

Bayesian Measurement Models

MIT | 17.S950 | Spring 2022 | Monday 3:00–5:00 | [E53-485](#)
Course site: <https://canvas.mit.edu/courses/12948>

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Course Description

This course covers quantitative measurement from a Bayesian perspective. It focuses on the specification of measurement models linking observed data (i.e., manifest indicators) to unobserved constructs (i.e., latent variables) of interest. For estimation of these models, we will rely on the probabilistic programming language `Stan`, as called from `R`, though we will occasionally touch on other `R`-based methods. The goal is to get students comfortable specifying and estimating “bespoke” measurement models tailored for particular applications. The course applies this basic framework to a large range of problems and topics, including hierarchical models, factor analysis, item response theory, latent class analysis, ecological inference, network data, and text analysis. Each is covered only in enough depth to provide a sense of what a Bayesian approach to the problem might look like. The course assumes a solid grasp of generalized linear models and the theory of likelihood and Bayesian inference, so successful completion of 17.804 (Quantitative Research Methods III) or its equivalent is a prerequisite for enrollment.

Required Texts

- Simon Jackman. 2009. *Bayesian Analysis for the Social Sciences*. Hoboken, NJ: Wiley (available as PDF)
- Julia Silge and David Robinson. 2017. *Text Mining with R: A Tidy Approach*. O’Reilly. <https://www.tidytextmining.com> (available online)
- Benjamin E. Lauderdale. 2021. “Pragmatic Social Measurement.” Unpublished book manuscript, September 1, 2021 (available as PDF)
- Stan Development Team. 2021. *Stan User’s Guide*. V. 2.28, November 22, 2021. <https://mc-stan.org/docs/2.28/stan-users-guide/>

Suggested Texts

- Anders Skrondal and Sophia Rabe-Hesketh. 2004. *Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models*. Boca Raton, FL: CRC Press
- Andrew Gelman et al. 2014. *Bayesian Data Analysis*. 3rd ed. Boca Raton, FL: CRC Press
- David J. Hand. 2016. *Measurement: A Very Short Introduction*. Oxford University Press

Assignments

Grades in this class will be based on three components:

- **Article presentation and general class participation (10%):** In addition to participating productively in class discussions throughout the term, each student is expected to give one presentation summarizing an applied paper and relating it to the topics of that session.
- **Homework exercises (45%):** Students are expected to complete 9 weekly homework exercises, each worth 5% of their course grade. The primary focus of these assignments will be using R and Stan to implement measurement models and then interpreting and assessing the results.
- **Research paper (45%):** The capstone assignment of this course is a research project that employs methods covered in the class. Co-authoring is permitted but not required. The project involves several components due at the following times:
 - **Session 5:** Submit project idea(s), having identified potential data sources and perhaps performed some exploratory analysis (5% of course grade).
 - **Session 8:** With any coauthors, submit brief description of proposed project, including a descriptive analysis of the dataset (summary statistics, plots, etc.) and an explanation of the concepts you propose to measure and the methods you anticipate using to do so (5% of course grade).
 - **Session 11, 12, or 13:** Give a short conference-style presentation of your project to the class (10% of course grade).
 - **One week after Session 13:** Submit final paper, revised to incorporate feedback from presentations (25% of course grade).

Semester Overview

1 January 31: Introduction

2 February 7: Hierarchical Models

→ *Before class:* Install Stan, rstan, and brms

3 February 14: Latent Variables and Response Processes

→ *Due:* Problem set #1

4 February 22: Scale Measurement with Metrical Data

→ *Due:* Problem set #2

5 February 28: Scale Measurement with Ordinal Data

→ *Due:* Problem set #3

→ *Due:* Research proposal idea

6 March 7: Dimension Selection and Joint Scaling

→ *Due:* Problem set #4

7 March 14: Hierarchical & Dynamic Measurement Models

→ *Due:* Problem set #5

March 21: NO CLASS (Spring Break)

8 March 28: Class Measurement and Mixture Models

→ *Due:* Descriptive analysis of research project

9 April 4: Ecological Inference

→ *Due:* Problem set #6

10 April 11: Network Analysis

→ *Due:* Problem set #7

April 18: NO CLASS (Patriots Day)

11 April 25: Analysis of Mismeasured Data

→ *Due:* Problem set #8

→ *In class:* Project presentations

12 May 2: Supervised Text Analysis

→ *Due:* Problem set #9

→ *In class:* Project presentations

13 May 9: Unsupervised Text Analysis

→ *In class:* Project presentations

May 16: NO CLASS

→ *Due:* Final paper

Course Schedule

1 January 31: Introduction

Topics

- representational vs. pragmatic measurement
- latent and manifest variables
- validity and reliability
- consequences of mismeasurement
- measurement from a Bayesian perspective
- Stan

Required Readings

Theory

- [PDF](#) Lauderdale, *Pragmatic Social Measurement*, **13–102 (chap. 1–6)**
- [PDF](#) Abigail Z. Jacobs and Hanna Wallach. 2021. “Measurement and Fairness.” In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency (FAccT ’21)*, 375–385, Virtual Event, Canada, March 3–10, 2021. New York: ACM. <https://doi.org/10.1145/3442188.3445901>

Implementation

- [WEB](#) <https://github.com/stan-dev/rstan/wiki/RStan-Getting-Started>

Application

- [PDF](#) Stephen Ansolabehere, Jonathan Rodden, and James M. Snyder Jr. 2008. “The Strength of Issues: Using Multiple Measures to Gauge Preference Stability, Ideological Constraint, and Issue Voting.” *American Political Science Review* 102 (2): 215–232

Suggested Readings

- Robert Adcock and David Collier. 2001. “Measurement Validity: A Shared Standard for Qualitative and Quantitative Research.” *American Political Science Review* 95 (3): 529–546

