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AI VS. EXPERT RESPONSES: A COMPARATIVE STUDY OF NUTRITION INFORMATION FOR YOUTH

Annotation. *Search engines have become essential gateways to information in the modern digital world for youth. They structure and mediate student users' access to knowledge, ensuring relevance and accessibility across disciplines. This paper examines the role of search engines in organizing the vast information space of the Internet, their underlying algorithms (particularly PageRank), and empirical studies*

comparing search accuracy and response time among systems such as Google, Bing, and Yahoo. We also explore user trust, behavioral patterns, and the development of digital libraries as complementary tools for academic information retrieval. The results highlight the dominance of Google in both speed and precision, while emphasizing the importance of cultural and contextual factors in search behavior.

Key words: *Search engines, PageRank, information retrieval, user behavior, Google, digital libraries, ranking algorithms.*

Анотація. *Пошукові системи стали незамінними воротами до інформації в сучасному цифровому світі для молоді. Вони структурують і опосередковують доступ студентів-користувачів до знань, забезпечуючи релевантність і доступність у різних галузях. У статті розглядається роль пошукових систем в організації величезного інформаційного простору Інтернету, їхні базові алгоритми (зокрема PageRank), а також емпіричні дослідження, що порівнюють точність пошуку та швидкість відгуку між такими системами, як Google, Bing і Yahoo. Нами досліджується довіра користувачів, поведінкові моделі та розвиток цифрових бібліотек як додаткових інструментів для академічного пошуку інформації. Результати підкреслюють домінування Google як у швидкості, так і в точності, водночас акцентуючи на важливості культурних і контекстуальних чинників у поведінці користувачів під час пошуку.*

Ключові слова: *пошукові системи, PageRank, пошук інформації, поведінка користувачів, Google, цифрові бібліотеки, алгоритми ранжування.*

Introductions. Today, search engines act as the main «gateways» to information in the digital world. They ensure access to knowledge across various domains, shaping the informational landscape of contemporary society. According to Google, in 2020 the system processed approximately 6.9 billion search queries per day [1], while the average user visited the site about 18 times daily [2]. Although Google remains

dominant, several other engines compete in terms of accuracy and search speed. The World Wide Web is one of the largest information sources. As of 2021, there were over 4,2 billion active web pages online [1]. The growing data volume complicates the task of identifying relevant information. A typical search engine architecture includes four main stages: *Crawler → Indexing → Index → Search*, which collect, structure, and deliver information to users [1]. Internet search has become an integral part of everyday life, allowing rapid integration of data from multiple sources. In the study by Edosomwan and Edosomwan [3], the authors empirically evaluated the accuracy and response speed of various systems. Their findings confirmed that users rely heavily on the top-ranked search results, expecting high relevance.

According to Urman and Makhortykh [4], most users trust search engines, as demonstrated in surveys conducted in Germany and Switzerland. The authors observed contextual differences in search behavior patterns related to age, gender, and cultural background. Alongside general-purpose engines, digital libraries have expanded rapidly, providing access to large data collections through advanced technologies [5]. One prominent example is Google Scholar, which has become an integral component of academic library systems [6]. Academic search engines such as *Microsoft Academic* and *Baidu Scholar* provide quick access to scholarly materials, often bypassing traditional publishers [7]. In their comparative analysis, Edosomwan and Edosomwan [3] examined seven search engines: Yahoo, Google, Gigablast, AlltheWeb, Zworks, AltaVista, and Bing. Their objective was to assess search algorithms using ten queries classified by topic and complexity. The researchers tested queries such as «What is data mining?» and «Neural network», as well as logical (AND/OR) and natural-language searches.

The aim of this article is to evaluate and compare the performance of major search engines in terms of accuracy and response time, using standardized queries and controlled testing conditions. Additionally, the study seeks to examine the effectiveness

of ranking algorithms—particularly PageRank—in enhancing search precision and determining the relevance of web pages based on link structure and quality.

For each query, the top ten results were analyzed to represent the most relevant outputs. Each query was executed across all systems within a 30-minute interval to minimize bias from index updates. Response time was defined as the period between query submission and result display, with an average computed for each system. Accuracy was calculated as the proportion of relevant results among the first ten. For instance, if five of ten results matched the expected content, the precision value was 0.5. The results revealed that Google outperformed other systems in both accuracy and response time, followed by MSN/Bing, while Gigablast and AlltheWeb performed the worst [3].

To improve search accuracy, numerous ranking algorithms have been developed, the most influential being PageRank**,** which underpins Google's success [2]. The idea is to evaluate a web page's importance based on the number and quality of inbound links. The PageRank formula is expressed as follows:

$$PR(u)=\sum_{v \in B_u} \frac{PR(v)}{L(v)}$$

where PR(u) is the rank of page *u***,** Bu is the set of pages linking to *u*, and L(v) represents the number of outgoing links from page *v*.

Each algorithm has its own strengths and limitations. An effective ranking method should be precise, stable, transparent, and compatible with global web standards. It must adapt to the dynamic nature of the Internet, where billions of new pages are created each year, and users expect accurate results within milliseconds. Modern ranking systems thus combine classical link-based algorithms such as PageRank with machine learning models that analyze contextual relevance, semantic similarity, and user interaction patterns. Google uses around 200 ranking factors, including keywords in titles, URL structure, link content, inter-page relationships, and domain authority. In addition,

factors such as page loading speed, mobile compatibility, and content freshness have become increasingly important as user behavior shifts toward mobile devices.

