

Ideas worth spreading:

How does network position influence the spread of research topics?

Allison Morgan, Dimitrios Economou, Samuel Way, Aaron Clauset



Science is a meritocracy... right?

Yet, we know that some scientists and institutions are far more influential than others.

Reputation and impact in academic careers

Alexander Michael Petersen^{a,1}, Santo Fortunato^{b,1}, Raj K. Pan^b, Kimmo Kaski^b, Orion Penner^c, Armando Rungi^a, Massimo Riccaboni^{c,d}, H. Eugene Stanley^{e,1}, and Fabio Pammolli^{a,e}

Proc. Natl. Acad. Sci. U.S.A 111(43) 15316-15321(2014)

The Matthew Effect in Science

The reward and communication systems of science are considered.

Robert K. Merton

Science 159.3810, 56-63 (1968)

Professional Standing and the Reception of Scientific Discoveries¹

Stephen Cole

State University of New York at Stony Brook, and Bureau of Applied Social Research, Columbia University

Am. J. Soc. 76(2), 286-306 (1970)

Inputs, Outputs, and the Prestige of University Science Departments*

Warren O. Hagstrom
University of Wisconsin

Sociol. Educ. 375-397 (1971)

DEPARTMENTAL EFFECTS ON SCIENTIFIC PRODUCTIVITY*

PAUL D. ALLISON
University of Pennsylvania

J. SCOTT LONG
Indiana University

Am. Soc. Rev. 55, 469-478 (1990)

**Publication, Power, and Patronage:
On Inequality and Academic Publishing**

Chad Wellmon and Andrew Piper¹

Critical Inquiry (2017)

Three explanations

- (1) genuine differences in merit
- (2) non-meritocratic social processes
- (3) non-meritocratic structural factors



Three explanations

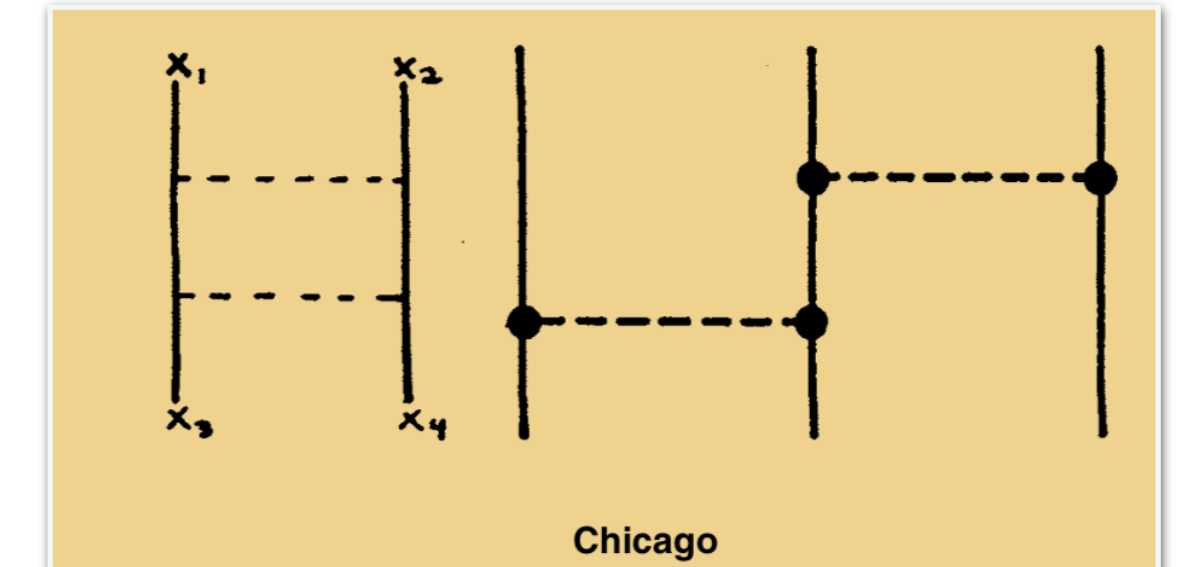
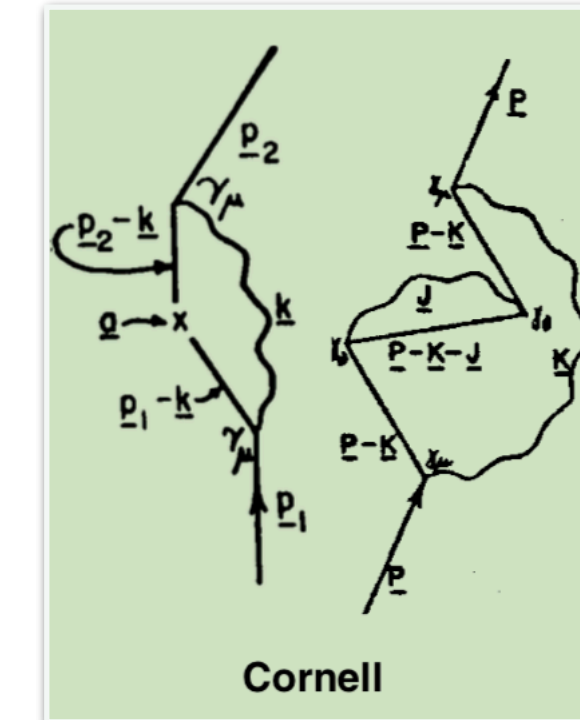
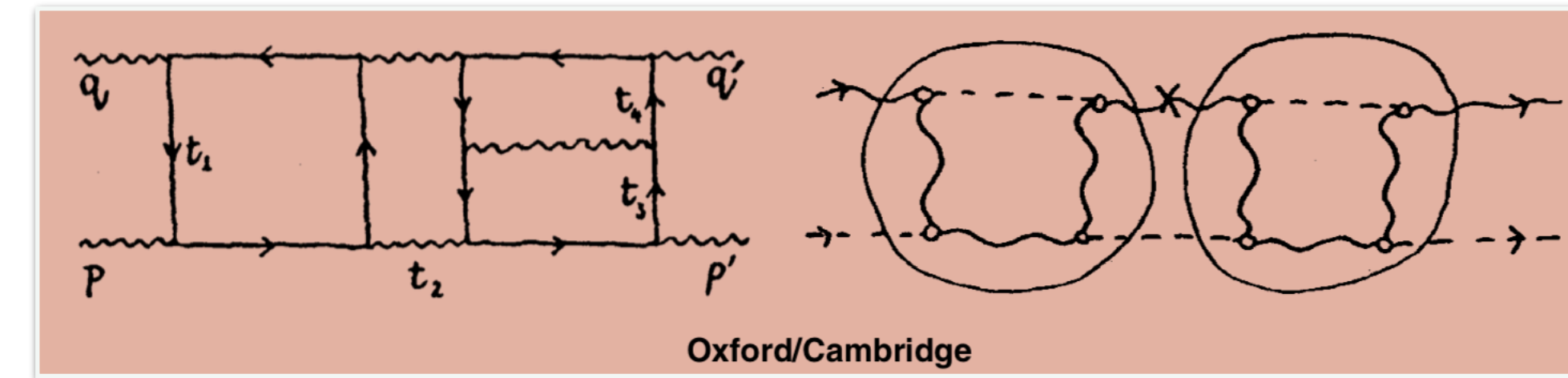
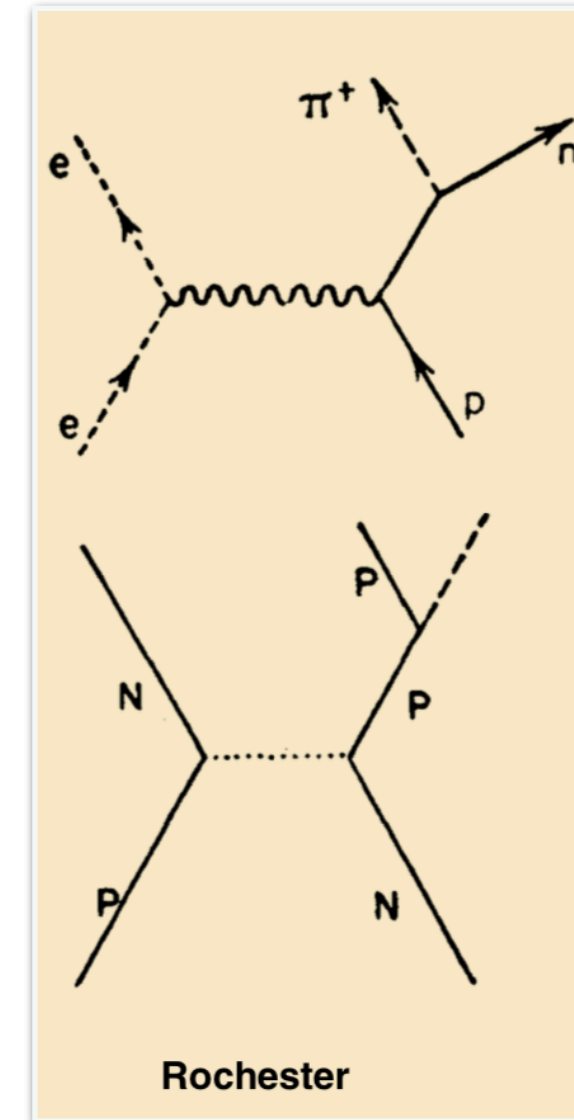
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Faculty hiring as a mechanism

