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SEARCH ENGINES AND METASEARCH ENGINES IN INFORMATION RETRIEVAL – A COMPARISON OF THE EFFECTIVENESS

1. Introduction

In times of rapid growth of information and knowledge sources, what we are searching for tends to be more and more concealed. Thus, finding crucial information is extremely important from the point of view of many different people, companies and institutions (particularly those, which are related to e-commerce and e-business).

With each year, Intelligent Software Agents gain more and more popularity and significance as the right tool to acquire, store and manage the information and knowledge needed for the proper functioning of active units in e-business.

From the point of view of management and e-business in particular, the most crucial and important are information agents, which are represented in Internet mainly by search and metasearch engines.

2. Information Retrieval in Management

The basic task of the search engine is to support the user with the information retrieval in networks and distributed systems. These engines have to be able-based on the user's profile – to find, extract and filter on his behalf the relevant information, and to present the results of this search in a proper way and form. Furthermore, from the point of view of the management, one expects search and metasearch engines to provide the access to the distributed information sources. To fulfil this task, it possesses the strategies of choosing the information sources and its access, these sources' models and ways to merge them. Information agent's (here: a search engine's) tasks include: finding answers for single queries to the information sources (or for the queries which occur frequently) or monitoring the sources of the information from the point of view of changes in their content. The example of such an agent is the agent, which monitors the stock exchange.

Dynamically changing content of WWW pages constitutes the main source of the information and knowledge for management. Other sources include e-mails and services like Usenet, newsgroups or IRC [Padget 2002; Impuls 2003]. Furthermore, some of the most advanced search engines can also “use” the work of other simple engines to take advantages of the information acquired by them. One calls them metasearch engines.

Main fields of management and e-business where search engines can be applicable include:

- strategic management (supporting decision processes, monitoring the decisions' execution) [Cardoso 1999; Ferber 1999],
- marketing (supporting marketing activities, cooperation with customers) [Sadeh 2002; Weiss 2001],
- logistics (activities on the field of distribution, stocks etc.),
- production and sale (improvement of technologies, production and products, negotiations with purchasers/customers) [Maes et al. 2003].

3. The Nature of Search Engines

The term “search engine” is often used to describe both crawler-based search engines and human-powered directories. These two types of search engines gather their listings in different ways. Crawler-based search engines “crawl” or “spider” automatically the web, then people search through what they have found.

If one changes one's web page, crawler-based search engines eventually find these changes.

A human-powered directory, depends on humans for its listings. One submits a short description to the directory for one's entire site. A search looks for matches only in the descriptions submitted.

Changing the web page has no effect on the listing.

In the web's early days, it used to be that a search engine either presented crawler-based results or human-powered listings. Today, it is extremely common for both types of results to be presented. Usually, a hybrid search engine will favour one type of listings over another. For example, MSN Search is more likely to present human-powered listings. However, it does also present crawler-based results.

Crawler-based search engines have three major elements. First is the spider, also called the crawler. The spider visits a web page, reads it, and then follows links to other pages within the site. The spider returns to the site on a regular basis, such as every month or two, to look for changes.

Everything the spider finds goes into the second part of the search engine, the index. The index is like a book containing a copy of every web page that the spider finds. If a web page changes, then this book is updated with new information.

Search engine software is the third part of a search engine. This is the program that sifts through the millions of pages recorded in the index to find matches to a search and rank them in order of what it believes is most relevant.

All crawler-based search engines have the basic parts described above, but there are differences in how these parts are tuned. That is why the same search on different search engines often produces different results.

3.1. Advanced Features of Search Engines

As mentioned above, search engines do not differ significantly from each other. However, in case of advanced features, it is not true. This is the area, where some of the search engines may offer something extra compared to the rivals.

Among the abovementioned, one can find features like clustering or page translation, as well as characteristics defining customisation – see below tables.

Table 1. Listing of the advanced features of the most popular search engines

Feature	Offered By
Related Searches	AltaVista, AllTheWeb, Excite, HotBot, Lycos, MSN, Yahoo Not yet updated, but may be still correct: iWon
Clustering	AltaVista, AllTheWeb, Excite, Google, HotBot, MSN, Northern Light
Find Similar	AltaVista, AOL Search, Google
Stemming	AOL Search, Direct Hit, HotBot, Inktomi (HotBot, MSN)
Search Within	AltaVista, Google, HotBot, Lycos
Spidered Version	Google
Search By Language	AltaVista, AllTheWeb, Excite, Google, HotBot, Lycos, MSN, Northern Light
Page Translation	AltaVista, Google, Lycos
Porn Filter	AltaVista, AllTheWeb, Google
Porn Warning	HotBot, MSN, Northern Light

Source: [Sullivan 2001].

