Critical Theory

and

quantification

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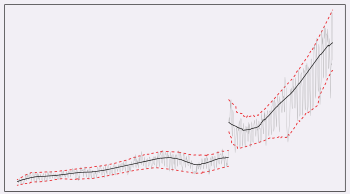
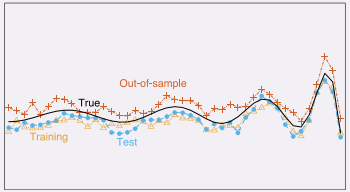
Histories of Artificial Intelligence: A Genealogy of Power
Mellon Sawyer Seminar Virtual Event
20 January 2021

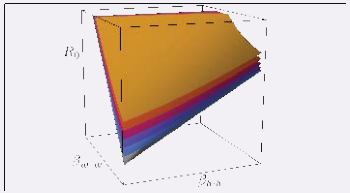
Roadmap/Works to discuss



“Identifying platform effects in social media data” (ICWSM 2016/dissertation 2018). Momin and adisor.



“A hierarchy of limitations in machine learning” (arXiv 2020/ forthcoming 2021). Momin alone.



“Reparations for Black American descendants of persons enslaved in the U.S. and their potential impact on SARS-CoV-2 Transmission” (medrxiv 2020/forthcoming 2021). Momin, Maya, + 9 others

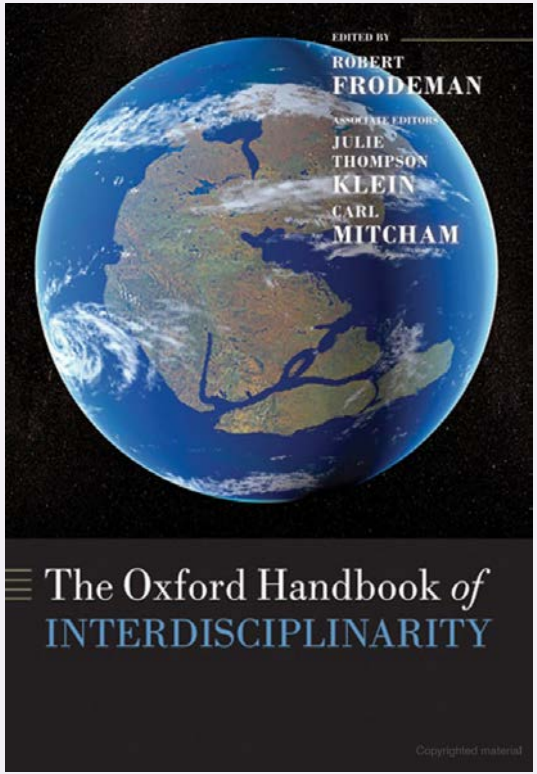
“Critical technical awakenings” (in submission, *Technology Ethics in Action*). Momin and Maya alone.

(Switch over to Maya)

Interdisciplinarity

- Department of the History of Science, Harvard University
- at Harvard University et & Society
- Oxford Internet Institute, University of Oxford
- Carnegie Mellon University School of Computer Science
- Carnegie Mellon University Societal Computing
- ML Machine Learning Department
- Data Science For Social Good Summer Fellowship
- Berkman Klein Center for Internet & Society at Harvard University

After reading through it all… I found the whole area disappointingly uninspiring →



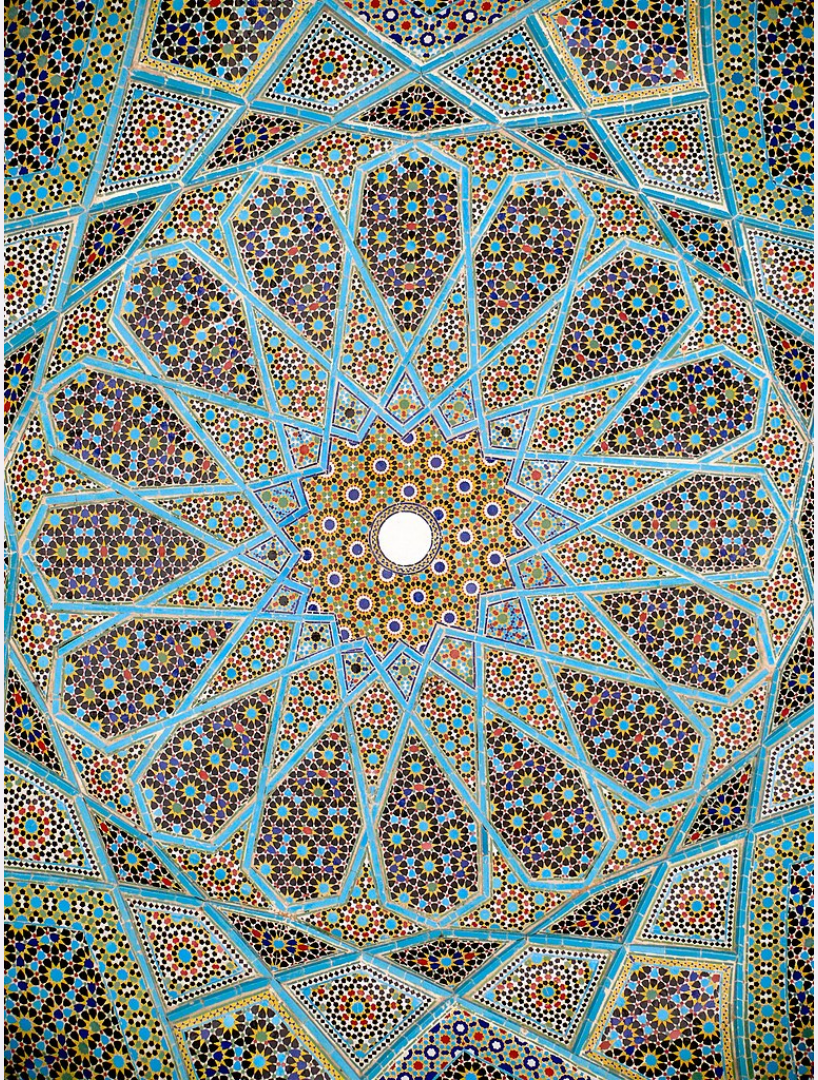
Thin/thick binary as a trap?

"…cultural studies have maintained a hermeneutics of suspicion toward the methods of quantification. But, to what extent does this suspicion toward quantitative inquiry compromise the deconstructive project of cultural studies by falling into the trap of the quantitative/qualitative and, related, nature/culture binaries?" (Dixon-Román 2016)

"Why, in a thick world, do economists stride with heads high through the corridors of power, while cultural historians pass along their possibly profound insights to one another? …we are dealing here not merely with a choice between alternative intellectual strategies of interpretation and analysis, but with practical ways of knowing the world and of shaping action." (Porter 2012)

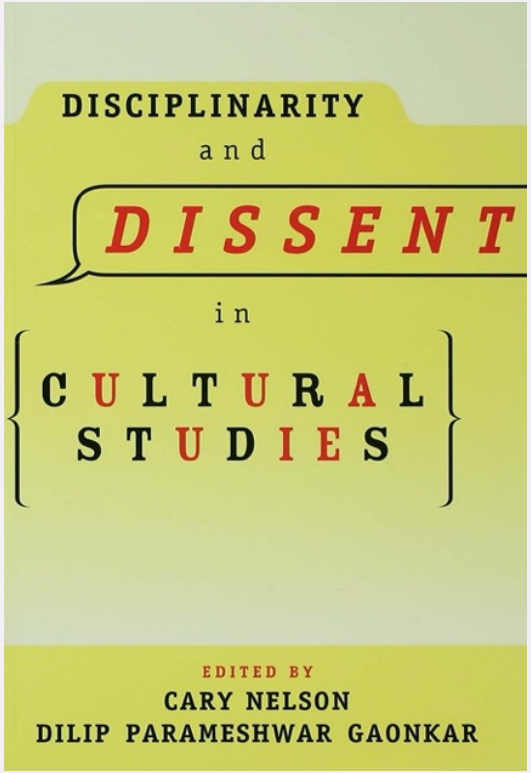
Symmetry?

~~Qual also good!~~
~~Quant also bad!~~
Qual also bad



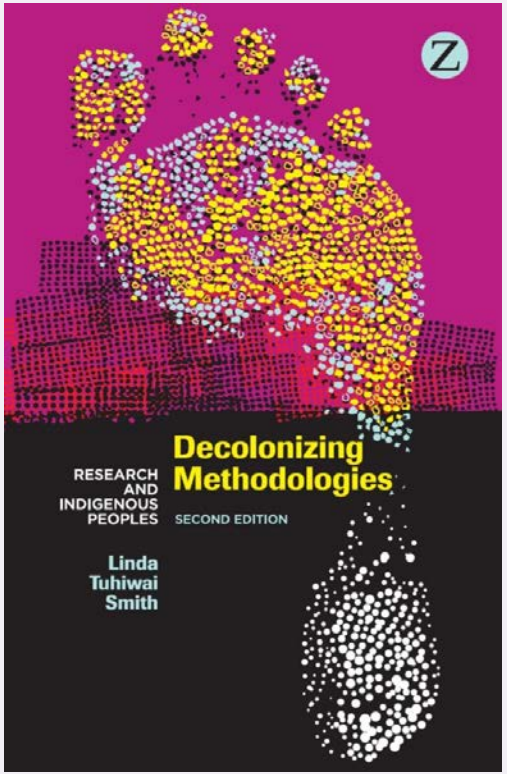
Does *intolerance* cut both ways?

