

Laurence Brandenberger, Ramona Roller
Syllabus

1/19

Syllabus






Data Science for Social Challenges

Laurence Brandenberger, Ramona Roller






ETH Zurich, Switzerland







Block 1: Simple Inference

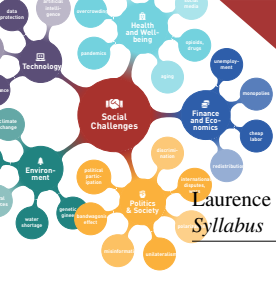
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|---|--|--|
|  | Lecture 1: What are pressing social challenges? | Exercise 1: Introduction to R |
| Introduction | | |
|  | Lecture 2: The gender pay gap | Exercise 2: Linear Regression |
| Week 2 | | |
|  | Lecture 3: Energy crisis: Project failures | Exercise 3: Logistic Regression |
| Week 3 | | |
|  | Lecture 4: The loneliness epidemic | Exercise 4: Panel Regression |
| Week 4 | | |
|  | Presentation S. Schlosser, MSc | Student Presentation 1 |
| Week 5 | | |

Block 2: Causal Inference

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|---|--|-------------------------------|
|  | Lecture 5: Causal Concepts | Student Presentation 2 |
| Week 6 | | |
|  | Lecture 6: Poverty and the minimum wage | Exercise 5: DiD |
| Week 7 | | |
|  | Lecture 7: Democracy and polit. participation | Exercise 3: Matching |
| Week 8 | | |
|  | Presentation G. Russo, MSc | Student Presentation 3 |
| Week 9 | | |
|  | Presentation G. Andres, MSc | Student Presentation 4 |
| Week 10 | | |

Block 3: Complex Inference

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|---|---|---------------------------------------|
|  | Lecture 8: Human migration | Exercise 6: Baselines |
| Week 11 | | |
|  | Lecture 9: Legalizing cannabis | Exercise 7: Network measures |
| Week 12 | | |
|  | Lecture 10: Information overflow | Exercise 8: Network regression |
| Week 13 | | |
|  | Open discussion | |
| Week 14 | | |



Block 1: Simple Inference

Week 1: What are pressing social challenges?

In the first part of the lecture, we discuss the role of social sciences in solving social challenges. We examine the basic elements of quantitative analyses: the research question, operationalization, the role of dependent, independent and control variables and how they form the basis for quantitative analyses (especially regressions). Further, we give an overview over the course and present the course requirements, i.e., assessments.



Lecture

Tuesday, September 20, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, September 23, 2022, 9-10am, Room LEE-F-118



Learning goal

Link between theory and empirics
The difficulties in operationalization of concepts

Method-focus

Basics behind regression analyses



Exercise

Introduction to R
Our favorite R-tutorial is: **R for Data Science**, <https://r4ds.had.co.nz>

Data

High-school data set.

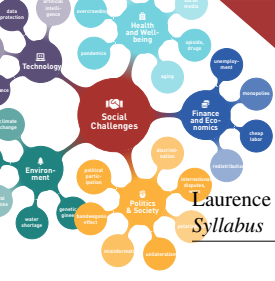


Reading

Angrist, J. D.; Pischke, J.-S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton NJ: Princeton University Press, Chapter 3—Making Regression Make Sense

Favorite blogs

Scientific American. <https://www.scientificamerican.com>Complexity Digest. <https://comdig.unam.mx>Nature. Human behavior. <https://www.nature.com/nathumbehav/>Causal Inference. <https://mixtape.scunning.com>Freakonomics. <https://freakonomics.com> (Podcast)FiftyThirtyEight. <https://fivethirtyeight.com>Linear Digressions. <http://lineardigressions.com/> (Podcast)



Block 1: Simple Inference

Week 2: Gender wage gap

This week we are investigating the gender wage gap. Evidence suggests that a large portion of the gender wage gap can be explained once we compare like with like, for example, the career-obsessed male lawyer vs the career-obsessed female lawyer rather than vs the unmotivated female nurse. However, despite accounting for these occupational and individual characteristics, a portion of the gender wage gap remains unexplained. Theorizing about societal feedback loops, we examine social processes that may explain this portion.