- Anders Skrondal and Sophia Rabe-Hesketh. 2007. “Latent Variable Modelling: A Survey.” *Scandinavian Journal of Statistics* 34 (4): 712–745
- Simon Jackman. 2008. “Measurement.” Chap. 6 in *The Oxford Handbook of Political Methodology*, edited by Janet M. Box-Steffensmeier, Henry E. Brady, and David Collier, 119–152. Oxford University Press
- Jackman, *Bayesian Analysis for the Social Sciences*, chap. 1–2
- David J. Hand. 2016. *Measurement: A Very Short Introduction*. Oxford University Press
- Gelman et al., *Bayesian Data Analysis*, 1–100 (chap. 1–4)

2 February 7: Hierarchical Models

Assignment Due

→ *Before class*: Install Stan, **rstan**, and **brms**

Topics

- Regression as measurement method
- Bias-variance trade-off
- Pooling/shrinkage
- Random effects as latent variables
- Design-based vs. model-based population inference
- Multilevel modeling and poststratification
- Posterior predictive sampling

Required Readings

Theory

- [PDF](#) Lauderdale, *Pragmatic Social Measurement*, chap. 8
- [PDF](#) Jackman, *Bayesian Analysis for the Social Sciences*, 301–378 (chap. 7: “Hierarchical Statistical Models”)
 - Focus on theory, not software implementation.

Implementation

- [WEB] Michael Betancourt. 2020. “An Introduction to Stan,” March. https://betanalpha.github.io/assets/case_studies/stan_intro
- [WEB] *Stan User’s Guide*, sec. 26 (“Posterior Predictive Sampling”) and 30 (“Post-stratification”)

Application

- [PDF] Andrew Gelman. 2014. “How Bayesian Analysis Cracked the Red-State, Blue-State Problem.” *Statistical Science* 29 (1): 26–35

Suggested Readings

- Bob Carpenter et al. 2017. “Stan: A Probabilistic Programming Language.” *Journal of Statistical Software* 76 (1): 1–32. <https://doi.org/10.18637/jss.v076.i01>
- Paul-Christian Bürkner. 2017. “brms: An R Package for Bayesian Multilevel Models Using Stan.” *Journal of Statistical Software* 80 (1): 26–35. <https://doi.org/10.18637/jss.v080.i01>
- Michael Betancourt. 2018. “A Conceptual Introduction to Hamiltonian Monte Carlo.” *arXiv e-prints* (July 16, 2018): 1–60. arXiv: 1701.02434 [stat.ME]
- <https://planscore.campaignlegal.org/models/data/2021D/>
- Andrew Gelman and Gary King. 1994. “A Unified Method of Evaluating Electoral Systems and Redistricting Plans.” *American Journal of Political Science* 38 (2): 514–555
- Jeffrey R. Lax and Justin H. Phillips. 2009. “How Should We Estimate Public Opinion in the States?” *American Journal of Political Science* 53 (1): 107–121
- Yair Ghitza and Andrew Gelman. 2013. “Deep Interactions with MRP: Election Turnout and Voting Patterns Among Small Electoral Subgroups.” *American Journal of Political Science* 57 (3): 762–776
- Daniel Stegmüller. 2013. “How Many Countries for Multilevel Modeling? A Comparison of Frequentist and Bayesian Approaches.” *American Journal of Political Science* 57 (3): 748–761
- Gelman et al., *Bayesian Data Analysis*, chap. 5 and 15
- Devin Caughey et al. 2020. *Target Estimation and Adjustment Weighting for Survey Nonresponse and Sampling Bias*. Elements in Quantitative and Computational

Methods for the Social Sciences. Cambridge, UK: Cambridge University Press. <https://doi.org/10.1017/9781108879217>

3 February 14: Latent Variables and Response Processes

Assignment Due

→ *Due*: Problem set #1

Topics

- Latent response formulation of GLMs
- Stochastic utility model
- Comparison data (Bradley–Terry)
- Inference over auxiliary quantities (ranks, etc.)

Required Readings

Theory

- Jackman, *Bayesian Analysis for the Social Sciences*, 379–434 (chap. 8: “Bayesian Analysis of Choice Making”)
 - Focus on theory, not implementation.
- Lauderdale, *Pragmatic Social Measurement*, chap. 7

Implementation

- <https://github.com/stan-dev/example-models/blob/master/knitr/bradley-terry/bradley-terry.pdf>

Application

- Cesar Zucco, Mariana Batista, and Timothy J. Power. 2019. “Measuring Portfolio Salience Using the Bradley–Terry Model: An Illustration with Data from Brazil.” *Research & Politics* 6 (1): 1–8. <https://doi.org/10.1177/2053168019832089>

Suggested Readings

- Skrondal and Rabe-Hesketh, *Generalized Latent Variable Modeling*, 21–48 (chap. 2)

- Peter John Loewen, Daniel Rubenson, and Arthur Spirling. 2012. “Testing the Power of Arguments in Referendums: A Bradley–Terry Approach.” *Electoral Studies* 31 (1): 212–221

4 February 22: Scale Measurement with Metrical Data

Assignment Due

→ *Due*: Problem set #2

Topics

- Factor analysis and PCA
- Identification of one-dimensional models
- Missing data

Theory

- Lauderdale, *Pragmatic Social Measurement*, chap. 11
- Jackman, *Bayesian Analysis for the Social Sciences*, 435–54 (part of chap. 9)
- Christopher M. Bishop. 2006. *Pattern Recognition and Machine Learning*. Springer, 559–86 (most of chap. 12)

Implementation

- <https://www.jamesuanhoro.com/post/2018/11/28/multidimensional-cfa-with-rstan/>

Application

- Jennifer Pan and Yiqing Xu. 2018. “China’s Ideological Spectrum.” *Journal of Politics* 80 (1): 254–273