"But that is how disciplines police their boundaries, by training their members to internalize them, naturalize them, and then fancy themselves free as birds. In some sectors of the culture… the unthinkable and undoable could be named and cast out when necessary. One of those sectors was the academy, and its disciplines would discipline unruliness whenever it arose." (Nelson and Gaonkar 1996)



Qual not *intrinsically* better

“we are suggesting that anthropological analyses (of pain and passion and power), when they are experience-distant, are at risk of delegitimating their subject matter's human conditions. The anthropologist thereby constitutes a false subject; she can engage in a professional discourse every bit as dehumanizing as that of colleagues who unreflectively draw upon the tropes of biomedicine or behaviorism to create their subject matter.” (Kleinman and Kleinman 1991; also, Smith 2012 →)



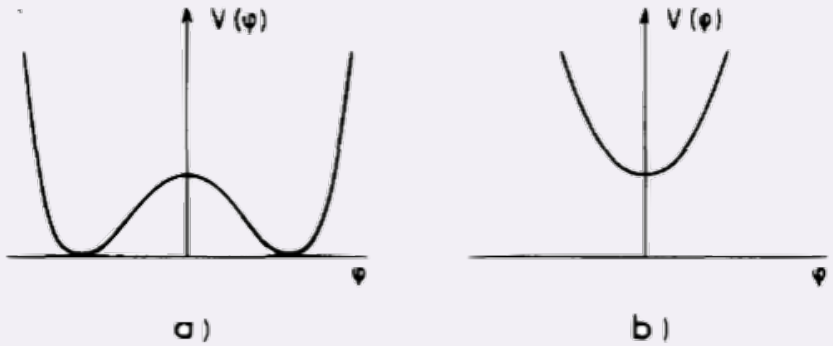


Fig. 1. Representation of the potential $V(\varphi)$ in a supersymmetric gauge theory, in terms of the complex scalar field φ. (a) Supersymmetry is conserved (for $\langle\varphi\rangle = 0$ it would be spontaneously broken, but the corresponding vacuum state is unstable). (b) Supersymmetry is spontaneously broken.

Asymmetry!
[incommensurabilities]

Methodology 101, day 1…

Issue	Positivism	Postpositivism	Critical theory et al.	Constructivism	Participatory
Ontology	Naïve realism—"real" reality but apprehensible	Critical realism—"real" reality but only imperfectly and probabilistically apprehensible	Historical realism—virtual reality shaped by social, political, cultural, economic, ethnic, and gender values; crystallized over time	Relativism—local and specific co-constructed realities	Participative reality—subjective-objective reality, cocreated by mind and given cosmos
Epistemology	Dualist/objectivist; findings true	Modified dualist/objectivist; critical tradition/community; findings probable true	Transactional/subjectivist; value-mediated findings	Transactional/subjectivist; co-created findings	Critical subjectivity in participatory transaction with cosmos; extended epistemology of experimental, propositional, and practical knowing; cocreated findings
Methodology	Experimental/ manipulative; verification of hypotheses; chiefly quantitative methods	Modified experimental/manipulative; critical multiplism; falsification of hypotheses; may include qualitative methods	Dialogic/dialectical	Hermeneutical/dialectical	Political participation in collaborative action inquiry; primacy of the practical; use of language grounded in shared experimental context

"Basic beliefs (metaphysics) of alternative inquiry paradigms" (Guba & Lincoln 2005)

“Understanding a person…” (from Barbara Kiviat)

“

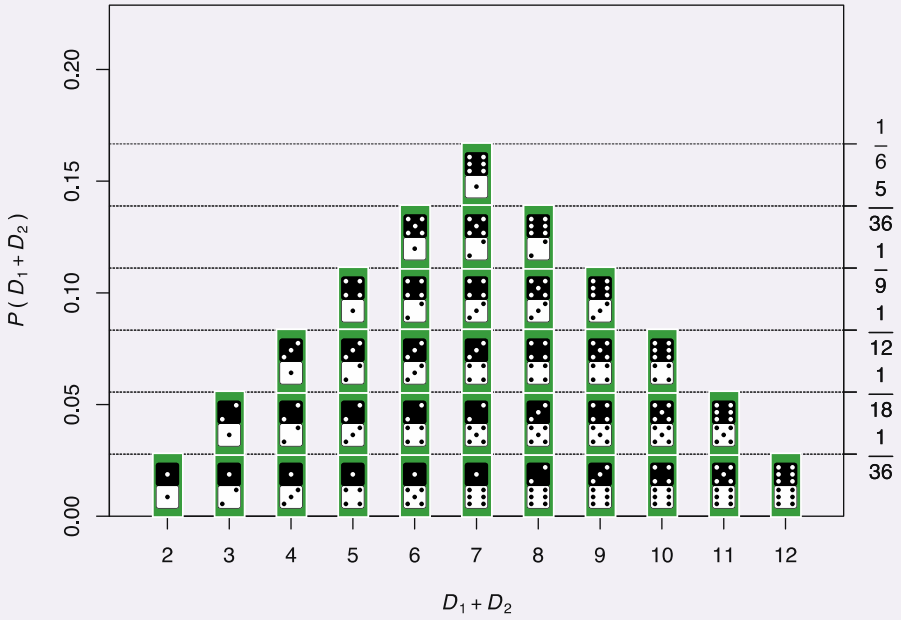
	As a case	In narrative
Context/circumstance	Stripped away	Key
Mental states	Absent (for the most part)	Crucial; constitutive
Relevant features	Determined in advance	Emergent
Orientation to time	Atemporal	Chronological
Ordering of features	Unimportant	Meaningful
Other actors	Invisible	Often present
Causal logic	Mathematical	Theoretical
To boost predictive validity	Add cases	Know person better

”

“Bowker and Star 2000; Bruner 1986; Desrosières 1998; Espeland 1998; Espeland and Stevens 1998, 2008; Fourcade and Healy 2017; Hacking 1990; Porter 1994, 1995; Ricouer 1998; White 1980, 1984”. I would add: Patton 2005; Abbott 1988

Core assumptions of stats

- There are entities in the world, which are comparable (of the same "underlying" type of thing)
- There is underlying regularity; departures from perfect uniformity are "haphazard variability" (Cox 1990)
- Probability theory gives an analogy/model for that variability, justifies reducing information (Fisher 1922) from multiple entities via *central tendencies* (mean, median, mode, majority class, quantile, higher-order central moments…)



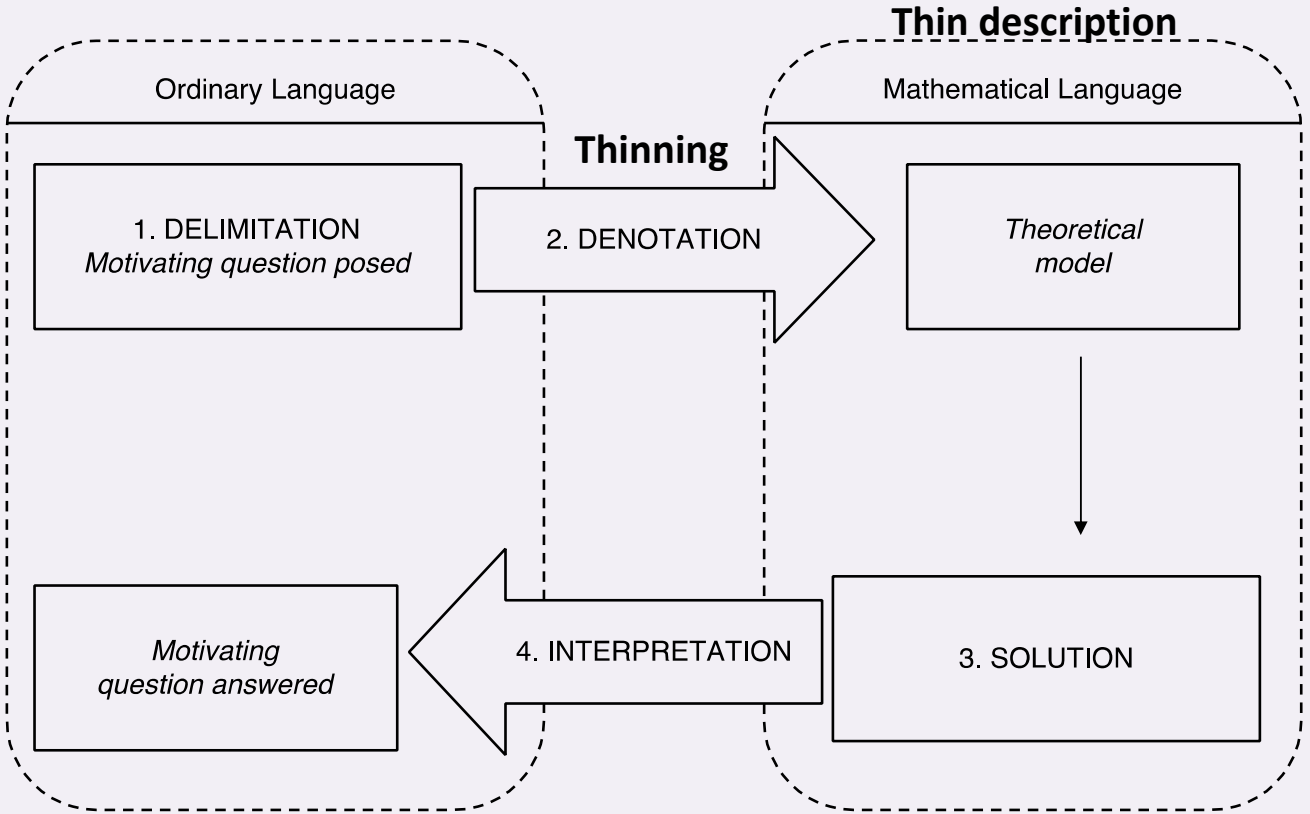
Statistics without realism?