In case of a typical Internet user, it is becoming more and more crucial, what the particular search engine may offer apart from the basic features. Thus, nowadays, it seems to be more and more critical to find and use the search engine that is up to user's expectations. More information about advanced features of search engines may be found in [Sullivan 2001].

Table 2. Selected advanced features of the most popular search engines concerning customisation

Feature	Supported By
Number Of Listings Shown (10 unless noted)	AltaVista, AllTheWeb, AOL Search (5), Direct Hit, Excite, Google, HotBot, LookSmart (15), Lycos, MSN (15), Northern Light Not yet updated, but may be still correct: iWon, Netscape, Yahoo (20)
Ability To Increase Number Of Listings?	AltaVista, AllTheWeb, Excite, Google, HotBot, MSN Not yet updated, but may be still correct: Yahoo
See 20 Results	AltaVista, AllTheWeb, Excite, Google, HotBot, MSN Not yet updated, but may be still correct: Yahoo
See 50 Results	AltaVista, AllTheWeb, Excite, Google, HotBot, MSN Not yet updated, but may be still correct: Yahoo
See 100 Results	AllTheWeb, Google, HotBot, Not yet updated, but may be still correct: Yahoo
Sort By Date	MSN Search, Northern Light
Date Range	AltaVista, Google, HotBot, MSN, Northern Light Not yet updated, but may be still correct: iWon, Yahoo
Date Displayed?	AltaVista, HotBot (for Inktomi results), Northern Light
Display Titles Only?	AltaVista, Excite, HotBot (URLs only option), MSN
Other Major Customize Options	AltaVista, AllTheWeb, Google

Source: [Sullivan 2001].

3.2. News Search

Apart from typical search engines looking in Internet for the pages containing information one requested, there are special services dedicated to search for the latest news stories from many different sources on the web. Because they crawl only news sites and revisit them several times a day, the results are usually focused and timely.

For example, *Google News* (<http://news.google.com>) – a winner for Best News Search Engine in 2002 – provides the ability to keyword search across thousands of news sources, while also providing the ability to browse categories of news where headlines are assembled automatically. One of the features of this service is a so-called *Google Alert* (<http://www.googlealert.com/>), which lets one automate the

process of running regular queries, sending an email whenever any new content is added to the Google database. One can track competitors, industries, and trends, which normally would have taken several hours.

Google News has its own crawlers that go out and are very rapidly scanning all the new sites trying to identify new articles as they appear. Once that new article is found, the title, body, and photos are extracted. *Google News* then clusters related articles and prioritises the news stories.

Among other leading news search engines one can point out *Yahoo News* (<http://news.yahoo.com/>), which allows to search across thousands of news sources found by Yahoo's news crawling machine, as well as browse categories of news, where articles and resources have been assembled by Yahoo editors. Another tool worthy mentioning is *AllTheWeb News* (<http://www.alltheweb.com/?cat=news>). This service lets one keyword search against content gathered from news sites across the web. It enables to narrow news sources to particular categories, such as sports or technology.

Other services, like *AltaVista News* (<http://news.altavista.com/>) and *Daypop* (<http://www.daypop.com/>) also lets one keyword search through content they find from crawling thousands of news sites throughout each day.

Major news partners such as the New York Times often supply the content found by these news search engines.

News services gather information from the Web and provide news to other Web sites.

One of the most advanced news aggregators – *Moreover* (<http://w.moreover.com>) – enables to get a variety of news topics across a wide variety of sources.

