# A Practical and Functional Evaluation of Some Semantic Search Engines

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***Abstract* -- Since the appearance of the first generations of the semantic engines, several comparative studies and categorizations were carried out for the classification of the various semantic approaches. In this paper, we would try to question and to examine some semantic search engines, among the most known and the most informed in the literature. The purpose is not to make a comparative study of these engines, but to try to show the existing possibilities in semantic search, to clarify the most used approaches and to examine some specified higher potentialities (morphological variations, synonymy, generalizations and concepts, natural languages, etc.). Our methodology is based on four search engines that we asked in a particular domain: the tourism domain. We would also try to determine some limitations bound(connected) to the lack of semantic relations between concepts.**

***Keywords-component; Semantic search; semantic search engine; semantic web;***

## I. INTRODUCTION

The last decade saw significant technological developments that have completely transformed the way we seek, use, share and/or manage information. In particular, the *World Wide Web* has revolutionized the way we do research and retrieval of deeper subjects by simply using a few clicks of the mouse. Among the preferred tactics for finding information, users adopt generally browsing with *open directories* and more especially *keyword searching* by using *search engines* to find answers to their queries.

Although, the web search engines provide a default support for the retrieval of information, the results of certain queries can be estimated to several billions pages. It is common for traditional search engines to use techniques such as keyword searching. The research process is typically summarized to match the keywords of a query and keywords associated with the stored information. Users, who are not familiar with the various search tactics and algorithms, may not necessarily find what they seek.

Search engines as tools of access to information, are thus considered as a subject of *wonder* and of *frustration* [1]. The reasons of frustration are generally numerous and can be related commonly by the non-expert users, to the fact that the required information is not online and they are not sure to find it. On the other hand, they don't know how to describe their *search problems*, simply because the engine uses an *unknown jargon* such as the *logical operators*, or then the engine overflow us by *the quantity* and the vagueness of the introduced documents [2]. Wonder can be sometimes due to the fact that some search engines quickly find answers to user requests while this information is not necessarily stored in databases.

Nowadays, the user is all the more amazed to be directly able to get back a precise answer to a composed question [3]. For example, the question `"who is the king of morocco?"` must get the exact answer to the question. Moreover, users are more demanding than the past [4]. The classical query like `"I would like the mountain"` might be enriched by additional constraints such as `"Please find an Hotel in Marrakech with a mountain view"` or `"I like an hotel with fitness center in Marrakech, with a mountain view and practical transportation"`.

So, *other factors of amazement comes from the new potentialities provided by the semantic search engines, namely: the possibilities of asking requests completely in natural language, of realizing automatically a correspondence between the expressions of the user and equivalent expressions, of realizing extensions on synonyms, acronyms, codes, references, etc.* More precisely, semantic search engines as an important application of the semantic web, can probably improve the relevancy of the search. The use of semantic information like meta-data, semantic annotation and concept classification by using ontologies (object and data proprieties), can produce meaning-based searches more relevant to users. The semantic web approach appears in this case more than necessary to improve the performance of knowledge workers, whether they are individual users, private or public companies [5].

Without getting into the details of how the Semantic Web can contribute to improve search, the main goal of this paper is to try to question and to examine some semantic search engines, among the most known and the

most documented in the literature. The goal is not to perform a comparative study of these engines, but to show the existing possibilities in semantic search, to clarify used approaches and to examine some specified higher potentialities (morphological variations, synonymy, general implementations and concepts, natural languages, etc.). This study seems complex and impractical because of the little available data concerning the design, technologies, working and results of semantic search engines. We are also convinced that our initiative does not consider all the approaches and does not treat all the existing tools, but we are however persuaded to capture the main part of the common characteristics and the main used approaches. We propose to proceed using an empirical methodology to examine the answers to chosen queries in a specific domain.

In this paper, it is aimed primarily to present some aspects of the background of the existing comparative studies addressed about semantic search engines. It also provides in the section 3 an overview of our research methodology. The section 4 presents a development of our research question, through the Google search engine considered as the best known and most widely used. In section 5, we present a proposed study of other semantic search engines along the criteria we introduce in Section 2. Finally, section 5 conclude the paper.

# II. Background of comparative studies

The Semantic Web, as was underlined by its creator Tim Berners Lee [6] is a very important initiative affecting the Web [7]. It consists of adding a new semantic layer to the Web to make it readable by humans and machines. Thus, for humans, it is to improve the indexing of content and consequently to improve their research. In this sense, several semantic search engines have emerged; but the design, technologies, working and results of these engines are often kept secret.

