

SOC576  
COMPUTATIONAL SOCIOLOGY  
Rutgers University

Syllabus

Thomas Davidson

Spring 2021

## **COURSE DESCRIPTION**

This course is designed to introduce students to computational methods and their applications to sociological research. We will discuss the computational toolkit from the bottom up, beginning with the fundamentals of programming and data analysis and management. Once these fundamentals are in place, we will turn to different methods for collecting data: application programming interfaces, web-scraping, and online experiments. The remainder of the course will focus on computational methods for data analysis. First, we will cover various methods for the quantitative analysis of text data including word embeddings, topic modeling, and supervised learning. Second, we will discuss supervised machine learning in more depth, assessing the relationship between prediction and explanation in social science, discussing bias and other limitations of these methods, as well as the opportunities these techniques present to work with images and multimodal data. Finally, we will explore the role of simulation and agent-based modeling in sociological research. Throughout the course students will gain hands-on experience with these different techniques, as well as an understanding of how these techniques are being used in cutting-edge sociological research. Overall this course will provide students with a strong conceptual foundation in computational sociology and the ability to apply various techniques for data collection and analysis in their own research. All assignments will be conducted using the R programming language.

## **PREREQUISITES AND PREPARATION**

This course is designed for students without any experience using computational methods or advanced statistics. Nonetheless, the course will proceed more efficiently if students without any such experience are willing to undertake some independent learning prior to the beginning of the course. In particular, I recommend students familiarize themselves with Github, the R programming language, the RStudio computing environment, and RMarkdown documents, as we will be using these tools throughout the course. We will review these topics over the first few weeks of class, but the more familiar students are with these tools, the more time we can spend focusing on their sociological applications.

Chris Bail (a sociologist at Duke University) recently published a series of video tutorials ([https://sicss.io/boot\\_camp](https://sicss.io/boot_camp)) and exercises designed to introduce these tools. I highly recommend that students watch these videos and review the relevant materials in *R for Data Science* (details on the book below) prior to the beginning of the semester.

## ASSESSMENT

There will be two types of assessment used in the course. There will be several homework assignments throughout the semester that will be designed to enable students to become familiar with the various methodological techniques covered in the course. A tentative schedule of these assignments can be found in the course outline below. Students will also write an empirical paper over the course of the semester. The paper will involve the collection of original data and preliminary analyses using one or more of the approaches covered in the course. I intend for the paper to be an opportunity for students to develop the basis for a qualifying exam, master's thesis, or dissertation chapter. Students are expected to make progress on the paper over the course of the semester. At various points in the semester I will provide feedback on the paper proposal, the methodology for data collection, and the data analysis (see course outline for a timeline).

## READINGS

There are weekly reading assignments for this course. These readings include methodological texts, reviews of relevant methodological and theoretical considerations, and examples of how sociologists and other social scientists apply computational approaches in their research. Given the complexity and unfamiliarity of some of the approaches we will cover in the course, I have included a diverse set of readings for each topic. Some students may find the technical readings more useful whereas others may benefit from the more contextualized applications.

### Require texts and useful references

*\* indicates a required text. All required texts and useful references are available for free online on the listed websites.*

- \*Matthew Salganik. 2017. *Bit by Bit* (<https://www.bitbybitbook.com/en/1st-ed/preface/>)
- \*Wickham, Hadley, and Garrett Grolemund. 2016. *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. (R4DS). O'Reilly Media, Inc. (<https://r4ds.had.co.nz/>)
- James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. 2013. *An Introduction to Statistical Learning*. Springer Texts in Statistics. (Entire book can be downloaded as a PDF via Rutgers Library)
- Manning, Christopher D., Hinrich Schütze, and Prabhakar Raghavan. 2008. *Introduction to Information Retrieval*. Cambridge University Press. (<https://nlp.stanford.edu/IR-book/information-retrieval-book.html>)
- Silge, Julia, and David Robinson. 2017. *Text Mining with R: A Tidy Approach*. O'Reilly Media. <https://www.tidytextmining.com/dtm.html>.
- Healy, Kieran. 2018. *Data Visualization: A Practical Introduction*. Princeton University Press. (<https://socviz.co/>)

## RESOURCES

There will be a Github repository containing all files related to this course (A link will be shared in the first week of class). I will also use this as a space to maintain a wiki links to various related resources. Students will also use Github to submit assignments. We will be using Slack to communicate with one another during this course, all enrolled students will receive an invite to join the Slack channel.