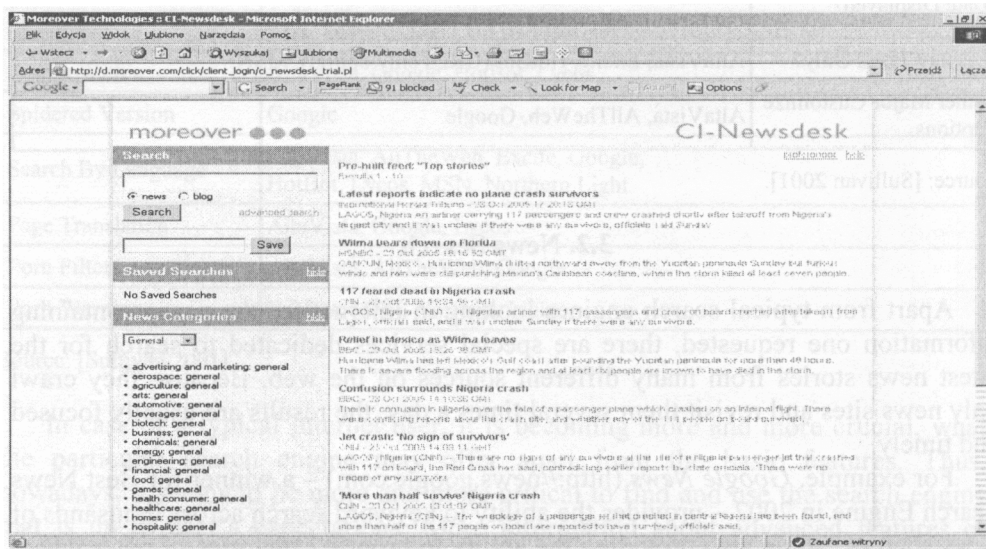


Fig. 1. Moreover – a news search engine.

Source: <http://w.moreover.com/>.

Moreover gathers its news information from more than 12000 news sources from over 126 countries in 36 languages. Additionally, it differentiates different types of news. It treats blogs separately from news, based on the assumption that news is more about journalistic integrity with more control and standards, while blogs tend to be more about opinions. Furthermore, *Moreover* does not accept any sponsorship.

Figure 1 presents the abovementioned news search engine.

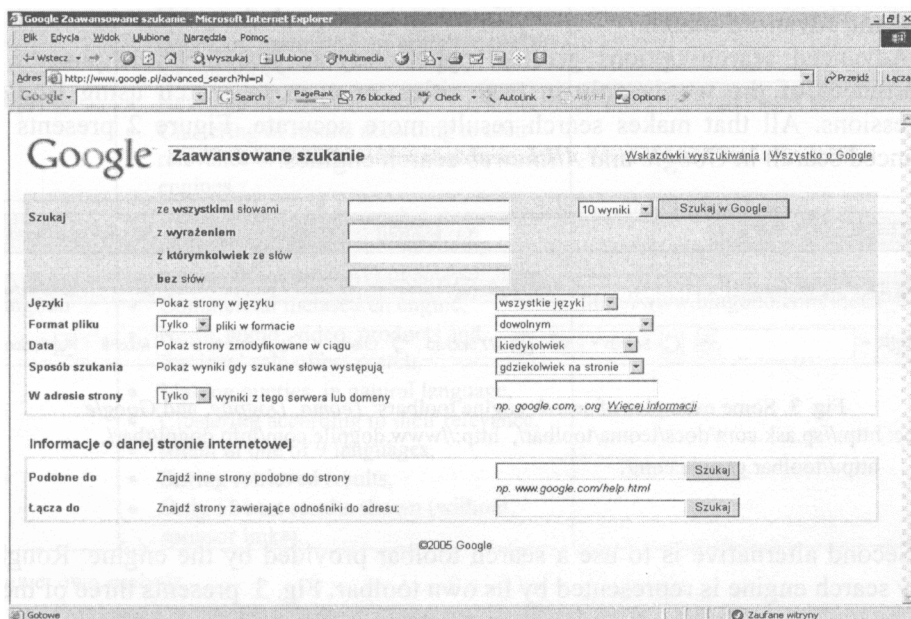
Another example of news search tool is *Topix.net*. It differentiates its news information via categorization and zip code level localization. News is available via its web site, partner feeds, RSS feeds, email alerts, and JavaScript iframe. It uses about 10000 news sources, to combine the information with ad models such as Google AdWords, and then to categorize and localize it, and send it to 300000 news channels and to its own site. The idea of *Topix.net* is to present news to the user much like a newspaper.

Many news search engines offer news in multimedia formats as well as text formats. For example, the *Yahoo News* offers photos, audio files, slide shows and video files. *Google News* includes photos during its crawling process.

