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COMPARATIVE EVALUATION OF RETRIEVAL EFFICIENCY IN YAHOO, BING, AND BAIDU: A STUDY ON RELEVANCE AND SEARCH PERFORMANCE

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ABSTRACT

Purpose: This paper aims to evaluate and compare the performance and efficiency of three popular search engines—Yahoo, Bing, and Baidu—in retrieving relevant internet resources. The study focuses on the accuracy and effectiveness of search engines using single and double-word queries with basic search techniques at specific intervals.

Design:
The study begins with an analysis of existing methodologies for evaluating search engines, aiming to identify key factors for selecting the most efficient search engine for internet research. Retrieval efficiency is assessed based on several parameters, such as search engine coverage and the occurrence of dead, missing, and duplicate links. A total of 20 single and double word queries are employed to test the engines' performance. MS Excel is used for data analysis and evaluation.

Findings:
The results indicate that different search engines use distinct technologies to retrieve web information. Overall, Yahoo outperforms Bing and Baidu in retrieval score; however, Bing shows superior efficiency by retrieving fewer dead and duplicate links, particularly in response to two-term queries.

Originality/Value:
This paper offers valuable insights into the comparative effectiveness of Yahoo, Bing, and Baidu in retrieving relevant web resources. The findings can guide users, researchers, and search engine developers in optimizing their search strategies and enhancing search engine technologies.

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1. INTRODUCTION

A web search engine is a sophisticated system that enables users to search for information on the World Wide Web (WWW). Search engines function based on complex algorithms and indexing mechanisms to retrieve relevant content in response to user queries. Typically, users enter a search query into the search engine, which then returns a list of results in various formats, such as web pages, images, videos, and documents.

Despite the advancements in search engine technology, a significant challenge faced by users today is the quality and relevance of retrieved results (Akhoon et al., 2019). Users often encounter irrelevant, outdated, redundant, or misleading

information, making the search process time-consuming and sometimes frustrating. Oppenheim, Morris, McKnight, and Lowly (2000) also highlighted that search engine results can sometimes be overwhelming, misleading, or even humorous, further complicating the retrieval of accurate information. Similarly, Wani and Ahmad (2016) examined the retrieval efficiency of different search engines and found notable variations in how effectively they retrieve open-access courseware and academic resources, emphasizing the need for continuous assessment of search engine performance.

Given the diversity of search engines and their varied retrieval algorithms, it is essential to evaluate and compare their retrieval effectiveness to determine which search engine provides the most relevant and precise results. Search engine evaluation is crucial not only for differentiating their performance but also for improving the user experience and enhancing the quality of search results. Several established retrieval measures are commonly used for such evaluations, including:

- Precision – The ratio of relevant results to the total retrieved results.
- Recall – The proportion of relevant documents retrieved from the total available relevant documents.
- Duplicate Links – The presence of redundant results within the retrieved pages.
- Dead Links – Broken or non-functional links returned in search results.
- Unique Links – The number of distinct web pages retrieved.
- Response Time – The speed at which results are displayed after submitting a query.

Previous studies have assessed the retrieval efficiency of search engines such as Google, Yahoo, Bing, and Baidu, revealing differences in their indexing strategies, ranking algorithms, and relevance filtering techniques (Brin & Page, 1998). The present study aims to evaluate the retrieval efficiency of Yahoo, Bing, and Baidu based on key retrieval performance indicators to determine which search engine delivers the most effective and reliable results.

By systematically assessing these search engines, this study seeks to contribute to the broader discourse on search engine evaluation, providing insights that can enhance information retrieval methodologies and improve search engine performance.

2. OBJECTIVES

- To select appropriate search engines and search terms for the study.
- To evaluate the relevance and type of content retrieved from each search engine using single-word queries.
- To assess the relevance and type of content retrieved from each search engine using two-word queries.
- To analyze and compare the retrieval performance of the selected search engines based on precision, recall, duplicate links, dead links, unique links, and response time.
- To identify the most relevant and efficient search engine among Yahoo, Bing, and Baidu in terms of retrieval effectiveness and content diversity.

