PL SC 596: "Modern Measurement"

Course Description

The idea behind this course is to ask and answer the question(s): "How can social scientists measure things in 2018?" In this context, "things" usually means observational data (turning real-world events / phenomena into data), with a heavy emphasis on data reduction and multiple indicators. The first 7-8 weeks of the course will be an overview of different kinds of multivariate statistics (uni- and multi-dimensional scaling, cluster analysis, factor analysis/PCA, etc.), and of psychometric item response theory (IRT). The latter half of the course will address newer approaches, primarily those for other kinds of data: machine learning-based approaches, text analysis (sentiment, topic models, named entity recognition, etc.), plus extracting / creating data from image, audio, video, and other kinds of digital sources.

Note that this is not a course on measurement theory *per se*. I'll also attempt not to duplicate measurement-related topics that are covered in other courses regularly offered in the Department (so, for example, we will not discuss the extensive and complex questions around designing surveys and survey instruments). The one exception will be in the area of text analysis, both because such models are of particular interest and because understanding them is critical to understanding methods for other types of data. Note as well that all course materials (including this syllabus, slides, notes, data, computer code, homework exercises, etc.) will be available on a dedicated Github repo, which can be found at https://github.com/PrisonRodeo/MM-git. Throughout this syllabus, hot links are in Penn State Blue.

Credits

The first part of this course owes a great deal to Bill Jacoby's long-running course on "Scaling and Dimensional Analysis" at the ICPSR Summer Program, and to my own training in such methods with Herb Weisberg at Ohio State. The second part is lifted in part from several existing courses on machine learning and the analysis of text data, including Justin Grimmer's course at Stanford, Ken Benoit's at ECPR/Trinity, and WIll Lowe's at various places (among others).

Texts

Required:

Everitt, Brian, and Thorsen Hothorn. 2011. *An Introduction to Applied Multivariate Analysis with R*. New York: Springer

Additional readings as necessary, all of which will be available via JSTOR™or on the course github repo.

The Everitt and Hothorn text will be the primary text for the first part of the course. It's expensive, but a good reference, and is available in an e-book version. Other articles are for the latter part of the course.

Recommended:

Manning, Christopher D., Prabhakar Raghavan and Hinrich Schutze, 2008. *Introduction to Information Retrieval*. New York: Cambridge University Press. `https://nlp.stanford.edu/IR-book/`

A Few Other Useful References:

Chang, Winston. 2013. *The R Graphics Cookbook*. Sebastopol, CA: O'Reilly Media.

Crawley, Michael J. 2012. *The R Book*, 2nd Ed. New York: Wiley.

Gardener, Mark. 2012. *The Essential R Reference*. New York: Wiley.

Teetor, Paul. 2011. *The R Cookbook*. Sebastopol, CA: O'Reilly Media.

Grading

Grading will be based on a total of 1000 points, divided as follows:

- Homework exercises: Five worth 100 points each.

- A final paper/poster/project, worth 500 points.

Details for the homework assignments and the final project will be announced in class.

Some Other Useful Resources

The **Inter-University Consortium for Political and Social Research** (ICPSR), at the University of Michigan, maintains an extensive archive of data in the social and behavioral sciences. Much of it is accessible via their homepage (`http://www.icpsr.umich.edu`).

The **Political Methodology Section** of the American Political Science Association was created to provide APSA members with an interest in political methodology with a forum in which to meet and discuss ideas. The section publishes a quarterly newsletter (*The Political Methodologist*), a quarterly journal on political methodology (*Political Analysis*), conducts a discussion list on topics relating to political methodology, and maintains an extensive electronic archive of papers, accessible via their homepage (at `http://polmeth.wustl.edu`).

The **Comprehensive R Archive Network** (CRAN) (`http://cran.r-project.org/`) is the place to go for downloads, packages, and documentation. Similarly, the **Stata**^{TM} homepage (`http://www.stata.com`) is a valuable resource for questions about Stata statistical software.

Obligatory Statement on Academic Integrity

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

Academic integrity includes a commitment by all members of the University community not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.

In cases of any violation of academic integrity it is the policy of the Department of Political Science to follow procedures established by the College of the Liberal Arts. More information on academic integrity and procedures followed for violation can be found here.

