

# Prestige, representation, and the spread of scientific ideas

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# 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

untangling the effects of social biases can make ~~science~~ better & more meritocratic



prestige shapes who joins the scientific workforce



prestige shapes which scientific ideas spread



prestige shapes who persists as a scientist, and what they study

# 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 of a department's position within networks of association and social exchange"

difficult to talk about *prestige* without talking about

USNews rankings, which are universally criticized\* 

 instead we can *infer* prestige from who hires whose graduates as faculty

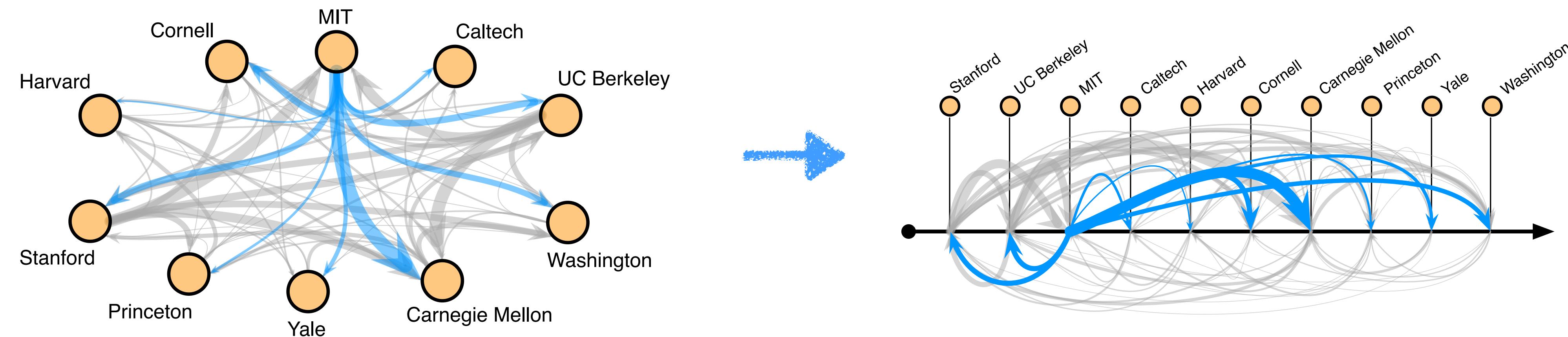
# who hires whose graduates as faculty?

*how to convert a faculty hiring network into a prestige ranking*

- 💡 e.g.: minimum violation rankings, select ranking  $\pi$  that minimizes "rank violations" :  
edges  $(u, v)$  where  $\pi_v < \pi_u$

$$\text{MVR}(A) = \inf_{\pi} \sum_{u,v} A_{u,v} \times \text{sign}(\pi_u - \pi_v)$$

- interpretation: higher-ranked nodes have greater *placement power*

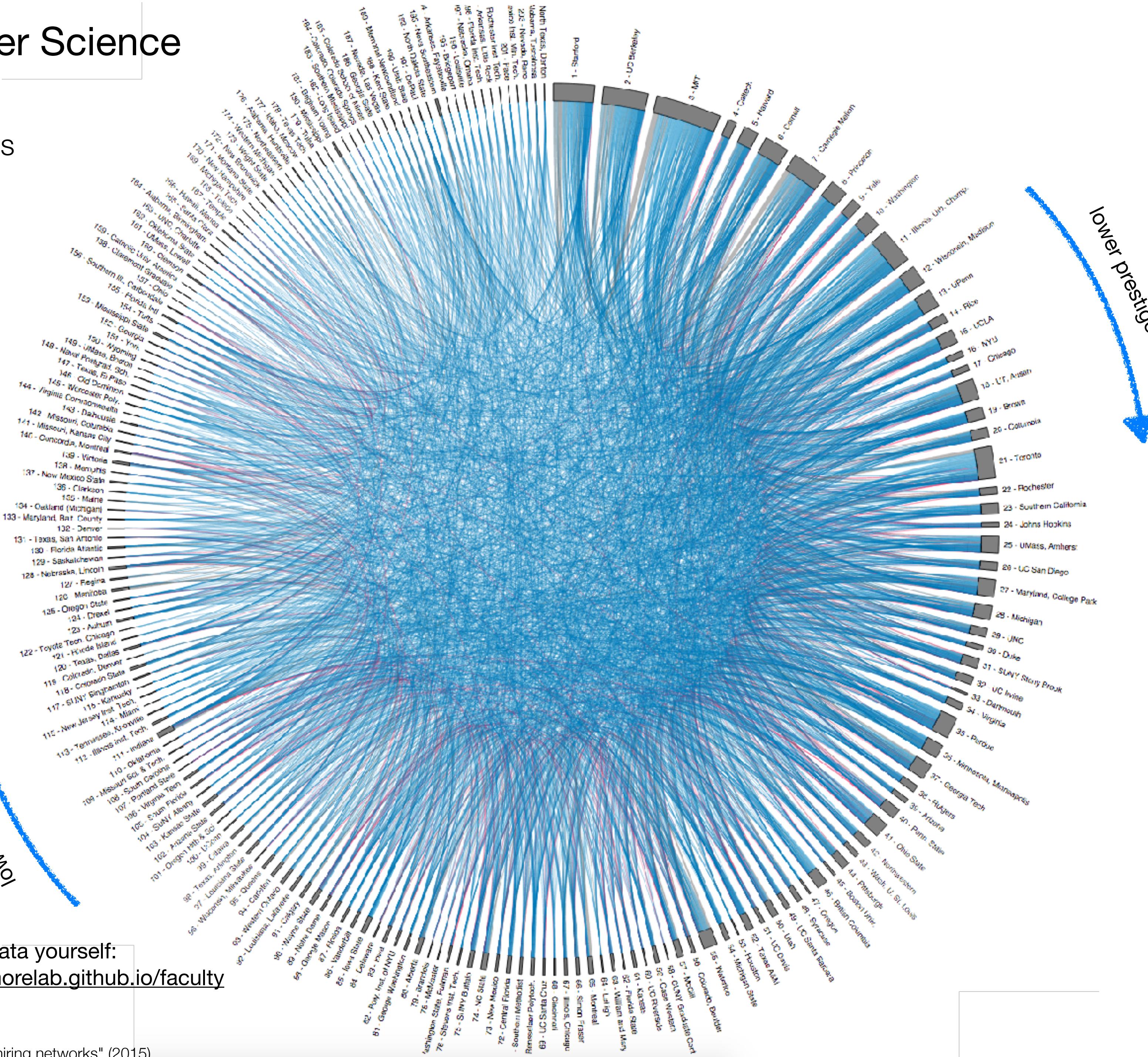


there are many ways to extract a ranking from a network  
Minimum Violation Rankings (MVRs) are equivalent to solving the MINIMUM FEEDBACK ARC SET problem (NP-hard)  
prestige in the sense of [Burris \(2004\)](#), as a form of social capital; many papers have analyzed faculty hiring networks since, all showing similar results

# Computer Science

$n = 205$  departments

$m = 5032$  faculty



explore the data yourself:  
<https://larremorelab.github.io/faculty>

# 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

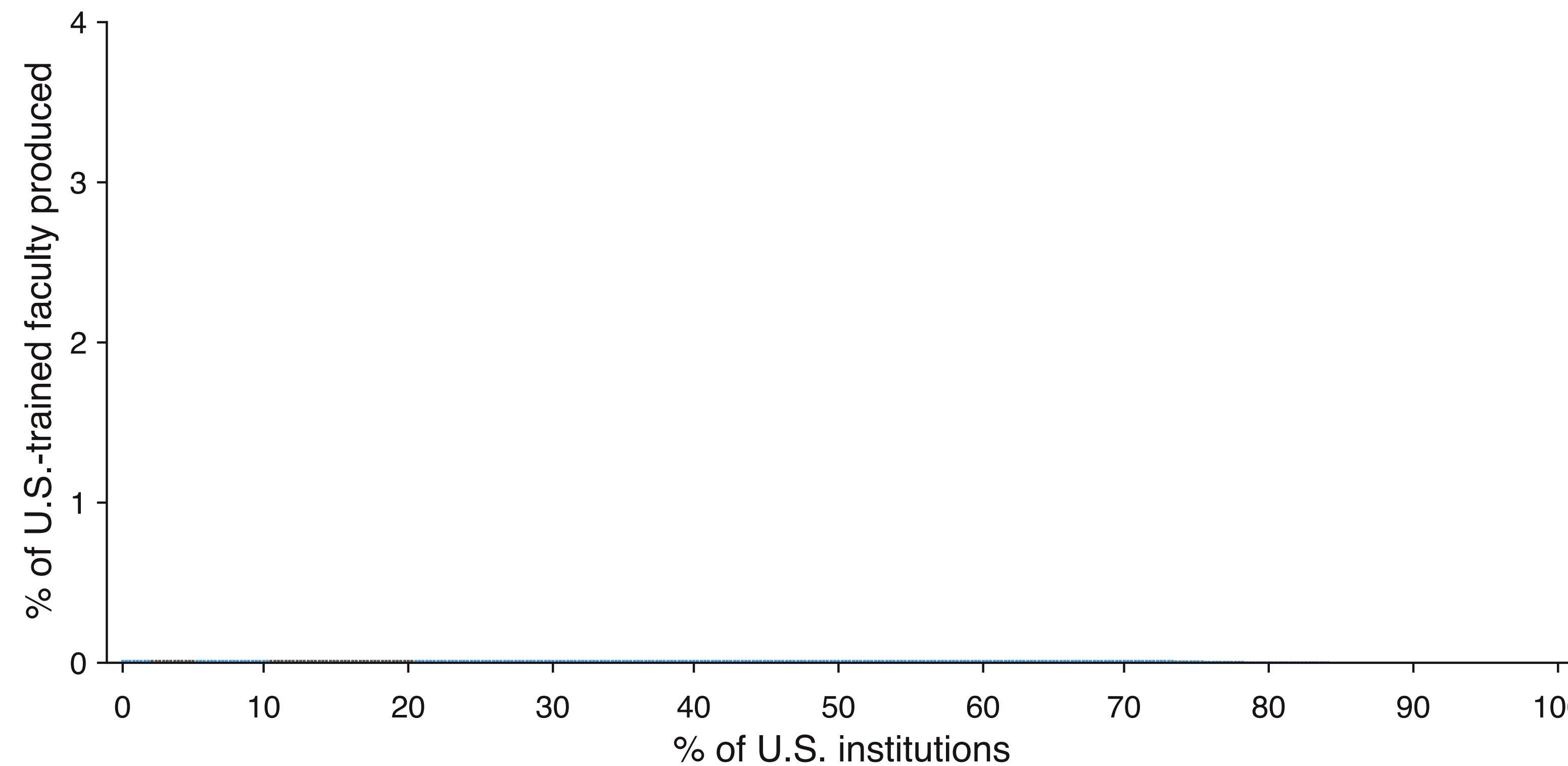


- ▶ how unequal is faculty production?
- ▶ what implications for epistemic inequalities?

# who hires whose graduates as faculty?

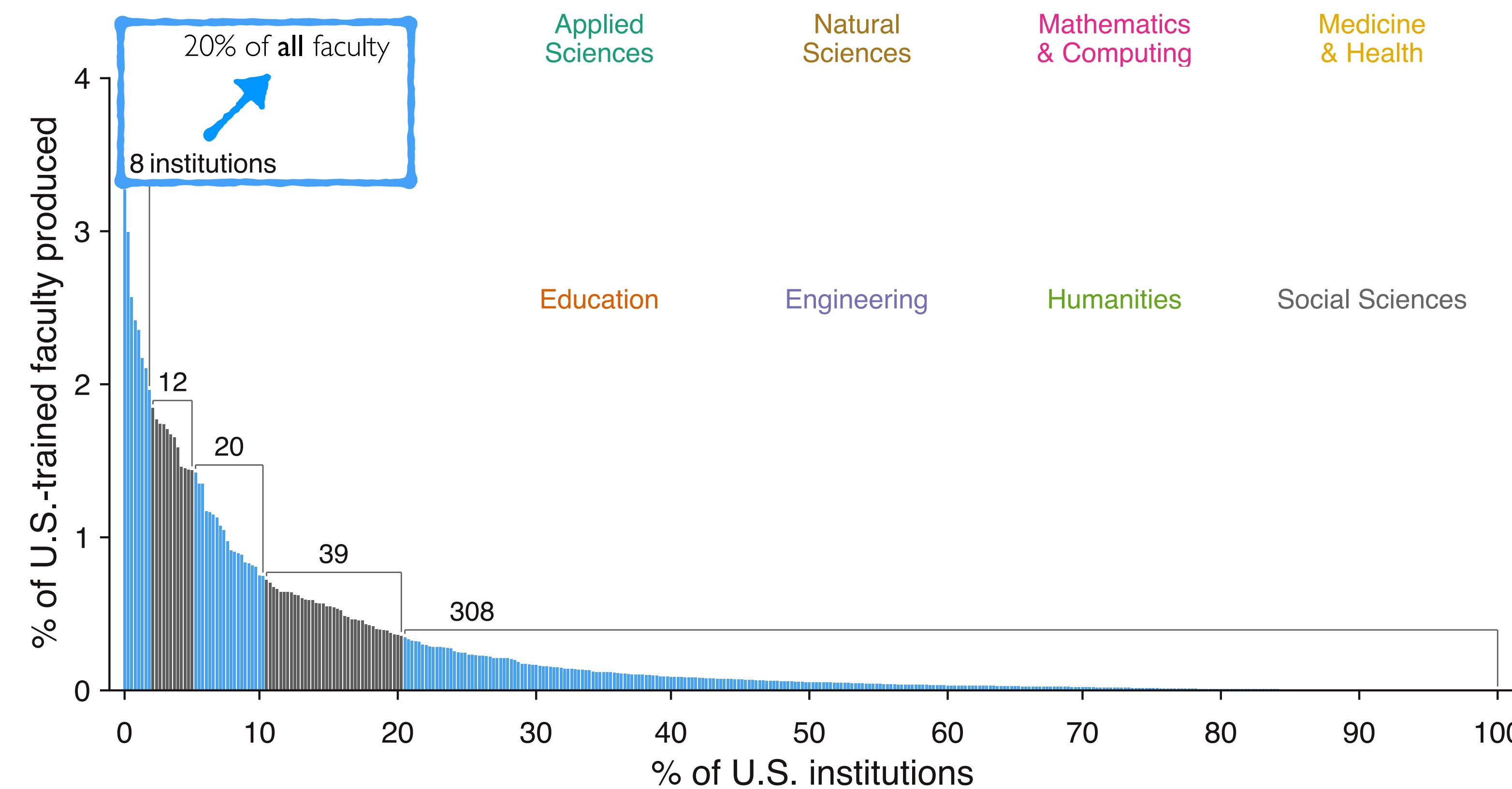
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- ▶ sort 387 institutions by overall production of faculty



