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| **Revised 1/29/20**  Prof. Richard B. Freeman | 617-868-3900 | <freeman@nber.org> | Harvard University | Dept of Economics |
| Office at: NBER, 1050 Mass. Ave. Cambridge | Tues & Thurs, 1:30-2:45pm | Emerson 108 |
| Office hours: by appt; request by e-mail | TF: Yang You, yangyou@g.harvard.edu | Section time tba |
|  |  |

**ECON 1818** **–** **THE ECONOMICS OF DISCONTINUOUS CHANGE – FAS Spring 2020**

**Requirements:**  Midyear, Final, Lectures, **Project**  
**Grading:** ½ exams; ½ project. Consideration given to participation and extra weight given for outstanding paper.  
**Readings:** The syllabus, with hyperlinks, will be posted to course website; most items have open-sourced hyperlinks.  
**Readings:** “r” accessible thru ec1818 Canvas “reserves” | **Readings**: “gs-H” find thru Hollis or Harvard’s google scholar.

(Contact [Jennifer@nber.org](mailto:Jennifer@nber.org) if you find broken links in the syllabus).

**SUGGESTED BOOKS:**

Barabasi, Albert-Laszlo. *Linked: The New Science of Networks* (Perseus, 2002)

Taleb, Nassim Nicholas. [*The Black Swan: The Impact of the Highly Improbable*](file:///G:\freeman\Desktop\wiki\The_Black_Swan_(book)).(Random House, 2007)

Gladwell, Malcolm. *The Tipping Point: How Little Things Can Make a Big Difference* (First Back Bay, 2002)

Watts, Duncan. *Everything Is Obvious: How Common Sense Fails Us* (Random House, 2011)

Pedro Domingos, *The Master Algorithm* (Basic Books, 2015)

Surowiez, James, Wisdom of Crowds (Anchor Books, 2005)

INTRODUCTION

**LECTURE 1: Introduction to Course: Discontinuity in Economic Analysis (Tues, Jan 28)**

r Schelling, Thomas. 1978. *Micromotives and Macrobehavior* (Norton) chapter 1

r Kuran, Timur. 1994. *Private Truths, Public Lies* (Harvard Univ Press) chapter 4, pp 60-83

Lenton, et al 2019 [Tipping Point in Climate Change](https://www.nature.com/articles/d41586-019-03595-0) Nature

1. SOCIAL INTERACTION MODELS

**LECTURE 2: Cellular Automata Models, Homophily, and Segregation (Thurs, Jan 30)**

r Schelling, Tom. 1978. *Micromotives and Macrobehavior* (Norton), chapter 4

r Kauffman, Stuart. 1995. *At Home in the Universe* (Oxford Univ Press), chapter 4.

“[What is cellular automata modeling](http://www.youtube.com/watch?v=EyrwOf239M4)? Youtube video.

Cellular Automata Models of Traffic Flow <https://www.coursera.org/lecture/modeling-simulation-natural-processes/cellular-automata-models-for-traffic-oIAOi>

**LECTURE 3: PD Games,Tit-for-tat, Ultimatum and Dictator Games (Tues, Feb 4)**

r Axelrod, Robert. 1990. *The Evolution of Cooperation*. (Penguin) chapters 1-2: pp 3-54

r Nowak, M., Robert May, Karl Sigmund. 1995. “The Arithmetic of Mutual Help,” *Sci Am* vol 272:6 (June) pp 76-81.

gs-H Bendor, J &P Swistak, 1998. “ [Evolutionary A](http://onlinelibrary.wiley.com.ezp-prod1.hul.harvard.edu/doi/10.1002/%28SICI%291099-0526%28199811/12%294:2%3c15::AID-CPLX4%3e3.)[dva](http://onlinelibrary.wiley.com.ezp-prod1.hul.harvard.edu/doi/10.1002/%28SICI%291099-0526%28199811/12%294:2<15::AID-CPLX4>3.)[nta](http://onlinelibrary.wiley.com.ezp-prod1.hul.harvard.edu/doi/10.1002/%28SICI%291099-0526%28199811/12%294:2<15::AID-CPLX4>3.)[ge of Conditional Cooperation](http://onlinelibrary.wiley.com.ezp-prod1.hul.harvard.edu/doi/10.1002/%28SICI%291099-0526%28199811/12%294:2<15::AID-CPLX4>3.),” *Complexity* Vol 4:2 pp 15-18.

