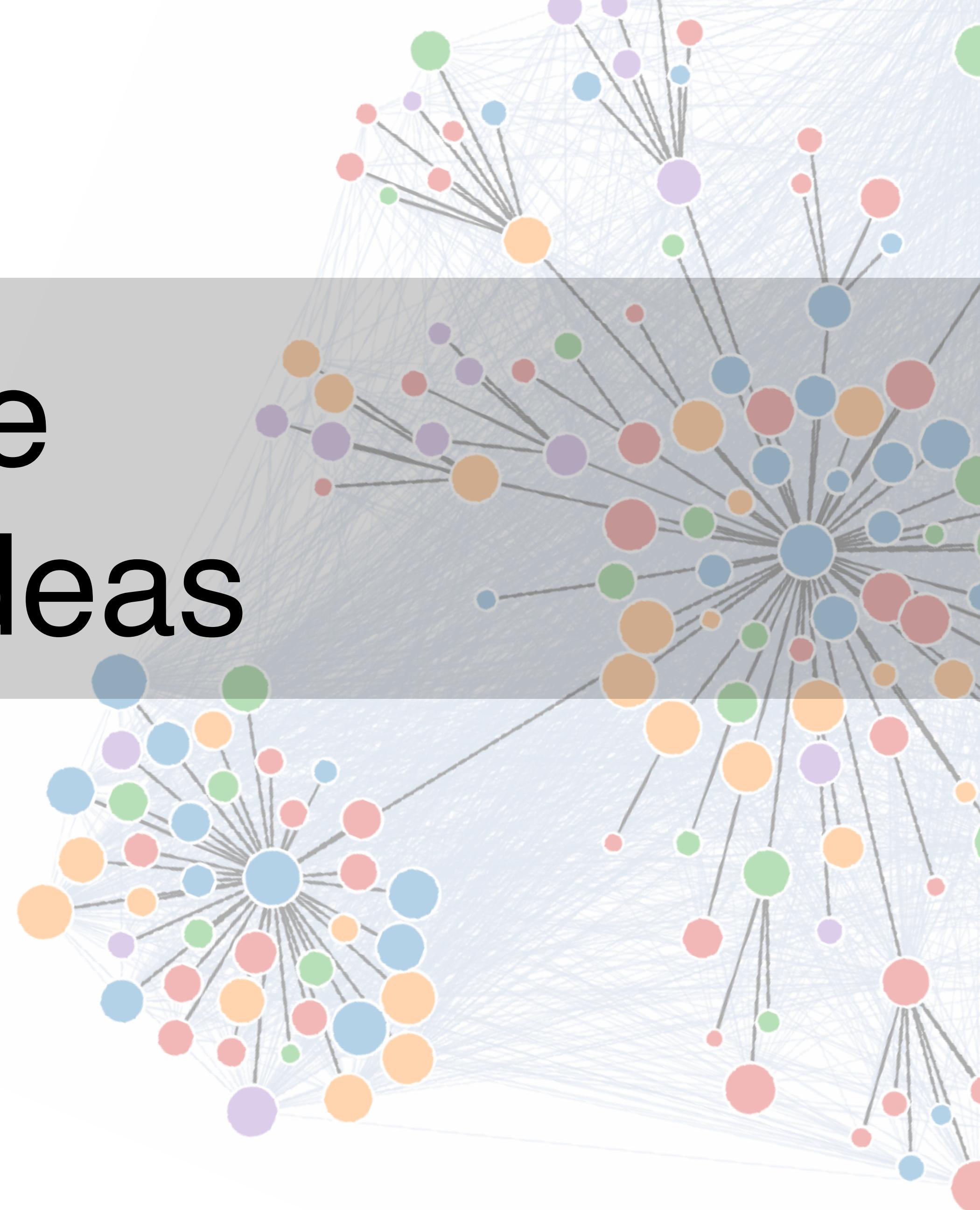


Faculty hiring and the spread of scientific ideas

Aaron Clauset
@aaronclauset
Professor
Computer Science Dept. & BioFrontiers Institute
University of Colorado, Boulder
External Faculty, Santa Fe Institute



science is not a meritocracy

good ideas do not always win out over mediocre ones



15 years of Alzheimer's research on A β oligomers

BLOTS ON A FIELD?

A neuroscience image sleuth finds signs of fabrication in scores of Alzheimer's articles, threatening a reigning theory of the disease *By Charles Piller*

Science 377, (2022)

science is not a meritocracy

good ideas do not always win out over mediocre ones



BLO
A neuroscience in
articles, thr

Science 377, (20

The Dunning-Kruger Effect Isn't What You Think It Is

The least skilled people know how much they don't know, but everyone thinks they are better than average

By Eric C. Gaze, The Conversation US on May 23, 2023

Scientific American (2023) statistical artifact and sampling bias

science is not a meritocracy

good ideas do not always win out over mediocre ones



The image displays two side-by-side scientific journal articles from the early 20th century. The left article is from 'Science' (vol. 377, 2019) and the right is from 'Nature' (vol. 70, 1904). Both articles discuss controversial topics where good ideas did not immediately prevail.

Science Article (Left):

- Title:** The Discovery of Polywater
- Abstract:** Vibrational spectra indicate unique stable polymeric structure.
- Authors:** Ellis R. Lippincott, Robert R. Stromberg, Warren H. Grant, Gerald L. Cessac
- Journal:** Science 164 (1969)
- Notes:** statistical artifacts and dirty samples

Nature Article (Right):

- Title:** The *n*-Rays
- Author:** R. W. WOOD
- Published:** 29 September 1904
- Journal:** Nature 70, 530–531 (1904) | [Cite this article](#)

science is not a meritocracy

good ideas do not always win out over mediocre ones



poor experimental design & causal misinterpretations

A thumbnail image of a Science magazine cover. The title 'BLOCKBUSTERS' is partially visible at the top. Below it, the main title reads 'The D...' and a subtitle 'V'. A small blurb says 'The least skilled people...'. At the bottom, it says 'Science 377, (2010)' and 'Scientific American'.

Power Posing: Brief Nonverbal Displays Affect Neuroendocrine Levels and Risk Tolerance

Psychological Science 21 (2010)

Dana R. Carney¹, Amy J.C. Cuddy², and Andy J. Yap¹

¹Columbia University and ²Harvard University

[View this article](#)

Female hurricanes are deadlier than male hurricanes

Kiju Jung^{a,1}, Sharon Shavitt^{a,b,1}, Madhu Viswanathan^{a,c}, and Joseph M. Hilbe^d

PNAS 111 (2014)

science is not a meritocracy

good ideas do not always win out over mediocre ones



A thumbnail image of a blog post from Scientific American. The title 'Blog: The D...' is partially visible at the top. Below it, the text 'An... Scie...' is visible. The background of the thumbnail is dark with some green and white elements.

Power Posing: Brief Nonverbal Displays Affect Neuroendocrine Levels and Risk Tolerance

these are "epistemic inefficiencies"

^aColumbia University and ^bHarvard University

[Read article](#)

Ellis R. Lippincott, Robert R. Stromberg,

Warren H. C...

Science 164 (1969)

Female hurricanes are deadlier than male hurricanes

Kiju Jung^{a,1}, Sharon Shavitt^{a,b,1}, Madhu Viswanathan^{a,c}, and Joseph M. Hilbe^d

PNAS 111 (2014)

science is not a meritocracy

good ideas do not always win out over mediocre ones

the best scientists are not reliably recognized



HISTORY OF INNOVATION

Who do we invent for? Patents by women focus more on women's health, but few women get to invent

Rembrand Koning^{1*}, Sampsa Samila², John-Paul Ferguson³

Science 372 (2021)

WHO BECOMES AN INVENTOR IN AMERICA?
THE IMPORTANCE OF EXPOSURE TO INNOVATION*

ALEX BELL
RAJ CHETTY
XAVIER JARAVEL
NEVIANA PETKOVA
JOHN VAN REENEN

The Quarterly J. Economics (2019)

* "Lost Einsteins" paper

The Diversity–Innovation Paradox in Science

Bas Hofstra^{a,1}, Vivek V. Kulkarni^b, Sebastian Munoz-Najar Galvez^a, Bryan He^b, Dan Jurafsky^{b,c}, and Daniel A. McFarland^{a,1}

cognitive & identity diversity correlate with innovative concepts

PNAS 117 (2020)

science is not a meritocracy

good ideas do not always win out over mediocre ones

the best scientists are not reliably recognized



HISTORY OF INNOVATION

Who do we invent for? Patents by women focus more

WHO BECOMES AN INVENTOR IN AMERICA?

ON*

social biases

drive epistemic inefficiencies

The Diversity–Innovation Paradox in Science

Bas Hofstra^{a,1}, Vivek V. Kulkarni^b, Sebastian Munoz-Najar Galvez^a, Bryan He^b, Dan Jurafsky^{b,c}, and Daniel A. McFarland^{a,1}

cognitive & identity diversity correlate with innovative concepts

PNAS 117 (2020)

The Quarterly J. Economics (2019)

* "Lost Einsteins" paper

science is not a meritocracy

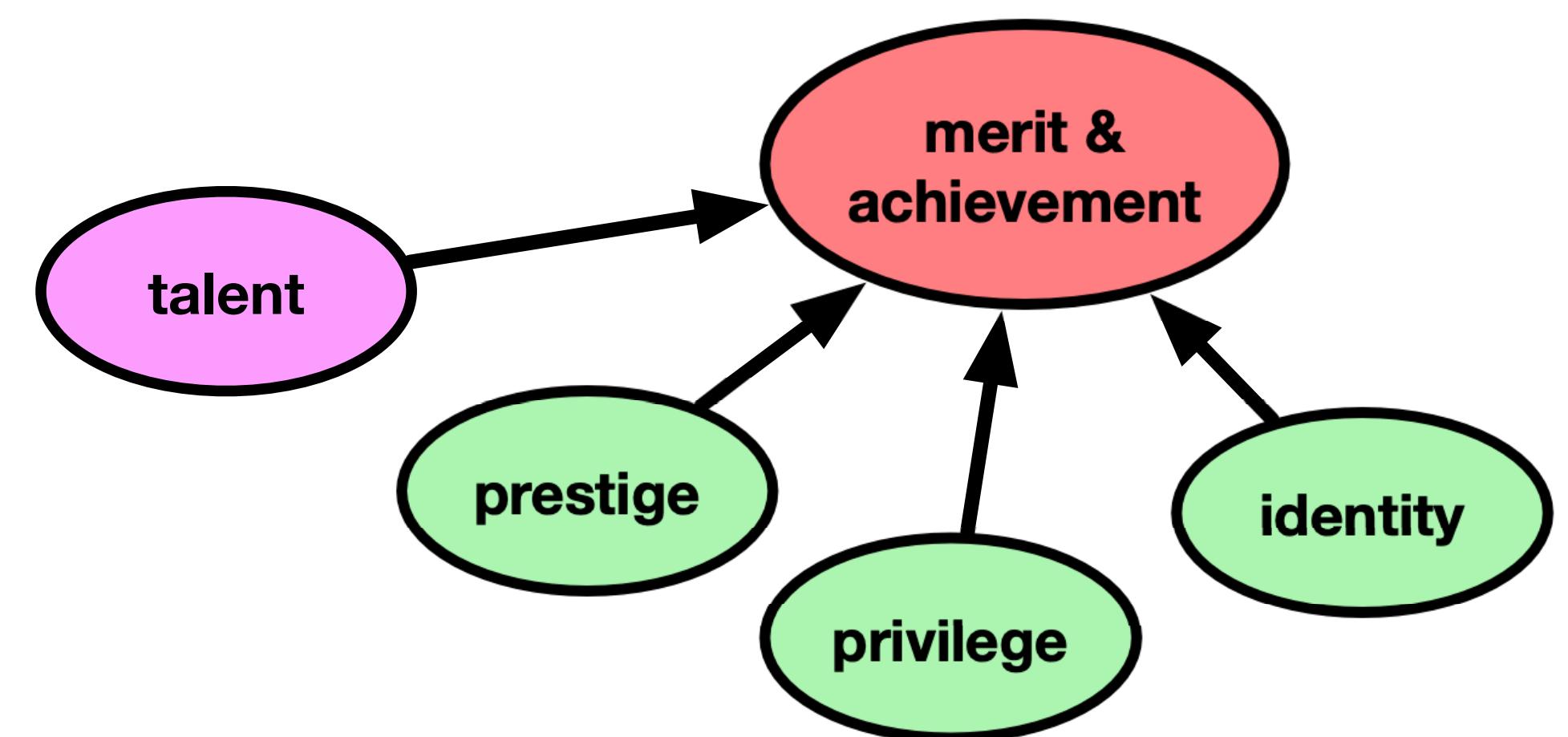
good ideas do not always win out over mediocre ones

the best scientists are not reliably recognized

because "merit" is entangled with social factors like **prestige**, **privilege**, and **identity**

untangling the effects of social biases can make science better, *more* meritocratic

and, we can study epistemic inefficiencies scientifically to untangle them



this talk

"little in academia makes sense except in light of prestige"



understanding epistemic and social inequalities requires understanding how prestige drives and maintains them



prestige shapes who joins the scientific workforce



prestige shapes which scientific ideas spread



prestige shapes who persists as a scientist

the scientific workforce

faculty are special part of the scientific workforce



- make scientific discoveries
- produce new scholarship
- technical experts on all manner of subjects
- pass on scientific, cultural, and historical knowledge
- train future scientists
- have long, stable careers

how does prestige shape who becomes faculty?

what is prestige?