# who hires whose graduates as faculty?

- ▶ faculty production is enormously *concentrated*



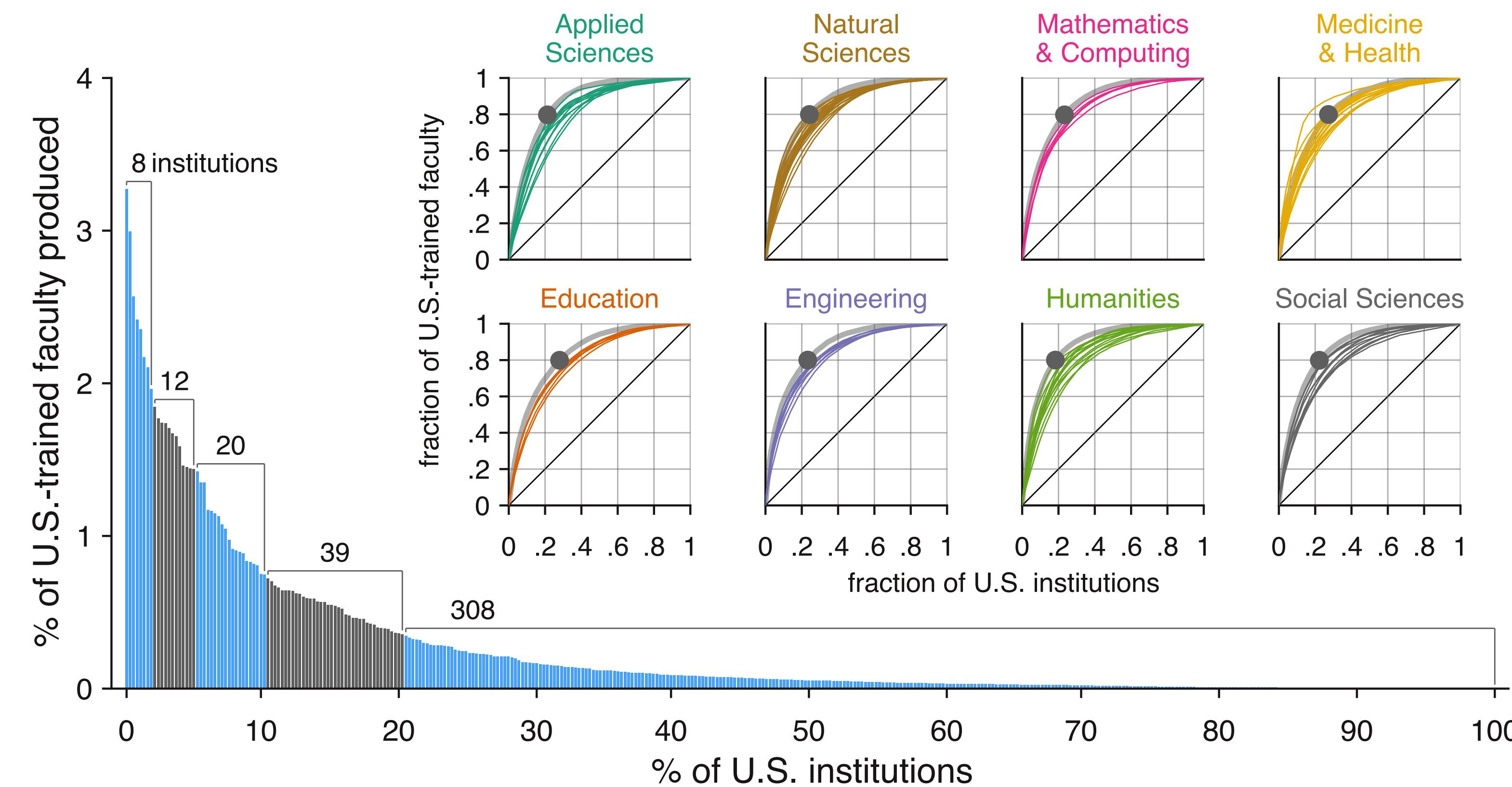
all-academia Gini = 0.75

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")

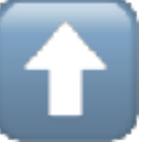


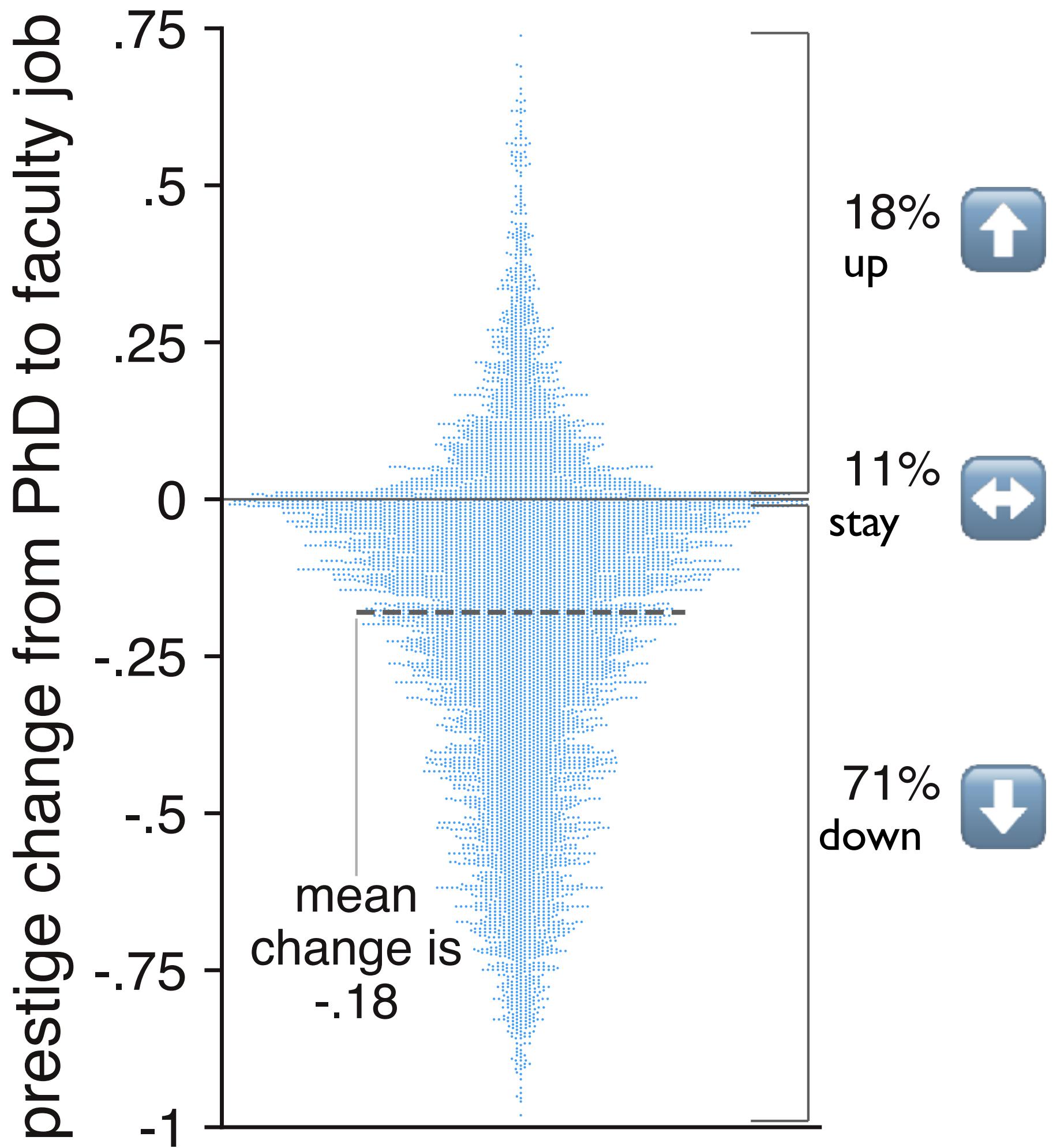
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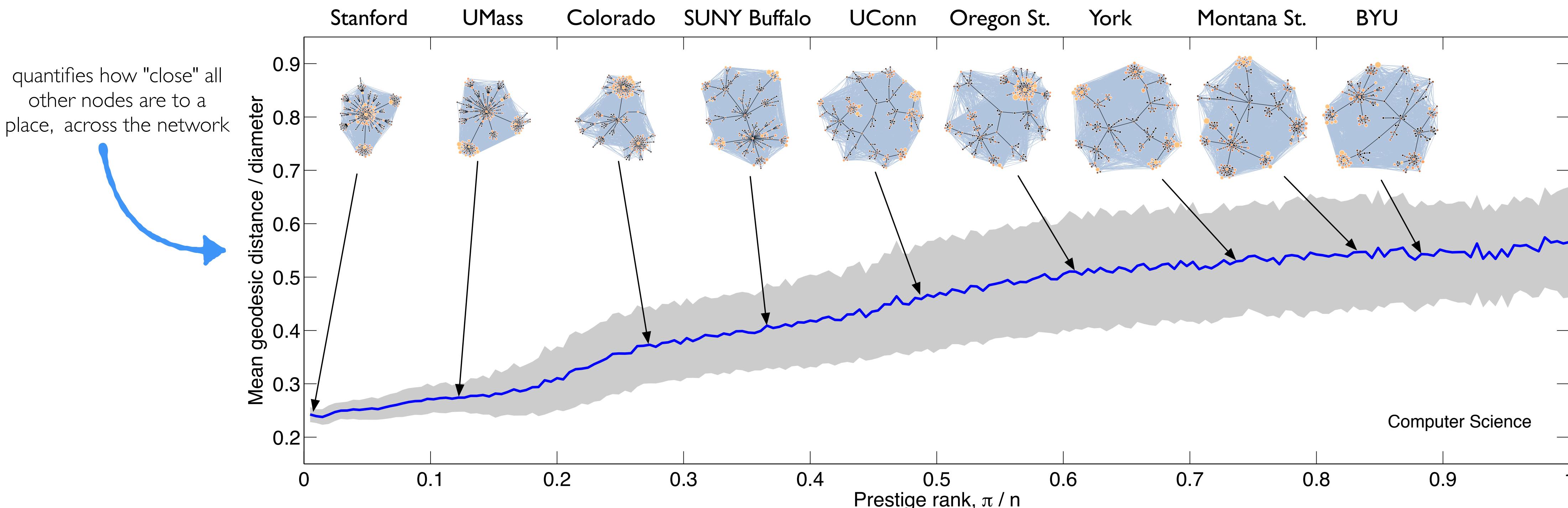
# who hires whose graduates as faculty?

- ▶ 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

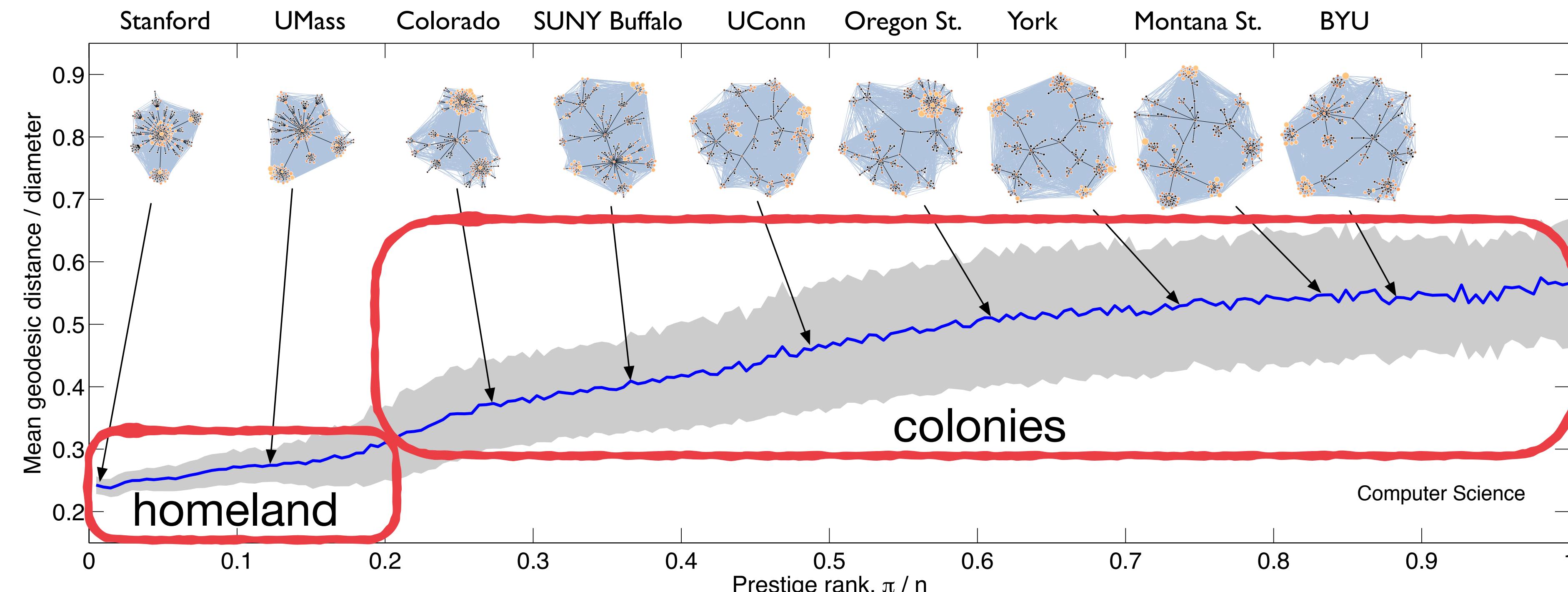


# who hires whose graduates as faculty?

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

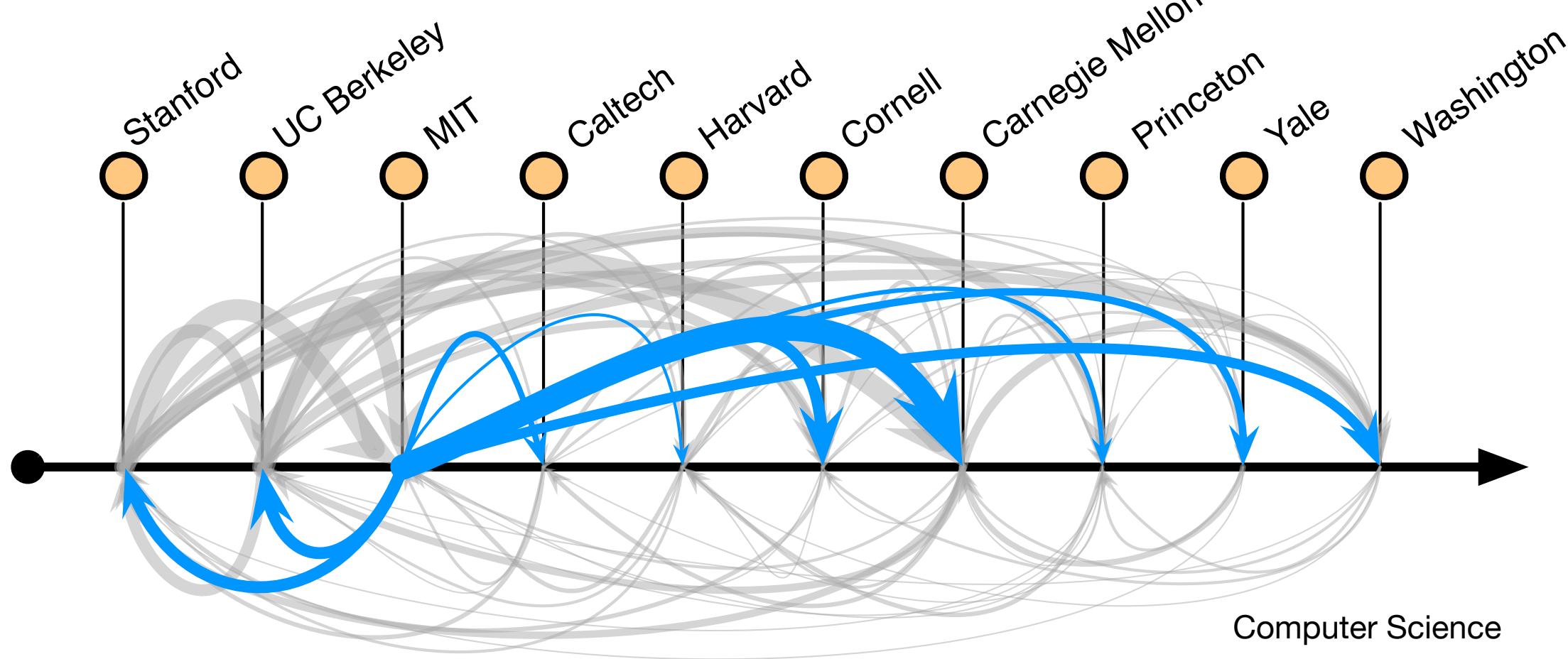
prestige → *influence* via doctoral placement