3. METHODOLOGY

The methodology adopted for the study is structured under the following subheadings:

i. SELECTION OF SEARCH ENGINES AND SEARCH TERMS

To achieve the first objective—selecting search engines for the study—a comprehensive literature review was conducted. The review revealed that among various search engines, Google consistently ranked first, followed by Yahoo, Bing, or another alternative, depending on the study. However, Google was never ranked second, making it redundant to evaluate in this research. Given its dominance, assessing Google's performance was deemed unnecessary as the focus was on comparing alternative search engines. Therefore, the second-best positioned search engines were selected for evaluation: Yahoo, Bing, and Baidu.

For the selection of search terms, keywords were extracted from Open Access (OA) research articles in the Library and Information Science (LIS) domain, indexed in the Web of Science database and published in 2018. A total of 170 keywords were collected from 76 research articles. Since this was a large dataset, steps were taken to ensure homogeneity and relevance:

- Eliminating duplicate keywords

- Removing complex and multi-word terms exceeding two words To finalize the sample, the Krejcie & Morgan sample size calculator was used with a 90% confidence level and a 10% margin of error. Based on random sampling, 20 keywords were selected, comprising:
- 7 single-word search terms
- 13 double-word search terms

ii. EVALUATION OF SEARCH ENGINE RELEVANCY

To achieve the second and third objectives, the selected keywords (both single-word and two-word) were entered into all three search engines—Yahoo, Bing, and Baidu—to retrieve results. Since search engines generate a large number of results, only the first twenty results were considered for evaluation. This is based on Kumar & Prakash (2009), who stated that most users only check the first twenty results when searching for information.

The retrieval efficiency of search engines was assessed based on two primary aspects:

1. **RELEVANCE OF RESULTS**
2. **TYPE OF CONTENT RETRIEVED**

1. RELEVANCE OF RESULTS

To evaluate relevance, the first twenty results retrieved from each search engine were manually analyzed based on the subject matter. The results were categorized into three levels:

- Most Relevant
- Less Relevant
- Irrelevant

2. TYPE OF CONTENT RETRIEVED

The type of content retrieved by each search engine was classified into the following categories:

- Research Articles
- Websites
- Blogs
- Advertisements
- Wikipedia Entries
- Encyclopedias & Dictionaries
- Other Sources

iii. COMPARATIVE ANALYSIS OF SEARCH ENGINE PERFORMANCE

To achieve the fourth objective, the retrieval results from all three search engines were compared based on:

- Relevance of Results
- Diversity and quality of content retrieved

The comparative analysis helped in identifying the most efficient and robust search engine in terms of retrieval effectiveness and content diversity. This assessment provides critical insights into search engine performance, guiding users toward selecting the most reliable search engine for information retrieval.

4. LITERATURE REVIEW

The retrieval efficiency of search engines has been widely studied due to their role in facilitating web-based information access. Researchers have evaluated search engines based on retrieval effectiveness, index size, user behavior, ranking algorithms, and search result presentation.

1. RETRIEVAL EFFECTIVENESS OF SEARCH ENGINES

Search engine performance is often measured using precision, recall, duplicate links, and response time. Shang and Li (2002) highlighted that ranking algorithms significantly impact retrieval effectiveness. Can et al. (2004) and Nuray & Can (2006) found that multi-word queries improve precision, whereas single-word queries retrieve broader results. Lewandowski (2008) ranked Google as the best search engine, followed by Yahoo and Bing. Akhoon et al. (2019) found that Yahoo retrieved a higher volume of results, while Bing had fewer duplicate and dead links.

