

Exploring the Complementary Roles of Social Networks and Search Engines

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ABSTRACT

The Web has become an important information repository; often it is the first source a person turns to with an information need. One common way to search the Web is with a search engine. However, it is not always easy for people to find what they are looking for with keyword search, and at times the desired information may not be readily available online. An alternative, facilitated by the rise of social media, is to pose a question to one's online social network. We present a series of studies that have explored the differences in the types of questions that people choose to explore via asking their networks versus using search engines, and compare the speed, quality, and quantity of answers discovered using these two methods. We then discuss the implications of these findings for next-generation information-seeking technologies that integrate the benefits of using both search engines and social networks. We believe there is an opportunity for tools to help people's friends collaborate with algorithmic information retrieval tools to produce better answers than either approach might identify alone.

INTRODUCTION

People take many approaches to information seeking, using both digital and traditional resources. Search engines, such as Bing and Google, are a common tool for digital information seeking [28], while interactions with friends, colleagues, or other experts are often a more traditional route to answering a question [9, 28]. Social networking sites (e.g., Facebook, LinkedIn, and Twitter) have made it possible to transform the traditional technique of querying friends into the digital realm. And with two-thirds of online U.S. adults having social networking accounts as of 2011 [17], the opportunity for online question asking is becoming ubiquitous.

Online social information seeking behavior appears to be common. In a 2008 survey, Wells and Rainie [28] found people used a mixture of internet search and social resources (e.g., phone calls and face-to-face meetings) to answer many types of questions. Torrey *et al.* [27] found that craft-artists kept their social networks informed of current projects in the hopes of receiving "gifts of information," including pointers to relevant online resources that might benefit their projects.

This behavior can be understood as a form of *social search*, a term which refers broadly to the process of finding information online with the assistance of social resources. Social search can include asking people for assistance with aspects of information seeking (e.g., [9]), as well as search over collections of socially-generated content (e.g., [26]). Researchers have proposed formal models to describe the interplay of social information seeking with the use of online information resources. For example, Pirolli [24] developed a model of social information foraging, and Evans and Chi [9] presented a model of social search based on existing non-social search models. To compare social search with more traditional search, Evans *et al.* [8] examined the usefulness of three types of online social search: directed asking, public asking, and searching repositories of user-generated content.

The Internet offers many opportunities for people to ask and answer questions online. Since 2009, we have undertaken a research program to understand the emerging phenomenon of *social network question asking*, in which people use their social networking site status message to broadcast a question to their contacts rather than to merely report their current status. Social network question asking differs from many of the more traditional means of question asking in that it enables the same question to be collaboratively answered by many members of one's network at the same time. It also differs from the use of Community Q&A sites (e.g., Yahoo! Answers) where people ask questions of a general online audience in that it requires use of a true identity, directs the question to a limited audience of known potential answerers, and is typically more restricted in terms of question length.

In this paper, we consider how this new social network question asking behavior relates to other forms of digital information seeking such as search engine use, with an eye towards designing improved information-seeking experiences. We summarize our research for the HCIC audience, and outline topics for reflection, discussion, and future work. More complete descriptions of our research can be found in our papers listed in the reference section [12, 19, 20, 25, and 29].

SOCIAL NETWORK QUESTION ASKING

We begin by presenting a characterization of the emerging phenomenon of social network question asking. Some types

Question Type	Percent	Example
Recommendation	29%	Building a new playlist – any ideas for good running songs?
Opinion	22%	I am wondering if I should buy the Kitchen-Aid ice cream maker?
Factual knowledge	17%	Anyone know a way to put Excel charts into LaTeX?
Rhetorical	14%	Is there anything in life you're afraid you won't achieve?
Invitation	9%	Who wants to go to Navya Lounge this evening?
Favor	4%	Needing a babysitter in a big way tonight... anyone??
Social connection	3%	I am hiring in my team. Do you know anyone who would be interested?
Offer	1%	Could any of my friends use boys size 4 jeans?

Table 1. Breakdown of question types for the 249 example questions survey respondents had asked their networks.

online question asking behavior has been well studied. For example, expertise-finding systems like Collabio [4] can be used to route questions to knowledgeable friends, colleagues, or strangers. Likewise, the now-defunct Aardvark system [13] used a combination of expertise and social graph information for question-routing. Community Q&A tools, such as electronic bulletin boards and question-answering sites, have been well-studied (e.g., [1, 2, 3, 11, 16, 30]). Community Q&A differs from social network Q&A in key ways, such as revelation of identity, network size, known nature of the audience, question length, the need to use a special purpose Q&A tool vs. integrating Q&A into other naturally-occurring activities. However, our work is informed by and complements this existing research, and we compare and contrast these different methods of information seeking with respect to factors such as answer quality and speed, for instance.

