Search a Great Leveler? Ensuring More Equitable Information Acquisition

Stephann Makri
City, University of London, UK
Stephann@city.ac.uk

Dana McKay, George Buchanan & Shanton Chang
University of Melbourne, Australia
Dana.Mckay@unimelb.edu.au;
George.Buchanan@unimelb.edu.au;
Shanton.Chang@unimelb.edu.au

Dirk Lewandowski
Hamburg University of Applied Sciences, Germany
Dirk.Lewandowski@haw-hamburg.de

Andy MacFarlane & Lynne Cole
City, University of London, UK
A.Macfarlane-1@city.ac.uk;
Lynne.Cole@city.ac.uk

Sanne Vrijenhoek
University of Amsterdam, Netherlands
S.Vrijenhoek@uva.nl

Andrés Ferraro
Universitat Pompeu Fabra, Barcelona, Spain
Andres.Ferraro@upf.edu

ABSTRACT

The ubiquitous search box promised to democratize knowledge access by making information universally accessible. But while many search engines cater well for certain user groups, information tasks and content types, they cater poorly for others. Poorly-served users include those with certain types of impairment (e.g. dyslexia), and weakly-supported tasks include highly exploratory goals, where it can be difficult to express information needed as a query. Furthermore, the overdominance of search functionality in many information environments has restricted support for other important forms of information acquisition, such as serendipitous information encountering and creative 'inspiration hunting.' Search results and recommendations can also promote certain types of content due to algorithmic bias. Rather than act as a great leveler by making information acquisition effective, efficient and enjoyable for all, search engines often unfairly favor some types of user, task or content over others. In short, search is not always equitable. This panel discussion will elucidate the inequity of search as an information acquisition paradigm from multiple perspectives and propose design principles to ensure more equitable information acquisition.

KEYWORDS

Information equity, information acquisition, search, design

PANEL MOTIVATION

The ubiquitous search box promised to democratize knowledge access by making information universally accessible. While early research focused on the ability of certain groups to gain access to information on the Web; the 'digital divide' (DiMaggio & Hargittai, 2001), researchers promptly identified the issue of information inequity. For example, it has been argued digital technologies *"have helped to exacerbate existing differences in information access and use, and may even have fostered new types of barriers"* (Lievrouw & Farb, 2003, p.499). This applies especially to search technologies; although mainstream search engines cater well for certain user groups, information tasks and content types, they cater poorly for others. For example, users with cognitive or communication impairments (Kerkmann & Lewandowski, 2012; MacFarlane et al., 2012), or lower education levels obtain inferior results (Hargittai, 2006). Similarly, highly exploratory tasks (where it can be difficult to express information needed in the form of a query) are not as well-supported as targeted forms of search, e.g. known-item search or fact-checking (Rose & Levinson, 2004).

This argument extends to search more generally, as a paradigm for information acquisition: search works better in and is therefore better suited to some situations than others (Martin & Quan-Haase, 2017). Most notably, search is better suited to information tasks where the expected format of the information is known (e.g. weather forecasts, a particular scholarly paper, news on a certain topic). The challenge of finding 'unknown unknowns'—where a person does not know what they hope to find was highlighted by Borgman (1996): Information retrieval is difficult to facilitate because it requires describing information you do not yet have. It is also known that requiring users to search for information disadvantages those with less knowledge of a field (Marchionini, 1997) and that marginalized groups prefer people to internet as information sources for reasons of convenience and access (Agosto & Hughes-Hassell, 2005).

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Despite search being better suited to certain situations, there has been much research focus on search as compared with other important forms of information acquisition (Baeza-Yates & Ribeiro-Neto, 2011). Also the overdominance of search functionality in many information environments has restricted support for other important forms of information acquisition, such as serendipitous information encountering (Erdelez & Makri, 2020) and creative 'inspiration hunting.' (McKay et al., 2020). Furthermore, search results and recommendations has also been found to unfairly favor some types of content due to algorithmic bias (Lewandowski, 2017; Ferraro et al., 2021).