prestige in the sense of Burris (2004) : a form of social capital

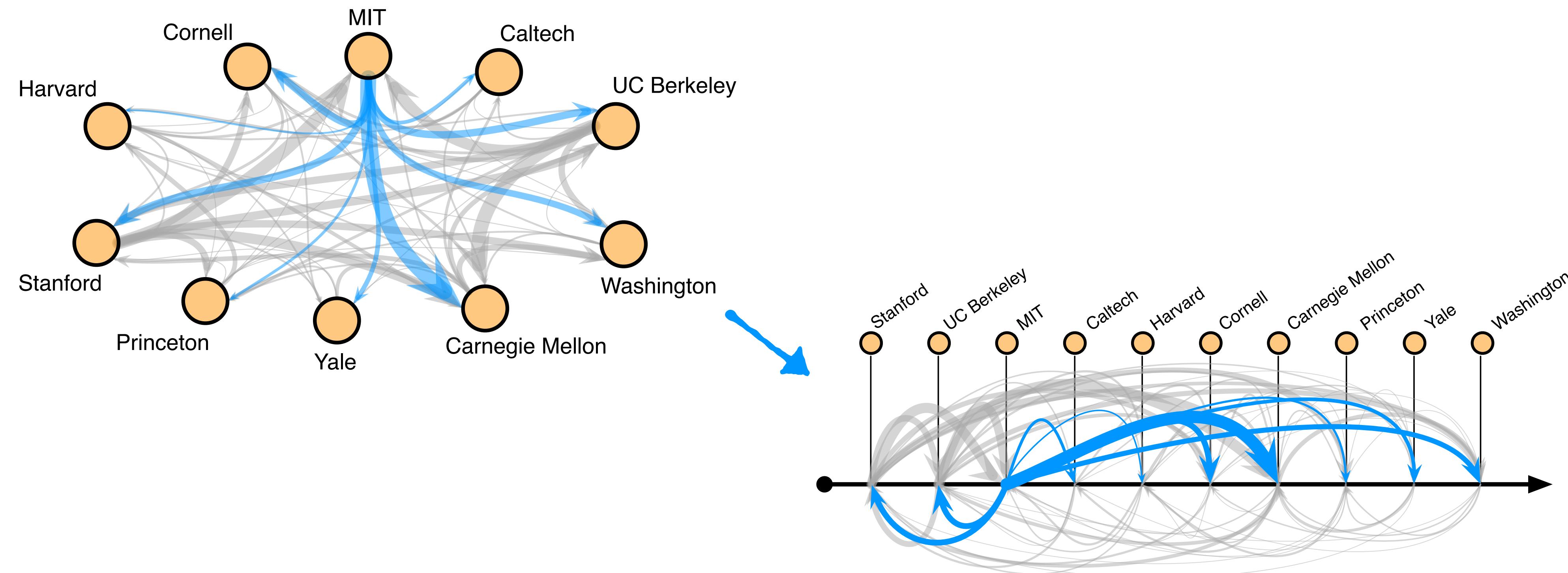
prestige "is an effect a department's position within networks of association and social exchange"

which we can infer from *who hires whose graduates as faculty*

faculty hiring networks

faculty hiring is a *network*

prestige → centrality in the faculty hiring network ("placement power")



faculty hiring networks

faculty hiring is a *network*

prestige → centrality in the faculty hiring network ("placement power")

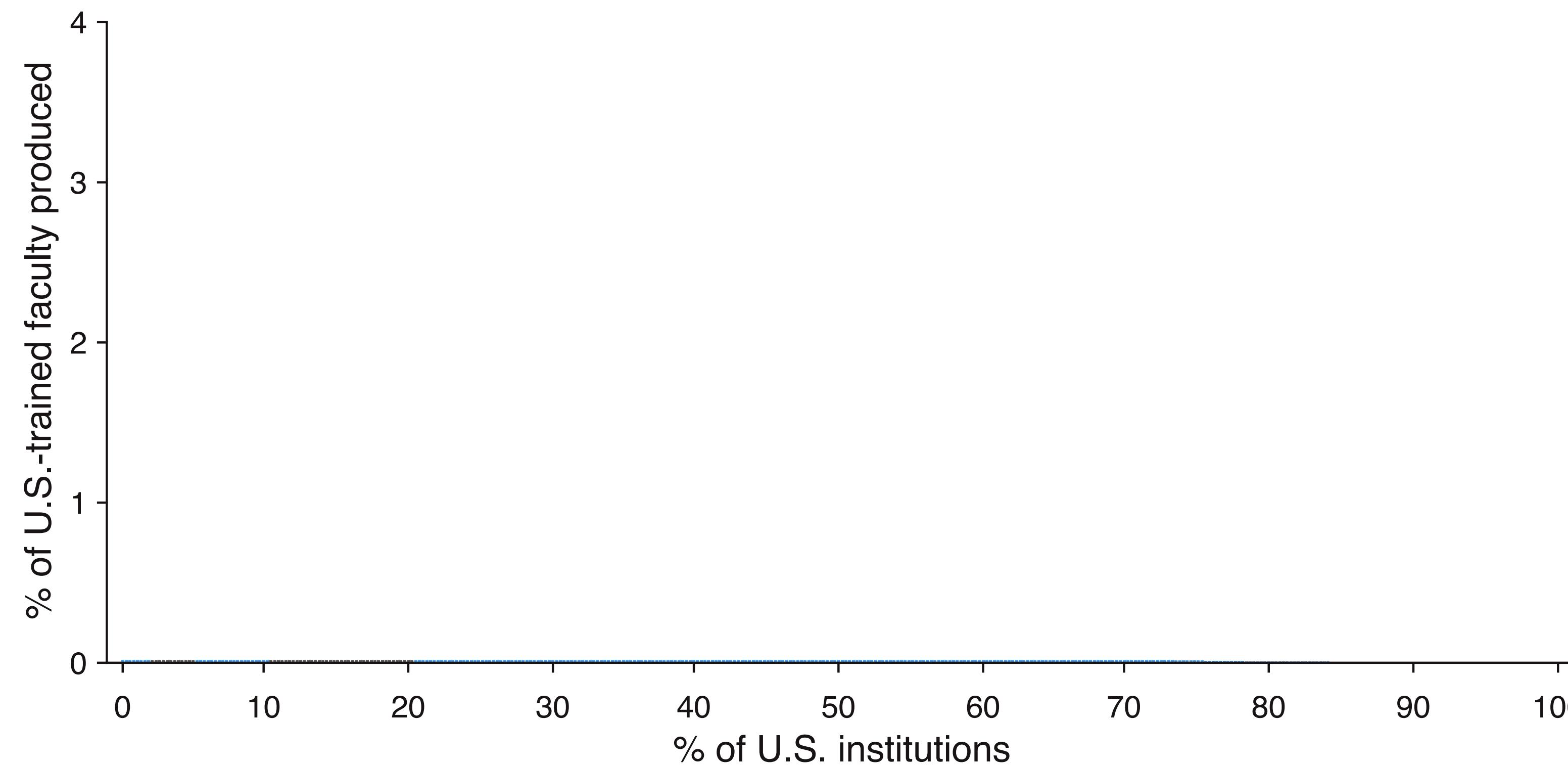
AARC census-level data on education and placement of 291,123 regular faculty at 10,612 departments across 86 fields, 2011 – 2020



- ▶ how unequal is faculty production?
- ▶ what implications for epistemic inequalities?

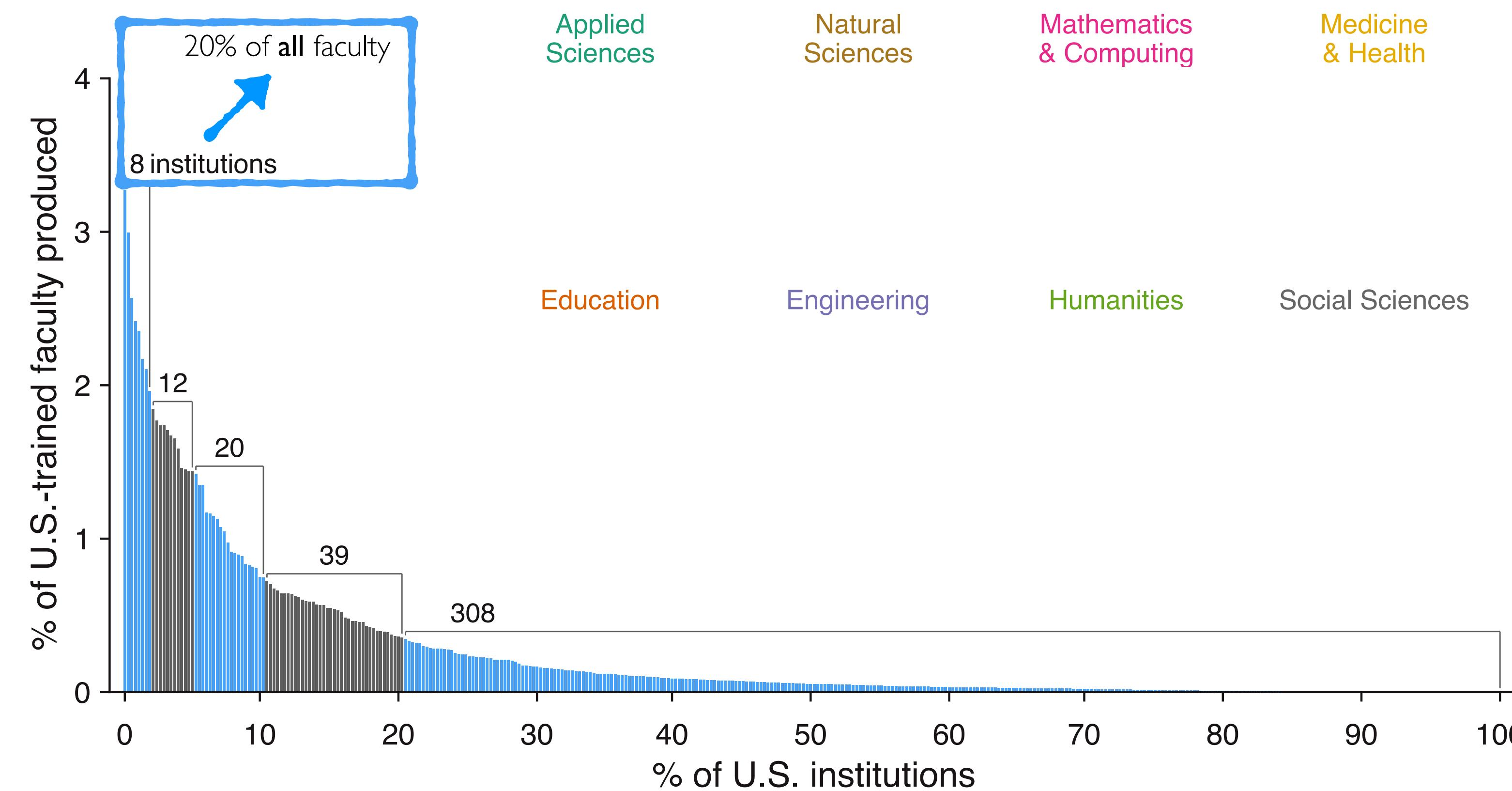
who hires whose graduates as faculty?

- ▶ sort 387 institutions by overall production of faculty



who hires whose graduates as faculty?

- ▶ faculty production is enormously *concentrated*



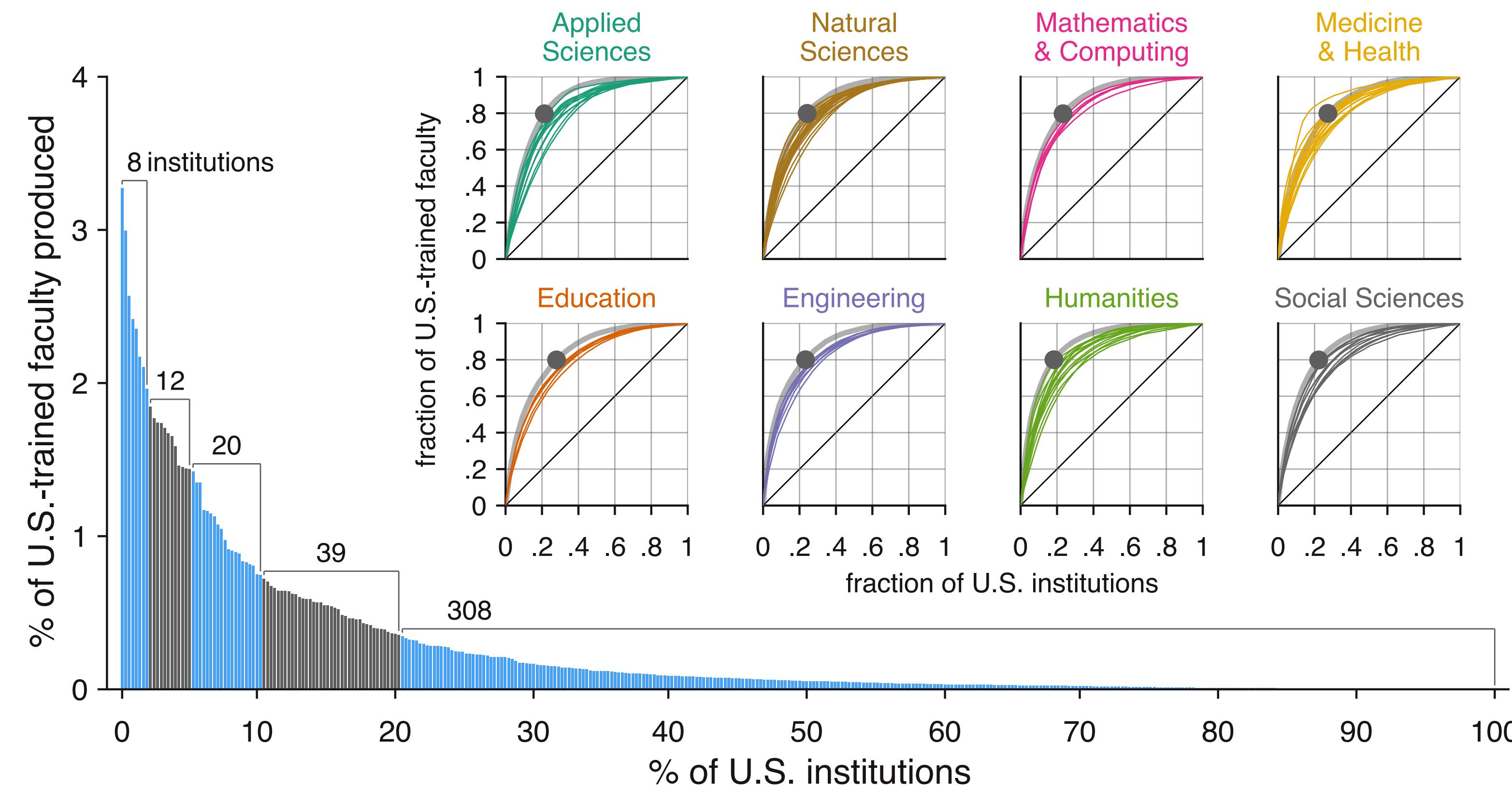
all-academia Gini = 0.75

the top 8: Berkeley, Harvard, Michigan, Wisconsin, Stanford, UIUC, MIT, UT Austin (note that only 3 of the 8 are private)

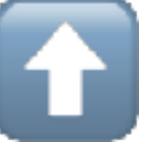
Wapman et al., "Quantifying hierarchy and dynamics in US faculty hiring and retention" (2022)