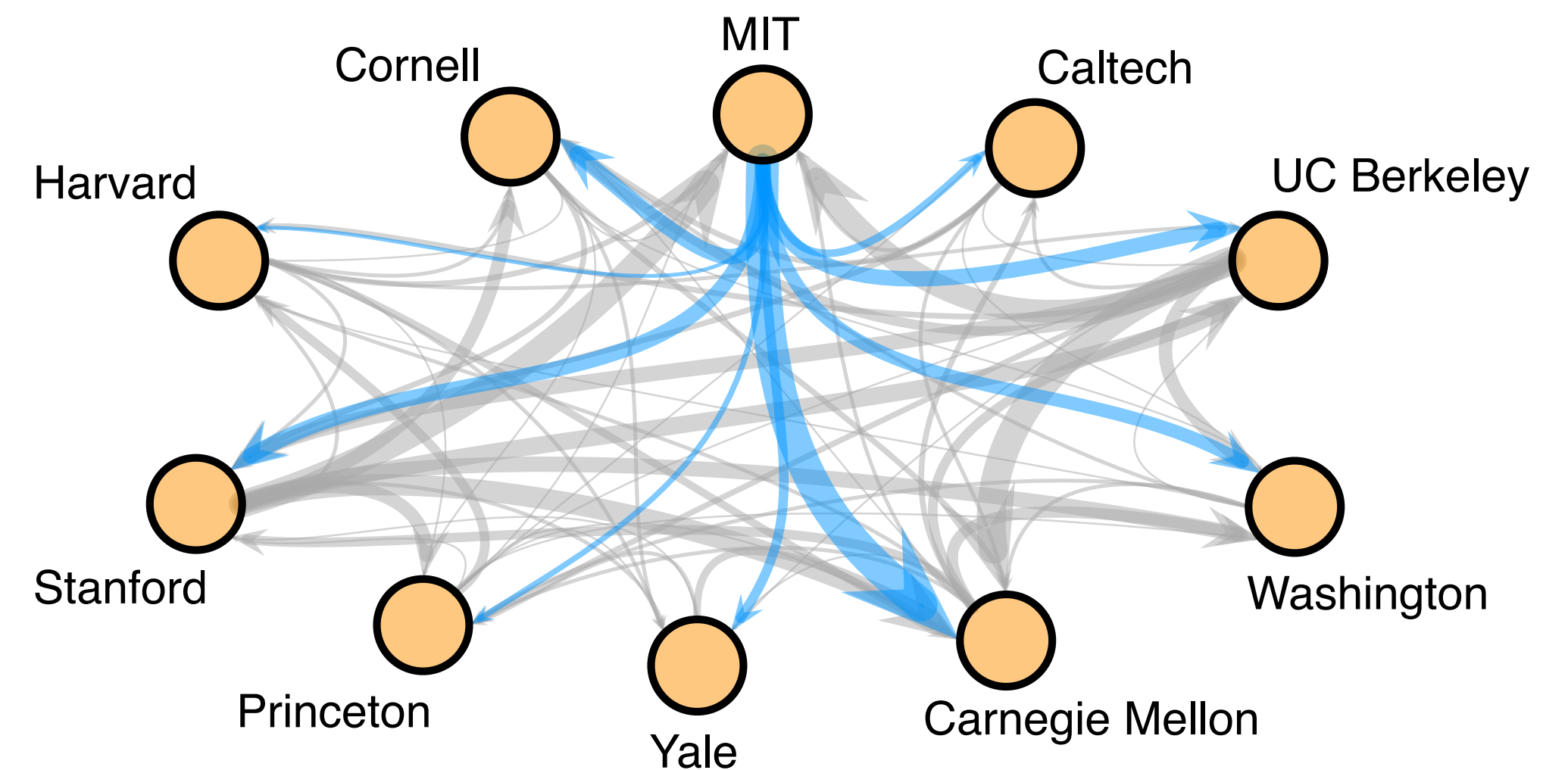
R1: Are research ideas carried by faculty hiring?

R2: Does the structure of the faculty hiring network affect the spread of ideas?



American Scientist 55, 156-165 (2005)

Proc. 11th Conf. on Web and Social Media (2017)



Sci. Adv. 1(1), e1400005, 2015.