To understand the extent and manner of use of social network status messages for question asking, we conducted two surveys. The first survey [19] conducted in 2009, surveyed 624 U.S.-based Microsoft employees (73% full-time employees and 27% college-student interns). The second survey [29], conducted a year and a half later, surveyed 933 Microsoft employees from four countries (the U.S., U.K., China, and India), in order to probe cultural differences in the use of social network question asking.

The findings from the cross-cultural survey were largely similar to those of the initial one, lending support to the notion that our findings extend beyond a single demographic. In this summary paper we report data primarily from the first survey where the findings of the two instruments were similar; we also note findings regarding cultural differences where applicable. Subsequent studies of information seeking on Twitter by Efron and Winget [7] and Paul *et al.* [23], and on Facebook by Lampe *et al.* [15] provide findings that complement ours; for instance, Efron and Winget create a taxonomy of question types on twitter that is similar to ours, though includes

Question Topic	Percent	Example
Technology	29%	Anyone know if WoW works on Windows 7?
Entertainment	17%	Was seeing <i>Up</i> in the theater worth the money?
Home & Family	12%	So what's the going rate for the tooth fairy?
Professional	11%	Which university is better for Masters? Cornell or Georgia Tech?
Places	8%	Planning a trip to Whistler in the off-season. Recommendation on sites to see?
Restaurants	6%	Hanging in Ballard tonight. Dinner recs?
Current events	5%	What is your opinion on the recent proposition that was passed in California?
Shopping	5%	What's a good Mother's Day gift?
Ethics & Philosophy	2%	What would you do if you had a week to live?

Table 2. Breakdown of question topics for the 249 example questions survey respondents had asked their networks. An additional 4% fell into the "Miscellaneous" category.

categories for non-information-seeking "questions," such as spam, while Lampe *et al.* use regression models to identify what factors make people more likely to view Facebook as a good source for information seeking.

Overall, we found that about half of the survey respondents reported having used their social network status messages to ask a question of their contacts, and three-quarters had seen someone else in their network ask one. Respondents who reported asking a question were asked to copy and paste a sample question they had asked their network into the survey form and share it with us.

The questions respondents shared were generally short, with a mean length of 75 characters. This is much shorter than the 140 character limit on Twitter or the 423 character limit on Facebook. Most (72%) of the questions consisted of a single sentence; those that included an extra sentence typically used the additional sentence to provide context that motivated the information need. Most (81.5%) questions also used a question mark for punctuation; those that expressed information needs as statements typically used phrasings such as "I wonder" or "I need" instead. Another phrasing trend observed from the sample questions was that 21% of questions used the phrase "anyone."

To understand the content of the questions, we conducted qualitative analyses to code the sample questions according to the *type* of information need expressed (Table 1), as well as by the *topic* of the question (Table 2). As can be seen in Table 1, 14% of questions were rhetorical, and did not express a true information need. Some of the questions asked were of types that are uniquely suited for a social network, including invitations, the asking of favors, requests for social connections, and offers of goods and services; in total, these questions comprised 17% of the questions we collected. However, the most prevalent question types (seeking recommendations, opinions, or

factual knowledge) all represent information needs that can also be serviced by search engines.

Table 2 shows the most common question topics, with the most popular topics being Technology, Entertainment, and Home & Family. Technology is likely over-represented in our sample due to our survey audience (Microsoft employees). Questions related to leisure activities such as entertainment, shopping, restaurants, and travel were also quite common. Several categories of questions that are popular on search engines were notably absent from our sample (and were explicitly mentioned by survey-takers as being too personal for social networks), including health, sex & dating, religion, politics, and finance. A subsequent study of Twitter Q&A by Paul *et al.* [23] reported a higher prevalence of health-related questions, although their categorization of health-related items appears to have been broader than ours, including questions about “body-piercings, hairstyles, and self-image.”

Our subsequent cross-cultural survey found some differences between the types and topics of questions in Asian countries (China and India) versus Western ones (the U.S. and U.K.). Users in Asian countries seemed to view social network question asking as a more serious endeavor; they asked fewer entertainment questions and more professional ones than their western counterparts; they also had fewer rhetorical inquiries, and increased use of the medium to request social connections with others (e.g., for professional introductions and networking).

