

CoZpace: A Proposal for Collaborative Web Search for Sharing Search Records and Interactions

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Abstract—Today’s search systems are mainly designed for one user to use individually. Search activities in practice can, however, be conducted by two or more users working together. This is due to the fact that information seeking tasks are complex and often requires multiple users’ efforts to collaboratively assess and search for relevant information. In some tasks, there is a large amount of information to search or such information requires human intelligence to judge whether it is relevant to information needs. This paper introduces the development of collaborative search system, named “CoZpace”. CoZpace is a Web-based application, which allows a pair or a group of users to create a collaborative search task. Within the created task, a user can invite and communicate with other members in a group, share search history records, and mark search results considered relevant. We also propose a newly developed feature, called “snapboard”, to support collaborative search activities. With the snapboard, users are allowed to take a snapshot of a part of focused information in a Web site and then share it among collaborators on a display board. A user can mark it as relevant or comment it for further reviews of other collaborators.

Keywords—CoZpace: Collaborative Search Activities; Information Retrieval; Explicit Collaboration; Synchronous and Asynchronous Collaboration

I. INTRODUCTION

Searching information on the Web is a non-trivial task. The amount of Web information is considerably large and it is not originally structured for search. Although many commercial search engines are available, they are typically designed for one user to use independently. In fact, information seeking is considered *not* a solitary activity [1]. Two or more users can carry out search by working together. This is because information seeking tasks are complex and require users to review a number of different documents. Users have to explore and assess all aspects of possible relevant information and finalize the outcome of their search into a summary of relevance to the tasks [2], [3]. In these tasks, multiple users can collaboratively work on searching information towards the same goal.

In this paper, we present a new collaborative search system named “CoZpace”. It is designed for a pair or a group of people with the same information seeking goal to perform search together. Also, CoZpace provides support for group awareness¹. We also introduce five main features of CoZpace: instant-messaging, commenting on a web page, recording activity history, marking a relevant web site, and taking a

¹Group awareness is to provide information to all group members about the status of search tasks and the activities of other collaborators at a given time. This does not matter how people search together synchronously or asynchronously.

snapshot of focused information. This last is a new feature called “Snapboard”. The system is a Web-base application using HTML, CSS and JavaScript.

The rest of this paper is structured as follows. In section II, we describe background and related work, followed by a survey of related collaborative search systems. Section IV explains a use case diagram and technologies behind the application development. Section V illustrates the architecture and design of CoZpace as well as all its features. We summarize our proposal in section VI.

II. BACKGROUND AND RELATED WORK

A. Dimensions of collaborative search

In collaborative search, the points of view of two dimensions, i.e., time and user’s intent, are described as follows.

1) Time-Based Collaboration

Synchronous collaboration is a real-time collaboration. Collaborators can work at the same time either in the same place or in the different places. Its immediacy helps users make a plan, solve a problem and make a decision together faster. A possible synchronous communication is, for example, a chat session.

Asynchronous collaboration collects activities of collaborators, e.g., chat history and query history, and then display them to other collaborators who come to search at different times.

2) User’s Intent

Implicit collaboration is a scenario in which one user can work with others without awareness of collaboration. For this type of collaboration, a search system exploits collaborators’ behaviors, e.g., relevant feedback, to improves search results of another user.

Explicit collaboration is a collaboration that users work together directly to carry out search tasks. For example, one user discusses about search plan with other users by instant messaging.

B. Studies in Collaborative Search Activities

Different collaboration styles may greatly affect user’s search actions. Yue *et al.* [4] compared the processes of searching activities in three different conditions given as follows: *i*) Collaborative search with explicit communication, *ii*) Collaborative search without explicit communication and *iii*) Individual search.

Despite the increasing of specifically designed tools to support the collaborative web search (e.g., Coagmento [1]

and SearchTogether [5]), most users commented that they hardly utilized advanced functions given by them such as video conferencing or shared screen projection. Morris [6] described that even though those functions offer rich collaborative experiences, users prefer using simpler functions for collaboration, e.g., e-mail, texting, instant-messaging, phone calls, and social networking.

III. RELATED SYSTEMS

1) *Coagmento*: [1] is a Firefox plugin that helps multiple users work in collaboration. It includes a toolbar and a sidebar that allows users to communicate, share and organize information among collaborators.