Data

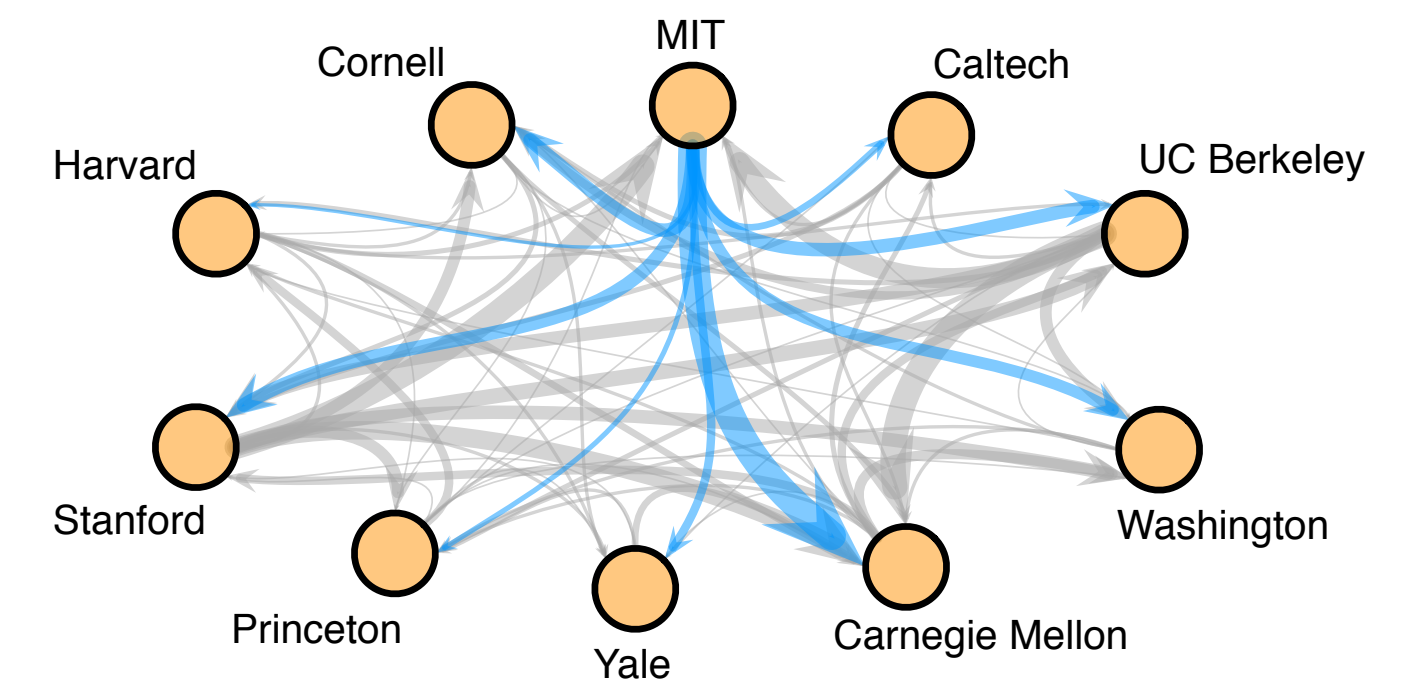
Education & employment for faculty from 205 U.S. and Canadian CS departments

- Institution (node) u with unique prestige π
- Edge (u, v) represents a PhD candidate from u who got an assistant faculty position at v

Over 200K publication records for 2.6K tenure-track faculty


- Title, author list, venue, and date
- Matched with employment start dates

Faculty hiring networks



Science Advances 1(1), e1400005, 2015.

Publication records



[c7] Leto Peel, Aaron Clauset:
Detecting Change Points in the Large-Scale Structure of Evolving Networks.
AAAI 2015: 2914-2920

[c6] Leto Peel, Aaron Clauset:
Predicting Sports Scoring Dynamics with Restoration and Anti-Persistence.
ICDM 2015: 339-348

[i19] Abigail Z. Jacobs, Samuel F. Way, Johan Ugander, Aaron Clauset:
Assembling thefacebook: Using heterogeneity to understand online social network assembly. CoRR abs/1503.06772 (2015)

[i18] Leto Peel, Aaron Clauset:
Predicting sports scoring dynamics with restoration and anti-persistence.
CoRR abs/1504.05872 (2015)

[i17] Amir Ghasemian, Pan Zhang, Aaron Clauset, Cristopher Moore, Leto Peel:
Detectability thresholds and optimal algorithms for community structure in dynamic networks. CoRR abs/1506.06179 (2015)

Proc. 25th Int'l World Wide Web Conf. (WWW), (2016)

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For each department that has adopted a research idea, either:

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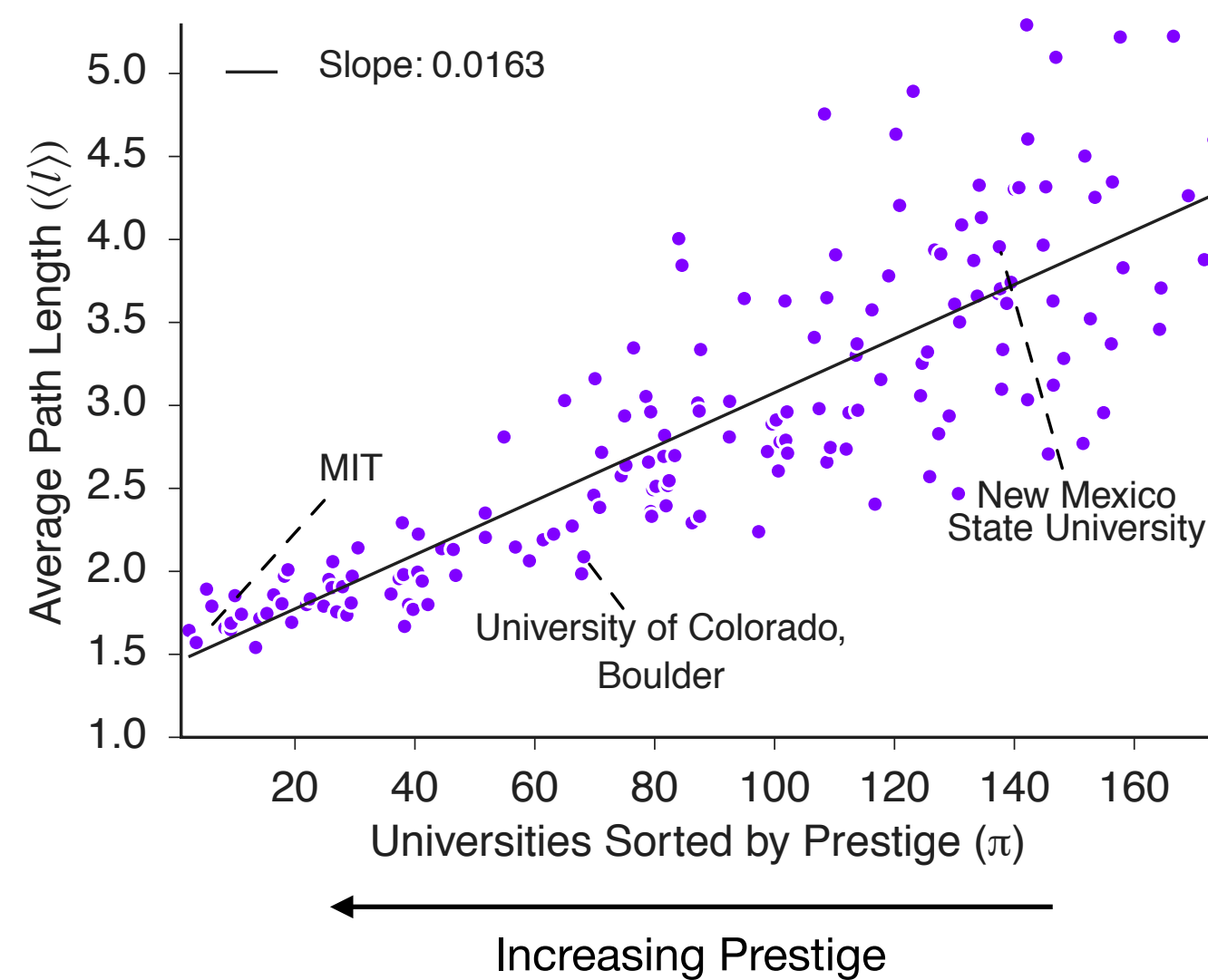
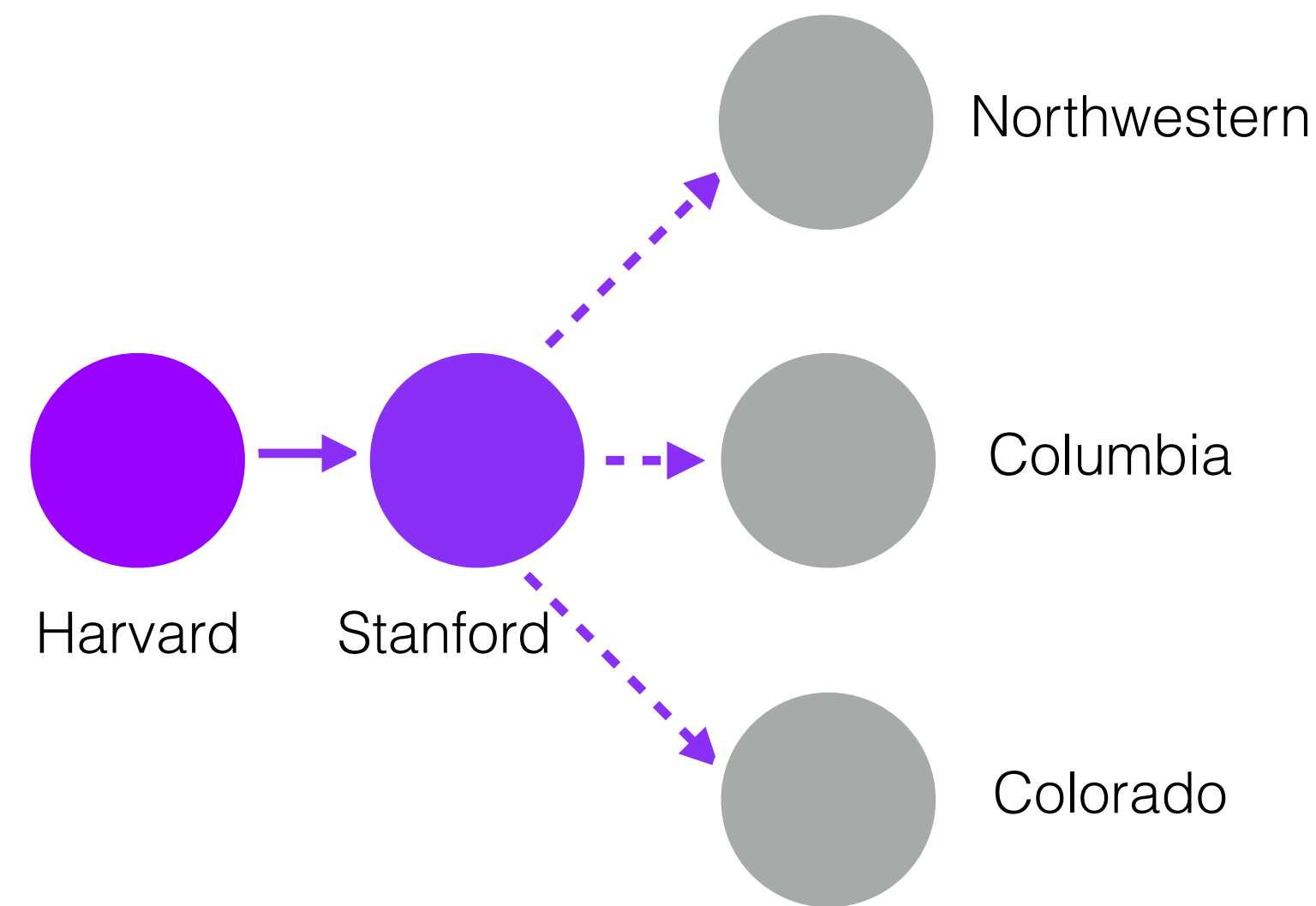
Test: choose 3 research topics and evaluate the fraction of times those topics spread via (a) in real life, compared to the expected fraction under a permutation of publication titles