Lecture

Tuesday, September 27, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, September 30, 2022, 9-10am, Room WEV-H-326



Learning goal

Difference between unadjusted and adjusted gender wage gap.
Understanding concepts of moderating, mediating, confounding, and colliding.
Modeling complex societal relations, such as between discrimination and occupation.



Method-focus

Linear regression



Exercise

Linear regression, interaction effects.



Data

High-school data set.



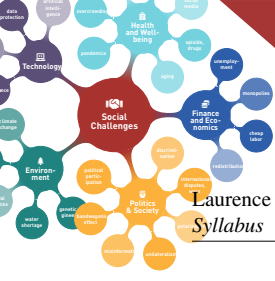
Reading

Angrist, J. D.; Pischke, J.-S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton NJ: Princeton University Press, Chapter 3—Making Regression Make Sense.

Muench, U.; Simon, M.; Guerbaai, R.-A.; De Pietro, C.; Zeller, A.; Kressig, R. W.; Zúñiga, F. (2019). Preventable hospitalizations from ambulatory care sensitive conditions in nursing homes: evidence from Switzerland. *International journal of public health* **64(9)**, 1273–1281

Dinovitzer, R.; Reichman, N.; Sterling, J. (2009). The differential valuation of women's work: A new look at the gender gap in lawyers' incomes. *Social Forces* **88(2)**, 819–864

Scientific American, 2017. The Persistent Problem of Gender Inequality. By Amanda Montanez.



Block 1: Simple Inference

Week 3: Renewable energy project failures

This week we are examining why the energy crisis has not been solved yet. Evidence suggests, the energy crisis could be solved with our current technical skills, yet many renewable energy projects face strong opposition and fail to come to fruition. Using the concept of social acceptance, we examine factors that are associated with renewable project success.



Lecture

Tuesday, October 4, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, October 7, 2022, 9-10am, Room WEV-H-326



Learning goal

Difference between social and technical problems.
Understanding the concept of social acceptance and why it matters.
Operationalitaion of latent concepts (such as public opinion).



Method-focus

Logistic regression



Exercise

Logistic regression, interaction effects, marginal effects.



Data

Titanic data set.



Reading

Harper, M.; James, P.; Anderson, B.; Bahaj, A. (2017). Identifying key influences for planning acceptance of onshore wind turbines

Langer, K.; Decker, T.; Roosen, J.; Menrad, K. (2018). Factors influencing citizens acceptance and non-acceptance of wind energy in Germany. *Journal of Cleaner Production* **175**, 133–144

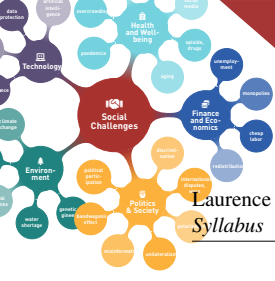
Scientific American, 2022: Renewable Energy Is Surging, but Trouble Looms. By Benjamin Storrow.

Scientific American, 2022: Three Fixes to Build Energy Projects Cleaner and Faster. By Rich Powell.

Spiceworks, 2022: What Is Logistic Regression? Equation, Assumptions, Types, and Best Practices. By Vijay Kanade.

Firestone, J.; Kirk, H. (2019). A strong relative preference for wind turbines in the United States among those who live near them. *Nature Energy* **4(4)**, 311–320

Cory, J.; Lerner, M.; Osgood, I. (2021). Supply chain linkages and the extended carbon coalition. *American Journal of Political Science* **65(1)**, 69–87



Block 1: Simple Inference

Week 4: The loneliness epidemic

This week we are diving into the topic of loneliness and how it is affecting the world population's mental and physical health. What are the drivers behind the growing loneliness epidemic that is spreading across western societies? How can loneliness be reliably measured? And how can changes in loneliness be identified?