Obligatory Statement on Accommodations for Disabilities

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. Student Disability Resources (SDR) website provides contact information for every Penn State campus

(http://equity.psu.edu/sdr/disability-coordinator). For further information, please visit the Student Disability Resources website (http://equity.psu.edu/sdr/).

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: See documentation guidelines at http://equity.psu.edu/sdr/guidelines. If the documentation supports your request for reasonable accommodations, your campus disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early as possible. You must follow this process for every semester that you request accommodations.

Obligatory Statement on Counseling and Psychological Services

Many students at Penn State face personal challenges or have psychological needs that may interfere with their academic progress, social development, or emotional wellbeing. The university offers a variety of confidential services to help you through difficult times, including individual and group counseling, crisis intervention, consultations, online chats, and mental health screenings. These services are provided by staff who welcome all students and embrace a philosophy respectful of clients' cultural and religious backgrounds, and sensitive to differences in race, ability, gender identity and sexual orientation.

Counseling and Psychological Services at University Park (CAPS) (http://studentaffairs.psu.edu/counseling/): 814-863-0395

Counseling and Psychological Services at Commonwealth Campuses (http://senate.psu.edu/faculty/counseling-services-at-commonwealth-campuses/)

Penn State Crisis Line (24 hours / 7 days/week): 877-229-6400. Crisis Text Line (24 hours / 7 days/week): Text LIONS to 741741.

Obligatory Statement on Educational Equity and Reporting Bias

Penn State takes great pride to foster a diverse and inclusive environment for students, faculty, and staff. Consistent with University Policy AD29, students who believe they have experienced or observed a hate crime, an act of intolerance, discrimination, or harassment that occurs at Penn State are urged to report these incidents as outlined on the University's Report Bias webpage (http://equity.psu.edu/reportbias/).

Course Schedule

Part I: Multivariate Statistics

- **January 11**: *Course Introduction*
  Readings: None.

- **January 18**: *No Class (GSERM).*

- **January 25**: *Measurement Theory, Etc.*
  Required:

  - Hand, D. J. 1996. "Statistics and the Theory of Measurement," with discussion. *Journal of the Royal Statistical Society, Series A* 159:445-492.
  - Heise, D. R. 2001. "Scaling and Classification in Social Measurement." In *Internattional Encyclopedia of Social and Behavioral Sciences*. Amsterdam: Elsevier.
  - Schedler, Andreas. 2012. "Judgment and Measurement in Political Science." *Perspectives on Politics* 10:21-36.
  - Stevens, S. S. 1946. "On the Theory of Scales of Measurement." *Science* 103:677-680.

  Recommended:

  - Jacoby, William G. 1999. "Levels of Measurement and Political Research: An Optimistic View." *American Journal of Political Science* 43: 271-301.
  - Klee, R. 1997. *Introduction to the Philosophy of Science: Cutting Nature at Its Seams*. NY: Oxford University Press.
  - Markus and Borsboom. 2013. *Frontiers of Test Validity Theory: Measurement, Causation, and Meaning.* New York: Routledge.
  - Weisberg, Herbert F. (1974) "Dimensionland: An Excursion into Spaces." *American Journal of Political Science* 18:743-776.
  - Young, Forrest W. 1981. "Quantitative Analysis of Qualitative Data." *Psychometrika* 46: 357-388.

- **February 1**: *Scaling*
  Required:

  - Everitt and Hothorn. 2011. Chapter 4.

- Mair, Patrick, and Jan De Leeuw. 2015. "Unidimensional Scaling." In *Wiley StatsRef: Statistics Reference Online*. New York: Wiley. pp. 1-3.

- Jacoby, William G., and David J. Ciuk. 2017. "Multidimensional Scaling: An Introduction." In P. Irwing, T. Booth, and D. Hughes (Eds.), *The Wiley Handbook of Psychometric Testing*. New York: John Wiley (forthcoming).

- Sijtsma, Klaas. 2009. "On the Use, Misuse, and the Very Limited Usefulness of Cronbach's Alpha." *Psychometrika* 74:107-120.

Recommended:

- Borg, Ingwer, and Patrick Groenen. 2005. *Modern Multidimensional Scaling: Theory and Applications*, Second Edition. New York: Springer.

- Coombs, Clyde H. 1950. "Psychological Scaling Without a Unit of Measurement." *Psychological Review* 57: 145-158.