topic	
deep learning	✗
topic modeling	✓
incremental computing	✓

2/3 of research topics were significantly more likely to be transmitted via hiring than at random

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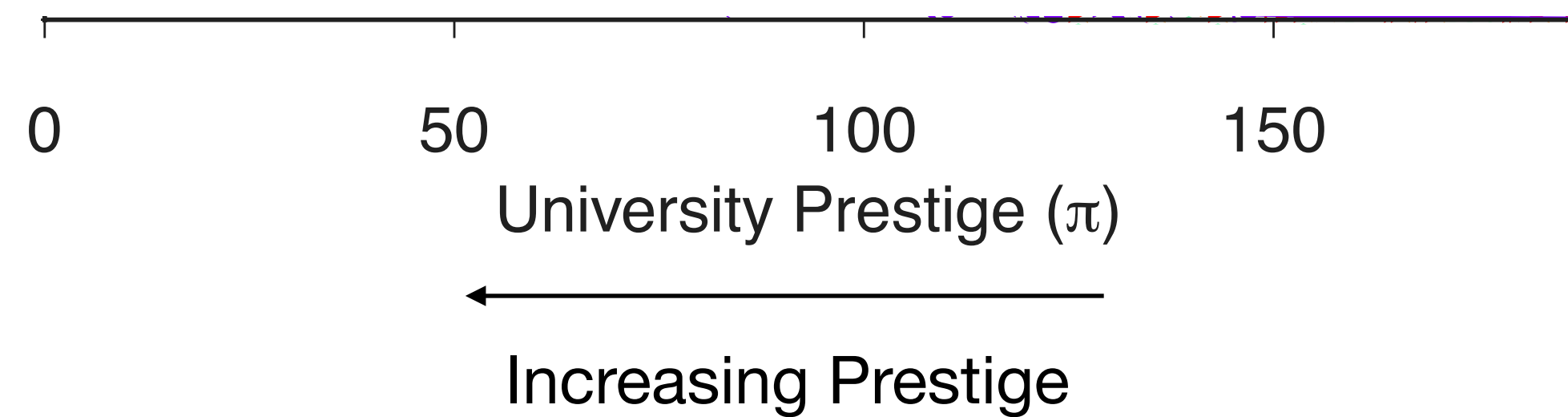
To simulate the diffusion of ideas, use a Susceptible-Infected (SI) model

Seed an epidemic at a single university with unique prestige π (network location)

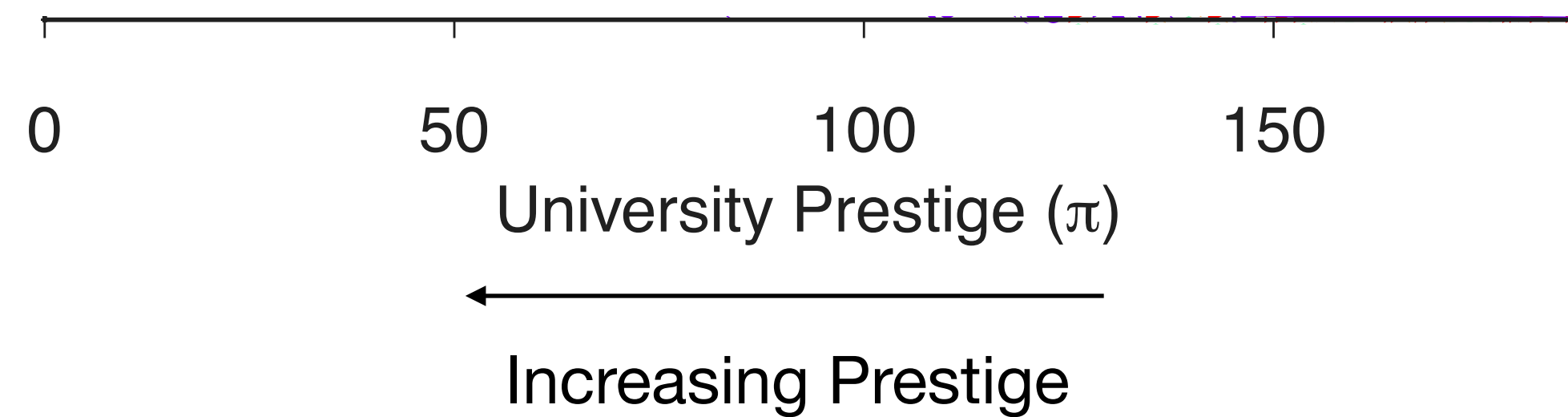
Varying the transmissibility p (quality of an idea)