However, different comparatives studies exist in the literature. Their application area and their realizations are diverse but often based on a common set of ideas. Most of the studies made in this direction base themselves on criteria such as: *the context of the search, the location, the intention of the user, the interaction, the variation of the words, synonymy, general and specialized requests, matching of concepts and requests in natural language* to supply relevant results of search, etc. Other criteria are surrounded in the literature; it would be for example the architecture of the search engine, its structure (if it is based on ontologies), transparency, user context, query modification, etc. In general, the benchmarks are very mixed. It would take too much space to present all of them and the feature of the used approaches. We present some categorization schemes based on selected comparative criteria, without going into the details of their implementation.

The first point of view was pointed by Guha [8] which presents two goals of semantic search engines. The first one is *to improuve traditional search results with data from the Semantic Web*. The second one consists to use an understanding of the denotation of the search term to improve traditional search. To achieve these goals, this author presents three main criteria to classify semantic search engines. The first one is the *denotation* that is to say determining the concept denoted by the search query. The second is *determining what to show*, that is what relevant data to pull from the Semantic Web. The thirst is the presentation; this need focuses on the format of presented data.

Eetu Makela [8] presents a survey of semantic search engines which is based on some 20 different papers and approaches to semantic search, as underlined by the author. Eetu Makela author distinguish five categories of classification criteria : *augmenting traditional keyword search with semantic techniques by using ontologies, basic concept location (assumption of concepts, instances and relationships, etc.), complex queries, problem solving based on reasoners and connecting path discovery* (by determining the graph connecting the items).

Yuangui Lei [9] by presenting the SemSearch engine proposed a classification scheme based on the user interface that the semantic search engines provide. The user interface corresponds to web forms that allow users to specify queries. In his classification, the author proposes four categories of semantic search engines: *form-based search engines, RDF-based querying languages fronted search engines, semantic-based keyword search engines and question answering tools*, which exploit available semantic mark-up to answer questions asked in natural language format.

Mangold [10] introduces a categorization based on seven criteria: *architecture, coupling, transparency, user context, query modification, ontology structure and ontology technology*. The architecture stand for two classes of engines: (1) Stand-alone search engine and (2) meta-engines which incorporate other search engines as part of the architecture. The transparency denotes the fact that the semantic capabilities of the search engine are hidden to the user. In this case, the author distinguishes interactive systems that may ask the user and others. The coupling criteria indicate if documents are or not committed to any available ontology. The query modification criteria designate if the semantic search engine include a technique where it often exploits information from ontologies.

G.Madhu [11], although his categorization is not focused on the classification criteria, proposed two variations of SWSE: *Semantic Ontology search engines and search engines*. He presented particularly approaches such as the ability to solve complex queries, the ability to direct inference results and system architecture. We note that what most interested the author is: precision, intention of the user and the disambiguation.

Other recent work like [12], summarize the classification scheme of two important variables related to the Retrieval Performance. In this context, they evaluated these variables on two parameters: *precision and recall.*

In the next sections, we will focus our presentation on all of these aspects in the tourism domain. We will particularly present our methodology,

# III. Research methodology

## A. The Scope of the Methodology

Although several comparative studies of semantic search engines are available as shown in the above section, only a few of them have focused on practical considerations. While these studies addressed good answers to the classification schemes, it remains, in our opinion insufficient to better assess the performance of semantic search engines. However, they are based on a common set of ideas, the comparative criteria are often purely technological (architecture, ontology, etc.), and other practical aspects were ignored. We distinguish in our generalization a few exceptions of work, as presented above.

Currently, a wide range of semantic search engines exists. Let's name for example, Simple HTML Ontology Extensions (SHOE)[13], TAP [14], Intelligent Semantic Web Retrieval Agent (ISRA) [15], Semantic Content Organisation and Retrieval Engine (SCORE)[16], Ontogator [17], WebSCSA [18], Swoogle [19], Hakia [20], Senseboot [21], Swangler [22], a dynamic reasoning engine [23], [24] SemanticMiner, Ontoseek [25] and KAON [26].

It would be absurd to try to compare all the existent semantic search engines. In our discussion, we propose to question and to examine some of them, among the most known and the most documented in the literature. For that, we chose to study four of these engines: *Hakia, Kngine, SenseBot and Google*. The search engine Google is naturally imposed in our step, seen that it is popular and it begins introducing semantics really as we shall see it afterwards. In adition, to give sense in our presentation, we chose to become restricted in a single domain: the tourism domain, seen that we work on tourist ontologies.

