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A Secured Cognitive Agent based Multi-strategic Intelligent Search System

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KEYWORDS

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Abstract Search Engine (SE) is the most preferred information retrieval tool ubiquitously used. In spite of vast scale involvement of users in SE's, their limited capabilities to understand the user/searcher context and emotions places high cognitive, perceptual and learning load on the user to maintain the search momentum. In this regard, the present work discusses a Cognitive Agent (CA) based approach to support the user in Web-based search process. The work suggests a framework called Secured Cognitive Agent based Multi-strategic Intelligent Search System (CAbMsISS) to assist the user in search process. It helps to reduce the contextual and emotional mismatch between the SE's and user. After implementation of the proposed framework, performance analysis shows that CAbMsISS framework improves Query Retrieval Time (QRT) and effectiveness for retrieving relevant results as compared to Present Search Engine (PSE). Supplementary to this, it also provides search suggestions when user accesses a resource previously tagged with negative emotions. Overall, the goal of the system is to enhance the search experience for keeping the user motivated. The framework provides suggestions through the search log that tracks the queries searched, resources accessed and emotions experienced during the search. The implemented framework also considers user security.

Abbreviations: BDI, Belief Desire Intention; CA, Cognitive Agent; CAbMsISS, Cognitive Agent based Multi-strategic Intelligent Search System; CIMM, Cognitive Information Mapping Model; COGSEMO, Cognitive Search Engine based on Emotions; MsIS, Multi-strategic Intelligent Search; OTP, One Time Password; PSE, Present Search Engine; Q, Query; QRT, Query Retrieval Time; R, Resource; RDJI, Retrieved Documents Judged Irrelevant; RDJR, Retrieved Documents Judged Relevant; SE, Search Engine; SQ, Semantic Query; Webcam, Web Camera

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1. Introduction

The size of the Web is growing at a very fast pace with billions of websites available today. Majority of users use SE's as the main tool to retrieve information from this huge repository (Rangaswamy et al., 2009). The scalability of the Web and everyday growing number of users poses formidable challenge to the SE's. The users submit their information needs to the SE's in the form of query consisting of a sequence of 2–3 keywords (Barr et al., 2008; Guo et al., 2009). In the present scenario, there is gap between the user's needs and results retrieved from the SE's. The reason attributed for this is the inability of the SE's to understand the user context for the query (Gulati and Garg, 2015a). As, the SE's do not understand the relations among concepts embedded into semantic annotations (Lamberti et al., 2009), therefore, understanding the user context presents another major challenge. This leads to inappropriate understanding of the query and thereby results in irrelevant retrieval i.e. retrieving from varying ranges of the query (Alafif and Sasi, 2012). Thus, the user needs to reframe the query multiple times to retrieve the relevant results.

Emotions are pervasive in online environment and certainly affect the user engagement in search activity, motivation to persist search in the face of irrelevant retrieval and desire to stay on the task. The method used to perform search and alternatives chosen are greatly influenced by affective states (emotions) experienced during search process (Flavian-Blanco et al., 2011; Kim, 2008). In addition, emotions that arise during search also act as "affective filters" for the user to evaluate the relevance of information (Nahl, 2005). The ill-defined tasks may put more strain on the user emotions (Kim, 2008). Emotion control has a significant effect on search behavior and users with different levels of emotion control tend to search Web differently (Kim, 2008). Overall, the search process ends with positive emotions if the user feels good and enjoys the search. In contrast, negative emotions generated from negative task-related feelings decrease the performance. The feelings of anxiety, fear and nervousness generated during the user interaction with computers influence the user's performance on computer related tasks and other affective processes (Liaw and Huang, 2006; Yee et al., 2004). Users with lower emotion control are more likely influenced by negative feelings spawned while working on complex task; and their performance might suffer. They are less likely to handle pressure well, which might make them stressed and distracted, therefore making more frequent, hasty and inefficient search moves. The work thereby suggests providing a mechanism to decrease cognitive and affective burden on the user to prevent stress and getting distracted during the search process.

Keeping this in view and the problem of irrelevant retrieval, there is a need to keep the user motivated during the search process. For this, the authors have suggested to include user emotions as a crucial parameter in the design of a Multi-strategic Intelligent Search System based on user context and emotions. Since, a CA as defined by (Lawniczak and Di Stefano, 2010) performs the cognitive acts of perceiving, reasoning, judging, responding and learning in a way similar to human beings, it is suggested to design a Cognitive Agent based Multi-strategic Intelligent Search System. Belief, Desire and Intention as described by (Rao and George, 1995) are the three components that constitute the "brain" of the agent in the proposed work.

2. Research contributions

Contributions of this research fall into the following categories:

- Clear knowledge of problems of the SE's from the aspect to achieve user satisfaction during search process.
- Framework called Secured Cognitive Agent based Multi-strategic Intelligent Search System (CAbMsISS) to perform search based on the user's cognitive style, context, emotions and timestamp.
- Implementation of the Secured CAbMsISS framework called COGSEMO to improve user satisfaction in terms of QRT, Precision and Proportion of RDJI.
- Analyzing the results retrieved and comparison of PSE: Google with Secured CAbMsISS.

The organization of the paper is as follows: Section 3 gives an overview of unsolved problems of SE's and the need for MsIS. In Section 4, we present our proposal for a Secured CAbMsISS framework. Different sub-sections in this section describe the functionality of the proposed framework. Section 5 elucidates the implementation of Secured CAbMsISS framework (COGSEMO) along with the experimental setup. Graphs and tables present the performance evaluation of the implemented framework in Section 6 followed by conclusion and future work in Section 7.

3. Problem formulation

The incapability of the SE's in understanding the searcher's diverse needs, choices and feelings experienced during the search process yields superfluous and useless information. Fig. 1 shows the result set obtained from PSE: Google (as on 20th Jan 2016, 11:26 am) for the query (Q1) = ns3. The user's context for Q1 was to fetch content related to nonstructural protein 3 (ns3) found in Hepatitis C virus. But, none among the top 10 results related to the protein ns3. Instead, the entire result set was associated with the theme of computer science. In this case, Proportion of RDJR = 0 i.e. Precision = 0. The SE's cannot determine the user context (motive/interest area) while searching (Gulati and Garg, 2015a). Instead, they are dependent on the searcher for formulating the query using all the required keywords.

The query (Q1) was restated as Q2 = ns3 + protein for retrieving the relevant content. The result set retrieved by PSE: Google (as on 20th Jan 2016, 11:35 am) for Q2 is presented in Fig. 2. The resources (results) obtained are consecutively numbered as R1, R2 and so on for elaboration. The following actions were performed on these resources: R1 – read (click the resource to open it), R2 – read and save (store it), R3 – read and found frustrating and R8 – read and save.

The user can manually save any resource for future using the following feature of the Web browser:

- adding the resource to the favorites (Browser – Internet Explorer),
- creating bookmarks (Browser-Mozilla Firefox, Google Chrome and Apple Safari).

This aspect relates to the browser and not to the SE, hence if the user shifts to another Web browser, then the favorites or

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