Christian Hilbe. 2014. Torsten Rohl & Manfred Milinski, ”[Extortio](http://www.nature.com/ncomms/2014/140529/ncomms4976/full/ncomms4976.html)[n subdues human](http://www.nature.com/ncomms/2014/140529/ncomms4976/full/ncomms4976.html) [players but is finally punished in the prisoner’s dilemma](http://www.nature.com/ncomms/2014/140529/ncomms4976/full/ncomms4976.html)” *Nature Communications*, May 29, 2014

H Engel, C. (2011). Dictator games: A meta study. Experimental Economics, 14(4), 583–610.

Videos: Fairness in monkees. https://www.youtube.com/watch?v=HL45pVdsRvE

**LECTURE 4: Evolutionary Stable and ZD Strategies (Thurs, Feb 6)**

r Hofbauer, Josef and Karl Sigmund. 1998. “Evolutionarily Stable Strategies,” Chapter 6: in *Evolutionary Games and Population Dynamics*, (Cambridge, England: Cambridge U Press) pp 55-66.

r/gs Fehr, Ernst and Simon Gachter. 2002. “[Altruistic Punishment in Humans](http://www.nature.com.ezp-prod1.hul.harvard.edu/nature/journal/v415/n6868/abs/415137a.html),” Nature vol 415:6868 (Jan 10): 137-40.

r/gs Sigmund K, Fehr E, Nowak M.A. (2002) “ [Economics of Fair Play](http://www.billsynnotandassociates.com.au/images/stories/documents/the_economics_of_fair_play.pdf),” *Scientific American* Vol 286:1 (Jan) pp 83-87.

r Nowak, M, A Sasaki, C. Taylor and D. Fudenberg “Emergence of cooperation and evolutionary stability in finite populations*” Nature*, April 8, 2004, pp 646-650

Stewart AJ, Plotkin JB (2012) “[Extortion and coopera](http://www.pnas.org/content/109/26/10134.full.pdf)[tion in the Prisoner’s Dilemma](http://www.pnas.org/content/109/26/10134.full.pdf)” *PNAS*  109(26):10134–10135.

John Maynard Smith on evolutionary game theory <https://www.youtube.com/watch?v=FKegQW_lsGI>

William H. Press and Freeman J. Dyson. 2012. “[Iterated Prisoner’s Dilemma contains strategies that dominate any evolutionary opponent](http://www.pnas.org/content/early/2012/05/16/1206569109.full.pdf)” PNAS May 16.

Tom Bartlett “[To the Trickster Go the Spoils](http://chronicle.com/blogs/percolator/to-the-trickster-go-the-spoils/30940)” *Chronicle of Higher Education*, September 18, 2012

2. STRATEGIES AND ALGORITHMS FOR FINDING OPTIMUM

**LECTURE 5: Fitness Landscape models; Simulated Annealing; Genetic Algorithm (Tues, Feb 11)**

r Kauffman, *At Home in the Universe* (Oxford Univ Press, 1995) chapter 8, p 149-189

<http://www.theprojectspot.com/tutorial-post/simulated-annealing-algorithm-for-beginners/6>

r Mitchell, Melanie. 1996.*An Introduction to Genetic Algorithms*, Chapter 4: “Theoretical Foundations of Genetic Algorithms” (Cambridge, MA: MIT): 117-131

Genetic Algorithm. <http://www.obitko.com/tutorials/genetic-algorithms/ga-basic-description.php>. Videos on Youtube and elsewhere: <http://medal-lab.org/blog/not-your-grandmothers-genetic-algorithm/> – start at 5 min. for substance; 4 Minute Cartoon explanation <https://www.youtube.com/watch?v=Y-XMh-iw07w>

**LECTURE 6: Economics/Math of Search and Dispersion of Prices/Wages (Thurs, Feb 13)**

Zaretsky, A & C.Coughlin. 1995. “[Introduction to the Theory and Estimation of a Job Model Search,”](http://research.stlouisfed.org/publications/review/95/01/Theory_Jan_Feb1995.pdf) St. Louis Fed.

