# An Attempt to Evaluate Chances and Limitations of Social Information Retrieval

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***Abstract*—We present an approach to evaluate a novel concept for distributed social information retrieval. The concept is based on the idea that users can query private information spaces of socially close people ("friends"), facilitating social interactions that correspond with typical human information sharing behavior to a higher extent. Thereby, we hope to establish more efficient and socially compatible information sharing among peers in social and collaborative networks. We give a short overview on related research from information science, psychology, and economics, explain and motivate our research questions, summarize our early findings, and sketch the setup of our upcoming empirical experiment.**

***Keywords–Social search; distributed social information retrieval; information seeking; social networking***

## I. INTRODUCTION

Relying on our social network to satisfy information needs is a strategy that is deeply linked to human social behavior [1]. Social media heavily builds upon the users' willingness to participate and share information. While current social networking sites like Facebook, Google+, or Twitter offer features to target information items to a specific audience, they don't facilitate social information retrieval in a way that optimally corresponds with human behavior. Users' readiness to share previously unshared information is impacted by a set of social mechanisms. We would like to leverage these concepts in order to provide a more efficient way of distributed social information retrieval, allowing users to benefit from collaboration with their contacts. Thereby, we focus on a scenario, where information seekers can query other users' information spaces (related to asking questions in normal human-human interaction). An information space constitutes a repository of private information items, generated by (but not necessarily limited to) analyzing the user's actions (e.g., web browsing, online transactions, communication) and contextual data (e.g., location, type of activity, other people present). Information seekers can query the information spaces of others (referred to as information providers) using their agent (e.g., implemented in a mobile device). An information provider's agent which received a query would analyze the information provider's private information space and – subject to the concrete configuration – recommend matching information items to the information provider as potential items for sharing. Upon confirmation, the results and additional comments given from the information provider would get shared with the information seeker.

The paper's main contribution is the documentation of the social search concept and the method to evaluate it. Other approaches for social search [2], [3], distributed social networks [4], or P2P file sharing [5] focus on questions related to the technical implementation, whereas our work aims to offer a different perspective on the topic, namely the social mechanisms that influence information dissemination in social networks fostering collaboration among users and the potential benefits from integrating social context.

The paper is structured as follows: Section II explains and motivates the research questions, Section III details relevant areas of research, which either build a basis for our concept or describe an approach that goes a similar track (in the latter case, the differences to our concept are explained). In Section IV, we introduce the planned empirical experiment, state how we will answer the research questions, and present first results obtained from pre-studies.

## II. RESEARCH QUESTIONS

To evaluate the corner stones of a social information retrieval system as outlined above, we analyzed literature in related fields (computer science, psychology, and economics). For some assumptions, documented research does either not provide an unambiguous answer or does not take the specific circumstances into account. Therefore, we planned to design a large-scale experiment which should help to answer the following questions:

### *A. RQ1: How do social context and interaction archetypes influence users' data sharing sensitivity?*

One of the basic ideas of social media is that people proactively share information with a wider audience (e.g., a group of other users considered as "friends"). One possible reason why social media can't harness its full potential in reality is that a large number of positive use cases rely on users who share the information – what they don't do to the required extent. We would like to analyze to which degree social context, i.e., the social closeness of information seeker and provider, and the type of interaction (e.g., directed/broadcasted request/reply, anonymous/not anonymous request/reply) influence the users' willingness to ask for or share information. It seems to be reasonable that the type of interaction may influence the users' willingness to share information with other users. This hypothesis is going to be evaluated with the dataset obtained from the described experiment. By considering the natural information sharing preferences of users in the design of a distributed social information retrieval system we hope to increase the amount of individually available information for social search.

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### B. RQ2a: How relevant are information items taken from non-public information spaces of socially close people when satisfying information needs?

When solving information needs, having access to originally private information does not necessarily result in higher satisfaction levels for the information seeker. Unpublished information held in private information spaces might, e.g., not have undergone the same degree of rigorous review as published work, might be common everyday knowledge or irrelevant and therefore possibly not be suited to satisfy information needs. The main objective of this research question is to verify whether friends' private information spaces contain relevant information.