- Statistics: most principled and well-developed of quantitative methods in social research, in that it has a theory of how the world is (although one based on mathematical convenience rather than conviction)
- (Machine learning inherits its foundations from statistics)
- (Can talk about simulation modeling, mathematical sociology, “sociophysics”, microeconomics…)
- Even the mainstream of Bayesian statistics is realist (there is an objective reality; subjective beliefs just help us get there faster)

Core incompatibility

"...*it is striking how absolutely these assumptions* (of linear models) *contradict those of the major theoretical traditions of sociology*. Symbolic interactionism rejects the assumption of fixed entities and makes the meaning of a given occurrence depend on its location… Both the Marxian and Weberian traditions deny explicitly that a given property of a social actor has one and only one set of causal implications… all approach social causality in terms of stories, rather than in terms of variable attributes." (Abbott 1988)

Any thinning flattens meanings



Spiegler 2015

Sticking points

- How can we dissolve such a powerful binary?

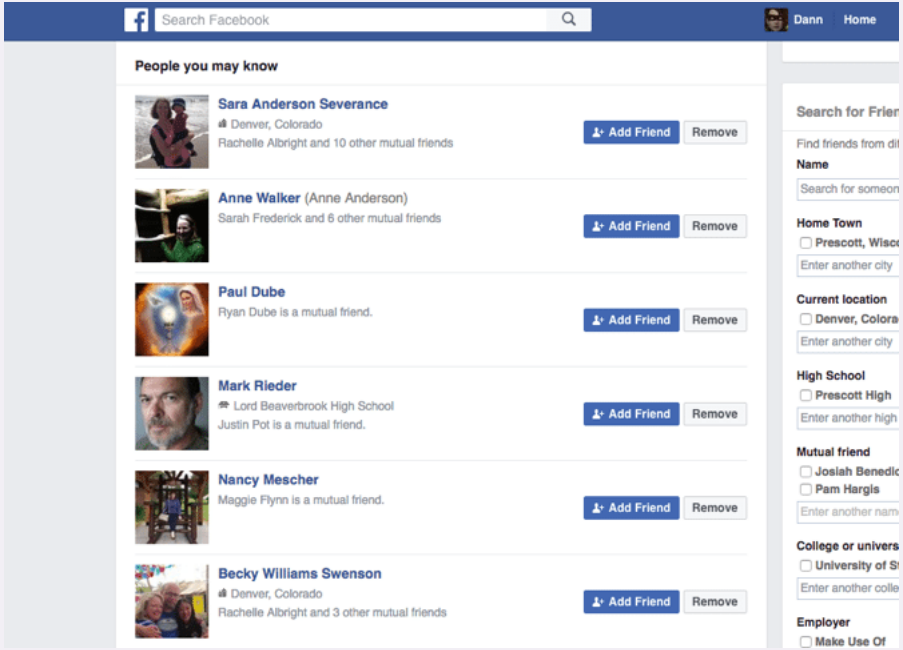
- Related: the the actor/analyst (emic/etic) binary (Jardine 2004; Collins 2008)
  - (lateral anthropology [Candea 2018, 2019; Gad and Jensen 2016] flattens how actor and analyst relate, but still has this binary)

Four attempted responses

1. Quant “demonstrations”
2. Juxtapose
3. Imagine
4. Convert

1. Quant “demonstrations”?

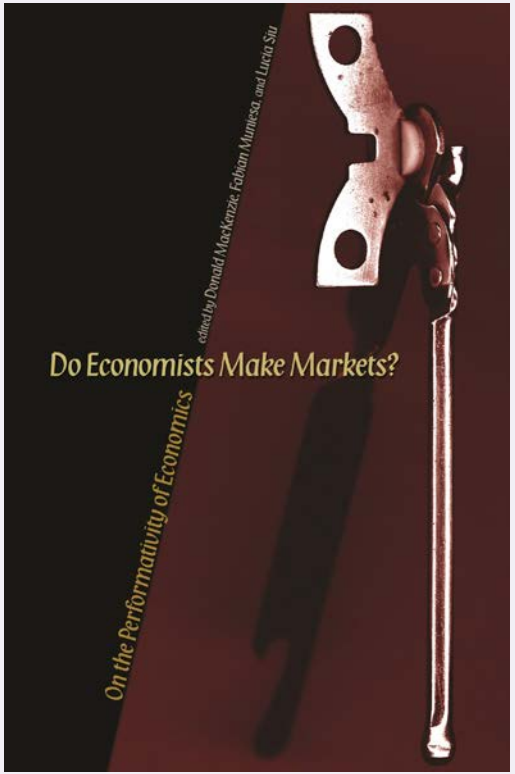
“Facebook uses its data on the structure of social relations to routinely suggest lists of **‘people you may know’** to users, with **the goal of encouraging users to add those people to their network**…” (Healy 2015)



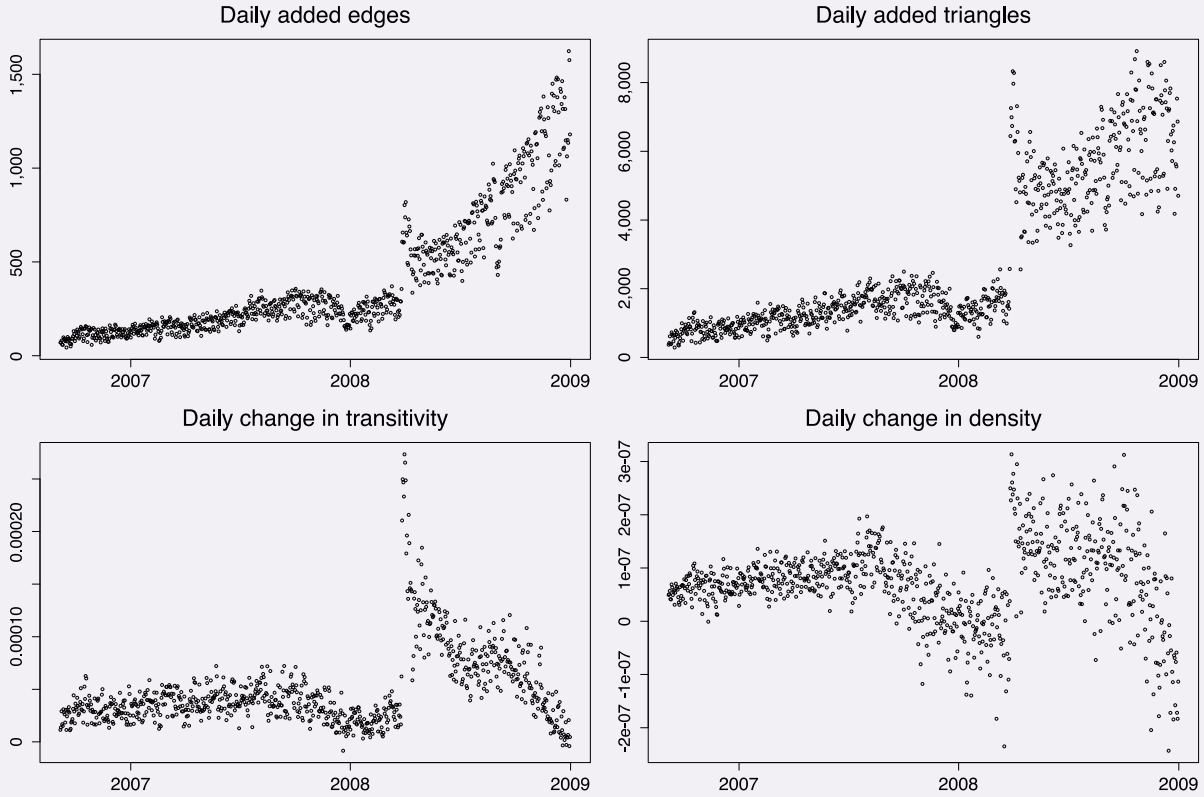
Dann Abright, makeuseof.com

Performativity

"the *performativity thesis* is that economics produces a body of formal models and transportable techniques that, when carried out into the world by its professionals and popularizers, **reformats and reorganizes the phenomena the models purport to describe**..." (Healy 2015)