## COURSE POLICIES

The Rutgers Sociology Department strives to create an environment that supports and affirms diversity in all manifestations, including race, ethnicity, gender, sexual orientation, religion, age, social class, disability status, region/country of origin, and political orientation. This class will be a space for tolerance, respect,

and mutual dialogue. Students must abide by the Code of Student Conduct at all times, including during lectures and in participation online.

All students must abide by the university's Academic Integrity Policy. Violations of academic integrity will result in disciplinary action.

In accordance with University policy, if you have a documented disability and require accommodations to obtain equal access in this course, please contact me during the first week of classes. Students with disabilities must be registered with the Office of Student Disability Services and must provide verification of their eligibility for such accommodations.

I will also be making additional accommodations due to the COVID-19 pandemic. If you or your family are affected in any way that impedes your ability to participate in this course, please contact me as soon as you can so that we can make necessary arrangements.

## **COURSE OUTLINE**

*This outline is tentative and subject to change.*

### **Week 1**

#### **Introduction to Computational Sociology**

##### *Readings*

- *R4DS*: Preface, C2-6, 21
- *Bit by Bit*, C1
- Lazer, David, et al. 2009. "Life in the Network: The Coming Age of Computational Social Science." *Science* 323 (5915): 721–23. <https://doi.org/10.1126/science.1167742>.
- Edelman, Achim, Tom Wolff, Danielle Montagne, and Christopher A. Bail. 2020. "Computational Social Science and Sociology." *Annual Review of Sociology* 46 (1): annurev-soc-121919-054621. <https://doi.org/10.1146/annurev-soc-121919-054621>.

### **Week 2**

#### **Data Structures**

##### *Readings*

- *R4DS*: C7-10, 16
- Golder, Scott A., and Michael W. Macy. 2014. "Digital Footprints: Opportunities and Challenges for Online Social Research." *Annual Review of Sociology* 40 (1): 129–52. <https://doi.org/10.1146/annurev-soc-071913-043145>.
- Bail, Christopher A. 2014. "The Cultural Environment: Measuring Culture with Big Data." *Theory and Society* 43 (3–4): 465–82. <https://doi.org/10.1007/s11186-014-9216-5>.

### **Week 3**

#### **Programming Fundamentals**

##### *Readings*

- *R4DS*: C14-15, 17
- Freese, Jeremy. 2007. "Replication Standards for Quantitative Social Science: Why Not Sociology?" *Sociological Methods & Research* 36 (2): 153–72. <https://doi.org/10.1177/0049124107306659>.

- Liu, David, and Matthew Salganik. 2020. "Successes and Struggles with Computational Reproducibility: Lessons from the Fragile Families Challenge," *Socius*.

## ***Assignment 1: The computational toolkit.***

### **Week 4**

#### **Data Collection I: APIs**

##### *Readings*

- *R4DS: C11*
- *Bit by Bit, C2*
- Baumgartner, Jason, Savvas Zannettou, Brian Keegan, Megan Squire, and Jeremy Blackburn. 2020. "The Pushshift Reddit Dataset." In *Proceedings of the International AAAI Conference on Web and Social Media*, 14:830–39.
- Freelon, Deen. 2018. "Computational Research in the Post-API Age." *Political Communication* 35 (4): 665–68. <https://doi.org/10.1080/10584609.2018.1477506>.