Measure the fraction of universities which have adopted the idea

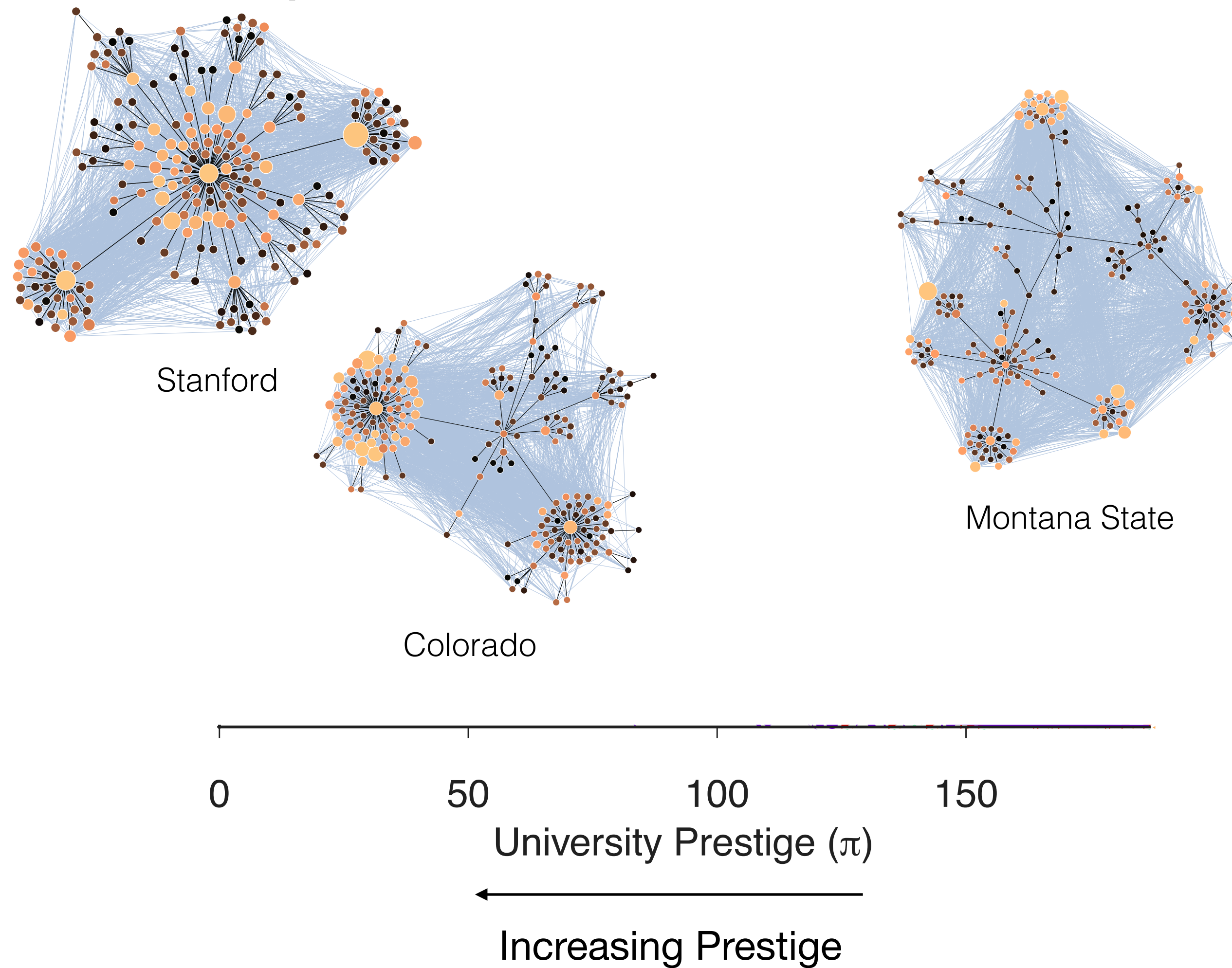
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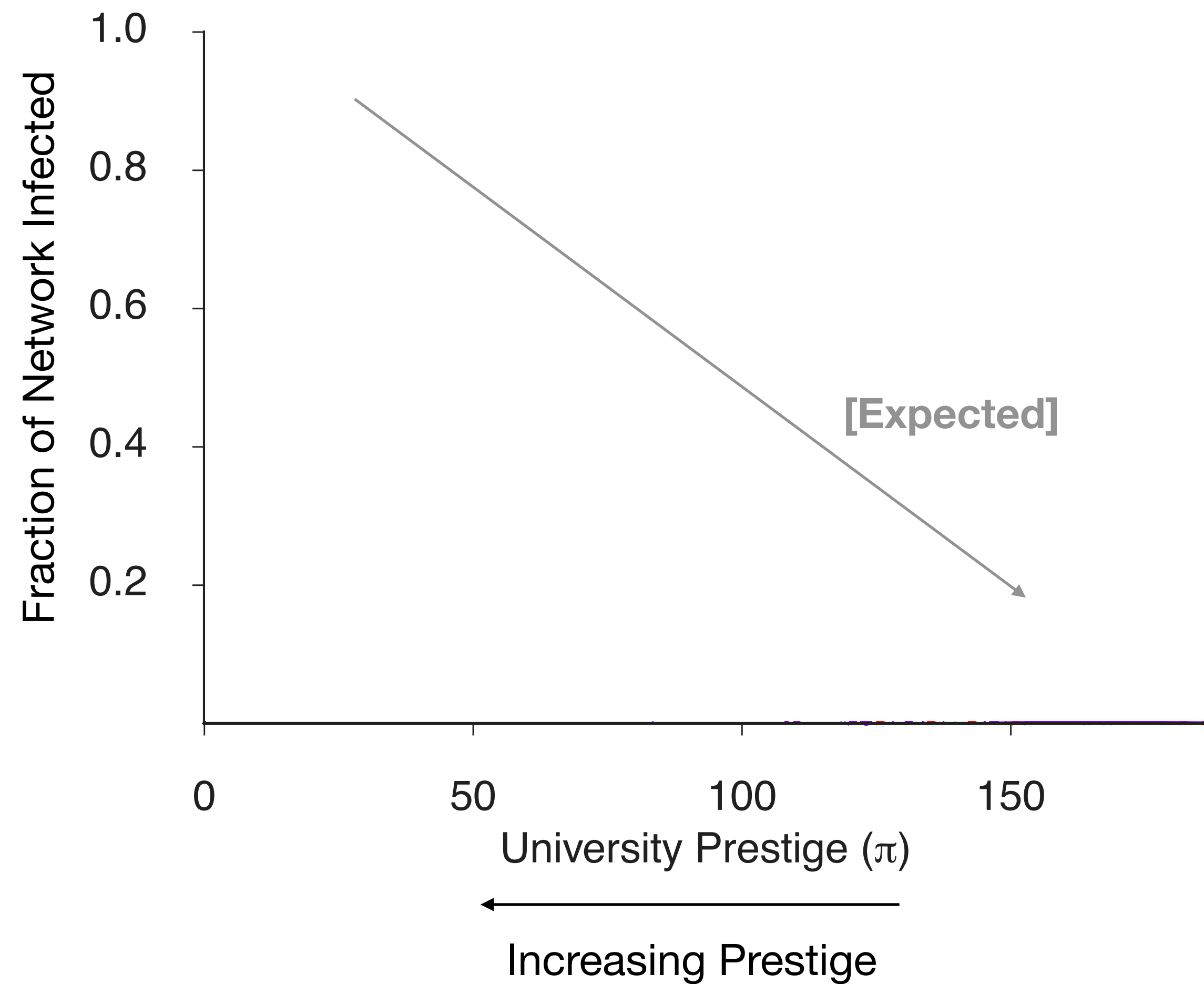
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