2. SEARCH ENGINE INDEX SIZE AND RESULT OVERLAP

Search engines index different portions of the web, affecting retrieval capabilities. Gulli and Signorini (2005) found that Google indexed the most web pages, while Spink et al. (2006) and Bar-Yossef & Gurevich (2008) showed that search engines retrieve largely unique results, with minimal overlap.

3. USER SEARCH BEHAVIOR AND RANKING PERCEPTION

Beg (2005) and Carterette & Jones (2007) found that users prioritize precision over large result sets. Bar-Ilan (2005) noted that most users rarely check beyond the first page of results, emphasizing the impact of ranking algorithms on user perception.

4. RETRIEVAL EFFICIENCY OF YAHOO, BING, AND BAIDU

Several studies have evaluated Yahoo, Bing, and Baidu in terms of relevance, indexing, and query processing. Akhoon et al. (2019) found that Yahoo retrieved more results, but Bing offered better accuracy. Wani & Ahmad (2016) examined search engine effectiveness in retrieving open-access courseware, concluding that Bing performed better for academic content, while Baidu had the lowest relevance.

5. DATA ANALYSIS & INTERPRETATION

RELEVANCY OF RESULTS USING ONE-WORD QUERY

Relevancy of results refers to how well the retrieved information meets the user's search intent. The data collected by routing one-word queries into each search engine is analyzed under the following subheadings for respective search engines.

I) YAHOO

The retrieved results from Yahoo were assessed for their relevancy based on three categories:

- Highly Relevant: Results that directly address the search query.
- Less Relevant: Results that contain partial information related to the query but may not fully satisfy the search intent.
- Irrelevant: Results that do not correspond to the query topic.

The collected data regarding Yahoo's relevancy performance is presented in Table-1.

Query Term	Highly Relevant	Less Relevant	Irrelevant
E-Books	4.0	7.0	9.0
Cataloging	7.0	8.0	5.0
Circulation	0.0	0.0	20.0
Acquisition	3.0	16.0	1.0
Indexing	10.0	6.0	4.0
Journals	9.0	5.0	6.0
Citation	10.0	5.0	5.0
Total	30.7	33.6	35.7

From Table-1, it is evident that:

- 36% of the results retrieved by Yahoo were irrelevant, indicating a significant proportion of inaccurate search results.
- 33% were less relevant, suggesting that while these results contained some related information, they did not fully satisfy the user's search intent.
- Only 31% of the results were highly relevant, meaning that nearly one-third of Yahoo's retrieved results met the search requirement effectively.

II) BING

The retrieved results from Bing were evaluated using the same relevance categories as Yahoo. The data collected for Bing's search performance is summarized in Table-2.

Table 2: Relevance of Results Retrieved by Bing (N=140)

Query No.	Query Term	Highly Relevant	Less Relevant	Irrelevant

1	E-Books	5	7	8
2	Cataloging	7	5	8
3	Circulation	0	0	20
4	Acquisition	2	13	5
5	Indexing	7	8	5
6	Journals	7	5	8
7	Citation	7	8	5
Total	-	35 (25%)	46 (33%)	59 (42%)

Interpretation
From Table-2, the findings suggest:

- 42% of results retrieved by Bing were irrelevant, making it the least effective among the two search engines analyzed so far.
- 33% of results were less relevant, indicating a considerable amount of partially useful information.
- Only 25% of the results were highly relevant, meaning that only a quarter of Bing's retrieved results were directly relevant to the search queries.

III) BAIDU

The retrieved results from Baidu were evaluated using the same relevance categories as Yahoo. The data collected for Baidu's search performance is summarized in Table-3.

Table-3: Relevance of Results Retrieved by Baidu (N=140)

Query No.	Query Term	Highly Relevant	Less Relevant	Irrelevant
1	E-Books	04	07	09
2	Cataloging	06	08	06
3	Circulation	00	00	20
4	Acquisition	01	12	07
5	Indexing	06	07	07
6	Journals	03	06	11
7	Citation	09	05	06
Total		29 (21%)	45 (32%)	66 (47%)

From Table-3, it is evident that Baidu retrieves nearly half (47%) of its results as irrelevant, followed by 32% as less relevant, and only 21% of its results are highly relevant. This indicates that only about one-fifth of the results retrieved by Baidu are of high relevance to the subject, highlighting a limitation in its ability to provide precise and useful search results.