##### *Recommended*

*I have included recommended readings that use a range of different APIs including Spotify (Askin and Mauskampf), Facebook (Davidson and Berezin), Google Trends (Davidson and Berezin; Bail, Brown, and Wimmer), Twitter (Mitts), and YouTube (Munger and Phillips).*

- Askin, Noah, and Michael Mauskampf. 2017. "What Makes Popular Culture Popular? Product Features and Optimal Differentiation in Music." *American Sociological Review* 82 (5): 910–44. <https://doi.org/10.1177/0003122417728662>.
- Davidson, Thomas, and Mabel Berezin. 2018. "Britain First and the UK Independence Party: Social Media and Movement-Party Dynamics." *Mobilization: An International Quarterly* 23 (4): 485–510. <https://doi.org/10.17813/1086-671X-23-4-485>.
- Bail, Christopher, Taylor Brown, and Andreas Wimmer. 2019. "Prestige, Proximity, and Prejudice: How Google Search Terms Diffuse across the World." *American Journal of Sociology* 124 (5): 1496–1548. <https://doi.org/10.1086/702007>.
- Mitts, Tamar. 2019. "From Isolation to Radicalization: Anti-Muslim Hostility and Support for ISIS in the West." *American Political Science Review* 113 (1): 173–94. <https://doi.org/10.1017/S0003055418000618>.
- Munger, Kevin, and Joseph Phillips. 2020. "Right-Wing YouTube: A Supply and Demand Perspective." *The International Journal of Press/Politics*, 34.

### **Week 5**

#### **Data Collection II: Webscraping**

##### *Readings*

- *Bit by Bit, C6*
- Fiesler, Casey, Nate Beard, and Brian C Keegan. 2020. "No Robots, Spiders, or Scrapers: Legal and Ethical Regulation of Data Collection Methods in Social Media Terms of Service." In *Proceedings of the Fourteenth International AAAI Conference on Web and Social Media*, 187–96.

##### *Recommended*

- King, Gary, Jennifer Pan, and Margaret E. Roberts. 2013. "How Censorship in China Allows Government Criticism but Silences Collective Expression." *American Political Science Review* 107 (02): 326–43. <https://doi.org/10.1017/S0003055413000014>.

## ***Assignment 2: Collecting and storing data***

### **Week 6**

#### **Data Collection III: Online experiments and surveys**

##### *Readings*

- *Bit by Bit*, C3-4
- Salganik, Matthew, Peter Sheridan Dodds, and Duncan Watts. 2006. "Experimental Study of Inequality and Unpredictability in an Artificial Cultural Market." *Science Reports* 311: 854–56.
- Kramer, Adam D. I., Jamie E. Guillory, and Jeffrey T. Hancock. 2014. "Experimental Evidence of Massive-Scale Emotional Contagion through Social Networks." *Proceedings of the National Academy of Sciences* 111 (24): 8788–90. <https://doi.org/10.1073/pnas.1320040111>.
- Munger, Kevin. 2016. "Tweetment Effects on the Tweeted: Experimentally Reducing Racist Harassment." *Political Behavior*, November. <https://doi.org/10.1007/s11109-016-9373-5>.
- Wang, Wei, David Rothschild, Sharad Goel, and Andrew Gelman. 2015. "Forecasting Elections with Non-Representative Polls." *International Journal of Forecasting* 31 (3): 980–91. <https://doi.org/10.1016/j.ijforecast.2014.06.001>.

## ***Paper proposal due***

### **Week 7**

#### **Natural Language Processing I: Fundamentals**

##### *Readings*

- *Text Mining with R*, C1-3.
- *Introduction to Information Retrieval*, pp. 117-126.
- Grimmer, Justin, and Brandon Stewart. 2013. "Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts." *Political Analysis* 21 (3): 267–97. <https://doi.org/10.1093/pan/mps028>.
- DiMaggio, Paul. 2015. "Adapting Computational Text Analysis to Social Science (and Vice Versa)." *Big Data & Society* 2 (2): 205395171560290. <https://doi.org/10.1177/2053951715602908>.
- Evans, James, and Pedro Aceves. 2016. "Machine Translation: Mining Text for Social Theory." *Annual Review of Sociology* 42 (1): 21–50. <https://doi.org/10.1146/annurev-soc-081715-074206>.