The Envelope Game (Secretary Problem), <http://www.uh.edu/engines/epi2040.htm>

Bruss, T. “[The Art of a Right Decision: Why decision makers may want to know the odds-algoritn”](http://www.ems-ph.org/journals/newsletter/pdf/2006-12-62.pdf) see pg 14-20.

**LECTURE 7: Algorithms Beating Us in Complex Games: Reinforcement Learning (Tues, Feb 18)**

Alpha Go Team Silver, et al. 2016. “[Mastering the game of Go with deep neural networks and tree search](https://www.researchgate.net/publication/292074166_Mastering_the_game_of_Go_with_deep_neural_networks_and_tree_search) *Nature* 529 (28 Jan): 484-9.

Gibney E. 2016. “[Google Masters Go: Deep learning softare excels at complex ancient board game](https://www.nature.com/news/polopoly_fs/1.19234!/menu/main/topColumns/topLeftColumn/pdf/529445a.pdf).” *Nature* 529 (Jan 28): 445-6.

Kach, Cristof <https://www.scientificamerican.com/article/how-the-computer-beat-the-go-master/>

<https://en.wikipedia.org/wiki/Computer_Go>

Cho, Adrian. 2016. “’[Huge Leap Forward’: Computer that mimics human brain beats professional at game of Go](https://www.sciencemag.org/news/2016/01/huge-leap-forward-computer-mimics-human-brain-beats-professional-game-go),” *Science* (Jan 26).

**LECTURE 8: Power of Markets Without Brains or Strategy: Minority Game (Thurs, Feb 20)**

Gode, D.K. and S. Sunder. 1993. “[Allocative Efficiency of Markets with Zero-Intelligence Traders](http://links.jstor.org/sici?sici=0022-3808(199302)101%3A1%3c119%3AAEOMWZ%3e2.0.CO%3B2-3),” *Journal of Political Economy* 101:1 (February) pp: 119-137

r/gs Casti, John. 1995-96. “[Seeing the Light at El Farol](http://onlinelibrary.wiley.com.ezp-prod1.hul.harvard.edu/doi/10.1002/cplx.6130010503/pdf),” *Complexity* vol 1:5: pp 7-10

Buchanan, Mark, 2012: “[A Bar May Be the Place to Understand Markets](http://www.bloomberg.com/news/2012-02-07/a-bar-may-be-best-place-to-understand-markets-commentary-by-mark-buchanan.html)”   
and “The [Physics of Finance](http://physicsoffinance.blogspot.com/2012/02/minority-games.html)” Blogspot.

r/gs Arthur, W. 1994. “[Inductive Reasoning and Bounded Rationality](http://www.jstor.org.ezp-prod1.hul.harvard.edu/stable/2117868?seq=1#page_scan_tab_contents)” *AEA Papers & Prcdings*, 84:2 (May): 406-411.

Zhang, Y.-C.. 1998. “[Modeling Ma](http://arxiv.org/pdf/cond-mat/9803308.pdf)[rket Mechanism with Evolutio](http://arxiv.org/pdf/cond-mat/9803308.pdf)[nary Games](http://arxiv.org/pdf/cond-mat/9803308.pdf)” *Europhysic News* (March-April):1-4.

Laureti, P, P. Ruch, J.Wakeling, and Y-C. Zhang. 2003. “[The Interactive Mino](http://arxiv.org/ftp/nlin/papers/0309/0309033.pdf)[rity Game: a Web-based investigation of human market interactions](http://arxiv.org/ftp/nlin/papers/0309/0309033.pdf),” *Physica* A v. 331 (July) 651-659

3. NETWORKS AND POWER LAWS

**LECTURE 9: Power Laws: Distribution of Size (Tues, Feb 25)**

r Hunter, Phillip. 2003. “The Power of Power Laws,” *The Scientist*, 17(8) (April 21) pp: 22.