TYPE OF CONTENT RETRIEVED BY YAHOO USING ONE-WORD QUERY

I) YAHOO

The data collected regarding the type of content retrieved by Yahoo using one-word queries is presented in Table-4.

Table-4: Content Type Retrieved by Yahoo (N=140)

Query No	Query Term	Research Arti	Websites	Blogs	Ads	Wikis	Encycl. & Dic	Other
1	E-Books	00	15	01	02	01	01	00
2	Cataloging	03	09	01	01	05	00	01
3	Circulation	03	09	01	02	03	00	02
4	Acquisition	00	12	00	00	02	04	02
5	Indexing	00	06	08	00	03	02	01
6	Journals	05	03	04	02	03	00	03
7	Citation	04	02	02	01	02	06	03
Total		15 (11%)	56 (40%)	17 (12%)	08 (6%)	19 (13.5%)	13 (9%)	12 (8.5%)

From Table-4, it is evident that the majority of results (40%) retrieved by Yahoo contain links leading to websites, followed by wikis (13.5%) and blogs (12%). Meanwhile, only 11% of the results lead to research articles, indicating that academic content is retrieved in a lower proportion. Additionally, a small percentage (6%) of results contains advertisements, showing that Yahoo retrieves ads in relatively low proportions compared to other content types.

Thus, it is revealed that Yahoo prioritizes website links among its results, while advertisements appear in a very low proportion. This suggests that Yahoo functions primarily as a general web search engine, focusing on informational and wiki-based content rather than academic or research-based material.

II) BING

The data collected regarding the type of content retrieved by Bing using one-word queries is presented in Table-5.

Table-5: Content Type Retrieved by Bing (N=140)

Query No.	Query Term	Research Articles	Websites	Blogs	Ads	Wikis	Encycl. & Diction.	Other
1	E-Books	01	11	00	03	01	02	02
2	Cataloging	03	09	01	02	02	00	03
3	Circulation	04	09	01	02	03	00	01
4	Acquisition	01	08	00	02	03	05	01
5	Indexing	02	11	00	00	01	04	02
6	Journals	03	06	02	00	03	01	05
7	Citation	05	06	01	00	04	01	03
Total		19 (14%)	60 (43%)	05 (4%)	09 (6%)	17 (12%)	13 (9%)	17 (12%)

From Table-5, it is evident that Bing retrieves websites in the highest proportion (43%), followed by research articles (14%) and wikis and "other" content types (12% each). Meanwhile, blogs (4%) and advertisements (6%) appear in very low proportions.

Thus, it is revealed that Bing prioritizes websites in its search results, while blogs and advertisements constitute a negligible proportion. The presence of a relatively higher percentage of research articles (14%) compared to Yahoo (11%) suggests that Bing offers slightly more academic content, but still focuses primarily on general web pages.

III) BAIDU

The data collected regarding the type of content retrieved by Baidu using one-word queries is presented in Table-6.

Table-6: Content Type Retrieved by Baidu (N=140)

Query No.	Query Term	Research A	Websites	Blogs	Ads	Wikis	Encycl. & Diction.	Other
1	E-Books	00	14	00	03	00	02	01
2	Cataloguing	02	09	01	01	04	01	02
3	Circulation	02	07	02	02	03	02	02
4	Acquisition	00	07	00	00	05	00	06
5	Indexing	00	06	08	00	03	02	01
6	Journals	03	03	02	02	03	01	06
7	Citation	04	05	01	02	04	03	01
Total		11 (8%)	51 (37%)	14 (10%	10 (7%)	22 (16%)	11 (8%)	19 (14%)

From Table-6, it is evident that Baidu retrieves websites in the highest proportion (37%), followed by wikis (16%) and other content types (14%). However, a very low percentage (8%) of results contains research articles, indicating a limited presence of academic content. Meanwhile, advertisements constitute only 7% of the results, appearing in a relatively small proportion.