4. Search vs. Metasearch Engines – a Comparison of Efficiency

4.1. How to Search?

To find the relevant information in Internet, one can use either a search engine (or a metasearch engine instead) or a search toolbar provided by this engine.



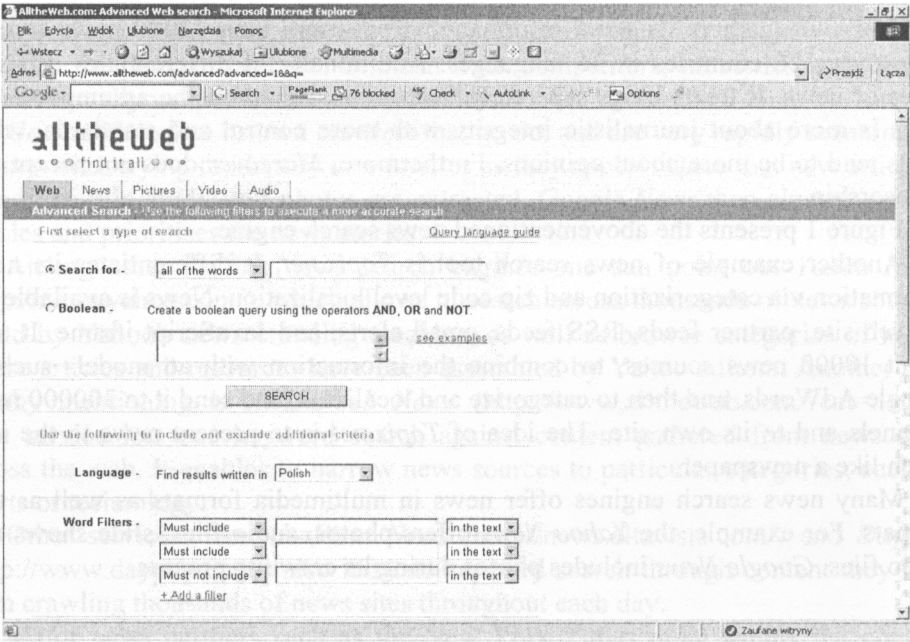


Fig. 2. Advanced search in Google and Alltheweb

Source: http://www.google.pl/advanced_search?hl=pl,
<http://www.alltheweb.com/advanced?advanced=1&q=>.

By choosing the first of these two alternatives, one has to take into account that the more precise (or narrowed) query gives better results. Thus, it is recommended to use the advanced search.

Advanced search options give an opportunity to search whole phrases, or occurrences of the words only in page titles, or even to search using Boolean expressions. All that makes search results more accurate. Figure 2 presents the advanced search in Google and Alltheweb search engines.



Fig. 3. Some examples of search engine toolbars: Teoma, Dogpile, and Google

Source: <http://sp.ask.com/docs/teoma/toolbar/>, <http://www.dogpile.com/info.dogpl/tbar/>,
<http://toolbar.google.com/>.

Second alternative is to use a search toolbar provided by the engine. Roughly every search engine is represented by its own toolbar. Fig. 3 presents three of them.

4.2. Metasearch and Specialised Search Engines

Using even the best search engine doesn't necessarily guarantee high efficiency of the information retrieval. Common is the situation, when one obtains huge number of results as an answer for a query, thus making it very time-consuming to extract only those relevant.

Table 3. Main characteristics of the most popular metasearch engines

Name	Characteristics	Web address
Emulti	<ul style="list-style-type: none"> • News, audio, video search, • Services and products' prices comparison, • Ranking results from individual search engines. 	http://www.emulti.pl
Metacrawler	<ul style="list-style-type: none"> • News, audio, video search, • Using more than 6 search engines, • MetaSpy – a list of the most common queries from other search engines, • Sorting results by relevance or ranking in search engines. 	http://www.metacrawler.com/
Mamma metasearch	<ul style="list-style-type: none"> • News, audio, video search, • Using 14 search engines, • "rSort" ranking algorithm – duplicates among the search results are not omitted, but they significantly influence the final ranking. 	http://www.mamma.com/
Search.com	<ul style="list-style-type: none"> • News, audio, video search, • Using only 4 search engines, but with an option of narrowing the search to one of 89 categories. 	http://www.search.com/
Dogpile	<ul style="list-style-type: none"> • News, audio, video search, • Clustering of results according to their relevance or based on their rank in search engines. 	http://www.dogpile.com/
Findspot	<ul style="list-style-type: none"> • News, audio, video search, • Only 15 best results, but including many(often a majority) of sponsor links. 	http://www.findspot.com/
Bingooo	<ul style="list-style-type: none"> • Commercial metasearch engine, • News, audio, video, products and services' sale offers search, • Making queries in natural language, • Clustering according to their relevance, • Menu in one of 9 languages, • Saving retrieved results, • Only 15 best results shown (without sponsor links). 	http://www.bingooo.com/index_e.html