- De Leeuw, J., and P. Mair. 2009. "Multidimensional Scaling Using Majorization: SMACOF in R." *Journal of Statistical Software* 31:1-30.

- McIver, John, and Edward G. Carmines. 1981. *Unidimensional Scaling*. New York: Sage.

- Poole, Keith T. 1984. "Least Squares Metric, Unidimensional Unfolding." *Psychometrika* 49: 311-323.

- Spector, Paul E. 1992. *Summated Rating Scale Construction*. New York: Sage.

- Young, Forrest W. 1984. "Scaling." *Annual Review of Psychology* 35: 55-81.

- **February 8**: *Principal Components and Factor Analysis*
  Required:

  - Everitt and Hothorn 2011. Chapters 3 and 5. (Also scan chapter 7.)

  - Greenacre, Michael. 2012. "Biplots: The Joy of Singular Value Decomposition." *Wiley Interdisciplinary Reviews: Computational Statistics* 4:399-406.

  - Henson, Robin K., and J. Kyle Roberts. 2006. "Use of Exploratory Factor Analysis in Published Research: Common Errors and Some Comment on Improved Practice." *Educational and Psychological Measurement* 66:393-416.

  Recommended:

  - Flora, David B., and Jessica K. Flake. 2017. "The Purpose and Practice of Exploratory and Confirmatory Factor Analysis in Psychological Research: Decisions for Scale Development and Validation." *Canadian Journal of Behavioural Science* 49:78-88.

○ Gabriel, K.R. 1971. "The Biplot Graphic Display of Matrices with Application to Principal Components Analysis." *Biometrics* 58:453-467.

○ Greenacre, Michael J., and Patrick J. F. Groenen. 2016. "Weighted Euclidean Biplots." *Journal of Classification* 33:442-459.

○ MacCallum, R.C. 1974. "Relations Between Factor Analysis and Multidimensional Scaling." *Psychological Bulletin* 81: 505-516.

- **February 15**: *Cluster Analysis*
  Required:

  ○ Everitt and Hothorn. 2011. Chapter 6.

  ○ Ahlquist, John, and Christian Breunig. 2012. "Model-based Clustering and Typologies in the Social Sciences." *Political Analysis* 20:92-112.

  Recommended:

  ○ Jakulin, Alecs, W. Buntine, T. Pira, and H. Brasher. 2009. "Analyzing the U.S. Senate in 2003: Similarities, Clusters, and Blocs." *Political Analysis* 17:291-310.

  ○ Ristei Gugiu, M., and M. Centellas. 2013. "The Democracy Cluster Classification Index." *Political Analysis* 21:334-349.

  ○ Wierzchon, Slawomir, and Mieczyslaw Klopotek. 2018. *Modern Algorithms of Cluster Analysis*. New York: Springer.

  Homework One due.

- **February 22**: *Item Response Theory*
  Required:

  ○ Hambleton, Ronald K., Hariharan Swaminathan, and H. Jane Rogers. 1991. *Fundamentals of Item Response Theory*. Newbury Park: Sage. pp. 7-46, 53-88, 109-122.

  Recommended:

  ○ Lewis, Jeffrey B. 2001. "Estimating Voter Preference Distributions from Individual-Level Voting Data." *Political Analysis* 9:275-297.

  ○ Lord, Frederic M. 1983. "Unbiased Estimates of Ability Parameters, of Their Variance, and of Their Parallel Forms Reliability." *Psychometrika* 48:477-82.

  ○ Rizopoulos, Dimitris. 2006. "`ltm`: An R Package for Latent Variable Modeling and Item Response Theory Analyses." *Journal of Statistical Software* 17(5).

- **March 1**: *Miscellaneous (Mostly IRT)*
  Required:

  - Everitt and Hothorn (2011), Chapter 7.

  - Ostini, Remo, and Michael L. Nering. 2011. *Polytomous Item Response Theory Models*. Thousand Oaks, CA: Sage. Chapter 4.

  - Reckase, M.D. 2011. *Multidimensional Item Response Theory*. New York: Springer. Chapters 4-5.

  - Shi, Tao, and Steve Horvath. 2006. "Unsupervised Learning With Random Forest Predictors." *Journal of Computational and Graphical Statistics* 15:118-138.