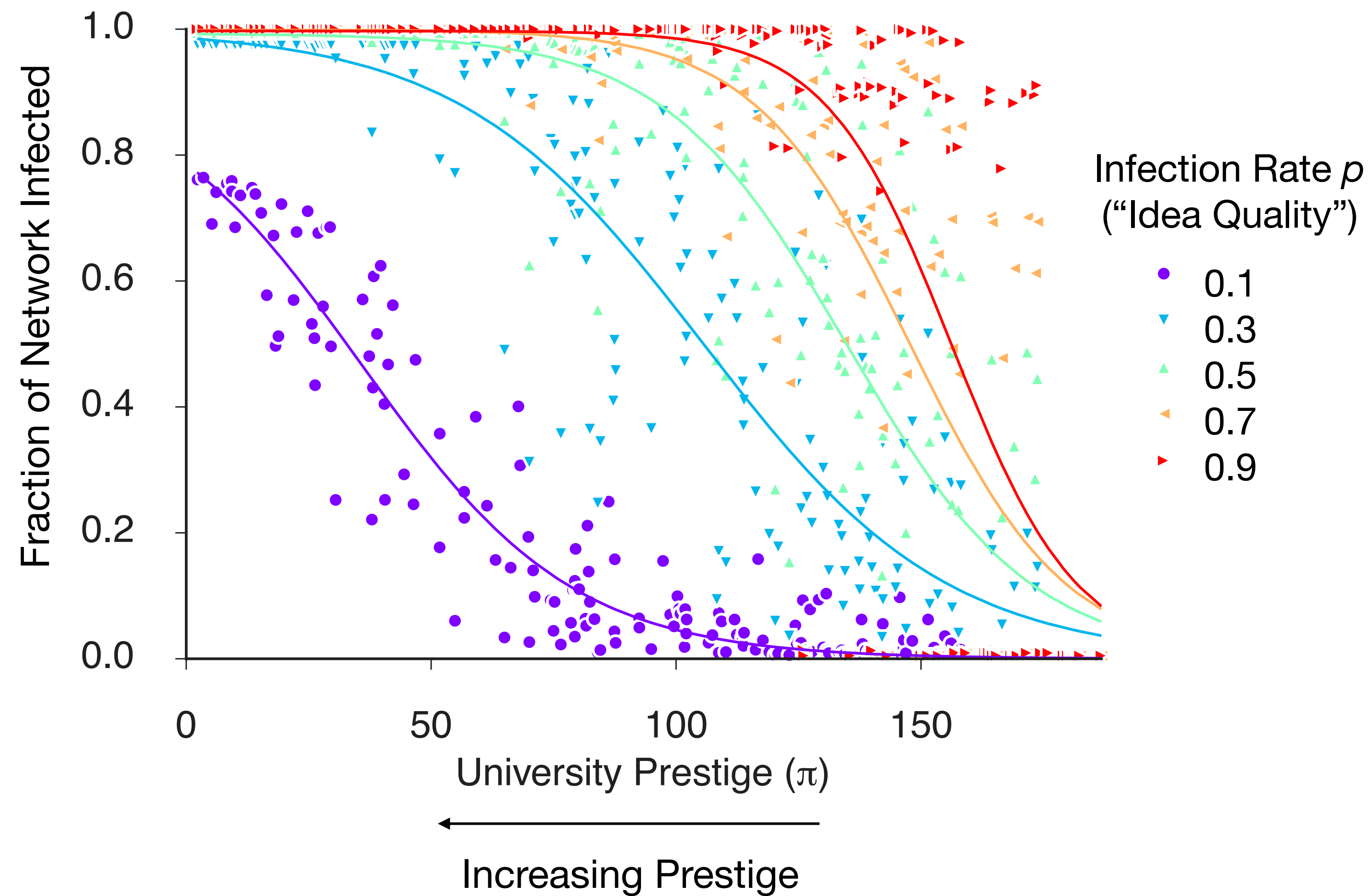
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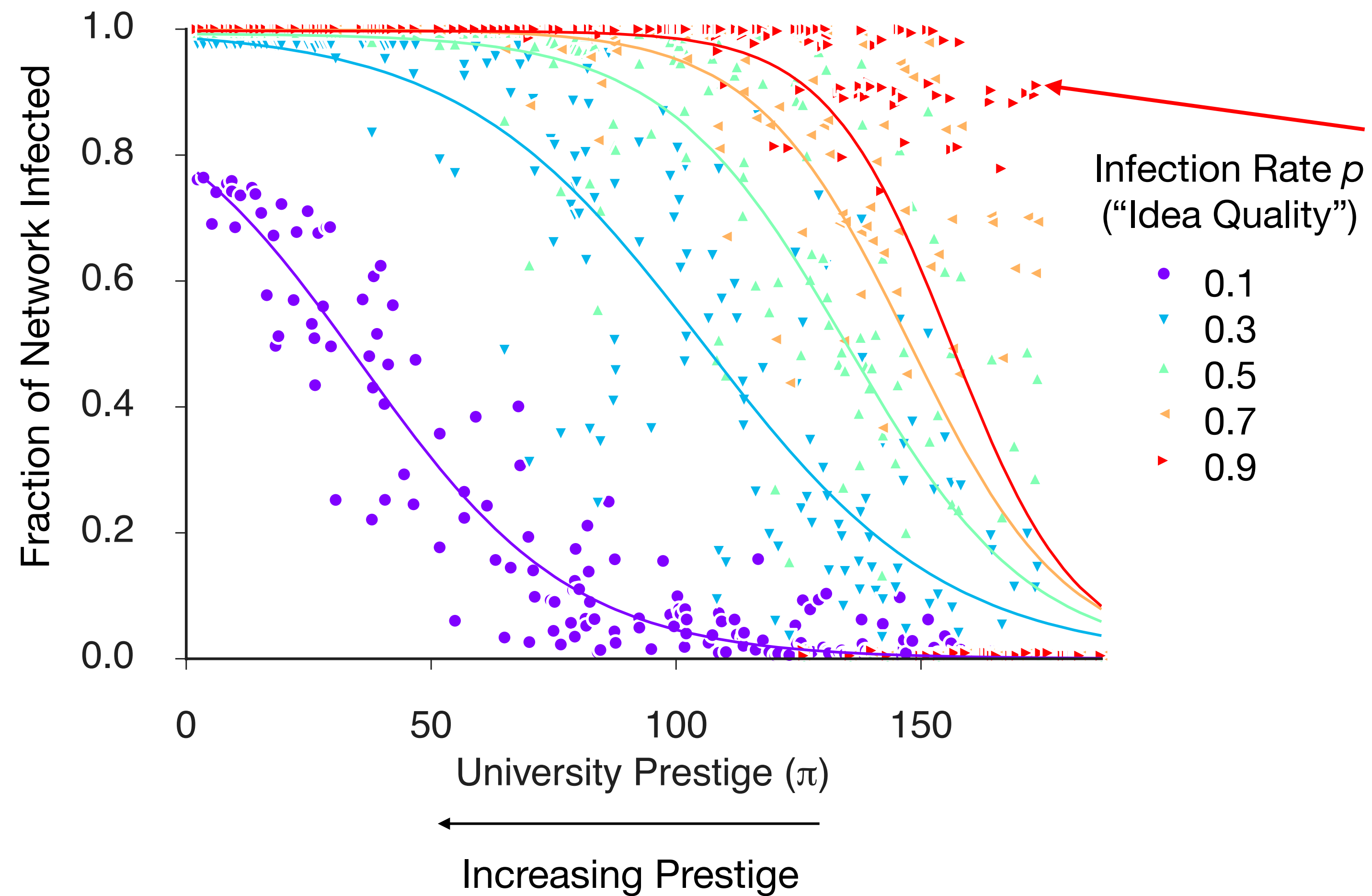
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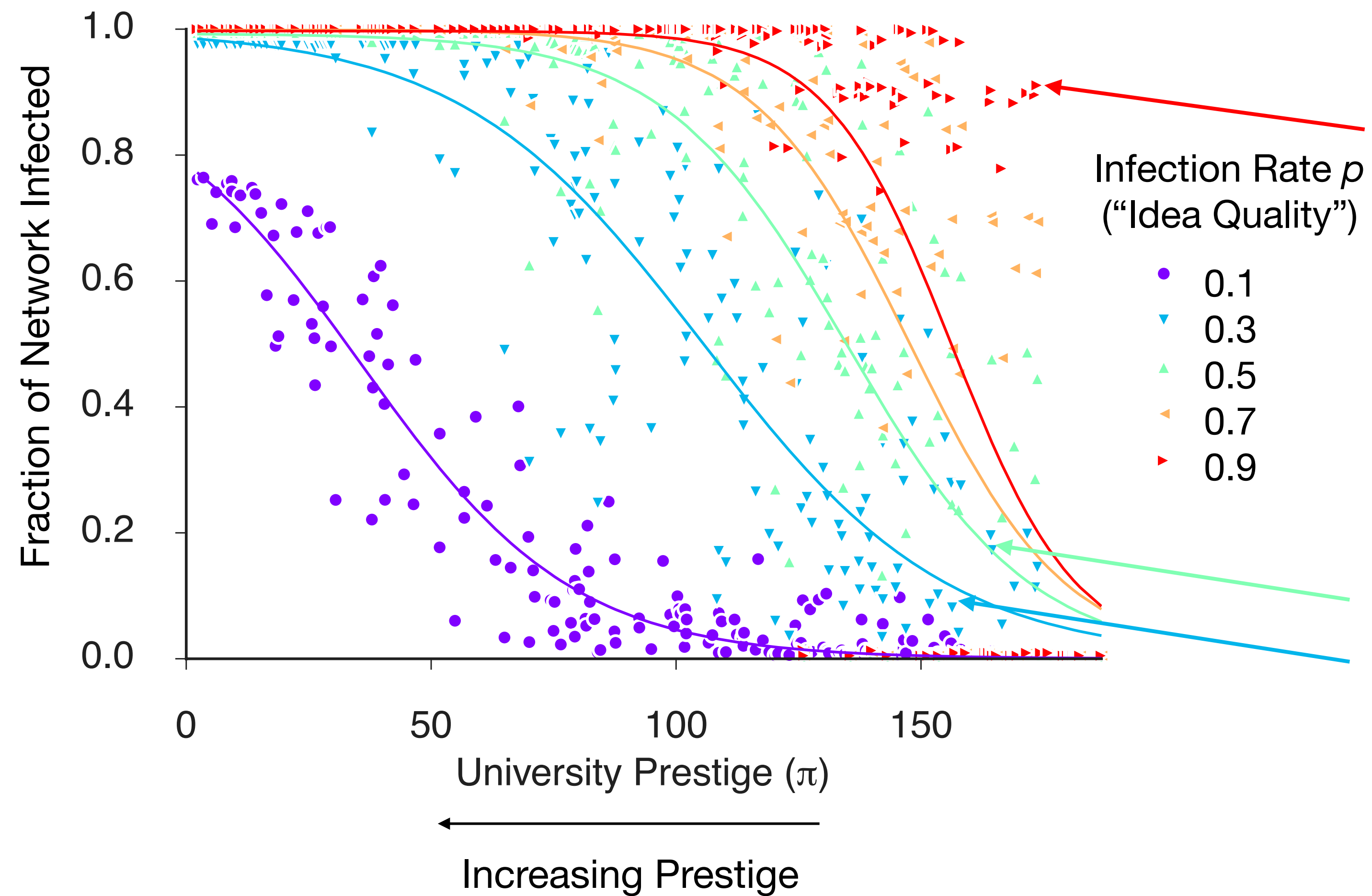