Lecture

Tuesday, October 11, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, October 14, 2022, 9-10am, Room WEV-H-326



Learning goal

Operationalitaion of latent concepts.
Understanding the difficulties in mental and physical health tracking.
Understanding between- and within effects.
Understanding the limitations of cross-sectional research designs.



Method-focus

Panel regression (including FE/RE). Panel attrition and rotation.



Exercise

Panel regression.



Data

US gun carry laws.



Reading

Harper, M.; James, P.; Anderson, B.; Bahaj, A. (2017). Identifying key influences for planning acceptance of onshore wind turbines

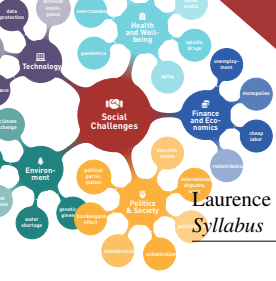
Yao, M. Z.; Zhong, Z.-j. (2014). Loneliness, social contacts and Internet addiction: A cross-lagged panel study. *Computers in Human Behavior* **30**, 164–170

Stepanikova, I.; Nie, N. H.; He, X. (2010). Time on the Internet at home, loneliness, and life satisfaction: Evidence from panel time-diary data. *Computers in Human Behavior* **26(3)**, 329–338

Low, D. M.; Rumker, L.; Talkar, T.; Torous, J.; Cecchi, G.; Ghosh, S. S. (2020). Natural language processing reveals vulnerable mental health support groups and heightened health anxiety on reddit during covid-19: Observational study. *Journal of medical Internet research* **22(10)**, e22635

Kahlon, M. K.; Aksan, N.; Aubrey, R.; Clark, N.; Cowley-Morillo, M.; Jacobs, E. A.; Mundhenk, R.; Sebastian, K. R.; Tomlinson, S. (2021). Effect of layperson-delivered, empathy-focused program of telephone calls on loneliness, depression, and anxiety among adults during the COVID-19 pandemic: A randomized clinical trial. *JAMA psychiatry* **78(6)**, 616–622

Cigna, 2022. The Loneliness Epidemic Persists: A Post-Pandemic Look at the State of Loneliness among U.S. Adults.



Intermezzo

Week 5: Political representation + professionalization

This week we examine the importance of political representation for our society. We discuss different forms of representation and democracy indices to assess the state of governments in terms of liberal values. The lecture is accompanied by a presentation on political professionalization from Sophia Schlosser, PhD Candidate at MTEC. Professionalization manifests in the choice of specific strategies of MPs to address certain topics. We discuss two building blocks of these strategies – issue engagement and issue linkage – and see how MPs use them to push their agenda.



Lecture

Tuesday, October 18, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, October 21, 2022, 9-10am, Room LEE-F-118



Learning goal

Assessing a real-world research design
Assessing relevance, reliability, generalizability.

Method-focus

Applied research: method-mix



Exercise

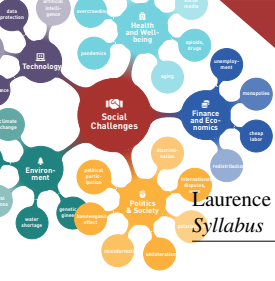
Student presentation: Peacekeeping missions;
alternative: R recap session

Reading

Dietrich, B. J. (2020). Using Motion Detection to Measure Social Polarization in the U.S. House of Representatives. *Political Analysis*, 1–61

Scientific American, 2020. Why Hatred and ‘Othering’ of Political Foes Has Spiked to Extreme Levels. By Christie Aschwanden

Neal, Z. P. (2020). A sign of the times? weak and strong polarization in the us congress, 1973–2016. *Social Networks* **60**, 103–112Shi, F.; Teplitskiy, M.; Duede, E.; Evans, J. A. (2019). The wisdom of polarized crowds. *Nature human behaviour* **3**(4), 329



Block 2: Causal Inference

Week 6: Causal concepts

This week we are learning to assess the effectiveness of interventions to social challenges, i.e., do interventions actually reduce the challenge? We discuss major fallacies about causal thinking and study an established statistical framework for causal inference: the potential outcome model.