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



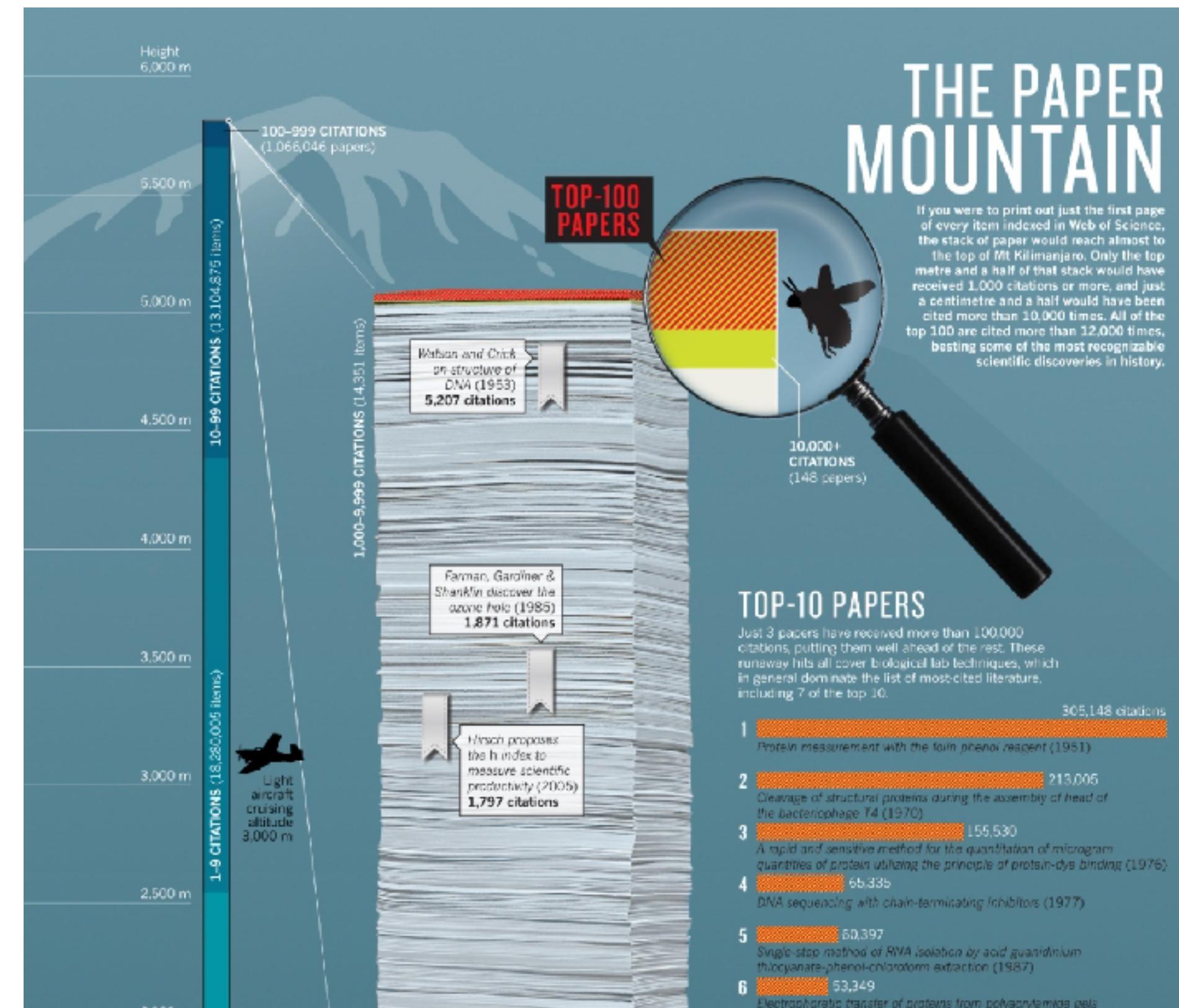
# who hires whose graduates as faculty?

- ▶ 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?

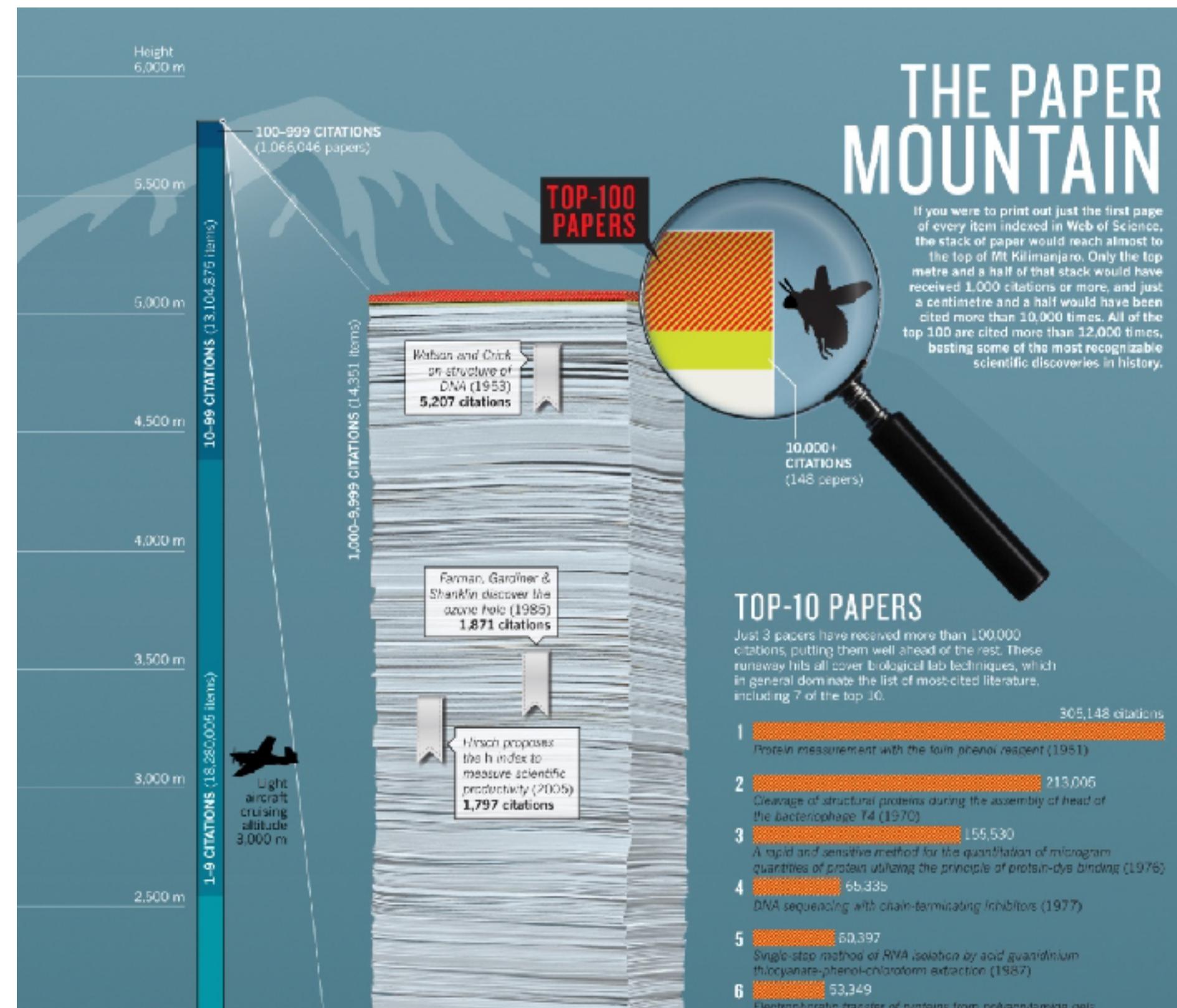


Nature "The top 100 papers." (2014)

# 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?

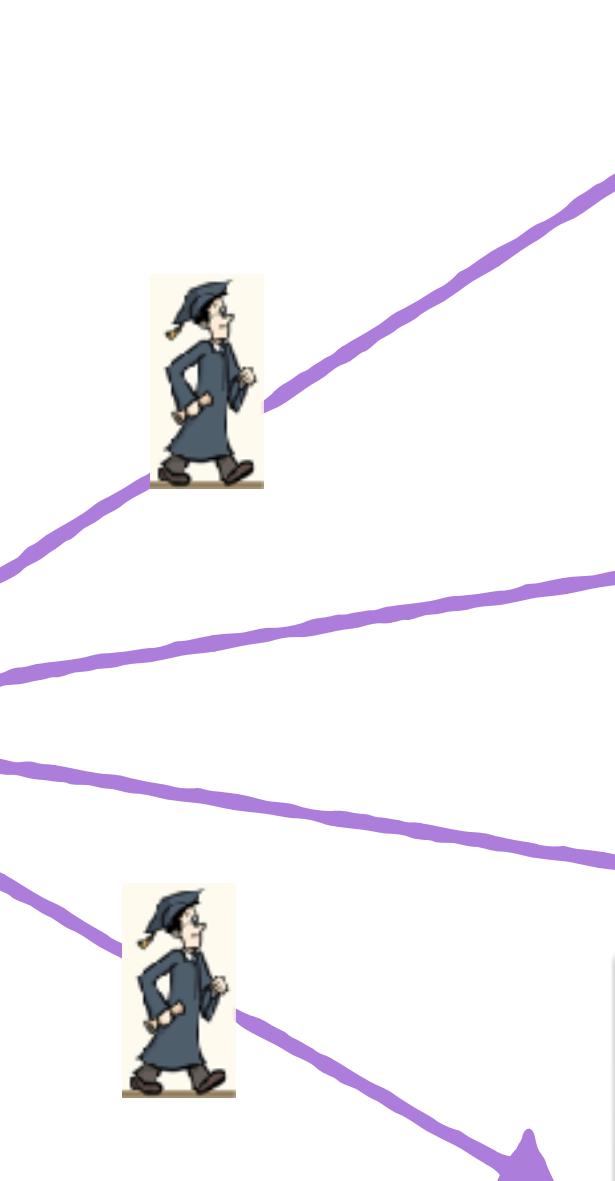
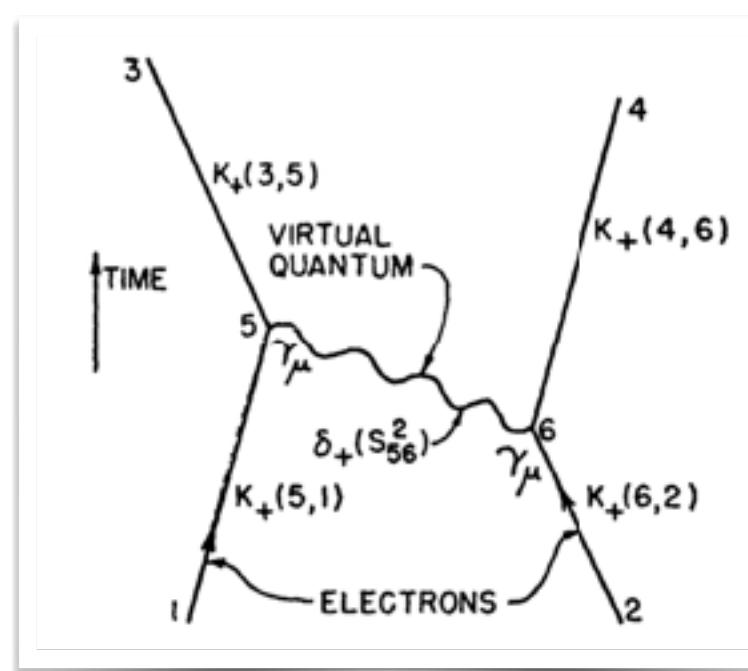
a *structural* explanation