We also asked survey respondents to describe what motivated them to pose a question to their social network. Table 3 summarizes these findings. Trust in the quality of answers provided by friends was the primary motivator. Another benefit is that social network question asking serves the dual purpose of strengthening social ties and fulfilling an information need. Failure (or assumptions of failure) of search engines to easily identify an answer to questions was also a motivating factor. Interestingly, some of these instances are based on inaccurate perceptions of search engine functionality, such as users who did not think that search engines could retrieve information about current news events or that search engines could not retrieve information useful for subjective decision making such as review, ratings, or opinions sites.

ASKING AN EFFECTIVE QUESTION

Inspired by the interesting differences we observed in question phrasing, we conducted a controlled experiment to study the impact of phrasing on the quantity, quality, and speed of the answers people get to their questions [25]. By having different people post variants of the same question to Facebook, we were able to discover that how a question is asked can influence the responses it receives.

Researchers have also explored what factors might influence how people respond to others online. Burke *et al.* [6] studied how post phrasing correlated with response

Motivation	Percent	Example Survey Responses
Trust	24.8%	- Because I trust my friends more than I trust strangers. - People that I know are reputable.
Subjective questions	21.5%	- A search engine can provide data but not an opinion. - It has no definite answer, it's more about collecting views rather than finding specific info.
Belief search engine would not work	15.2%	- Because search engine technology doesn't work that well yet. - I'm pretty sure a search engine couldn't answer a question of that nature. - Because search engines don't have breaking news. - Search engines aren't updated often enough.
Specific audience	14.9%	- Friends with kids, first hand real experience. - Better visibility among expert users of SQL Server.
Connect socially	12.4%	- I wanted my friends to be aware that I was asking the question. - I wanted to ask the question but also express my frustration to my social network.
Answer speed	6.6%	- Quick response time, no formalities. - Needed information ASAP.
Context	5.4%	- Friends know my tastes. - Search engine is not personalizable.
Failed search	5.4%	- I tried searching and didn't get good results. - A quick search on the search engine didn't give me any useful results.
Easy	5.4%	- It's easier. Results are targeted... don't need to sift out the 'junk'. - There are too many choices on the web, I wanted something more filtered. - Didn't want to look through multiple search results for answers.
Answer quality	4.1%	- Human-vetted responses. - Better quality results some of the time.
No harm	3.3%	- No cost.
Fun	2.1%	- More fun.
Non-urgent	1.7%	- I didn't need an answer straight away.

Table 3. Survey respondents' motivations for asking their social network rather than (or in addition to) conducting a Web search. Some responses fell into multiple categories, so percentages total to more than 100% (out of 242 responses).

likelihood on Usenet groups, and observed that messages making requests were likely to get more responses than those not making requests. Liu *et al.* [16] used machine learning to predict satisfaction with answers received on a Q&A site, and found important factors included the asker's length of membership and the question topic. However, the relationships that have been found represent correlations.

In our study, 282 people posted a variant of the question, “Should I watch E.T.?” as their Facebook status message. See Figure 1 for an example. We used the popular film *E.T.* (Universal Studios, 1982) as the basis for our question since it corresponded to a highly popular topic (entertainment) and question type (opinion) from our earlier survey study, and since the appeal of the movie is broad enough that it is a plausibly natural question for people from a variety of demographics to ask.



Figure 1. An example of a question asked in our study via a social network status update and the responses received.

Participants were sent a calendar appointment containing the question text, and were instructed to post it verbatim as their Facebook status within the given time range (either in the morning or afternoon, Pacific Daylight Time). They were instructed not to change their status for 24 hours after posting, and not to respond to others' comments on their status. They then sent us a screenshot containing their post and the time-stamped responses (Figure 1).

Table 4 shows the 12 variants of our base question that we studied. Variations included punctuation type (phrasing as a question versus a statement), number of sentences (one sentence, or the inclusion of a second "context" sentence, "Taking it easy."), and scoping (no scoping, inclusion of the generic scoping phrase "anyone," or specific scoping to "my movie buff friends." These variants were based on the naturally-occurring trends in question phrasing observed in the samples collected in our earlier survey study. Roughly equal numbers of participants posted each variant. There is some slight variation in the actual numbers due to the fact that some data was discarded when participants did not adhere strictly to the study protocol.