Lecture

Tuesday, October 25, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, October 28, 2022, 9-10am, Room WEV-H-326



Learning goal

Understand the potential outcome model (POM) for causal inference.
Distinguish measures of causal effects from causal estimators.



Method-focus

Estimating causal effects



Exercise

Student presentation: Slavery and gun-ownership



Reading

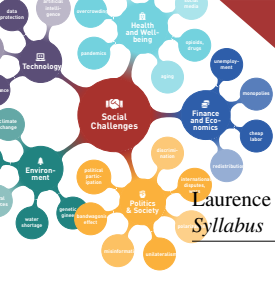
Angrist, J. D.; Pischke, J.-S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton NJ: Princeton University Press

Gangl, M. (2010). Causal inference in sociological research. *Annual review of sociology* **36**, 21–47

Cunningham, S. (2021). Causal Inference: The Mixtape. <https://mixtape.scunning.com/>, ch. 4: potential outcome model.

Rubin, D. B. (1974). Estimating causal effects of treatments in randomized and non-randomized studies. *Journal of educational Psychology* **66(5)**, 688

Splawa-Neyman, J. (1923). On the application of probability theory to agricultural experiments. Essay on principles. *Annals of Agricultural Sciences* **10**, 1–51



Block 2: Causal Inference

Week 7: Poverty and the minimum wage

This week we are examining the effects of the minimum wage on society. Traditionally, supporters of the minimum wage praise its potential to reduce poverty whereas its critics warn against rising unemployment since employers cannot afford to increase the salary of all employees. Equipped with the potential outcome model, we test these claims and estimate the causal effect of the minimum wage on society.



Lecture

Tuesday, November 1, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, November 4, 2022, 9-10am, Room WEV-H-326



Learning goal

Understand the pros and cons of the minimum wage
 Understand the concept of a natural experiment
 Understand and test the parallel trends assumption



Method-focus

Difference-in-differences (DD)



Exercise

Application of DD (2×2 research design)

Data

Soda tax data



Reading

Cunningham, S. (2021). Causal Inference: The Mixtape. <https://mixtape.scunning.com/>, ch. 5: difference-in-differences

Card, D.; Krueger, A. B. (1994). Minimum wages and employment: A case study of the fast food industry in New Jersey and Pennsylvania. *American Economic Review* **84**, 772–793

Kronenberg, C.; Jacobs, R.; Zucchelli, E. (2017). The impact of the UK National Minimum Wage on mental health. *SSM-population health* **3**, 749–755

Snow, J. (1855). *On the Mode of Communication of Cholera*. London: John Churchill, 2nd edn

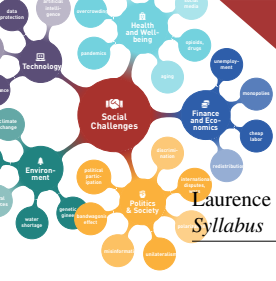
Miller, S.; Johnson, N.; Wherry, L. R. (2021). Medicaid and mortality: new evidence from linked survey and administrative data. *The Quarterly Journal of Economics* **136**(3), 1783–1829

Cantoni, D.; Dittmar, J.; Yuchtman, N. (2018). Religious competition and reallocation: The political economy of secularization in the protestant reformation. *The Quarterly Journal of Economics* **133**(4), 2037–2096

Manning, A. (2021). The elusive employment effect of the minimum wage. *Journal of Economic Perspectives* **35**(1), 3–26

Neumark, D.; Wascher, W. (1992). Employment effects of minimum and subminimum wages: panel data on state minimum wage laws. *ILR Review* **46**(1), 55–81

Neumark, D.; Wascher, W. (2002). Do minimum wages fight poverty? *Economic Inquiry* **40**(3), 315–333



Block 2: Causal Inference

Week 8: Democracy and political participation

This week we look at voter turnout and how democracies face a decline in voter attention. While a decline in voter turnout does not necessarily threaten democracy, it often goes hand in hand with a decline for certain groups/minorities. Thus, this inadvertent exclusion of certain groups from the democratic process threatens the legitimacy of western democracies. We examine factors that drive voter turnout, taking a particularly close look at effects of incarceration on political participation. To ensure empirical estimations are less biased, we look towards matching procedures to balance samples and estimate unbiased average treatment effects.