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

Feynman diagrams, born 1948

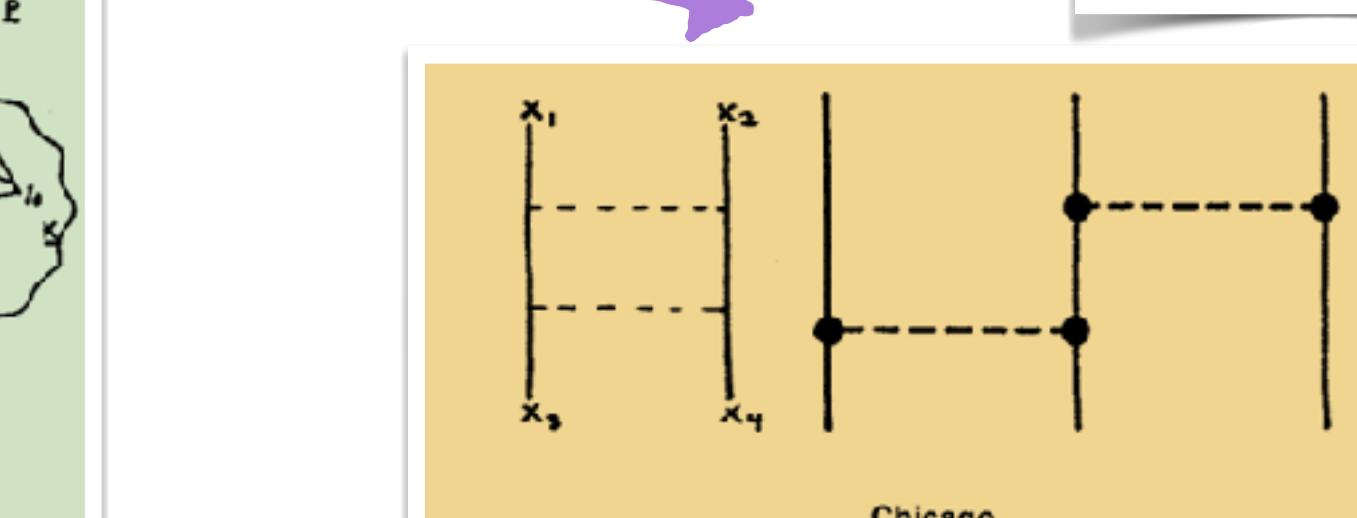
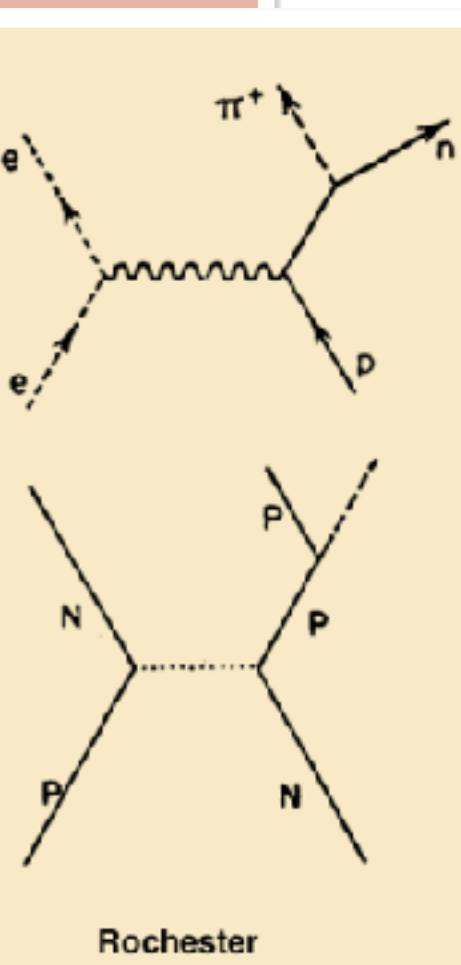
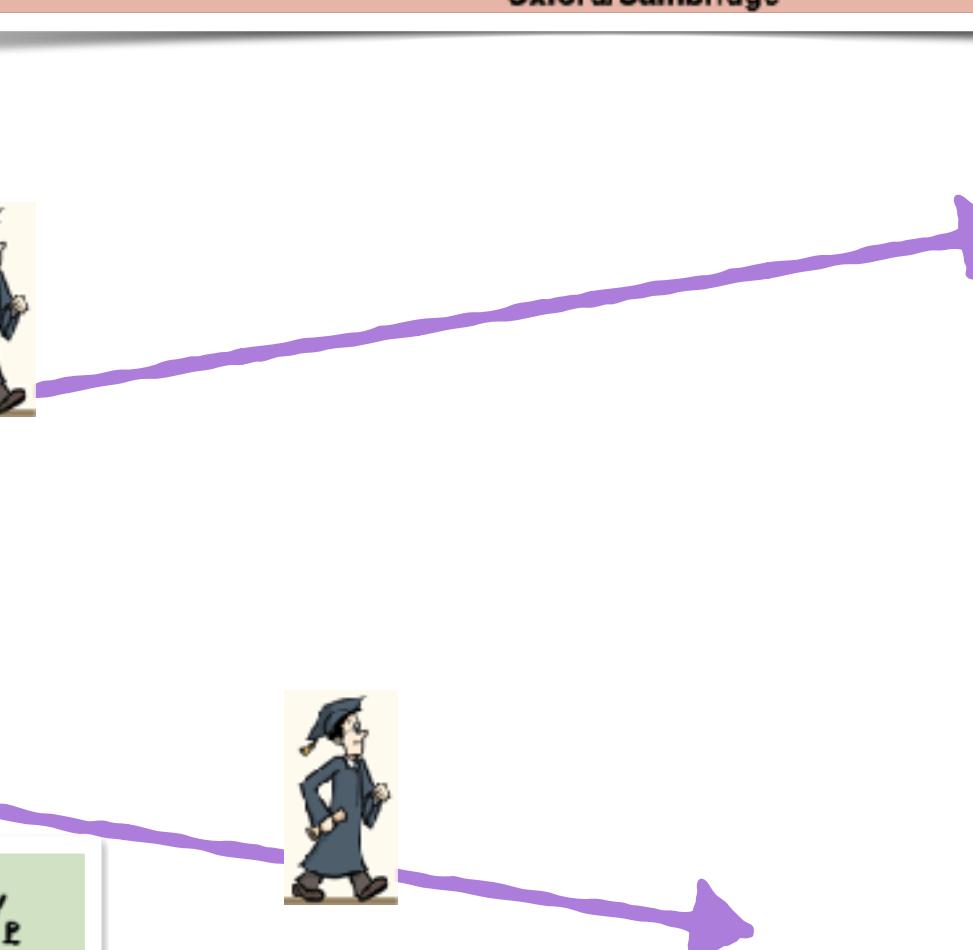
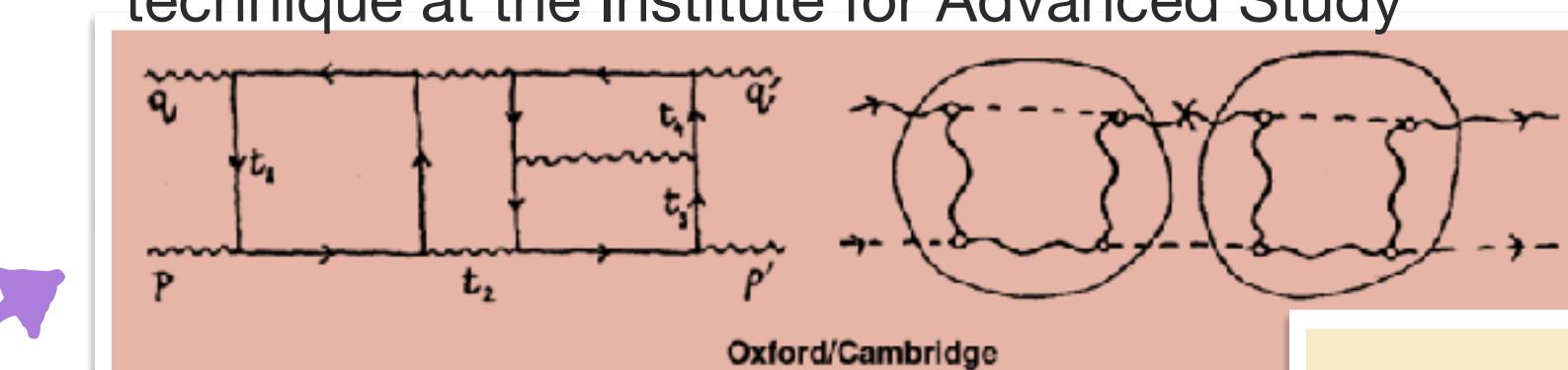


Lamb, Wheeler, Pais, Feynman,  
Feshbach & Schwinger



Cornell

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



# what shapes the spread of ideas?

a *structural* explanation

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

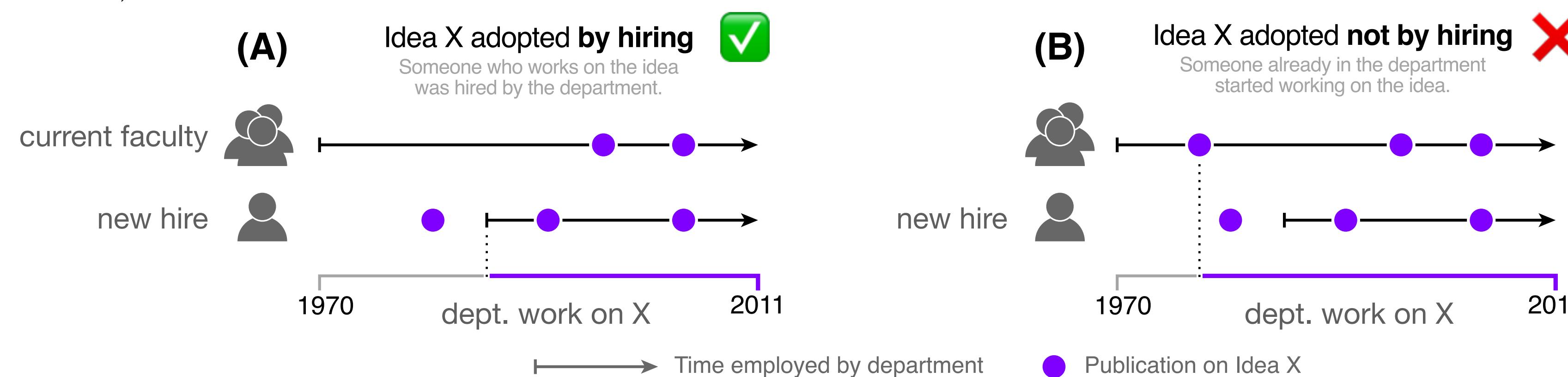


- two tests:
  1. (data) does faculty hiring explain *where* an idea is studied (prestige)?
  2. (simulation) how *big* an effect does prestige have on the spread of ideas?

# what shapes the spread of ideas?

1. (data) does faculty hiring explain *where* an idea is studied (prestige)?
  - combine CS faculty hiring data + matched DBLP 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               | $f_{\text{obs}}$ | $f_{\text{exp}}$ | $p$             |
|-----------------------|------------------|------------------|-----------------|
| topic modeling        | 0.35             | 0.23             | $0.01 \pm 0.01$ |
| incremental computing | 0.39             | 0.20             | $0.01 \pm 0.01$ |
| deep learning         | 0.35             | 0.34             | $0.34 \pm 0.01$ |
| quantum computing     | 0.32             | 0.22             | $0.01 \pm 0.01$ |
| mechanism design      | 0.48             | 0.21             | $0.01 \pm 0.01$ |



fraction of real hires  
that spread idea X



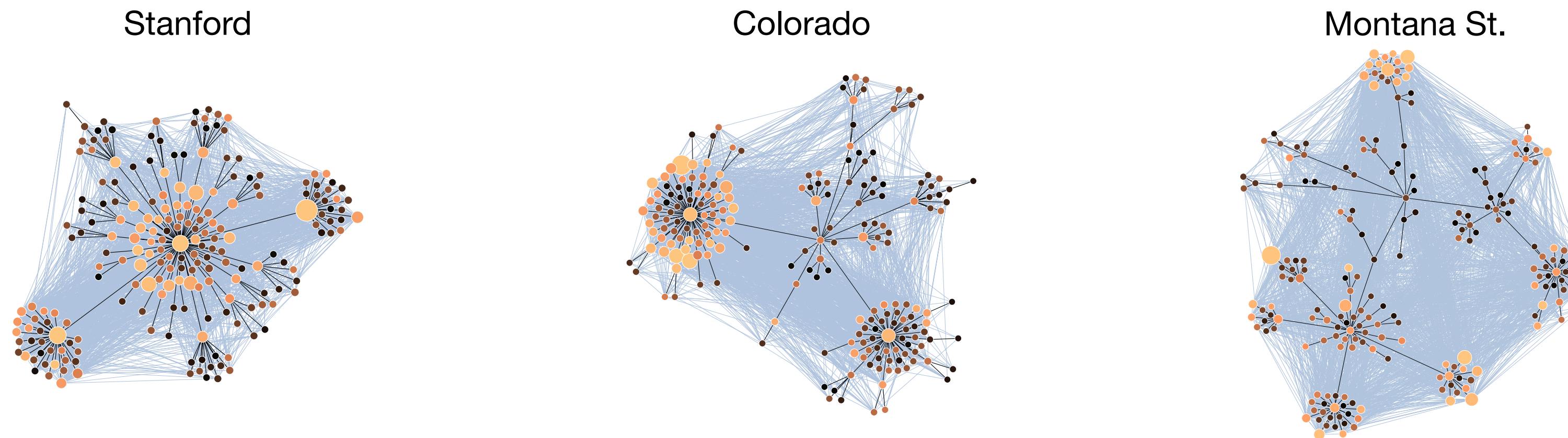
fraction under  
permutation test

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



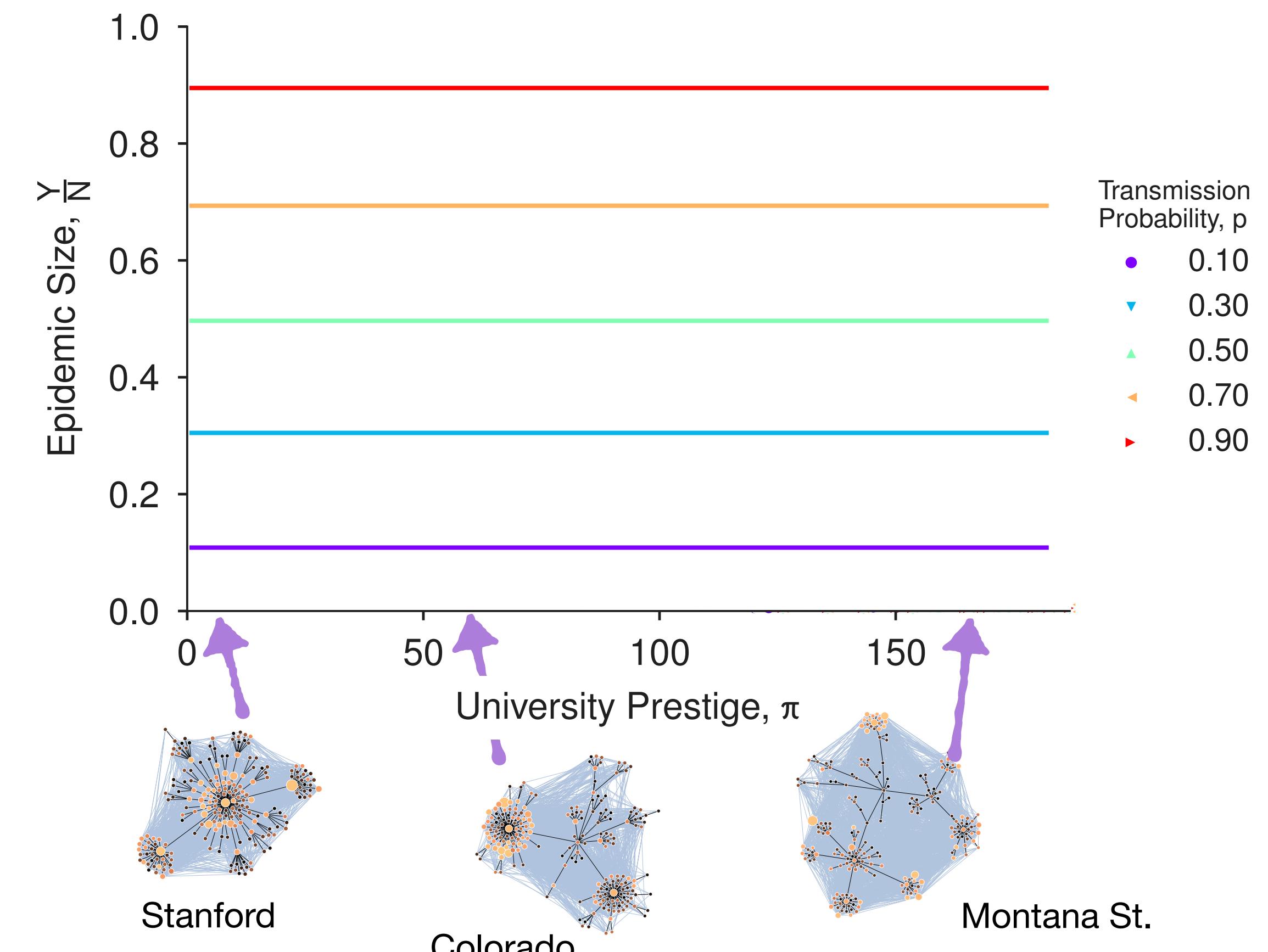
- ideas spread according to Independent Cascade (IC) model
- vary prestige  $\pi$  of "origin" place where an idea begins
- vary idea transmissibility (underlying merit)  $p \in \{0.1, 0.3, 0.5, 0.7, 0.9\}$
- measure how far it spreads: normalized cascade size  $Y/N$