2) *ResultsSpace*: [7] is designed for a small group to collaborate asynchronously. Its user interface supports the awareness of previous and ongoing actions of collaborators. Capra *et al.* [7] presented the main features of ResultSpace, including collaborative ratings and displays embedded into search results, a results filtering mechanism, a peripheral display of past queries of collaborators.

3) *Search Together*: [5] is a prototype that allows remote users to synchronously or asynchronously collaborate while searching information. The system supports users to collaborate both the processes (e.g., formulating queries and choosing result to explore) and products (e.g., commenting on, rating found items and creating a shared summary).

4) *CoFox*: [8] provides a synchronous collaboration of a pair of users, i.e., the local user and remote user, as if they are co-located. The system has two interfaces: *i*) The local user area allows the local user to perform search by using, for example, tab browsing, search for text on a given page, etc. *ii*) The remote user area is a real time video streaming that shows what the other user is doing.

IV. SYSTEM ANALYSIS AND DEVELOPMENT

A. Use Case Diagram

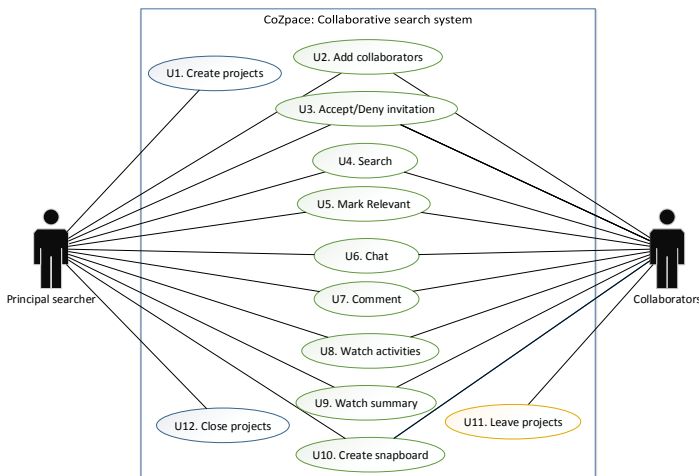


Figure. 1: Use case diagram of CoZpace

We show a use case diagram of CoZpace in Fig. 1, representing the user's interactions with the system and functional

requirements. The details of its components are described as follows:

- **Principle Searcher** - This user initializes a project, called a collaborative search task, and can invite any user to join it.
- **Collaborators** - These users share a common information need and wish to join the project. They all work together toward the same goal.
- **U1: Create projects** - This function is for creating the project or collaborative search task.
- **U2: Add collaborator** - A principle searcher or collaboration partners can invite others to join the project.
- **U3: Accept/deny invitation** - After receiving an invitation, a collaborator can accept to join the project or deny it.
- **U4: Search** - Users can perform search by using their natural language in text queries.
- **U5: Mark Relevant** - After finding relevant search results or websites, users can mark them as relevant to the search task/project.
- **U6: Chat** - Users can communicate with everyone in the group by instant messaging.
- **U7: Comment** - This function allows users to comment on a web page.
- **U8: Watch activities** - A user can browse the project timeline that shows all collaborators' previous activities.
- **U9: Watch summary** - A user can see a summary of all activities (i.e., query history, seen websites, snapboard and relevant websites). The summary can be filtered by types of activities.
- **U10: Create snapboard** - Any user can make a snapshot of focused information. The snapshot will then be posted on a display board for sharing among collaborators. Each snapshot is a link that can be clicked to navigate the source of information.
- **U11: Leave projects** - Any collaborator, excluding the principle searcher, can leave the project.
- **U12: Close projects** - Only the principle searcher can close a project when it completed.

B. Technologies

- **Web sockets** [9] defines a full-duplex single socket connection over which messages can be sent between client and server. The Web Socket standard simplifies much of the complexity around bi-directional web communication and connection management.
- **NodeJs** [10] is server-side javascript. It uses the concept of asynchronous event-driven model to support the concurrency in order to reduce the overhead between threads. It is suitable for system to work in "real time".

