Large Language Models Amplify the Matthew Effect in Scientific Research

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3 School of Engineering and Applied Sciences, Harvard University, USA

Motivation

- Human citation behavior (~training data) has some well-documented biases (Letchford et al., 2015; Price, 1976; Wang, 2014; Wuchtly et al., 2007)

Letchford, A., Moat, H. S., & Preis, T. (2015). The advantage of short paper titles. Royal Society open science, 2(8), 150266.

Ng, J. Y., Maduranayagam, S. G., Suthakar, N., Li, A., Lokker, C., Iorio, A., Haynes, R. B., & Moher, D. (2025). Attitudes and perceptions of medical researchers towards the use of artificial intelligence chatbots in the scientific process: An international cross-sectional survey. The Lancet Digital Health, 7(1), e94–e102.

Price, D. D. S. (1976). A general theory of bibliometric and other cumulative advantage processes. Journal of the American society for Information science, 27(5), 292-306.

Wang, J. (2014). Unpacking the Matthew effect in citations. Journal of Informetrics, 8(2), 329-339.

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https://www.nature.com/articles/d41586-023-02980-0

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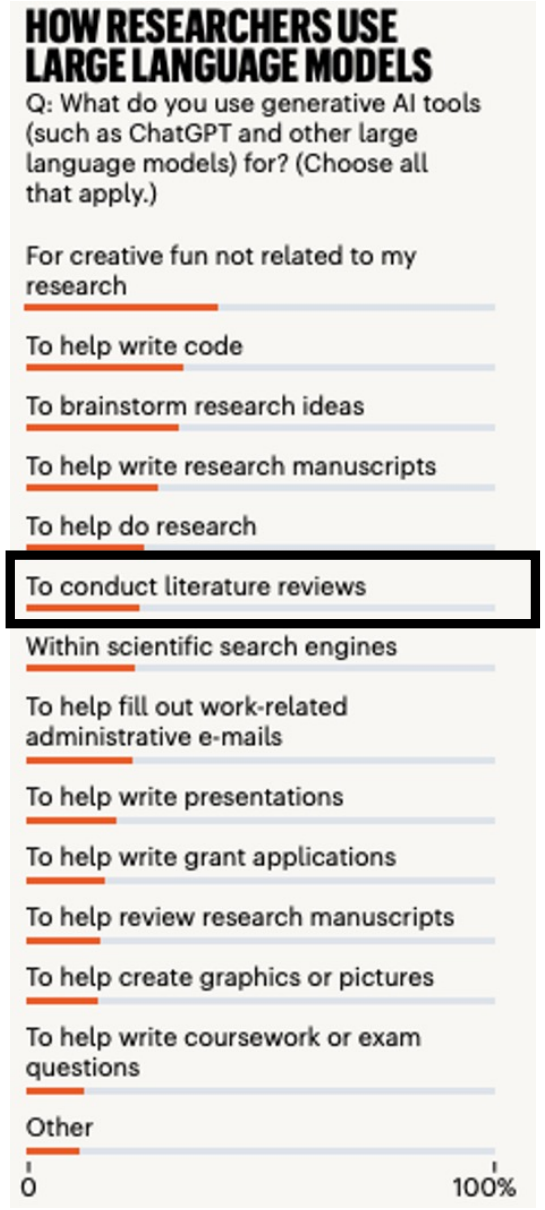
A Nature survey in September 2023



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- Researchers are using LLMs in literature reviews (Ng et al., 2025), although a lot is still unknown about "real-world" usage
- Shortage of experiments that focus on a "controlled laboratory" setting (~parametric knowledge)

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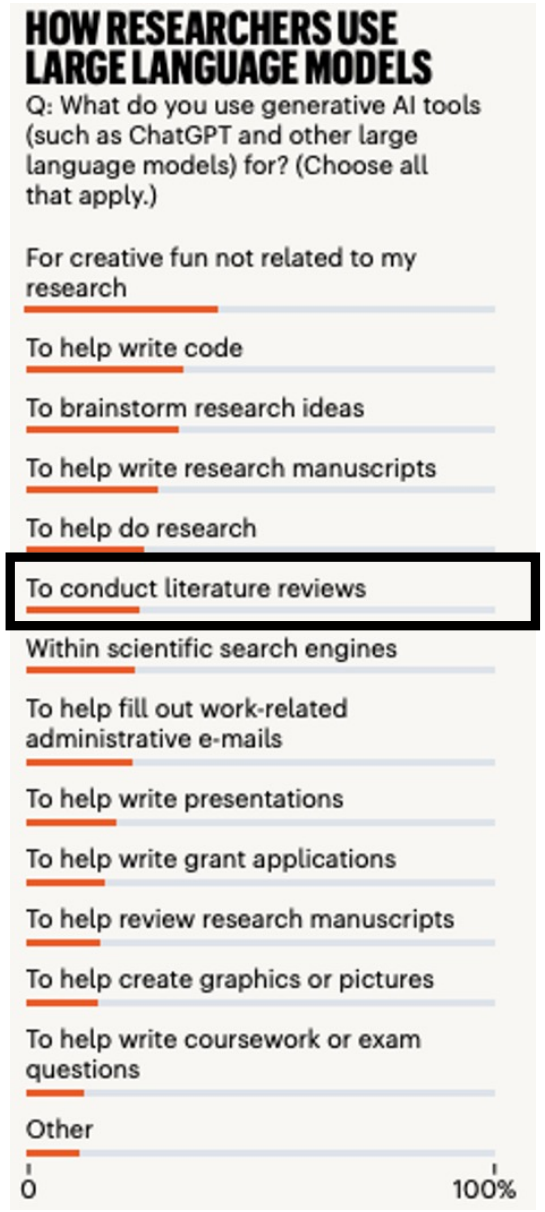

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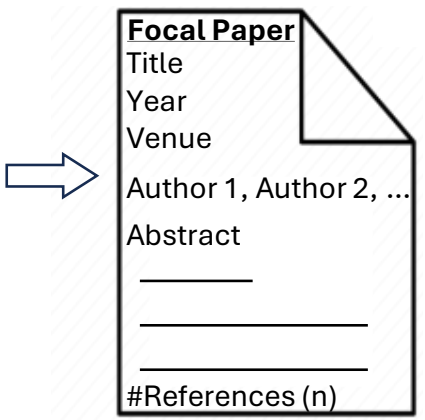
Prompt GPT-4o to Generate Reference Suggestions

SciSciNet

- Q1 Journal
- 1999 -2021
- 3 < #references < 54
- #citations > 1



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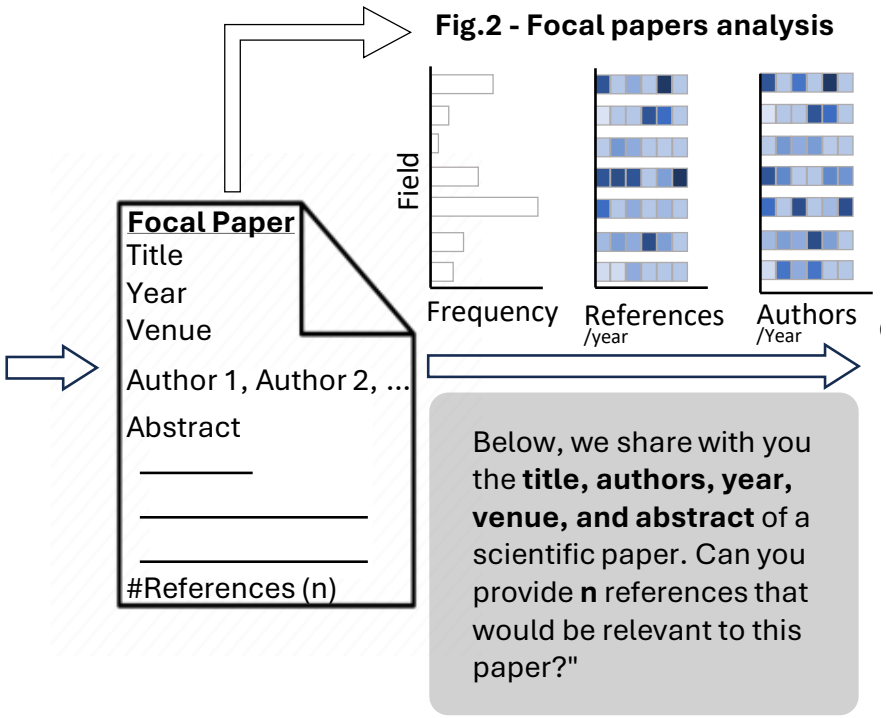