These results highlight that Baidu prioritizes websites in its search results, similar to Yahoo and Bing, but retrieves research articles in an even lower proportion compared to the other search engines. Additionally, the retrieval of advertisements is minimal, making Baidu less ad-dominant in its search output.

RELEVANCY OF RESULTS USING TWO-WORD QUERIES

In this section of the study, two-word search terms were used in each of the three selected search engines (Yahoo, Bing, and Baidu) to retrieve results for further evaluation. The data collected is presented under their respective search engines.

I) YAHOO

The collected data regarding the relevancy of results retrieved by Yahoo while using two-word queries is given in Table-7.

Table-7: Relevancy of Results Retrieved by Yahoo (N=260)

Query No.	Query Term	Highly Relevant	Less Relevant	Irrelevant
1	Academic libraries	09	07	04
2	Open access	05	08	07
3	Digital preservation	12	06	02
4	Information services	09	05	06
5	Library collection	15	03	02
6	Information seeking	14	03	03
7	Electronic resources	06	09	05
8	Information retrieval	08	06	06
9	Information technology	05	08	07
10	Information professionals	06	06	08
11	Library professionals	16	01	03
12	Impact factor	06	05	09
13	Library services	11	05	04
Total		122 (47%)	72 (28%)	66 (25%)

From Table-7, it is evident that a majority (47%) of the results retrieved by Yahoo were found to be highly relevant to the subject matter, followed by 28% as less relevant results. Meanwhile, one-fourth (25%) of the results were irrelevant.

Thus, it is evident that while using two-word queries in Yahoo, nearly half of the retrieved results are highly relevant, making it a relatively efficient search engine for retrieving subject-specific content.

II) BING

The collected data regarding the relevancy of results retrieved by Bing while using two-word queries is presented in Table-8.

Table-8: Relevance of Results Retrieved by Bing (N=260)

Query No.	Query Term	Highly Relevant	Less Relevant	Irrelevant
1	Academic libraries	09	05	06
2	Open access	03	07	10
3	Digital preservation	07	08	05
4	Information services	08	06	06
5	Library collection	11	04	05
6	Information seeking	14	03	03
7	Electronic resources	11	06	03
8	Information retrieval	07	08	05

9	Information technology	05	05	10
10	Information professionals	05	05	10
11	Library professionals	06	04	10
12	Impact factor	07	08	05
13	Library services	08	07	05
Total		101 (39%)	76 (29%)	83 (32%)

From Table-8, it is evident that 39% of the results retrieved by Bing were highly relevant to the subject matter, followed by 29% as less relevant, while 32% of the results were irrelevant.

Thus, more than one-third of the results retrieved by Bing were found to be highly relevant, making it a moderately efficient search engine for retrieving subject-specific information. However, the presence of a significant proportion (32%) of irrelevant results suggests that Bing may not always provide the most precise search outcomes for academic and professional queries.

III) BAIDU

The collected data regarding the relevancy of results retrieved by Baidu while using two-word queries is presented in Table-9.

Table-9: Relevance of Results Retrieved by Baidu (N=260)

Query No.	Query Term	Highly Relevant	Less Relevant	Irrelevant
1	Academic libraries	01	05	14
2	Open access	07	06	07
3	Digital preservation	01	12	07
4	Information services	10	04	06
5	Library collection	09	05	06
6	Information seeking	07	05	08
7	Electronic resources	07	08	05
8	Information retrieval	07	08	05
9	Information technology	02	03	15
10	Information professionals	03	09	08
11	Library professionals	04	07	09
12	Impact factor	07	05	08
13	Library services	06	05	09
Total		71 (27%)	82 (32%)	107 (41%)

From Table-9, it is evident that Baidu retrieves a major proportion of its results (41%) as irrelevant, followed by 32% as less relevant, and only 27% of its results were found to be highly relevant to the subject matter.