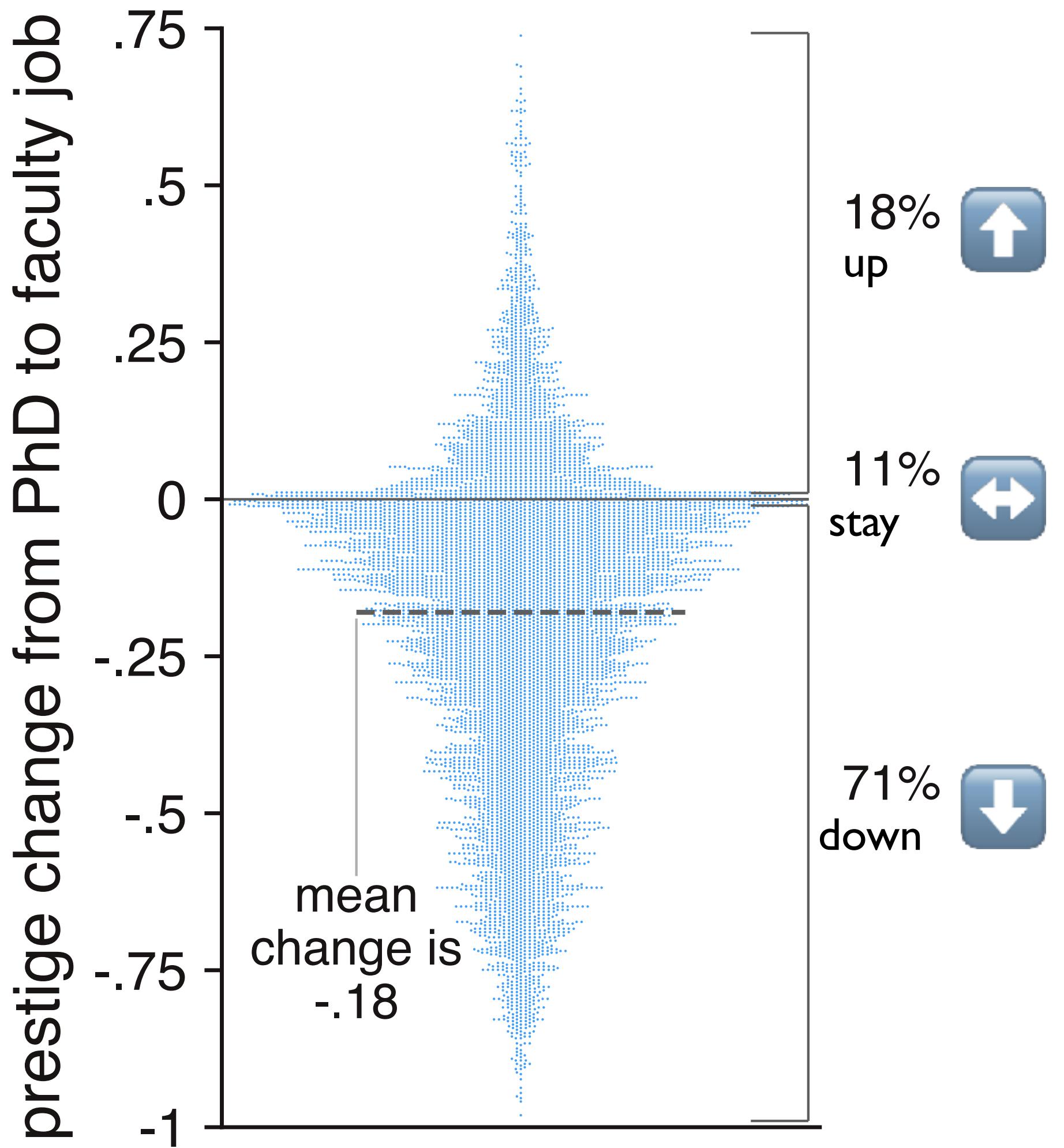
who hires whose graduates as faculty?

- ▶ faculty production is enormously *concentrated*
- ▶ recapitulated in all 86 fields (a roughly universal "80-20 rule")



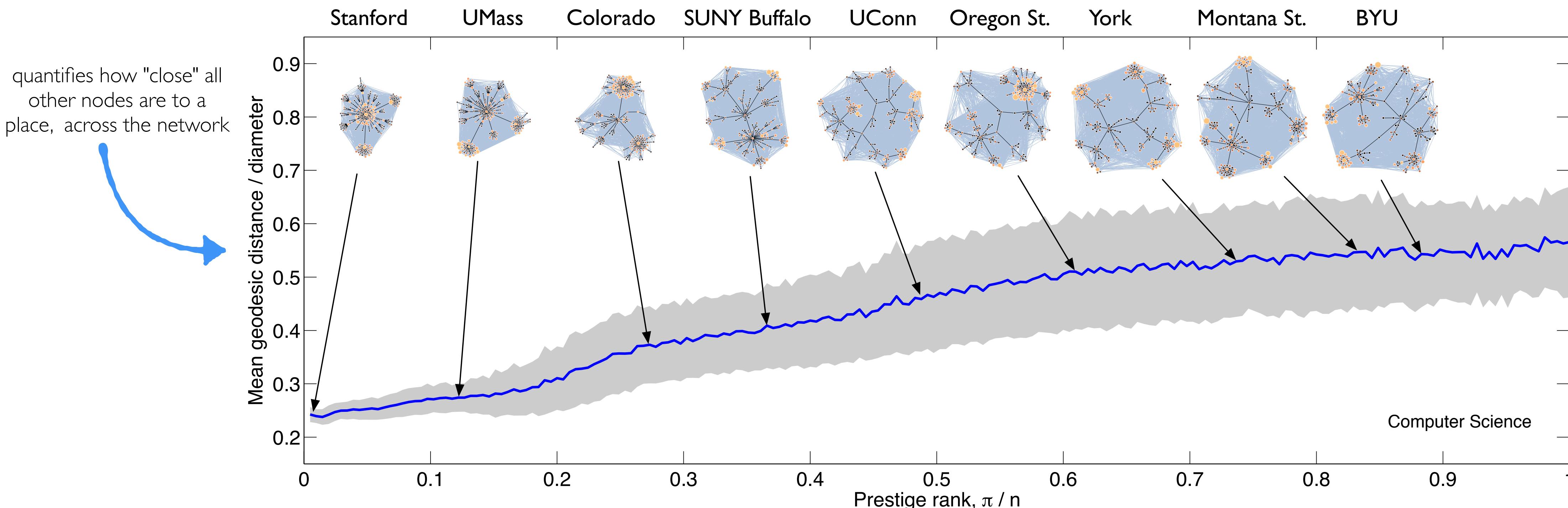
who hires whose graduates as faculty?

- ▶ prestige hierarchies are steep 
- ▶ faculty placement mostly "down" (71%) 
- only 18% (mean) move "up" 
- ▶ only 20% of departments have trained more faculty than they've hired



who hires whose graduates as faculty?

network organized as core and periphery : high ranked nodes are more central

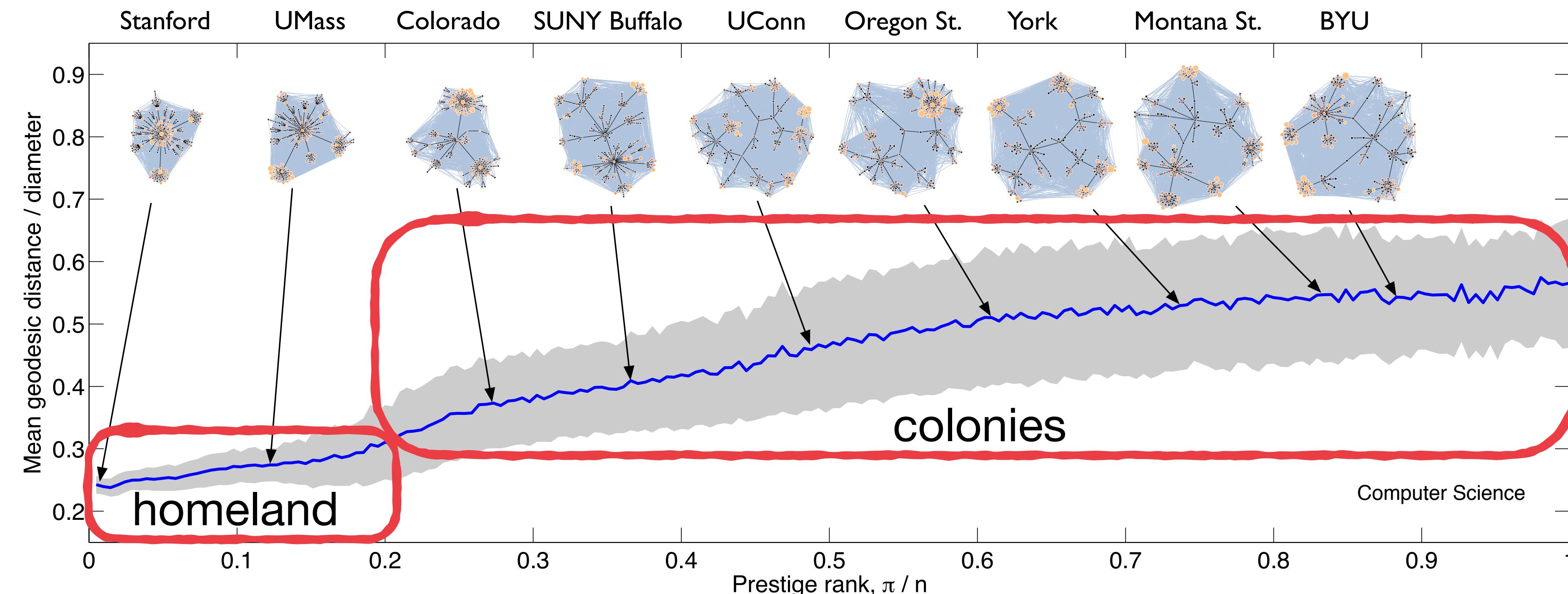


who hires whose graduates as faculty?

network organized as ~~core and periphery~~ *homeland* and *colonies*

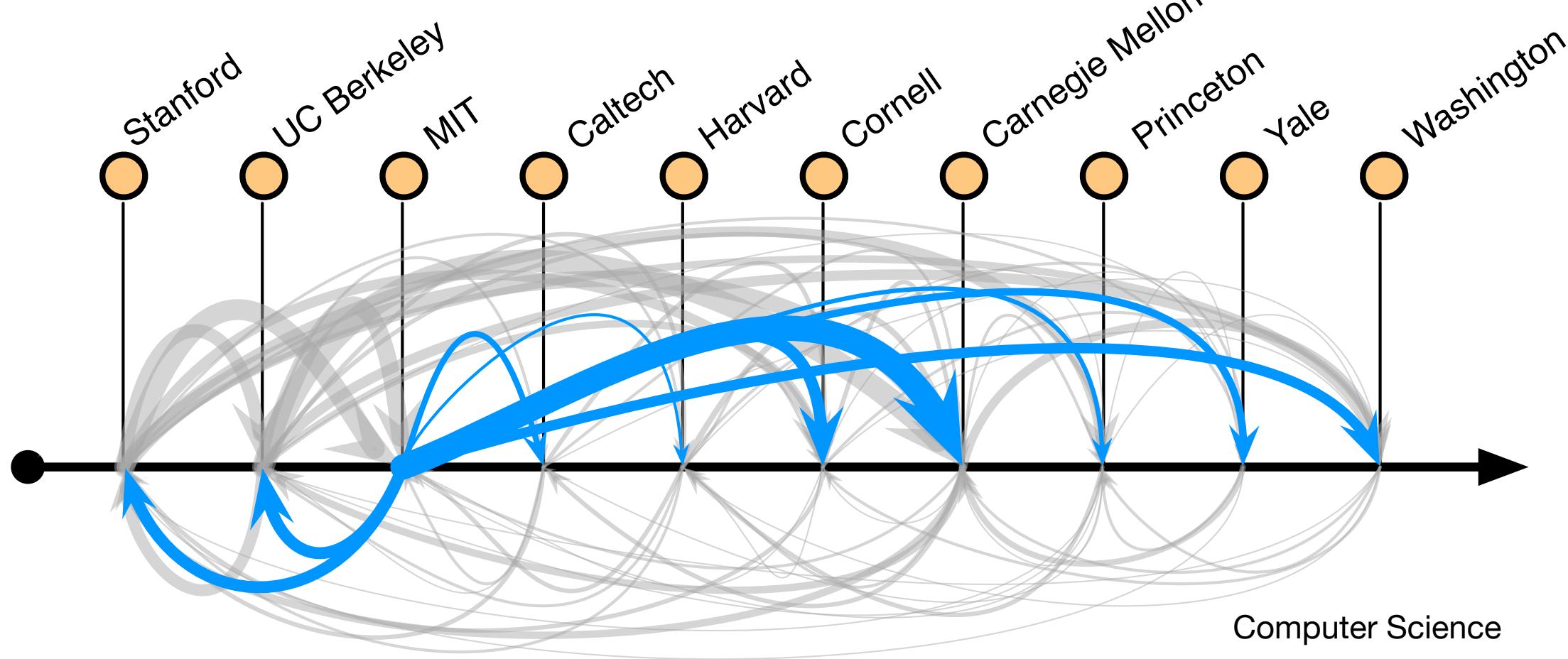
prestige → *influence* via doctoral placement

over research agendas, research communities, and departmental norms across a field



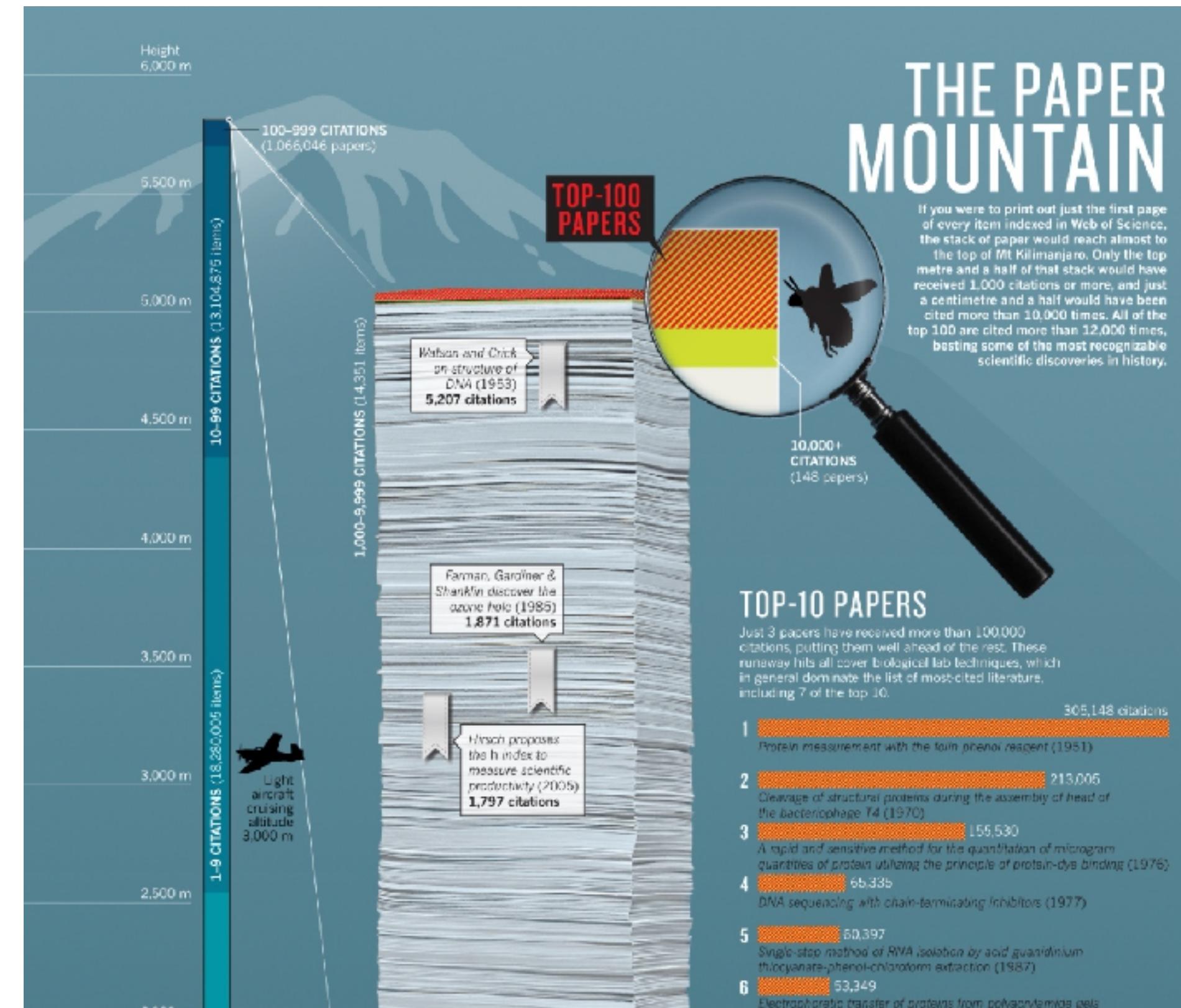
who hires whose graduates as faculty?

