Gibbs Sampler and Metropolis-Hasting Algorithms.
- Bayesian Model Assessment and Robustness

Course learning outcomes

By the end of this course, students should successfully be able to:

- Understand central elements of decision theory
- Compute Bayes risk and frequentist risk and derive Bayes rules
- Understand important statistical principles that motivate various modes of inference
- Build realistic Bayesian models and specify appropriate prior distributions using a variety of approaches
- Fit Bayesian models to data using numerical techniques, including Gibbs sampling and Markov chain Monte Carlo
- Assess and validate the assumptions underlying empirical Bayes and hierarchical Bayes models

COURSE MATERIALS AND TECHNOLOGIES

Textbooks

Required

- Berger, J.O. (1985), “Statistical Decision Theory and Bayesian Analysis,” second edition, New York, NY: Springer. This eBook is freely available for download from the OSU library website: https://library.ohio-state.edu/record=b8694733
- Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A. and Rubin, D.B. (2014), “Bayesian Data Analysis” third edition, Chapman & Hall. This book is also freely available in electronic format through the library: https://learning.oreilly.com/library/view/bayesian-data-analysis/9781439898222/

Recommended/optional

- Some topics covered in the course will be based on material presented in additional books and articles. Appropriate references will be provided as needed.

Necessary Software

- This class requires you to use the statistical software packages called R (The R Project for Statistical Computing; http://www.r-project.org/) and RStudio (https://posit.co). These software packages are available as Free Software. More details will be given in class.

GRADING AND FACULTY RESPONSE

ASSIGNMENT CATEGORY	PERCENTAGE
Homework	40%
Midterm	25%
Final Exam	35%
Total	**100%**

Homework: There will be regular homework assignments. Homework must be uploaded to Carmen by the posted deadline on the day it is due. Homework is not accepted by email. You are encouraged to work together on the homework, but do not copy any part of others' work. Each student must produce his/her own homework to be handed in.

Exams: There will be one midterm and one final exam. All exams will be administered in the classroom. The final exam will take place at the time and date established by the University. All exams are closed book/closed notes. There are no make-up exams. A basic calculator is allowed – tablets, laptops, and cellphones are not allowed. Statistical tables will be provided as needed.

Late assignments

<Policy will be added when the course is offered>

Instructor feedback and response time

<Policy will be added when the course is offered>

COURSE SCHEDULE

Refer to the Carmen course for up-to-date assignment due dates.

WEEK	DATES	TOPICS
1	1/8, 1/10, 1/12	Basic elements of decision theory; Bayesian expected loss; frequentist risk; Bayes risk; decision principles Reading: Berger, Chapter 1
2	1/17, 1/19	Minimax and admissible decision rules Reading: Berger, Chapter 5.2 and 5.3 (this would take much longer than 2 lectures if we wish to provide any detail)
3	1/22, 1/24, 1/26	Overview of Bayesian analysis; admissibility of Bayes rules; complete class theorem Reading: Berger, Chapter 4.1, 4.2, 4.4, 4.8.1, 8.1, 8.2, 8.5-8.9
4	1/29, 1/31, 2/2	Generalized Bayes rules; admissibility of generalized Bayes rules; relationships between minimax Bayes and admissible rules; James-Stein estimator; prior distributions Reading: Berger Chapter 4.4, 4.8.2, 5.3, 5.4, 8.9, 3
5	2/5, 2/7, 2/9	Prior distributions (continued); empirical Bayes analysis (nonparametric and parametric) Reading: Berger Chapter 3, 4.5
6	2/12, 2/14, 2/16	Empirical Bayes for regression structures; general hierarchical models; Bayesian analysis of the linear model Reading: Berger Chapter 4.5, 4.6, Lindley and Smith (1972), "Bayes Estimates for the Linear Model," JRSS-B
7	2/19, 2/21, 2/23	Distinct points of view about statistical hypothesis testing; checking Bayesian models; Bayesian model diagnostics Reading: Christensen, R. (2005), "Testing Fisher, Neyman, Pearson, and Bayes," The American Statistician, 59, 121-126; Lehmann, E. L. (1993), "The Fisher, Neyman-Pearson Theories of Testing Hypotheses: One Theory or Two?," JASA, 88, 1242-1249; Gelman et al. Ch. 6

WEEK	DATES	TOPICS
8	2/26, 2/28, 3/1	Bayes factors and testing; Bayesian model averaging; Bayesian model comparison Reading: Berger Chapter 4.3.3; Madigan, D. and Raftery, A. E. (1994). Model selection and accounting for model uncertainty in graphical models using Occam's window, Journal of the American Statistical Association 89(428): 1535–1546; Hoeting, J. A., Madigan, D., Raftery, A. E. and Volinsky, C. T. (1999). Bayesian model averaging: a tutorial, Statistical science pp. 382–401; Wasserman, L. (2000). Bayesian model selection and model averaging, Journal of mathematical psychology 44(1): 92–107; Kadane, J. B. and Lazar, N. A. (2004). Methods and criteria for model selection, Journal of the American statistical Association 99(465): 279–290; Clyde, M. and George, E. I. (2004). Model uncertainty, Statistical science pp. 81–94.
9	3/4, 3/6, 3/8	Computation of Bayesian analysis. Sampling from a distribution Reading: Gelman et al., Chapter 10
10	3/18, 3/20, 3/22	Gibbs sampler algorithm and examples in R Reading: Gelman et al., Chapter 11.1-11.3
11	3/25, 3/27, 3/29	Metropolis-Hasting algorithm and examples in R Reading: Gelman et al., Chapter 11.4-11.5
12	4/1, 4/3, 4/5	MCMC tuning and assessing convergence in R Reading: Gelman et al., Chapter 11.6-11.10
13	4/8, 4/10, 4/11	Bayesian analysis for hierarchical linear models Reading: Gelman et al., Chapter 15
14	4/15, 4/17, 4/19	Bayesian analysis for GLM Reading: Gelman et al., Chapter 16
15	4/22	Case study analysis