We then analyzed how the phrasing variants, time of day, and other demographic factors influenced the quantity, quality, and speed of responses:

For quantity, we measured the percent of questions receiving a response, and, for those that did receive a

response, the average number of responses received.

For quality, we measured response length in characters, which prior works suggests is indicative of response quality on Q&A sites [11]. We also manually coded two other quality metrics – the percent answered (did the question contain a direct response as to whether the asker should watch the film *E.T.*, such as "Soooo boring. I vote no."), and the percent useful, which measured whether the responses contained valuable information that might interest someone who is deciding whether to watch *E.T.*, such as describing related films that may also be of interest (e.g., "I'd suggest *Weird Science.*") or mentioning facts about the movie (e.g., "Drew Barrymore's first time in a movie."). Overall, 82.3% of the participants received a response, and those who got one received 3.2 responses on average, 72% of which were "useful," and taking an average of one hour and twenty-seven minutes to get a first response. Panovich *et al.* [22] have explored who is likely to contribute valuable information in social network Q&A, and found that strong ties offer more valued contributions than weak ones.

For speed, we studied the average time to first response for a question, given that at least one response was received. Because response time distributes logarithmically, we use the log of the response time to keep long times from dominating; our findings, however, are consistent whether we use the log or not.

Demographics, such as age, gender, and frequency of Facebook use had little impact on our response metrics, with the exception of network size – users with larger networks (over 200 friends) received significantly more responses, of higher quality, and much faster than those with smaller networks. For example, the average time to first response for those with networks of over 200 was 52 minutes. The time of day of the post also had an effect, with users receiving significantly more responses (and faster responses) when asking in the afternoon rather than in the morning.

Punctuation	Sentences	Scoping	Example	Number posted
Question	One	None	Should I watch E.T.?	26
		Anyone	Does anyone think I should watch E.T.?	26
		Movie buff	Do my movie buff friends think I should watch E.T.?	27
	Two	None	Taking it easy. Should I watch E.T.?	18
		Anyone	Taking it easy. Does anyone think I should watch E.T.?	26
		Movie buff	Taking it easy. Do my movie buff friends think I should watch E.T.?	20
Statement	One	None	I wonder if I should watch E.T.	24
		Anyone	I wonder if anyone thinks I should watch E.T.	27
		Movie buff	I wonder if my movie buff friends think I should watch E.T.	23
	Two	None	Taking it easy. I wonder if I should watch E.T.	21
		Anyone	Taking it easy. I wonder if anyone thinks I should watch E.T.	22
		Movie buff	Taking it easy. I wonder if my movie buff friends think I should watch E.T.	22

Table 4. The different question phrasings studied, and the number of participants who posted each.

		Count	Quantity		Quality			Speed
			Percent with response	Number of responses	Percent answered	Percent useful	Response length	Time to first response
Punctuation	Question	143	88.1%*	3,413	63.6%	80.4%*	56.930	1:25
	Statement	139	76.3%*	2,962	54.0%	63.3%*	53.979	1:30
Sentences	One	153	88.2%*	3,681*	72.5%*	80.4%*	55.246	1:08
	Two	129	75.2%*	2,546*	42.6%*	62.0%*	56.048	1:55
Scope	None	89	77.5%	2,623	53.9%	62.9%*	43.837*	1:37
	Anyone	95	83.2%	3,241	61.1%	73.7%	57.671*	1:20
	Movie buff	98	85.7%	3,655*	61.2%	78.6%*	63.264*	1:27

Table 5. Response measures broken down by how the question was phrased. Significant differences are shaded ($p < .05$) and indicated with a * ($p < .01$). For scope significance is compared with *None*; differences between *Anyone* and *Movie buff* were not significant.

Table 5 presents the findings on the impact of question phrasing (punctuation, sentences, and scoping) on response metrics. Phrasing a question with a question mark, rather than as a statement, results in a higher overall percentage of questions with responses and more high-quality responses than phrasing as a sentence. Using short, single-sentence questions results in improvements in result quantity, quality, and speed. The use of scoping (either to the generic “anyone” or specific “movie buff”) also results in an increase in both the number of responses received and the quality of those responses.

The question phrasing also appeared to impact the types of responses people received. For example, despite negatively impacting the quantity, quality, and speed of responses, the extra context sentence did appear to provide some value. Question that included “Taking it easy,” were significantly more likely to receive responses that offered an alternative movie suggestion, and significantly less likely to receive a request for clarification.