##### *Recommended*

- Pang, Bo, and Lillian Lee. 2008. "Opinion Mining and Sentiment Analysis." *Foundations and Trends in Information Retrieval* 2 (1–2): 1–135.
- Danescu-Niculescu-Mizil, Cristian, Robert West, Dan Jurafsky, Jure Leskovec, and Christopher Potts. 2013. "No Country for Old Members: User Lifecycle and Linguistic Change in Online Communities." In *Proceedings of the 22nd International Conference on World Wide Web*, 307–318. <http://dl.acm.org/citation.cfm?id=2488416>.
- Niculae, Vlad, Srikanth Kumar, Jordan Boyd-Graber, and Cristian Danescu-Niculescu-Mizil. 2015. "Linguistic Harbingers of Betrayal: A Case Study on an Online Strategy Game." *ArXiv Preprint ArXiv:1506.04744*. <http://arxiv.org/abs/1506.04744>.
- McFarland, Daniel A., Dan Jurafsky, and Craig Rawlings. 2013. "Making the Connection: Social Bonding in Courtship Situations." *American Journal of Sociology* 118 (6): 1596–1649. <https://doi.org/10.1086/670240>.

## Week 8

### Natural Language Processing II: Word Embeddings

#### *Readings*

- *Text Mining with R*: C5.
- Mikolov, Tomas, Ilya Sutskever, Kai Chen, Greg Corrado, and Jeff Dean. 2013. "Distributed Representations of Words and Phrases and Their Compositionality." In *Advances in Neural Information Processing Systems*, 3111–3119. <http://papers.nips.cc/paper/5021-distributed-representations>.
- Hamilton, William, Jure Leskovec, and Dan Jurafsky. 2016. "Diachronic Word Embeddings Reveal Statistical Laws of Semantic Change." In *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics*, 1489–1501.
- Devlin, Jacob, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. 2019. "BERT: Pre-Training of Deep Bidirectional Transformers for Language Understanding." In *Proceedings of NAACL-HLT 2019*, 4171–86. ACL.
- Kozlowski, Austin, Matt Taddy, and James Evans. 2019. "The Geometry of Culture: Analyzing the Meanings of Class through Word Embeddings." *American Sociological Review*, September, 000312241987713. <https://doi.org/10.1177/0003122419877135>.

#### *Recommended*

- Manning, Christopher D., Kevin Clark, John Hewitt, Urvashi Khandelwal, and Omer Levy. 2020. "Emergent Linguistic Structure in Artificial Neural Networks Trained by Self-Supervision." *Proceedings of the National Academy of Sciences*, June, 201907367. <https://doi.org/10.1073/pnas.1907367117>.

## Week 9

### Natural Language Processing III: Topic Models

#### *Readings*

- *Text Mining with R*: C6.
- Blei, David 2012. "Probabilistic Topic Models." *Communications of the ACM* 55 (4): 77. <https://doi.org/10.1145/2133806.2133826>.
- Mohr, John, and Petko Bogdanov. 2013. "Introduction—Topic Models: What They Are and Why They Matter." *Poetics* 41 (6): 545–69. <https://doi.org/10.1016/j.poetic.2013.10.001>.
- Roberts, Margaret, Brandon M. Stewart, Dustin Tingley, Christopher Lucas, Jetson Leder-Luis, Shana Kushner Gadarian, Bethany Albertson, and David Rand. 2014. "Structural Topic Models for Open-Ended Survey Responses: Structural Topic Models for Survey Responses." *American Journal of Political Science* 58 (4): 1064–82. <https://doi.org/10.1111/ajps.12103>.

#### *Recommended*

- DiMaggio, Paul, Manish Nag, and David Blei. 2013. "Exploiting Affinities between Topic Modeling and the Sociological Perspective on Culture: Application to Newspaper Coverage of U.S. Government Arts Funding." *Poetics* 41 (6): 570–606. <https://doi.org/10.1016/j.poetic.2013.08.004>.
- Karell, Daniel, and Michael Freedman. 2019. "Rhetorics of Radicalism." *American Sociological Review* 84 (4): 726–53. <https://doi.org/10.1177/0003122419859519>.
- Stoltz, Dustin S, and Marshall A Taylor. 2019. "Textual Spanning: Finding Discursive Holes in Text Networks." *Socius*.