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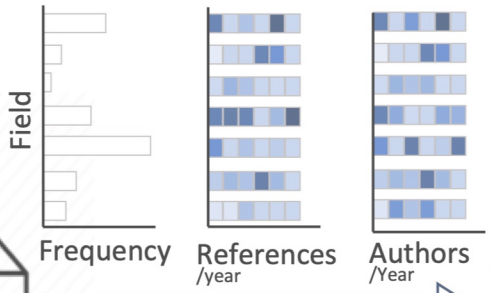
Focal Paper
Title
Year
Venue
Author 1, Author 2, ...
Abstract
#References (n)

Fig.2 - Focal papers analysis



Below, we share with you the **title, authors, year, venue, and abstract** of a scientific paper. Can you provide **n** references that would be relevant to this paper?"

Generated Reference List

Fig.3 – Reinforcing Matthew

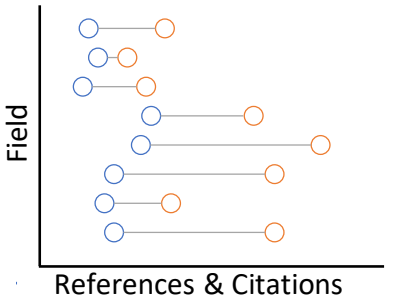


Fig.4 – Time, Author & Title Bias

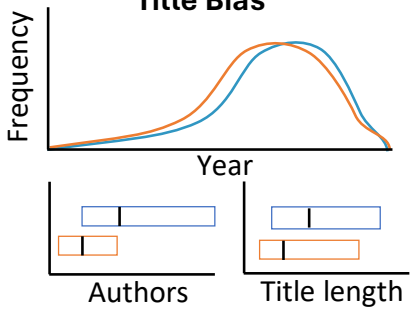


Fig.5 – Textual embedding

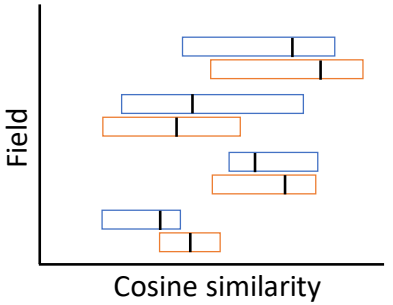
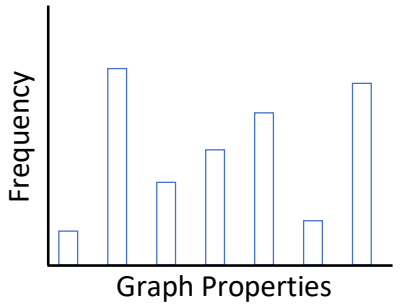
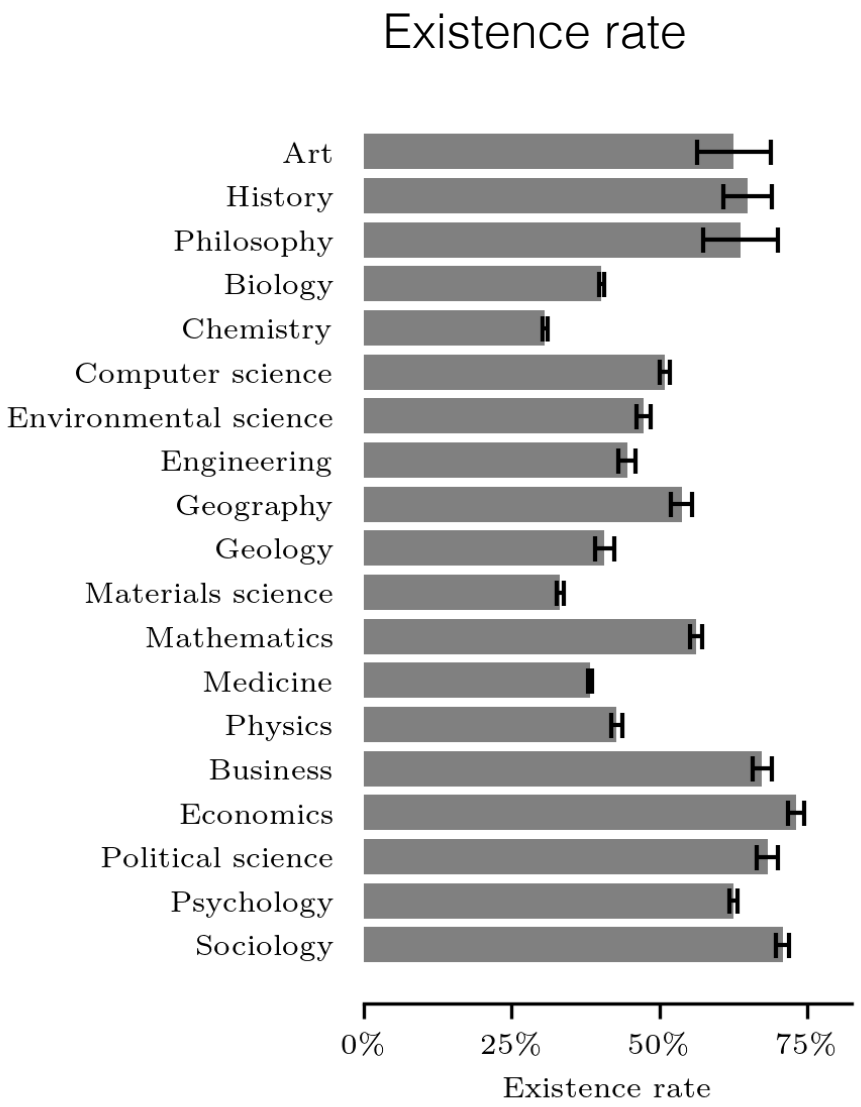