Research results. Beyond PageRank, Google's algorithm now incorporates natural-language processing (NLP) models such as BERT and MUM, which help interpret search intent rather than just literal keyword matching. This semantic analysis allows the engine to distinguish between informational, navigational, and transactional queries, providing results that align more closely with user needs. For example, a query like «how to plant tomatoes indoors» triggers not only gardening guides but also video tutorials, regional climate data, and visual images — evidence of multimodal search optimization. By contrast, simpler ranking models used by smaller engines often rely primarily on keyword frequency and backlink quantity, which can lead to less relevant or even misleading results.

Another emerging dimension is the ethical evaluation of algorithms. Because ranking systems influence what information people see first, they carry a subtle yet powerful impact on knowledge formation and public opinion. Transparency in ranking criteria, therefore, becomes crucial. Researchers argue that «algorithmic opacity» may reproduce bias, privileging certain sites or viewpoints over others. To counteract this, leading search engines have introduced quality-assessment guidelines and human-review teams that monitor algorithmic fairness and prevent manipulation through artificial link networks or «black-hat SEO» practices.

At the same time, personalization adds both opportunities and risks. By tracking user preferences, location, and previous searches, algorithms can tailor results to individual contexts, increasing efficiency. However, this personalization can also produce so-called filter bubbles, in which users are exposed primarily to content confirming their prior beliefs. Hence, search engine optimization (SEO) and algorithm design must balance personalization with diversity, ensuring that information retrieval remains both relevant and pluralistic.

Over 85% of clicks are concentrated in the top five positions. These statistics illustrate the disproportionate attention given to high-ranking outcomes, making the first few search positions extremely valuable for visibility, marketing, and information dissemination. For example, 52,5% of all clicks in Google and 55,13% in Bing go to the first-ranked result. Urman and Makhortykh [5] found that users most frequently click on the top results. In Google, 97,11% of all clicks occur on the first page, while in Bing this figure reaches 99,49%.

This «first-page effect» also highlights the psychological dimension of online search. Users tend to equate ranking with credibility, assuming that top results are more authoritative. Cognitive research suggests that individuals often make quick judgments within seconds of scanning a results page, focusing primarily on titles and short snippets. As a result, even small changes in snippet text or meta descriptions can significantly alter click-through rates. Search engines, aware of this behavioral tendency, continuously refine their ranking interfaces to encourage user engagement and satisfaction.

The well known, regional differences were also observed: users in Switzerland tend to select higher-ranked results (average position 2,49) than those in Germany (average 3,13). This indicates that even in countries with advanced digital infrastructures, user behavior varies significantly. Cultural and linguistic factors partly explain these variations. In multilingual contexts like Switzerland, users may compare results in different languages, sometimes scrolling beyond the top rankings to find more linguistically relevant sources. In contrast, German users—operating within a more linguistically homogeneous environment—tend to click within the first few results, demonstrating a higher level of trust in algorithmic ranking.

Moreover, socioeconomic factors shape search practices. In regions with widespread digital literacy and high broadband access, users are more likely to evaluate multiple sources and cross-check information before making decisions. Conversely, in

areas where access is limited or where users rely primarily on mobile devices, quick, surface-level interactions prevail. This reinforces the importance of optimizing search systems for diverse technological contexts.

User behavior studies also reveal generational differences. Younger users, often referred to as «digital natives», tend to perform multitasking searches and use voice assistants such as Google Assistant, Siri, or Alexa. These tools interpret natural speech patterns, requiring search engines to further refine semantic processing and speech recognition accuracy. Older generations, however, display a preference for traditional text-based searches and more cautious navigation, often using advanced filters and Boolean operators. Consequently, ranking algorithms must accommodate multiple input styles and presentation formats to maintain accessibility for all age groups.

Another key trend is the rise of multimodal search, which combines text, voice, and image queries. Visual search tools like Google Lens or Bing Visual Search integrate computer vision techniques that identify objects, landmarks, or products directly from photos. This expansion of search modalities demonstrates how ranking algorithms are evolving beyond purely textual analysis into integrated frameworks that process complex signals from multiple sources. Such innovations not only improve relevance but also redefine what «search» means in the 21st century — transitioning from keyword retrieval to comprehensive information understanding.

In addition, algorithmic updates such as Google's Helpful Content and E-E-A-T (Experience, Expertise, Authoritativeness, and Trustworthiness) emphasize the human dimension of search quality. Pages created primarily for manipulation or low-value content are ranked lower, while expert-authored, original materials gain prominence. Academic and governmental websites benefit from these criteria, which privilege reliability and factual accuracy over popularity.

Ultimately, ranking algorithms serve as the invisible architecture of the digital information ecosystem. Their refinement requires ongoing collaboration among

computer scientists, linguists, psychologists, and sociologists to align technical efficiency with ethical responsibility. The integration of artificial intelligence, semantic web technologies, and human-centered design will continue to shape the future of search, determining how billions of people navigate and construct meaning in the digital age.

Conclusions. Search engines remain the fundamental mechanism for information access in the digital age. The PageRank algorithm forms the backbone of modern web search, ensuring both relevance and efficiency. Among the tested systems, Google demonstrates the highest accuracy and speed. However, user behavior differs by country, age, and social context, underscoring the need for further research. Enhancing search quality requires balancing relevance with diversity, accounting for regional user patterns, and integrating academic search engines and digital libraries, which complement one another in building a comprehensive knowledge environment.

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