

When Web Search Fails, Searchers Become Askers: Understanding the Transition

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ABSTRACT

While Web search has become increasingly effective over the last decade, for many users' needs the required answers may be spread across many documents, or may not exist on the Web at all. Yet, many of these needs could be addressed by asking people via popular Community Question Answering (CQA) services, such as Baidu Knows, Quora, or Yahoo! Answers. In this paper, we perform the first large-scale analysis of how searchers become askers. For this, we study the logs of a major web search engine to trace the transformation of a large number of failed searches into questions posted on a popular CQA site. Specifically, we analyze the characteristics of the queries, and of the patterns of search behavior that precede posting a question; the relationship between the content of the attempted queries and of the posted questions; and the subsequent actions the user performs on the CQA site. Our work develops novel insights into searcher intent and behavior that lead to asking questions to the community, providing a foundation for more effective integration of automated web search and social information seeking.

Categories and Subject Descriptors

H.3.3 [Information Systems]: Information Storage and Retrieval

Keywords

query analysis, community question answering

1. INTRODUCTION

While Web search engines have significantly progressed in effectiveness and efficiency over the last decade, there still exist certain user needs that cannot be satisfied. This could be due to a number of reasons, such as the difficulty of expressing a complex need as a short search query, the lack of existing relevant content on the Web (e.g., for unique or "tail" needs that keep appearing), and for more "social" needs, for which the user prefers to interact with a real human.

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In fact, Hitwise in August 2011 reported that only 66-80% of the searches are successful¹, and Hassan et al. [15] obtained a similar success rate of search goals (73%) via human labeling. We argue that many such unsatisfied searches could be addressed by asking people via Community Question Answering (CQA) services, such as Baidu Knows, Quora, or Yahoo! Answers. It already happens in practice. For example, we have observed that about 2% of web search sessions performed by users who are also members of the Yahoo! Answers community, lead to a question posted to the community. Consider Figure 1a, which depicts a sample search submitted to a major search engine. The searcher is not satisfied with the results, and eventually posts a related question on the Yahoo! Answers site, which is then answered to the searcher's satisfaction. Understanding and improving the synergy between searching and community question answering is at the heart of this work.

Specifically, our goal is to better understand the behavior of these users, as well as characterize the types of Web searches that could be effectively handled by CQA sites. Insights acquired during such analysis should bring multiple benefits to both search engines and CQA systems. On one hand, search engines always need to better understand when searchers are unsatisfied by the returned results. More specifically, Web search engines would find value in analyzing the search session patterns of such unsuccessful queries, the associated underlying query intents, and possibly reflect these findings in search effectiveness metrics. One can even imagine new search experiences that would allow users to turn to the community for certain types of needs better addressed by people than by traditional Web search. Additionally, CQA systems could potentially improve the asking experience by taking advantage of the context provided by unsuccessful queries preceding a posted question. One can imagine several ways to leverage this context, such as automatically giving examples of irrelevant answers to clarify the question to the community.

To the best of our knowledge, our work is the first to perform a large-scale study of the transformation of searchers into askers. That is, we start our analysis with web search sessions, trace the searcher through her visit to a CQA site, and analyze the resulting questions posted for the community.

We focus on one of the most visited, and more mature, CQA systems existing today, namely Yahoo! Answers, which

¹www.hitwise.com/us/about-us/press-center/press-releases/experian-hitwise-reports-google-share-of-search/

how many bottles to buy for a newborn

5,120,000 results

WEB IMAGES VIDEO SHOPPING APPS BLOGS MORE

Buy Similac® Bottles Sponsored Results
 Similac Products are Available to Order at the Abbott® Store Online.
abbottstore.com/Similac

How many bottles should I buy my newborn when she arrives?
 [Oct 14, 2009] Best Answer: You should have 4-5 regular sized 8oz bottles, and maybe 3 of the 4oz. Congratulations! ;) I did it twice and worth it both times... ~ by Mrs T - Ellie's mummy! (7 comments)
answers.yahoo.com/question/index?qid=20091014135755AAx19b - [Cached](#)
[More results from answers.yahoo.com »](#)

How many bottles should I buy for my newborn?
 [Mar 23, 2011] Best Answer: I would just buy the big bottles, because they will only use 3 ounces for a very short time. Some might use them longer than others, but you ... ~ by Moon M (12 comments)
answers.yahoo.com/question/index?qid=20110323104145AAD7Dwt - [Cached](#)

(a)

How many bottles should I purchase for my new baby? And what brand is best?

I am 9 mo. pregnant and still need to buy bottles. I will be trying to breast feed but I am unsure of how many bottles and what sizes I should buy. Is there anything else I will need for feeding and what brand do you recommend? Thanks!

Best Answer - Chosen by Voters

For The Brands you should ask friends or family members to what they thought was good...and if one brand was mentioned more...then I would get that.