Fig.6 – Network Properties



Generated References Exhibit a Heightened Citation Bias



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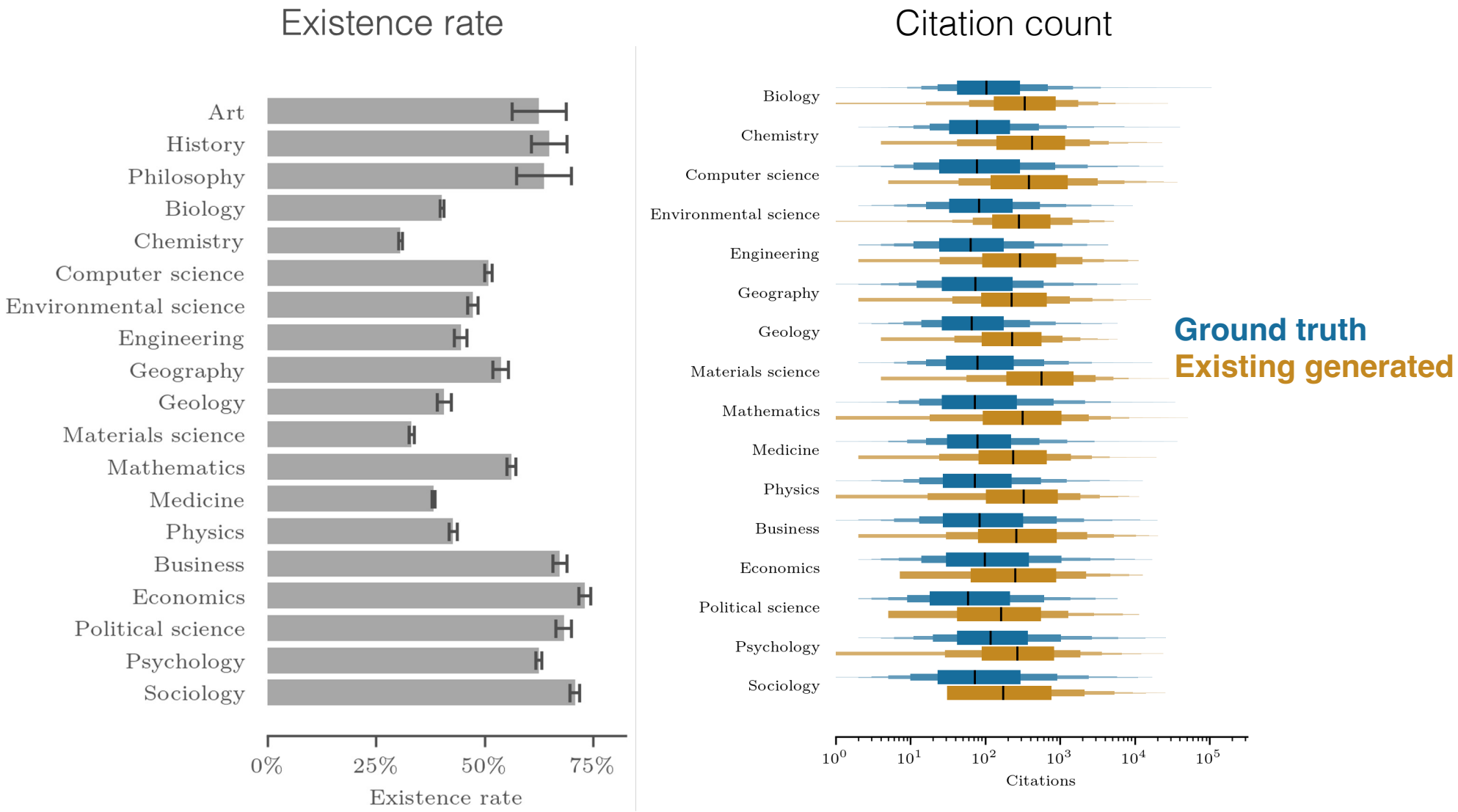

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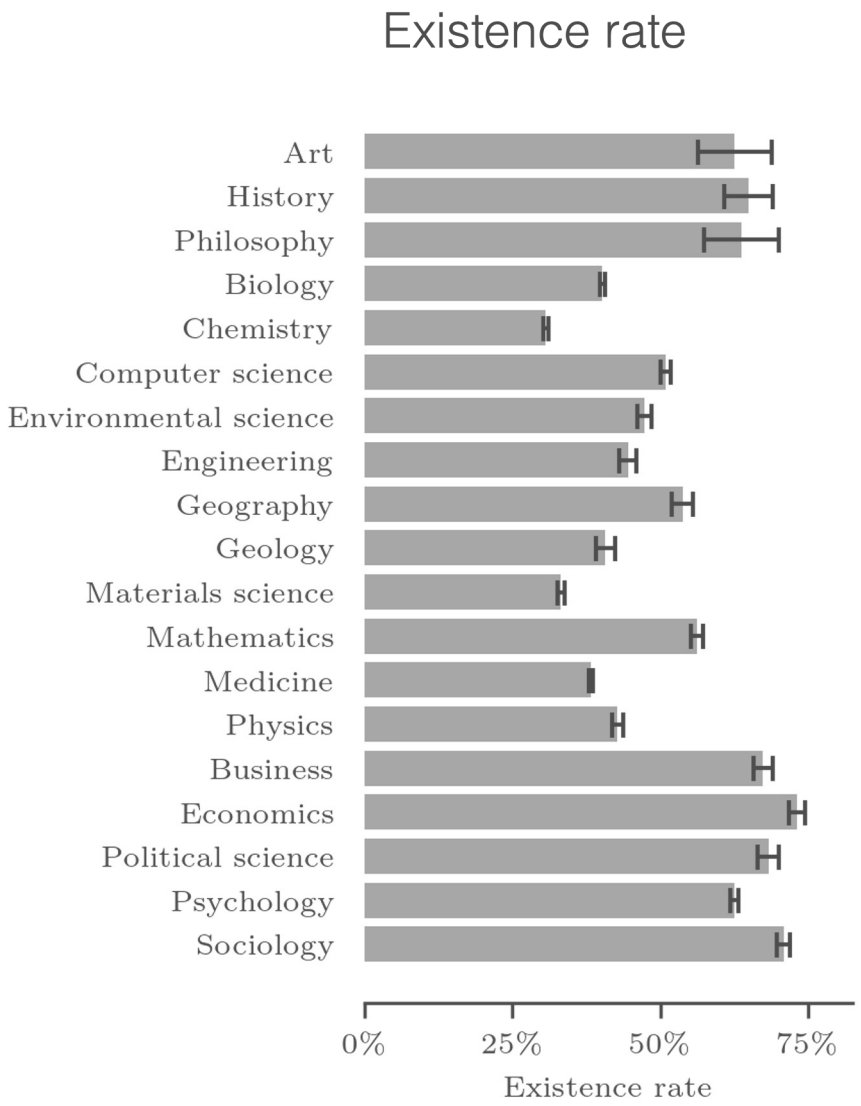