## ***Assignment 3: Natural language processing***

### **Week 10**

#### **Machine Learning I: Prediction and explanation**

##### *Readings*

- Molina, Mario, and Filiz Garip. 2019. "Machine Learning for Sociology." *Annual Review of Sociology* 45: 27–45.
- Davidson, Thomas. 2020. "Black-Box Models and Sociological Explanations: Predicting High School Grade Point Average Using Neural Networks." *Socius: Sociological Research for a Dynamic World* 5 (January): 237802311881770. <https://doi.org/10.1177/2378023118817702>.

##### *Recommended*

- Hofman, Jake, Amit Sharma, and Duncan Watts. 2017. "Prediction and Explanation in Social Systems." *Science* 355 (6324): 486–488. <https://doi.org/10.1126/science.aal3856>.
- Mullainathan, Sendhil, and Jann Spiess. 2017. "Machine Learning: An Applied Econometric Approach." *Journal of Economic Perspectives* 31 (2): 87–106. <https://doi.org/10.1257/jep.31.2.87>.

### ***Paper initial data collection due***

### **Week 11**

#### **Machine learning II: Text classification**

##### *Readings*

- Hanna, Alex. 2013. "Computer-Aided Content Analysis of Digitally Enabled Movements." *Mobilization: An International Quarterly* 18 (4): 367–388.
- Davidson, Thomas, Dana Warmusley, Michael Macy, and Ingmar Weber. 2017. "Automated Hate Speech Detection and the Problem of Offensive Language." In *Proceedings of the 11th International Conference on Web and Social Media (ICWSM)*, 512–515.
- Barberá, Pablo, Amber E. Boydstun, Suzanna Linn, Ryan McMahon, and Jonathan Nagler. 2020. "Automated Text Classification of News Articles: A Practical Guide." *Political Analysis*, June, 1–24. <https://doi.org/10.1017/pan.2020.8>.
- Nelson, Laura. 2017. "Computational Grounded Theory: A Methodological Framework." *Sociological Methods & Research*, November. <https://doi.org/10.1177/0049124117729703>.

##### *Recommended*

- King, Gary, Patrick Lam, and Margaret E. Roberts. 2017. "Computer-Assisted Keyword and Document Set Discovery from Unstructured Text." *American Journal of Political Science* 61 (4): 971–88.
- Miller, Blake, Fridolin Linder, and Walter R. Mebane, Jr. 2019. "Active Learning Approaches for Labeling Text: Review and Assessment of the Performance of Active Learning Approaches." *Political Analysis*. [http://www-personal.umich.edu/~wmebane/Paper\\_Active\\_Learning\\_Approaches\\_for\\_Labeling\\_Text.pdf](http://www-personal.umich.edu/~wmebane/Paper_Active_Learning_Approaches_for_Labeling_Text.pdf).

### **Week 12**

#### **Machine learning III: Challenges**

##### *Readings*

- Salganik, Matthew, Ian Lundberg, Alexander Kindel, et al. 2020. "Measuring the Predictability of Life Outcomes with a Scientific Mass Collaboration." *Proceedings of the National Academy of Sciences*.

- Buolamwini, Joy, and Timnit Gebru. 2018. "Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification." In *Proceedings of Machine Learning Research*, 81:1–15.
- Davidson, Thomas, Debasmita Bhattacharya, and Ingmar Weber. 2019. "Racial Bias in Hate Speech and Abusive Language Detection Datasets." In *Proceedings of the Third Workshop on Abusive Language Online*, 25–35. Florence, Italy: Association for Computational Linguistics. <https://doi.org/10.18653/v1/W19-3504>.
- De-Arteaga, Maria, Alexey Romanov, Hanna Wallach, Jennifer Chayes, Christian Borgs, Alexandra Chouldechova, Sahin Geyik, Krishnaram Kenthapadi, and Adam Tauman Kalai. 2019. "Bias in Bios: A Case Study of Semantic Representation Bias in a High-Stakes Setting." In *Proceedings of the Conference on Fairness, Accountability, and Transparency - FAT\* '19*, 120–28. Atlanta, GA, USA: ACM Press. <https://doi.org/10.1145/3287560.3287572>.
- Gonen, Hila, and Yoav Goldberg. 2019. "Lipstick on a Pig: Debiasing Methods Cover up Systematic Gender Biases in Word Embeddings But Do Not Remove Them." In *Proceedings of NAACL\_HLT*, 609–14. Minneapolis, Minnesota: Association for Computational Linguistics.