### C. RQ2b: Does social context imply a valuable contribution to retrieving information from the unconscious information need (serendipitous information)?

Theories on homophily [6] suggest that socially close people have similar preferences and therefore keep information items that are of potential (mutual) interest in their information spaces. Referring to Mizzaro's model of relevance [7] we would like to investigate whether information spaces of socially close users could foster finding information items that are considered as serendipitous by the information seeking users.

### D. RQ3: Which social concepts impact the users' routing decisions?

In a majority of existing approaches for P2P document retrieval systems, routing decisions for queries are based mainly on content characteristics (i.e., does a specific node store a certain document?). In these settings, the social relationship between information seeker and provider is not important – the document is standardized and not linked to the specific social context: It is not important for the seeker where the document comes from – as long as it contains the expected content. In scenarios where social search is expected to perform best [8], the source of an information can be of importance. Selecting a user as an information provider is not only based on the availability of content, but on other (more social) criteria as well (referred to as "social concepts"). Given a system which allows routing of queries to potential information providers within ones own social network to satisfy information needs, we would like to understand why some people are chosen as information providers and others not. Borgatti and Cross [9] already published some theories on social interaction in information retrieval, but focus only on professional settings (in the work environment of large organizations). We assume that a more general situation might reveal different results since the workplace implies a specific set of rules, which do not apply in broader environments.

### E. RQ4: Which category of information needs could benefit from social information retrieval?

Traditional web search engines excel at finding published factual information, like Mozart's date of birth. The information items in the information spaces of others might be much more subjective than publicly available information – therefore they might be relevant for certain types of information needs, which would profit from various subjective recommendations and/or opinions, as Oeldorf-Hirsch et al. [8] already suggested for SMQA (it is important to note that Oeldorf-Hirsch et al.'s study only allowed public broadcasting of questions and therefore investigated a different setting).

## III. Releated Work

### A. Information Retrieval

*1) Models & Approaches:* Elementary concepts of information retrieval approaches include traditional vector space models based on *term frequency-inverse document frequency* (TF-IDF, [10, p. 118]), where documents are represented as vectors in a multi-dimensional vector space. The dimensions are defined by the terms which are derived from the words occurring in the documents of the collection. The position of a document within this vector space is defined by calculating the *term frequency* (how often does a specific word occur in a document) and the *inverse document frequency* (how many documents of the collection contain the word). By combining those two factors, it is possible to identify words describing the prevalent content of the document and at the same time differentiating the document from the other documents in the collection [10]. One of the main assumptions in most TF-IDF based approaches is that the order of words does not matter (*bag-of-words assumption*). BM25F, an improved version of BM25 (Best Matching), also relies on the bag-of-word assumption but distinguishes between different fields of a document and adjusts the weighting according to the importance of the respective field [11]. More recent approaches, like *term weights-IDF* (TW-IDF) [12], use a graph-based representation which outperforms classical approaches, like BM25, by considering the relations between terms using a unweighted directed graph.

Our work builds upon these concepts: each user's information space has to be indexed using those classical techniques in combination with probabilistic elements like topic models/Latent Dirichlet Allocation (LDA) [13] to suggest personal information items to be shared with an information seeker.

*2) Relevance & Serendipity:* In naive TF-IDF approaches, the relevance of a document for a query is often calculated using a metric like cosine similarity or Euclidian distance to compare document vectors and query vector. Beyond this mechanical way of calculating relevance, Mizzaro [7] distinguished between *real ("objective") information need* and *perceived ("subjective") information need* which have some overlap, but are not equal. The information seeking user is only aware of the perceived information need and uses this as a starting point when formulating the query. During the search process, the user's mental model about the topic of interest evolves and the user's subjective information need iteratively changes while consuming more information (and ideally would cover more of the real information need). As a consequence, information items might be relevant according to the user's *real* information need, but might not be considered as relevant by an algorithm which is designed to maximize the relevance for the user's query (because the latter is derived from the *perceived* information need). This allows *serendipity*, where items do not necessarily fit the entered query but are considered as relevant by the user. Previous literature covers measurement [14], exploration [15], [16], and formalization [17], [18], [19] of serendipity.