# 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



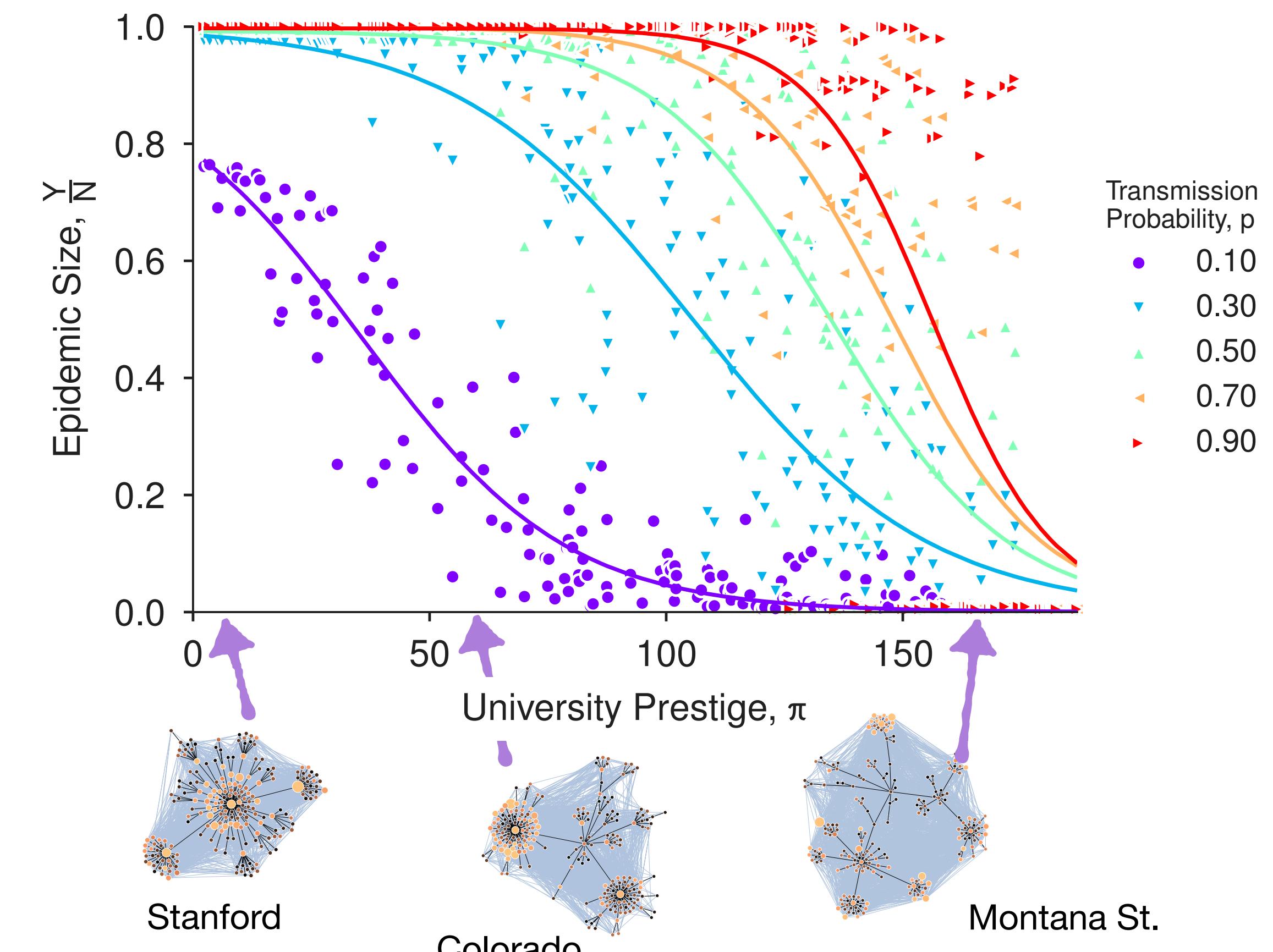
# what shapes the spread of ideas?

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 hierarchies do have benefits – rapid synchronization of knowledge, culture

■ prestige → faculty production → influence

# who gets to be faculty?

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

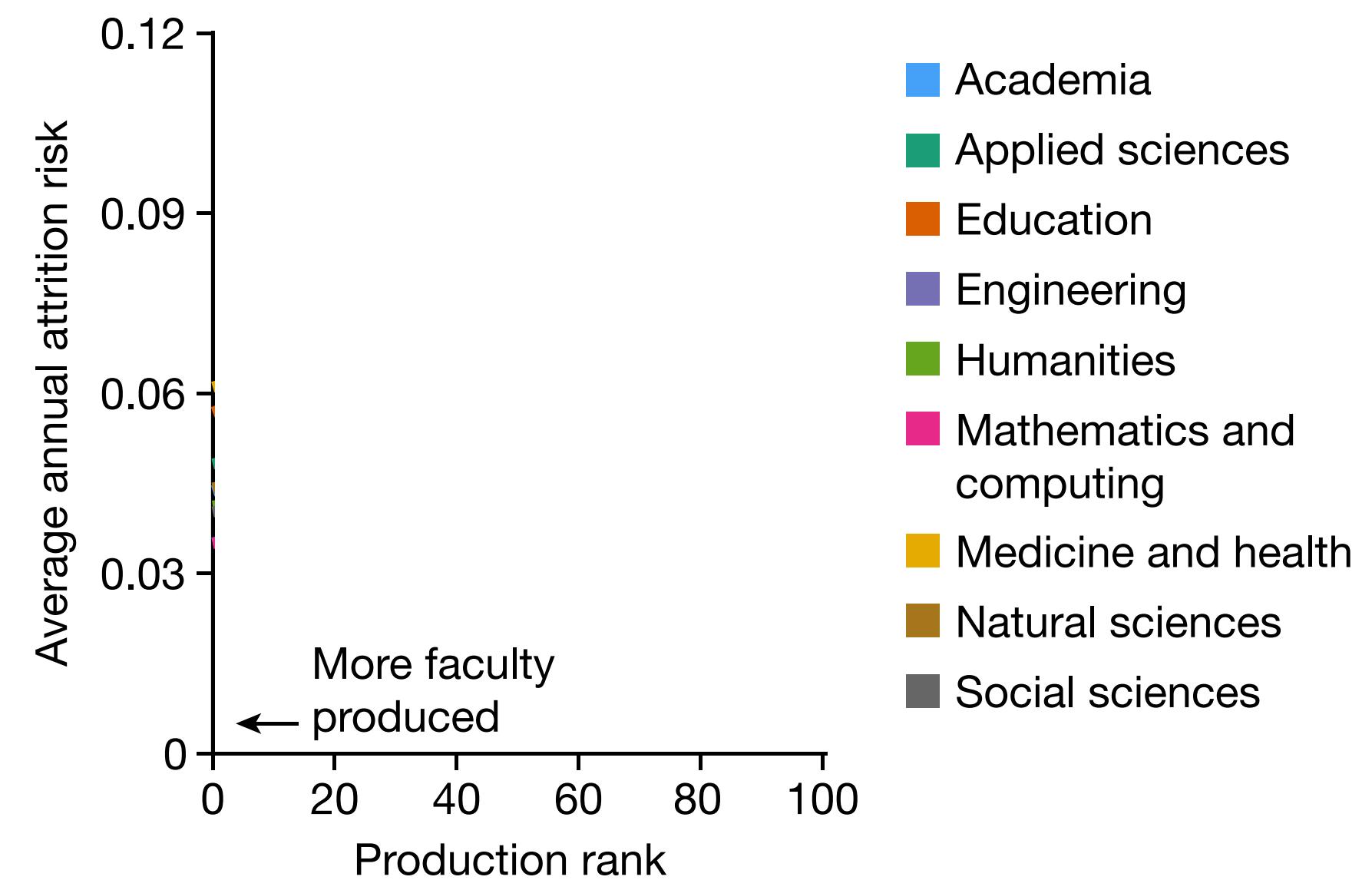
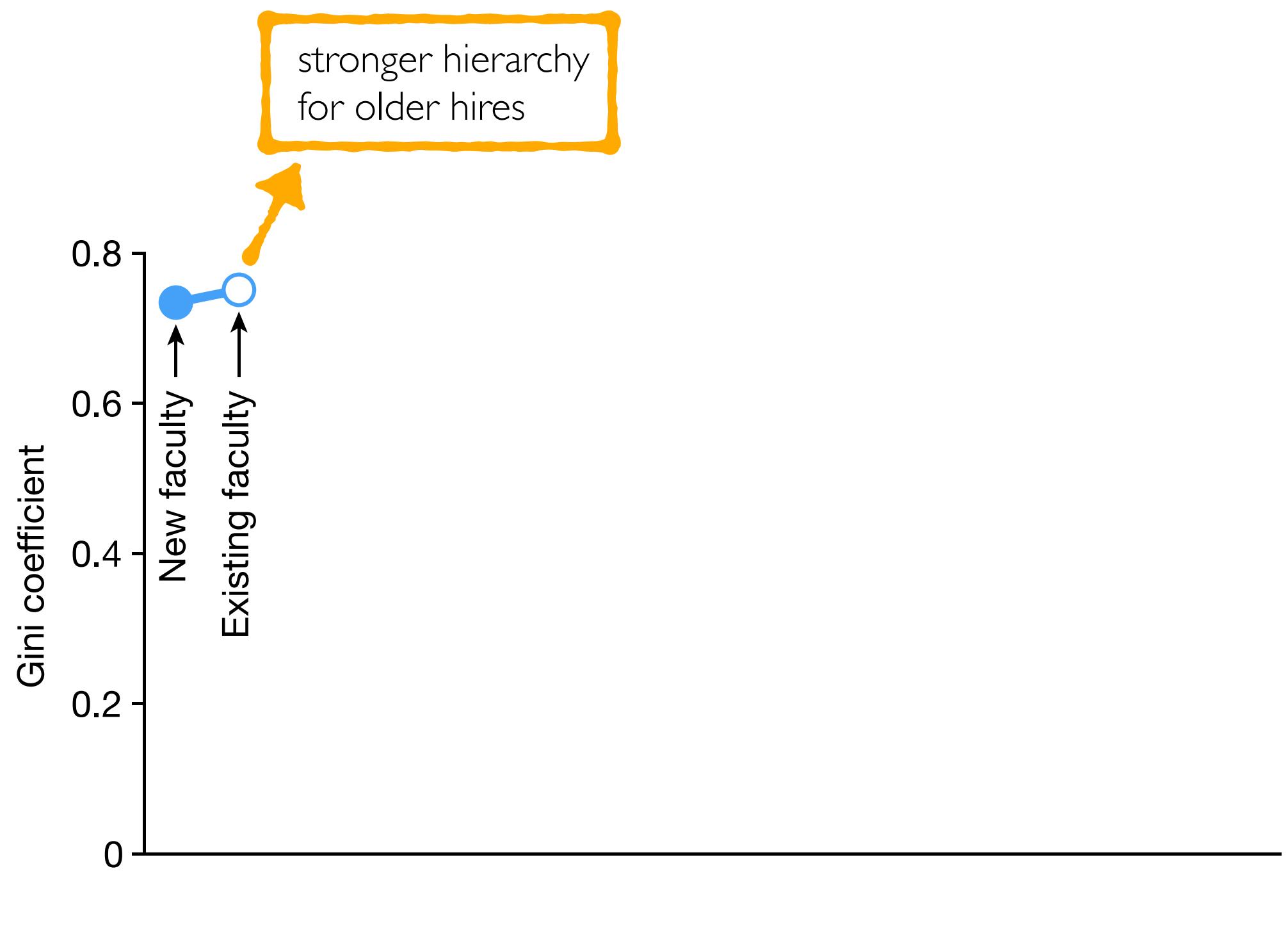
under-representation by race / gender are well studied → faculty are mostly white men  
with elite PhDs