For the size...they have different stages, the first 3 months will be smaller type bottles...and then they get a bit bigger.... just read the label and buy the 0-3 months size for now.

I personally had three.... I washed them immediately after use... you could buy a little more if you feel like it.... I use the gerber brand, just because my baby did not want to

(b)

Figure 1: Example search (a) followed by a question posted by the same user on the Yahoo! Answers site with a satisfactory answer from the community (b).

with more than 1 billion posted answers² is highly visible in most search engines result pages. We built a corpus of query-to-question transitions and studied it in order to understand when and why searchers become askers. A privacy-preserving subset of the data has recently been made publicly available through Yahoo's Webscope program³.

More specifically, our study is organized around the following three research questions, each associated with a set of hypotheses:

Research Question 1: When do searchers turn to CQA for answers?

- **Hypothesis 1:** Queries and information needs of search sessions that lead to posting questions are hypothesized to share common characteristics, and differ from general web searches in words and information needs (Section 3.1).
- **Hypothesis 2:** We hypothesize that searchers who switch to CQA exhibit common search behavior. For instance, they tend to click more on CQA results on the search result page, and their search sessions are longer, allowing to characterize different types of users in the same spirit as [7] (Section 3.2).

Research Question 2: How do search queries relate to the associated questions posted on CQA sites?

- **Hypothesis 3:** Queries and questions follow different word distributions. More specifically, words in queries are hypothesized to follow different distributions than those appearing in questions, and a clear vocabulary gap between these can be observed (Section 4).
- **Hypothesis 4:** Questions are typically more specific than queries and include additional context (e.g., personal background) absent from the original queries. We hypothesize that these differences are reflected in the lexicographic differences between questions and queries,

such as occurrence of personal pronouns or sentiment indicators (Section 4).

Research Question 3: How do searchers behave after transferring to the CQA site?

- **Hypothesis 5:** We further hypothesize that the *content* and the *topics* of the questions posted after a search session differ substantially from the general question distribution (Section 5.1).
- **Hypothesis 6:** We hypothesize that the question sessions after switching from searching, exhibit different characteristics than general question sessions and search sessions explored in depth in previous research work [17][10]. We study these different types of sessions in terms of duration and persistence for specific users and examine their behavior over time (Section 5.2).

The rest of this paper is dedicated to answering the above questions and verifying the associated hypotheses.

2. ACQUIRING DATA

In order to understand how searchers become askers, we collected a dataset that contains both the search session part and asking session part of each user who conducted a search session that resulted in posting a question. Our dataset is derived from joining a sample of the query logs of the Yahoo! search engine and the Yahoo! Answers question logs, both for June 2011.

To create this dataset, we first created a mapping of users between the two logs, based on the clicks on the same Yahoo! Answers question page following the same query on the same time frame, as they appear in both logs. Then, we extracted user actions from the query and question logs, e.g. posting queries and clicking on results from query logs, as well as posting questions and re-viewing them from the question logs. We constructed search sessions from these extracted actions, with a 30 minutes timeout as a session boundary. Question sessions have no temporal boundary, since every action in the session unambiguously refers to the question posted by the asker.

²<http://yanswersblog.com/index.php/archives/2010/05/03/1-billion-answers-served/>

³<http://webscope.sandbox.yahoo.com/>

Table 1: Statistics of the constructed datasets.

Description	Number of sessions
Total sampled search sessions	1,287,238 (100%)
SearchOnly sessions	1,233,279 (95.8%)
Search sessions that include question sessions	53959 (4.2%)
SearchAsk sessions: search sessions with a single relevant question posted after searching	21231 (1.65%)

Once we had search sessions and question sessions, and mapping between some of them, we created two datasets. The first, termed *SearchAsk* dataset, contains search sessions that turned into question sessions. We only kept such sessions that resulted in posting one and only one question for simplicity of analysis later on. In addition, we only kept sessions in which the posted question is “relevant” to a previously issued query (if the query and the question share at least one non-stopword, they were considered relevant). By observing that some users actually searched for Yahoo! Answers to navigate to its home page before they posted a question there, we deleted such special navigational clicks and corresponding queries from the user action sequences. The second dataset, termed *SearchOnly* dataset, consists of search sessions that did not turn into question sessions. In both datasets, we only kept sessions for users that posted at least once in Yahoo! Answers, since these users are aware of the site and know how to post a question there, thus removing the potential investment of effort for newcomers to join the site, and filtering out the users that simply do not know where to ask questions.