In our work, we would like to evaluate which social relations make occurrences of serendipity happen more likely

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to allow the user to consciously manipulate the answer's degree of serendipity by selecting information providers from different social communities. Thereby, we define serendipity as combination of relevance and unexpectedness of the result.

*3) Distributed & Personalized Search:* Several approaches for *Distributed Search* have been proposed in the past, examples relying on agents are (among others) DS4 [2], [3], Blogracy [20] (where the authors also provide a comprehensive overview of distributed social networking approaches), RAIS [21], or DIAMS [22]. YaCy [23] forms a distributed index for web search and Callan [24] provides an early overview of distributed information retrieval, coining the term "federated search" where an information seeker queries several search engines in parallel. Shokouhi and Si [25] profoundly summarize approaches for the sub-steps in federated search. To include the information seeker's individual context in the evaluation of potential search results, several attempts have been made to *personalize* search results. Micarelli et al. [26], Steichen et al. [27], and Ghorab et al. [28] published comprehensive surveys, clustering the existing approaches. Some approaches also personalize results based on the information seeker's social network [29] or use the social network to rank information [30]. Carmel et al. [31] compare different strategies to use information obtained from different social networks (familiarity-based, similarity-based, overall network with both types of edges) to personalize search results. Their comparison with personalization based on topics suggests that all three personalization strategies relying on social networks outperform the topic-based approach (e.g., indexing and ranking).

Our intended concept combines several characteristics of other approaches: The idea of selecting different information providers (and thus repositories) is comparable to federated search [24] or DS4 [2], [3], where the social component is not taken into account to the same extent. Other approaches like YaCy [23], Carmel et al.'s [31], or SNDocRank [30] cover parts of the search process.

### B. Social Search

*1) Definition:* McDonnell and Shiri [32] list a variety of definitions for social search; for the remaining part of this chapter, we define social search broadly as integrating others in the search process and therefore are very close to Evan et al.'s definition [33].

*2) Social Context:* By analyzing usage patterns of mobile search, Teevan et al. [34] and Church and Oliver [35] show that social context highly influences the search process, either by searching collaboratively or by discussing the search results with others. While Teevan et al. and Church/Oliver only consider the short-term social context during the search process, Kramr et al. [36] use clusters of users with similar interests to disambiguate queries (and thus rely on the long-term social context). After having conducted an online survey with 150 participants, Evans and Chi [37] conclude that social interactions "play a key role throughout the search process". Their findings suggest that existing tools do not fully meet the users' requirements.

Our objective is to understand the users' social behavior and to build a concept to improve information dissemination among users.

*3) Social Media Question Asking:* While many studies cover the social aspects of search performed using traditional web search engines, some also investigate social interaction when users try to get information from their social contacts. In *Social Media Question Asking* (SMQA), information seekers satisfy information needs by asking other people via social network platforms like Twitter, Facebook, or Google+. Efron and Winget [38] propose a taxonomy of questions asked in a microblogging environment, Paul et al. [39], and Teevan et al. [40] identify patterns for question asking and answering, Lampe et al. [41] investigate Facebook's value as an information service while Oeldorf-Hirsch et al. [8] compare SMQA with searching on traditional web search engines.

Those findings show that there are specific types of information needs which people prefer to solve by leveraging the knowledge of their peers. Our concept aims to improve this process by reducing involved social costs and increasing the efficiency of the process (e.g., by recommending information items, which might be suitable answers, to the information provider – in later versions, an automatic reply could also be possible).