Source: own analysis.

One of the solutions to the abovementioned problem may be using metasearch engines instead. They provide results from many search engines simultaneously, usually reducing them to only several most relevant.

Metasearch engines unify results from as much as ten single search engines. Table 3 summarizes the characteristics of the most popular metasearch engines.

As shown in tab. 3, better functionality makes metasearch engines improve the information retrieval process, which is reflected in a higher speed and better quality of retrieved documents.

Apart from metasearch engines, it is often useful to use so-called “speciality search engines”. Their purpose is to search only within the particular domain (e.g. mailing lists, computers, government issues), what makes them often more effective than metasearch engines. More details can be found in [Sullivan 2002].

One of the domains particularly attractive for search engines is medicine. Last days proved that specialized medical search engines are needed both for doctors and patients.

A search engine called Healthline represents this domain.

According to the polls, more Americans search for health information on the web than make doctor visits each day.

There is a lot of great health care information available on *Healthline*.

Figure 4 presents the homepage of *Healthline* search engine.

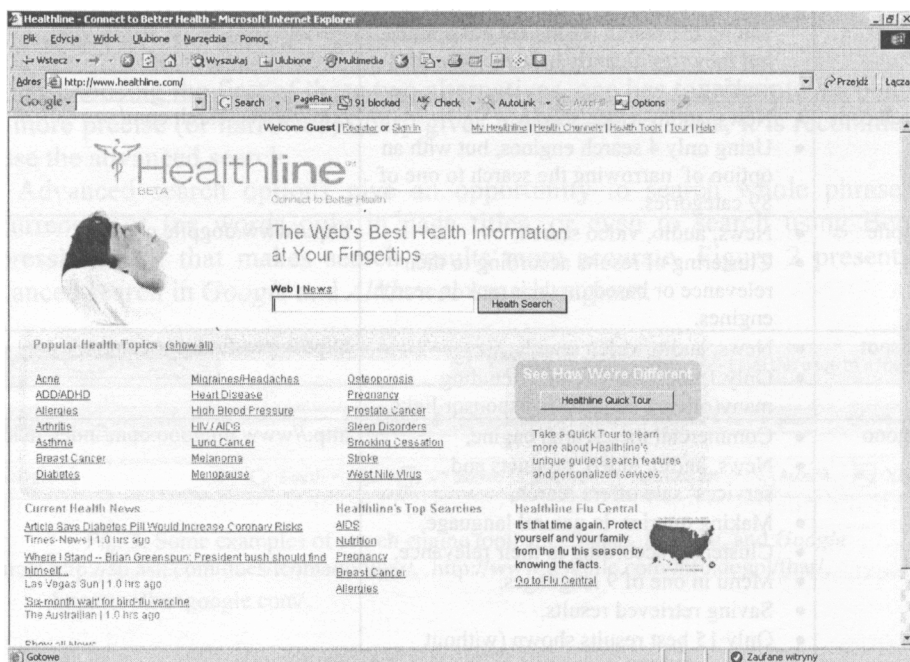


Fig. 4. A homepage of *Healthline* search engine

Source: <http://www.healthline.com/>.

Healthline is a specialized search engine that focuses exclusively on reliable, doctor-vetted information, covering 62000 web sites with around 50 million pages. The site also features content licensed from reliable providers.

When one searches, terms are translated and relevant medical information is presented.

Healthline is one of the best, easiest to use health information sources on the web. The "patient friendly" interface combined with first-rate, vetted content make it an excellent resource for anyone researching health related information.

4.3. Experimental Methodology

The main problem concerning search and metasearch engines defined by the author was to find arguments for or against using particular search tools.