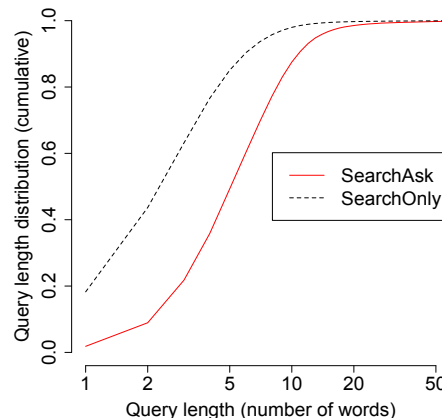
Table 1 reports the statistics of the datasets we obtained. As shown in the table, 95.8% of all the search sessions are SearchOnly sessions, while SearchAsk sessions account for 1.65%. Despite the sparsity of the SearchAsk sessions, we still believe that understanding how searchers become askers in such sessions can be helpful for improving the search experience of these users and perhaps more users. Indeed, the two datasets allow us to investigate the differences between sessions in which users posted a question following attempted searches, mainly due to search failure or searcher frustration, and sessions in which users that have experience of asking questions on Yahoo! Answers did not bother or did not need to ask questions at that time. Recall, that the users in these datasets satisfy two conditions: (1) having clicked at least a Yahoo! Answers question page within this month; and (2) having asked at least one question on Yahoo! Answers within the month. Yet, we believe that such users still represent the general, though somewhat experienced, web searchers.

3. FROM SEARCHING TO ASKING: QUERY AND BEHAVIOR ANALYSIS

As a first step, we study the characteristics of queries leading to a question post on Yahoo! Answers (Section 3.1), and the characteristics of searcher behavior before question asking (Section 3.2).

3.1 Characteristics of Queries leading to Questions

The first interesting question is which queries are more likely to be unsuccessful for automated search, but instead are more amenable to be answered by a CQA site. To get such queries, we examine each SearchAsk session, and

**Figure 2: Distribution of query length****Table 2: Statistics of words per query**

	Avg # words	Avg # stop-words	Avg % stop-words	Avg word length
SearchAsk queries	6.5	2.4	28%	5.1
SearchOnly queries	3.4	0.72	11%	6.0

extract the queries that are issued before the question is posted, and are relevant to the question. We call such queries *SearchAsk queries*. For comparison, we also extract the queries in each SearchOnly session which are called *SearchOnly queries*. In the following, we explore how SearchAsk queries are different from SearchOnly queries in terms of length, words, frequency, and results.

Query Length Distribution.

Figure 2 compares the distribution of query length (in terms of number of words in the query) for the SearchAsk and SearchOnly queries. We can see that SearchAsk queries tend to be longer than SearchOnly queries, as 85% of the SearchOnly queries contain at most 5 words, while about 50% of the SearchAsk queries contain more than 5 words. Therefore, searchers issuing longer queries are more likely to turn to Yahoo! Answers to post a relevant question.

Table 2 compares the average word length per query and the average number of stopwords for the SearchAsk queries and SearchOnly queries. We can see that, on average, queries turning to questions tend to contain more words (but shorter words) than queries that do not turn to questions. The main reason could be that SearchAsk queries contain more stopwords (which are often short) than SearchOnly queries. Indeed, the percentage of stopwords in SearchAsk queries is over 2.5 times higher than in SearchOnly queries.

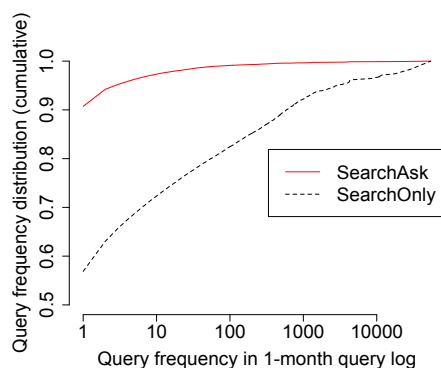


Figure 3: Distribution of query frequency

Query Words Distribution.

To better understand the difference between the content of SearchAsk queries and SearchOnly queries, we compare their word distributions and show the main difference in Table 3. We can see that SearchOnly queries are more likely to be navigational, e.g., to reach websites like Facebook or YouTube, or to find information related to the searcher's common tasks such as looking up the weather, hunting for coupons, or finding a cooking recipe. In contrast, SearchAsk queries are more likely to start with question words (e.g., 'how', 'what'), and tend to use more verbose natural language to express the needs of the searchers (e.g., 'want', 'to', 'know') rather than using only keywords.

Query Frequency Distribution.

To verify the hypothesis from the above word distribution analysis that SearchAsk queries are more likely to be unique, we compute the frequency⁴ of SearchAsk queries and SearchOnly queries in our 1-month query log. Figure 3 shows the results. We can see that over 90% of SearchAsk queries are tail (actually unique) queries, indicating the variety of the needs of searchers and the ways to express them. In contrast, SearchOnly queries contain more popular queries, e.g., around 20% of SearchOnly queries occur in more than 100 search sessions.