## B. The Categorization Scheme

The categorization scheme we use to classify different semantic search engines is based on functional and linguistic considerations, like: the morphological variations, the synonymy, the generalization and the extension on connected concepts and the suggestion of search. According to [27], these characteristics can be summarized as follows:

- The morphological variations - A semantic search engine is supposed to manipulate all the morphological variations (the time, the plural, etc.) on a substantial base. In other words, the results do not have to change if we seize `"to reserve"` and `"reservation"`, or `" hotel "` and `" hotels "`, for the plural etc. The questions `" to reserve hotel "` and `“reserving hotel”` can illustrate the morphological quality of a semantic engine;
- The synonymy - A semantic search engine must be able to manipulate synonyms (amazigh, tamazight, Berber, kabil, etc.), in the good context and with the common sense;
- The generalization- A search engine manipulates the generalizations when the request is expressed in a general form and when the expected results are specific. The example of the question " what are the types of accommodation? " normally has to give rise to an exhaustive list of answers, namely: hotel, hosts' house, campsite(camping), etc;
- Extension on connected concepts - suggestions of search. A semantic search engine has to supply cuttings segmentations, relations made between the subjects. This level generally arises from an ontology. It consists of semantic links between concepts (travaille_avec, est_relié_à, interagit_avec, etc.). This type of semantic extension can be used to suggest an automatic extension of the searches by using in a relevant way the semantic links;
- The natural language and the questions - A semantic search engine is planned to answer sensibly when a request is asked in the form of question (what, where, how, why, etc.). The main task of a search engine is to classify the results of search in a most logical way so that the answer to the question establishes a single entity. The semantic engine must be able to answer directly and not to supply a list of pages, but especially a specified answer to a composed question. Furthermore, the user of a semantic engine has to ask his question in natural language;

These types of extension largely meet the needs of a tourist as a user of search engines. During this paper, we show through a certain number of examples how these extensions are taken into account by the chosen semantic engines.

# IV. Google and Semantics

Google has often been seen as a traditional search engine. Google questions its engine by means of the principle of keywords using the famous algorithm of "PageRank" [28, 29]. This algorithm bases itself of on vote for a page. So, more a page receives votes (inbound links), more it will be considered as relevant for Google. But the important question is not directly related to the value and relevance of the latter. Similarly, the choice depending on the keywords limits Google's vision, in the sense that the semantic extensions are absent.

It is true that Google has not often been associated with the semantic search. This was certainly true a few years ago, but if you look closer, some semantic processing are already managed [30]. Thus, contrary to received ideas, Google has put the Semantic Web in structuring the unstructured data. It has also improved its search algorithm and proposed a longer description of the results.

We can also add the fact that it is expanding the semantic field and includes concepts related to the keyword. It was also interested in the social networks such as Twitter, for research in real-time [31]. Google also seems to answer user's questions, instead of using only keywords. Thus, it is true that recently, some curious answers of Google, including the birth dates, other facts, or the family ties, Google answers the question directly instead of proposing a list of page. It works for now more in English.

Let us take for example the question ″ `Who is The King of Morocco` ″. This question will return us the first result (Figure 1):


Figure 1. Answer of "who is the king of morocco"

Other questions such as: ″ `Is amazigh a language?` ″ will have as answer: The berber language (Figure 2)


Figure 2. Answers of « Is amazigh a language?".

We note in the above answers several important elements. - This is the first result that is the answer to our questions. Google seeks to answer sometimes by using the Wikipedia Tool. One might think that Google extract important information from both the `question "King of Morroco"`, and our question does not have the answer "Mohamed IV." Google For the second question, whether it extract single "Amazigh" and "language", his answer contains the word "Berber" which is synonymous with "Amazigh".

Similarly, if we continue our questions, two questions ″Is Amazigh arab? ( or in plural "Are Amazigh arabs? ( does not change the result. This suggests that Google uses morphological variations. It appears, therefore, that in the collected responses, Google performs treatments on requests.

We note, however, that the response to complex queries such as: (I want to discover the mountain Amazigh culture - answers sometimes mixed with as a first response "at the heart of the mountains and landscapes Sahrawi Amazigh". In the text of the resource found a mountain guide suggests visiting "the Matmata Mountains south of Tunisia." If we simplify the query by asking ( discover the Berber culture mountain", we can get more information on the sites most classified, we can get deeper into the answers "rental mules, introduction to Berber and discovery tours, etc.." are of course sponsored links.