Lecture

Tuesday, November 1, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, November 4, 2022, 9-10am, Room WEV-H-326



Learning goal

Understanding selection bias in population samples.
 Understanding the basics of matching.
 Understanding when matching is necessary to correct selection effects.



Method-focus

Matching



Exercise

Matching



Data

US Congress data



Reading

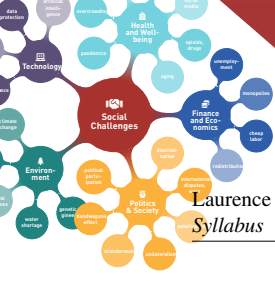
Angrist, J. D.; Pischke, J.-S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton NJ: Princeton University Press, Chapter 3.3—Heterogeneity and Nonlinearity

Iacus, S. M.; King, G.; Porro, G. (2012). Causal inference without balance checking: Coarsened exact matching. *Political analysis* **20(1)**, 1–24

Di Salvatore, J. (2019). Peacekeepers against Criminal Violence Unintended Effects of Peacekeeping Operations? *American Journal of Political Science* **63(4)**, 840–858

Weaver, V. M.; Lerman, A. E. (2010). Political consequences of the carceral state. *American Political Science Review* **104(4)**, 817–833

King, G.; Nielsen, R. (2019). Why propensity scores should not be used for matching. *Political Analysis* **27(4)**, 435–454



Intermezzo

Week 9: Online hate

This week we examine how online hate shapes online and offline behavior. As life shifts towards online experiences, so does information exchange and retrieval. Research finds a continuous pull towards moving in so-called echo-chambers, where information is limited to one point of view and thus exacerbates online and offline hate. The lecture is accompanied by a presentation from Giuseppe Russo, PhD Candidate at MTEC.



Lecture

Tuesday, November 15, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, November 18, 2022, 9-10am, Room WEV-H-326



Learning goal

Assessing a real-world research design
Assessing relevance, reliability, generalizability.

Method-focus

Applied research: method-mix



Exercise

Student presentation: Imprisonment and recommitment

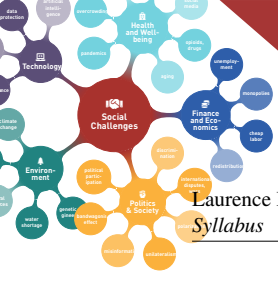


Reading

Scientific American, 2019. Researchers Model Online Hate Networks in Effort to Battle Them. by David Noonan.

Johnson, N. F.; Leahy, R.; Restrepo, N. J.; Velásquez, N.; Zheng, M.; Manrique, P.; Devkota, P.; Wuchty, S. (2019). Hidden resilience and adaptive dynamics of the global online hate ecology. *Nature* **573**(7773), 261–265

Scientific American, 2002. Why Social Media Makes Us More Polarized and How to Fix It by Damon Centola.



Intermezzo

Week 10: Network balance

This week we dive deeper into social networks and how positive and negative social ties drive interactions. The lecture is accompanied by a presentation from George Andres, PhD Candidate at MTEC.



Lecture

Tuesday, November 22, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, November 25, 2022, 9-10am, Room LEE-F-118



Learning goal

Assessing a real-world research design
Assessing relevance, reliability, generalizability.