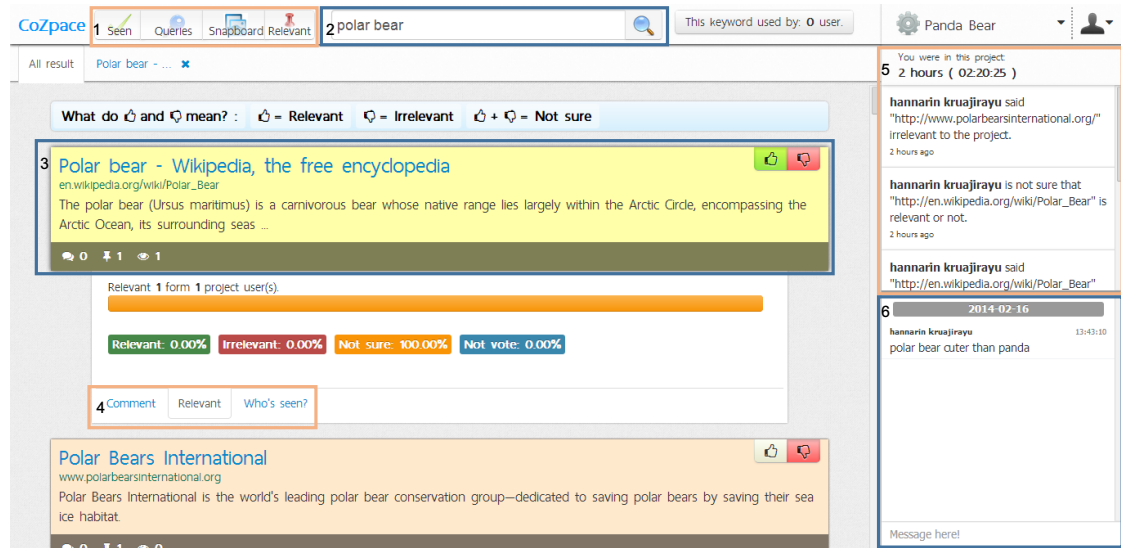


Figure. 2: Interface for showing search results

- **Bing API** is a search service that enables developers to embed a search mechanism in their websites or applications. It offers a search functionality for seeking information in multiple source types, e.g., web, images, news and videos. We employ the Bing API to provide web search in the CoZpace.

V. SYSTEM DESIGN AND IMPLEMENTATION

A. Architecture

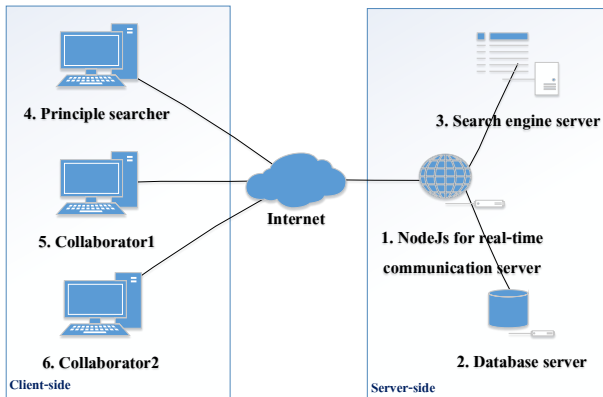


Figure. 3: Architecture of CoZpace system

An architecture of CoZpace and its components are demonstrated in Fig. 3. The details of five components are given as follows:

- 1) **NodeJs server** - A server that provides services of real-time communication, such as instant messaging and real-time activity stream.
- 2) **Database server** - A server that collects data of user activities, such as query history, chat history and web history.
- 3) **Search engine server** - A server that collects web pages to show search results from user's search queries.
- 4) **Principle searcher** - A user that can create and close a project as well as invite other collaborators into the project to search information together.

- 5) **Collaborator** - A user that accepted the invitation from principle searcher and afterwards is eligible to invite other collaborators to join the project.

B. CoZpace's design and features

In this section, we illustrate the interfaces of our collaborative search system. CoZpace provides a project timeline that shows history of all collaborators' activities. Moreover, for direct communication, the user can use instant message. The system interfaces are composed of three main components: i) Show search results. ii) Manage project. iii) Show websites

Fig. 2 demonstrates the interface that is designed to show search results. It consists of six sections as follows:

- 1) Four buttons on the top-left show options to groups of search activities done by everyone in a current project.
 - a) **"Seen" button** presents a list of websites that have already been seen by any collaborators and are sorted chronologically.
 - b) **"Queries" button** shows the queries that was used by the collaboration partners.
 - c) **"Snapboard" button** demonstrates the pictures of anchor links that were snapped by anyone in a group.
 - d) **"Relevant" button** displays the searched websites that are judged or marked by group members, i.e., relevant, irrelevant or not sure.
- 2) The search box allows users to enter a search query, submitted to the Bing API.
- 3) This section shows search results responding to a user's query. It contains two buttons on the top-right, i.e., thumb up button as "relevant button" and thumb down button as "irrelevant button". These buttons allow the user to mark the website relevant or irrelevant. We use three colors to represent relevant status of documents:
 - a) **Green** when the relevant button is pressed.
 - b) **Red** when a user presses the irrelevant button.
 - c) **Yellow** when a user presses both two buttons, it means not sure.
- 4) This section presents three tabs that show the details of the searched websites:

- a) **Comment tab** is to receive comments of searched website from collaborators.
 - b) **Relevant tab** displays a percent of relevant, irrelevant and not sure.
 - c) **Who's seen? tab** shows a list of collaborators who have already seen the searched website.
- 5) This section presents the project timeline that shows all collaborators' history, e.g., query that is used, the website that is opened or closed and the project that is closed.
 - 6) This section provides an instant messaging for the collaborators to talk with one another and exchange their opinions.

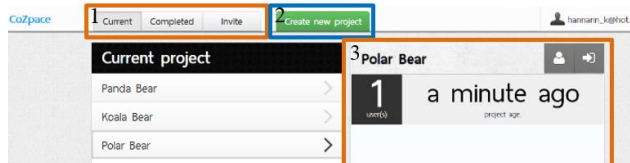


Figure 4: Interface for managing a project

Fig. 4 shows the details of interface for managing project, composed of three sections. These include:

- 1) Three tabs on the top-left are given as follows.
 - a) **Current tab** presents the current projects.
 - b) **Completed tab** presents the closed projects.
 - c) **Invite tab** shows notifications of the invitation from the principle searcher.
- 2) Create new project button can be used to create a new project.
- 3) The box on the right side presents the detail of a current project. Any user can invite anyone to his current projects by clicking on the first button on the top-right and also can access to his current project by clicking the second button.

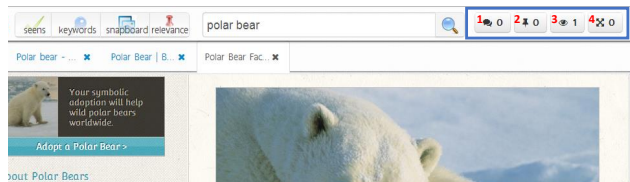


Figure 5: Interface for showing websites

We show a CoZspace interface for showing websites in Fig. 5. There are four buttons on the top-right, consisting of:

- 1) **Comment button** can be used to provide feedback or exchange opinion of a website.
- 2) **Relevant button** can be used to mark the website relevant or irrelevant.
- 3) **Seen button** presents a list of the collaborators that have seen the website.
- 4) **Snapboard button** can be used to take a snapshot in some part of the website.

In Fig. 6, we illustrate the snapboard function of CoZspace. Snapboard supports both synchronous and asynchronous collaborations to help users collaborate both at the same time and at different times. The core of snapboard function is listed as follows:

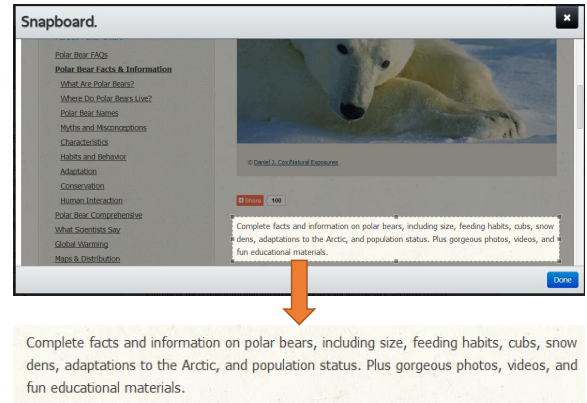


Figure 6: Snapboard function of CoZspace

- 1) A user can take a snapshot of the main idea in web page.
- 2) A user can share a snapshot among collaborators.
- 3) A user is able to comment in a snapshot.
- 4) The web address is included in a snapshot.

VI. CONCLUSION

In this paper, we introduced the CoZspace that was developed by using a Web Socket technology for real-time communication between clients and a server. By doing so, our system accommodates multiple users for “synchronous collaboration” via, for example, instant messaging and live-update of user activities. All user interactions with the system are also recorded in database and showed in a search history. As a result, collaborators can carry out search tasks at different times, enabling “asynchronous collaboration” and increasing awareness of search collaborators. For the future work, we plan to conduct a user study to evaluate the effectiveness of CoZspace.

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