OTHER COURSE POLICIES

Academic integrity policy

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct **http://studentlife.osu.edu/csc/**.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.
If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.
Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct web page (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)

Copyright for instructional materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on Title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu

Commitment to a diverse and inclusive learning environment

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

Land Acknowledgement

We would like to acknowledge the land that The Ohio State University occupies is the ancestral and contemporary territory of the Shawnee, Potawatomi, Delaware, Miami, Peoria, Seneca, Wyandotte, Ojibwe and Cherokee peoples. Specifically, the university resides on land ceded in the 1795 Treaty of Greeneville and the forced removal of tribes through the Indian Removal Act of 1830. I/We want to honor the resiliency of these tribal nations and recognize the historical contexts that has and continues to affect the Indigenous peoples of this land.

More information on OSU's land acknowledgement can be found at https://mcc.osu.edu/about-us/land-acknowledgement

Your mental health

As a student you may experience a range of issues that can cause barriers to learn, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

ACCESSIBILITY ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Requesting accommodations

The university strives to make all learning experiences as accessible as possible. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. **SLDS contact information:** slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

Accessibility of course technology

This course requires use of CarmenCanvas (Ohio State's learning management system) and other communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- Canvas accessibility (go.osu.edu/canvas-accessibility)
- Streaming audio and video
- CarmenZoom accessibility (go.osu.edu/zoom-accessibility)
- Collaborative course tools

STAT 7302: Advanced Statistical Theory II

Spring 2020

Instructor: **Xinyi Xu**
Office: 440G Cockins Hall
Email: xu.214@osu.edu
Office Hours: Monday 3-4pm, or by appointment

Grader: **Prateek Sasan**
Email: sasan.1@buckeyemail.osu.edu

Lecture Hours: MWF 9:10-10:05am, Journalism Bldg 295

Prerequisites: Statistics 7201 and 7301

Course Description:

STAT 7302 is the second course of a two-semester sequence on Advanced Statistical Theory. The sequence is intended primarily for PhD students in Statistics or Biostatistics. The first half of the course will follow Chapters 3 and 4 of the textbook "Testing Statistical Hypotheses", and the second half will consist of introductions to various recent developments of hypothesis testing. Core topics covered in this course include: the Neyman-Pearson lemma, uniformly most powerful tests, monotone likelihood ratio models, confidence bounds, unbiased tests, asymptotic theory of the tests, an introduction to the bootstrap and Bayesian hypothesis testing.

Text: *Testing Statistical Hypotheses*, 3rd Edition, by E.L. Lehmann and J.P. Romano

Additional References:

1) *Mathematical Statistics*, Second Edition, Peter J. Bickel and Kjell A. Doksum
2) *An Introduction to the Bootstraps*, by B. Efron and R. Tibshirani
3) *Elements of Large-Sample Theory*, by E.L. Lehmann

Website: https://carmen.osu.edu

Important announcement and homework assignments will be posted here.

Grading:

Homework	40%
Midterm	30%
Final project and presentation	30%

Homework: Homework will be collected approximately bi-weekly in the first half of the semester. Students are encouraged to work together on the problems, but each student must hand in his or her own work.

Midterm: There will be an in class, closed-book, closed-notes midterm exam, which focuses on the materials from Chapters 3 and 4 in "*Testing Statistical Hypotheses*" and asymptotic hypothesis tests. The tentative date of the midterm is April 6, Monday.

Final project and presentation: In the second half of the semester, each student is expected to choose a topic related with hypothesis testing, to read research papers and to even perform some simple analysis. At the end of the course, each student is expected to submit a written project report and make an oral presentation. Further details on the project will be given in class.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/ .

Special Accommodations: Students with disabilities (including mental health, chronic or temporary medical conditions) that have been certified by the Office of Student Life Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office of Student Life Disability Services is located in 098 Baker Hall, 113 W. 12th Avenue; telephone 614-292-3307, **slds@osu.edu**; **slds.osu.edu**.

Tentative weekly schedule*

Week	Topic
1	The structures of non-randomized tests and randomized tests
2	Neyman-Pearson lemma and most powerful tests
3	Monotone likelihood ratio distributions and UMP tests
4	p-values
5	Confidence bounds
6	Least favorable distributions and two-sided hypothesis tests
7	Unbiased tests, similarity and completeness
8	UMP unbiased tests
9	Asymptotic hypothesis tests
10	Asymptotic hypothesis tests, bootstrap
11	Bootstrap
12	Bayesian hypothesis tests
13	Final project presentations
14	Final project presentations

*: This is just a tentative schedule; the actual materials covered in each lecture might not be exactly the same

No class: January 20 (MLK) and March 9-13 (spring break)