Suggested Readings

- Julia Gray and Jonathan B. Slapin. 2012. “How Effective Are Preferential Trade Agreements? Ask the Experts.” *Review of International Organizations* 7 (3): 309–333
- Jennifer L. Selin. 2015. “What Makes an Agency Independent?” *American Journal of Political Science* 59 (4): 971–987

5 February 28: Scale Measurement with Ordinal Data

Assignments Due

- *Due*: Problem set #3
- *Due*: Research proposal idea

Topics

- Item response theory
- Spatial models of choice
- identification of multidimensional models (QR/whitening)

Required Readings

Theory

- Lauderdale, *Pragmatic Social Measurement*, chap. 12
- Joshua Clinton, Simon Jackman, and Douglas Rivers. 2004. “The Statistical Analysis of Roll Call Data.” *American Political Science Review* 98 (2): 355–370
- Kevin M. Quinn. 2004a. “Bayesian Factor Analysis for Mixed Ordinal and Continuous Responses.” *Political Analysis* 12 (4): 338–353

Implementation

- Paul-Christian Bürkner. 2021. “Bayesian Item Response Modeling in R with brms and Stan.” *Journal of Statistical Software* 100 (5): 1–54. <https://doi.org/10.18637/jss.v100.i05>

Application

- Tsung-han Tsai and Chang-chih Lin. 2017. “Modeling Guessing Components in the Measurement of Political Knowledge.” *Political Analysis* 25 (4): 483–504

Suggested Readings

- Fox, *Bayesian Item Response Modeling*, 1–20 (most of chap. 1)
- Douglas Rivers. 2003. “Identification of Multidimensional Spatial Voting Models.” Unpublished manuscript

- Daniel E. Ho and Kevin M. Quinn. 2008. “Improving the Presentation and Interpretation of Online Ratings Data with Model-Based Figures.” *The American Statistician* 62 (4): 279–288
- Royce Carroll et al. 2009. “Comparing NOMINATE and IDEAL: Points of Difference and Monte Carlo Tests.” *Legislative Studies Quarterly* 34 (4): 555–591
- Jean-Paul Fox. 2010. *Bayesian Item Response Modeling: Theory and Applications*. Springer
- Adam Bonica. 2013. “Ideology and Interests in the Political Marketplace.” *American Journal of Political Science* 57 (2): 294–311
- Devin Caughey, Hiroto Katsumata, and Teppei Yamamoto. 2019. “Item Response Theory for Conjoint Survey Experiments.” Unpublished working paper, June 29, 2019
- Scott J. LaCombe. 2021. “Measuring Institutional Design in U.S. States.” *Social Science Quarterly* 102 (4): 1511–1533
- https://www.robertkubinec.com/post/stancon2018_paper/
- https://mc-stan.org/users/documentation/case-studies/pcm_and_gpcm.html

6 March 7: Dimension Selection and Joint Scaling

→ *Due*: Problem set #4

Topics

- bridging across time, countries, institutions, indicators, etc.
- dimension selection

Required Readings

Theory

- Gary King et al. 2004. “Enhancing the Validity and Cross-Cultural Comparability of Measurement in Survey Research.” *American Political Science Review* 98 (1): 191–207
- William Marble and Matthew Tyler. 2021. “The Structure of Political Choices: Distinguishing Between Constraint and Multidimensionality.” Pre-published, *Political Analysis*, <https://doi.org/10.1017/pan.2021.3>

Implementation

- Jørgen Bølstad. 2020. “Capturing Rationalization Bias and Differential Item Functioning: A Unified Bayesian Scaling Approach.” *Political Analysis* 28 (3): 340–355

Application

- Stephen A. Jessee. 2016. “(How) Can We Estimate the Ideology of Citizens and Political Elites on the Same Scale?” *American Journal of Political Science* 60 (4): 1108–1124

Suggested Readings

- Joseph Bafumi and Michael C. Herron. 2010. “Leapfrog Representation and Extremism: A Study of American Voters and Their Members in Congress.” *American Political Science Review* 104 (3): 519–542
- Christopher Hare et al. 2015. “Using Bayesian Aldrich-McKelvey Scaling to Study Citizens’ Ideological Preferences and Perceptions.” *American Journal of Political Science* 59 (3): 759–774
- Jeffrey B. Lewis and Chris Tausanovitch. 2015. “When Does Joint Scaling Allow for Direct Comparisons of Preferences?” Paper presented at the Conference on Ideal Point Models, Massachusetts Institute of Technology, Cambridge, MA, May 1, 2015. <http://idealpoint.tahk.us/papers/lewisTausanovitch.pdf>
- David A. Bateman, Joshua D. Clinton, and John S. Lapinski. 2016. “A House Divided? Roll Calls, Polarization, and Policy Differences in the U.S. House, 1877–2011.” *American Journal of Political Science* 61 (3): 698–714
- Adam Bonica. 2018. “Inferring Roll-Call Scores from Campaign Contributions Using Supervised Machine Learning.” *American Journal of Political Science* 62 (4): 830–848
- Frederico Batista Pereira. 2020. “Assessing Political Knowledge Scales Across Countries: Evidence from Latin America.” *Revista Latinoamericana de Opinión Pública* 9, no. 1 (37-62)
- Ryan Bakker, Seth Jolly, and Jonathan Polk. 2020. “Analyzing the Cross-National Comparability of Party Positions on the Socio-Cultural and EU Dimensions in Europe.” Pre-published, *Political Science Research and Methods*, <https://doi.org/10.1017/psrm.2020.26>