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Great ideas can spread
regardless of starting place

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Great ideas can spread regardless of starting place

Good ideas spread more easily from high-prestige universities

Conclusion

Ideas spread in academia via faculty hiring. The structure of this network privileges elite institutions.

Good ideas can spread further and faster from prestigious universities, but great ideas can spread from any university.

Future work should consider other (non-meritocratic) mechanisms, as well as the full text of research papers or other research ideas.

Remaining questions: How should we address this inequality?

Thanks!

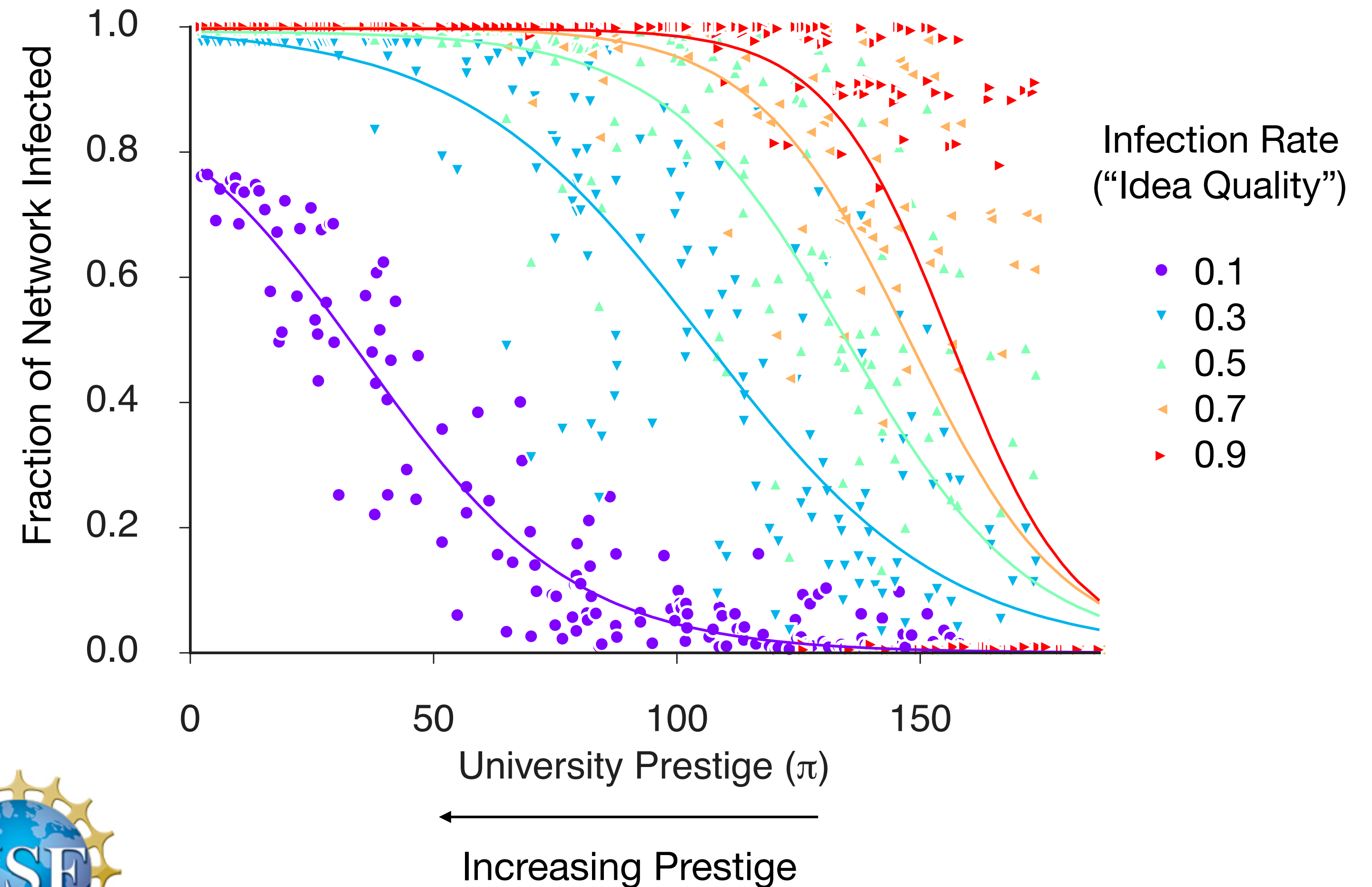
Collaborators: Dimitrios Economou,
Samuel Way, Aaron Clauset