- ▶ prestige is a *structural variable* in the scientific workforce
- placement power quantifies reputation via outcomes
(not inputs, as in USNRW)
- reveals *core-periphery* structure of academia
 - faculty flow from core → periphery ("the colonies")
 - modest fraction stays inside core ("homeland")
 - small fraction flows "upstream"
 - these hierarchies extremely stable over time
- prestige → faculty production → hierarchy



what shapes the spread of ideas?

some ideas spread further than others – why?

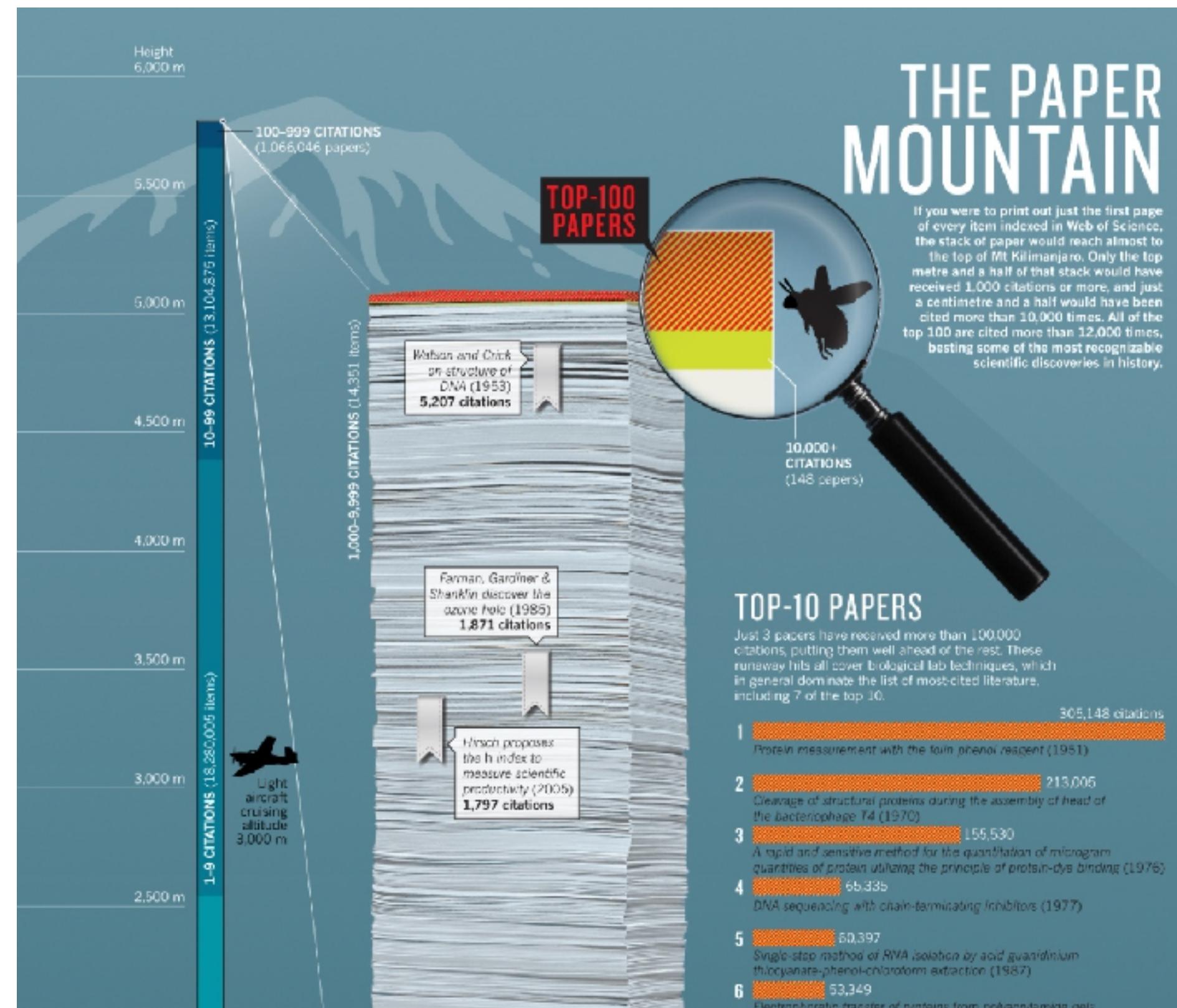


Nature "The top 100 papers." (2014)

what shapes the spread of ideas?

three explanations:

- genuine differences in merit
some ideas are just better than others
- non-meritocratic social processes
fame, seniority, discrimination, history, etc.
biases in who gets credit & opportunities
- non-meritocratic structural factors (aka prestige...)
scientists carry ideas from PhD to faculty institution
difference in placement power drives epistemic inequality
a mechanism (agenda setting theory): biases in who does what work, where



Nature "The top 100 papers." (2014)

what shapes the spread of ideas?

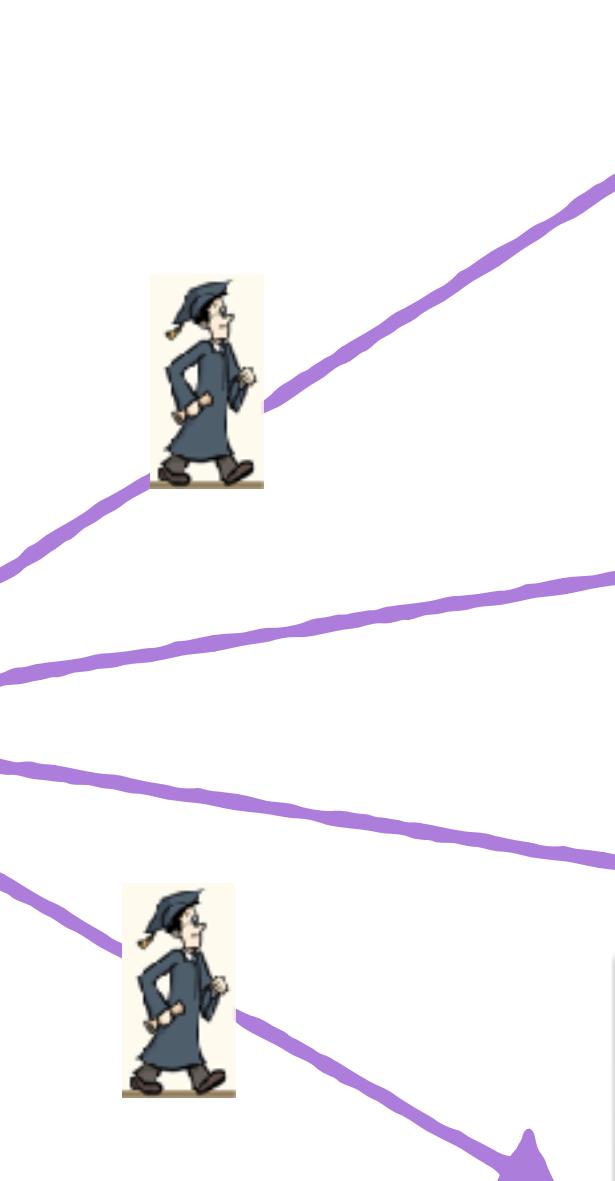
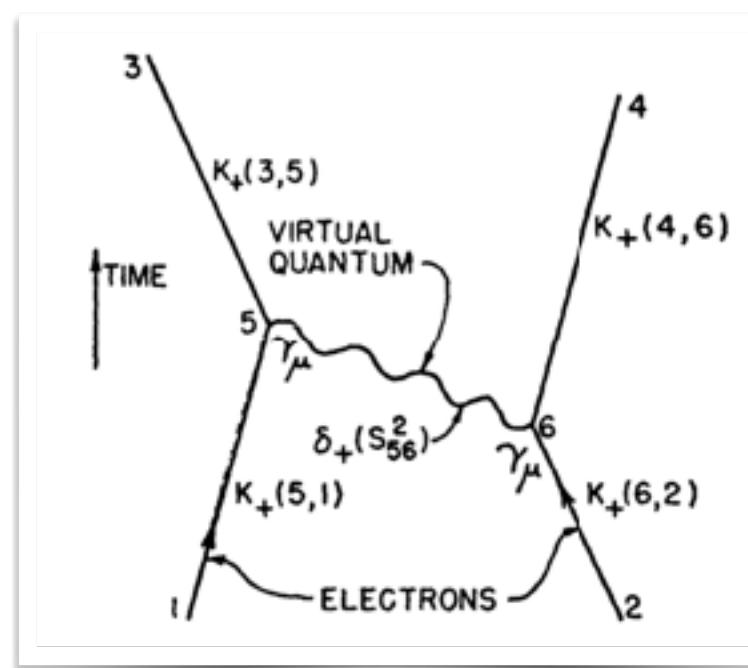
a *structural* explanation

- non-meritocratic structural factors
scientists carry ideas from PhD to faculty institution

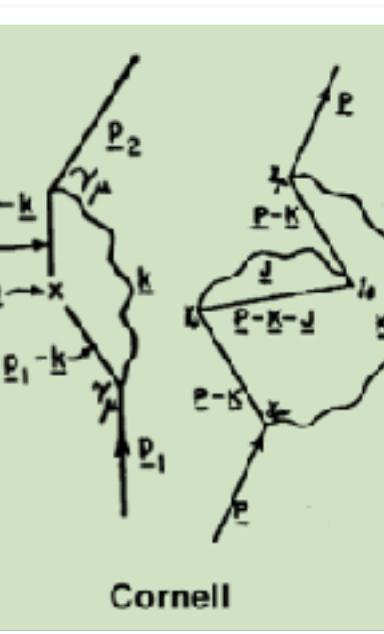
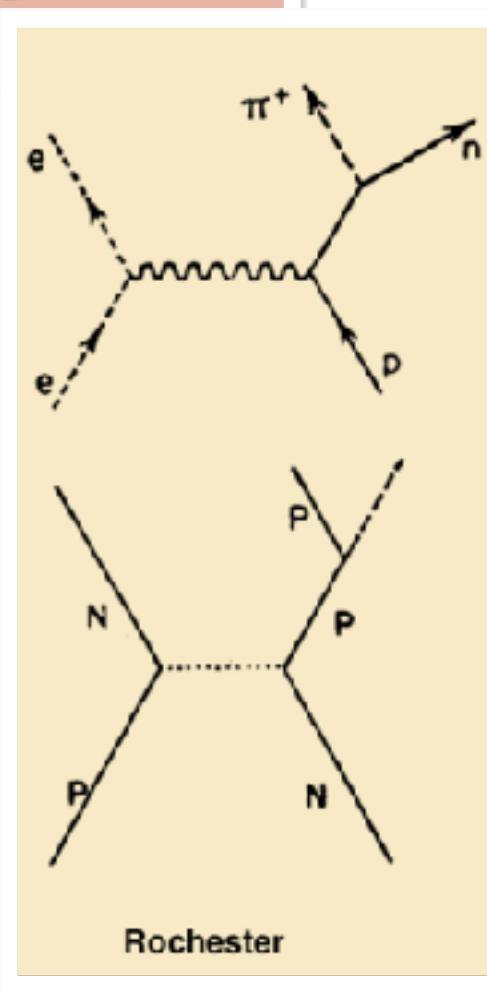
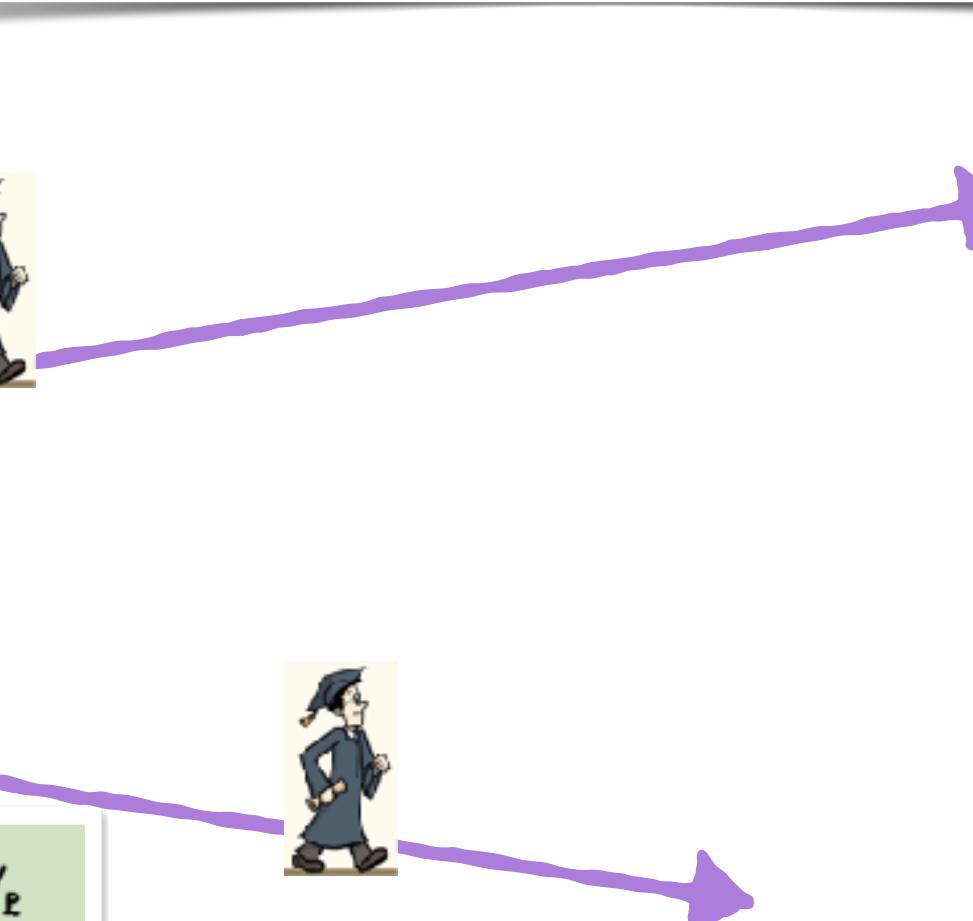
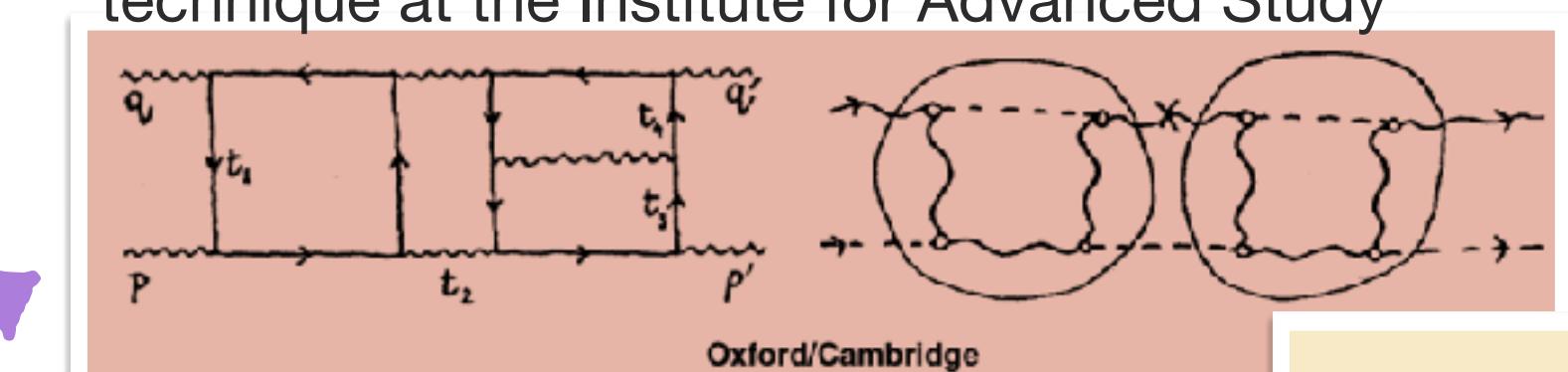
Feynman diagrams, born 1948