7 March 14: Hierarchical & Dynamic Measurement Models

→ *Due:* Problem set #5

Topics

- Hierarchical measurement models
- Dynamic linear models
- Forecasting

Theory

- Jackman, *Bayesian Analysis for the Social Sciences*, 471–488
- Devin Caughey and Christopher Warshaw. 2015. “Dynamic Estimation of Latent Opinion Using a Hierarchical Group-Level IRT Model.” *Political Analysis* 23 (2): 197–211. <http://dx.doi.org/10.1093/pan/mpu021>

Implementation

- <https://fate-ewi.github.io/bayesdfa/>

Application

- Drew A. Linzer. 2013. “Dynamic Bayesian Forecasting of Presidential Elections in the States.” *Journal of the American Statistical Association* 108 (501): 124–134

Suggested Readings

- Andrew D. Martin and Kevin M. Quinn. 2002. “Dynamic Ideal Point Estimation via Markov Chain Monte Carlo for the U.S. Supreme Court, 1953–1999.” *Political Analysis* 10 (2): 134–153
- Andrew D. Martin and Kevin M. Quinn. 2007. “Assessing Preference Change on the US Supreme Court.” *Journal of Law, Economics, and Organization* 23, no. 2 (June): 365–385
- Devin Caughey, Tom O’Grady, and Christopher Warshaw. 2019. “Policy Ideology in European Mass Publics, 1981–2016.” *American Political Science Review* 113 (3): 674–693. <https://doi.org/10.1017/S0003055419000157>

March 21: NO CLASS (Spring Break)

8 March 28: Class Measurement and Mixture Models

→ *Due:* Descriptive analysis of research project

Topics

- Gaussian mixture models
- Latent class models

Required Readings

Theory

- Lauderdale, *Pragmatic Social Measurement*, chap. 10 and 13

Implementation

- <https://mc-stan.org/users/documentation/case-studies/bball-hmm.html>

Application

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Suggested Readings

- https://mc-stan.org/users/documentation/case-studies/Latent_class_case_study.html#variational-bayes-vb
- Jong Hee Park. 2012. “A Unified Method for Dynamic and Cross-Sectional Heterogeneity: Introducing Hidden Markov Panel Models.” *American Journal of Political Science* 56 (4): 1040–1054

9 April 4: Ecological Inference

→ *Due:* Problem set #6

Topics

- The ecological fallacy and modifiable areal unit problem
- Hierarchical and dynamic ecological inference

- Combining individual-level and aggregate data
- Dirichlet and logistic-normal models

Theory

- Wendy Tam Cho and Charles F. Manski. 2008. “Cross-Level/Ecological Inference.” In *The Oxford Handbook of Political Methodology*, edited by Janet M. Box-Steffensmeier, Henry E. Brady, and David Collier. Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199286546.003.0024>
- Ori Rosen et al. 2001. “Bayesian and Frequentist Inference for Ecological Inference: The $R \times C$ Case.” *Statistica Neerlandica* 55 (2): 134–156
- Kevin M. Quinn. 2004b. “Ecological Inference in the Presence of Temporal Dependence.” Chap. 9 in *Ecological Inference: New Methodological Strategies*, edited by Gary King, Ori Rosen, and Martin A. Tanner, 207–233. New York: Cambridge University Press
- Adam N. Glynn and Jon Wakefield. 2010. “Ecological Inference in the Social Sciences.” *Statistical Methodology* 7 (3): 307–322

Implementation

- Devin Caughey and Mallory Wang. 2019. “Dynamic Ecological Inference for Time-Varying Population Distributions Based on Sparse, Irregular, and Noisy Marginal Data.” *Political Analysis* 27 (3): 388–396. <https://doi.org/10.1017/pan.2019.4>

Application

- J. Kevin Corder and Christina Wolbrecht. 2006. “Political Context and the Turnout of New Women Voters after Suffrage.” *Journal of Politics* 68 (1): 34–49

Suggested Readings

- Gary King. 1997. *A Solution to the Ecological Inference Problem*. Princeton, NJ: Princeton University Press
- David A. Freedman. 2001. “Ecological Inference and the Ecological Fallacy.” In *International Encyclopaedia of the Social and Behavioural Sciences*, edited by N. J. Smelser and P. B. Baltes, 6:4027–4030. New York: Elsevier
- Wendy K. Tam Cho and Brian J. Gaines. 2003. “The Limits of Ecological Inference: The Case of Split-Ticket Voting.” *American Journal of Political Science* 48 (1): 152–171

- Gary King, Ori Rosen, and Martin A. Tanner, eds. 2004. *Ecological Inference: New Methodological Strategies*. New York: Cambridge University Press
- Jon Wakefield. 2004. “Ecological Inference for 2×2 Tables.” *Journal of the Royal Statistical Society. Series A (General)* 167 (3): 385–445
- D. James Greiner. 2007. “Ecological Inference in Voting Rights Act Disputes: Where Are We Now, and Where Do We Want to Be.” *Jurimetrics* 47 (Winter): 115–167
- Adam N. Glynn and Jon Wakefield. 2014. “Alleviating Ecological Bias in Poisson Models Using Optimal Subsampling.” *Sociological Methodology* 44 (1): 159–184
- D. James Greiner and Kevin M. Quinn. 2010. “Exit Polling and Racial Bloc Voting: Combining Individual-Level and $R \times C$ Ecological Data.” *Annals of Applied Statistics* 4 (4): 1774–1796

10 April 11: Network Analysis

→ *Due*: Problem set #7

Topics

- Exponential random graph models (ERGMs)
- Latent-space models
- Additive and multiplicative effects network (AMEN) models
- Latent variables as nuisance parameters vs. quantities of interest

Theory

- Skyler J. Cranmer et al. 2017. “Navigating the Range of Statistical Tools for Inferential Network Analysis.” *American Journal of Political Science* 61 (1): 237–251
- Peter Hoff. 2021. “Additive and Multiplicative Effects Network Models.” *Statistical Science* 36 (1): 34–50
- Jean-Gabriel Young, George T. Cantwell, and M. E. J. Newman. 2021. “Bayesian Inference of Network Structure from Unreliable Data.” *Journal of Complex Networks* 8 (6): cnaa046