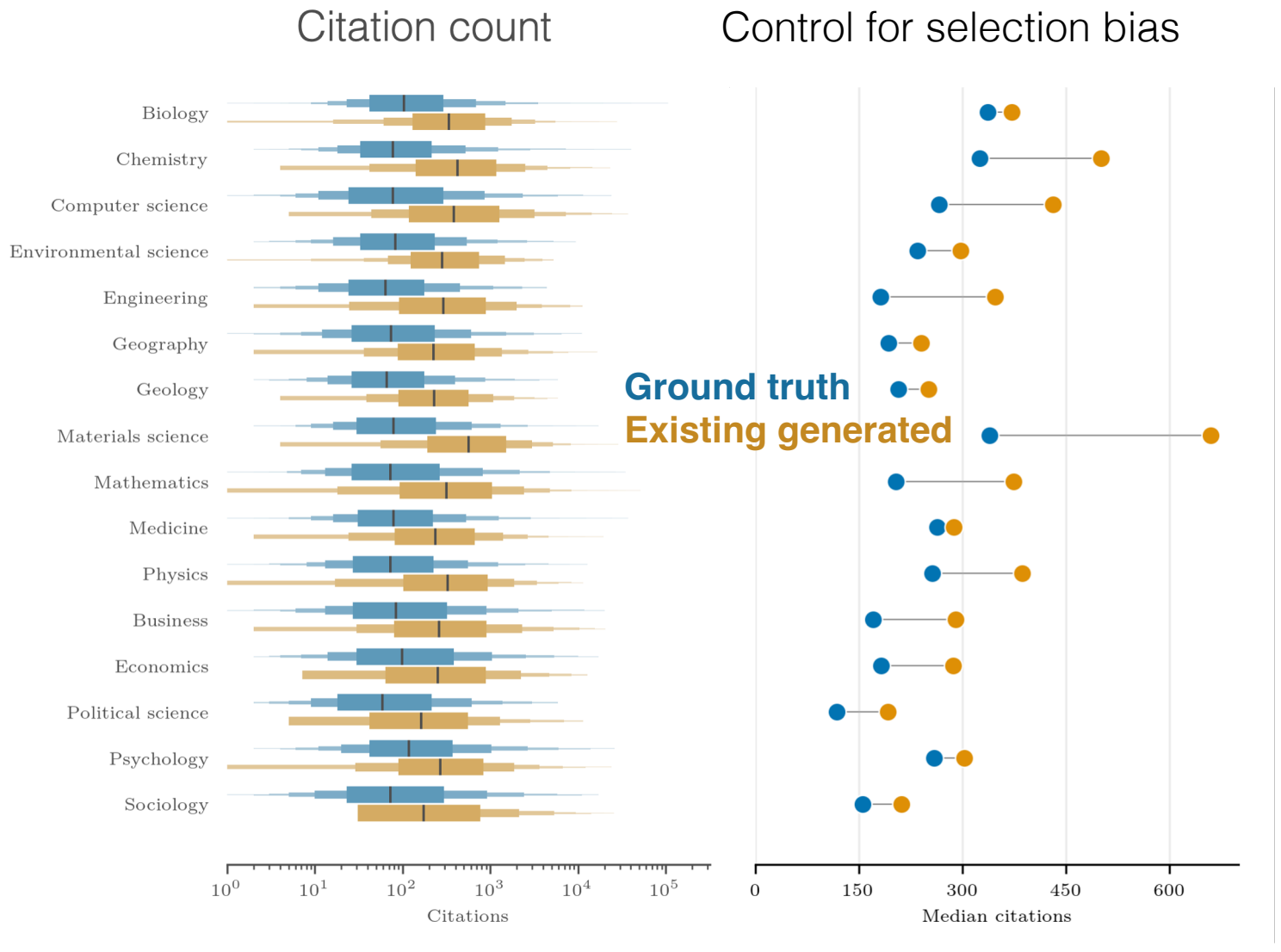

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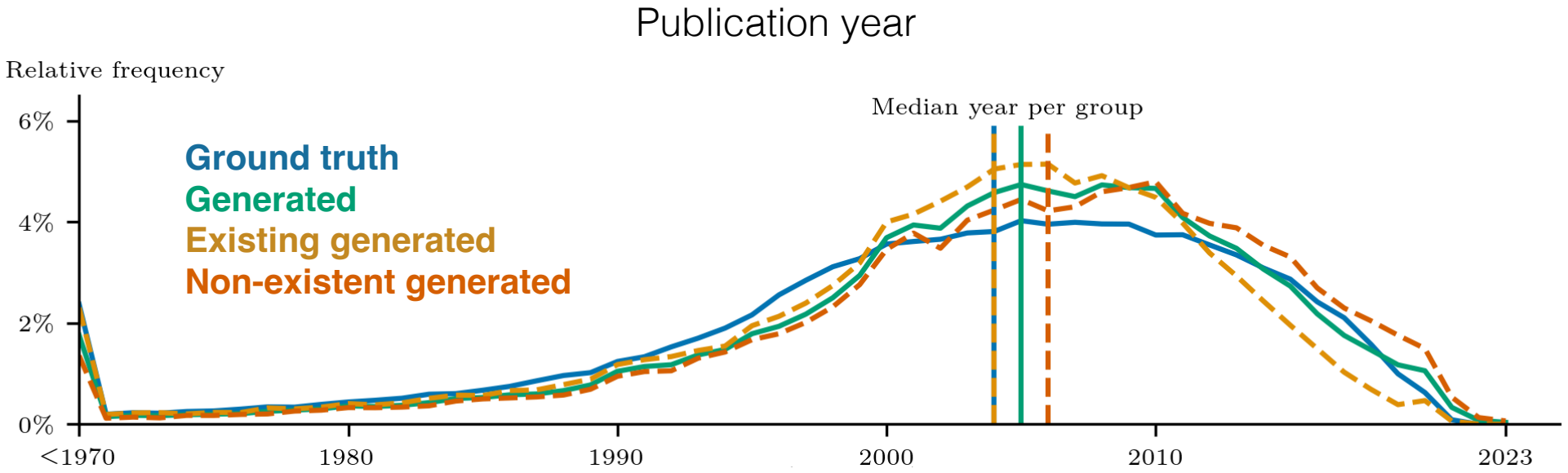

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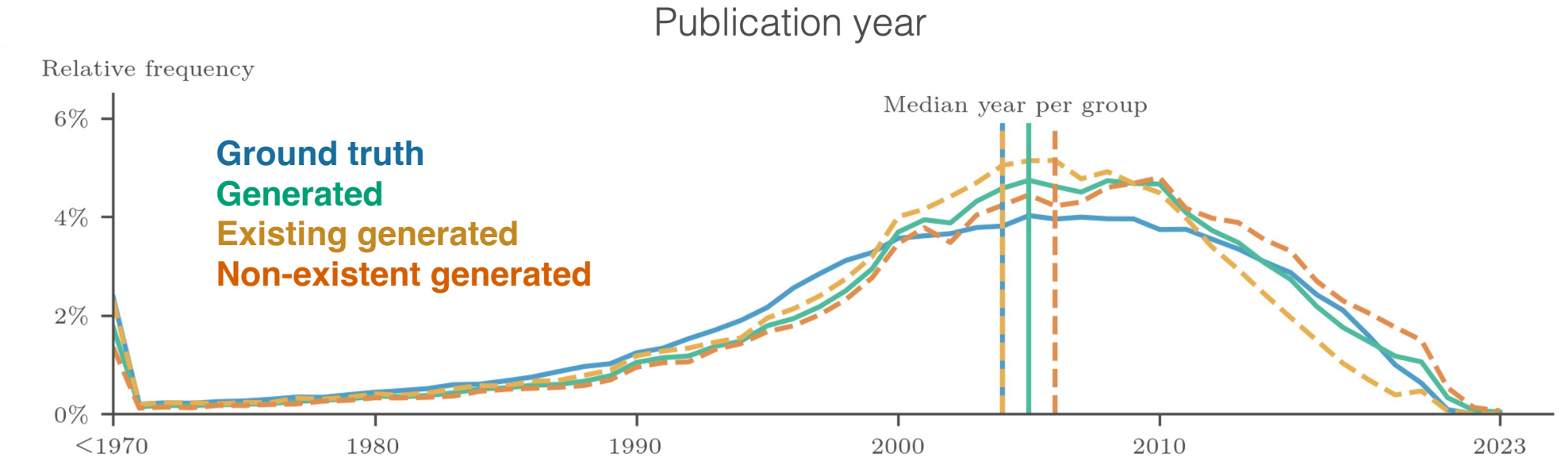