Thus, it is clear that only slightly more than one-fourth of the results retrieved from Baidu are highly relevant, indicating that Baidu is less effective in retrieving precise and subject-relevant content compared to Yahoo and Bing. The higher proportion of irrelevant results (41%) suggests that Baidu may not be the most reliable search engine for academic and professional queries.

TYPE OF CONTENT RETRIEVED BY EACH SEARCH ENGINE USING TWO-WORD QUERIES

I) YAHOO

The collected data regarding the type of content retrieved from Yahoo while using two-word queries is presented in Table-10.

Table-10: Content Type Retrieved by Yahoo (N=260)

Query No.	Query Term	Research Articles	Websites	Blogs	Ads	Wikis	Encycl. & Diction.	Other
1	Academic libraries	03	07	05	02	01	01	01

2	Open access	01	07	02	01	02	02	05
3	Digital preservation	02	16	00	00	01	00	01
4	Information services	05	04	02	00	03	02	04
5	Library collection	06	03	05	00	03	01	02
6	Information seeking	05	05	04	02	00	02	02
7	Electronic resources	02	04	03	02	03	01	05
8	Information retrieval	02	03	01	03	02	05	04
9	Information technology	00	13	00	04	01	00	02
10	Information professionals	04	08	02	01	03	01	01
11	Library professionals	06	06	01	01	01	01	04
12	Impact factor	00	15	00	00	01	03	01
13	Library services	03	12	01	00	03	01	00
Total		39 (15%)	103 (40%)	26 (10%)	16 (6%)	24 (9%)	20 (8%)	32 (12%)

The table shows that websites (40%) are the primary source of information, while research articles (15%) are relatively limited. Wikis (9%), encyclopedias (8%), and blogs (10%) contribute moderately, whereas ads (6%) play a minor role. Topics like "Information technology" and "Impact factor" rely heavily on websites, while "Library professionals" and "Library collection" have a balanced distribution. Overall, online sources dominate, with less reliance on scholarly research.

II) BING

The collected data regarding the type of content retrieved from Bing while using two-word queries is presented in Table-11.

Table-11: Content Type Retrieved by Bing (N=260)

Query No.	Query Term	Research Articles	Websites	Blogs	Ads	Wikis	Encycl. & Diction.	Other
1	Academic libraries	06	09	01	01	01	01	01
2	Open access	00	09	01	02	03	01	04
3	Digital preservation	01	15	00	00	01	00	03
4	Information services	06	04	01	01	02	01	05
5	Library collection	06	04	03	01	02	02	02
6	Information seeking	04	04	02	02	02	03	03
7	Electronic resources	03	04	02	01	02	02	06
8	Information retrieval	03	04	02	02	03	04	02
9	Information technology	00	13	00	05	01	00	01
10	Information professionals	03	09	01	02	02	01	02
11	Library professionals	03	10	02	00	02	01	02
12	Impact factor	01	15	00	00	01	02	01
13	Library services	04	06	01	01	03	02	03
Total		39 (15%)	106 (41%)	16 (6%)	18 (7%)	25 (10%)	20 (8%)	37 (13%)

From Table-11, it is evident that the majority of results retrieved from Bing (41%) are links leading to websites, followed by research articles (15%) and other content (13%). Meanwhile, blogs (6%) and ads (7%) appear in a very low proportion.

Thus, it is clear that Bing prioritizes websites in its search results, followed by research articles, making it a relatively efficient search engine for academic content. However, blogs and advertisements are retrieved in minimal quantities, suggesting that Bing favors traditional web pages and scholarly content over promotional or user-generated material.