  Recommended:

  - Cai, Li, Kilchan Choi, Mark Hansen, and Lauren Harrell. 2016. "Item Response Theory." *Annual Review of Statistics and Its Application* 3:297-321.

  - Chalmers, R. Philip. 2012. "`mirt`: A Multidimensional Item Response Theory Package for the R Environment." *Journal of Statistical Software* 48:1-29.

  - Fox, John. 2002. "Structural Equation Models" (Appendix to *An R and S-PLUS Companion to Applied Regression*). Available at https://wolfweb.unr.edu/ zal/STAT755/appendix-sems.pdf.

  - Jeon, M., and F. Rijmen. 2016. "A Modular Approach for Item Response Theory Modeling with the R Package FLIRT." *Behavior Research Methods* 48:742-755.

  - Thissen, D., and L. Steinberg. 1986. "A Taxonomy of Item Response Models." *Psychometrika* 51:567-577.

  Homework Two due.

- **March 8**: **No Class – Spring Break**

Part II: Text and Other Delights

- **March 15**: *Text Analysis: Fundamentals*
  Required:

  ○ Denny, Matthew J., and Arthur Spirling. 2018. "Text Preprocessing For Unsupervised Learning: Why It Matters, When It Misleads, And What To Do About It." *Political Analysis* 26: forthcoming.

  ○ Grimmer, Justin, and Brandon M. Stewart. 2013. "Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts." *Political Analysis* 21:267-297.

  ○ Miner, Gary, John Elder IV, Thomas Hill, Robert Nisbet, Dursun Delen, and Andrew Fast. 2012. *Practical Text Mining and Statistical Analysis for Non-structured Text Data Applications*, 1st Ed. Cambridge, MA: Academic Press. Chapters 2 and 3. Available at https://nlp.stanford.edu/IR-book/.

  ○ O'Connor, Brendan, David Bamman, and Noah A. Smith. 2011. "Computational Text Analysis for Social Science: Model Assumptions and Complexity." NIPS Conference.

  Recommended:

  ○ Monroe, Burt and Phillip Schrodt. 2008. "Introduction to the Special Issue: The Statistical Analysis of Political Text." *Political Analysis* 16:351-355.

  ○ Pathak, Manas A. 2014. *Beginning Data Science with R*. New York: Springer. Chapter 8.

  ○ Roberts, Margaret E. 2017. "Introduction to the Virtual Issue: Recent Innovations in Text Analysis for Social Science." *Political Analysis* Virtual Issue.

  Homework Three due.

- **March 22**: **No Class.**

- **March 29**: *Sentiment Analysis and Dictionary-Based Methods*
  Required:

  ○ Pang, Bo, and Lillian Lee. 2008. "Opinion Mining and Sentiment Analysis." *Foundations and Trends in Information Retrieval* 2:1-135.

○ Dodds, Peter and Christopher Danforth. 2009. "Measuring the Happiness of Large-Scale Written Expression: Songs, Blogs, and Presidents." *Journal of Happiness Studies* 11:441-456.

○ Soroka, Stuart and Lori Young. 2012. "Affective News: The Automated Coding of Sentiment in Political Texts." *Political Communication* 29:205-231.

Recommended:

○ Haselmayer, Martin, and Marcelo Jenny. 2017. "Sentiment Analysis of Political Communication: Combining a Dictionary Approach with Crowdcoding." *Quality & Quantity* 51:2623-2646.

○ Loughran, Tim and Bill McDonald. 2011. "When is a Liability Not a Liability? Textual Analysis, Dictionaries, and 10-Ks." *Journal of Finance* 66:35-65.

○ Rice, Douglas R., and Christopher Zorn. 2017. "Corpus-Based Dictionaries for Sentiment Analysis of Specialized Vocabularies." Working paper: Pennsylvania State University.

○ Sevenans, Julie, Quinn Albaugh, Tal Shahaf, Stuart Soroka, and Stefaan Walgrave. 2014. "The Automated Coding of Policy Agendas: A Dictionary Based Approach (v. 2.0.)" Paper prepared for the CAP Conference 2014, Konstanz.

○ Shellman, Stephen M. 2008. "Coding Disaggregated Intrastate Conflict: Machine Processing the Behavior of Substate Actors Over Time and Space." *Political Analysis* 16:464-477.