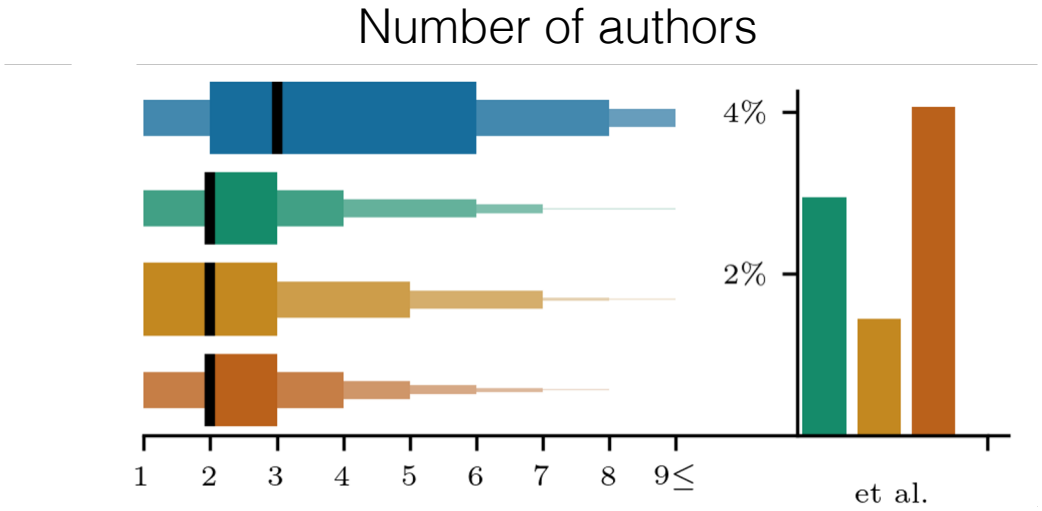

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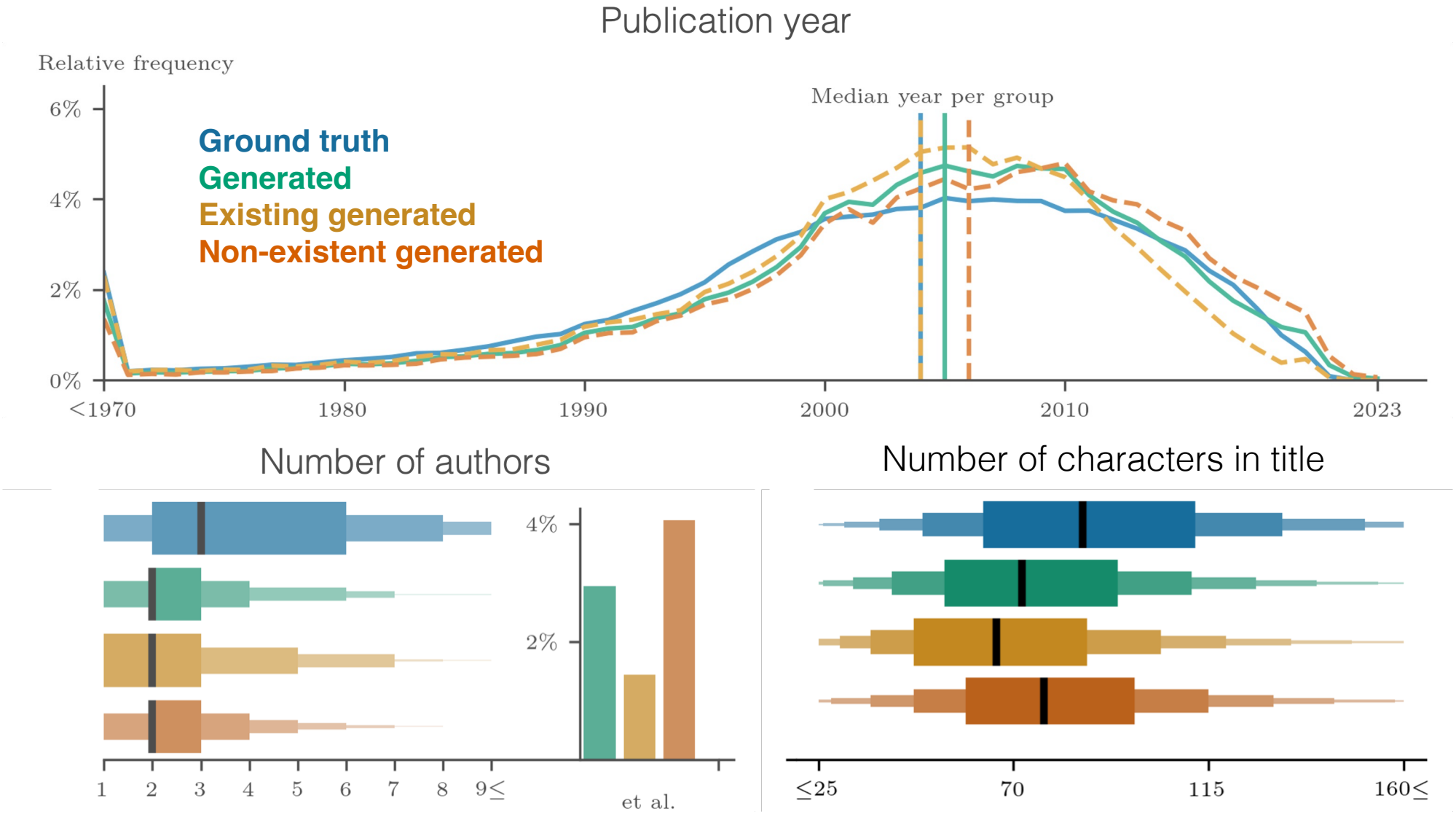
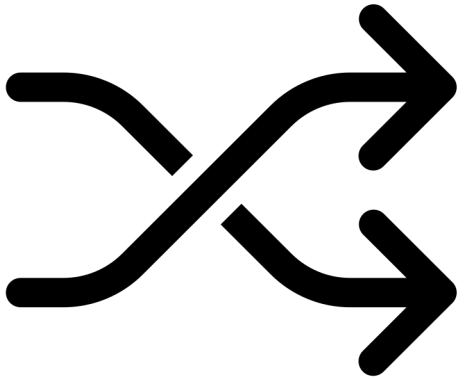


Generated References Reflect Human Citation Patterns in the OpenAI Embedding Space

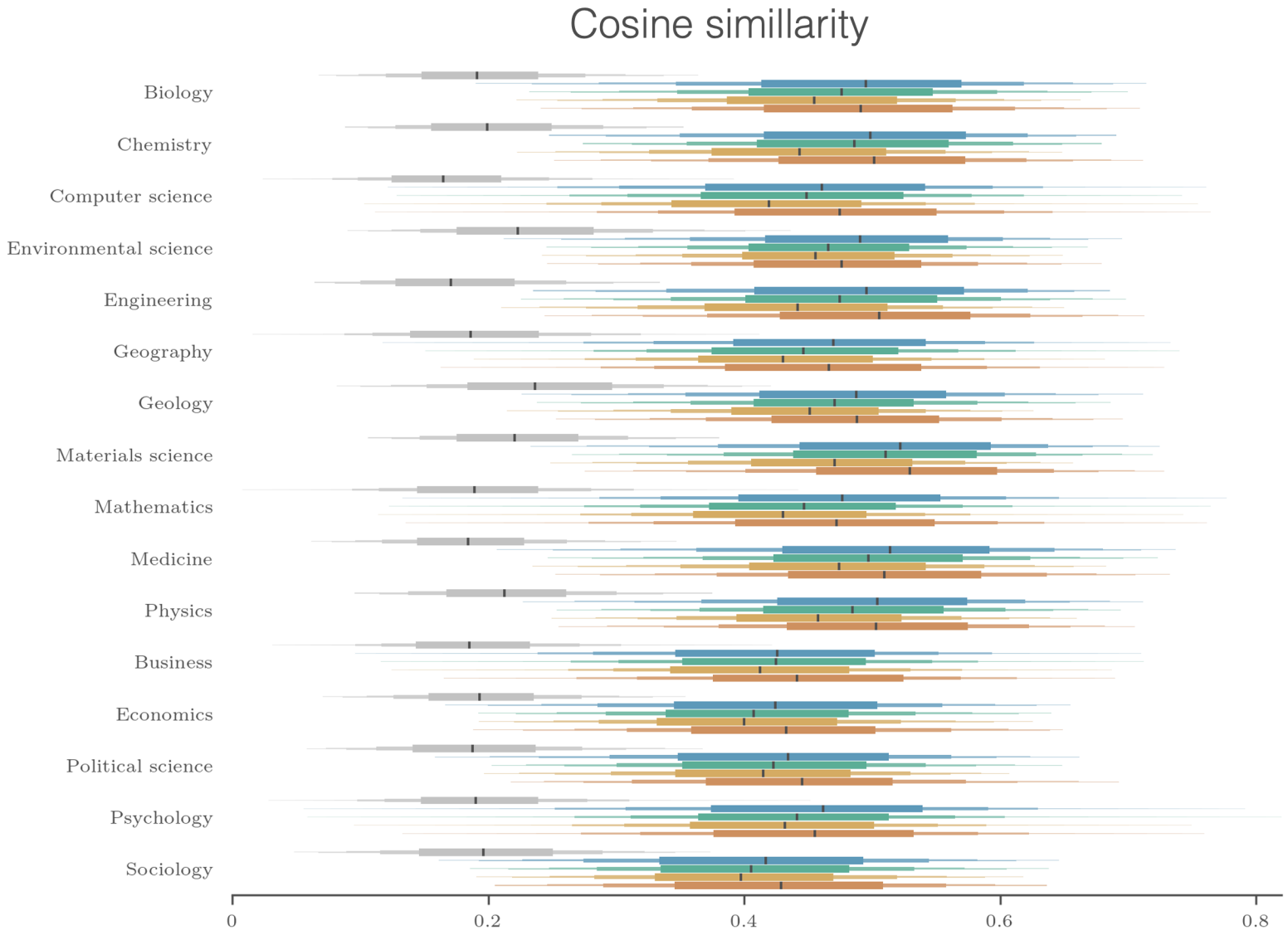
Random baseline

Ground truth references



(while fixing the field of study)