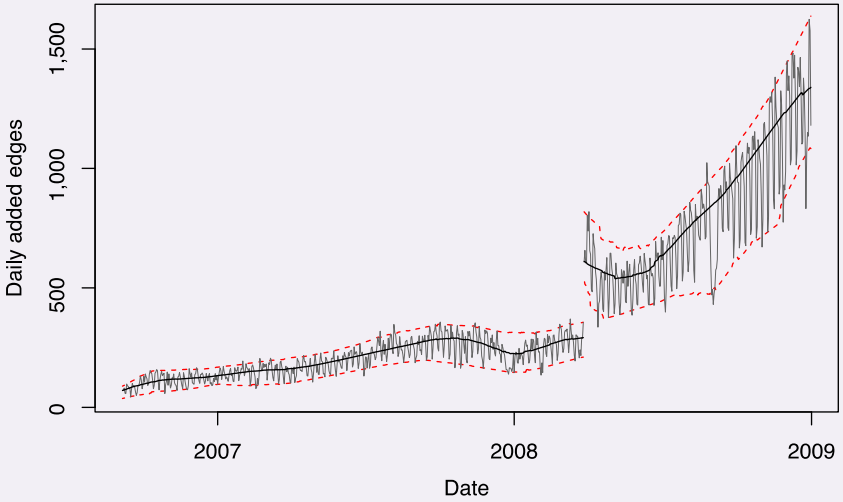


Facebook’s “People you may know"

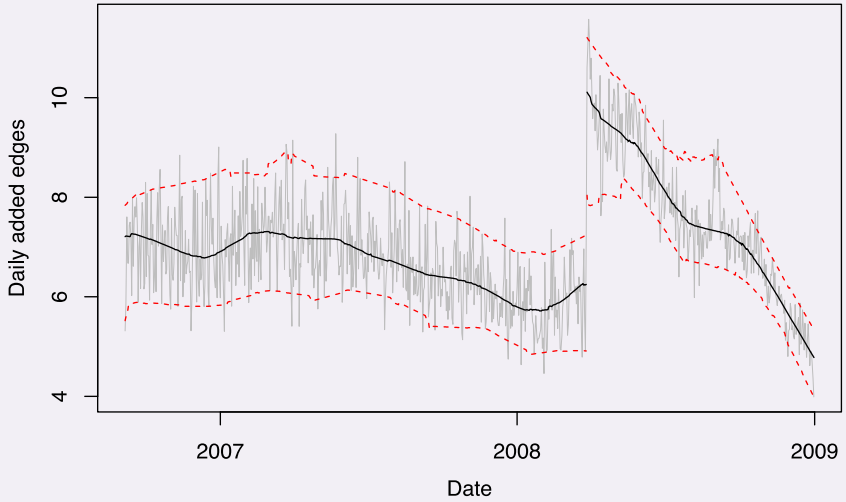


PYMK impacting network structure

- Triangles: +3.8 triangles per edge (x1.62)



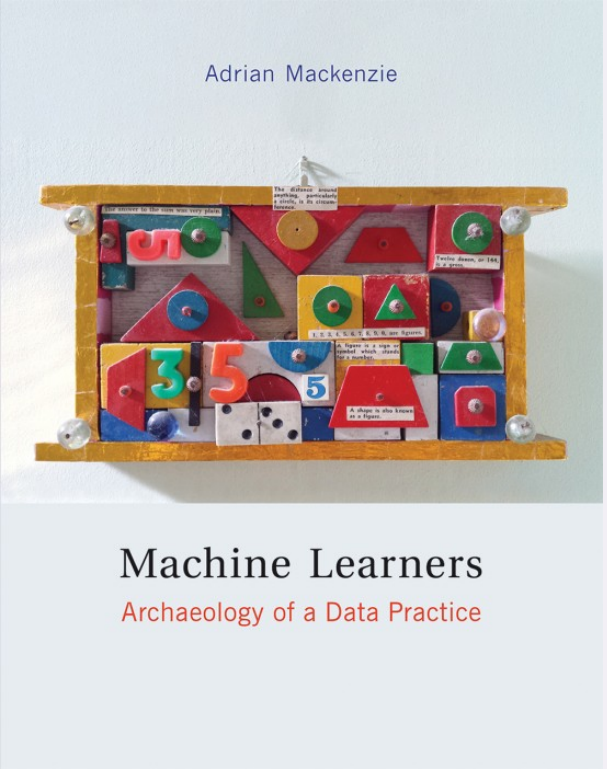
- Facebook links: +300 new edges per day (x2)



Problem: “weak” performativity

- Weak version: the modeling led to a specific, measurable outcome that would not have otherwise happened
- Strong version: the reformatting of the world itself happens with the basic concepts of forms of modeling, not specific models (Dixon-Román 2016)
- Ultimately, this paper is the weak version.
- And, quant for quant’s sake?

2. Juxtapose?



9 We might also approach the epistopic fault line in machine learning topologically. More than a decade ago, the cultural theorist Brian Massumi wrote that "the space of experience is really, literally, physically a topological hyperspace of transformation" (Massumi 2002, 184). Much earlier, Gilles Deleuze had conceptualized Michel Foucault's philosophy as a topology, or "thought of the outside" (Deleuze 1988b), as a set of movements that sought to map the diagrams that generated a "kind of reality, a new model of truth" (Deleuze 1988b, 35). More recently, this topological thinking has been extended and developed by Celia Lury among others. In "The Becoming Topological of Culture," Lury, Luciana Parisi, and Tiziana Terranova suggest that "a new rationality is emerging: the moving ratio of a topological culture" (Lury, Parisi, and Terranova 2012, 4). In this new rationality, practices of ordering, modeling, networking, and mapping co-constitute culture, technology, and science (Lury, Parisi, and Terranova 2012, 5). At the core of this new rationality, however, lies a new ordering of continuity. The "ordering of continuity," Lury, Parisi, and Terranova propose, takes shape "in practices of sorting, naming, numbering, comparing, listing, and calculating" (4). The phrase "ordering of continuity" is interesting because we don't normally

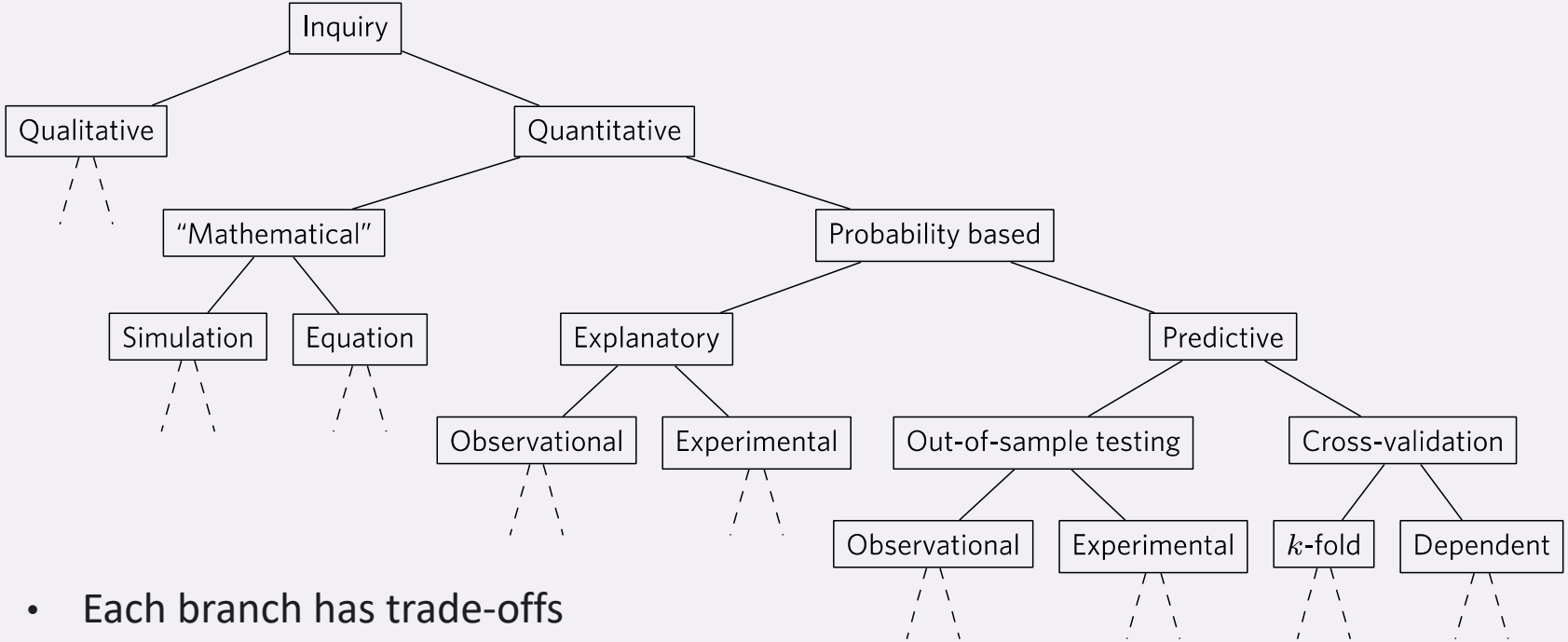
and Andrew Ng advocate returning often to equations). The mainstay of statistics, the linear regression model, usually appears in a more or less algebraic form:

$$\hat{Y} = \hat{\beta}_0 + \sum_{j=1}^{p} X_j \hat{\beta}_j \tag{3.1}$$

$$\hat{Y} = X_T \hat{\beta} \tag{3.2}$$

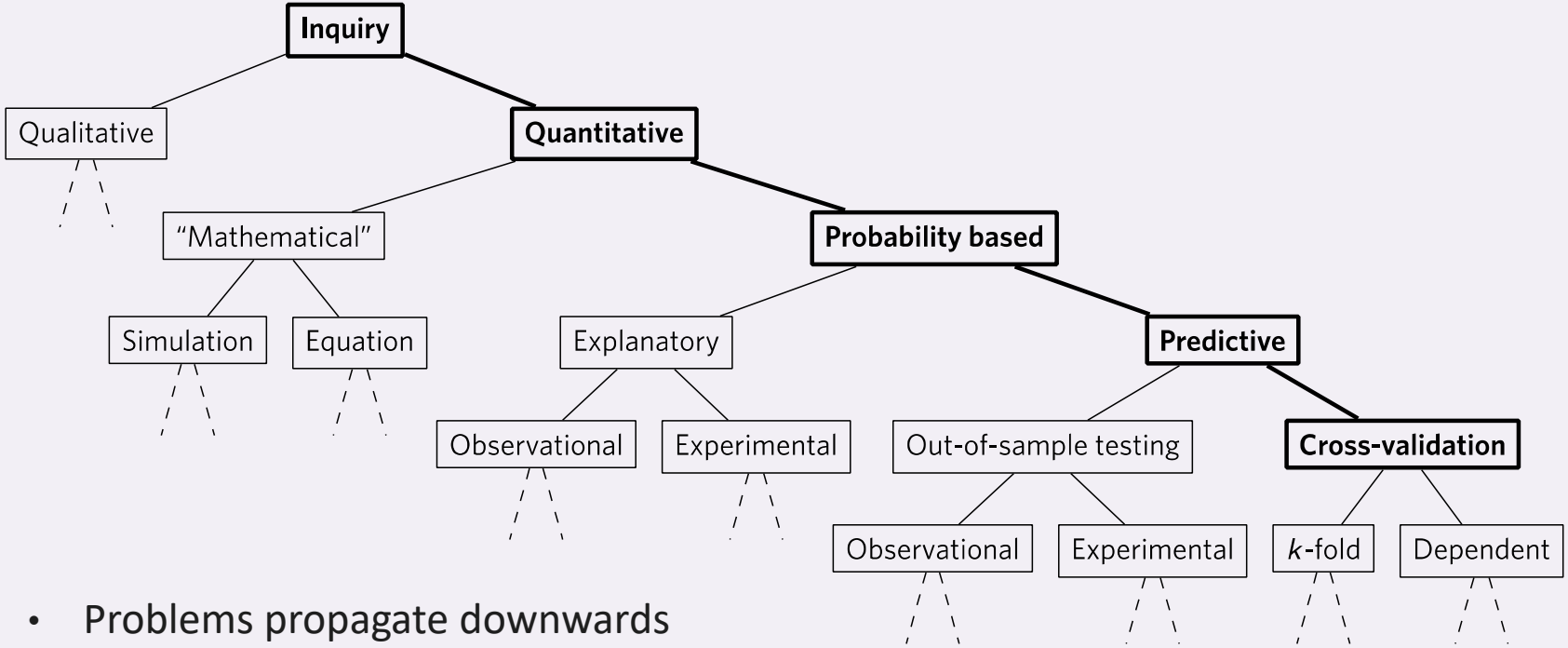
Equations 3.1 and 3.2 express a plane (or hyperplane) in increasingly diagrammatic abstraction. The possibility of diagramming a high-dimensional space derives largely from linear algebra. Reading equation 3.1 from left to right, the expression $\hat{Y}$ already

Hierarchy of methodological choices



- Each branch has trade-offs
- No one method is better any other
- Mixed methods can combine

Machine learning is only one path



- Problems propagate downwards
- E.g., quantification affects everything below

Quant component

$$
\begin{aligned}
\mathrm{Err}(\hat{\mu}) &= \tfrac{1}{n}\mathbb{E}_f \| Y^* - \widehat{Y} \|_2^2 \\
&= \tfrac{1}{n}\left[\mathbb{E}_f \| Y^* \|_2^2 + \mathbb{E}_f \| \widehat{Y} \|_2^2 - 2\mathbb{E}_f(Y^{*T}\widehat{Y})\right] \\
&= \tfrac{1}{n}\left[\mathbb{E}_f \| Y^* \|_2^2 + \mathbb{E}_f \| \widehat{Y} \|_2^2 - 2\,\mathrm{tr}\,\mathbb{E}_f(Y^*\widehat{Y}^T)\right] \\
&\quad + \tfrac{1}{n}\left[\ \mu^T\mu + \mathbb{E}_f(\widehat{Y})^T\mathbb{E}_f(\widehat{Y}) + 2\,\mathrm{tr}\,\mu\mathbb{E}_f(\widehat{Y})^T\right] \\
&\quad + \tfrac{1}{n}\left[-\mu^T\mu - \mathbb{E}_f(\widehat{Y})\mathbb{E}_f(\widehat{Y})^T - 2\mu^T\mathbb{E}_f(\widehat{Y})\right] \\
&= \tfrac{1}{n}\left[\mathrm{tr}\,\Sigma + \|\mu - \mathbb{E}(\widehat{Y})\|_2^2 + \mathrm{tr}\,\mathrm{Var}_f(\widehat{Y}) - 2\,\mathrm{tr}\,\mathrm{Cov}_f(Y^*, \widehat{Y})\right] \\
&= \ \text{irreducible error} + \text{bias}^2 + \text{variance} - \text{optimism}
\end{aligned}
$$

Quant component

- Imagine we have, for $\mathbf{\Sigma}_{ii} = \sigma^2$ and $\mathbf{\Sigma}_{ij} = \rho\sigma^2, \quad i \neq j$

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} \sim \mathcal{N}\left(\begin{bmatrix} \mathbf{X} \\ \mathbf{X} \end{bmatrix} \beta, \begin{bmatrix} \mathbf{\Sigma} & \rho\sigma^2 \mathbf{1}\mathbf{1}^T \\ \rho\sigma^2 \mathbf{1}\mathbf{1}^T & \mathbf{\Sigma} \end{bmatrix} \right)$$

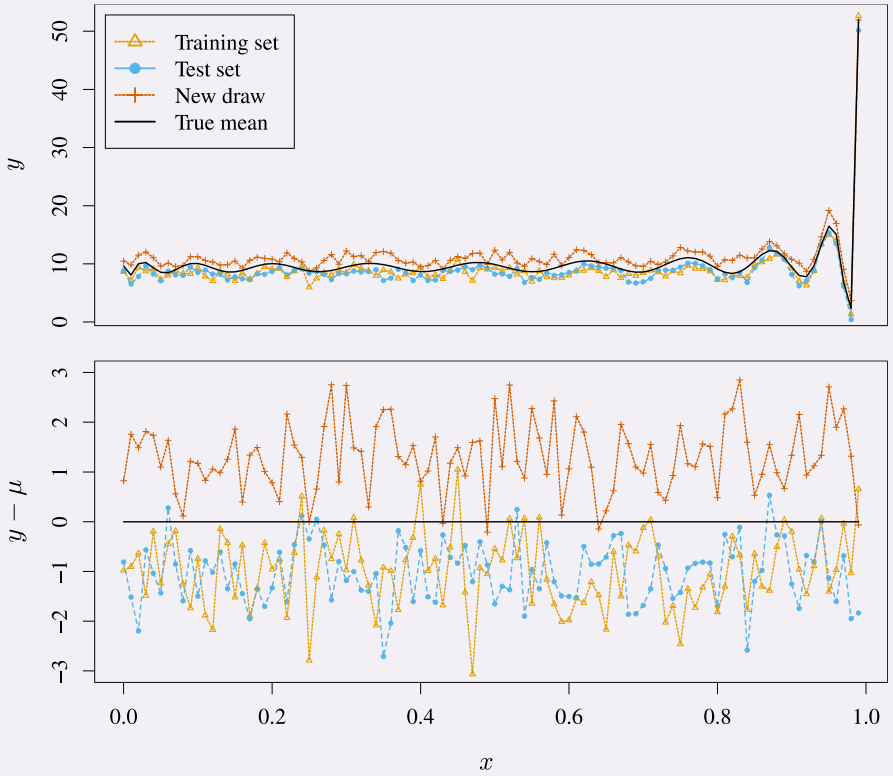
- Then, optimism in the training set is:

$$\frac{2}{n} \operatorname{tr} \operatorname{Cov}_f(Y_1, \widehat{Y}_1) = \frac{2}{n} \operatorname{tr} \operatorname{Cov}_f(Y_1, \mathbf{H} Y_1) = \frac{2}{n} \operatorname{tr} \mathbf{H} \operatorname{Var}_f(Y_1) = \frac{2}{n} \operatorname{tr} \mathbf{H}\mathbf{\Sigma}$$

