ABSTRACT
Within the past few years, many patterns and principles have been proposed towards the enhancement of search user interfaces and experience. However, to access and explore information efficiently is still significantly challenging. Recently, we have seen the rise of a new kind of information retrieval approach, the so-called semantic search systems. These systems promise more accurate results while exploring semantics of the data. Although there exist several search user interfaces tailored to semantic search, there is still a lack of usability studies as well as good practices. In this work, we discuss the applicability of traditional search user interfaces in semantic search systems. Furthermore, we propose a new interaction model based on four patterns: Poli-Communicative, Discrete Display, Heterogeneous Data-face and Dive in-place.

Keywords
Semantic Search User Interface, Interaction Design, Human-Computer Interaction, Semantic Search

1 INTRODUCTION
Although significant efforts have been devoted to research and development of search engines, the search is not a solved problem. In fact, users still find it challenging to access and explore information. With the advent of the Internet, personal computers, mobile devices as well as Smart TVs, the amount of information generated by users is increasing day by day. More and more users resort to search engines to find the information needed. Indeed, search engines are shaping how we access and learn information. However, apart from the sophisticated algorithms behind search engines, there are other aspects as important as a good search algorithm: the user interface.

User interfaces are the gateway of the search engines, they facilitate users to find, explore, and understand the information. Since the inception of the first search engine [3], many ideas have been developed to enable and facilitate content access and exploration. Some of these ideas have become repeatable good practices to solve common problems and thereby have been established as patterns. Examples of such patterns are Faceted Search and Autocomplete.

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In this work, we discuss the applicability of search patterns and propose an extension of those for semantic search interfaces. By semantic search, we do not restrict our view to engines that make use of RDF data, but to applications that try to understand the searcher’s intent by using the contextual meaning of the terms in the query. Moreover, we extend the concept of semantics to visual aspects of the results been displayed to the user. As it is shown by many researchers [5, 8, 9], these aspects do influence the user’s cognitive perception and thus should be explored. Our aim is to develop a semantic search user interface as part of the openQA framework [7]. openQA is a framework designed for fast and easy development of questions answering and semantic search approaches. The remaining of this paper is structured as follows. Section 2 discusses four patterns for semantic search that we propose. Finally, Section 3 concludes with an outlook of the future work.

2 A SEMANTIC SEARCH USER INTERFACE
In this section, we present and illustrate four patterns – (1) Poli-Communicative, (2) Discrete Display, (3) Heterogeneous Data-face and (4) Dive in-place – that extend the ten previously introduced patterns. Some of the proposed patterns are (partially) implemented in some of the existing semantic search applications, but they were not previously defined [8]. The four patterns are based on user experience as well as an analytical review of the literature.
2.1 Poli-Communicative

The Poli-Communicative pattern is about the query type and presentation of the result. Semantic search systems are becoming smarter every day. In the past 24 years, search interfaces have changed from supporting simple text \(^3\) to gestures \(^6\). However, a fundamental principle is that all aspects involved in a search are related to the communication process. Communication “is the purposeful activity of information exchange between two or more participants in order to convey or receive the intended meanings through a shared system of signs and semiotic rules” \(^1\). Thus communication is a complex process in which the goal is to transport a message from one interlocutor to another. There are two categories of communication: (1) verbal and (2) non-verbal. Some of the non-verbal communications include, but are not restricted to, gestures, facial expressions, eyes contact and even behavior. Furthermore, search interface users can have cognition problems or environmental disturbances such as noise environments that can affect their interaction and understanding. Thus, we propose that a good search interface should be a good interlocutor, that is, be poli-communicative.

The interface should be able to communicate efficiently in different ways. An efficient search interface is able to interpret different input formats and present the results in a comprehensive and customized manner to the users. A good example is a teaching class. Teachers in a classroom use a wide range of communication methods to transmit the knowledge. For instance, when a teacher asks a question to his students, those who raise their hands are indicating that they want to answer the question. The professor then uses his hand to indicate which student should answer. In this scenario, the communication interchanges between verbal and gestures. Other scenarios can impose interaction restrictions. The interlocutors involved in the communication process choose unconsciously or consciously the most efficient communication method which is available. The interaction between the user and a search user interface should flow likewise. The user should be able to use all the available communication methods for querying. The interface, on the other hand, should present the result efficiently. For instance, when being in a noisy environment, typing might be a better communication option. However, when cooking or practicing sports, the use of voice might be a better option.

The case of “Vossa mercê” Vossa mercê is a pronoun in Portugues language that means in yours concession or in yours grace. During several years, this pronoun has evolved to other forms, chronologically, vossemecê, vosmecê, vancê and later você. In Brazil, its evolution did not stop which had generated other colloquial forms, more often used in Minas Gerais state, as oce and cê. With the advent of keyword typing, the last colloquial form was expanded to just cê. The case of Vossa mercê is important to (1) show that efficient communication also affects the language, which, in this case, means the use of the shortest number of symbols to express the same thing. We call it ‘express more and say less’. Another important observation illustrated in this case is that (2) communication through devices does not use the same sort of symbols as speaking or writing and (3) it usually tends to be more efficient. That makes the design of search user interfaces a hard task.
We propose that semantic search interfaces should not limit themselves to merely support Natural Language techniques such as query expansion or better understanding complex queries, but be poli-communicative. That is, displaying the information more efficiently, embracing users with cognitive difficulties as well as the many aspects of the communication process.

