ECON 7800: Econometrics I

University of Utah - Department of Economics
Spring 2021

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Office Hours: By appointment

Location: Zoom
Time: Tuesday and Thursday 9:10-10:30 a.m.
Credit Hours: 3

Course Description:
This course aims at introducing students to the theory of data analysis in social sciences. Students will be introduced to the philosophy of Bayesian inference and applied methods in Bayesian statistics with a focus on information theoretic interpretations.

Student Learning Outcomes: By the end of the course, students will have a firm understanding of the logic of inference and be able to construct useful analysis with data using modern Bayesian and information theoretic techniques. Students will have a working understanding of foundational concepts such as exchangeability, priors, and posterior probabilities and be equipped with an understanding of methods of theory and model comparison using the maximum entropy principle of inference. Depending on time and interest we may also cover special topics such as frequency domain analysis, mixture models, and statistical equilibrium models. Emphasis will be placed on students leaving this course with a command over Markov Chain Monte Carlo (MCMC) methods for posterior inference.

Assignments: Students will be required to complete several written assignments as well as a final exam.

Teaching and Learning Methods:
This course is an interactive virtual classroom (IVC) based course. All lectures will be live and recorded.
Attendance: Attendance is required for this course. If for any reason you cannot attend a lecture please contact me ahead of time.

Grading Policy: Assignments (60%), Midterm (15%), Final (25%)

Scale	Score
A	93-100
A-	90-92
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
E	0-59

Important Dates:

Martin Luther King Jr. Day holiday	January 20
Presidents' Day holiday	February 17
Spring Break	March 9-13

Main References: This is a list of various interesting and useful books that will be touched on during the course. All books can be found at http://used.addall.com/.

Required (*)

Probability Theory

- *E. T. Jaynes, *Probability Theory, The Logic of Science*, Cambridge University Press, 2003.
- A. Zellner, *An Introduction to Bayesian Inference in Econometrics*, Wiley, 1971.
- J. M. Bernardo and A. F. M. Smith, *Bayesian Theory*, Wiley, 2000.
- D. S. Sivia and J. Skilling, *Data Analysis: A Bayesian Tutorial*, Oxford University Press, 2006.
- M. H. DeGroot and M. J. Schervish, *Probability and Statistics*, Pearson, 4th Ed. 2012.

Bayesian Statistics

- *A. Gelman, J. Carlin, H. Stern, D. Dunson, A. Vehtari, and D. Rubin, *Bayesian Data Analysis.*, Chapman & Hall/CRC Texts in Statistical Science; 3rd ed. 2013.
- A. Gelman, J. Hill, *Data Analysis Using Regression and Multilevel/Hierarchical Models*, Cambridge University Press, 2007.
- J. K. Kruschke *Doing Bayesian Data Analysis: A Tutorial with R, JAGS, and Stan*, Elsevier; 2nd ed. 2015.

Information Theory

- *D. MacKay, *Information Theory, Inference, and Learning Algorithms*, Cambridge University Press, 2003. (Available at http://www.inference.phy.cam.ac.uk/itila/book.html)
- A. Golan *Foundations of Info-Metrics*, Oxford University Press, 2018.

Philosophy of Probability

- F. Ramsey, *The Foundations of Mathematics and Other Logical Essays*, Martino Fine Books, 2013.
- J. M. Keynes, *A Treatise on Probability: The Connection Between Philosophy and the History of Science*, Wildside Press, 2010.
- L. J. Savage, *The Foundations of Statistics*, Dover, 1972.
- H. Jeffreys, *Theory of Probability*, Oxford Classic Texts in the Physical Sciences, 1998.
- B. D. Finetti, *Theory of Probability. A Critical Introductory Treatment*, John Wiley & Sons Ltd.; Vol. 1 and 2, 1974 and 1975.
- R. Von Mises, *Probability, Statistics and Truth*, Dover, 1982.

Useful Resources:

- R - http://www.r-project.org
- RStudio - http://www.rstudio.com
- RStan - http://mc-stan.org/rstan.html
- Essays by E.T. Jaynes - http://bayes.wustl.edu/etj/node1.html

Tentative Course Outline:
Required readings (*)

1. *The Statistical Problem and Laws of Probability*
   Readings:
   - *E.T. Jaynes (2003) Preface and Ch. 1-2.
   - *E. T. Jaynes, "Bayesian Methods: General Background: An Introductory Tutorial," in *Maximum Entropy and Bayesian Methods in Applied Statistics*, J. H. Justice, (ed.), Cambridge University Press. 1985.
   - D. S. Sivia and J. Skilling, *Data Analysis: A Bayesian Tutorial*, Oxford University Press, 2006. Ch.1.
   - C. Sims, "Understanding Non-Bayesians," withheld chapter from Oxford University Press Handbook of Bayesian Econometrics.
   - M. H. DeGroot and M. J. Schervish (2012) Ch. 1-3.
   - A. Gelman et al. (2013) Ch. 1
2. *Bernoulli Trials and the Multinomial Model*
   Readings:
   - *E.T. Jaynes (2003) Preface and Ch. 3.
   - *A. Gelman et al. (2013) Ch. 2.
   - D. S. Sivia and J. Skilling, *Data Analysis: A Bayesian Tutorial*, Oxford University Press, 2006. Ch.2.
3. *Probabilities and Information*
   Readings:
   - *A. Golan (2018) *Foundations of Info-Metrics* Ch. 1-4.
   - *E. T. Jaynes (1978). "Where do we stand on maximum entropy?" pp. 1-74.
   - C. E. Shannon (1948). "A Mathematical Theory of Communication," Bell System Technical Journal.
   - R. Niven (2007) "Combinatorial Information Theory: Philosophical Basis of Cross-Entropy and Entropy," https://arxiv.org/abs/cond-mat/0512017v5.
4. *Data Compression*
   Readings:
   - *D. MacKay (2003) *Information Theory, Inference, and Learning Algorithms* Ch.1-5.
   - *C. Sims, "Macroeconomics and Methodology," *The Journal of Economic Perspectives*, 10, 1, 1996.