Query Results Distribution.

To better understand user needs behind SearchAsk queries, we further examine the results returned in their search engine result pages (SERPs). We found a significant difference between SearchAsk and SearchOnly queries based on whether a SERP contains a Yahoo! Answers question page. As shown in Figure 4, a Yahoo! Answers question page occurs in the SERPs for half of the queries that eventually turn to questions, but for only 13% of SearchOnly queries. It is clear that SearchAsk queries are more likely to have a Yahoo! Answers question page in the SERP. This is not surprising. First, having a Yahoo! Answers question page in search results indicates that the query could be relevant to an existing Yahoo! Answers question. Therefore, answers from a human might be more suitable to address the need behind the query, encouraging the searcher to post a question on Yahoo! Answers. Second, more impressions often leads to more clicks. After landing on the Yahoo! Answers

⁴The frequency of a query in this paper is computed as the number of search sessions containing the query.

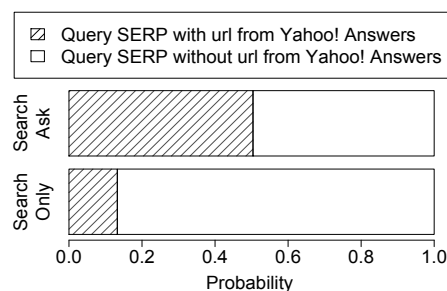


Figure 4: Distribution of query results

site, the searcher might realize that a community might be able to answer her information need, and try posting a question.

Summary of Query Characteristics.

As a summary of the above analysis, we conclude that queries that are more likely to fail in search and lead to a question post on Yahoo! Answers tend to be longer, and use more verbose natural language to express the searchers' needs. The needs behind such queries tend to be more unique and complex than those associated with SearchOnly queries.

3.2 Searcher Behavior Before Asking Questions

To understand how searchers become askers, we analyze the searcher behavior in search sessions, with an associated question posted by the same user on Yahoo! Answers.

Last Action Before Question Asking.

First, we examine what searchers do right before they start question asking, i.e., we examine the last user action prior to a question being posted. We found that the last search action before question asking is a click on Yahoo! Answers question result in 47.8% of the sessions, a click on other result in 31.2% of the sessions, and a query in 17.4% of the sessions. We notice that in about half of the sessions, the searcher posts a question right after clicking on a Yahoo! Answers question page from the search engine results. There may be several reasons for this. First, such a click indicates that the query is relevant to the clicked question, and therefore it probably carries an information need that would benefit from a human response. Second, when the clicked Yahoo! Answers question page cannot satisfy the search need, it encourages the user to post a new question on Yahoo! Answers. Of course, it is also possible that a searcher had already decided to post a question when seeing the original SERP, and she then clicked on a Yahoo! Answers question result simply to navigate to the Yahoo! Answers site.

Distribution of Clicks.

To better understand the effects of clicking on a Yahoo! Answers question result on the transformation of searchers into askers, we compute and compare the likelihood of such clicks in SearchAsk and SearchOnly sessions. Figure 5 shows the results. First, 21% of SearchOnly sessions and 81% of SearchAsk sessions contain a Yahoo! Answers question page in the SERPs. Next, after seeing a Yahoo! Answers question page in the SERPs, 81% of the searchers who turned to

Table 3: Frequent words in SearchAsk queries and SearchOnly queries

More likely in SearchAsk queries	
Words	to, a, be, i, how, do, my, can, what, on, in, the, for, have, get, with, you, if, yahoo, it
First words	how, what, can, be, why, i, do, my, where, yahoo, if, when, 0000, a, will, 00, best, who, which, should
Content words	yahoo, 00, use, 0, work, song, old, help, make, need, like, change, year, good, long, mail, answer, email, want, know
More likely in SearchOnly queries	
Words	facebook, youtube, google, lyric, craigslist, free, online, new, bank, game, map, ebay, county, porn, tube, coupon, recipe, home, city, park
First words	facebook, youtube, google, craigslist, ebay, the, you, gmail, casey, walmart, amazon, *rnrdr, justin, facebook.com, mapquest, netflix, face, fb, selena, home
Content words	facebook, youtube, google, craigslist, lyric, free, bank, map, ebay, online, county, porn, tube, coupon, recipe, anthony, weather, login, park, ca

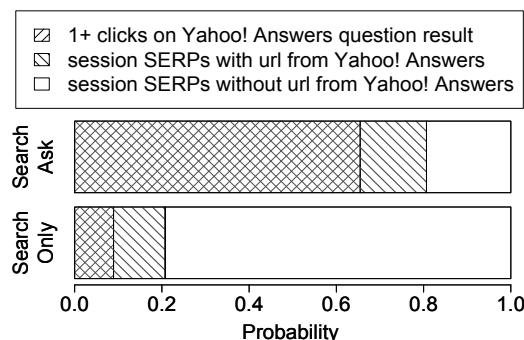


Figure 5: Distribution of clicks

askers had clicked on a Yahoo! Answers question result while 19% of them hadn't; in contrast, 43% of the searchers in SearchOnly sessions seeing a Yahoo! Answers question result clicked on it while 57% of them didn't. Therefore, users in SearchAsk sessions are about twice as likely as in SearchOnly sessions to click on a Yahoo! Answers question page in the search results once seeing it. This indicates that searchers are more likely to post a question once clicking on a Yahoo! Answers question result.