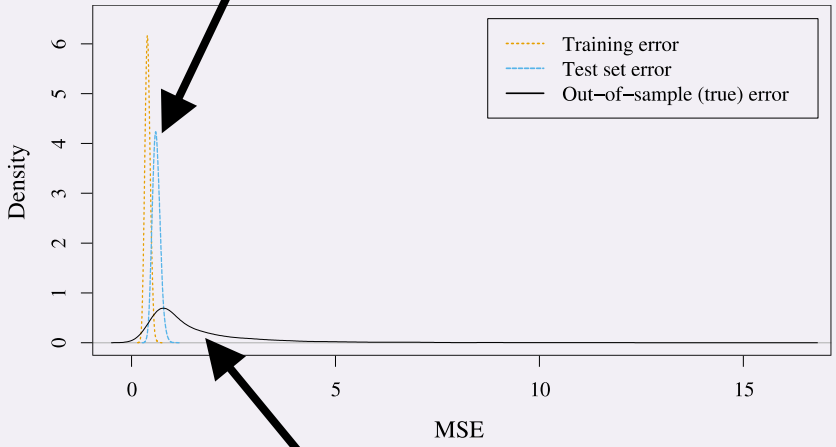
- But test set also has nonzero optimism!

$$\frac{2}{n} \operatorname{tr} \operatorname{Cov}_f(Y_2, \widehat{Y}_1) = \frac{2}{n} \operatorname{tr} \operatorname{Cov}_f(Y_2, \mathbf{H} Y_1) = \frac{2\rho\sigma^2}{n} \operatorname{tr} \mathbf{H}\mathbf{1}\mathbf{1}^T = 2\rho\sigma^2$$

Quant component



Error rate in held-out data (what machine learning papers report)



Error rate in new data (what happens when models are deployed): *much* worse!

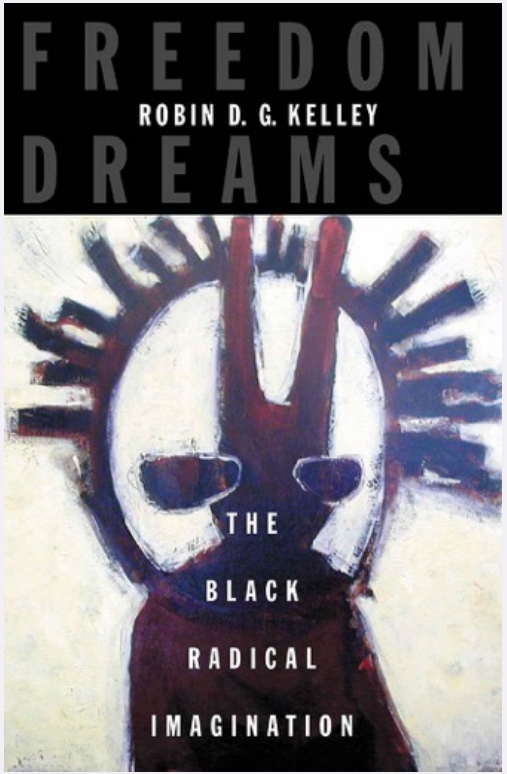
Problems

- On the one hand, I am immeasurably excited and proud to have put this together. On the other hand, I am underwhelmed by originality.

- What it does: hopefully help qual people critique quant with something that has quant legitimacy

3. Imagine?

“reparations proposals from black radical movements focus less on individual payments than on securing funds to build autonomous black institutions, improving community life, and in some cases establishing a homeland that will enable African Americans to develop a political economy geared more toward collective needs than toward accumulation.” (Kelley 2002)



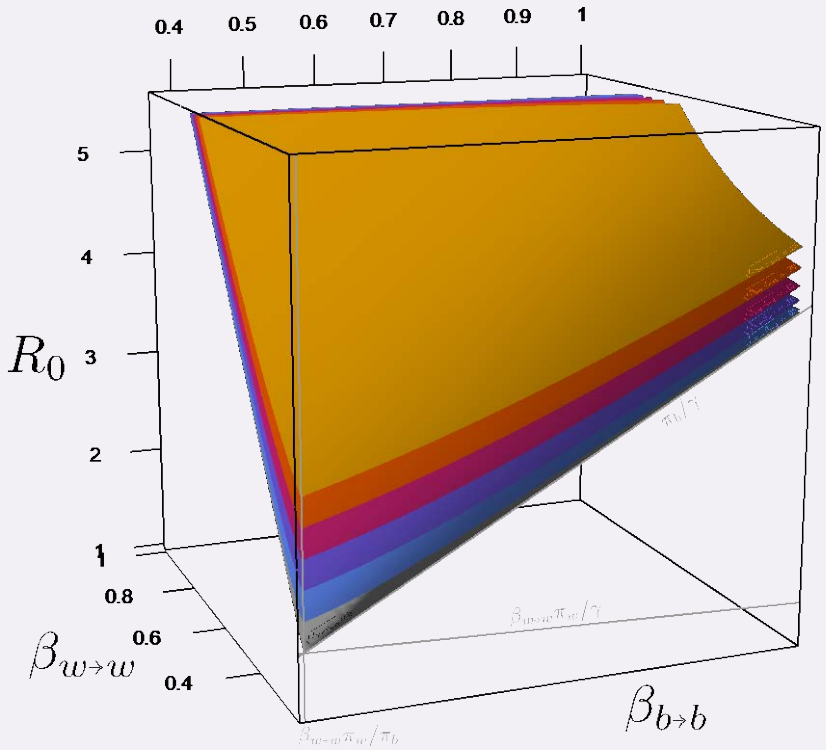
Why not imagine with quantitative means?

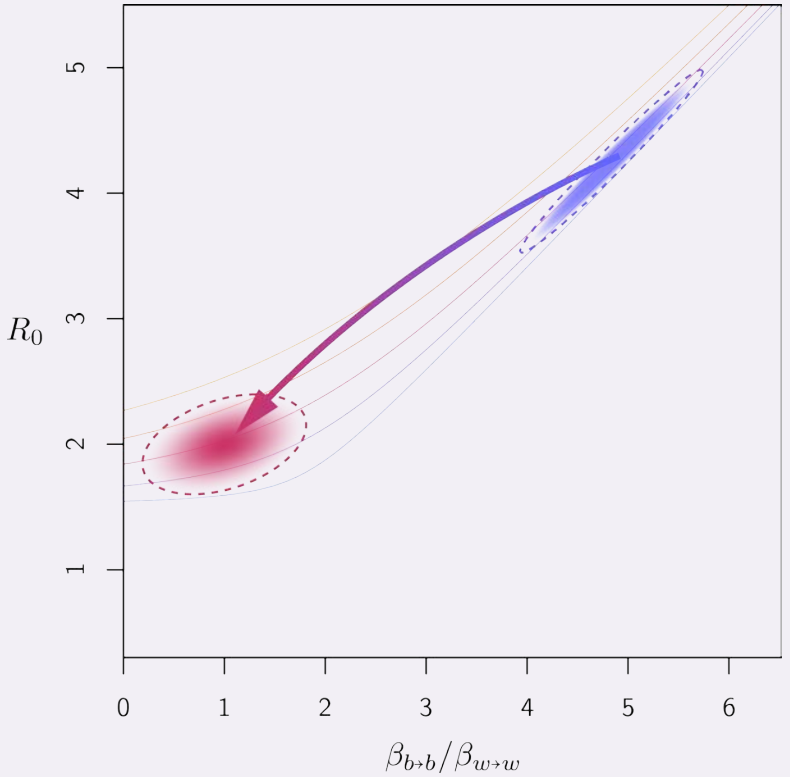
- A transfer like the amount due for reparations (~$800K per household) has never happened before
- Bring it into public health (COVID-19), SIR modeling

$$\mathbf{G} = \begin{bmatrix} g_{b\to b} & g_{b\to w} \\ g_{w\to b} & g_{w\to w} \end{bmatrix} = \begin{bmatrix} \frac{\tau c_{b\to b}\pi_b}{\gamma} & \frac{\tau c_{b\to w}\pi_b}{\gamma} \\ \frac{\tau c_{w\to b}\pi_w}{\gamma} & \frac{\tau c_{w\to w}\pi_w}{\gamma} \end{bmatrix} = \begin{bmatrix} \frac{\beta_{b\to b}\pi_b}{\gamma} & \frac{\beta_{b\to w}\pi_b}{\gamma} \\ \frac{\beta_{w\to b}\pi_w}{\gamma} & \frac{\beta_{w\to w}\pi_w}{\gamma} \end{bmatrix}$$