These findings not only indicate ways in which individual

users can maximize their social network question asking experience, but also suggest ways in which an automated system might phrase questions in order to sound natural and optimize specific response metrics. Recent work by Nichols and Kang [21] adds to our findings by exploring factors impacting question responses from strangers (rather than friends) on Twitter.

In the next section we look at the relative benefits of searching and asking, and then discuss how to use what we have learned about question asking and its benefits to improve the information seeking experience.

ASKING VS. SEARCHING

To better understand why someone might choose to use social network question asking to find information, we conducted a laboratory study in which users asked a question to their social network and simultaneously conducted a more traditional Web search [20].

Twelve participants each came to the lab with a real information need in mind. They logged in to Facebook and expressed this need in their own words to their friends.

Task (as expressed to the social network)	Network size	Initial responses	Total responses	Minutes to first response	Minutes searching
Is now looking for a new phone to get... Any suggestions???	466	3	20	15	38
any tips for tiling a kitchen backsplash?	231	3	7	8	29
Anyone know how to stop an in-car nav system from constantly rebooting???? Ugggggh	275	2	2	19	46
Does anyone know how to train for half marathon? Links...training...diet to follow would be great!	50	0	0	N/A	21
Lauren's going away for a month, anyone know any good vegetarian recipes?	401	1	10	36	36
So...after getting the PMP, what else is anyone doing to keep up their development?	96	0	2	1519	14
should I wait for ZuneHD or buy Ipod touch (to gift someone)?	104	1	3	7	32
is wanting to move away from Live Space for storing and sharing pictures... Any recommendations?	206	0	5	184	12
Can one defeat Seattle winter with a trip to New Zealand? Does anybody have the beta on bouldering there?	240	0	5	77	31
is looking for recommendations (restaurants and activities) in Cancun	143	2	2	5	49
is starting to plan my Thanksgiving trip to Disneyland...what are the must see attractions, especially for a 3-year that loves princesses? Any websites out there for planning other than disneyland.com?	743	5	10	8	22
Does anyone have any recommendations on a good medium to high end TV?	169	0	0	N/A	34
Average	260.33	1.42	5.50	187.80	30.33

Table 6. Questions posted to Facebook by each of the 12 study participants, and their related task performance data.

Table 6 shows the questions they posed. Participants were then asked to close Facebook and use a search engine to research the question on their own. When they were satisfied with the answers they had found, they informed the experimenter. They then logged back into Facebook to check whether they had received any responses from their friends within the time period of their search. They were asked a series of follow-up questions comparing and contrasting the information found by each method. They also sent a screenshot three days later to document any additional responses received from the social network.

On average, participants spent 30 minutes searching the web, which involved issuing a mean of 6.5 search engine queries and visiting 35.4 non-search-engine Web pages. Seven of the 12 participants received at least one response from their Facebook network before their search was complete; of those who received responses, the average was 1.4 responses with a range from 1 to 5. Participants with larger networks were more likely to receive responses quickly. By the three-day follow-up, all but two participants had received responses, with the average response number being 5.5 and ranging between 1 and 20. For those who received a response, the median time to first response was 17 minutes.

When asked to reflect on the information found via each approach, participants indicated that each had its own unique benefits. Search engines were considered beneficial because they retrieved answers very quickly, and enabled users to refine their query as they learned more about a topic (whereas reposting a new question to the network was considered rude, akin to “spamming” ones friends). Search engines were also considered (perhaps naively) to be a source of objective and unbiased content.

In contrast, social network question asking provided social benefits, such as promoting awareness to one’s friends of the asker’s current interests and strengthening feelings of connection between the asker and the answerer. Participants also enjoyed receiving answers that were highly personalized to their tastes (such as the participant who searched for Disneyland activities, and received warnings about rides that might be too scary for her young daughter). Participants also liked when they found the same answers on both the search engine and from their contacts – for example, the participant deciding what model of phone to purchase felt more confident about a particular model when it featured prominently both in his search results and in his friends’ suggestions.

People’s social networks sometimes provided answers that would not have been available through search, either because the question asker was not looking for answers like the ones provided or because the information did not exist to be indexed. For example, one person’s friend suggested “Start your own consulting business,” in response to a question about career advancement. The participant

reflected on this response, noting, “It allowed me to think that not only training was an option but also detach myself from corporate work and start my own business.” Likewise, the participant planning travel to New Zealand received an offer to stay at the home of an acquaintance.

These findings indicate that search engines and social networks provide distinct, yet complementary, types of information seeking experiences, and that for certain tasks and under the proper circumstances the speed of social network Q&A can approach the speed of conducting a traditional search.