Axtell, R. 2001. “[Zipf Distribution of US Firm Sizes](http://www.uvm.edu/~pdodds/files/papers/others/2001/axtell2001a.pdf)” *Science* 293:5536 (September 7) pp: 1818-1820.

r/gs Smethhust, D. P. and Williams, H.C. 2001. “[Power Laws: Are Waiting Lists Self-regulating](http://www.nature.com.ezp-prod1.hul.harvard.edu/nature/journal/v410/n6829/abs/410652a0.html)?” *Nature* 410: 6829, pp 652-653 (April 5.).

Adamic, L. and B Huberman. 2001. “[The Web’s Hidden Order](http://www.hpl.hp.com/research/papers/weborder.pdf),” *Communications of the ACM*, 44:9 (Sep): 1-4.

Mitzenmacher, Michael, “[A Brief History of Generative Models for Power Law and Lognormal Distributions](http://www.eecs.harvard.edu/~michaelm/NEWWORK/postscripts/history.pdf)”

r/gs Gabaix, Xaviar. 1999. “[Zipf’s Law for Cities](http://www.jstor.org.ezp-prod1.hul.harvard.edu/stable/2586883?seq=1#page_scan_tab_contents),” *Quarterly Journal of Economics*, Vol 114:3 (Aug).pp 739-67.

r/gs Farrior CE, Bohlman SA, Hubbell S, Pacala S “[Dominance of the suppressed: Power-law size structure in tropical](http://science.sciencemag.org.ezp-prod1.hul.harvard.edu/content/351/6269/155.short) [Forests](http://science.sciencemag.org.ezp-prod1.hul.harvard.edu/content/351/6269/155.short).” *Science.* 2016 Jan 8:155-7.

**LECTURE 10: Benford's Law: Distribution of Digits (Thurs, Feb 27)**

Lines, Malcom E. 1986. *A Number for Your Thoughts: Facts and Speculations About Numbers from Euclid to then Latest Computers*: (London: England: Inst of Physics Publishing): Ch 6: “The Baffling Law of Benford) pp 43-53.

Hill, Ted. 1998. “[The First Digit Phenomenon,”](http://www.americanscientist.org/issues/feature/1998/4/the-first-digit-phenomenon) *American Scientist*  (July-August) pp 358-363.

Hill, Ted. 1997. “[Benford’s Law](http://en.wikipedia.org/wiki/Benford's_law) ,” *Encyclopedia of Mathematics Supplement*, Vol. 1, p. 102 (Kluwer).

**LECTURE 11: Random Graphs and Small Worlds (Tues, Mar 3)**

Watts, D., Strogarz, S. 1998. “[Collective Dynamics of small world networks,”](http://www.nature.com/nature/journal/v393/n6684/abs/393440a0.html) *Nature* Vol 393:4 pp 440-42.

Adamic, Lada. “[The Small World Web](http://www.hpl.hp.com/shl/papers/smallworld/smallworldpaper.html)” Information Dynamics HP Labs.

Kleinberg, Jon. 2000. “[Navigation in a small world](http://www.cs.cornell.edu/home/kleinber/nat00.pdf),” *Nature* 406 (Aug 24) p: 845.

Barabasi, A-L and E. Bonabeau. 2003 [“Scale Free Networks,”](http://www.barabasilab.com/pubs/CCNR-ALB_Publications/200305-01_SciAmer-ScaleFree/200305-01_SciAmer-ScaleFree.pdf) *Scientific American* 288 (May 2003), pp 50-59

Durett, R, “[The New Science of (Random) Networks: Two Books Reviewed”](http://www.ams.org/notices/200402/rev-durrett.pdf) *Notices of AMS* Feb 2004: 201-04

**LECTURE 12: Network Models (Thurs, Mar 5)**

r Bak, Per. *How Nature Works* (Oxford Univ Press, 1997), chapters 1, 3, 7.

r Raup, D.M.1997. “A Breakthrough Book? Review of How Nature Works” *Complexity* Vol 2:6 (July/Aug): 30-32.

Horgan, John. 1995. [“From Complexity to Perplexity,”](http://www2.econ.iastate.edu/tesfatsi/hogan.complexperplex.htm) *Scientific American* Vol 272:6 (June) pp 104-109.

r Porter, M. &M. Stumpf. 2012. “Critical Truths About Power Laws” *Science*, 335:6069 (Feb 10): 665-666.   
 Ball, Philip “[Too Darn Hot](http://www.nature.com/news/2000/000317/full/news000323-2.html)” *News at Nature.com*, March 17/00.