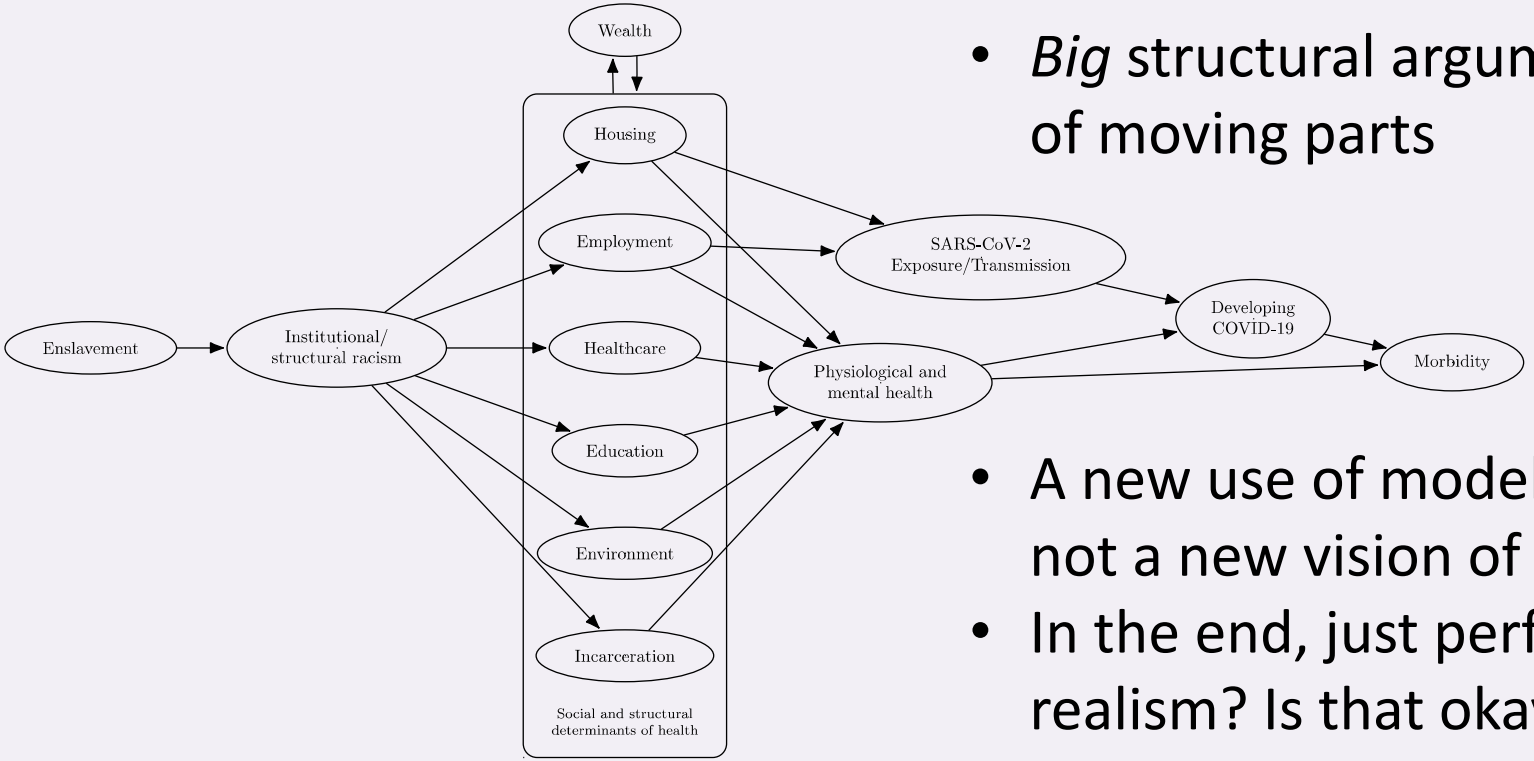
- Segregation: off-diagonals would have a ratio of around 1:2
- Overcrowding: Higher transmission rate $\beta_{b\to b}$ than $\beta_{w\to w}$, in addition to other factors

Moving around in the parameter space





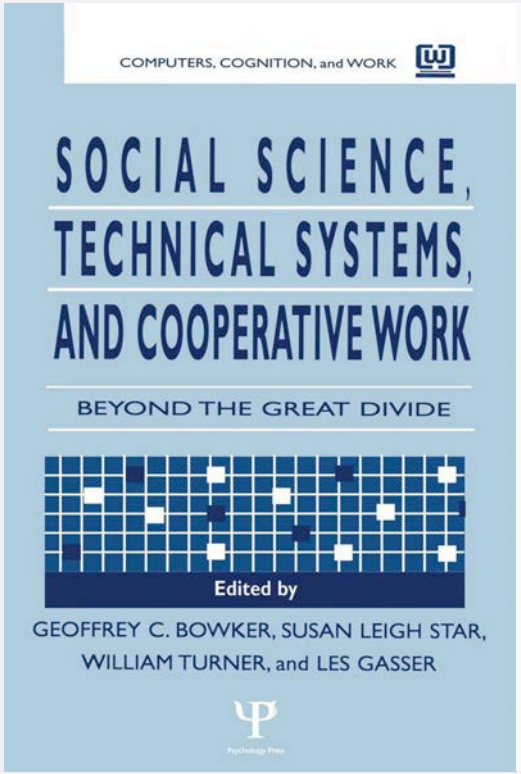
Problems



- *Big* structural argument, lots of moving parts

- A new use of modeling; but not a new vision of society
- In the end, just performative realism? Is that okay?

4. Convert?



6

Toward a Critical Technical Practice: Lessons Learned in Trying to Reform AI

Philip E. Agre
University of California, San Diego

Every technology fits, in its own unique way, into a far-flung network of different sites of social practice. Some technologies are employed in a specific site, and in those cases we often feel that we can warrant clear

Critical “awakening”

“At first I found [critical] texts impenetrable, not only because of their irreducible difficulty but also because **I was still tacitly attempting to read everything as a specification for a technical mechanism**… My first intellectual breakthrough came when, for reasons I do not recall, it finally occurred to me to stop translating these strange disciplinary languages into technical schemata, and instead simply to learn them on their own terms…”

Critical “awakening”

“I still remember the **vertigo** I felt during this period; I was speaking these strange disciplinary languages, in a wobbly fashion at first, without knowing what they meant — without knowing what *sort* of meaning they had…
“In retrospect, this was the period during which **I began to ‘wake up’, breaking out of a technical cognitive style that I now regard as extremely constricting**.”

Conscientization, but incomplete

- Critical technical practice failed to take hold: only scattered adoption, mostly in Human-Computer Interaction, e.g. Phoebe Sengers (Hertz 2015), nothing within AI.
- Matches a Kuhnian paradigm shift, but better understood through Freire's "conscientization," and subsequent studies and theorizing of "perspective transformation" in adult education (Mezirow 1978).
  1. A disorienting dilemma
  2. Self-examination with feelings of guilt or shame
  3. A critical assessment of assumptions
  4. **Recognition that one's discontent and process of transformation are shared and that others have negotiated a similar change**
  5. **Exploration of options for new roles, relationships, and actions**

…

Problems

- Probably a very small number of people on the verge of a critical awakening
- Will the article actually help them?
- Still an elite-focused strategy

- Interdisciplinary work as utilizing different ways of knowing, epistemologies, knowledge constructs
- Arts-based methods as valid modes of inquiry, knowledge production, and mobilization
- Non-western ways of knowing as valuable

Kenyatta A.C. Hinkle, 2019, *The Rubber Tree*

Lessons learned from non-quant research

- Reflexivity
- Positionality
- Cultural humility (lifelong learning)
- Transformative Education
- Community Based Participatory/ Participatory Action Research
- Validity of Arts-based methods and ways of knowing
- Disciplines as a barrier

Reflexivity

- What is it?
- Why it is important to all research and not just qualitative processes?
- What underlying theoretical/philosophical assumptions are involved in the practice of reflexivity?
  - Social constructivist and post positivism

Positionality

- Positionality of my collaborators
- My perspective
- Identify what you bring to the inquiry e.g. social location, professional and personal experience
- What is the social, cultural, political, institutional context of this inquiry?
- The positionally of my discipline
- Where is the power?

Kara Walker, 2000, *Emancipation Approximation* 7.19

Positionality affects parts of the research process

- Design
- Data collection
- Data analysis
- Implementation
- Co-production
- Dissemination
- Knowledge mobilization

Kara Walker, 2000, *Emancipation Approximation* 7.14-7.15

Quant reflexivity

Kara Walker, 2000, *Emancipation Approximation* 7.16

- What might reflexive quant (Jafar 2018) work look like?
  - A way to define the boundaries of one's research
  - Address biases directly within paper
  - Show limit of scope of research in reporting and dissemination of information
  - Contextualize work

Equity-focused

- Makes us think about the possible harms our study and the outcomes can have on marginalized populations we interact with
- Possible harms my work can cause (how can this knowledge produced be weaponized by those in power against the marginalized?)