Random
Ground truth
Generated
Existing generated
Non-existent generated



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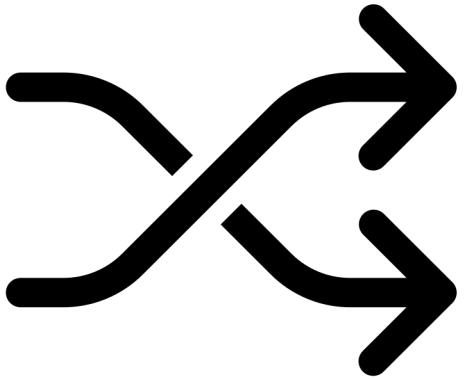

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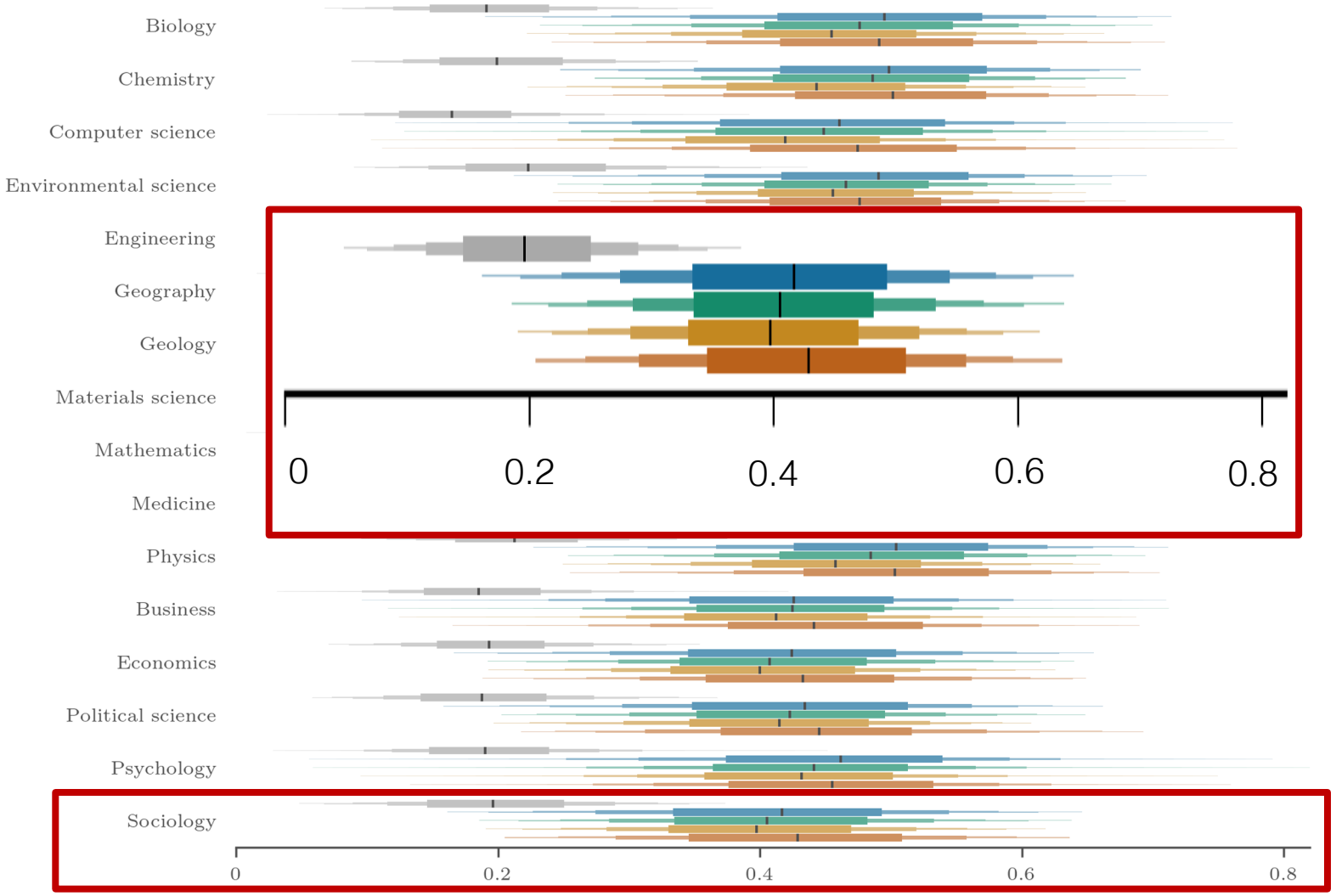
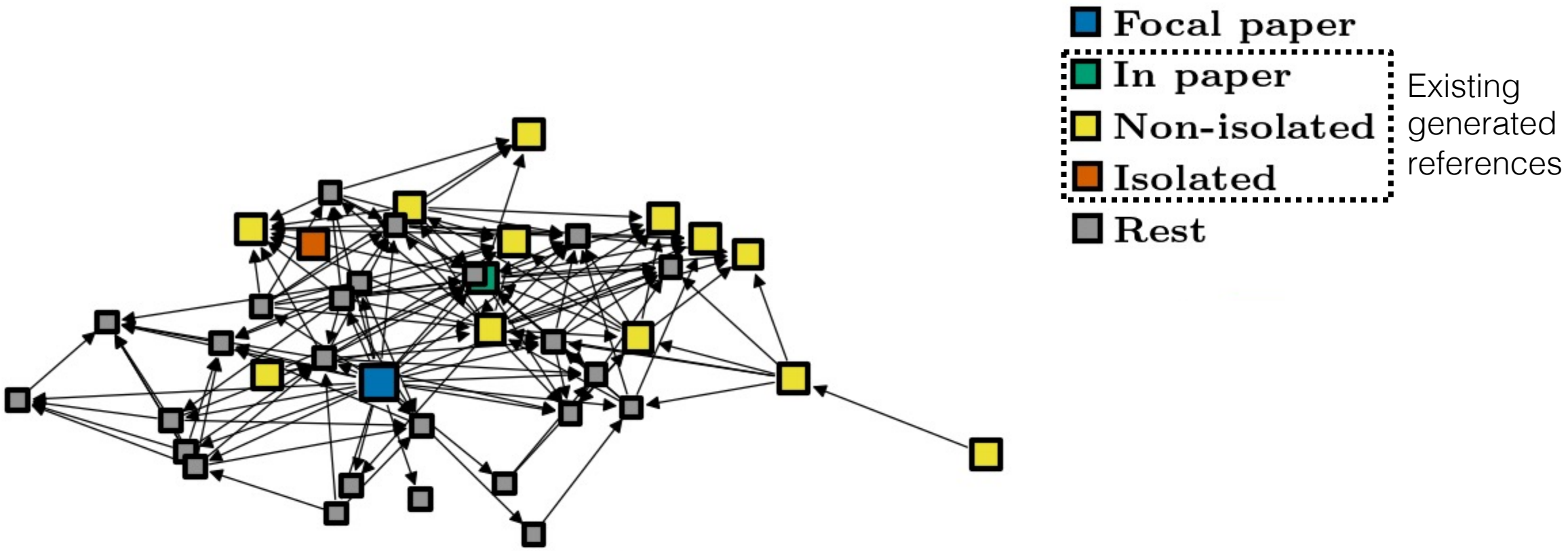
Random
Ground truth
Generated
Existing generated
Non-existent generated