**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

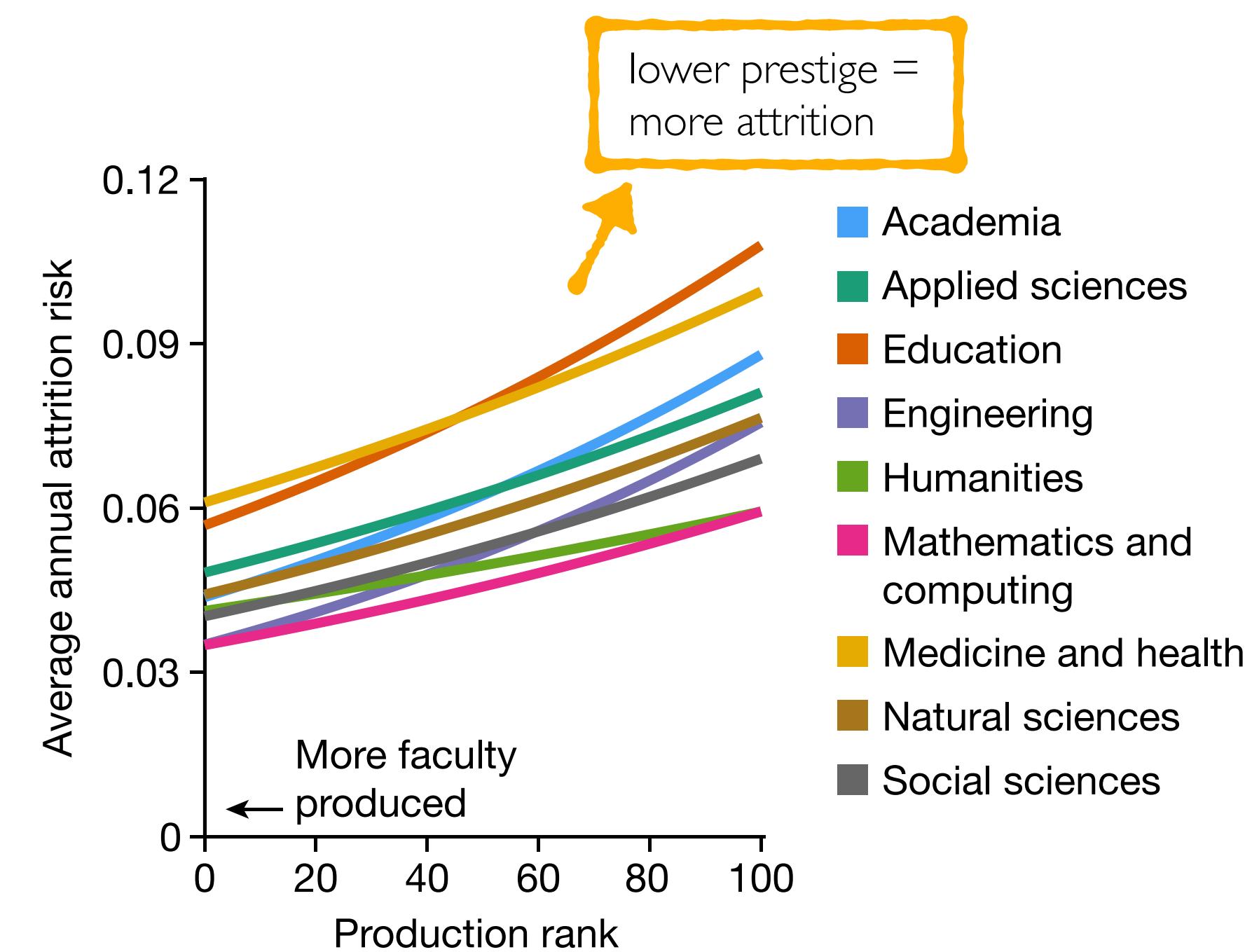
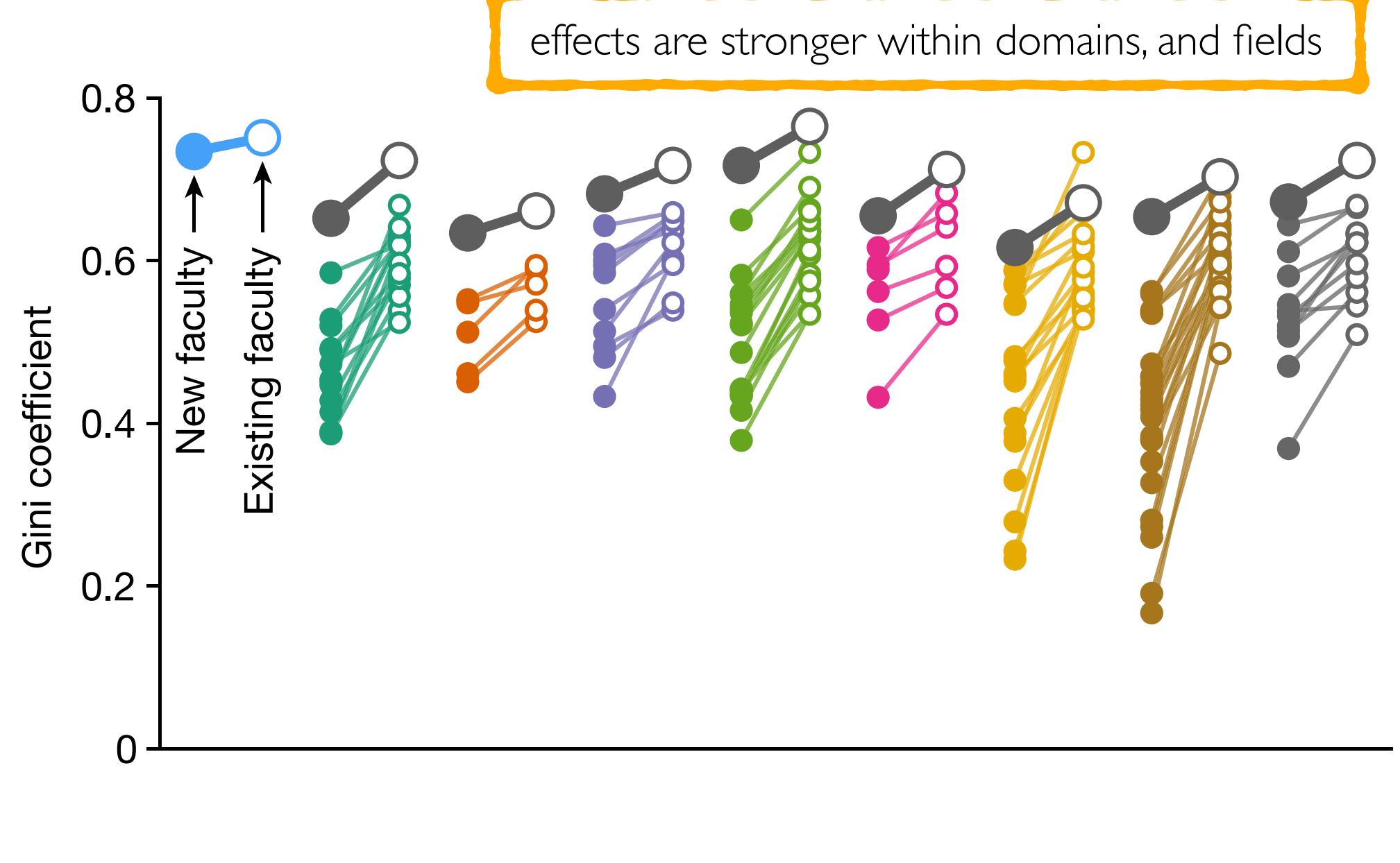


# who gets to be faculty?

► *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



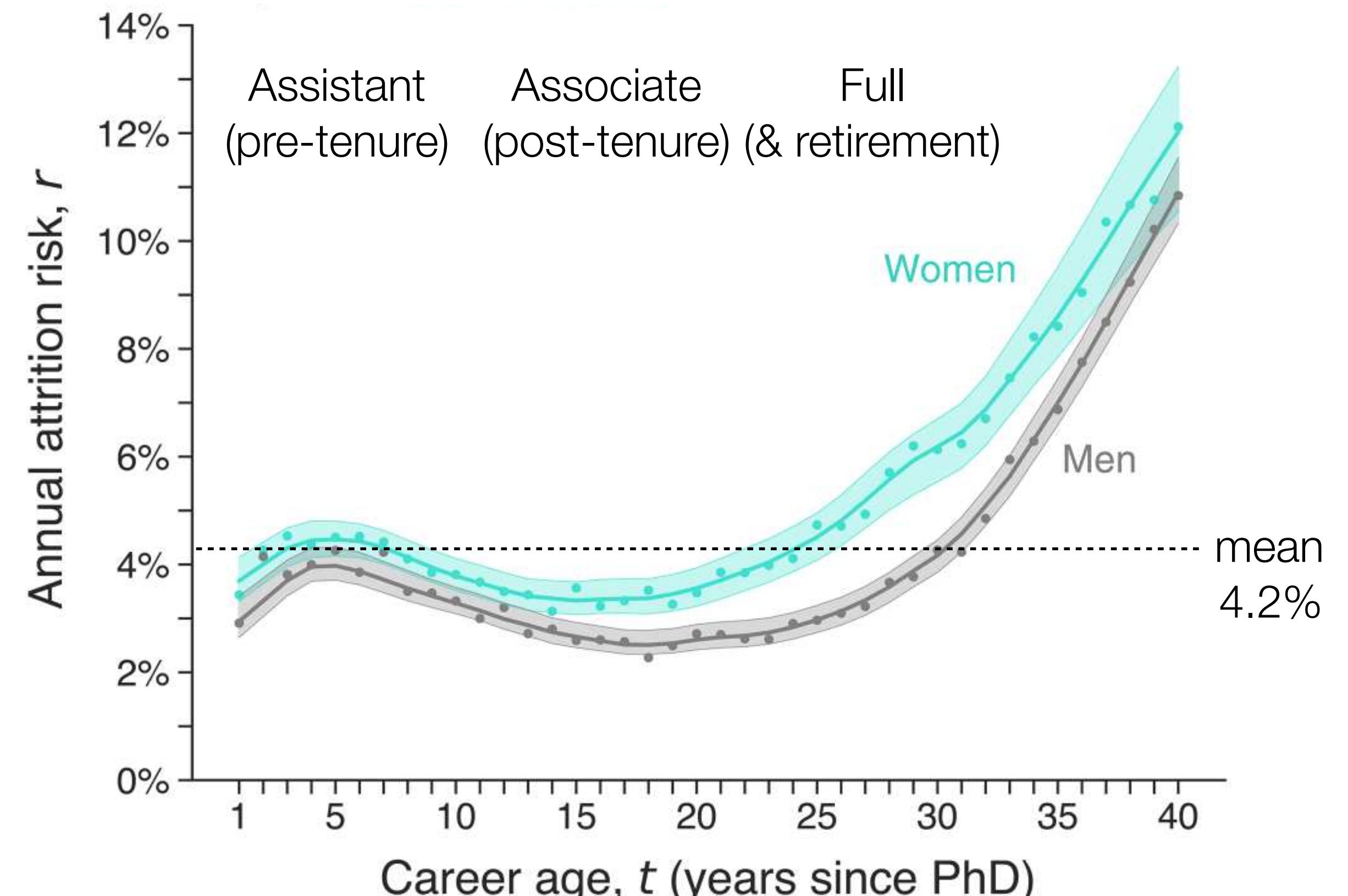
# who gets to be faculty?

- ▶ *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)

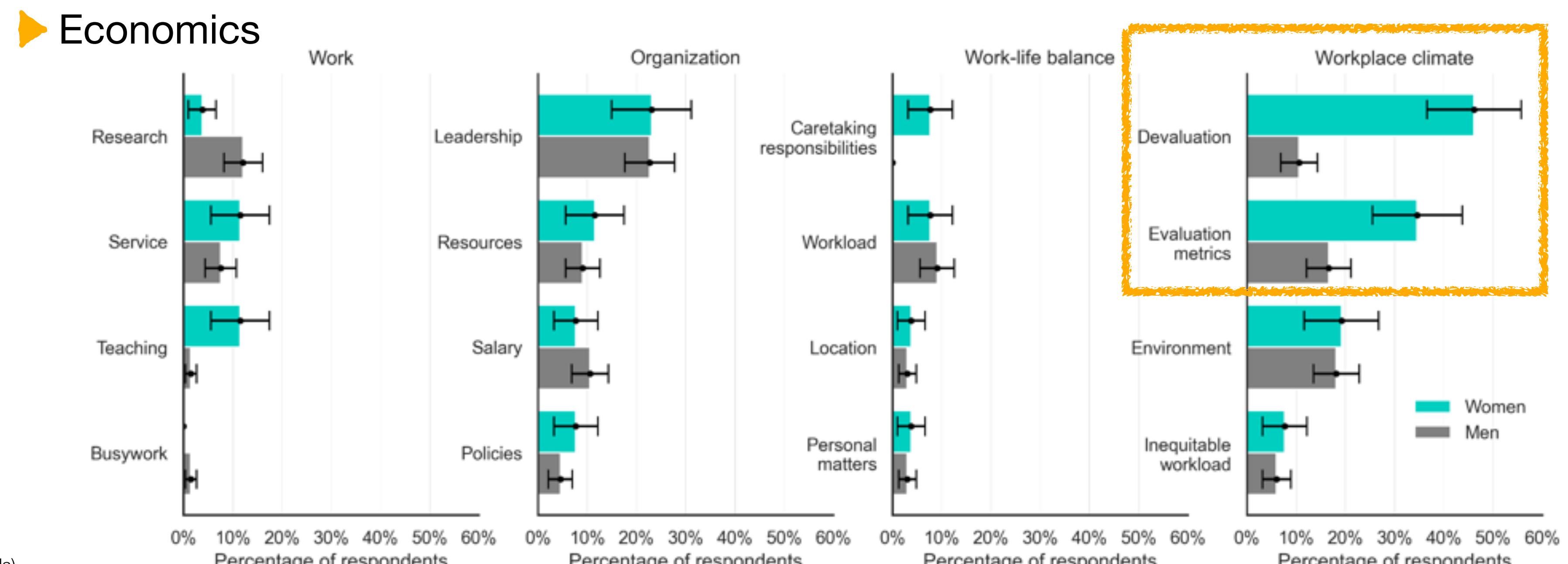
# who gets to be faculty?

## ► 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

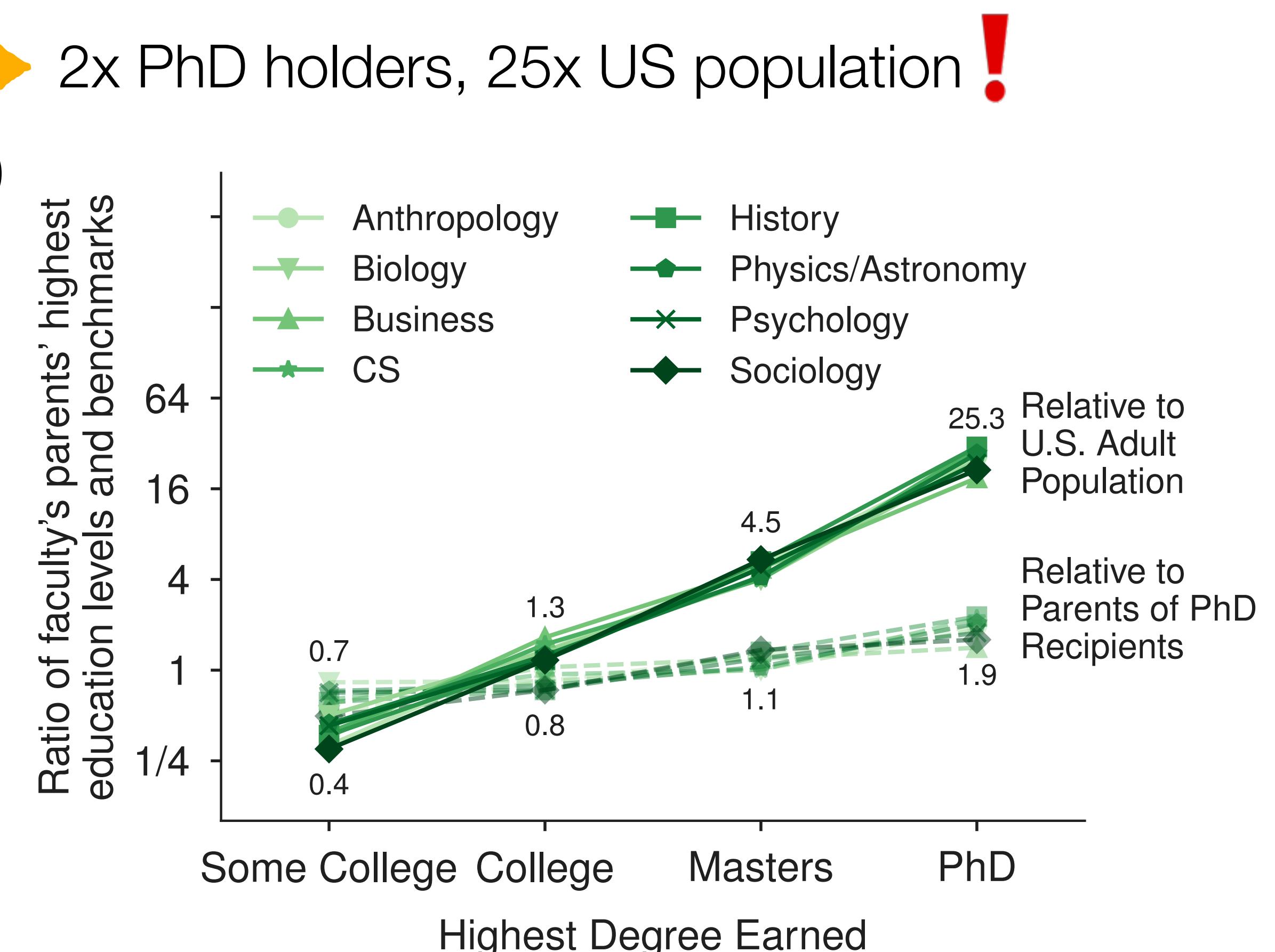
|                                   | Elementary | Some HS | HS   | Some College | College | Masters | PhD  |
|-----------------------------------|------------|---------|------|--------------|---------|---------|------|
| All Professors                    | 2.6        | 2.9     | 13.7 | 9.5          | 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)