Implementation

- https://github.com/adamlauretig/AMEN_models_in_stan

- <https://github.com/jg-you/noisy-networks-measurements>

Application

- Cassy Dorff, Max Gallop, and Shahryar Minhas. 2020. “Networks of Violence: Predicting Conflict in Nigeria.” *Journal of Politics* 82 (2): 476–493

Suggested Readings

- Peter D. Hoff, Adrian E. Raftery, and Mark S. Handcock. 2002. “Latent Space Approaches to Social Network Analysis.” *Journal of the American Statistical Association* 97 (460): 1090–1098
- Matthew O. Jackson. 2008. *Social and Economic Networks*. Princeton University Press
- Skyler J. Cranmer and Bruce A. Desmarais. 2011. “Inferential Network Analysis with Exponential Random Graph Models.” *Political Analysis* 19 (1): 66–86
- Mark Newman. 2018. *Networks*. Oxford, UK: Oxford University Press. Oxford Scholarship Online, <https://doi.org/10.1093/oso/9780198805090.001.0001>
- Shahryar Minhas, Peter D. Hoff, and Michael D. Ward. 2019. “Inferential Approaches for Network Analysis: AMEN for Latent Factor Models.” *Political Analysis* 27 (2): 208–222

April 18: NO CLASS (Patriots Day)

11 April 25: Analysis of Mismeasured Data

→ *Due*: Problem set #8

→ *In class*: Project presentations

Required Readings

Theory

- Shawn Treier and Simon Jackman. 2008. “Democracy as a Latent Variable.” *American Journal of Political Science* 52 (1): 201–217. **Focus on appendix.**
- Matthew Blackwell, James Honaker, and Gary King. 2017b. “A Unified Approach to Measurement Error and Missing Data: Overview and Applications.” *Sociological Methods & Research* 46 (3): 303–341

- Dean Knox, Christopher Lucas, and Wendy K. Tam Cho. 2022. “Testing Causal Theories with Learned Proxies.” Pre-published, *Annual Review of Political Science* 25:1–23. <https://doi.org/10.1146/annurev-polisci-051120-111443>

Implementation

- <https://osf.io/preprints/socarxiv/rn9xk>

Application

- Christopher Claassen. 2020. “Does Public Support Help Democracy Survive?” *American Journal of Political Science* 64 (1): 118–134
- Yuehong Cassandra Tai, Hu Yue, and Frederick Solt. 2021. “Democracy, Public Support, and Measurement Uncertainty.” Unpublished working paper. https://github.com/fsolt/dcpo_dem_mood/raw/master/paper/dcpo_demsupport.pdf

Suggested Readings

- Martin A. Tanner. 1996. *Tools for Statistical Inference Methods for the Exploration of Posterior Distributions and Likelihood Functions*. 3rd ed. New York: Springer
- Jonathan P. Kastellec et al. 2015. “Polarizing the Electoral Connection: Partisan Representation in Supreme Court Confirmation Politics.” *Journal of Politics* 77 (3): 787–804
- Matthew Blackwell, James Honaker, and Gary King. 2017a. “A Unified Approach to Measurement Error and Missing Data: Details and Extensions.” *Sociological Methods & Research* 46 (3): 342–369
- Christian Fong and Justin Grimmer. 2021. “Causal Inference with Latent Treatments.” Pre-published, *American Journal of Political Science*, 1–16. <https://doi.org/10.1111/ajps.12649>

12 May 2: Supervised Text Analysis

→ *Due*: Problem set #9

→ *In class*: Project presentations

Topics

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Required Readings

Theory

- Justin Grimmer and Brandon M. Stewart. 2013. “Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts.” *Political Analysis* 21 (3): 267–297. **Read pp. 267–80.**

Implementation

- Silge and Robinson, *Text Mining with R*, , chap. 1–3 and 5.

Application

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Suggested Readings

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13 May 9: Unsupervised Text Analysis

→ *In class*: Project presentations

Topics

- Latent Dirichlet allocation (LDA) models
- Structural topic models
- Bayesian word embeddings

Required Readings

Theory

- *id.* **Read pages 280-295.**
- Margaret E. Roberts, Brandon M. Stewart, and Edoardo M. Airoldi. 2016. “A Model of Text for Experimentation in the Social Sciences.” *Journal of the American Statistical Association* 111 (515): 988–1003

Implementation

- Silge and Robinson, *Text Mining with R*, , chap. 6

Application

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Suggested Readings

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Suggested Readings

- <https://mc-stan.org/docs/2.28/stan-users-guide/latent-dirichlet-allocation.html>
- <https://arxiv.org/abs/1904.01628>

May 16: NO CLASS

→ *Due:* Final paper

This syllabus was last modified on February 23, 2022.