Carlson, J.M. and J Doyle. 2002. “[Complexity and Robustness](http://www.pnas.org/content/99/suppl.1/2538.full),” *PNAS.* Vol 99: suppl 1 (Feb 19) pp 2438-45.

“Highly Optimized Tolerance,” <http://www.physics.ucsb.edu/~complex/research/hot.htm>

r Mullins, J. 2014. “42nd St Paradox: Cull the best to make things better,” 16 January, *New Scientist* 2952:30-33

*MIT Tech Review*. Feb 19, 2013 [Braess’ Paradox Infects Social Networks Too, Say Computer Scientists](http://www.technologyreview.com/view/510801/braess-paradox-infects-social-networks-too-say-computer-scientists/)

Skinner, Brian. 2011. “[The price of anarchy in basketball](http://arxiv.org/pdf/0908.1801v4.pdf)” Arxiv.org

**LECTURE 13: Networks in Science (Tues, Mar 10)**

Newman, M.E.J. “[Who is Best Connected Scientist](http://www.santafe.edu/research/publications/workingpapers/00-12-064.pdf)?

Newman, M.E.J. 2004. [“Coauthorship Networks and Patterns of Scientific Collaboration,”](http://www.pnas.org/content/98/2/404.full) *PNAS* 101: suppl 1 (April 6): 5200-5205.

Newman, M.E.J. 2001. “[The Structure of Scientific Collaboration Networks](http://links.jstor.org.ezp1.harvard.edu/sici?sici=0027-8424(20010116)98:2%3c404:TSOSCN%3e2.0.CO;2-1),” *PNAS* 98:2 (Jan 16): 404-09.

Watts, D “[Social contagion: What do we really know](http://www.poptech.org/e1_duncan_watts)? March 19, 2012. Pop!Tech

MJ. Salganik, P, Sheridan Dodds, Duncan J. Watt, 2006. “[Experimental Study of Inequality and Unpredictability in an Artificial Cultural Market](http://www.princeton.edu/~mjs3/salganik_dodds_watts06_full.pdf)” *Science,* 10 Feb 2006, VOL 311.

Hotis, Kooti, and Lerman. 2013. [Friendship Paradox Redux: Your Friends Are More Interesting Than You](http://arxiv.org/pdf/1304.3480v1.pdf)

Eom and Jo. 2014. “[Generalized friendship paradox in complex networks](http://arxiv.org/pdf/1401.1458v1.pdf)”

**SPRING BREAK: Thursday March 12 (no class) through March 22**

**LECTURE 14: Financial Disasters and Econophysics (Tues, Mar 24)**

Mandelbrot, Benoit and Nassim Taleb. 2006. “[A focus on the exceptions that prove the rule](http://www.ft.com/intl/cms/s/2/5372968a-ba82-11da-980d-0000779e2340.html#axzz3yHjA6LWU)” FT, March 23.

r Taleb, Nassim, *The Black Swan*, chapters 12, 15-17;

Farmer, J. Doyne and Andrew Lo. 1999. “[Frontiers of Finance: evolution and efficient markets,](http://www.pnas.org/content/96/18/9991.full.pdf)” *Proceedings of the National Academy of Science*, vol 96 (August) pp 9991-2.

r Arthur, Brian. 1995. “Complexity in Economic and Financial Markets,” *Complexity*, Vol 1:1 pp 20-25

Thurner, Stefan, J.Doyne Farmer, and John Geanakopolos. 2012. “[Leverage causes fat tails and clustered volatility](http://tuvalu.santafe.edu/~jdf/papers/LeverageFatTails.pdf)” *Quantitative Finance*, Vol. 12, No. 5, May, 695–707.

T. Lux. 2008. “[Applications of Statistical Physics in Finance and Economics](http://www.ifw-members.ifw-kiel.de/publications/applications-of-statistical-physics-in-finance-and-economics/KWP_1425_Applicati)” Kiel WP No. 1425 (June).