Transitions between Actions.

To better understand searcher actions, we further compute the probability of transitions between actions in SearchAsk and SearchOnly sessions respectively, and compare them in Figure 6. The transition probability between two actions a_i and a_j in SearchAsk (SearchOnly) sessions is computed using Maximum Likelihood estimation: $P(a_i, a_j) = N_{a_i, a_j} / N_{a_i}$, where N_{a_i, a_j} is the number of transitions from action a_i to action a_j in all SearchAsk (SearchOnly) sessions, and $N_{a_i} = \sum_{a_k} N_{a_i, a_k}$. SearchAsk transition probabilities are shown in red before the slash symbol, while SearchOnly transition probabilities are shown in black after the slash symbol. If we look at the transitions for SearchOnly sessions from the figure, we can see that after issuing a query, the searcher is very likely to click on other result, then with perhaps more queries and clicks on other result, and then ends the session. Clicking on a Yahoo! Answers question result is very unlikely. However, in SearchAsk sessions, the searcher has a higher probability on clicking a Yahoo! Answers question result. After the click, the searcher in SearchAsk sessions would post a question on Yahoo! Answers for around half of the time.

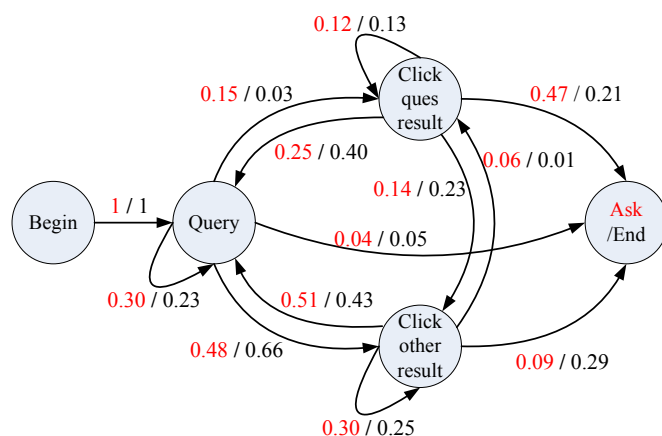


Figure 6: Transition probabilities for actions in SearchAsk (in red, before the slash symbol) and SearchOnly (in black, after the slash symbol) sessions. Note that two other actions (Pagination and Click interface) are ignored for simplicity.

Action Sequences Before Question Asking.

To better understand how searchers become askers, we examine the user action sequences in SearchAsk sessions before the question post, and compare them with action sequences in SearchOnly sessions. Table 4 shows a sample of top frequent user action sequences. The top frequent path in SearchOnly sessions indicates navigational needs of the searchers, i.e., they issue a query, click on a search result and leave the session. Such navigational cases account for 30% of total SearchOnly sessions. In contrast, the top frequent path in SearchAsk sessions indicates more “social” needs of the searchers, i.e., they issue a query, click on a search result of Yahoo! Answers question page, and then ask a question on Yahoo! Answers. Yet, the path distribution is more balanced for SearchAsk sessions. Moreover, clicks on Yahoo! Answers question results are common in the paths.

Session Size Distribution.

Finally, we compare the distribution of session sizes for SearchAsk and SearchOnly sessions. Session size can be measured in several ways, e.g., by the number of (unique) queries issued by the searcher in the session, by the number of actions performed in the session, or by the duration that the session lasts. We use the first option in this paper. The results are shown in Figure 7. While only one query

Table 4: Top frequent user action sequences in SearchAsk sessions and SearchOnly sessions (B: Begin a session, Q: Query, C_{qr} : Click on a Yahoo! Answers question result, C_{or} : Click on other result, A: Ask a question, E: End a session)

SearchAsk sessions	Distribution
B Q C_{qr} A	10%
B Q C_{or} A	3.8%
B Q Q C_{qr} A	3.3%
B Q A	2.8%
B Q C_{or} Q C_{qr} A	2.0%
SearchOnly sessions	Distribution
B Q C_{or} E	30.2%
B Q C_{or} Q C_{or} E	7.1%
B Q E	6.1%
B Q C_{or} C_{or} E	3.6%
B Q Q C_{or} E	3.6%