References

- Adcock, Robert, and David Collier. 2001. "Measurement Validity: A Shared Standard for Qualitative and Quantitative Research." *American Political Science Review* 95 (3): 529–546.
- Ansolabehere, Stephen, Jonathan Rodden, and James M. Snyder Jr. 2008. "The Strength of Issues: Using Multiple Measures to Gauge Preference Stability, Ideological Constraint, and Issue Voting." *American Political Science Review* 102 (2): 215–232.
- Bafumi, Joseph, and Michael C. Herron. 2010. "Leapfrog Representation and Extremism: A Study of American Voters and Their Members in Congress." *American Political Science Review* 104 (3): 519–542.
- Bakker, Ryan, Seth Jolly, and Jonathan Polk. 2020. "Analyzing the Cross-National Comparability of Party Positions on the Socio-Cultural and EU Dimensions in Europe." Pre-published, *Political Science Research and Methods*, <https://doi.org/10.1017/psrm.2020.26>.
- Bateman, David A., Joshua D. Clinton, and John S. Lapinski. 2016. "A House Divided? Roll Calls, Polarization, and Policy Differences in the U.S. House, 1877–2011." *American Journal of Political Science* 61 (3): 698–714.
- Betancourt, Michael. 2018. "A Conceptual Introduction to Hamiltonian Monte Carlo." *arXiv e-prints* (July 16, 2018): 1–60. arXiv: [1701.02434](https://arxiv.org/abs/1701.02434) [stat.ME].
- . 2020. "An Introduction to Stan," March. https://betanalpha.github.io/assets/case_studies/stan_intro.
- Bishop, Christopher M. 2006. *Pattern Recognition and Machine Learning*. Springer.
- Blackwell, Matthew, James Honaker, and Gary King. 2017a. "A Unified Approach to Measurement Error and Missing Data: Details and Extensions." *Sociological Methods & Research* 46 (3): 342–369.
- . 2017b. "A Unified Approach to Measurement Error and Missing Data: Overview and Applications." *Sociological Methods & Research* 46 (3): 303–341.
- Bølstad, Jørgen. 2020. "Capturing Rationalization Bias and Differential Item Functioning: A Unified Bayesian Scaling Approach." *Political Analysis* 28 (3): 340–355.
- Bonica, Adam. 2013. "Ideology and Interests in the Political Marketplace." *American Journal of Political Science* 57 (2): 294–311.
- . 2018. "Inferring Roll-Call Scores from Campaign Contributions Using Supervised Machine Learning." *American Journal of Political Science* 62 (4): 830–848.

- Bürkner, Paul-Christian. 2017. “brms: An R Package for Bayesian Multilevel Models Using Stan.” *Journal of Statistical Software* 80 (1): 26–35. <https://doi.org/10.18637/jss.v080.i01>.
- . 2021. “Bayesian Item Response Modeling in R with brms and Stan.” *Journal of Statistical Software* 100 (5): 1–54. <https://doi.org/10.18637/jss.v100.i05>.
- Carpenter, Bob, Andrew Gelman, Matthew D Hoffman, Daniel Lee, Ben Goodrich, Michael Betancourt, Marcus Brubaker, Jiqiang Guo, Peter Li, and Allen Riddell. 2017. “Stan: A Probabilistic Programming Language.” *Journal of Statistical Software* 76 (1): 1–32. <https://doi.org/10.18637/jss.v076.i01>.
- Carroll, Royce, Jeffrey B. Lewis, James Lo, Keith T. Poole, and Howard Rosenthal. 2009. “Comparing NOMINATE and IDEAL: Points of Difference and Monte Carlo Tests.” *Legislative Studies Quarterly* 34 (4): 555–591.
- Caughey, Devin, Adam J. Berinsky, Sara Chatfield, Erin Hartman, Eric Schickler, and Jasjeet J. Sekhon. 2020. *Target Estimation and Adjustment Weighting for Survey Nonresponse and Sampling Bias*. Elements in Quantitative and Computational Methods for the Social Sciences. Cambridge, UK: Cambridge University Press. <https://doi.org/10.1017/9781108879217>.
- Caughey, Devin, Hiroto Katsumata, and Teppei Yamamoto. 2019. “Item Response Theory for Conjoint Survey Experiments.” Unpublished working paper, June 29, 2019.
- Caughey, Devin, Tom O’Grady, and Christopher Warshaw. 2019. “Policy Ideology in European Mass Publics, 1981–2016.” *American Political Science Review* 113 (3): 674–693. <https://doi.org/10.1017/S0003055419000157>.
- Caughey, Devin, and Mallory Wang. 2019. “Dynamic Ecological Inference for Time-Varying Population Distributions Based on Sparse, Irregular, and Noisy Marginal Data.” *Political Analysis* 27 (3): 388–396. <https://doi.org/10.1017/pan.2019.4>.
- Caughey, Devin, and Christopher Warshaw. 2015. “Dynamic Estimation of Latent Opinion Using a Hierarchical Group-Level IRT Model.” *Political Analysis* 23 (2): 197–211. <http://dx.doi.org/10.1093/pan/mpu021>.
- Cho, Wendy K. Tam, and Brian J. Gaines. 2003. “The Limits of Ecological Inference: The Case of Split-Ticket Voting.” *American Journal of Political Science* 48 (1): 152–171.
- Cho, Wendy Tam, and Charles F. Manski. 2008. “Cross-Level/Ecological Inference.” In *The Oxford Handbook of Political Methodology*, edited by Janet M. Box-Steffensmeier, Henry E. Brady, and David Collier. Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199286546.003.0024>.