Method-focus

Applied research: method-mix



Exercise

Student presentation: Opioids and politics



Reading

Newcomb, T. M. (1956). The prediction of interpersonal attraction. *American psychologist* **11(11)**, 575

Facchetti, G.; Iacono, G.; Altafini, C. (2011). Computing global structural balance in large-scale signed social networks. *Proceedings of the National Academy of Sciences* **108(52)**, 20953–20958

Festinger, L. (1962). *A Theory of Cognitive Dissonance*, vol. 2. Stanford CA: Stanford University Press



Block 3: Complex Inference

Week 11: Human migration

This week we dive into the topic of human migration. Humans have been migrating across borders for thousands of years and many acquisitions, such as the introduction of Arabic numbers in Europe, can be attributed to the flow of people. However, at least since the European ‘refugee crisis’ in 2015, migration has also sparked negative associations as migrants are often seen as a threat. We will learn that migration is subject to a complex network of interdependencies and analyse its driving factors.



Lecture

Tuesday, November 29, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, December 2, 2022, 9-10am, Room WEV-H-326



Learning goal

Understanding the concepts of a null hypothesis and null model.
Being familiar with the pros and cons of various types of null models, including pre-network and network permutations.



Method-focus

Randomization techniques



Exercise

Network permutation tests



Data

US Congress data

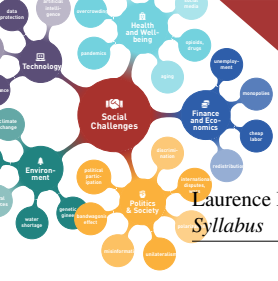


Reading

Farine, D. R. (2017). A guide to null models for animal social network analysis. *Methods in Ecology and Evolution* **8(10)**, 1309–1320

Yeo, J. (2018). Antecedents of Border Management Network in El Paso, Texas: An Exponential Random Graph Model. *Journal of Homeland Security and Emergency Management* **15(3)**, 20160011

Schon, J.; Johnson, J. C. (2021). How inter-state amity and animosity complement migration networks to drive refugee flows: A multi-layer network analysis, 1991–2016. *Plos one* **16(1)**, e0245712



Block 3: Complex Inference

Week 12: Legalizing Cannabis

This week we are addressing the question of whether cannabis should be legalized. We will learn that cannabis - like any drug - may cause harm on the individual and societal level. Hence, its legalization represents a social challenge. We will learn that the type and amount of harm of a drug do not only depend on its chemical properties but also on the legal situation. To examine the reasons why adolescents consume cannabis we will have a look at peer network analyses. We will discuss the major challenge of these analyses: disentangling social influence and social selection.



Lecture

Tuesday, December 6, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, December 9, 2022, 9-10am, Room WEV-H-326



Learning goal

Understand the dependence between cannabis usage and legal setting.
Be familiar with established network motifs and methods to compute and apply them.



Method-focus

Network motifs in regression, ERGMs, as test statistic for hypothesis testing.



Exercise

Network centrality measures, clustering, triadic closure.



Data

US Congress data.



Reading

Nutt, D. J.; King, L. A.; Phillips, L. D. (2010). Drug harms in the UK: a multicriteria decision analysis. *The Lancet* **376(9752)**, 1558–1565

Scientific American 2022. The Federal Government Should Decriminalize Marijuana. By Richard A. Grucza, Andrew D. Plunk.

Rivera, M. T.; Soderstrom, S. B.; Uzzi, B. (2010). Dynamics of dyads in social networks: Assortative, relational, and proximity mechanisms. *annual Review of Sociology* **36**, 91–115



Block 3: Complex Inference

Week 13: Information overload

This week we study information overload in our society and its effects on voting behavior. We are confronted with ever more sources of information. It matters which information we consume and how this information affects our behavior. We discuss how disinformation, the deliberate spread of empirically false information, affects voting behavior and may harm democracies. We will use network models to capture interdependencies between news producers and consumers.



Lecture

Tuesday, December 13, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, December 16, 2022, 9-10am, Room WEV-H-326



Learning goal

Understanding how network data feeds into conventional statistical/data science problems.
Combination of network analysis with conventional analyses.
Understanding how success can be made measurable and what the limitations are.