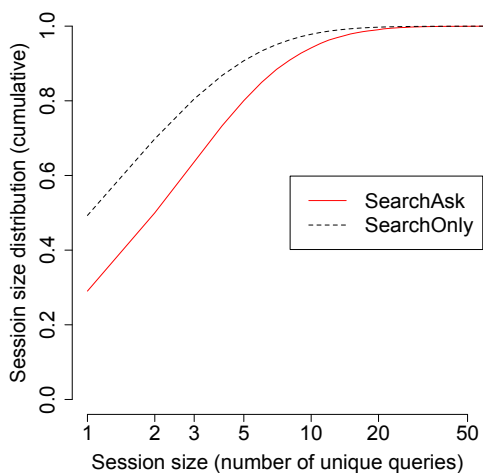


Figure 7: Distribution of session size

is issued in the half of SearchOnly sessions, at least three different queries are issued in the half of SearchAsk sessions. The average session size is 2.5 for SearchOnly sessions and 3.8 for SearchAsk sessions. This shows that searchers tend to issue more queries in SearchAsk sessions, possibly because SearchOnly sessions contain more navigational needs, while SearchAsk sessions are associated with more difficult or complex needs, and thus require more effort in finding answers.

4. QUERIES VS. QUESTIONS: CONTENT ANALYSIS

After discovering the unique attributes of queries that lead to asking a question, we next want to understand better the process of turning a search session, as captured by a query, into a question posted on Yahoo! Answers.

The most expected difference between queries and questions is their length. Table 5 shows these differences. From the table we can see that a question has 66 more words than its associated query on average. This indicates two things: first, as expected, questions are much more verbose, being natural language expressions, compared to the concise queries; second, since Yahoo! Answers questions are not

Table 5: Statistics of length difference between a query and its associated question (number of words).

	Median	Avg	Max
question - query	42	66	1431
subject - query	3	4	27
content - query	31	55	1428

Table 6: Overlap of content words (CW) between a query and its associated question.

	?=question	?=subject	?=content
$CW_{?} \supset CW_{query}$	31.4%	14.6%	14%
$CW_{?} = CW_{query}$	1.8%	6.2%	0.4%
$CW_{?} \subset CW_{query}$	0.7%	3.7%	17.1%
$CW_{?} \not\supset CW_{query}$	66.1%	75.5%	68.5%
$CW_{?} \not\subset CW_{query}$			

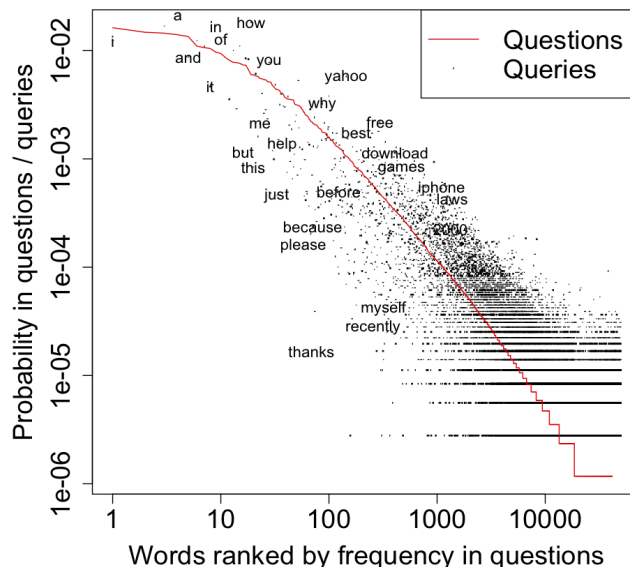


Figure 8: Word distributions over question words

limited in length, additional knowledge of the problem to be solved is added. Interestingly, the subject of the question is very close in length to the query, which shows that searchers still think in search-style writing for the subject. However, the content part of the question is significantly longer, and much more information is added in this question part.

We next look at word distribution differences, since they may point at the lexical gap between queries leading to questions and their associated posted questions. Figure 8 depicts the word occurrence distribution over word ranking by frequency for search-related questions. The most notable difference between the two distributions is that questions tend to be more personal and verbose, as captured by the abundant usage of the pronouns such as ‘I’, ‘me’, ‘it’ and ‘this’, connectives such as ‘but’, ‘because’, ‘recently’, and ‘just’, as well as sentiment indicators such as ‘help’, ‘please’, and ‘thanks’. Queries, on the other hand, tend to focus more on the things or actions that are searched for, with content words like ‘best’, ‘free’, ‘download’ and ‘games’ as well as question words like ‘how’, ‘why’ and ‘what’ occurring more frequently than in the associated questions corpus. Interestingly, one to four digit figures, such as car model years,

Table 7: Examples showing semantics difference between the query and the question.