MONKEY MARKETS: https://www.youtube.com/watch?v=DUd8XA-5HEk

4. LARGE DATA SETS TO THE RESCUE?

**LECTURE 15: Data Mining and Global Search Neural Net models (Thurs, Mar 26)**

r Klimasauskas, C. 1996. "Applying Neural Networks", chapter 3 in R. Trippi and E. Turban *Neural Networks in Finance and Investing*, pp 47-71.

r Elder, John F. and Daryl Pregibon. 1996. “A Statistical Perspective on Knowledge Discovery in Databases,” Ch 4 in Fayyad, Usama M., Gregory Piatetsky-Shapiro, Padhraic Smyth, and Ramasamy Uthurusamy (eds) *Advances in Knowledge Discovery and Data Mining* (MIT Press) pp 83-113

Friedman, Jerome H. 1997. “[Data Mining and Statistics: What’s the Connection?](http://www.salford-systems.com/doc/dm-stat.pdf)” mimeo, Stanford Univ, Dept of Statistics and Stanford Linear Accelerator Center, pp 1-7.

Bhandari, et al. “[Advanced Scout: Data Mining and Knowledge Discovery in NBA Data](http://www.msci.memphis.edu/~linki/7118f00present/NBA.pdf),” *Data Mining and Knowledge Discovery* 1 (1997): 121-125.

**LECTURE 16: Tree Models, Rule-Based Models, (Tues, Mar 31)**

McAfee, A. and E. Brynjolfsson. 2012. “[Big Data: The Management Revolution](http://hbr.org/2012/10/big-data-the-management-revolution/ar/1)” *Harvard Business Review¸*Oct.

Davenport T. & D.J. Patil. 2012. “[The data Scientist: The Sexiest Job of the 21st Century](http://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century/ar/1)”, *Harvard Bus Review (Oct).*

Barton, Dominic and David Court. 2012. “[Making Analytics Work for You](http://hbr.org/2012/10/making-advanced-analytics-work-for-you/ar/1)”, *Harvard Business Review (*October).

Hutchinson, James, Andrew Lo, Tomas Poggio. 1994. “[A Non-Parametric A](http://links.jstor.org/sici?sici=0022-1082(199407)49%3A3%3c851%3AANATPA%3e2.0.CO%3B2-D)[pproach to Pricing and Hedging Derivative Securities Via Learning Networks](http://links.jstor.org/sici?sici=0022-1082(199407)49%3A3<851%3AANATPA>2.0.CO%3B2-D),” *Journal of Finance* Vol 49: 3 (July), pp 851-889.

Rulequest Research Data mining Tools. <http://www.rulequest.com/>

Treeratpituk, Pucktada, and C.Lee Giles. 2009. “[Disambiguating Authors in Academic Publications using Random Forests](http://clgiles.ist.psu.edu/papers/JCDL2009-random-forests-disambiguation.pdf),” *JCDL’09* (June 15–19, 2009) Austin, Texas, USA.

**LECTURE 17: Real Time Analysis – Concept Drift; Volatility (Thurs, April 2)**

gs Choi, Hyunyoung, Hal Varian, “[Predicting Initial Claims for Unemploym](http://static.googleusercontent.com/external_content/untrusted_dlcp/research.google.com/en/us/archive/papers/initialclaimsUS.pd)[ent Benefits](http://static.googleusercontent.com/external_content/untrusted_dlcp/research.google.com/en/us/archive/papers/initialclaimsUS.pd),” July 5, 2009

Chevalier, Judith and Austan Goolsbee, [“Measuring Prices and Price Competition Online:](http://faculty.chicagobooth.edu/austan.goolsbee/research/amzn.pdf) [Amazon.com and Barnes and Noble.com](http://www.springerlink.com.ezp-prod1.hul.harvard.edu/content/h7h4l6503qu3hp58/fulltext.pdf),” *Quantitative Marketing and Economics,* vol 1:2 (June 2003): 203–222.

James Surowiecki “[A Billion Prices Now](http://www.newyorker.com/talk/financial/2011/05/30/110530ta_talk_surowiecki?printable=true)” *New Yorker* May 30, 2011; <http://bpp.mit.edu/>

**LECTURE 18: Concentration of Measure/Fat Tails/ Stats of Extremes (Tues, April 7)**

T Poggio & S Smale. 2003. “[The Mathematics of Learning: Dealing with Data](http://www.ams.org/notices/200305/fea-smale.pdf)” *Notices of AMS* 50:5(May): 537-544.