Method-focus

Network regression (gHype)



Exercise

Team network operationalizations, measuring their effect on bill passage.



Data

US Congress data.



Reading

Sciarini, P.; Fischer, M.; Gava, R.; Varone, F. (2021). The influence of co-sponsorship on MPs agenda-setting success. *West European Politics* **44**(2), 327–353

Scientific American, 2022. Senate Passes Historic Climate Bill
Heres What Comes Next by Benjamin Storrow.



Block 3: Complex Inference

Week 14: Mental health

This week is all about the topics you would like to discuss. Based on your suggestions, we chose mental health and principal component analysis (PCA) as the content for the lecture. We have a look at some global mental health statistics and discuss why mental health has become an uprising social challenge. Specifically, we examine the results of the VSETH survey that assessed mental health and other aspects of well-being among ETH students in 2019. To analyze surveys, we introduce PCA as a handy dimensionality reduction technique.



Lecture

Tuesday, December 20, 2022, 10am-12pm, Room WEV-F-109



Exercise

Friday, December 16, 2022, 9-10am, Room WEV-H-326



Learning goal

Understanding how network data feeds into conventional statistical/data science problems.
 Combination of network analysis with conventional analyses.
 Understanding how success can be made measurable and what the limitations are.



Method-focus

PCA



Exercise

Question hour

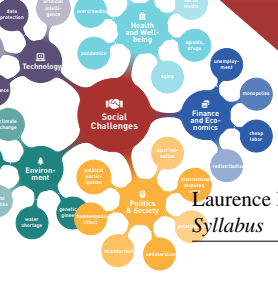


Data

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Reading

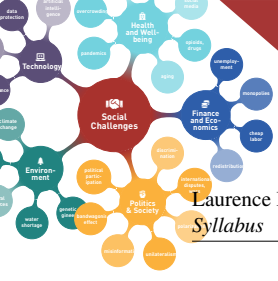


References

- Angrist, J. D.; Pischke, J.-S. (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton NJ: Princeton University Press.
- Cantoni, D.; Dittmar, J.; Yuchtman, N. (2018). Religious competition and reallocation: The political economy of secularization in the protestant reformation. *The Quarterly Journal of Economics* **133**(4), 2037–2096.
- Card, D.; Krueger, A. B. (1994). Minimum wages and employment: A case study of the fast food industry in New Jersey and Pennsylvania. *American Economic Review* **84**, 772–793.
- Cory, J.; Lerner, M.; Osgood, I. (2021). Supply chain linkages and the extended carbon coalition. *American Journal of Political Science* **65**(1), 69–87.
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- Di Salvatore, J. (2019). Peacekeepers against Criminal Violence Unintended Effects of Peacekeeping Operations? *American Journal of Political Science* **63**(4), 840–858.
- Dietrich, B. J. (2020). Using Motion Detection to Measure Social Polarization in the U.S. House of Representatives. *Political Analysis*, 1–61.
- Dinovitzer, R.; Reichman, N.; Sterling, J. (2009). The differential valuation of women's work: A new look at the gender gap in lawyers' incomes. *Social Forces* **88**(2), 819–864.
- Fachetti, G.; Iacono, G.; Altafini, C. (2011). Computing global structural balance in large-scale signed social networks. *Proceedings of the National Academy of Sciences* **108**(52), 20953–20958.
- Farine, D. R. (2017). A guide to null models for animal social network analysis. *Methods in Ecology and Evolution* **8**(10), 1309–1320.
- Festinger, L. (1962). *A Theory of Cognitive Dissonance*, vol. 2. Stanford CA: Stanford University Press.
- Firestone, J.; Kirk, H. (2019). A strong relative preference for wind turbines in the United States among those who live near them. *Nature Energy* **4**(4), 311–320.
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- Harper, M.; James, P.; Anderson, B.; Bahaj, A. (2017). Identifying key influences for planning acceptance of onshore wind turbines.
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