ID	Type of context added	Query	Question (Category, Subject, and Content)
1	N/A	what to serve with chicken salad	Food & Drink>Cooking & Recipes what can you serve with chicken salad?
2	thought	best nba players without a championship	Sports>Basketball Greatest NBA players to never win championship? Patric k ewing, reggie miller, charles barkley, karl malone? Who else?
3	task	pt cruiser ac fix	Cars & Transportation>Car Makes>Chrysler how much does it cost to fix an ac system in a pt cruiser?
4	task	solve $n^2 - 2n - 3 = 5000$	Education & Reference>Homework Help Algebra question, Need Help Pls!!!!? An owner of a key rings company found that the profit earned (in thousands of dollars) per day by selling n number of key rings is given by $n^2 - 2n - 3$, where n is the number of key rings in thousands. Find the number of key rings sold on a particular day when the total profit is \$5000. Thanx
5	limit	chocolate croissant menlo park	Dining Out>United States>San Jose Where can I get a good Chocolate Croissant near Menlo Park, CA? Something with thick, dark chocolate? And please, don't say La Boulanger.
6	situation, task	chicago fried chicken	Dining Out>United States>Chicago Where can I get really good fried chicken in the Lakeview area in Chicago? I really want fried chicken after watchin a special on TV. But I cant find any place near me that has decent priced chicken thats not fast food and is homemade and delicious. Any one know of a place?
7	situation, task	douglas az	Education & Reference>Higher Education (University +) Radiology schools in Arizona? Does any one know any schools in az that offer radiology degree programs, I moved to Douglas az and don't know any schools near to study radiology. If any one can help that would be great :)
8	attribute, situation, task	how many bottles to buy for a newborn	Pregnancy & Parenting>Newborn & Baby How many bottles should I purchase for my new baby? And what brand is best? I am 9 mo. pregnant and still need to buy bottles. I will be trying to breast feed but I am unsure of how many bottles and what sizes I should buy. Is there anything else I will need for feeding and what brand do you recommend? Thanks!

also appear more in question-related queries than in their associated questions, probably since they capture much of the essence of the target information need.

To further understand the semantic difference between composing a query and its related question, we measured the distribution of query-question pairs in which the same words are used for both query and question, the pairs in which one is included in the other, and those pairs in which each contains words that do not occur in the other. Table 6 presents these statistics, while Table 7 provides examples of such pairs, annotated with the type of context added when switching from query to question, as been classified by [23], i.e., task, situation, attribute, limit, and thought.

Some interesting question composition patterns are evident from this analysis. First, in the majority of pairs (66%), both queries and questions contain unique words that do not occur in the other. This is somewhat surprising, since we would expect more complete inclusion of the query terms in the question. However, it seems that with the freedom of writing a free text question, searchers tend to rephrase some of the terms they used in their queries. For example, abbreviations and short terms are turned into their more complete forms, e.g. 'AZ' into 'Arizona' and 'newborn' into 'new baby' (see example 7 and 8 in Table 7). In addition, while 31% of the pairs do show complete inclusion of the query terms in the question, many times the query terms do not all appear in the question's subject or content, but spread in both question parts. Table 7 shows that most of the extensions of

the query into a question include additional details that are related to the search task. Yet, many times details of the personal situation are added, such as the state of mind, e.g. "after watching a special on TV" (example 6 in Table 7).

One interesting future research is to automatically generate questions from queries [25][26]. However, adding context information to the question, such as the situation or limit is a difficult challenge. Still, expanding the query expression to an explicit question form may be possible for many cases, e.g. examples 1 and 3 in Table 7.

5. ASKING AFTER SEARCHING: QUESTION ANALYSIS

As our final analysis, we are interested in discovering unique activity patterns in Yahoo! Answers that searchers posting a question have, compared to typical asker behavior in Yahoo! Answers. Specifically, we first examine the differences in lexicon, that is whether different words are used when composing a question (Section 5.1). Then, we analyze the difference in asker *behavior* after posting such questions, in terms of "traditional" CQA activities (Section 5.2).

5.1 Characterizing Questions Posted after a Search Session

As expected, we find that there is a large difference between the word distribution for the corpus of all questions posted in June 2011 and the distribution of the corpus of

Table 8: Categories with largest differences in assignment probability between questions coming from search and general questions

Categories more likely for general questions	Categories more likely for questions following search
Polls & Surveys (Entertainment & Music)	Maintenance & Repairs (Cars)
Singles & Dating	Law & Ethics
Religion & Spirituality	Dogs (Pets)
Politics	Pregnancy
Friends	Maintenance & Repairs (Home & Garden)
Mathematics	Renting & Real Estate
Diet & Fitness	Accounts & Passwords
Lesbian, Gay, Bisexual, and Transgendered	Other - Yahoo! Mail
Other - Beauty & Style	Military
Basketball	Problems with Service
Baby Names	Garden & Landscape
Adolescent	Cooking & Recipes

questions posted by searchers. In addition, the entropy of generating a word from the search-related question corpus is much lower, showing a more focused vocabulary. But what are the reasons for this large difference? It turned out to be mainly topical.

