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User control of search algorithms would improve science

Popular scientific search platforms use algorithms that exacerbate disparities in science. We call on platforms to allow greater user control, and we explain why this would also benefit the platforms themselves.

When scientists search for articles using platforms such as Google Scholar, Scopus and Web of Science, the results that they see are determined by search algorithms. These algorithms prioritize highly cited papers. On the one hand, this strengthens the association of these papers with corresponding keywords, which helps to surface dominant publications from prevailing disciplines. However, it also narrows exposure to alternative methods, theories or research programmes. Consequently, researchers who explore emerging topics or interdisciplinary problems face diminished chances of discovering relevant but less-cited perspectives.

These scientific 'recommender systems' shape our information environments, and amplify popular items through self-reinforcing feedback loops[1]. Items that initially gain prominence receive disproportionately greater visibility, and gain popularity simply because they are already popular — regardless of their quality or utility[2]. This inadvertently constrains individuals' potential to engage with a fuller spectrum of ideas.

Although popularity can indeed reflect quality, aid literature navigation or help to solidify shared paradigms, overreliance on popularity reduces opportunities for scientists to encounter innovative or disciplinary diverse content. This risks slowing the pace of scientific discovery, and could overly constrain the nature of those discoveries[3,4]. These dynamics are not unique to academia but also occur across various cultural and information markets, where popularity-driven recommendations regress to the mode, which stifles diverse voices and niche perspectives[5]. Recognizing these hidden costs highlights the need to rethink how search algorithms and platforms prioritize and present information.

The consequences of algorithmic narrowing for scientific progress run deep. Innovation thrives on diversity; breakthroughs often emerge from the cross-pollination of disparate ideas, the challenging of established paradigms or the application of methods from one field to another[6]. When search algorithms consistently funnel attention towards mainstream, highly cited work, they inadvertently curtail exposure to the vast 'long tail' of potentially valuable niche knowledge. This limits exploration of the intellectual ecosystem, and reduces the chances for serendipitous discovery and novel synthesis. By homogenizing the apparent landscape of ideas, such systems can dampen the pace and restrict the scope of scientific adaptation and discovery, just as low variance limits adaptation in biological evolution[7].

Beyond hindering innovation, the privileging of popularity by search algorithms exacerbates existing inequities within the scientific community. This dynamic disproportionately benefits already-prominent researchers and dominant theoretical frameworks, and creates a Matthew effect in which visibility and resources accumulate among those who are already successful[8]. Conversely, contributions from early-career scientists, researchers working outside established networks or scholars from structurally marginalized groups often struggle for initial visibility. Without the early citations needed to satisfy popularity-biased algorithms, their work might remain undiscovered and unrewarded, which perpetuates cycles of disadvantage and represents a considerable loss of talent and diverse perspectives for the entire scientific enterprise. Such inequities have always existed to some degree, but search platforms are likely to substantially amplify these structural biases.

We believe that it is the responsibility of search platforms, and particularly scientific search platforms, to mitigate these limitations by offering users explicit control over the algorithms that drive their search results. Typically, search algorithms — which are proprietary and opaque to users — blend parameters such as popularity (view or citation count), recency and relevance (keyword matches or semantic similarity) into a single ranking metric. Presently, the relative weight (importance) of each parameter is most probably applied uniformly across all users. This one-size-fits-all approach disregards differences in needs, objectives and contexts, which vary across individual researchers as well as their particular tasks. We call on scientific search platforms to:

- Empower users to directly control the weighting of core search parameters such as popularity, recency and relevance.

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BOX 1

Search in the time of LLMs

Algorithmic search is undergoing a rapid transformation driven by LLMs[9]. New tools such as Perplexity.ai and LLM 'Deep Research' features, as well as artificial-intelligence (AI)-generated summaries atop results from major search engines (such as Google), exemplify this shift, as models increasingly filter, synthesize and sometimes opaquely mediate search results. This trend raises concerns about potential homogenization, the obscuring of primary sources and the erosion of critical engagement by users presented with pre-digested summaries[10]. Although these risks are substantial (particularly in science, in which nuance and source evaluation are paramount), LLMs also present opportunities to enhance the user-directed discovery advocated in this piece.

Moving beyond simple keyword matching, an LLM-powered semantic search enables researchers to articulate complex information needs in natural language. Critically, this suggestion differs from the use of LLM-generated search results; instead, we suggest that LLMs could be used to translate user prompts into more nuanced and bespoke search queries. Strategic prompting could enable users to explicitly guide searches towards specific goals — for instance, requesting less-cited papers on a topic, seeking cross-disciplinary analogues or deliberately avoiding dominant authors or paradigms. Such capabilities could provide researchers with powerful tools to actively counteract popularity bias and explore the diverse intellectual landscape more effectively.

Ultimately, the value of harnessing LLMs to facilitate scientific discovery depends on system design choices that prioritize user agency, transparency in how results are generated, and alignment with the core scientific values of critical evaluation and intellectual diversity. It almost goes without saying that this consideration lays on top of potential concerns regarding the environmental and social costs of large AI models.

- Implement system-level features (for example, parameter defaults that reduce popularity bias or large language model (LLM)-assisted semantic search (Box 1)) to promote broader discovery.

Scholars have strong intuitions about the kinds of information they seek. Allowing scientists to adjust search parameters would empower them to tailor searches more precisely to their immediate goals, and promote results that are better aligned with their specific intellectual or practical aims. For instance, a scholar who is advancing a defence or critique of a dominant paradigm might prefer to reduce the algorithm's emphasis on popularity and instead increase the weight of semantic relevance to enable discovery of alternative approaches and counteract the homogenizing tendencies that hide marginal perspectives and stifle innovation. Researchers who can refine parameter settings dynamically will effectively produce meta-searches that increase the density of useful papers at the top of the search results.

Further, platforms themselves would benefit considerably from these steps. Current recommender systems, which are designed for general audiences and standardized preferences, systematically underserve users with niche interests. By enabling users to adjust search parameters, platforms can better support scientists' diverse disciplinary backgrounds and shifting research goals. This flexibility would increase user engagement, foster greater platform loyalty and differentiate the platforms from competitors who offer generic algorithms. The proprietary nature of search algorithms need not be compromised. Instead, platforms could provide a set of parameters to increase user control of search results. By empowering users to fine-tune results according to their immediate objectives, platforms could better support diverse scientific communities who are currently underserved by one-size-fits-all search strategies. Such user calibration would also benefit the larger scientific community by contributing to a more equitable and innovative research ecosystem.

By giving scientists direct control over search parameters — balancing popularity with relevance, recency or novelty — scientific recommender systems will increase their value to science. Researchers will be able to tailor discovery to specific needs, while systemically promoting encounters with diverse perspectives that facilitate both innovation and equity. Search algorithms have a critical role in the practice of science, and user-specific calibration is a pragmatic and necessary step for platforms that aim to better serve researchers and the scientific endeavour.

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Competing interests

The authors declare no competing interests.