It is, undoubtedly, very difficult (if not impossible at all) to state inevitably, which of the search engines are better and why.

The main reason is that it is impossible to say how do they work, because the algorithms and a methodology used by search engines are kept secret. All one can find is a general information concerning their characteristics (described in p.3).

Nonetheless, the author decided to make a following experiment:

There were eight search and seven metasearch engines taken into account. Next, there were made more than 30 different queries to each of the engines. All the queries were in four different forms (where possible), as shown in tab. 4.

Table 4. Types of queries made to search and metasearch engines

Query	Description	Example
Basic	Find the documents comprising all given words	Hybrid Intelligent Systems
Basic in title	Find the documents comprising in their title all given words	allintitle: Hybrid Intelligent Systems intitle: Hybrid Intelligent Systems
Phrase	Find the documents comprising a given phrase	„Hybrid Intelligent Systems”
Phrase in title	Find the documents comprising in their title a given phrase	allintitle: “Hybrid Intelligent Systems” intitle: “Hybrid Intelligent Systems”

Source: own analysis.

All the queries were different by subject. There were also two languages used (Polish and English) to formulate them.

Next, using two measures, the efficiency of engines was compared. One of them was the *Precision*; another one was the mean number of pages retrieved.

The first measure, *Precision* is the number of relevant and retrieved documents to the number of all retrieved documents. There are numerous other quality measures that can be used, e.g. *Recall* (i.e. the number of relevant and retrieved documents to the number of all relevant documents) [Neuman 2002]. However,

using the *Recall* measure in this experiment is groundless, because Internet resources, which are huge, make it impossible to say the exact number of all relevant documents.

Based on the results obtained from search and metasearch engines there was made an effort to verify following hypotheses:

Hypothesis 1:

Using metasearch engines improves the information retrieval process.

At the bases to formulate the above statement lie personal observations of the author, which indicate that the majority of search engines gives back at least by two factors more retrieved results than metasearch engines do, which in turn makes the task of finding relevant ones much more time-consuming (often even aimless because of the time and effort put to check the results' relevance).

In author's opinion, the reason of the situation described above are two characteristics describing search engines, i.e. the number of indexed pages and so-called "page depth" constituting the maximal number of words indexed on a single page [Sullivan 2004].

The number of pages indexed in case of the most popular search engines varies from 2,5 do 8,1 billion, while the page depth ranges from 101 do 500 thousand.

Such big values of these parameters result in a high number of documents retrieved, which hampers getting relevant ones.

Hypothesis 2:

A mean value of *Precision* combined with an average number of documents retrieved determines the competitiveness of search and metasearch engines.

This hypothesis results from the author's conviction that it is impossible to judge the quality of information retrieval tools using one measure only.

Own author's observations together with information from leading companies analysing search and metasearch engines only confirm the above thesis. So, choosing the tool for retrieving information from Internet, one has to follow at least two factors. The *Precision* together with an average number of documents retrieved may constitute the solution.

It seems that the combination of relatively small number of results with high *Precision* (which is equal to the high relevance) is the desired solution.

4.4. Experiment's Results

Because the number of all information retrieval tools available is enormous (the estimations for year 2004 tell of over 900 search engines and over 300 metasearch engines – see: [W3S 2004]), there were examined only eight search and seven metasearch engines.

During the first stage of the selection, there were excluded all tools with no English interface – mainly local search engines (e.g. *AgriBOT* – the one searching only in the Canadian agriculture's databases or *Cycle Search* – looking only for

information concerning cycling). The second stage of the selection resulted in elimination of less known or no longer updated search engines.

The abovementioned procedure resulted in following engines taken into account during the experiment (see tab. 5 for details):

Search engines: *Excite, Google, Yahoo, Onet, Szukacz, AskJeeves, MSN and Alltheweb,*

Metasearch engines: *Emulti.pl, Metacrawler, Mamma, Search.com, Dogpile, Findspot and Bingooo.*

Table 5. Search and metasearch engines examined in the experiment

Search engines	
Name	Web address
Excite	http://www.excite.com
Google	http://www.google.com
Yahoo	http://search.yahoo.com
Onet	http://szukaj.onet.pl
Szukacz	http://www.szukacz.pl
AskJeeves	http://askjeeves.com
MSN	http://www.msn.com
Alltheweb	http://www.alltheweb.com
Metasearch engines	
Name	Web address
Emulti	http://www.emulti.pl
Metacrawler	http://www.metacrawler.com/
Mamma metasearch	http://www.mamma.com/
Search.com	http://www.search.com/
Dogpile	http://www.dogpile.com/
Findspot	http://www.findspot.com/
Bingooo	http://www.bingooo.com/index_e.html

Source: own analysis.