## Week 13

### Machine learning IV: Image classification

#### *Readings*

- Krizhevsky, Alex, Ilya Sutskever, and Geoffrey Hinton. 2012. "Imagenet Classification with Deep Convolutional Neural Networks." In *Advances in Neural Information Processing Systems*, 1097–1105. <http://papers.nips.cc/paper/4824-imagenet-classification-with-deep-convolutional-neural-networks>.
- Jean, N., M. Burke, M. Xie, W. M. Davis, D. B. Lobell, and S. Ermon. 2016. "Combining Satellite Imagery and Machine Learning to Predict Poverty." *Science* 353 (6301): 790–94. <https://doi.org/10.1126/science.aaf7894>.
- Gebru, Timnit, Jonathan Krause, Yilun Wang, Duyun Chen, Jia Deng, Erez Lieberman Aiden, and Li Fei-Fei. 2017. "Using Deep Learning and Google Street View to Estimate the Demographic Makeup of Neighborhoods across the United States." *Proceedings of the National Academy of Sciences* 114 (50): 13108–13. <https://doi.org/10.1073/pnas.1700035114>.
- Zhang, Han, and Jennifer Pan. 2019. "CASM: A Deep-Learning Approach for Identifying Collective Action Events with Text and Image Data from Social Media." *Sociological Methodology* 49 (1): 1–57. <https://doi.org/10.1177/0081175019860244>.

### *Paper preliminary analyses due*

### *Assignment 4: Machine learning*

## Week 14

### Agent-Based Models

#### *Readings*

- Macy, Michael, and Robert Willer. 2002. "From Factors to Factors: Computational Sociology and Agent-Based Modeling." *Annual Review of Sociology* 28 (1): 143–66. <https://doi.org/10.1146/annurev.soc.28.110601.141117>.
- Bruch, Elizabeth, and Jon Atwell. 2015. "Agent-Based Models in Empirical Social Research." *Sociological Methods & Research* 44 (2): 186–221. <https://doi.org/10.1177/0049124113506405>.
- Centola, Damon. 2015. "The Social Origins of Networks and Diffusion." *American Journal of Sociology* 120 (5): 1295–1338. <https://doi.org/10.1086/681275>.



- DellaPosta, Daniel, Yongren Shi, and Michael Macy. 2015. "Why Do Liberals Drink Lattes?" *American Journal of Sociology* 120 (5): 1473–1511. <https://doi.org/10.1086/681254>.
- Goldberg, Amir, and Sarah K. Stein. 2018. "Beyond Social Contagion: Associative Diffusion and the Emergence of Cultural Variation." *American Sociological Review* 83 (5): 897–932. <https://doi.org/10.31235/osf.io/uqv3d>.

*Recommended*

- Shirado, Hirokazu, and Nicholas A. Christakis. 2017. "Locally Noisy Autonomous Agents Improve Global Human Coordination in Network Experiments." *Nature* 545 (7654): 370–74. <https://doi.org/10.1038/nature22332>.
- Silver, David, Julian Schrittwieser, Karen Simonyan, Ioannis Antonoglou, Aja Huang, Arthur Guez, Thomas Hubert, et al. 2017. "Mastering the Game of Go without Human Knowledge." *Nature* 550 (7676): 354–59. <https://doi.org/10.1038/nature24270>.

***Assignment 5: Agent-based models***

**Work on final projects**

***Final paper due (date to be confirmed)***