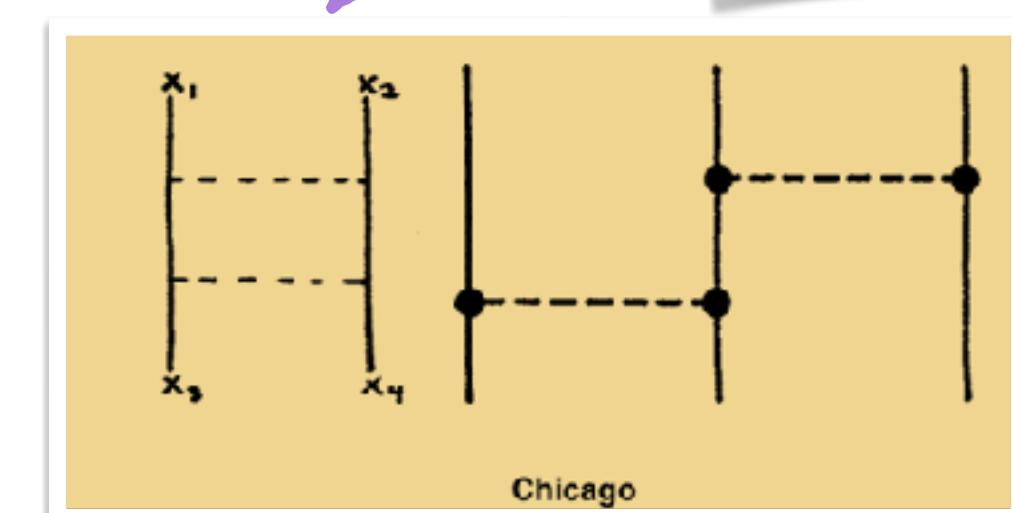
Lamb, Wheeler, Pais, Feynman,
Feshbach & Schwinger



then spread by postdocs who learned the technique at the Institute for Advanced Study



Cornell



Chicago

what shapes the spread of ideas?

a *structural* explanation

- non-meritocratic structural factors
scientists carry ideas from PhD to faculty institution

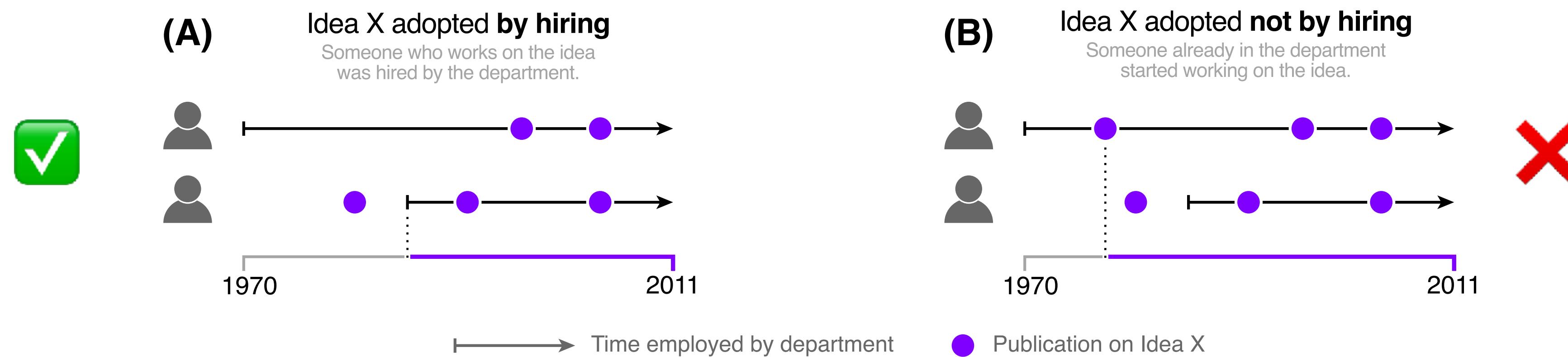


- two tests:
 1. (data) does faculty hiring explain *where* an idea is studied (prestige)?
 2. (simulation) how *big* an effect does prestige have on the spread of ideas?

what shapes the spread of ideas?

1. (data) does faculty hiring explain *where* an idea is studied (prestige)?
 - combine CS faculty hiring data + matched publication histories

two possibilities:



count (A) and (B) cases for 5 ideas: topic modeling, incremental computing, deep learning, quantum computing, mechanism design

what shapes the spread of ideas?

1. (data) does faculty hiring explain *where* an idea is studied (prestige)?

topic X	f_{obs}	f_{exp}	p
topic modeling	0.35	0.23	0.01 ± 0.01
incremental computing	0.39	0.20	0.01 ± 0.01
deep learning	0.35	0.34	0.34 ± 0.01
quantum computing	0.32	0.22	0.01 ± 0.01
mechanism design	0.48	0.21	0.01 ± 0.01



fraction of real hires
that spread idea X



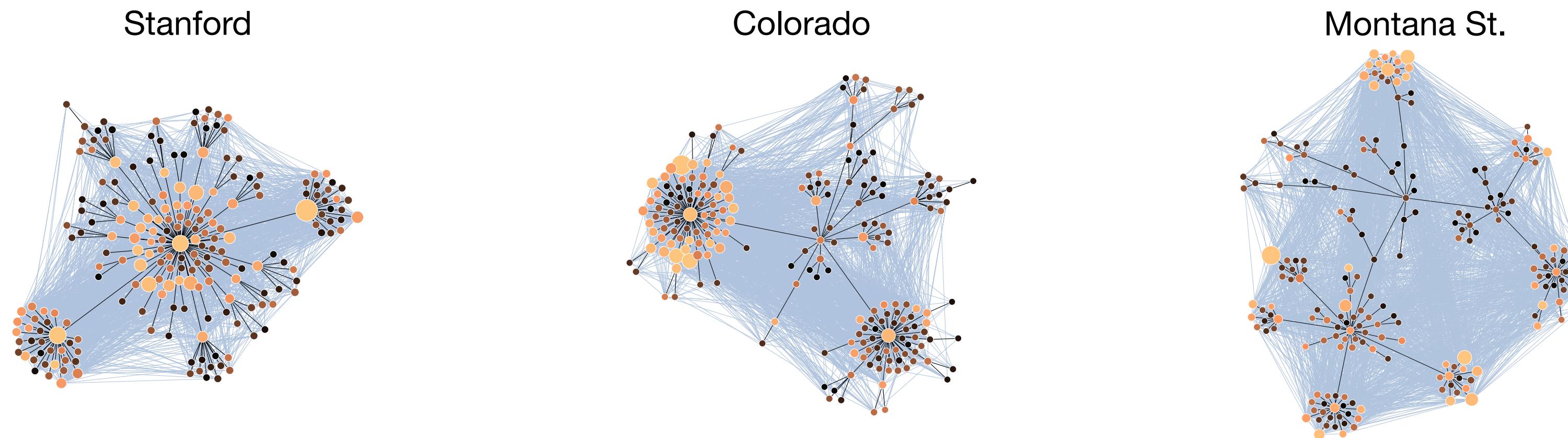
fraction under
permutation test

yep. faculty hiring is a *significant* driver of the spread of some ideas

what shapes the spread of ideas?

2. (simulation) how *big* an effect does prestige have on the spread of ideas?

- use actual CS faculty hiring network + simulate idea transmission



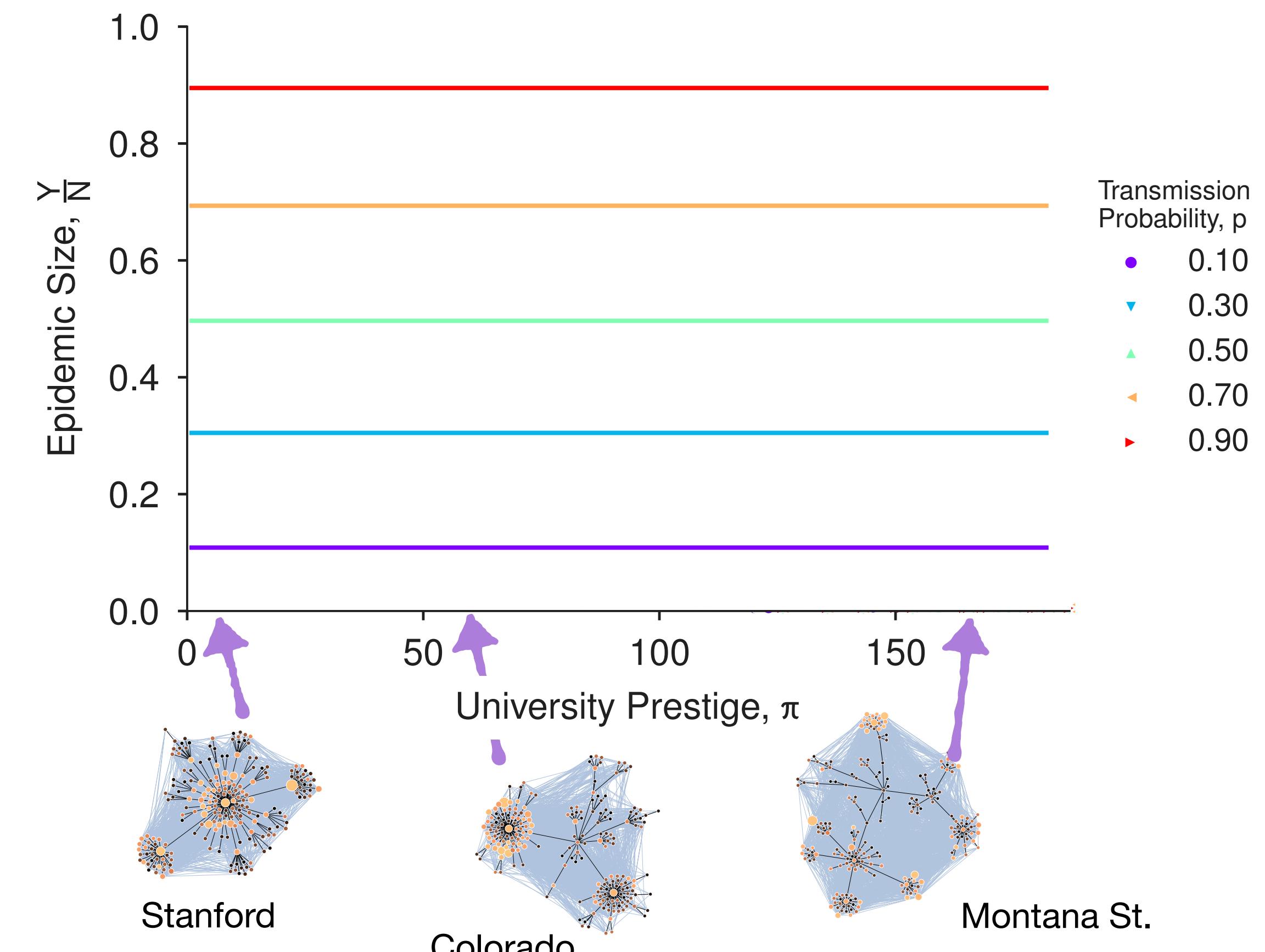
- ideas spread according to Independent Cascade (IC) model
- vary prestige π of "origin" place where an idea begins
- vary idea transmissibility (underlying merit) $p \in \{0.1, 0.3, 0.5, 0.7, 0.9\}$
- measure how far it spreads: normalized cascade size Y/N

what shapes the spread of ideas?

2. (simulation) how *big* an effect does prestige have on the spread of ideas?

meritocracy?