We can note however that the answer to complex requests such as: "*`I wish to discover the amazigh culture of mountain`*" - provides mitigated answers, with as first answer "*in the middle of mountains and Sahrawi amazighs landscapes*". In the text of the found resource, a mountain guide suggests visiting "*the mountains of Matmata in the South of Tunisia*". If we simplify the request by asking `"to discover the Berber culture of mountain"`, we manage to obtain more information on the most classified sites, we manage to have further in the answers "*Hiring of mules, initiation to the Berber language, and circuits of discovery, etc*", they are in fact a list of sponsored links.

# V. Some Semantic Search Engines

## A. The Search Engine HAKIA

Hakia is a search engine designed to provide search results based on the meaning of their content rather than page's popularity (or PageRank) [20, 32]. During the indexing stage, the search engine focuses on the age of the web content as well as the credibility of the source. Hakia uses a semantic classification algorithm proposed by OntlogicalSemantics [32], which is strongly based on the ontological semantics and the computational linguistics. This algorithm is based on a concept called OntoSem, it is a linguistic database where words are classified according to their different meanings. The semantic classification algorithm allows the semantic decomposition of the sentences, which is similar to a morpho-syntactic analysis.

During indexing using the QDEX algorithm (Query Indexing Technique)[33], each page is parsed and the algorithm extracts all requests leading to this page. Another feature of Hakia classification system is based on the algorithm SemanticRank. Similarly, the novelty of Hakia concerns the search results that are organized into tabs: Web results, credible sites, images, videos and news.

After this characterization of tools used by Hakia, we are now trying to do some tests in comparison with Google. If we take the same queries proposed Google, let us consider the following question, that is : "Who is the king of Morroco? (, the result is almost identical to that of Google (Figure 3), namely:


Figure 3 Answers of « Who is the King of Morocco?".

The first result is the same as Google, but the results that follow are more recent and have the Moroccan constitution being changed and the relationship with King Mohammed IV. The following answers are quite relevant as they show the royal family with a link to King Hassan II, who is the father of current reforms links, etc.. The links are recent, using semantic relationships (relationship with King Hassan II). In addition, the resource classification is done according to the categories: Web, Credible News, Blogs, etc. The number of responses is not very large and contains only five pages. Unlike Google, the time taken to respond is quite large compared to Google. We also note that the first response is based on the Wikipedia.

For question (Is Amazigh language?(, the result is completely different from Google. Hakia presents a result explaining the terminology of the Amazigh language, which is a research paper. The second result comes from Wikipedia and considers: the Amazigh as a language of the indigenous people of North Africa. Sixth, it has the Berber alphabet or "Tifinagh", while the word Amazigh does not exist in the source, only the word "Tamazight" figure. Here we see that the synonymy is treated. In the News part, some semantic links appears linking the amazigh language with the culture. Google focuses more on the words "Amazigh language" or "Berber Language" although he gives the answer to the question in the first place.

Regarding the question: "Is Amazigh Arab? (, the answer is classified in the first place and it is similar to Google. The answer to this question lies on one page with semantic links. The question: (are Amazigh Arabs? ( does not, however, the same result as the previous one. We can conclude that the morphological analysis is less important than the semantics or the answer to the question.

For query (discover the Amazigh Culture(, the answers are more relevant. First, a document entitled " `Where can I find information about Amazigh culture?` " is presented from the source Yahoo! Answers. On complex queries such as "`discover the amazigh culture in mountains`", impressive results are presented with a hotel in southern Morocco in the mountains of the Zagora region, with a perfect incentive to discover the Berber culture. The following answers are also relevant because they are: Kabyle culture and mountains, discovering music, attractions such as the festival of Imilchil.

## B. The Search Engine Kngine

Kngine uses a knowledge base called 'Kngine live Objects' that consists of more than 1 billion information with 7 million concepts [34]. This knowledge base is used to determine: synonyms, relations between concepts, the meaning of concepts, document classification, analysis and context-based fuzzy search. According to the same source as before [34], work in progress includes: indexing technology called "Snippet Search". This mechanism has a goal to provide the user with rich paragraphs showing content resources, without being opening them.

Kngine offers interesting functionalities that we explored according to requests studied in this paper. Firstly, we can mention disambiguation. For example, for the query "`Amazigh`", Kngine has two meanings in two different tabs: `"Berber people"` and `"Berber Language"`. From there, we can first deduct that it also manipulates synonymy, by offering term `"Berber".` It also manipulates morphological variations; in fact, the outcome is the same if you enter `"Amazigh"` or `"Amazighs".` Kngine offers directly answers to questions (Fig. 4), and to the `question "Who is the king of Morroco? "`, the answer is placed in the first line, possibly with a photo, a map of Morocco and additional information (number inhabitants of Morocco, language, etc.).