NEXT-GENERATION SOCIAL SEARCH TOOLS

We have seen from our prior studies [19, 20, 25, 29] that the experience of asking a question of one’s social network is a common one (and one that is often prompted by anticipated or actual failure of search engines for a task), that it is motivated by a variety of benefits that differ from those provided by search engine use (social benefits such as providing awareness and strengthening connections, and informational benefits such as trusted, personalized answers), and that outcomes like response quantity, quality, and speed can be enhanced.

Previous work by Evans *et al.* [8] has shown that using multiple social search strategies can outperform any single strategy alone. We believe, in particular, that social network question asking can be combined with traditional search tools to create an enhanced information seeking experience. Building on our findings, in this section we suggest next-generation search tools that combine the benefits of search engine use (speed, access to a variety of information sources, ease of refinement, etc.) with those of social network question asking (ease of expression, social connections, trusted and personalized responses, etc.). We consider this integration from two perspectives: search-centric approaches and social-networking-site-centric approaches.

Search-Centric Approaches

Recently, major search engines have begun to explore the potential to integrate social network data into the search experience. For example, Bing’s Facebook integration and Google’s Search Plus Your World features both annotate traditional Web search results with information about their popularity among your contacts, and use social information to re-rank results behind the scenes. Our research suggests that it would be possible (and desirable) for search engines to take social network integration a step further, by prompting users to engage their social networks in the process of information seeking. Note that what we are proposing differs from *collaborative search* [18], in which a group of users with a shared information need work together on an information seeking task; rather, we propose a *social search* experience in which a user’s social network serves as an additional source of “nearly real-time” [5] answers available to the search engine.