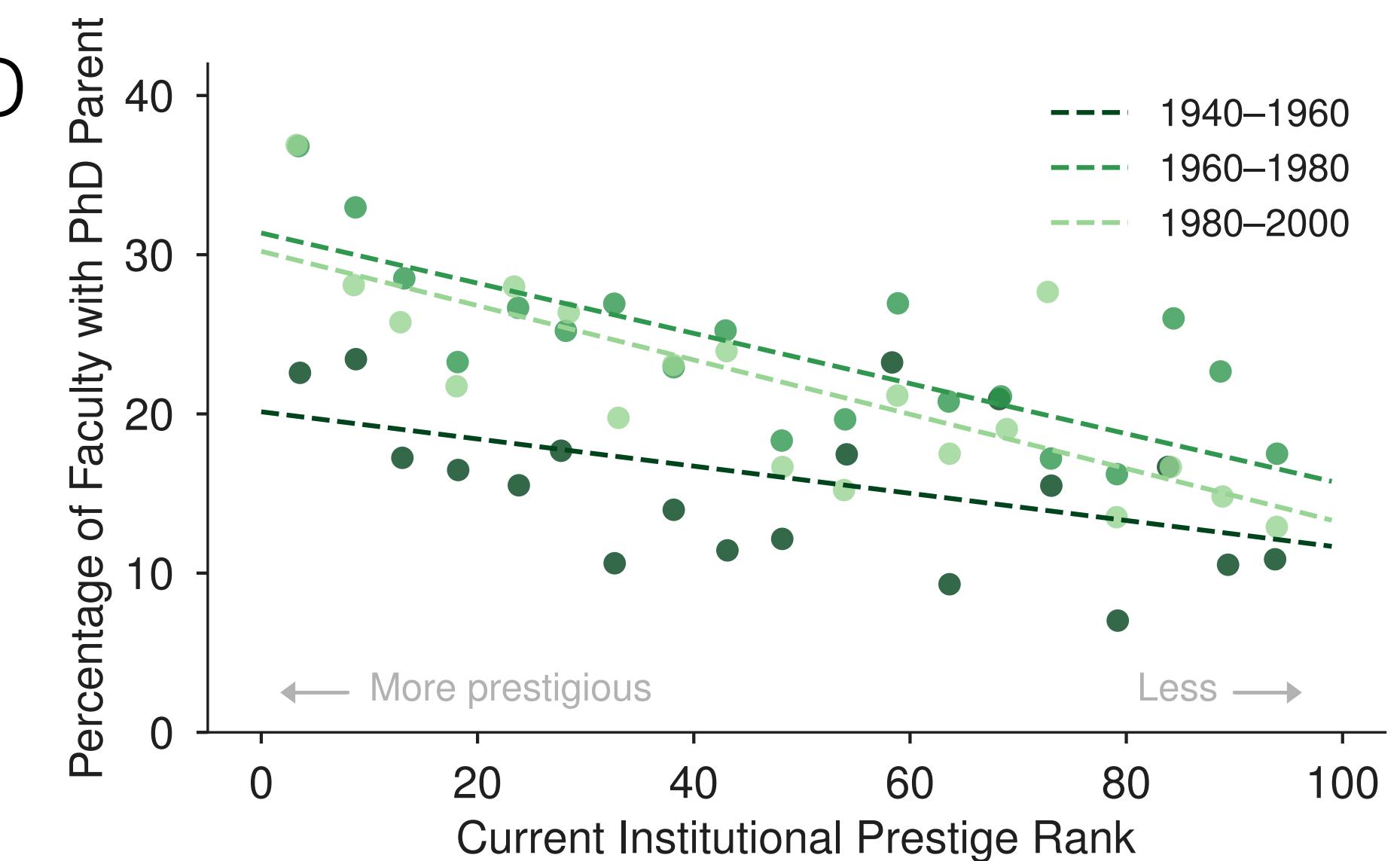
- ▶ half (51.8%) of all faculty have parent with MS or PhD
- quarter (22.2%) have parent with PhD → 2x PhD holders, 25x US population !
- it's universal (not field or domain specific)



# who gets to be faculty?

a PhD parent correlates with *more prestigious faculty jobs*

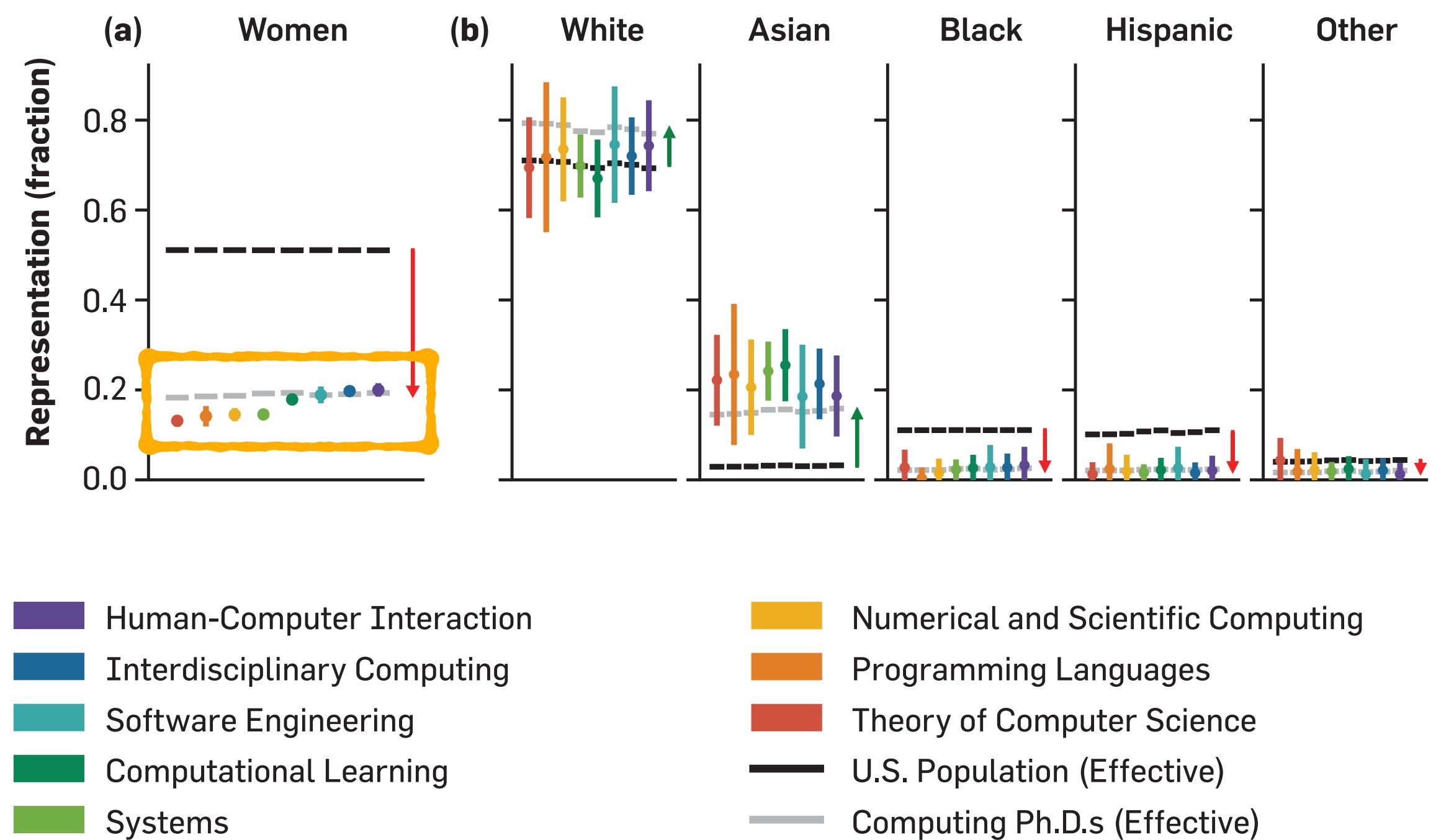
- ▶ faculty at elite universities are 2x more likely to have PhD parents than faculty *at other universities* (50x more than U.S. population)
- 🤔 should having PhD parents, or not, influence *how prestigious* the faculty job a person gets?



# subfield mediates gender & prestige

BUT faculty hiring typically at the subfield level – hire in "AI" or in "Numerical Computing" etc.

- ▶ does representation vary across subfield? does subfield vary with prestige?

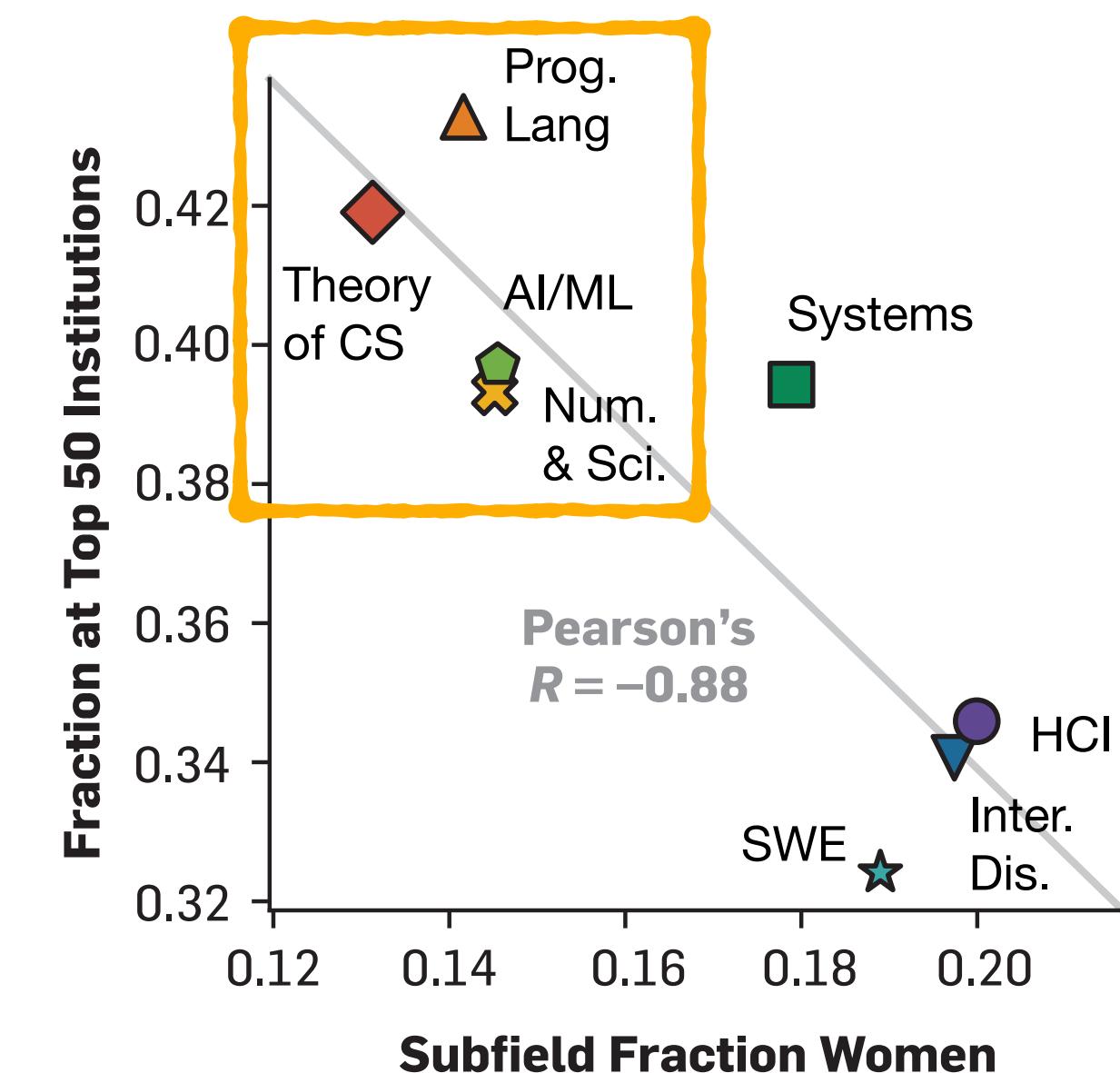
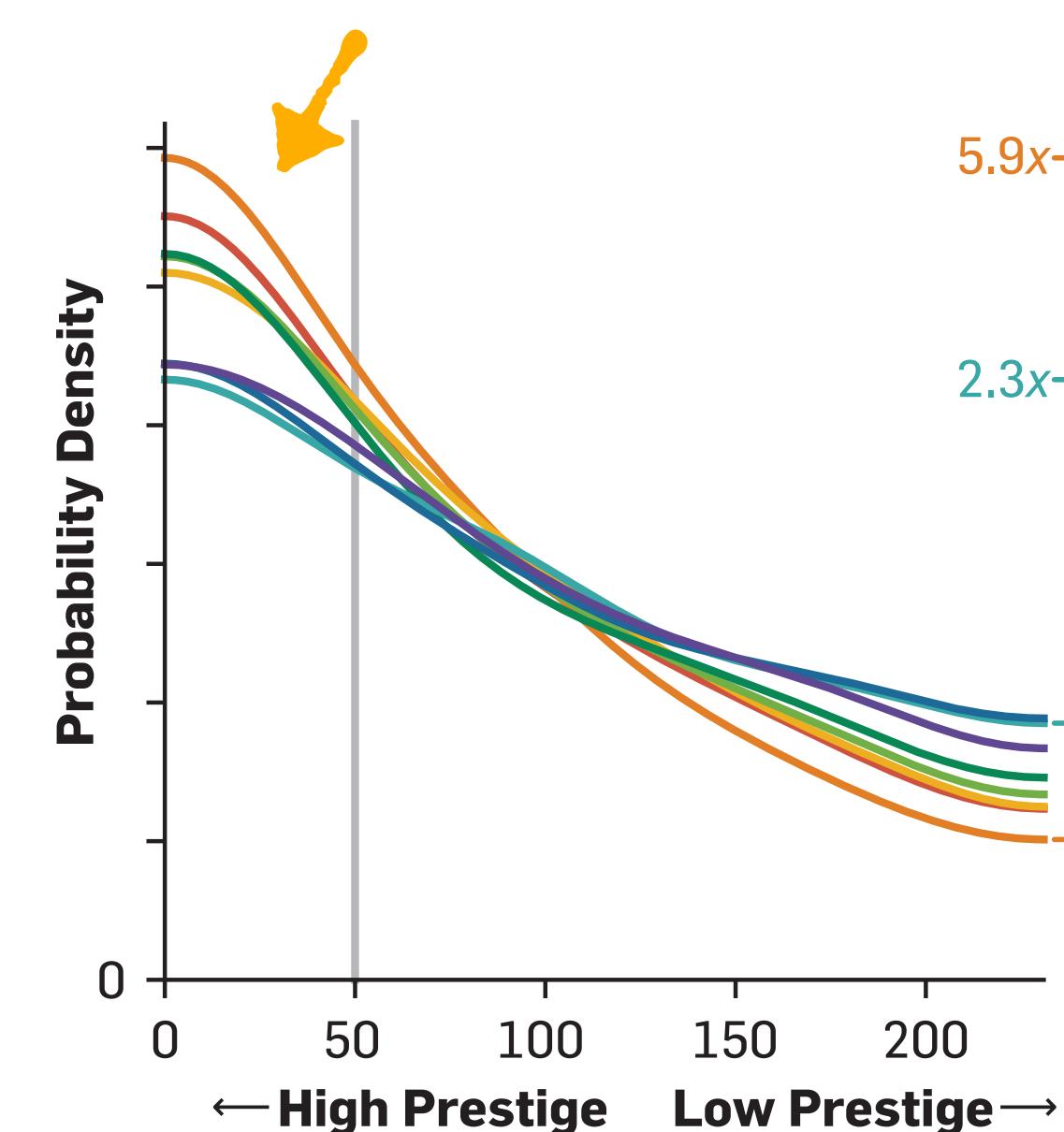