### C. Motivation to share information

Alan P. Fiske suggests in [42] that human social life could be explained by combining four psychological models, namely *communal sharing* (CS), *authority ranking* (AR), *equality matching* (EM), and *market pricing* (MP). Following this approach, information sharing could be considered as a social act, allowing to express the underlying motivation as a combination of Fiske's models. In CS, people treat members of their specific group as equivalents. People within the group behave altruistic and are sometimes linked by kinship. In AR, people are ordered linearly according to some social hierarchical dimension. People with higher ranks typically have privileges, prestige, and prerogatives, which people with lower ranks don't have. EM describes a relation between two people who try to keep the balance of their relationship even. This is the standard behavior between people who meet multiple times and follow a tit-for-tat strategy or some other reciprocal granting of favors. In contrast, in MP relationships all relevant features are reduced to a lower dimensional value or utility metric (e.g., price) that is used to compare different factors. This is the default relationship for people who only meet once and don't plan any further encounters. Applying these concepts to distributed social search, the motivation to provide information to the information seeker highly depends on the type of relationship: Following a CS regime, people would be much more interested in sharing information while offering information to socially more distant friends or even strangers would follow a more strict EM or even MP regime. AR regimes could be characteristic for certain professional settings.

Manski [43] models social interactions based on the concepts *expectation* (agents choose actions based on the experience of others who had the same problem), *constraint* (the respective good is limited and therefore needs to be shared/allocated wisely), *preference* (own choice depends on others' choice), and *equilibrium* (occurs when all agents' actions are mutually consistent). Jackson and Rogers [44] analyze theoretic games in social networks and distinguish

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between *strategic complements* and *strategic substitutes*. Examples for strategic complements are, e.g., the majority game (a user's payoff is higher when she/he does the same as her/his neighbors), which could model for example the adoption of new technologies. Strategic substitutes describe situations where a user's payoff is lower when she/he does the same as her/his neighbors (e.g., best shot public goods game; it doesn't make any sense for a user to buy a book when she/he can borrow it from her/his neighbors). With chronobot [45], Li and Chang implemented a bidding system for tasks with the required time as currency, including a proposal to determine exchange rates according to preference or expertise levels. Using Fiske's model above, this system would follow a clear MP approach, offering standardized prices calculated based on objective input parameters. Social relationships and human traits in sharing information are not explicitly considered.

By conducting our planned experiment, we would like to understand users' social behavior when sharing or asking for information in the social information retrieval scenario described in in the introduction section. We will build upon Fiske's work [42] and use it as a framework to distinguish different types of social interactions. Assuming that users are acting rationally, Jackson and Roger's theories [44] might show parallels when analyzing the underlying market mechanisms of our scenario.

## IV. First Results & Proposed Research Outline

We plan to conduct a larger experiment on distributed information retrieval with $150 - 200$ participants within the coming months, allowing us to generate empirical data to answer the research questions outlined above. In some cases, we already did pre-studies to obtain first insights. The participants will disclose their individual social networks, assign weights to their social edges (tie strength, knowledge similarity, social context similarity, sympathy) and provide an index to something we consider as their private information space (visited URLs on the web, extracted from their browser history, crawled and indexed using LDA [13]). In addition, we will receive information about individually viewed and bought products from a leading online store. The experiment consists of three parts (manual query mode, automatic query mode, and semantic product search):

*Manual query mode* – Participants define three queries they would like to solve by asking people within their social network. During query definition and assignment of potential information providers to the queries, users are asked to justify their decisions. In addition to the self-defined queries, each participant will also be asked to satisfy three predefined information needs taken from domains which are suitable for social information retrieval (based on [8]). Information providers will be asked to answer the query and to fill out an online survey, information seekers are expected to review the received results and rate them.

*Automatic query mode* – Participants define queries, a background task uses a randomly selected strategy to choose potential information providers (possible strategies include tie strength, knowledge similarity, social context similarity, and sympathy). Since all participants of the experiment uploaded an index to their private information space in advance, it is possible to query the index of the identified group of information providers in the background. In case of any matches, the respective information provider is informed about the incoming query and the identified result within her/his information space and is asked to provide the information (i.e., the URL to the site corresponding to the index position) and fill out a survey. After the information seeker received the response, she/he is also asked to evaluate the results. To allow further comparisons, one of the answering information providers for each query will be an (undisclosed) technical user account, querying a traditional web search engine and returning the first five resulting URLs to the information seeker.