Kara Walker, 2000, *Emancipation Approximation* 7.10

Action/impact-focused

- Changing things in the real world
- Getting outside the academic bubble
- Focusing on “street tasks” versus solely intellectual tasks
- Acknowledges the importance of policy, systems, structures, institutions in connection with knowledge production
- Research with actionable goals

Kara Walker, *Untitled (Girl with Bucket)*

Critical frameworks

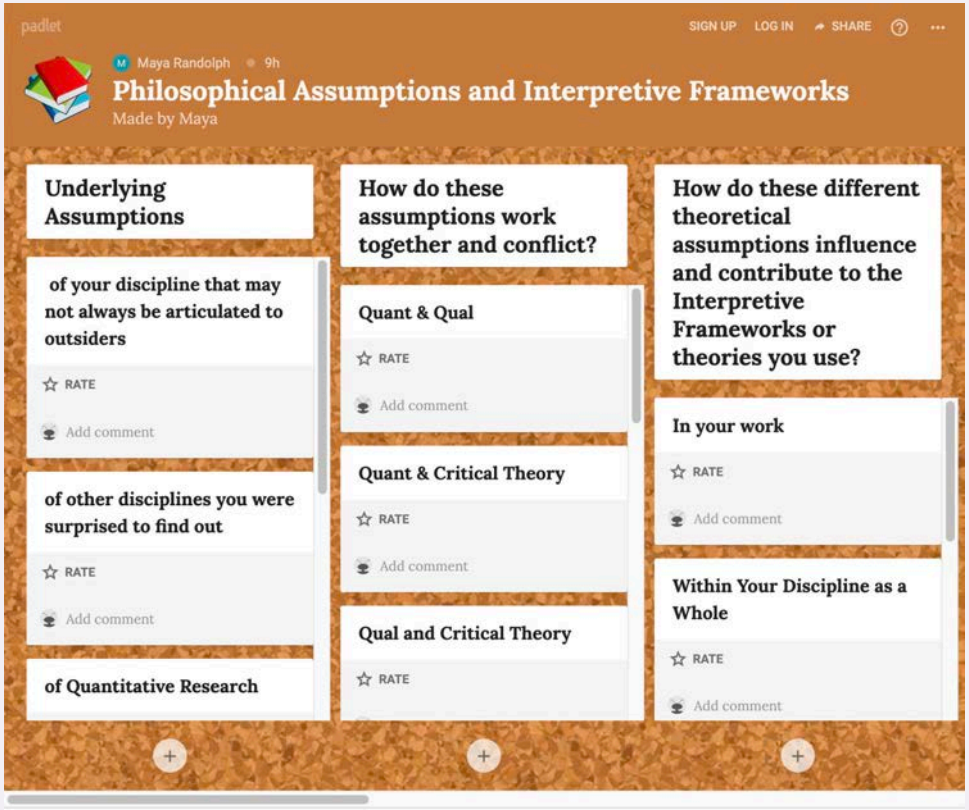
- The political nature of research and the researcher
- The lack of separation of research from the rest of the social world
- Pushing back on the idea of objective or neutral
- To acknowledge and right historical wrongs through:
  - Reconciliation
  - Reparations
  - Landback/Sovereignty Movements
- To combat current structures that inflict
  - Harm
  - Violence
  - Retraumatization

Philosophical assumptions

- Beliefs about
  - ontology – the nature of reality
  - epistemology – what counts as knowledge and how knowledge claims are justified
  - axiology – the role of values in research
  - methodology – the process of research (Creswell 2018)

Activity

https://padlet.com/mrandolph08/xsg7xjmhl3go1ttr



Works cited

Abbott, Andrew. 1988. “Transcending General Linear Reality.” *Sociological Theory* 6 (2): 169–186. https://doi.org/10.2307/202114.

Agre, Philip E. 1997. “Towards a Critical Technical Practice: Lessons Learned from Trying to Reform AI.” In *Social Science, Technical Systems, and Cooperative Work: Beyond the Great Divide*, edited by Geoffrey C. Bowker, Susan Leigh Star, Will Turner, and Les Gasser, 131–158. Lawrence Erlbaum Associates.

Candea, Matei. 2018. *Comparison in Anthropology: The Impossible Method*. Cambridge University Press.

Candea, Matei. 2019. “Going Full Frontal: Two Modalities of Comparison in Social Anthropology.” In *Regimes of Comparatism: Frameworks of Comparison in History, Religion and Anthropology*, edited by Renaud Gagné, Simon Goldhill, and Geoffrey Lloyd, 343–371. BRILL. https://doi.org/10.1163/9789004387638_011.

Collins, Harry. 2008. “Actors’ and Analysts’ Categories in the Social Analysis of Science.” In *Clashes of Knowledge: Orthodoxies and Heterodoxies in Science and Religion*, edited by Peter Meusburger, Michael Welker, and Edgar Wunder, 101–110. Springer. https://doi.org/10.1007/978-1-4020-5555-3_4.

Cox, D. R. 1990. “Role of Models in Statistical Analysis.” *Statistical Science* 5: 169–174. https://doi.org/10.1214/ss/1177012165.

Creswell, John W. and Cheryl N. Poth. 2018. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. 4th ed. SAGE.

Dixon-Román, Ezekiel J. 2016. “Diffractive Possibilities: Cultural Studies and Quantification.” *Transforming Anthropology* 24 (2): 157–167. https://doi.org/10.1111/traa.12074.

Fisher, Ronald A. 1922. “On the Mathematical Foundations of Theoretical Statistics”. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences* 222: 309–368. https://doi.org/10.1098/rsta.1922.0009.

Gad, Christopher, and Casper Bruun Jensen. 2016. “Lateral Concepts.” *Engaging Science, Technology, and Society* 2. https://doi.org/10.17351/ests2016.77.

Guba, Egon G., and Yvonna S. Lincoln. 2005. “Paradigmatic Controversies, Contradictions, and Emerging Confluences.” In *The SAGE Handbook of Qualitative Research*, edited by Norman K. Denzin and Yvonna S. Lincoln, 191–215. 5th ed. SAGE.

Healy, Kieran. 2015. “The Performativity of Networks.” *European Journal of Sociology* 56 (2): 175–205. https://doi.org/10.1017/S0003975615000107.

Hertz, Garnet. 2015. “Critical Technical Practice and Critical Making: Phoebe Sengers in Conversation with Garnet Hertz.” *Theorizing 21C* 008 (July 29). http://ctheory.net/ctheory_wp/conversations-in-critical- making-2-critical-technical-practice-and-critical-makin/.

Jafar, Anisa J. N. 2018. “What is Positionality and Should it be Expressed in Quantitative Studies?” *Emergency Medical Journal* 35 (5): 578. https://doi.org/10.1136/emermed-2017-207158

Jardine, Nick. 2004. “Etics and Emics (Not to Mention Anemics and Emetics) in the History of the Sciences.” *History of Science* 42 (3): 261–278. https://doi.org/10.1177/007327530404200301.

Kelley, Robin D. G. 2002. “A Day of Reckoning: Black Feminist Dreams.” In *Freedom Dreams: The Black Radical Imagination*, 110–134. Boston: Beacon Press.

Kleinman, Arthur and Joan Kleinman. 1991. “Suffering and its Professional Transformation: Towards an Ethnography of Interpersonal Experience.” *Culture, Medicine and Psychiatry* 15 (3): 275-301. https://doi.org/10.1007/BF00046540

Mackenzie, Adrian. 2017. *Machine Learners: Archaeology of a Data Practice*. The MIT Press.

Malik, Momin M. 2020. “A Hierarchy of Limitations in Machine Learning.” https://www.arxiv.org/abs/2002.05193.

Malik, Momin M., and Jürgen Pfeffer. 2016. “Identifying Platform Effects in Social Media Data.” In *Proceedings of the Tenth International AAAI Conference on Web and Social Media* (ICWSM-16), 241–249. AAAI Press. http://mominmalik.com/malik_chapter2.pdf.

Mezirow, Jack. 1978. “Perspective Transformation.” *Adult Education* 28 (2): 100–110. https://doi.org/10.1177/074171367802800202.

Nelson, Cary and Gaonkar, Dilip Parameshwar. 1996. “Cultural Studies and the Politics of Disciplinarity: An Introduction.” In *Disciplinarity and dissent in Cultural Studies*, edited by Cary Nelson and Dilip Parameshwar Gaonkar, 1–22. Routledge.

Patton, Michael Quinn. 2015. *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*. 4th ed. SAGE.

Porter, Theodore M. 2012. “Thin Description: Surface and Depth in Science and Science Studies.” *Osiris* 27 (1): 209–226. https://doi.org/10.1086/667828.

Smith, Linda Tuhiwai. 2012. *Decolonizing Methodologies: Research and Indigenous Peoples*. 2nd ed. London & Zed Books.

Spiegler, Peter. 2015. *Behind the Model: A Constructive Critique of Economic Modeling*. Cambridge University Press.