Rather than acting as a great leveler by making information acquisition effective, efficient and enjoyable for all, search is not always equitable (Lewandowski, 2017). We frame this issue as *inequity* rather than inequality as it extends beyond unequal information distribution; it involves *unfairly favoring some types of user, task or content over others*. We consider this favoring not only unequal, but also *unfair* and therefore *inequitable*. It has also been argued that equity is more attainable than 'equal' information distribution, making it a suitable framing (Lievrouw & Farb, 2003).

This panel will elucidate the inequity of search as an information acquisition paradigm from multiple user group, task and content perspectives. The nine diverse panelists will bring a range of viewpoints on the limitations of contemporary search technologies. Some will focus on specific user groups, others on specific information task types and others on biases for and against specific types of content. All will present arguments, based on their own research, centered on how and why search unfairly favors some types of users, tasks or content types. As well as highlighting inequity, the discussion will also take steps towards ensuring more equitable information acquisition by proposing design principles aimed at reducing information inequity in search and digital information environments more broadly.

We now outline the positions of each panelist. Each position aims to elucidate the inequity of search as an information acquisition paradigm by explaining how and why search is inequitable for particular types of user, task or content:

THE USER PERSPECTIVE: SEARCH UNFAIRLY FAVORS SOME TYPES OF USERS

Search favors users who do not have certain impairments

Dr. Andrew MacFarlane: Search engines focus on the needs of the general population rather than those of users with impairments. The widespread use of machine learning algorithms only enhances this focus. However, users with impairments often have very different needs that are not well-served by search interfaces or ranking mechanisms (Berget & MacFarlane, 2019). Search may disadvantage those with a variety of impairments, including cognitive (e.g. users with specific learning difficulties such as dyslexia, ADHD or autism), sensory (visual or hearing) and motor (physical impairments). For example, there is evidence visually impaired searchers formulate more expressive queries to reduce the overhead of inspecting results, as this can be time-consuming and effortful due to the linear nature of screen readers (Sahib et al., 2012). It is not yet known how best to support searchers with different impairments, but different design interventions and accessible technologies are likely needed for different impairments (and perhaps even for different difficulties faced by searchers with the same impairment). We are currently investigating how best to support searchers with aphasia—a communication impairment often the result of a stroke that can lead to difficulties in formulating or comprehending language—by understanding search difficulties they face and workarounds they use.

Lynne Cole: As an example of a specific learning impairment, search disadvantages people with dyslexia due to differences in how they process information (Reid, 2016). It relies heavily on cognitive skills people with dyslexia may find problematic, such as reading and spelling (Morris et al., 2018). Some features such as voice search (Morris et al., 2018) and visual icons (Berget et al., 2016) help alleviate these difficulties. However, there are additional (and less researched) cognitive aspects of dyslexia that can further exacerbate the inequity of search; people with dyslexia can find vocabulary recall from long term memory difficult (Snowling, 2000), hence, communicating information needs through query formulation an editing can present barriers. Dyslexia can also create issues with working memory (Cole, et al., 2020); during search working memory capacity may be fully engaged with reading, interpreting and evaluating information to the extent the information need or search queries used are forgotten. This suggests the need for dyslexia-specific search support to aid query formulation and reformulation and memory aids, such as the option to create placeholders or provide reminders of previous queries entered and results or documents examined.

Search favors users who submit English-language queries

***Prof. Shanton Chang*:** Global search engines do not usually cater to non-English searches (Bar-Ilan & Gutman, 2005), resulting in the creation of language-specialist engines such as Qwant (French), Baidu (Chinese) and Yandex (Russian). Mainstream search engines unfairly favoring English over other language queries presents an important challenge; many countries are multicultural and multilingual, so people may use different search engines within the same geo-socio-political region. For example, COVID-19 highlighted that migrants who live in English dominant

countries do not always access English resources; international students in Australia, for example, continued to use own-language search engines, precluding them from receiving crucial pandemic-related information while in their host country (Chang et al., 2020), resulting in language-based inequity. This inequity is being further entrenched by English-dominant machine learning techniques such as natural language processing (Névéol et al., 2018). It is essential global search engines cater better for non-English queries to curb the widening of the information access gap.