Cosine simillarity



Generate References Are Well Embedded in the Local Citation Context



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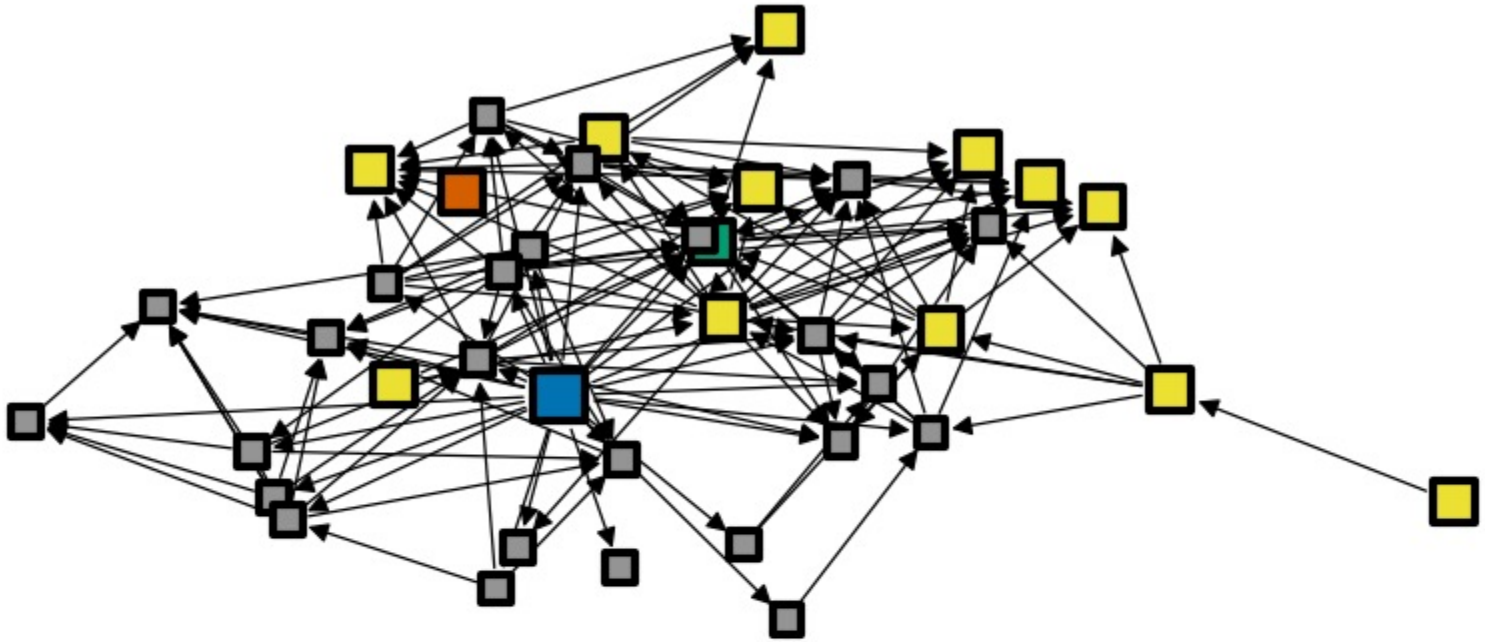
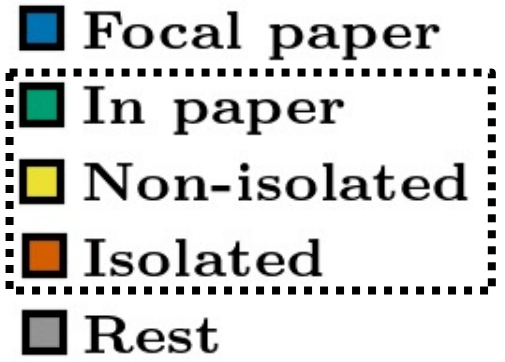
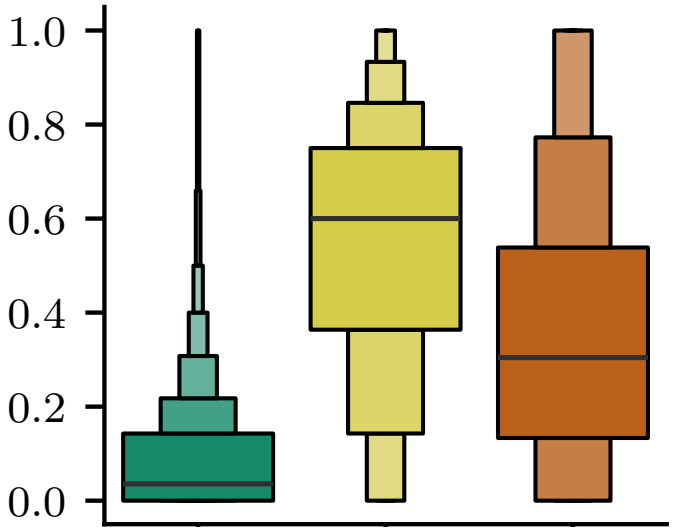