- ▶ gender varies by subfield
  - older subfields are less diverse
- ▶ little racial variation across subfield
  - but, strong variation by career stage
  - Whites overrepresented at PhD, but proportional at faculty
  - Black, Hispanic, underrepresented at PhD, but proportional at faculty

# subfield mediates gender & prestige

BUT faculty hiring typically at the subfield level – hire in "AI" or in "Numerical Computing" etc.

- ▶ does representation vary across subfield? does subfield vary with prestige?



- ▶ less gender diverse subfields = more prestigious

# 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...?

**how does who gets to do research shape what discoveries are made?**

# 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.]

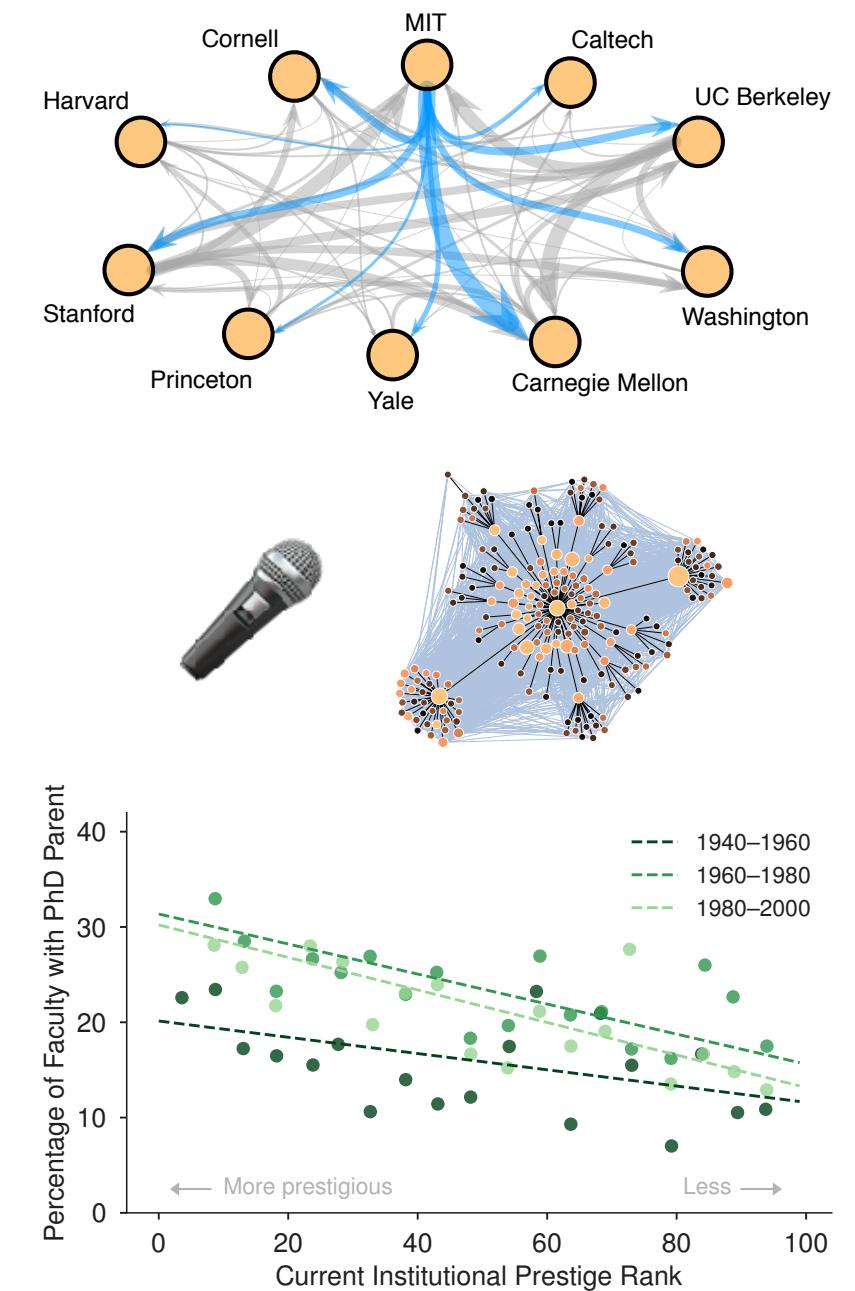


system-wide diversification depends on who *elite* departments train

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

some things have improved in 40 years, but prestige hierarchy is *very stable*

how can we use prestige to our advantage, to expand and diversify the community?



**NETWORK SCIENCES**

# Systematic inequality and hierarchy in faculty hiring networks

Aaron Clauset,<sup>1,2,3\*</sup> Samuel Arbesman,<sup>4</sup> Daniel B. Larremore<sup>5,6</sup>

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<sup>1,2</sup>, Sam Zhang<sup>2</sup>, Aaron Clauset<sup>1,2,4</sup> & Daniel B. Larremore<sup>1,2,5</sup>

Nature 610, 120–127 (2022)

**EPJ.org****REGULAR ARTICLE****Open Access**

## Prestige drives epistemic inequality in the diffusion of scientific ideas

Allison C. Morgan<sup>1\*</sup>, Dimitrios J. Economou<sup>1</sup>, Samuel F. Way<sup>1</sup> and Aaron Clauset<sup>1,2,3</sup>

EPJ Data Science 7, 40 (2018)

**SOCIAL SCIENCES**

## Gender and retention patterns among U.S. faculty

Katie Spoon<sup>1\*</sup>, Nicholas LaBerge<sup>1</sup>, K. Hunter Wapman<sup>1</sup>, Sam Zhang<sup>2</sup>, Allison C. Morgan<sup>1</sup>, Mirta Galesic<sup>3</sup>, Bailey K. Fosdick<sup>4</sup>, Daniel B. Larremore<sup>1,5</sup>, Aaron Clauset<sup>1,3,5,\*</sup>

Science Advances 9(42) adi2205 (2023)

## Gendered devaluation underlies faculty retention

Katie Spoon,<sup>1,\*</sup> Joanna Mendi,<sup>2,3</sup> Maria Martinez,<sup>2</sup> Mirta Galesic,<sup>4</sup> Daniel B. Larremore,<sup>1,4,5</sup> Aaron Clauset,<sup>1,4,5</sup> and Lauren A. Rivera<sup>6,†</sup>

Preprint, socarxiv : g6xwk (2024)

**OPEN**

## Socioeconomic roots of academic faculty

Allison C. Morgan<sup>1,2\*</sup>, Nicholas LaBerge<sup>1</sup>, Daniel B. Larremore<sup>1,2</sup>, Mirta Galesic<sup>3</sup>, Jennie E. Brand<sup>4</sup> and Aaron Clauset<sup>1,2,3\*</sup>

Nature Human Behaviour 6, 1625–1633 (2022)

BY NICHOLAS LABERGE, K. HUNTER WAPMAN,  
ALLISON C. MORGAN, SAM ZHANG, DANIEL B. LARREMORE,  
AND AARON CLAUSSET

## Subfield Prestige and Gender Inequality among U.S. Computing Faculty

Comm. ACM 65, 46–55 (2022)



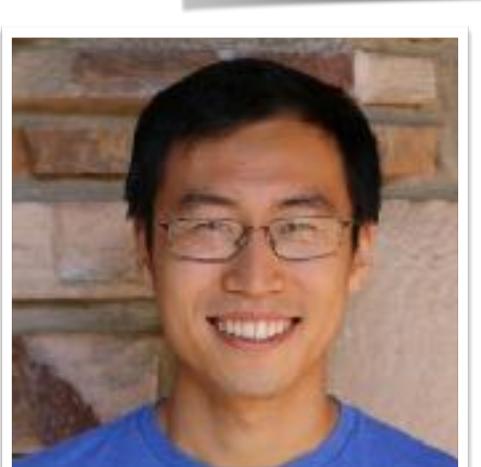
Dr. K. Hunter Wapman



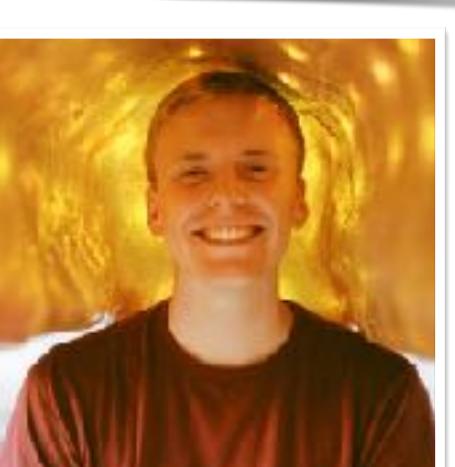
Dr. Allison C. Morgan  
(Code for America)



Dr. Katie Spoon  
(Stanford)



Prof. Sam Zhang  
(Vermont)



Dr. Nick LaBerge  
(US Census)



Dr. Samuel F. Way  
(Microsoft)



Dimitrios Economou  
(Queen's U.)



Joanna Mendi  
(Colorado)



Maria Martinez  
(Colorado)



Dr. Bailey Fosdick  
(GTI Energy)



Prof. Lauren Rivera  
(Northwestern)



Prof. Jennie Brand  
(UCLA)



Dr. Sam Arbesman  
(Lux Capital)



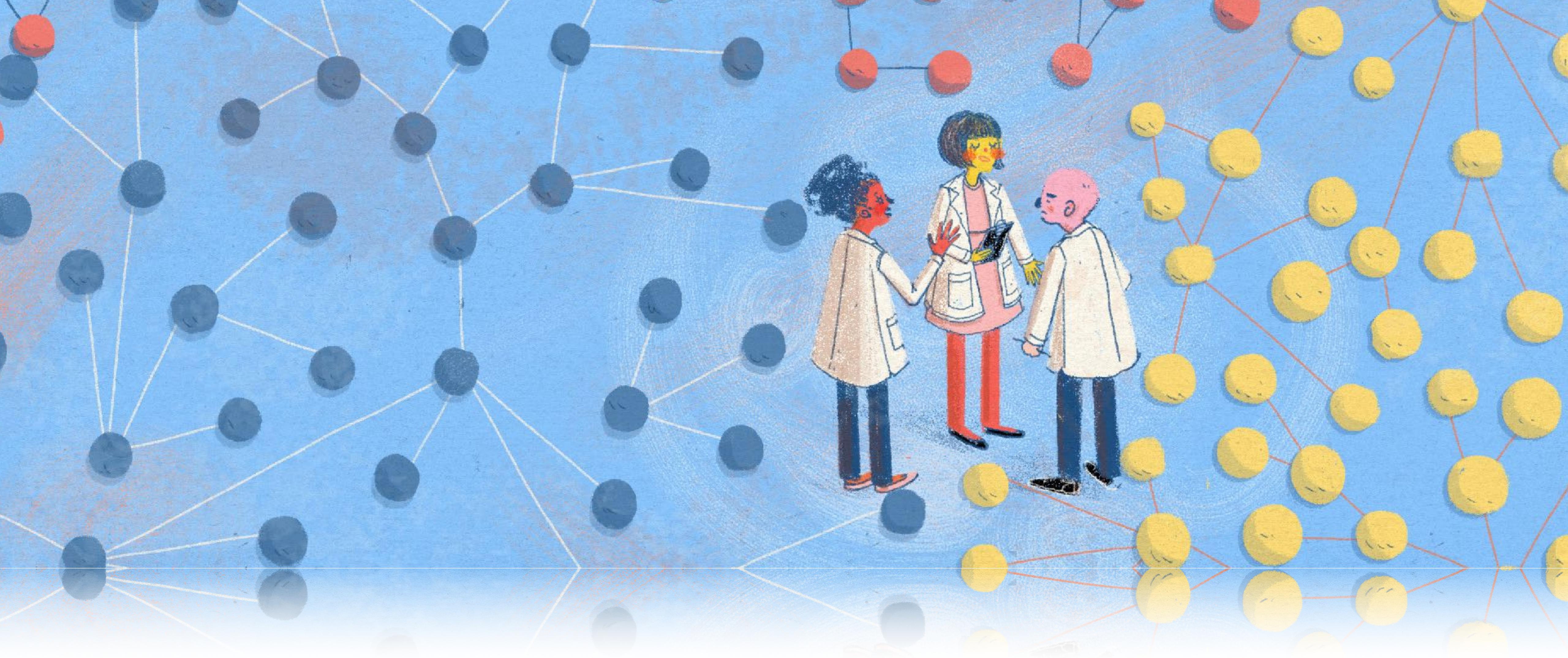
Prof. Mirta Galesic  
(Complexity Sci. Hub)



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>**