Paper: “Prestige drives epistemic
inequality in the diffusion of scientific
ideas” [arXiv:1805.09966](https://arxiv.org/abs/1805.09966)

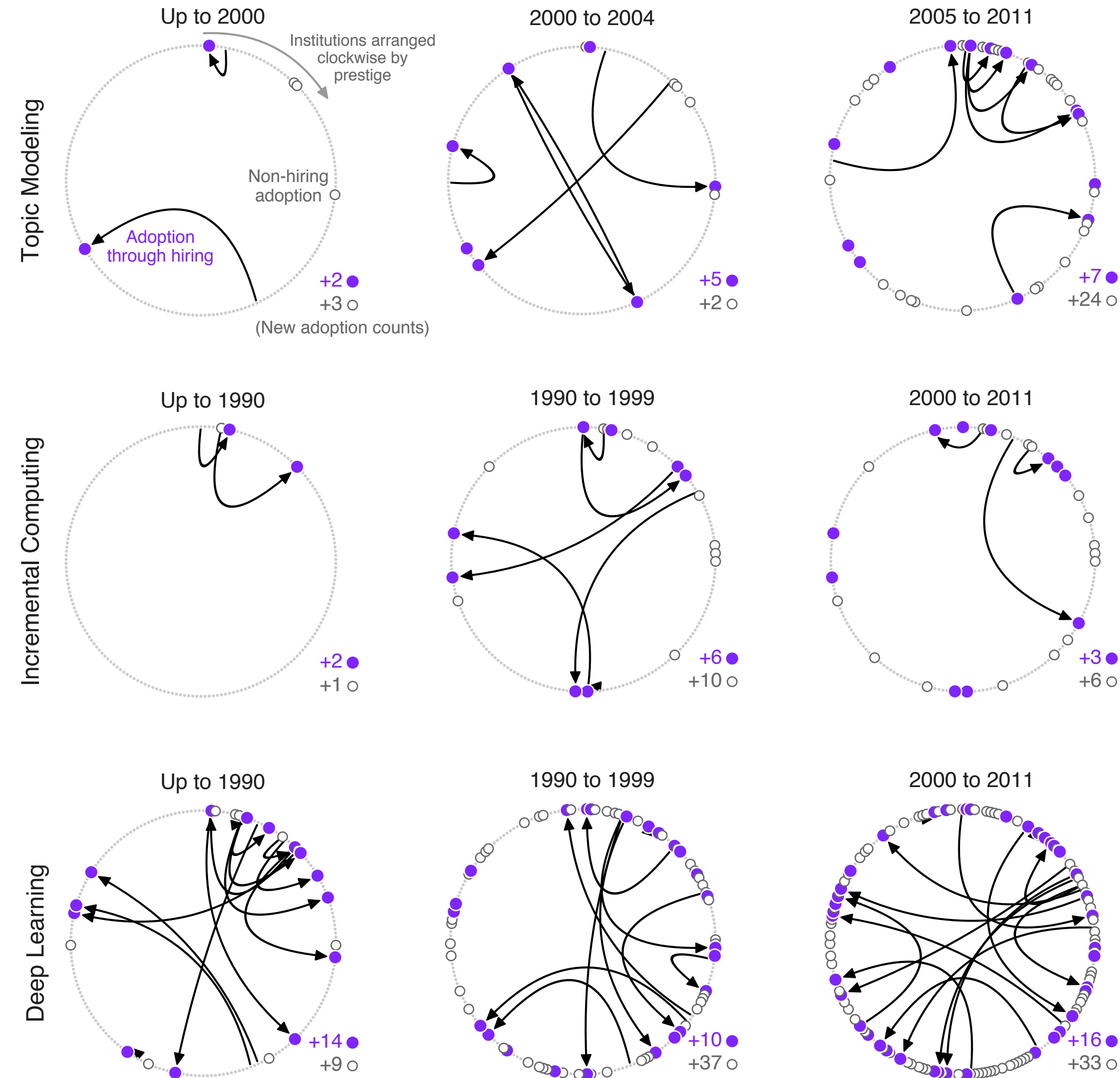
Code: [github.com/allisonmorgan/
epistemic_inequality](https://github.com/allisonmorgan/epistemic_inequality)



University of Colorado **Boulder**



R1: Are research ideas carried by faculty hiring?



R1: Are research ideas carried by faculty hiring?

topic X	h_o	h_e	p
deep learning	0.34	0.30	0.16 ± 0.01
topic modeling	0.33	0.22	0.01 ± 0.01
incremental computing	0.39	0.19	0.01 ± 0.01

topic_modeling_keywords = ["probabilistic latent semantic analysis", "plsa", "latent dirichlet allocation", "latent semantic analysis", "latent semantic indexing", "topic model", "probabilistic topic modeling"]

incremental_keywords = ["incremental computation", "self-adjusting computation", "program derivative", "dbtoaster", "incremental view", "partial evaluation", "incremental computing", "incrementally compute", "frtime", "adaptive functional programming", "delta ml", "haskell adaptive", "cornell synthesizer generator", "icedust", "adapton", "one-way dataflow constraints", "reactive computation", "differential dataflow", "jane street incremental", "incremental datalog", "incremental prolog", "incremental type checking", "self-adjusting"]

deep_learning_keywords = ["convolutional net", "convolutional neural net", "convolutional neural field", " rnn ", "deep learning", "deep-learning", "recursive neural net", "lstm", "long short-term memory", "generative adversarial network", "theano", "neural network", "deep belief net", "boltzmann machine", "convnet", "deep reinforcement learning", "deep neural network", " dnn ", " dnn-", "multilayer perceptron", "autoencoder", "auto-encoder", "activation function", "backprop", "back-prop", "ladder network", "bidirectional rnn", "bidirectional recurrent", "imagenet", "restricted boltzmann", "rmsprop", "convnet", "artificial neural network", "connectionist"]