- Claassen, Christopher. 2020. "Does Public Support Help Democracy Survive?" *American Journal of Political Science* 64 (1): 118–134.
- Clinton, Joshua, Simon Jackman, and Douglas Rivers. 2004. "The Statistical Analysis of Roll Call Data." *American Political Science Review* 98 (2): 355–370.
- Corder, J. Kevin, and Christina Wolbrecht. 2006. "Political Context and the Turnout of New Women Voters after Suffrage." *Journal of Politics* 68 (1): 34–49.
- Cranmer, Skyler J., and Bruce A. Desmarais. 2011. "Inferential Network Analysis with Exponential Random Graph Models." *Political Analysis* 19 (1): 66–86.
- Cranmer, Skyler J., Philip Leifeld, Scott D. McClurg, and Meredith Rolfe. 2017. "Navigating the Range of Statistical Tools for Inferential Network Analysis." *American Journal of Political Science* 61 (1): 237–251.
- Dorff, Cassy, Max Gallop, and Shahryar Minhas. 2020. "Networks of Violence: Predicting Conflict in Nigeria." *Journal of Politics* 82 (2): 476–493.
- Fong, Christian, and Justin Grimmer. 2021. "Causal Inference with Latent Treatments." Pre-published, *American Journal of Political Science*, 1–16. <https://doi.org/10.1111/ajps.12649>.
- Fox, Jean-Paul. 2010. *Bayesian Item Response Modeling: Theory and Applications*. Springer.
- Freedman, David A. 2001. "Ecological Inference and the Ecological Fallacy." In *International Encyclopaedia of the Social and Behavioural Sciences*, edited by N. J. Smelser and P. B. Baltes, 6:4027–4030. New York: Elsevier.
- Gelman, Andrew. 2014. "How Bayesian Analysis Cracked the Red-State, Blue-State Problem." *Statistical Science* 29 (1): 26–35.
- Gelman, Andrew, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin. 2014. *Bayesian Data Analysis*. 3rd ed. Boca Raton, FL: CRC Press.
- Gelman, Andrew, and Gary King. 1994. "A Unified Method of Evaluating Electoral Systems and Redistricting Plans." *American Journal of Political Science* 38 (2): 514–555.
- Ghitza, Yair, and Andrew Gelman. 2013. "Deep Interactions with MRP: Election Turnout and Voting Patterns Among Small Electoral Subgroups." *American Journal of Political Science* 57 (3): 762–776.
- Glynn, Adam N., and Jon Wakefield. 2010. "Ecological Inference in the Social Sciences." *Statistical Methodology* 7 (3): 307–322.
- . 2014. "Alleviating Ecological Bias in Poisson Models Using Optimal Subsampling." *Sociological Methodology* 44 (1): 159–184.

- Gray, Julia, and Jonathan B. Slapin. 2012. “How Effective Are Preferential Trade Agreements? Ask the Experts.” *Review of International Organizations* 7 (3): 309–333.
- Greiner, D. James. 2007. “Ecological Inference in Voting Rights Act Disputes: Where Are We Now, and Where Do We Want to Be.” *Jurimetrics* 47 (Winter): 115–167.
- Greiner, D. James, and Kevin M. Quinn. 2010. “Exit Polling and Racial Bloc Voting: Combining Individual-Level and $R \times C$ Ecological Data.” *Annals of Applied Statistics* 4 (4): 1774–1796.
- Grimmer, Justin, and Brandon M. Stewart. 2013. “Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts.” *Political Analysis* 21 (3): 267–297.
- Hand, David J. 2016. *Measurement: A Very Short Introduction*. Oxford University Press.
- Hare, Christopher, David A. Armstrong II, Ryan Bakker, Royce Carroll, and Keith T. Poole. 2015. “Using Bayesian Aldrich-McKelvey Scaling to Study Citizens’ Ideological Preferences and Perceptions.” *American Journal of Political Science* 59 (3): 759–774.
- Ho, Daniel E., and Kevin M. Quinn. 2008. “Improving the Presentation and Interpretation of Online Ratings Data with Model-Based Figures.” *The American Statistician* 62 (4): 279–288.
- Hoff, Peter. 2021. “Additive and Multiplicative Effects Network Models.” *Statistical Science* 36 (1): 34–50.
- Hoff, Peter D., Adrian E. Raftery, and Mark S. Handcock. 2002. “Latent Space Approaches to Social Network Analysis.” *Journal of the American Statistical Association* 97 (460): 1090–1098.
- Jackman, Simon. 2008. “Measurement.” Chap. 6 in *The Oxford Handbook of Political Methodology*, edited by Janet M. Box-Steffensmeier, Henry E. Brady, and David Collier, 119–152. Oxford University Press.
- . 2009. *Bayesian Analysis for the Social Sciences*. Hoboken, NJ: Wiley.
- Jackson, Matthew O. 2008. *Social and Economic Networks*. Princeton University Press.
- Jacobs, Abigail Z., and Hanna Wallach. 2021. “Measurement and Fairness.” In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency (FAccT ’21)*, 375–385, Virtual Event, Canada, March 3–10, 2021. New York: ACM. <https://doi.org/10.1145/3442188.3445901>.
- Jessee, Stephen A. 2016. “(How) Can We Estimate the Ideology of Citizens and Political Elites on the Same Scale?” *American Journal of Political Science* 60 (4): 1108–1124.

- Kastellec, Jonathan P., Jeffrey R. Lax, Michael Malecki, and Justin H. Phillips. 2015. "Polarizing the Electoral Connection: Partisan Representation in Supreme Court Confirmation Politics." *Journal of Politics* 77 (3): 787–804.
- King, Gary. 1997. *A Solution to the Ecological Inference Problem*. Princeton, NJ: Princeton University Press.
- King, Gary, Christopher J. L. Murray, Joshua A. Salomon, and Ajay Tandon. 2004. "Enhancing the Validity and Cross-Cultural Comparability of Measurement in Survey Research." *American Political Science Review* 98 (1): 191–207.
- King, Gary, Ori Rosen, and Martin A. Tanner, eds. 2004. *Ecological Inference: New Methodological Strategies*. New York: Cambridge University Press.
- Knox, Dean, Christopher Lucas, and Wendy K. Tam Cho. 2022. "Testing Causal Theories with Learned Proxies." Pre-published, *Annual Review of Political Science* 25:1–23. <https://doi.org/10.1146/annurev-polisci-051120-111443>.
- LaCombe, Scott J. 2021. "Measuring Institutional Design in U.S. States." *Social Science Quarterly* 102 (4): 1511–1533.
- Lauderdale, Benjamin E. 2021. "Pragmatic Social Measurement." Unpublished book manuscript, September 1, 2021.
- Lax, Jeffrey R., and Justin H. Phillips. 2009. "How Should We Estimate Public Opinion in the States?" *American Journal of Political Science* 53 (1): 107–121.
- Lewis, Jeffrey B., and Chris Tausanovitch. 2015. "When Does Joint Scaling Allow for Direct Comparisons of Preferences?" Paper presented at the Conference on Ideal Point Models, Massachusetts Institute of Technology, Cambridge, MA, May 1, 2015. <http://idealpoint.tahk.us/papers/lewisTausanovitch.pdf>.
- Linzer, Drew A. 2013. "Dynamic Bayesian Forecasting of Presidential Elections in the States." *Journal of the American Statistical Association* 108 (501): 124–134.
- Loewen, Peter John, Daniel Rubenson, and Arthur Spirling. 2012. "Testing the Power of Arguments in Referendums: A Bradley–Terry Approach." *Electoral Studies* 31 (1): 212–221.
- Marble, William, and Matthew Tyler. 2021. "The Structure of Political Choices: Distinguishing Between Constraint and Multidimensionality." Pre-published, *Political Analysis*, <https://doi.org/10.1017/pan.2021.3>.
- Martin, Andrew D., and Kevin M. Quinn. 2002. "Dynamic Ideal Point Estimation via Markov Chain Monte Carlo for the U.S. Supreme Court, 1953–1999." *Political Analysis* 10 (2): 134–153.