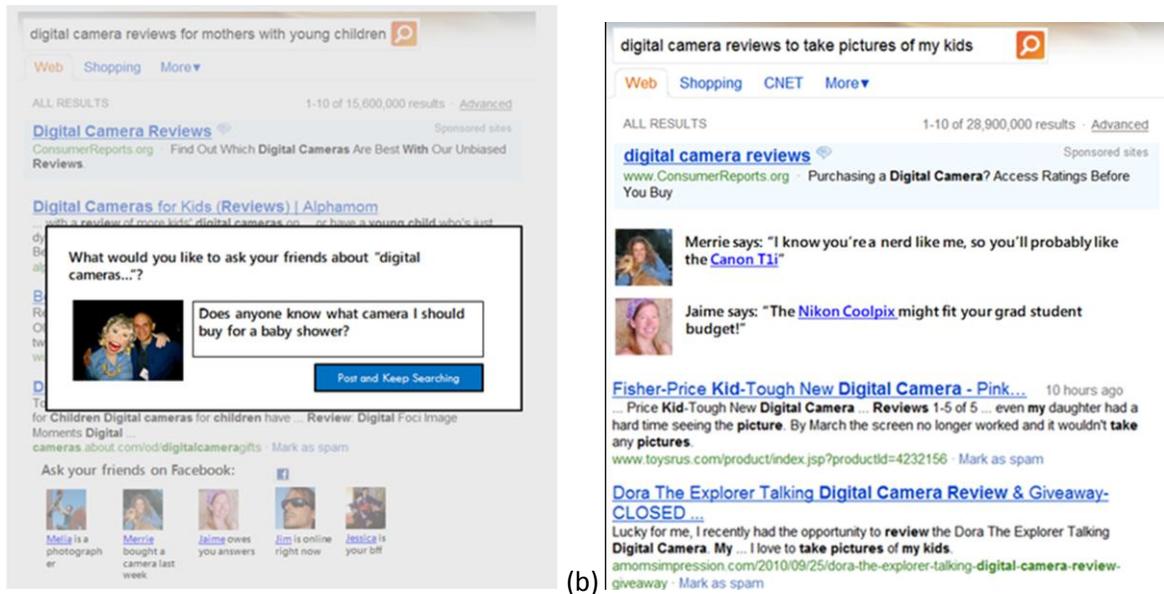


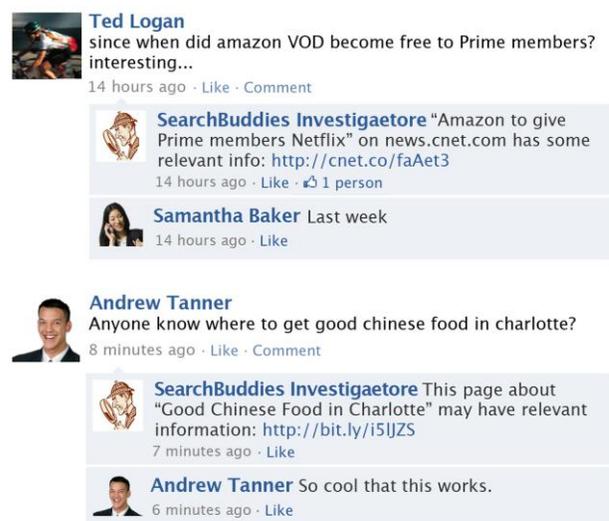
Figure 2. This figure illustrates a concept for a search-centric integration of search engines with social network question asking, inspired by our survey and experimental findings. (a) After conducting several search engine queries on a single topic (digital cameras, in this example), the user is prompted to use their social network as an additional source of information; the system presents a question phrasing optimized for response speed as a default suggestion. (b) As the user continues to search on-topic, responses from the social network could be integrated into the search results list.

For example, a search engine might detect instances in which a user is having difficulty finding information and is nearing the point of abandoning the search engine entirely using methods such as those described in [10], or a search engine might detect instances in which a user is engaging in a long multi-query (or even-multi-session) investigation of a topic using methods such as those described in [14]. In either of these scenarios, the system might then evaluate other relevant contextual factors, such as the time of day and the user’s network size, to ascertain the probability of obtaining a nearly real-time response from a social networking site. If such calculations work out favorably, the search engine might prompt the user to question their network contacts, and could even suggest a default phrasing for the question that would optimize response speed and likelihood. As answers from the social network begin to arrive, they could be integrated directly into the result lists for ongoing on-topic searches. Figure 2 shows a mock-up illustrating this process. Implementing this concept is an area of future work that interests us, and that we look forward to discussing with the HCIC audience.

SNS-Centric Approaches

An alternative perspective to consider is how to incorporate algorithmically identified search content into the social network question asking process. We call algorithmic search tools incorporated into social networking sites *socially embedded search engines*, and have created the first full-fledged prototype of this concept, a system we call SearchBuddies [12].

We have implanted SearchBuddies within Facebook; users install our Facebook application and then choose one or buddies to “friend.” The SearchBuddies then monitor a user’s status updates for messages that appear to represent an information need (such as those ending with a “?”), a heuristic employed in prior work by Efron and Winget [7]); upon finding such an update, each SearchBuddies a user is friends with determines whether it ought to contribute to the ensuing conversation between the user and her friends. We have implemented two buddies, the Investigator and the



Figures 3a (top) and 3b (bottom). Two examples of Investigator responses to questions from Facebook users.

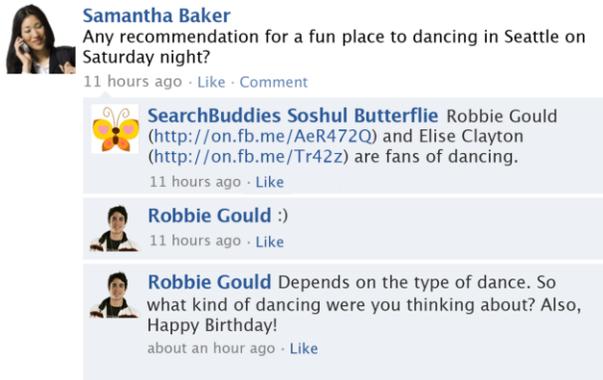


Figure 4a (top) and 4b (bottom). Two Social Butterfly responses.

Social Butterfly, who take different approaches in the types of answers they provide.

The Investigator passes the user’s question to the Bing API, and checks whether any of the top-ranked results are from a set of high-quality, white-listed domains. The Investigator will then choose the highest-ranked result that meets these criteria and return a natural-sounding response by randomly selecting among several pre-coded templates such as “This page about <page title> may have relevant information: <shortened url>.” We use the URL shortener bit.ly in order to track clickthrough rates on the SearchBuddies’ suggestions. Figure 3 illustrates sample interactions with the Investigator from our initial deployment (names and photos have been changed for privacy reasons).

Rather than return links to relevant Web pages, the Social Butterfly takes a different approach, searching for friends who might be able to answer the user’s question. The Social Butterfly uses information from a user’s friends’ Facebook profiles (in accordance with the permissions granted upon application installation and with the friends’ privacy settings) to create a model of friends’ interests and geographic histories. The Social Butterfly extracts entities from a user’s question and compares them to this model in order to identify relevant contacts. It then chooses at most four relevant friends to mention in its response, prioritizing friends who are currently online and therefore likely to be available for interaction. Figure 4 illustrates sample interactions with the Social Butterfly from our initial deployment (with names and photos changed for privacy).