- idea spread is proportional to idea "quality"
- spread is independent of birthplace



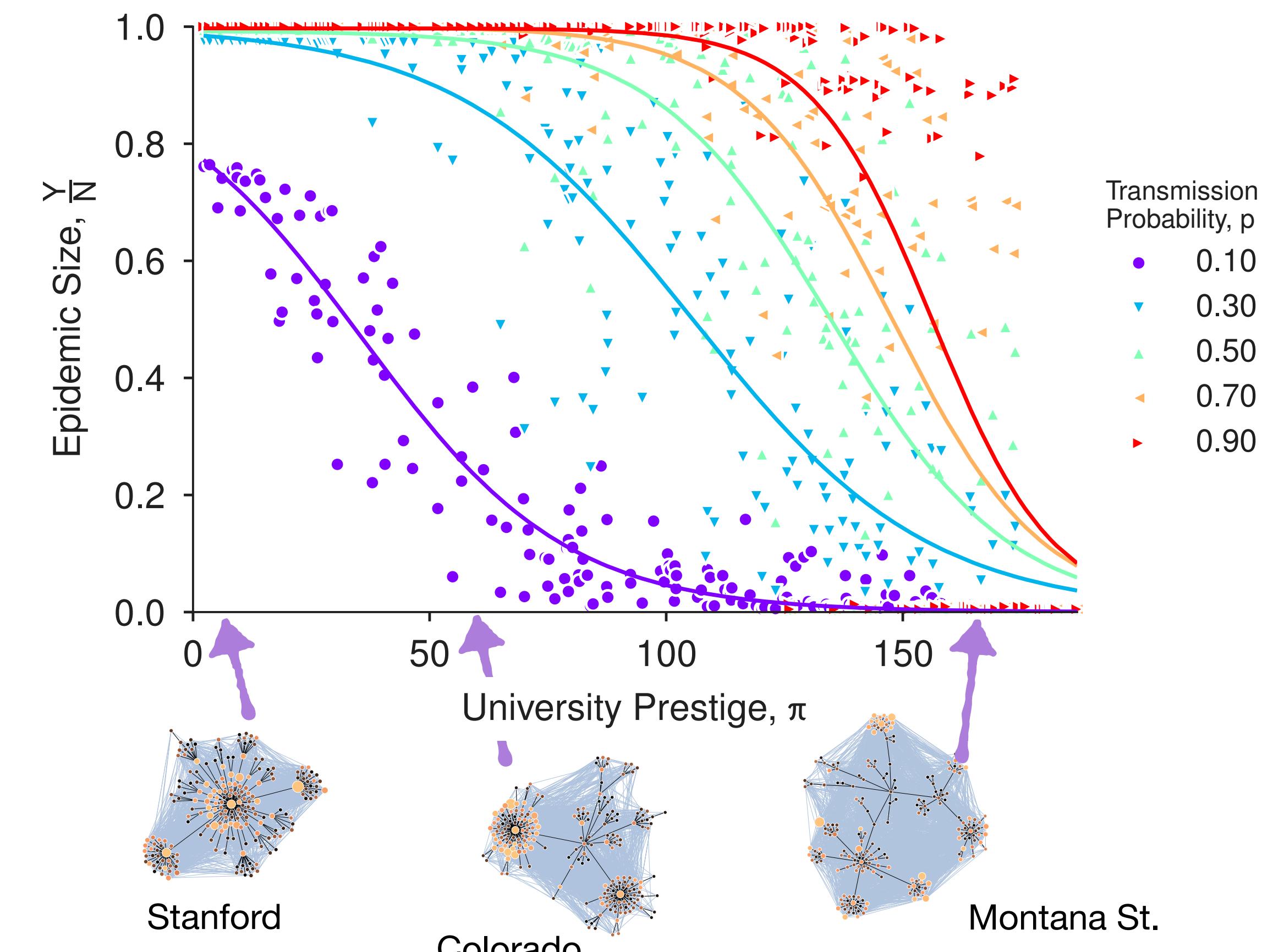
what shapes the spread of ideas?

2. (simulation) how *big* an effect does prestige have on the spread of ideas?

not-a-meritocracy.

- best ideas spread independent of origin
- bad ideas spread easily from elite departments
- good ideas from mid-prestige spread less well than bad ideas from high-prestige

💡 *prestige is an idea amplifier*



what shapes the spread of ideas?

► prestige is a *structural variable* in the spread of knowledge

■ scientists carry ideas from PhD to faculty institution



■ prestige (placement power) drives *epistemic inequalities*

simulations suggests exponential dependence of "impact" on increased prestige

your position in the network shapes how far your ideas spread

■ prestige → faculty production → influence

who gets to be faculty?

U.S. academia has never been *representative* of the U.S. population

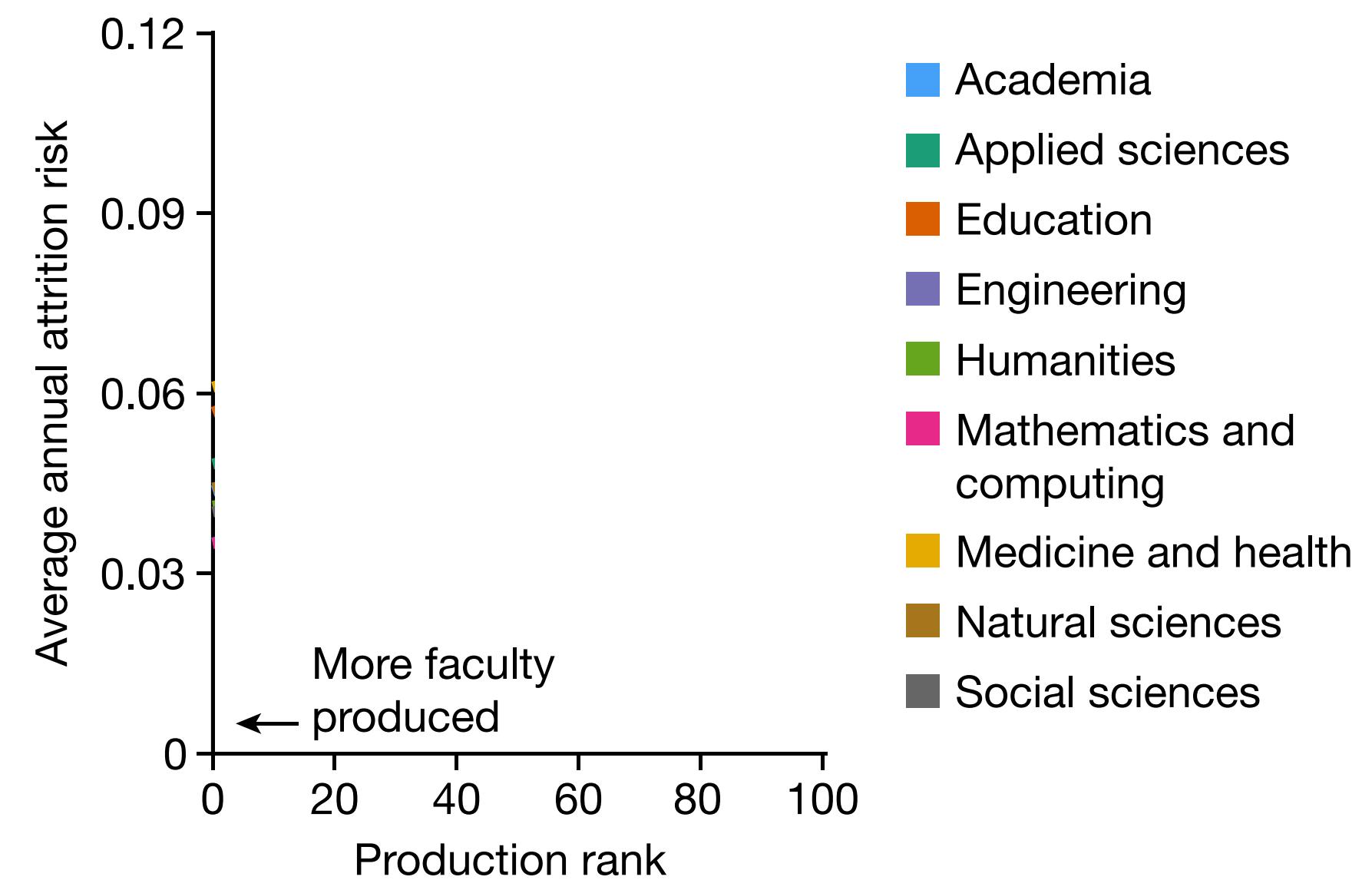
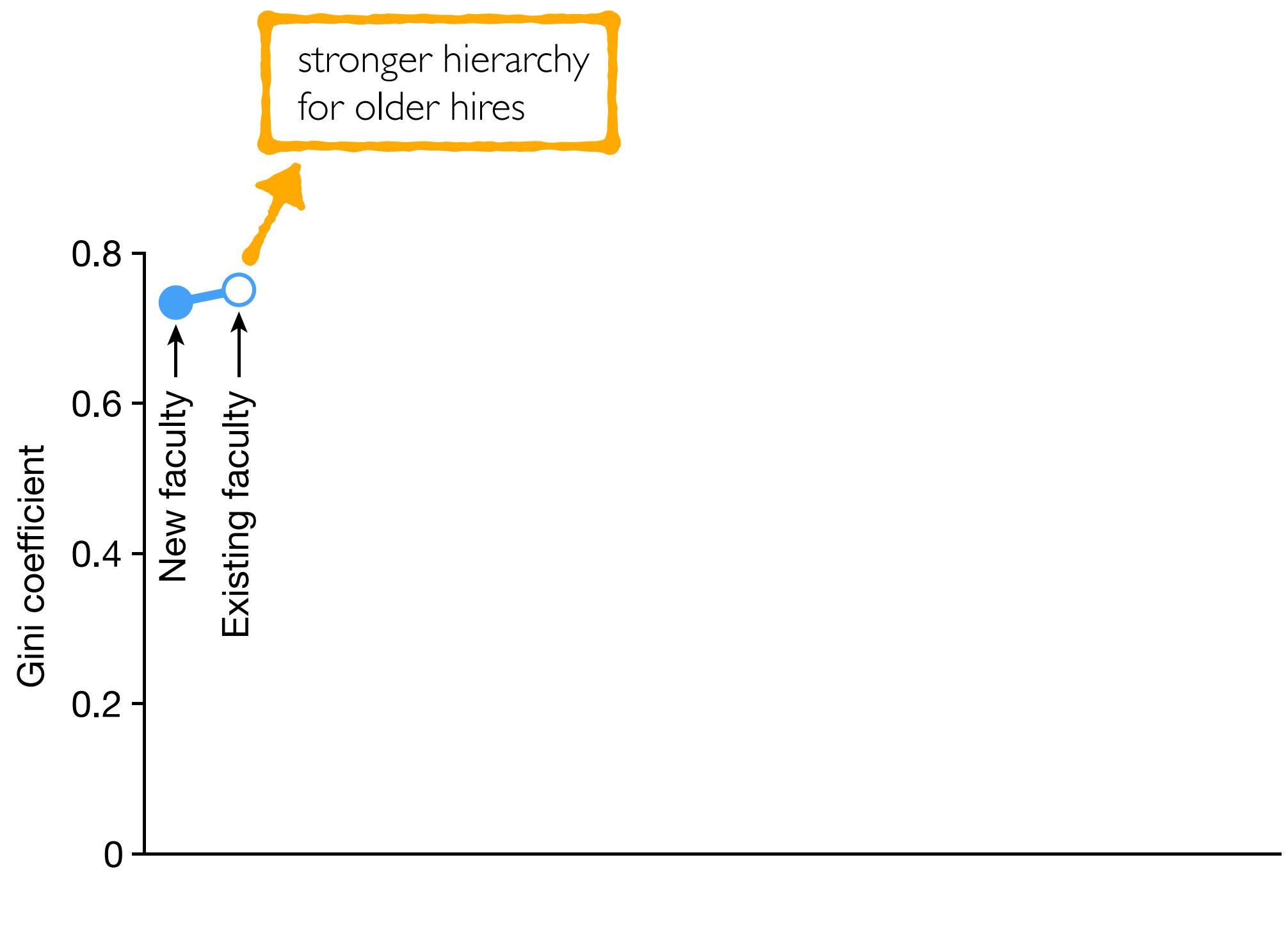
under-representation by race / gender are well studied → faculty are mostly white men
with elite PhDs

who persists as faculty, and how might representation shape our scholarship?

who gets to be faculty?