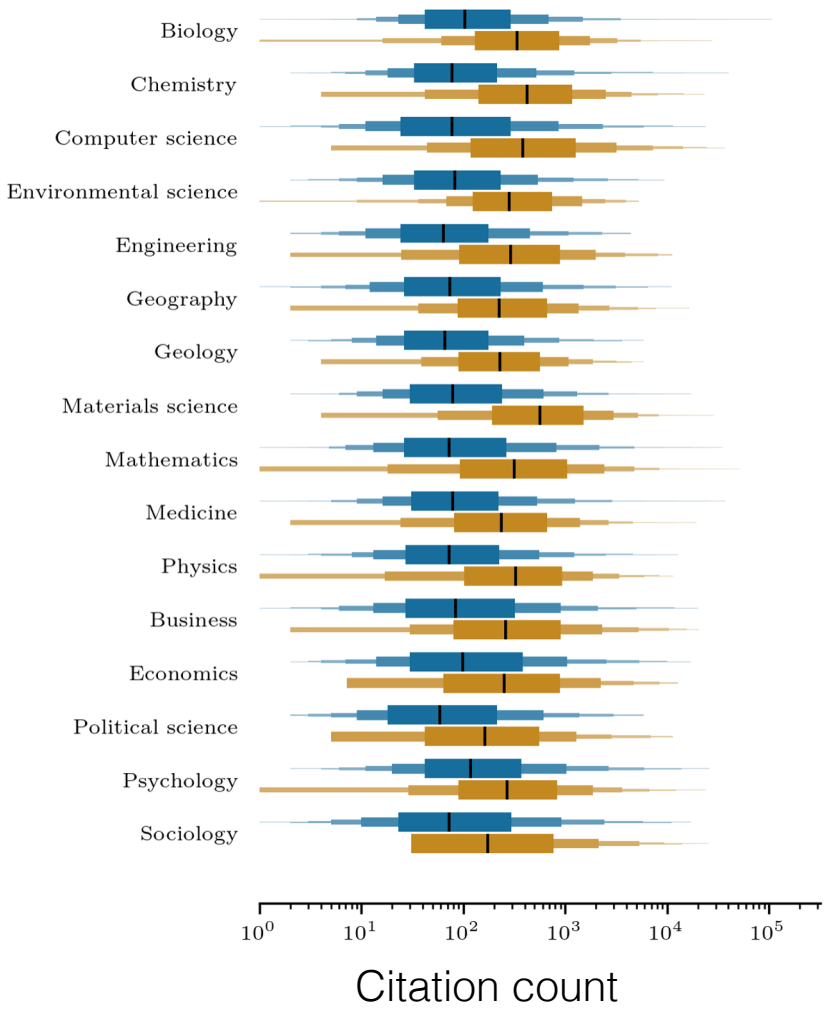
Existing generated references

Existing gen. references per focal paper

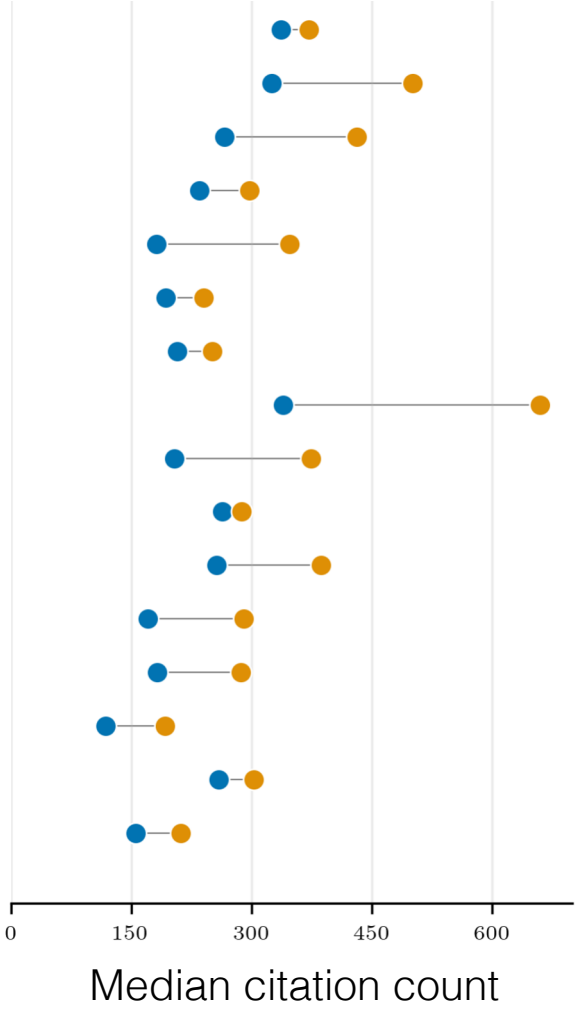


Key Takeaways

LLMs Exhibit a Heightenend Citation Bias



Even When Controlling for Selection Bias



Ground truth

Existing generated

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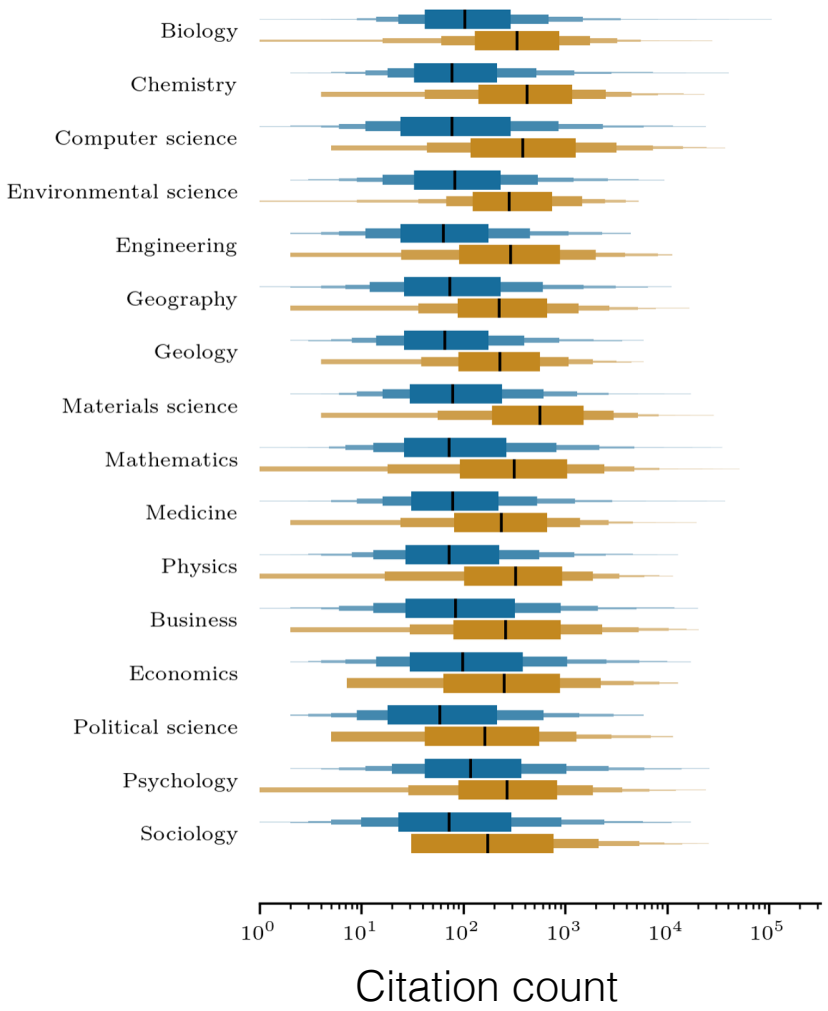

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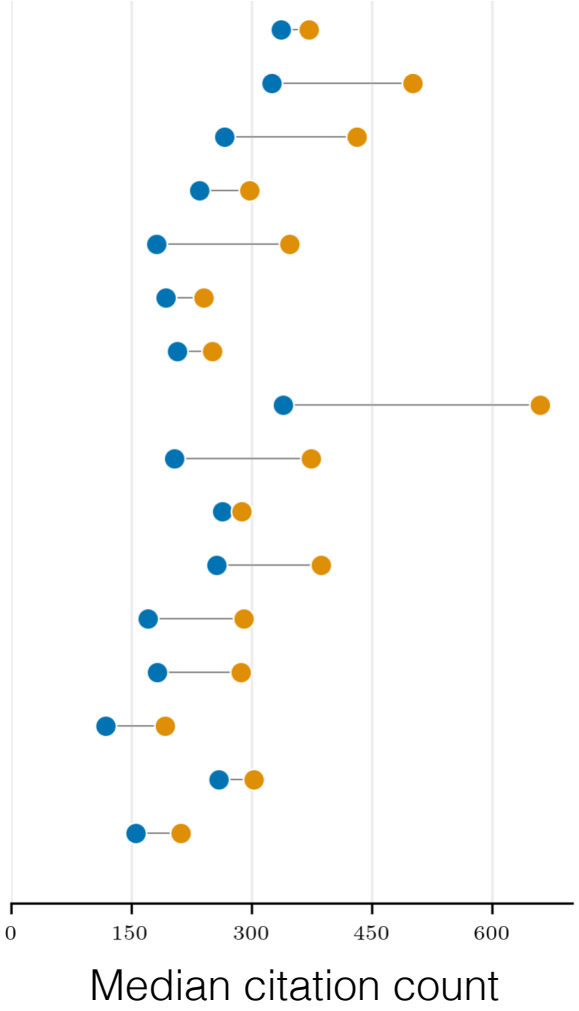
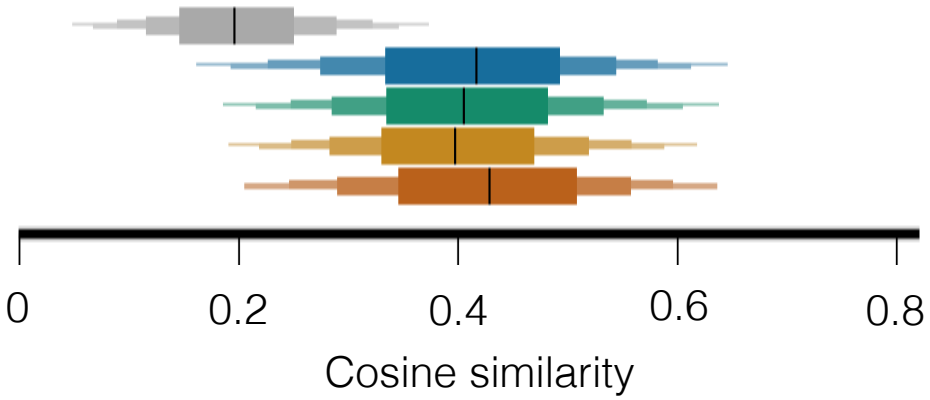


LLMs Resemble Human Citation Patterns in the OpenAI Embedding Space



Random
Ground truth
Generated
Existing generated
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Large Language Models Amplify the Matthew Effect in Scientific Research

Main paper

Related work

In-text citations for Computer Science (NAACL findings)

Graphs & embeddings (ICLR tiny paper)


Andres Algaba


Floriano Tori


Melika Mobini


Brecht Verbeken


Sylvia Wenmackers


Vincent Ginis

https://github.com/AndresAlgaba/LLMs_scientific_literature

https://zenodo.org/records/15124610

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Harvard John A. Paulson School of Engineering and Applied Sciences