Figure 5. An example of how socially embedded search engines could be used to post supplementary information in addition to answering questions directly.

We deployed SearchBuddies to a pilot pool of 122 users over a two month sign-up period. During this time, SearchBuddies observed 1,692 status updates; it identified 262 of these updates as questions (median of two questions per user). Human raters determined that 190 of these questions actually expressed information needs; most of the 72 false positives were rhetorical questions. The Investigator answered 22.1% of the identified questions and the Social Butterfly answered 26.7%. The identification of rhetorical questions is an important issue to address in the design of effective socially embedded search engines; responses to such questions by the SearchBuddies were sometimes viewed as humorous or serendipitous, but were often awkward. Paul *et al.* [23] used Mechanical Turk to attempt to weed out rhetorical questions from public Twitter posts (with limited success; there were still many rhetorical questions in the final set they arrived at); however, it is not clear that this method is applicable to non-public content such as Facebook posts. Brainstorming privacy-preserving methods for crowdsourcing parts of the socially-embedded search process may be an interesting area for discussion at HCIC.

Clickthrough rate is a common metric used in evaluating search engine performance; the clickthrough rates on links to URLs (from the Investigator) and friends’ profile pages (from the Social Butterfly) were 57.4% and 61.0% respectively. Our deployment also revealed how socially embedded search engines provide other types of rich implicit feedback that could be harnessed to improve performance. For example, users provided positive feedback by using the “like” action on the buddies’ comments and also through natural language interactions within the comment thread, such as by providing positive emoticons (e.g., “😊”), exclamations like “so cool,” or explicitly thanking the SearchBuddies. Users also provided implicit negative feedback, such as by explicitly chastising the SearchBuddies in their comments “No! Unrelated,” deleting irrelevant posts by the SearchBuddies, or offering alternative answers in subsequent comments. Learning how to recognize and utilize the rich feedback from the social network ecosystem is an important area for future work, and one we look forward to discussing with the HCIC audience.

Our experience creating and deploying the SearchBuddies prototype has helped us to better articulate and understand the tradeoffs of the design space of socially embedded search engines. For example, a SearchBuddy might respond instantaneously to a post, or might wait a set period of time to allow human responders a first chance at the question (or to utilize crowdsourcing or other types of *slow search* techniques). A SearchBuddy might engage publically with a user and her friends, or might choose instead to respond to certain types of inquiries through private messages, either to the asking user to preserve privacy, or perhaps to a relevant friend in order to more explicitly encourage human-human interaction. A SearchBuddy might attempt to answer a question directly, or might instead choose to supplement a human friend's answer with additional details, as in the mock-up depicted in Figure 5. Discussing these and other design choices, and determining which are most promising to pursue next is a topic we hope to get feedback on from our colleagues at HCIC.

CONCLUSION

In this paper, we have provided an overview of a series of research projects aimed at understanding the use of social network question asking as an information-seeking alternative and complement to search engines. We have explored peoples' motivations for engaging in social network question asking and identified the types and topics of questions asked [19, 29], compared this behavior to search engine use [20], shown how to optimize the social network question asking experience for a variety of response metrics [25], and created tools for unifying social and algorithmic search techniques [12]. More details about each of these efforts, as well as more thorough treatments of related work, can be found in the original source documents [12, 19, 20, 25, and 29].

Through these studies, we have discovered an opportunity for online tools to help people's friends collaborate with algorithmic information retrieval tools. Based on our findings thus far, we believe that friends and algorithms working together have the potential to provide a person with better answers than either approach could produce alone. Significant algorithmic, interface, and evaluation challenges remain to be addressed in order to prove this hypothesis.

At HCIC, we look forward to engaging with the broader HCI and Social Computing communities to discuss the ideas presented in this paper; we are particularly eager to receive feedback on our next steps along this research path, including brainstorming solutions to some of the privacy and critical mass challenges of conducting ecologically valid evaluations of socially embedded search systems.

ACKNOWLEDGMENTS

We thank our collaborators Mark Ackerman, Lada Adamic, Darren Gergle, Brent Hecht, Dan Liebling, Katrina Panovich, and Jiang Yang, as well as the participants in our studies.

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