► *faculty attrition* correlates with prestige

new hires more diverse in prestige

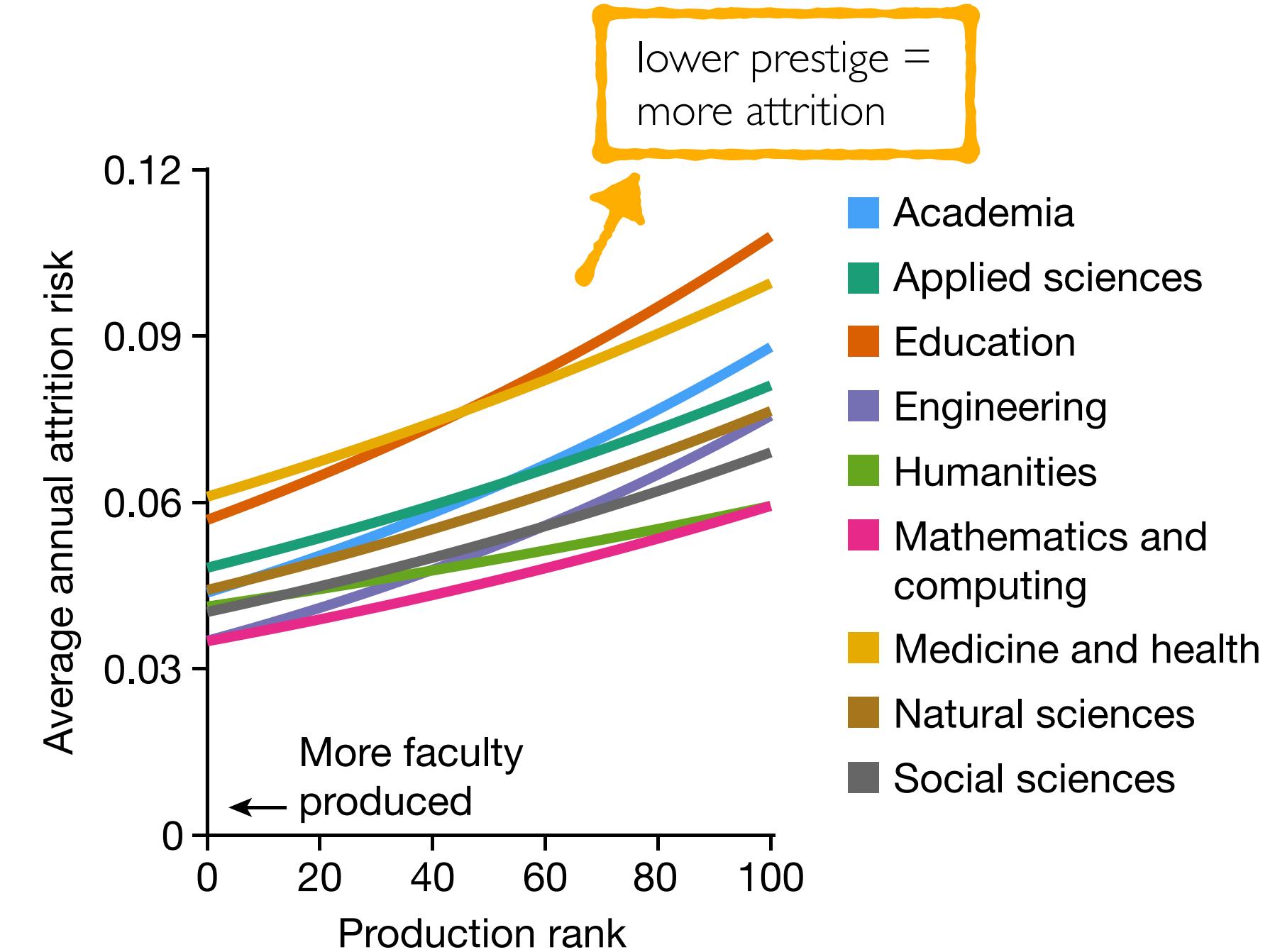
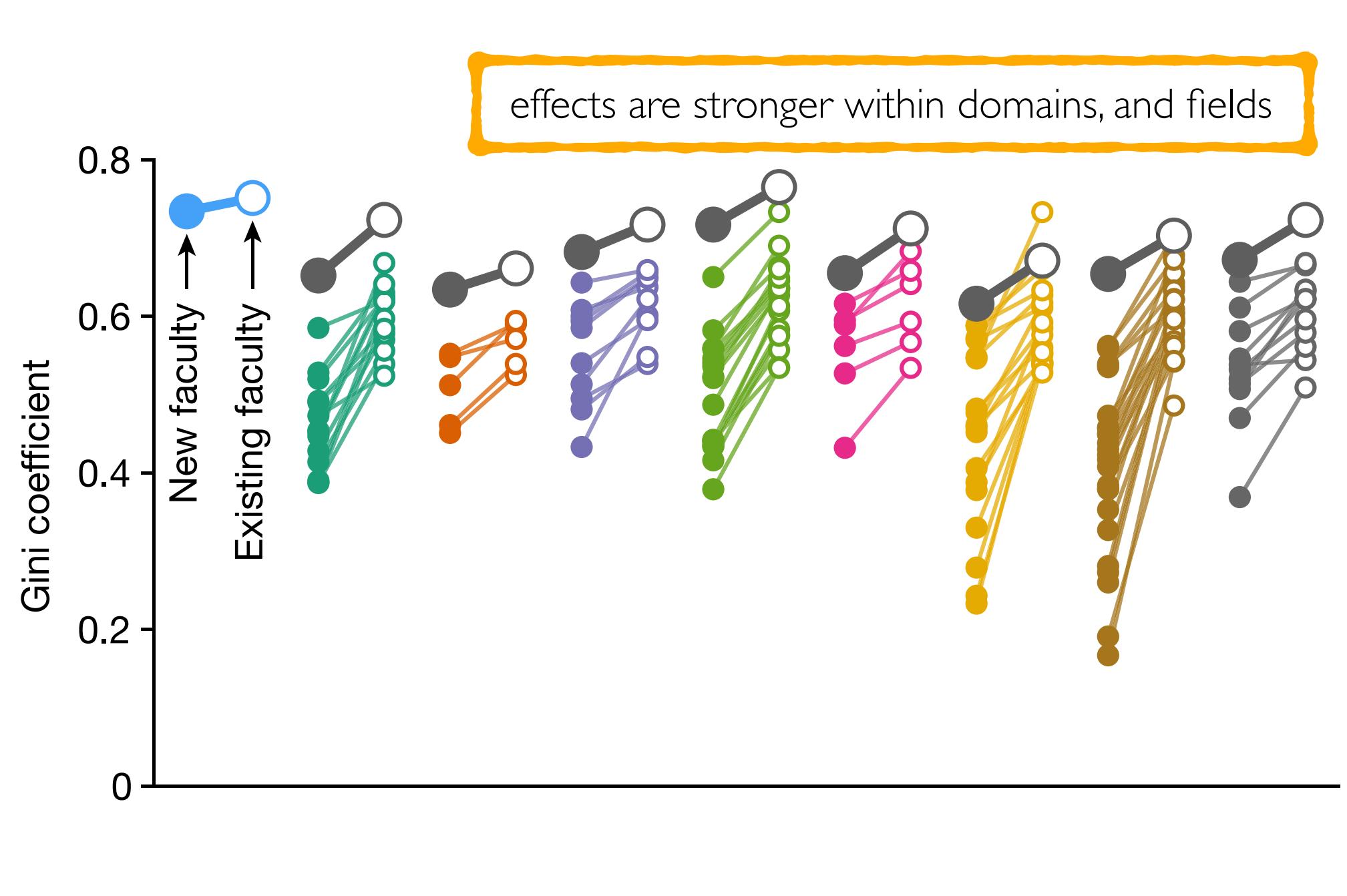


who gets to be faculty?

► *faculty attrition* correlates with prestige

new hires more diverse in prestige + non-elite hires more likely to leave = stable hierarchy

attrition higher for PhDs from outside {US, UK, Canada} or low-ranked school



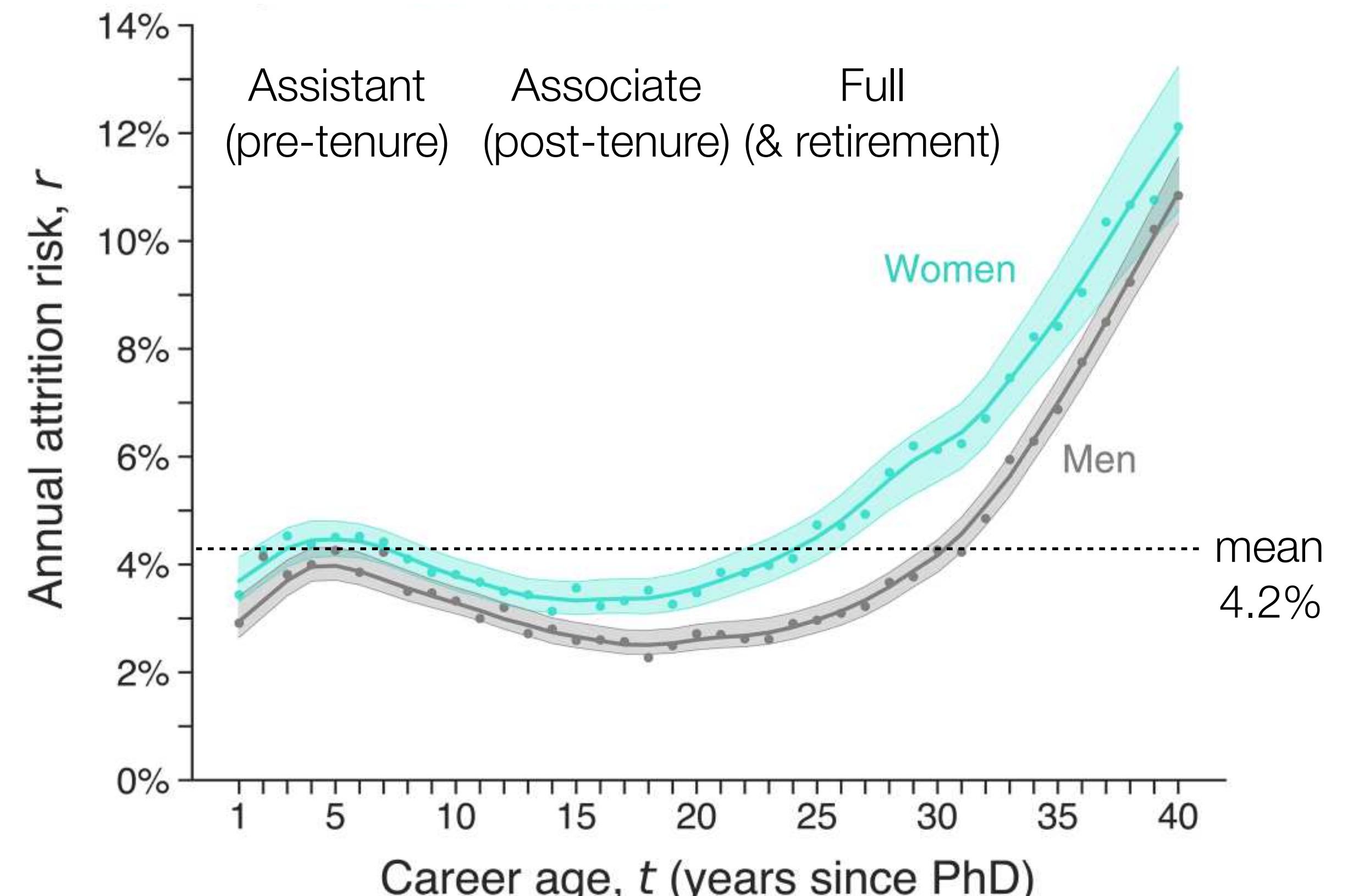
who gets to be faculty?

- ▶ *faculty attrition* correlates with gender

"all-cause" attrition risk $r = (\# \text{ who left}) / (\# \text{ who could have left})$ over all faculty in all fields

at every career age, women are more likely to leave than men

the disparity is *larger* at less prestigious universities,
especially in non-STEM fields



mean 4.2% is for career age $t \leq 40$ years

$N = 245,270$ faculty, PhD-granting departments, employment data 2011-2020 from AARC

Spoon et al., "Gender and retention patterns among U.S. faculty." (2023)

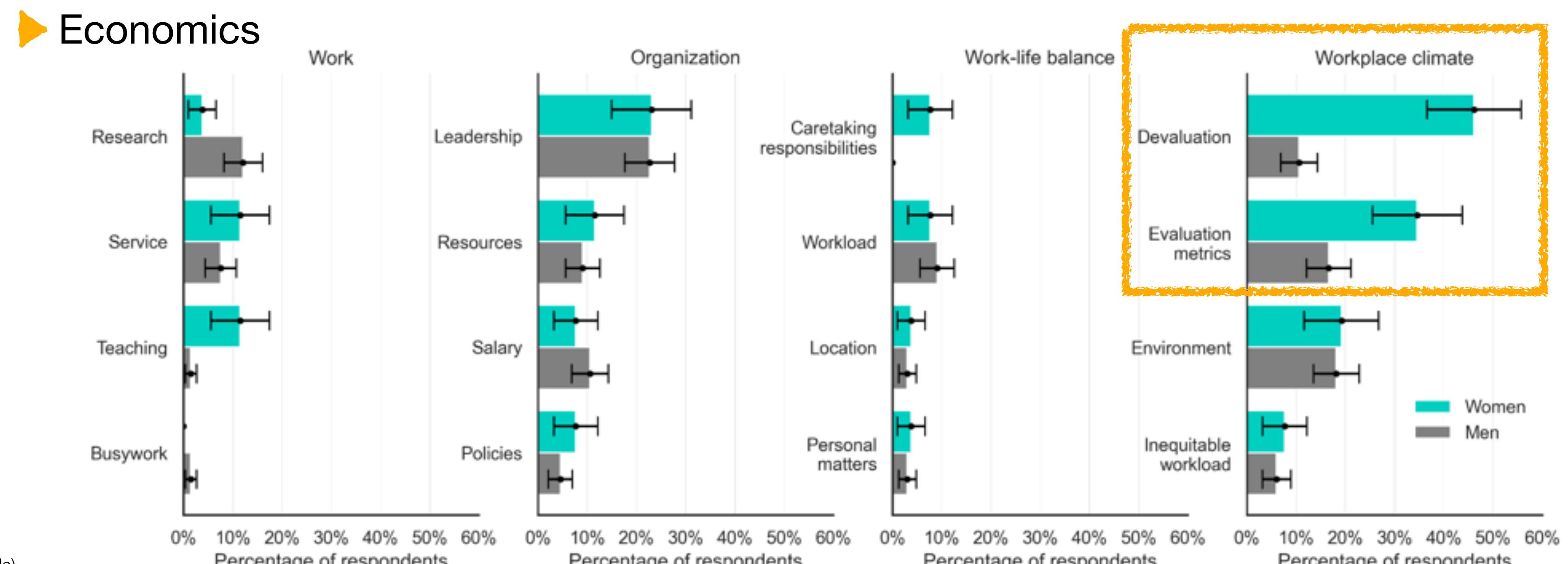
who gets to be faculty?

► gendered attrition correlates with feeling devalued

women more likely to leave / would leave "due to a push"

women more likely to self-report feeling devalued in academic workplace

work-life balance not the most gendered factor



who gets to be faculty?

faculty tend to come from highly educated families (socioeconomic background)

- ▶ half (51.8%) of all faculty have parent with MS or PhD
- quarter (22.2%) have parent with PhD → 2x PhD holders, 25x US population !

percent faculty parents highest educational attainment

	Elementary	Some HS	HS	Some College	College	Masters	PhD
All Professors	2.6	2.9	13.7	9.5	19.5	29.6	22.2
Anthropology Professors	0.8	2.2	15.1	7.0	19.0	32.8	23.0
Biology Professors	3.2	3.3	14.1	11.6	19.5	26.3	21.9
Business Professors	2.3	3.3	14.5	8.4	24.1	30.9	16.6
Computer Science Professors	3.2	3.4	10.8	8.9	21.6	26.1	26.0
History Professors	1.6	1.3	10.5	8.6	17.0	34.3	26.7
Physics / Astronomy Professors	4.1	4.1	12.1	10.2	18.2	27.4	23.9
Psychology Professors	1.6	2.1	17.4	9.9	17.0	31.1	20.7
Sociology Professors	1.8	2.7	17.3	7.1	17.3	34.9	18.9
Survey of Earned Doctorates (NSF)	←	25.2	→	14.0	23.1	26.0	11.8
U.S. Population (Census)	8.7	10.5	35.6	23.1	14.6	6.5	0.9

percent reference population highest educational attainment

who gets to be faculty?

faculty tend to come from highly educated families (socioeconomic background)

- ▶ half (51.8%) of all faculty have parent with MS or PhD
- quarter (22.2%) have parent with PhD → 2x PhD holders, 25x US population !
- it's universal (not field or domain specific)

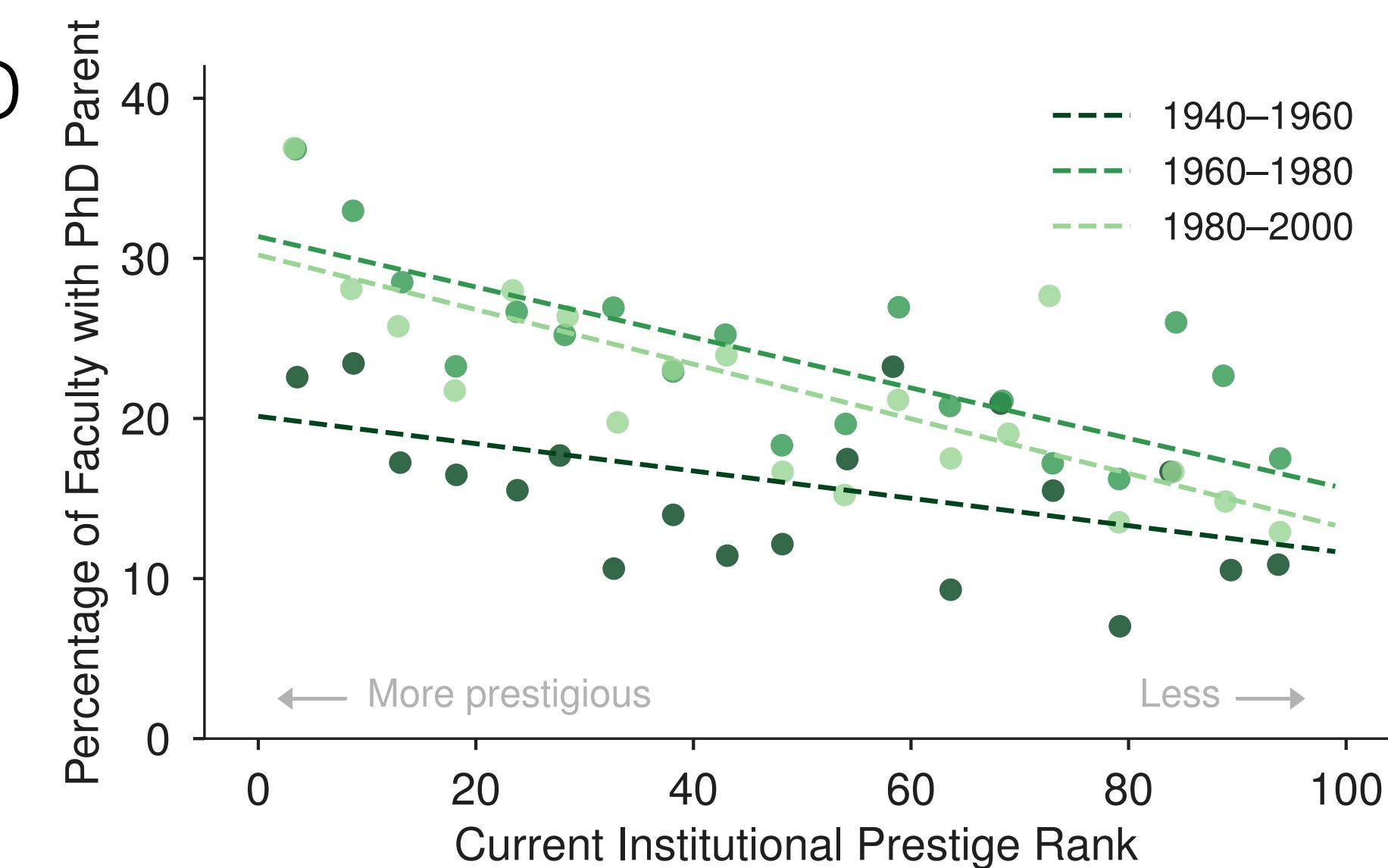
more education → more likely as faculty parents



who gets to be faculty?

