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Serendipity in an algorithm-driven culture

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Algorithmic tools promise to help researchers cut through the mass of scientific literature, but serendipitous encounters with papers remain essential for scientific progress.

"It has become impossible for the average scientific worker … to keep up with the progress of his own field"[1], wrote J. D. Bernal, bemoaning the sheer quantity of scientific articles being published. Most physicists would agree. Yet Bernal was writing in 1939, prior to a post-war boom in publishing with continued exponential growth in the literature, and major shifts in technology. Nearly 90 years on, there seem to be no easy solutions to overwhelming publication numbers. The challenge remains for researchers to keep up with the latest advances and find the papers that spark new ideas.

Bernal took the view that "we need to be sure that every scientific worker … receives just that information that can be of the greatest use to him in his work and no more". Today, tools such as Web of Science, Google Scholar and newer AI-based offerings promise to fulfil his vision: rather than trawling through everything, you can simply put the right search terms or prompts to an algorithm and receive a list of papers, often sorted explicitly by 'relevance'. But most physicists have experienced the practical shortcomings of this approach. Fields of research aren't always well defined by keywords (are you looking for the 'nucleus' of an atom or of a cell?), or the most relevant terms may be too broad (pity the poor physicist who works on 'lasers').

Alternatively, you might rely explicitly on recommendations from other scientists. At times, social media has served well to enable scientists to share their work with each other — ideally in a way that lets interesting work get reposted widely without regard for how well-known the author is. But the usefulness of social media depends on network effects such as how many scientists are on the same platform and how well they're connected to each other. Furthermore, most social media platforms today are geared to keep users on the platform for as long as possible, and if the underlying code is changed to down-rate posts with links, for example, even strong networks may struggle to share papers efficiently.

All these approaches rely on an algorithm to sort search results or posts. If your main approach to searching is to look at the first few articles sorted by relevance, it is likely that what you are seeing is skewed towards recent papers with relatively higher numbers of citations. Relying on these results could exacerbate the Matthew effect, in which works that are already highly cited receive even more citations[2]. But when the algorithm is a black box to the user, it is impossible to accurately account and compensate for such effects. Especially in the case of social media, algorithms are typically driven by factors unrelated to the content of the papers, and highly visible articles may therefore not be the ones most relevant to the user's research.

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More fundamentally, Bernal's quest for the papers of "greatest use" assumes that one can know in advance what will be most useful. But breakthroughs often occur when scientists find unexpected connections — a theoretical approach that can be applied in a new subfield, for example. To make these sorts of connections, one needs to read widely. In some sense, although Bernal may not have wanted to read outside his field, he was better placed to make unexpected connections, as he would have flicked through physical copies of journals, passing over a range of articles that might have caught his eye unexpectedly. In today's algorithm-driven reading culture, there is little room for such serendipity.

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