2.2 Discrete Display

Information can be more or less important for a given input query. Krug et al. [5] argue that users spend a little time reading most Web pages. Instead, they scan, looking for words or phrases that catch their eye. Therefore, Krug concludes that clear visual hierarchy is the best way to make a page easy to grasp in a hurry. Most of the semantic search interfaces restrict the differentiation of result relevance by its position in the resulting list. However, the layout is very important for user’s interaction and perception, it has to be with the organization of the data being displayed.

We propose that the relevance of an information should not just affect its position, but also its style as well as the mode it is being displayed with. For instance, data with more importance should be displayed with more details and more evidence (big fonts, big boxes, big images) than other data. Google’s interface provides these capabilities to some extent. For instance, when displaying the result for the query “Michael Schumacher” Google shows the required information on the right while the documents sorted by relevance are on the left side. However, the user might be looking for the result in the right, but when displaying documents on the left, Google is clearly giving more emphasis to the documents.

This design pattern clears is inconsistent with usability studies [2, 9, 4] that shows that user’s attention follows the same read/write patterns (F-Shaped Pattern). That is, the user’s attention goes descending from left to right and top to bottom. Furthermore, the documents are being displayed with the same font and emphasis. The only apparent difference is the position in the result list.

Figure 2 shows one of most emblematic examples of Discrete Display, the newspaper. The newspaper displays information accordingly with its relevance. The most relevant information occupied more space, have bigger fonts and appears on the first pages. Figure 1(a) depicts an example of Discrete Display for semantic search interfaces in which the most relevant result is positioned on top with more evidence.

2.3 Heterogeneous Data-face

A good semantic search interface should support different data presentation. Most of the data semantic search interfaces do not take into consideration the type of data being displayed. Heterogeneous Data-face (HD) is an extension of the pattern Structured Results. The main difference is that Structured Results is about having structured data in the result page mainly focusing on user’s intent, while HD is about displaying results from different data sources in the resulting page—e.g. video, audio, documents, structured information, and image. Data can have different types and properties, thereby are heterogeneous. In this sense, a good semantic search interface must support different types of data presentation. Many search interfaces already explore this concept such as Google, Yahoo, and Bing. For instance, geographic data can be displayed on a map while video can be displayed in a video canvas. However, there is still a place for improvement. One example is the result displayed in Google for the query “videos of formula one”—Figure 3—in which there are documents instead of the required videos.

The problem is that—for the previous query “videos of formula one”—there is a need to switch between different tabs (Web, Video, among others) in order to obtain the required information. One of the big challenges is how to improve the way the content is being displayed. Although there are different contents related to the query (e.g. Video, Web pages, and Structured Data), the top one structured information is displayed on the right and the top ten documents are listed on the left. These patterns often repeat between semantic

https://www.nngroup.com/articles/f-shaped-pattern-reading-web-content
search engines, but: (1) Why not display videos, images and other content related to the query? and; (2) Why—instead of displaying the top one structured data and top ten web pages—search engines do not display the top ten results, independently of the data type?

We propose that semantic search interfaces should have a heterogeneous data-face. Figure 1(a) shows a semantic search interface displaying heterogeneous results, an example of the pattern HD. The given example also implements a better version of Actionable Results than the one used by Google in Figure 3. Different from the previous models, it can promote a better interaction experience to users because all query related contents are displayed in a single canvas where it can also be activated.

2.4 Dive in-place

Dive in-place is an extension of the pattern Actionable Results. The idea behind this concept is that the interface should be self-contained. That is, the user should be allowed to explore the displayed information in-place. Dive in-place is not the same as Faceted Search. Faceted Search necessarily involves a change of the elements in the view and is also known as Faceted Navigation or Faceted Browsing, which involves the application of filters. Dive in-place is followed close by the design principle of Cooper et al. [1] that emphasizes as a good design principle the reduction of places to go. According to Cooper, reducing the number of screens, pages, and modes on Web sites increases people’s ability to stay oriented.

Dive in-place involves the addition of new elements, it allows a more detailed version of the content without leaving the view. Some applications implement this pattern as a modal window or as a more button, where a detailed content is revealed to the user. However, a good example of Dive in-place is the Google’s Image tab which allows users to interact with the images by giving an expanded version in-place. Different from the Image tab, a bad example is the Map tab. When a user requests the Map tab of the current search, the content is displayed in a new page. Good behavior is to open an extended view in-place in the same canvas in which the user can interact with the content. Search engines, usually force users to open the content in different windows in order to find the information needed.

By switching back and forth in order to find the information, the exploration can become tedious. Dive in-place is a good pattern to avoid such an experience. Figure 1(b) demonstrates the pattern Dive in-place in action. In the given interface, an extended view of the page content is shown enabling further exploration.

3 CONCLUSION AND FUTURE WORK

In this work, we presented four patterns for semantic search interface: (i) Poli-Communicative, (ii) Discrete Display, (iii) Heterogeneous Data-face and (iv) Dive in-place. As future work, we plan to do an extensible and detailed evaluation as well literature review. We see this work as the first step towards the enhancement of semantic search user interfaces.

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5 REFERENCES