PhD parents correlates with *more prestigious faculty jobs*

- ▶ faculty at elite universities are 2x more likely to have PhD parents than faculty *at other universities* (50x more than U.S. population)
- 🤔 why should having PhD parents, or not, influence *how prestigious* the faculty job a person gets?



who gets to be faculty?

"Talent is equally distributed but opportunity is not" — Leila Janah

prestige is a *structural variable* in who persists in science

- ▶ high SES backgrounds are *dramatically* over-represented in U.S. academia
- ▶ prestige *correlates* with higher SES background and persistence
- ▶ women less likely to persist in academia *at all career ages* [similarly for race (other studies)]
- ▶ faculty with less prestigious pedigree less likely to persist in academia

white faculty 1.4x more likely
to have PhD parents than
Black or Hispanic faculty

is this meritocracy...?

what impact is this representational skew having on scholarship?

faculty, prestige, and scholarship

"*little in academia makes sense except in light of prestige*"



understanding epistemic and social inequalities requires understanding how prestige drives and maintains them

- ▶ prestige hierarchies shape who joins the scientific workforce (80-20 rule)
- ▶ prestige is *influence* over research agendas, communities, and norms
- ▶ prestige is an *attention amplifier* for ideas
- ▶ prestige is a *demographic filter*, making U.S. academia more skewed toward highly privileged, white, and male faculty from elite institutions

prestige rules everything around me [p.r.e.a.m.]

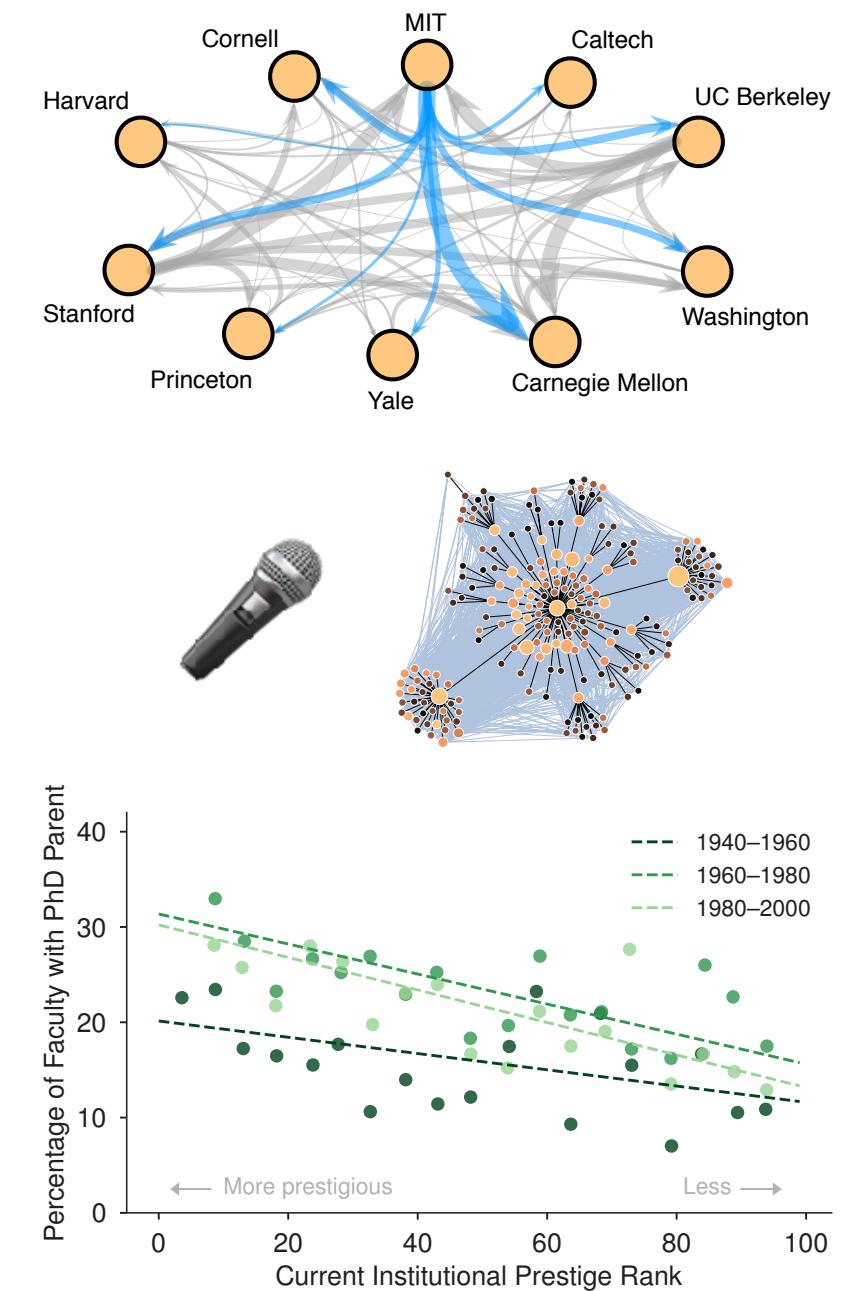


system-wide diversification depends on who elite departments train

workforce composition surely shapes the *rate and type of scientific discoveries*

some things have improved in 40 years, but we have WORK to do yet

what can we each do to make academia more meritocratic?



NETWORK SCIENCES

Systematic inequality and hierarchy in faculty hiring networks

Aaron Clauset,^{1,2,3*} Samuel Arbesman,⁴ Daniel B. Larremore^{5,6}

Science Advances 1(1), e1400005 (2015)

Article

Quantifying hierarchy and dynamics in US faculty hiring and retention

<https://doi.org/10.1038/s41586-022-05222-x> K. Hunter Wapman^{1,2}, Sam Zhang², Aaron Clauset^{1,2,4} & Daniel B. Larremore^{1,2,5}

Nature 610, 120–127 (2022)

EPJ.org

REGULAR ARTICLE

Open Access



Prestige drives epistemic inequality in the diffusion of scientific ideas

Allison C. Morgan^{1*}, Dimitrios J. Economou¹, Samuel F. Way¹ and Aaron Clauset^{1,2,3}

EPJ Data Science 7, 40 (2018)

SOCIAL SCIENCES

Gender and retention patterns among U.S. faculty

Katie Spoon^{1*}, Nicholas LaBerge¹, K. Hunter Wapman¹, Sam Zhang², Allison C. Morgan¹, Mirta Galesic³, Bailey K. Fosdick⁴, Daniel B. Larremore^{1,5}, Aaron Clauset^{1,3,5,*}

Science Advances 9(42) adi2205 (2023)

Gendered devaluation underlies faculty retention

Katie Spoon,^{1,*} Joanna Mendy,^{2,3} Maria Martinez,² Mirta Galesic,⁴ Daniel B. Larremore,^{1,4,5} Aaron Clauset,^{1,4,5} and Lauren A. Rivera^{6,†}

Preprint, socarxiv :g6xwk (2024)

OPEN

Socioeconomic roots of academic faculty

Allison C. Morgan^{1,2*}, Nicholas LaBerge¹, Daniel B. Larremore^{1,2}, Mirta Galesic³, Jennie E. Brand⁴ and Aaron Clauset^{1,2,3*}

Nature Human Behaviour 6, 1625–1633 (2022)



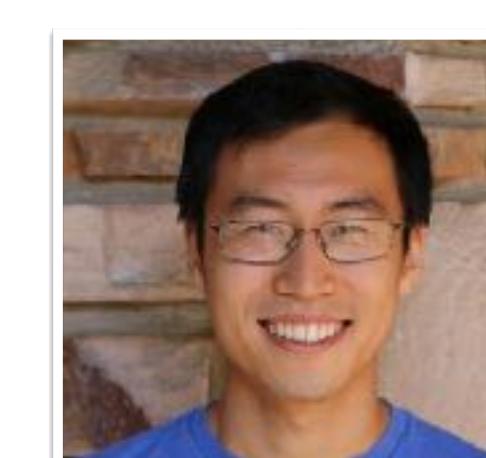
Dr. K. Hunter Wapman



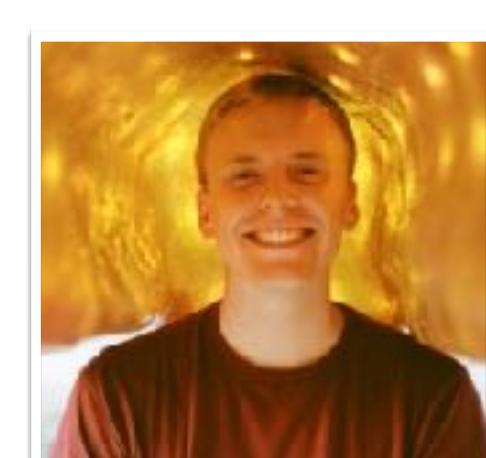
Dr. Allison C Morgan
(Code for America)



Katie Spoon
(Colorado)



Sam Zhang
(Colorado)



Nick LaBerge
(Colorado)



Dr. Samuel F Way
(Flatiron Health)



Dimitrios Economou
(Queen's U.)



Joanna Mendy
(Colorado)



Maria Martinez
(Colorado)



Dr. Bailey Fosdick
(GTI Energy)



Prof. Lauren Rivera
(Northwestern)



Prof. Jennie Brand
(UCLA)



Dr. Sam Arbesman
(Lux Capital)



Prof. Mirta Galesic
(Santa Fe)

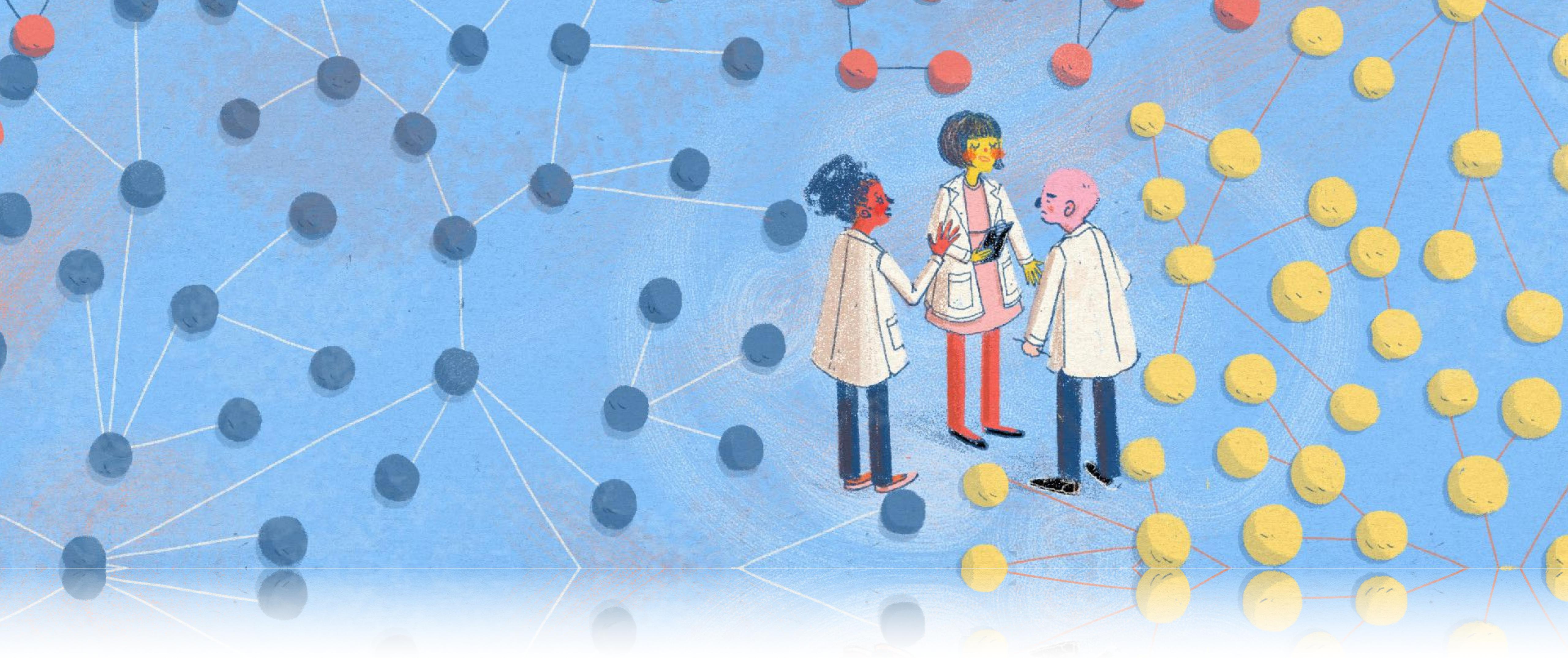


Prof. Daniel B Larremore
(Colorado)

Funding:



a special thank you to all our survey respondents and to the AARC for sharing data



fin



papers, code, data

<https://aaronclauset.github.io>