- P. Gründwald (2017) *The Minimum Description Length Principle* Ch.1.
- R. Stine (2004) "Model Selection Using Information Theory and the MDL Principle," *Sociological Methods and Research* 33(2).

5. *Frequency Model of Probability*
Readings:

- *E. T. Jaynes (2003) *Probability Theory, The Logic of Science*, Ch. 9,16.
- R.T. Cox (1946) "Probability, Frequency, and Reasonable Expectation." *American Journal of Physics* 14(1).
- R. von Mises (1957) *Probability, Statistics, and Truth.* Dover. Lectures 1-2.
- E.T. Jaynes, "Foundations of Probability Theory and Statistical Mechanics," in *Delaware Seminar in the Foundations of Physics*, M. Bunge (ed.), Springer-Verlag, 1967.

6. *Inference for the Normal Distribution*
Readings:

- *E. T. Jaynes (2003) *Probability Theory, The Logic of Science*, Ch. 7.
- A. Zellner, *An Introduction to Bayesian Inference in Econometrics*, Wiley, 1971.
- Bernardo and Smith (2000) Ch. 4: Modelling.

7. *Markov Chain Monte Carlo*
Readings:

- R. Neal (2011). MCMC using Hamiltonian dynamics, *Handbook of Markov Chain Monte Carlo*, ed. S. Brooks, A. Gelman, G. Jones, and X. Meng.
- S. Chib and E. Greenberg (1995). Understanding the Metropolis-Hastings Algorithm, *American Statistical Association*, 49(4).
- G. Casella and E. George (1992). Explaining the Gibbs Sampler, *The American Statistician*, 46(3).
- J. K. Kruschke (2015) Ch. 7: MCMC Methods, Ch. 9: Stan.
- C. P. Robert and G. Casella (2010) Ch. 2,3,6,7.
- A. Gelman et al. (2013) Part 3: Advanced Computation.

8. *Error Models*
Readings:

- *A. Zellner (1971) *An Introduction to Bayesian Inference in Econometrics*, Ch. 3-4.
- *A. Gelman et al. (2013) Ch. 3-4.
- J. Geweke (1993). "Bayesian Treatment of the Independent Student-t Linear Model, *Journal of Applied Econometrics*, 8.

9. *Hierarchical Models*
Readings:

- *A. Gelman and J. Hill (2007) Ch. 11, 12.
- *A. Gelman et al. (2013) Ch. 5: Hierarchical Models.
- J. Kruschke (2015) Ch. 9.

10. *Model Checking*
Readings:

- *A. Golan (2018) *Foundations of Info-Metrics* Ch. 10.
- *E. Soofi (2002) "Information indices: unification and applications," *Journal of Econometrics*, 107.
- *A. Gelman et al. (2013) Ch. 6-7.
- S. Chib (1995) "Marginal Likelihood from the Gibbs Output," *Journal of the American Statistical Association*, 90 (432).
- D. S. Sivia and J. Skilling (2006) Ch. 4: Model Selection

11. *Mixture Models*
Readings:

- *A. Gelman et al. (2013) Ch. 12: Finite Mixture Models
- G. J. McLachlan, S. X. Lee, and S. I. Rathnayake (2019) "Finite mixture models," *Annual review of statistics and its application*, 6, pp. 355–378

Note: This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.

Academic Honesty:

"The term plagiarism includes, but is not limited to: (i) use by paraphrase or direct quotation of the published or unpublished work of another person without fully and properly crediting the author with footnotes, citations or bibliographical reference; (ii) unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic materials; or (iii) unacknowledged use of original work/material that has been produced through collaboration with others without release in writing from collaborators."

There are many types of plagiarism, all are serious offenses and will be treated according to the University of Missouri Rules and Procedures of Student Conduct Matters. Using another author's or researcher's work without attribution is plagiarism. Rewriting another author's or researcher's work (changing words or word order) while retaining the structure and ideas of the work is plagiarism. Submitting your own work from other courses without permission is plagiarism. Sloppy citations, such as missing quotations marks even when a footnote appears, are plagiarism. Any incidents of plagiarism will result in a grade of zero for the assignment. All essays and assignments must be written in your own words with proper citations.

See the The Code of Student Rights and Responsibilities at https://regulations.utah.edu/academics/6-400.php for more details.

University Policies:

1. The Americans with Disabilities Act. The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services. [The Addressing Sexual Misconduct Statement is strongly suggested on every course syllabus. According to University policy, at minimum instructors must include the contact information of the Title IX Coordinator.]

2. Addressing Sexual Misconduct. Title IX makes it clear that violence and harassment based on sex and gender (which Includes sexual orientation and gender identity/expression) is a civil rights offense

subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).

3. All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is faculty responsibility to enforce responsible classroom behaviors, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.