THE TASK PERSPECTIVE: SEARCH UNFAIRLY FAVORS SOME TYPES OF TASKS

Search favors known-item and fact-checking information tasks over exploratory tasks

Dr. Dana Mckay: A fundamental driver of search engines has been to provide a single (or restricted set of) 'correct answers' to searchers' queries, resulting in precision—providing *only* relevant documents—as a longstanding measure of quality (Baeza-Yates & Ribeiro-Neto, 2011). Search has moved on from focusing solely on precision and recall though, incorporating features such as knowledge-graph-based semantic linking that may better support exploratory search—searching to learn, without looking for anything specific (White & Roth, 2009). There are also new success measures, including novelty and diversity (Clarke et al., 2008). Despite these developments, search still favors highly directed tasks. This is not the case for browsing, which has two fundamental advantages over search; the ability to explore without having to know anything about a collection and the ability to readily broaden possible selection options simply by moving around (McKay et al., 2018). While improvements to search may eventually support effective result exploration, the limitation of needing to formulate queries to produce results remains. The predominant focus on search to the exclusion of other forms of information acquisition has disadvantaged new entrants to a field, explorers, and those who are simply stumped (Marchionini 1997; McKay et al., 2020). It is past time we stop privileging those who know what they are looking for and better support those less sure, or who just want to explore.

Search favors active information seeking over passive information encountering

Dr. Stephann Makri: Search also favors active information seeking over passive information encountering. Unlike expressly seeking information, encountering involves information seeking *you*; serendipitous information encounters can happen when looking for information on a different topic, when not looking for any particular information, or not looking for information at all (Erdelez & Makri, 2020). Passive encountering has traditionally been under-researched as compared to active forms of acquisition, particularly search, but is increasingly being recognised as an important means of finding information and of creating new knowledge (Makri et al., 2019). While this form of serendipitous information acquisition often occurs during active search, this is as an unintended byproduct (Makri et al., 2014). Search environments typically support passive information encountering indirectly and incidentally; as an unexpected but often welcome distraction to the search at hand (Makri & Buckley, 2020), but a distraction nonetheless. Although recommender systems, including those that drive personalized search, now value search result novelty and diversity as well as relevance (Castelis et al.,2015), search is still better suited to active seeking than passive encountering. Perhaps search favors active seeking due to its intrinsic nature; searchers must express what they hope to find when formulating queries and therefore must have some idea of what they expect to find. On the other hand, encounterers do not have this expectation and if they hope at all, it is only to somehow be pleasantly surprised.

Search favors tasks that involve finding existing knowledge over creating new knowledge

Dr. George Buchanan: Search supports finding existing knowledge well, but creating new knowledge less well. A key type of knowledge creation occurs as an outcome of creative problem-solving. This involves generating novel solutions to which no existing 'off-the-shelf' solution exists, or where established methods cannot be used. Information acquisition can play a key role in this type of knowledge creation (Maiden et al, 2018), for example by facilitating 'inspiration hunting' (McKay et al., 2020). However, this is difficult to achieve in search environments. For example, architectural students had to click on image search thumbnails of inspirational building designs and view the image in the context of the surrounding Webpage text to gain sufficient context to decide whether and how to incorporate aspects of the designs into their own novel design projects (Makri & Warwick, 2010). As search engines rarely provide direct creativity support (Maiden et al, 2018), search favors information tasks that involve finding existing knowledge over creating new knowledge. Search has a bias towards presenting topically similar results (Baeza-Yates & Raghavan, 2010). This reduces the chances of passively encountering a novel idea that can provide the kernel of a creative solution (Maiden et al., 2018). In contrast, browsing better facilitates rapidly seeding more ideas. This is often more fruitful than deeply investigating a few. The pursuit of ever higher levels of relevance has further exacerbated the inequity of search when it comes to providing the diversity needed to fuel creative inspiration.