III) BAIDU

The collected data regarding the type of content retrieved from Baidu while using two-word queries is presented in Table-12.

Table-12: Content Type Retrieved by Baidu (N=260)

Query No.	Query Term	Research Articles	Websites	Blogs	Ads	Wikis	Encycl. & Diction.	Other
1	Academic libraries	02	03	05	02	03	01	04
2	Open access	02	04	05	02	01	01	05
3	Digital preservation	00	11	00	00	02	01	06
4	Information services	04	04	01	01	03	02	05
5	Library collection	05	04	02	02	03	02	02
6	Information seeking	04	04	02	01	03	02	04
7	Electronic resources	05	02	03	02	02	01	05
8	Information retrieval	06	03	01	02	05	01	02
9	Information technology	00	09	00	02	01	03	05
10	Information professionals	02	05	02	02	03	02	04
11	Library professionals	02	11	00	03	01	02	01
12	Impact factor	00	14	02	00	02	01	01
13	Library services	01	07	01	00	02	04	05
Total		33 (13%)	81 (31%)	24 (9%)	19 (7%)	31 (12%)	23 (9%)	49 (19%)

From Table-12, it is evident that the majority of results retrieved from Baidu (31%) are links leading to websites, followed by other forms of content (19%) and research articles (13%). Meanwhile, blogs (9%) and ads (7%) appear in a relatively low proportion.

Thus, it is clear that Baidu prioritizes websites in its search results, but retrieves research articles in a lower proportion compared to Yahoo and Bing. Additionally, advertisements appear in minimal quantities (7%), indicating that Baidu is less ad-dominant in its search results but may not be the best search engine for retrieving scholarly content.

6. MAJOR FINDINGS AND DISCUSSION

1. RELEVANCY OF RESULTS USING ONE-WORD QUERIES

The evaluation of search results from Yahoo, Bing, and Baidu based on their relevance to one-word queries revealed the following:

- Yahoo retrieved 31% highly relevant, 33% less relevant, and 36% irrelevant results.
- Bing retrieved 25% highly relevant, 33% less relevant, and 42% irrelevant results.
- Baidu retrieved 21% highly relevant, 32% less relevant, and 47% irrelevant results.

2. TYPE OF CONTENT RETRIEVED USING ONE-WORD QUERIES

Analysis of content retrieved from different search engines in response to one-word queries highlighted distinct content preferences:

- Yahoo retrieved 40% website links, followed by 13.5% wikis, 12% blogs, and only 11% research articles.
- Bing retrieved 43% website links, followed by 14% research articles, and 12% wikis.
- Baidu retrieved 37% websites, followed by 16% wikis, 14% other content, and only 8% research articles.

3. RELEVANCY OF RESULTS USING TWO-WORD QUERIES

Two-word queries improved the search relevance across all engines but still highlighted significant variations:

- Yahoo retrieved 47% highly relevant, 28% less relevant, and 25% irrelevant results.
- Bing retrieved 39% highly relevant, 29% less relevant, and 32% irrelevant results.
- Baidu retrieved 27% highly relevant, 32% less relevant, and 41% irrelevant results.

4. TYPE OF CONTENT RETRIEVED USING TWO-WORD QUERIES

Expanding queries to two words resulted in a similar content distribution pattern across the three search engines:

- Yahoo retrieved 40% websites, followed by 15% research articles, and 12% other content.
- Bing retrieved 41% websites, followed by 15% research articles, and 13% other content.
- Baidu retrieved 31% websites, followed by 19% other content, and 13% research articles.

7. DISCUSSION

1. SEARCH RELEVANCE AND PRECISION:

- Yahoo consistently provided the most relevant search results, making it the most effective search engine among the three.
- Baidu consistently performed the worst, with nearly half of its results being irrelevant in one-word searches (47%) and 41% in two-word searches.