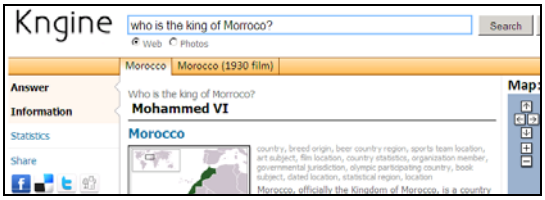


Figure 4 : Aswers of « Who is the King of Morocco?".

## C. The Search Engine SenseBot

SenseBot introduces an interesting interface including several engines that can be questioned to such as: Google, Yahoo, Bing, and SenseBot (Figure 5). Besides, research is offered in several languages [34].

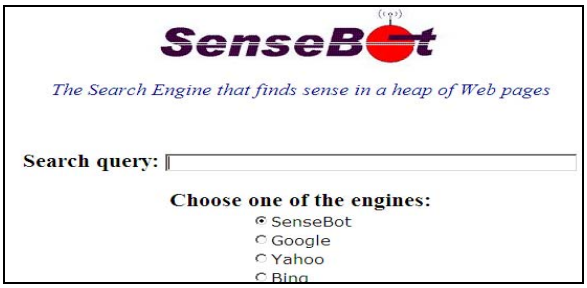


Figure 5. Interface of SenseBot

For key word "amazigh", we can conclude the use of synonymy by offering the term "berber". On the contrary, the usage of the plural changes absolutely deals, and results are not the same. The answer to request "King of Morroco" give a generic answer showing the list of the kings of the world, without introducing a direct answer. Using French, we find the answer to the query in the first position, of course based on Wikipedia. Other Answers are also interesting and current (visit of the Minister of Tunisia to Morocco, etc.).

Other requests such as "The Amazigh people are Arabs?", gives rise to interesting sites, also providing a list of important research topics. For query " to know Amazigh culture", a set of links dealing with major events related to the Amazigh culture are proposed; such as music, festivals, etc. In answers, we can see the reference to the forums. However, we can observe the absence of Berber traditions.

# VI.Discussion

Through our questionings, we can see the alignment of the most part of the introduced engines (including Google), compared to semantic criteria chosen. Apart from a few imperfections, most of the criteria are checked and proved.

In comparison with chosen criteria, the majority of the questioned engines answered negative to the morphological variations of plural. The answers of requests in natural language are precise in the case of questions with unique concept or in the case of simple questions.

For the synonymy criteria, generalization or the extension of request, we noticed the alignment of the majority of the engines by provision in these criteria, although technologies and used algorithms must be ameliorated to augment the expressiveness of the semantic field.

The basic views of a semantic search are identified in our questionings. Compared to Works like [37], [38] and [39], some of the functionalities are implemented, like the using of ontologies, basic concept location (assumption of concepts, instances and relationships, etc.), and the answer to some complex queries, as we presented above. So, some search engines such as SenseBot (Fig. 5) use meta-engines as introduced in [38]. The Swoogle search engine for example (http://swoogle.umbc.edu/), offer an interface leading to ontology.

For the idea of interfaces pointed by Yuangui Lei [40] is also proved in our paper. For example, SenseBot offers a specific interface showing three search engines, as well as the possibility of having several languages. We can also note some important new questions as interfaces that are more or less open and sophisticated (using links to Google, Yahoo, Bing, etc.), the categorization of responses (Web, credible sites, images, videos and news, etc..), the presentation of recent information, the use of Wikipedia, etc.

# VII.Conclusion

Semantic search technology has just beginning to make its mark. Thus, as we could show in this paper, semantic engines are not so numerous. Among those we have selected four known and the most documented ones, the goal is to try to show the existing possibilities in semantic search, to clarify the most used approaches and to examine some specified higher potentialities (morphological variations, synonymy, generalizations and concepts, natural languages, etc.). Examples of applications that we examined were related to a particular field that is the 'Amazigh culture' in relation to tourism. It is true that some engines are better than others on certain specific points. We have not really taken a position on the answers and mostly we avoided prepare a comparative table, although this was done implicitly.

We can discuss for a long time and test the way which have the semantic search engines to answer us, but the conclusions can only be speculative, since the technology and used algorithms are confidential. But, all of these features combined, will give some impetus to the semantic search. In addition, as we present below, the specialization to a specific domain is probably important.

All this makes us think that these systems have complementary capabilities, and sometimes sources of wonder. We believe that the integration of specific ontologies can improve some research in the field that we examined. In this context, we plan to continue this work by testing our own ontology of Moroccan tourism (OMT) that we have already published; to improve it and to build a specific semantic search engine of tourism in Morocco.

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