THE CONTENT PERSPECTIVE: SEARCH UNFAIRLY FAVORS SOME TYPES OF CONTENT

Search results and recommendations can be biased

Prof. Dirk Lewandowski: Search engine bias involves a predominant representation of certain aspects in the (top) search results, resulting in some types of content being unfairly favored over others. Types of empirically identified search engine bias include gender (Otterbacher, et al., 2017), race (Noble, 2018) and commercial intent (Lewandowski & Sünkler, 2019). To address this bias, it is paramount to better understand how results pages are generated and how (plus to what extent) key stakeholder groups influence these results. There are five such groups (Schultheiß & Lewandowski, 2021); *search engine providers* determine ranking through algorithms, but may unfairly promote their own offerings (European Commission, 2017); *content providers* influence search results not only through what they produce, but also potentially by promoting their own content using *search engine optimization (SEO)* and *paid search marketing (PSM)*. These, as professions in their own right, form separate groups. Also, *users* influence result rankings through interaction with results, which can potentially be gamed. Understanding and quantifying stakeholder influences on search results is paramount for shaping search engines to be as fair as possible.

Andrés Ferraro: Recommender systems are intended to provide a helping hand in identifying interesting or useful information, but can be inequitable by unfairly favoring some types of content. As noted earlier, there are many possible types of search bias. These affect recommender systems too. In the music domain, a particularly concerning bias type is *gender bias*; music recommenders are more likely to promote music by male than female artists, putting (on average) male artists in the first recommendation position and the first female artist in the seventh or eighth position (Ferraro et al., 2021). This introduces an exposure bias, as recommendations lower in the list are less likely to be viewed. This, in turn, exacerbates existing music industry inequalities; women represent < 20% of registered composers and songwriters, while 98% of works performed by major orchestras are by male composers (Smith et al., 2018). To address this inequity, Ferraro et al. (2021) proposed a simple approach to provide more exposure to female artists by re-ranking recommendations and moving male artists a specified number of positions downwards.

Sanne Vrijenhoeck: In an online news context, recommender bias can influence how users see the world and can therefore potentially undermine democratic values (Helberger, 2019). Current news recommenders often focus on measuring increases in user engagement, such as through click-rates (Beel et al., 2013), rather than measuring the user's longer-term interest in a diverse news diet. This may unduly promote sensationalist content, the viewpoint of the 'majority,' or content already in line with the user's own opinions; a 'filter bubble' effect (Pariser, 2011). When developing equitable news recommenders, these should not only be evaluated based on traditional metrics such as accuracy and diversity, but also based on the normative notion of diversity (Vrijenhoeck et al., 2021). Doing this requires translation of abstract notions such as 'tolerance' into something computational: a likely painful process that will require strong inter-disciplinary collaboration, but necessary for news recommenders to become more equitable.

DESIGN PRINCIPLES FOR ENSURING MORE EQUITABLE INFORMATION ACQUISITION

As well as raising awareness of issues around the inequity of search as an information acquisition paradigm, this discussion will take steps towards ensuring more equitable information acquisition. All panelists and attendees will be asked to reflect on broad design principles and more specific design guidelines for reducing inequity in search and digital information environments more broadly, such as more closely integrating search and browse functionality and providing explicit support for meaning-making, knowledge scaffolding and information (re)organization.

PANEL FORMAT AND DIVERSITY

This 90-minute panel will follow a highly interactive format. We will begin by spending 5 mins. introducing the panelists and the overarching argument that search is an inequitable information acquisition paradigm. Then each panelist will spend 3 mins. presenting their specific position on how and why search in inequitable for a particular type of user, task or content. After each panelist position statement, 4 additional mins. will be dedicated to questions or comments from attendees. Attendees will be particularly encouraged to present counter arguments on search equitability to facilitate lively discussion and debate. The remaining 20 mins. (approx.) will be dedicated to synthesis, remaining questions and discussion on how to design more equitable information environments. This discussion will follow a 'fishbowl' format, where attendees will be encouraged to 'jump in' to the discussion one at a time, encouraging broader participation and interactivity. Backchannel debate via chat will also be encouraged and issues raised and questions asked fed into the live discussion. We will also provide an *asynchronous* chat channel to facilitate discussion with people who watch the recording. The panel includes representation from a diverse range of academics and reflects the following types of diversity: gender, ethnic, cultural, linguistic, sexuality, disability, geographical, and career stage. The panel also represents a diversity of perspectives on ensuring more equitable information acquisition.

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Author/s:
Makri, S;McKay, D;Buchanan, G;Chang, S;Lewandowski, D;MacFarlane, A;Cole, L;Vrijenhoek, S;Ferraro, A

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