Donoho, David,“[Aide-Memoire. High-Dimensional Data Analysis: The Curses and Blessings of Dimensionality](http://www-stat.stanford.edu/~donoho/Lectures/AMS2000/Curses.pdf)”

A. Clauset, C.R. Shalizi, and M.E.J. Newman. 2009. "Power-law distributions in empirical data" SIAM Review 51(4), 661-703. <http://arxiv.org/pdf/0706.1062.pdf>

Y. Virkar and A. Clauset. 2012. "[Power-law distributions in binned empirical data](http://arxiv.org/abs/0706.1062)", arXiv:1208.3524 (2012)

**LECTURE 19: Meta-statistics: creating large data from many studies (Thurs, April 9)**

Anderson, Richard G. and Areerat Kichkha. 2017. "[Replication, Meta-analysis, and Research Synthesis in](https://www.jstor.org/stable/44250360?seq=1#metadata_info_tab_contents) Economics." *American Economic Review*, 107(5): 56-59.

r Doucouliagos, H., R. Freeman, and P. Laroche. 2018. “[How Credible Is Trade Union Research? Forty Years of Evidence on the Monopoly–Voice Trade-Off](http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=heh&bquery=JN+%26quot%3bILR+Review%26quot%3b+AND+DT+20180301&type=1&searchMode=Standard&site=ehost-live&scope=site),” *Industrial and Labor Relations Review* 71(2): 287-305.

Havranek, T. Z Irsova and O. Zeynalova. 2018. “[Tuition Fees and University Enrolment: A Meta‐Regression Analysis](http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=132626394&site=ehost-live&scope=site)” *Oxford Bulletin of Economics and Statistics* 80:6 (December): 1145-1184

5. SMALL DATA SETS/SURVEYS TO THE RESCUE?

**LECTURE 20: Fuzzy Logic and Expert Systems (Tues, April 14)**

Fuzzy Logic <http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4/sbaa/report.html>

Xpert Rule Software. “[White Paper: Fuzzy Logic in Knowledge Builder](http://www.attar.com/pages/fuzzy.htm)”

Zadeh, L. “[Is there a need for fuzzy logic?”](http://www.eecs.berkeley.edu/~zadeh/papers/Is%20there%20a%20need%20for%20fuzzy%20logic.pdf)  *Information Sciences* 178 (2008) 2751–2779.

**LECTURE 21: Case studies via QCA Boolean Models (Thurs, April 16)**

Freedman, David A. “[Black Ravens, White Shoes, and Case Selection](http://www.stat.berkeley.edu/~census/crow.pdf)” [www.stat.berkeley.edu/~census/crow.pdf](https://www.stat.berkeley.edu/~census/crow.pdf)

Ragin, C. 1987. *The Comparative Method: Moving Beyond Qualitative & Quantitative Strategies.*Ch 6 (UC Press).

D.M. Cress & D. A. Snow. 2000. “[The Outcomes of Homeless Mobilization](http://www.jstor.org/stable/3003888): The Influence of Organization, Disruption, Political Mediation, and Framing,” *Journal of Sociology*, Vol. 105, No. 4 (Jan.), pp. 1063-110

**LECTURE 22: Wisdom of Crowds, futures markets (Tues, April 21)**

r Surowiez, James, chapters 1-9 from Wisdom of Crowds

Wolfers, Justin and Eric Zitzewitz “[Prediction Markets”](http://www.eecs.harvard.edu/cs286r/courses/fall12/papers/Predictionmarkets.pdf) *Journal of Economics Perspectives* 18:2 107-126

*Journal of Prediction Markets*, see what interests you [www.ingentaconnect.com/content/ubpl/jpm](http://www.ingentaconnect.com/content/ubpl/jpm)

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6. SIMULATIONS TO THE RESCUE?

**LECTURE 23: Systems Dynamics Models & Artificial Agent Models and Applications (Thurs, April 23)**

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**IN-CLASS FINAL EXAM ON LAST DAY – focused on post take-home exam material (Tues, April 28).**

**RESEARCH PAPERS DUE: Friday May 8**