*Semantic product search* – The participants will be asked to search for items using a customized user interface to a well-known online store, where items which have been viewed at and/or bought by friends are highlighted. In addition to the results obtained from the normal search functionality of the online store, products viewed/bought by close friends (identified by various strategies) will be added to the result list (without revealing the friends' identities). Those additional products do not necessarily match the search query exactly, but might be considered as relevant due to the social relationship between the product owner/viewer and the information seeker. Participants will be asked to evaluate usefulness and degree of predictability/novelty for each item in the result list. In addition, click behavior will be recorded.

### A. RQ1: How do social context and interaction archetypes influence users' data sharing sensitivity?

In a small pre-study (online survey with $112$ participants) [46], we re-run a modified and reduced version of Oeldorf-Hirsch et al.'s [8] experiment. Oeldorf-Hirsch's observation was that people are quite hesitant to ask others for help in a social media environment. Our hypothesis was that this might be caused by the fact that users had to post questions visible to a majority or all of their friends ("broadcast") on the social network platform. Our findings suggest that people's willingness to ask for information highly depends on the audience – if it is possible to target a single recipient or a limited audience, social means for information retrieval are considered much more often.

In the upcoming experiment, we plan to ask the user who provides an information item whether she/he has already shared the information item on any public media channel (like Facebook, Twitter, Google+, etc.), whether she/he would share it on a social media channel, and whether she/he would share it with a friend who asks for it. In addition, we ask the potential information provider to assess the information item's degree of privacy (using a slider on a scale from $0$ to $100$, with expressive descriptions for minimum/maximum values). One possible outcome is that the degree of information sharing (i.e., how much "privacy" does someone share?) highly depends on the social context (audience) and the type of interaction (reactive, proactive).

### B. RQ2a: How relevant are information items taken from non-public information spaces of socially close people when satisfying information needs?

Analyzing two datasets obtained from Twitter and Facebook [47], our early findings suggest that content created by socially close people is of higher interest for us than content from strangers. During the social information retrieval experiment we will ask the information seekers to assess the

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quality of responses given by the information providers in order to obtain a measureable value for relevance, novelty, and personalization. In addition, we plan to correlate the results with social metrics like tie strength, knowledge similarity, social context similarity, and sympathy.

### C. RQ2b: Does social context imply a valuable contribution to retrieving information from the unconscious information need (serendipitous information)?

Focusing on the use case to buy a product, we will compare the relevance of product items returned from a well-known online store with those items taken from the list of viewed and bought items from people within the own, individual social network (defined using the max/min values of tie strength, knowledge similarity, social context similarity, and sympathy). We will compare the degree of relevance and novelty between the different groups of origin.

### D. RQ3: Which social concepts impact the users' routing decisions?

When adding a user as a recipient of a search query in the manual query mode of the experiment, we will ask the user to justify her/his choice. During the assessment of the result quality, we ask the user which other contacts could have also been potential information providers (and why the user hesitated to nominate them). We also gather information about the motives for sharing information to be able to describe the relationship between the information seeker and provider using Fiske's [42] model.

### E. RQ4: Which category of information needs could benefit from social information retrieval?

In a different study, we used highly specialized websites as proxies for specific topics to derive the degree of socialness for the topic. After a first initial pre-study we plan to elaborate on this, scaling the experiment with the help of crowdsourcing platforms and a larger URL database. In the upcoming study, we will ask the participants to provide queries which are considered to be suited for social information retrieval. We plan to validate these expectations using the quality assessments of the results and will compare these findings with previous literature.

## V. Summary & Conclusion

The objective of this paper is to propose a concept for "distributed social information retrieval" and a possible evaluation approach. We explained and motivated the research questions, described first results and outlined the agenda for the following experiment. By understanding the underlying psychological details, we would like to create a system that facilitates information retrieval among social peers and allows to efficiently incorporate the knowledge that is available within one's own social network.

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