As mentioned earlier on, the experiment consisted of certain queries formulated to check the number of the answers got to determine the relevance of the results obtained. Table 6 presents example results.

Table 6. Results of 10 queries put to the metasearch engine *Emulti.pl*.

	Query	Sort of a query	No. of relevant documents found	No. of all documents found	Precision
1	2	3	4	5	6
1	<i>Katedra Systemów Sztucznej Inteligencji</i>		15	35	42,86%
		in title	0	0	
		" "	10	10	100,00%
		" " in title	0	0	
2	<i>Hybrid Intelligent Systems</i>		32	35	91,43%

Table 5, cont.

1	2	3	4	5	6
		in title	12	36	33,33%
		" "	40	45	88,89%
		" " in title	15	24	62,50%
3	<i>Information Retrieval Tools</i>		24	46	52,17%
		in title	21	64	32,81%
		" "	22	49	44,90%
		" " in title	17	42	40,48%
4	<i>Cognitive Systems Architecture</i>		2	48	4,17%
		in title	2	27	7,41%
		" "	6	9	66,67%
		" " in title	2	16	12,50%
5	<i>Meta Search Engines</i>		20	38	52,63%
		in title	24	62	38,71%
		" "	23	41	56,10%
		" " in title	24	41	58,54%
6	<i>Intelligent Software Agents in Management</i>		8	62	12,90%
		in title	8	49	16,33%
		" "	3	25	12,00%
		" " in title	8	25	32,00%
7	<i>Narzędzia Pozyskiwania Informacji</i>		0	50	0,00%
		in title	0	0	
		" "	0	0	
		" " in title	0	0	
8	<i>Cheap Flights to Portugal</i>		53	58	91,38%
		in title	45	48	93,75%
		" "	55	57	96,49%
		" " in title	47	49	95,92%
9	<i>Systemy Informacyjne Konferencja</i>		0	53	0,00%
		in title	0	0	
		" "	3	16	18,75%
		" " in title	0	0	
10	<i>Tanie noclegi we Francji</i>		2	39	5,13%
		in title	2	11	18,18%
		" "	2	8	25,00%
		" " in title	2	9	22,22%

Source: own analysis.

Wanting to verify hypotheses 1 and 2, one needs to scan the mean values of the *Precision* and a number of results. Figure 5 presents them (excluding the results from the *Onet* search engine).