○ Soroka, Stuart, Lori Young, and Meital Balmas. 2015. "Bad News or Mad News? Sentiment Scoring of Negativity, Fear, and Anger in News Content." *The Annals of the American Academy of Political and Social Science* 659:108-121.

• **April 5**: *Topic Models*.
  Required:

○ Blei, David, Andrew Ng, and Michael Jordan. 2003. "Latent Dirichlet Allocation." *Journal of Machine Learning* 3:993-1022.

○ Blei, David. 2012. "Probabilistic Topic Models." *Communications of the ACM* 55:77-84.

○ Roberts, Margaret E., Brandon M. Stewart, and Edoardo M. Airoldi. 2016. "A Model of Text for Experimentation in the Social Sciences." *Journal of the American Statistical Association* 111:988-1003.

Recommended:

○ Quinn, Kevin M., Burt L. Monroe, Michael Colaresi, Michael H. Crespin, and Dragomir R. Radev. 2010. "How to Analyze Political Attention with Minimal Assumptions and Costs." *American Journal of Political Science* 54:209-228.

○ Roberts, Margaret E., Brandon M. Stewart and Dustin Tingley. 2018 "stm: R Package for Structural Topic Models." *Journal of Statistical Software*, forthcoming.

○ Grimmer, Justin. 2010. "A Bayesian Hierarchical Topic Model for Political Texts: Measuring Expressed Agendas in Senate Press Releases." *Political Analysis* 18:1-35.

Homework Four due.

- **April 12**: *Text Scaling*
  Required:

○ Laver, Michael, Kenneth Benoit, and John Garry. 2003. "Extracting Policy Positions from Political Texts Using Words as Data." *American Political Science Review* 97:311-331.

○ Lowe, Will. 2008. "Understanding Wordscores." *Political Analysis* 16:356-371.

○ Slapin, Jonathan and Sven-Oliver Prokschk. 2008. "A Scaling Model for Estimating Time-Series Party Positions from Texts." *American Journal of Political Science* 52:705-722.

○ Benjamin Lauderdale and Alexander Herzog, "Measuring Political Positions from Legislative Speech." *Political Analysis* 24:374-394.

  Recommended:

○ Beauchamp, Nick. 2012. "Using Text to Scale Legislatures with Uninformative Voting." Manuscript: Northeastern University.

○ Lowe, William, Kenneth Benoit, Slava Mikhaylov, and Michael Laver. 2011. "Scaling Policy Preferences From Coded Political Texts." *Legislative Studies Quarterly* 26:123-155.

○ Benoit, Kenneth, Slava Mikhaylov, and Michael Laver. 2009. "Treating Words as Data with Error: Uncertainty in Text Statements of Policy Positions." *American Journal of Political Science* 53:495-513.

○ Lauderdale, Benjamin E., and Tom S. Clark, "Scaling Meaningful Political Dimensions Using Texts and Votes." *American Journal of Political Science* 58:754-771.

○ Lowe, WIll. 2016 (etc.) "Scaling Things We Can Count." Manuscript: Princeton University. http://dl.conjugateprior.org/preprints/all-on-the-line.pdf

- **April 19**: *Analyzing Image / Audio / Video Data*.
  Required:

  - Casas, Andreu, and Nora Webb Williams. 2017. "Computer Vision for Political Science Research: A Study of Online Protest Images." Prepared for New Faces in Political Methodology IX, April 29, 2017, Pennsylvania State University.

  - Dietrich, Bryce J., Ryan D. Enos, and Maya Sen. 2017. "Gender Dynamics in Elite Political Contexts: Evidence from Supreme Court Oral Arguments." Working paper: University of Iowa.

  - Knox, Dean, and Christopher Lucas. 2017. "A General Approach to Classifying Mode of Speech: The Speaker-Affect Model for Audio Data." Working paper, MIT.

  Recommended:

  - Barthelme, Simon. 2017. "Getting Started with `imager`." Available at urlhttps://cran.r-project.org/web/packages/imager/vignettes/gettingstarted.html.

  - Knox, Dean, and Christopher Lucas. 2018. "A Dynamic Model of Speech for the Social Sciences." Working paper, Harvard University.

  - LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. 2015. "Deep Learning." *Nature* 521:436-444.

- **April 26**: *NO CLASS*.

  Homework Five due.

- **May 4**: **Final Papers Due**.