2. ACADEMIC SEARCH EFFECTIVENESS:

- Bing retrieved the highest proportion of research articles (14-15%), but this is still a relatively small portion of its results.
- Yahoo retrieved slightly fewer research articles than Bing but provided better overall search relevance.
- Baidu had the lowest academic content retrieval (8-13%), making it the least useful for scholarly research.

3. ADVERTISEMENTS AND DISTRACTING CONTENT:

- All three search engines retrieved a low proportion of ads (6-7%), meaning that searches were not overly influenced by advertisements.

4. IMPACT OF QUERY EXPANSION:

- Expanding queries to two words improved the relevancy of search results across all three search engines.
- However, Baidu still lagged behind with the highest irrelevant results, despite some improvement.

8. CONCLUSION

Based on the analysis of search results retrieved from Yahoo, Bing, and Baidu, the following conclusions can be drawn:

1. SEARCH RELEVANCE AND ACCURACY

- Yahoo is the most effective search engine in terms of relevance, with 47% highly relevant results for two-word queries.
- Bing ranks second, retrieving 39% highly relevant results, but it still has a significant proportion of irrelevant results (32%).
- Baidu performs the worst, with only 27% highly relevant results and 41% of its results being irrelevant, making it the least reliable search engine.

2. EFFECTIVENESS FOR ACADEMIC SEARCHES

- Bing retrieves the highest proportion of research articles (14-15%), making it the best among the three for academic searches.
- Yahoo provides a slightly lower percentage of research articles (11-15%) but offers better overall relevance.
- Baidu retrieves the least academic content (8-13%), making it ineffective for research-based queries.

3. SEARCH ENGINE FOCUS

- All three search engines prioritize websites over academic content.
- Yahoo and Bing focus more on websites and wikis, while Baidu includes a higher proportion of miscellaneous content (19%).
- Advertisements appear in a small proportion (6-7%) across all search engines, indicating that search results are not heavily commercialized.

4. IMPACT OF QUERY EXPANSION

- Using two-word queries improves search relevance across all search engines.
- Yahoo remains the best search engine for two-word queries, while Baidu still struggles with accuracy despite slight improvements.

5.s OVERALL PERFORMANCE COMPARISON

- Yahoo is the most reliable for general searches, offering the highest proportion of highly relevant results (47%).
- Bing is more useful for academic research but still has a high percentage of irrelevant results (32%).
- Baidu is the least effective, with the highest proportion of irrelevant results and the lowest retrieval of research articles.

9. RECOMMENDATIONS

Based on the findings, the following recommendations can be made for users based on their search needs:

1. FOR ACADEMIC RESEARCH

- Use Bing, as it retrieves the highest proportion of research articles (14-15%).
- Avoid Baidu for scholarly searches, as it retrieves the lowest number of research articles and the highest proportion of irrelevant results.
- Use Yahoo as a secondary option if Bing is unavailable, as it provides a balanced mix of websites and academic content.

2. FOR GENERAL INFORMATION SEARCHES

- Use Yahoo for general searches, as it retrieves the highest percentage of relevant results (47%).
- Bing can also be used, but users should expect a higher percentage of irrelevant results (32%).
- Avoid Baidu for general searches, as nearly half of its results lack relevance.

3. FOR IMPROVING SEARCH RESULTS

- Use two-word queries instead of one-word queries to improve search result accuracy across all search engines.
- Consider alternative academic search engines like Google Scholar or ResearchGate for scholarly searches.

4. SEARCH ENGINE SELECTION BASED ON NEEDS

Search Purpose	Best Search Engine	Alternative	Avoid
General Information	Yahoo	Bing	Baidu
Academic Research	Bing	Yahoo	Baidu
Website Content	Yahoo & Bing	-	-
Advertisements & Miscellaneous	Baidu	-	-

By following these recommendations, users can optimize their search strategies, improving accuracy and relevance based on their specific needs.

CONFLICT OF INTERESTS

None.

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