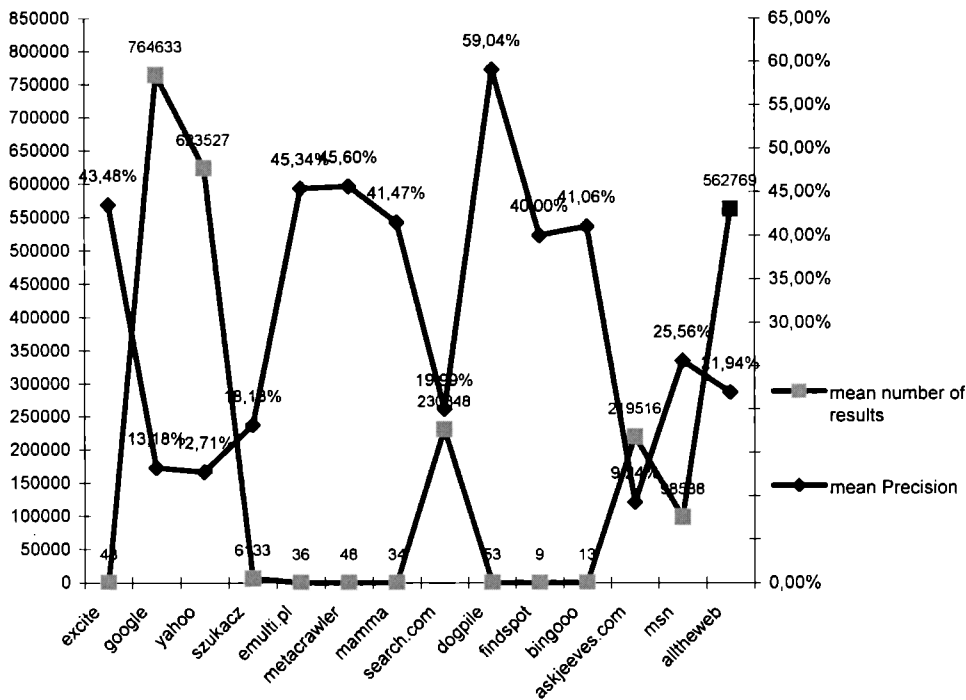


Fig. 5. A mean number of results and a mean Precision for chosen search and metasearch engines
Source: own analysis.

Table 7. Mean values of the *Precision* and number of results for search and metasearch engines

	Mean value of the <i>Precision</i>	Mean value of the number of results
Search engines <i>Excite, Google, Yahoo, Szukacz, AskJeeves, MSN, Alltheweb</i>	18,03%	284396
Metasearch engines (excluding <i>Search.com</i>) <i>Emulti.pl, Metacrawler, Mamma, Dogpile, Findspot, Bingooo</i>	41,78%	32

Source: own analysis.

In the author’s opinion, above results constitute the evidence that using metasearch engines in information retrieval from the Internet is much more useful than using simple search engines (except for the *Search.com* metasearch engine,

which can be characterised both by a huge number of results and a low value of *Precision*).

Analysis of the results presented in Fig. 5 prompt to confirm the first hypothesis. Its proof shall be the following table.

Figure 5 and Tab. 7 confirm that using typical search engines is generally less effective compared to metasearch engines. The latter ones prove to have a higher efficiency in informational retrieval (expressed by the factor of *Precision* – the number of relevant and retrieved documents to the number of all retrieved documents) barely reaching value lower than 40%. Yet, in case of search engines, this factor is hardly exceeding 40%. Furthermore, crucial here is the value of the number of retrieved results. In case of metasearch engines, it is relatively small (except *Search.com*), which makes it easier to extract from the obtained results only the relevant ones. Meanwhile, for search engines this value is much higher and often exceeds several thousand.

Thus, the experiment results apart from confirming the hypothesis 1, incline one to grant the truth to the hypothesis 2.

There can be seen a substantial correlation between the *Precision* and the number of results. It is particularly vivid in Fig.5, i.e. a high *Precision* goes head to head with a small number of results, and vice versa.

Apart from the tools presented in this paper, the process of information retrieval should be supported with more advanced applications like Multi-Agent Systems (MAS) and Distributed Agent Systems (DAS).

5. Conclusions

These days, Information Retrieval from the Web plays a crucial role in management. Getting the right information on time is the task that can be supported by using a wide range of tools, including: search engines, news search engines, metasearch, and specialised search engines. Although, they do not differ substantially from each other (or rather one is unable to tell – due to the lack of sufficient data about how do they really work), the results of the retrieval process show some differences.

In this paper, the author made an effort to compare the effectiveness of both search and metasearch engines. The experiment carried out shows that using metasearch engines gives significantly fewer results, which helps to select only the relevant ones. In case of metasearch engines, both measures used in experiment score better.

Because the market of search engines is constantly changing, the studies began in this paper are going to be continued with evaluation of further range of tools, which fit well into the information retrieval process.

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WYSZUKIWARKI I METAWYSZUKIWARKI W POZYSKIWANIU INFORMACJI – PORÓWNANIE EFEKTYWNOŚCI

Streszczenie

W artykule tym autor opisał najważniejsze wyszukiwarki i metawyszukiwarki internetowe. Główny nacisk został położony na sprawdzenie efektywności obu rodzajów wyszukiwarek. Na podstawie przeprowadzonego eksperymentu autor podjął próbę wskazania najlepszego sposobu użycia tych narzędzi w wyszukiwaniu informacji. Ponadto autor próbował znaleźć odpowiedź na następujące pytania: które z wyszukiwarek są bardziej efektywne od innych i dlaczego oraz jakie czynniki powinny być wzięte pod uwagę jako argumenty świadczące o „jakości” wyszukiwarek.

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