- Martin, Andrew D., and Kevin M. Quinn. 2007. "Assessing Preference Change on the US Supreme Court." *Journal of Law, Economics, and Organization* 23, no. 2 (June): 365–385.
- Minhas, Shahryar, Peter D. Hoff, and Michael D. Ward. 2019. "Inferential Approaches for Network Analysis: AMEN for Latent Factor Models." *Political Analysis* 27 (2): 208–222.
- Newman, Mark. 2018. *Networks*. Oxford, UK: Oxford University Press. Oxford Scholarship Online, <https://doi.org/10.1093/oso/9780198805090.001.0001>.
- Pan, Jennifer, and Yiqing Xu. 2018. "China's Ideological Spectrum." *Journal of Politics* 80 (1): 254–273.
- Park, Jong Hee. 2012. "A Unified Method for Dynamic and Cross-Sectional Heterogeneity: Introducing Hidden Markov Panel Models." *American Journal of Political Science* 56 (4): 1040–1054.
- Pereira, Frederico Batista. 2020. "Assessing Political Knowledge Scales Across Countries: Evidence from Latin America." *Revista Latinoamericana de Opinión Pública* 9, no. 1 (37-62).
- Quinn, Kevin M. 2004a. "Bayesian Factor Analysis for Mixed Ordinal and Continuous Responses." *Political Analysis* 12 (4): 338–353.
- . 2004b. "Ecological Inference in the Presence of Temporal Dependence." Chap. 9 in *Ecological Inference: New Methodological Strategies*, edited by Gary King, Ori Rosen, and Martin A. Tanner, 207–233. New York: Cambridge University Press.
- Rivers, Douglas. 2003. "Identification of Multidimensional Spatial Voting Models." Unpublished manuscript.
- Roberts, Margaret E., Brandon M. Stewart, and Edoardo M. Airoidi. 2016. "A Model of Text for Experimentation in the Social Sciences." *Journal of the American Statistical Association* 111 (515): 988–1003.
- Rosen, Ori, Wenxin Jiang, Gary King, and Martin A. Tanner. 2001. "Bayesian and Frequentist Inference for Ecological Inference: The $R \times C$ Case." *Statistica Neerlandica* 55 (2): 134–156.
- Selin, Jennifer L. 2015. "What Makes an Agency Independent?" *American Journal of Political Science* 59 (4): 971–987.
- Silge, Julia, and David Robinson. 2017. *Text Mining with R: A Tidy Approach*. O'Reilly. <https://www.tidytextmining.com>.

- Skrondal, Anders, and Sophia Rabe-Hesketh. 2004. *Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models*. Boca Raton, FL: CRC Press.
- . 2007. “Latent Variable Modelling: A Survey.” *Scandinavian Journal of Statistics* 34 (4): 712–745.
- Stan Development Team. 2021. *Stan User’s Guide*. V. 2.28, November 22, 2021. https://mc-stan.org/docs/2_28/stan-users-guide/.
- Stegmuller, Daniel. 2013. “How Many Countries for Multilevel Modeling? A Comparison of Frequentist and Bayesian Approaches.” *American Journal of Political Science* 57 (3): 748–761.
- Tai, Yuehong Cassandra, Hu Yue, and Frederick Solt. 2021. “Democracy, Public Support, and Measurement Uncertainty.” Unpublished working paper. https://github.com/fsolt/dcpo_dem_mood/raw/master/paper/dcpo_demsupport.pdf.
- Tanner, Martin A. 1996. *Tools for Statistical Inference Methods for the Exploration of Posterior Distributions and Likelihood Functions*. 3rd ed. New York: Springer.
- Treier, Shawn, and Simon Jackman. 2008. “Democracy as a Latent Variable.” *American Journal of Political Science* 52 (1): 201–217.
- Tsai, Tsung-han, and Chang-chih Lin. 2017. “Modeling Guessing Components in the Measurement of Political Knowledge.” *Political Analysis* 25 (4): 483–504.
- Wakefield, Jon. 2004. “Ecological Inference for 2×2 Tables.” *Journal of the Royal Statistical Society. Series A (General)* 167 (3): 385–445.
- Young, Jean-Gabriel, George T. Cantwell, and M. E. J. Newman. 2021. “Bayesian Inference of Network Structure from Unreliable Data.” *Journal of Complex Networks* 8 (6): cnaa046.
- Zucco, Cesar, Mariana Batista, and Timothy J. Power. 2019. “Measuring Portfolio Salience Using the Bradley–Terry Model: An Illustration with Data from Brazil.” *Research & Politics* 6 (1): 1–8. <https://doi.org/10.1177/2053168019832089>.