To measure this topical difference between the two types of questions, we looked at the distribution of categories to which the questions in the two compared corpora are assigned. Table 8 shows the categories with largest differences in assignment probability, those that are preferred more in the general question corpus and in the search-related question corpus respectively. These lists show that searchers tend to ask informational questions [14] to get fact- or advice-oriented answers, such as how to fix the car or maintain one's garden, how to bake cookies, but also questions related to Yahoo products, such as Yahoo! Mail. On the other hand, regular askers are more likely to ask conversational questions [14] with a social flavor, such as discussions around music or sports events, politics and religions, and opinions on possible baby names. We manually labeled 100 questions randomly sampled from the search-related question corpus, and found none are conversational, showing a very different distribution compared to that 38% of Yahoo! Answers questions are conversational as reported in [14]. We conjecture that this is because searchers usually turn to search engines to find information instead of starting conversations. Another kind of questions that are less likely searched first over the web are personal questions, in which the asker is interested in adding very personal details. These include topics such as diet and fitness advices, dating and style opinions. Finally, there are questions that are too complex, for which the asker knows the answer cannot be found on the web. A good example are Math questions, such as example 4 in Table 7.

To further investigate the differences between the two question types, we removed the strong bias caused by the different category distributions within the two corpora by sampling questions from the general question corpus based on the category distribution of the search-related question corpus. By comparing the word distribution between the sampled corpus and the search-related question corpus, we found that hardly no topical differences remained. That is, the topical variation in the two corpora is more or less completely captured by the level of assigned categories, without

Table 9: Statistics of words in SearchAsk questions and sampled general questions

Avg. corpus statistics	Sampled general questions	SearchAsk questions
# words	78.3	73.7
# words per sentence	13.5	13.7
# sentences	5.8	5.4
% stopwords	66.3	65.0
word length	4.22	4.17

Table 10: Statistics about user follow-up activities around their posted questions.

	SearchAsk	Ask	Search
Avg duration	30h	32h	19.4m
Median duration	2.2h	3.7h	11.6m
Avg #actions	6.41	7.45	-
Median #actions	5	5	-

more subtle topical differences evident. Still, there may be stylish variations in question composition between searchers and typical askers. Table 9 provides the stylish statistics for the general-sampled and search-related question corpora. The significant difference between the two corpora is the number of words per question: for the same topics, general questions contain 6% more words compared to search-related questions. Yet, interestingly, this attribute is due to more sentences that are written on average per general question, while if we look at the number of words per sentence, we see that surprisingly search-related questions have slightly more words in each sentence. This could be related to more information-focused nature of the questions posted after a search session, and suggests further investigation.

5.2 Asker Follow-up Activity after a Search

As our final question behavior analysis, we wanted to test whether a searcher interacts more or less with Yahoo! Answers after posting the question. To that end, we measured both the number of actions that both searchers and regular askers perform around a specific question they posted, as well as the duration of this set of actions. Follow-up actions after a posted question include: browsing the question page (*e.g.* checking for new answers), adding more details to the question, selecting a best answer, reporting abusive answers, voting for answers, and deleting the question.

Table 10 provides the average statistics of these actions, while Figures 9 and 10 depict the distribution of number of actions and their duration for searchers and regular askers. From the table we can see that searchers perform fewer yet similar number of actions as typical askers do, but in a much shorter duration. As can be seen by Figure 9, in terms of number of actions, the difference of about one more action on average for regular askers is small though constant. For the duration of the interaction, regular askers spend about 7% more time on average around the question, but looking at the median, the difference is substantially larger, with half the searchers spending 2.2 hours or less while the typical askers tend to spend about 68% more time, or 3.7 hours, at the median. As an interesting comparison, we also measured the average time the searchers spent searching before asking questions, to show the substantial difference between

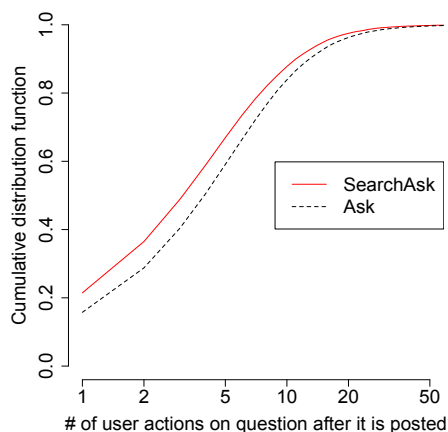


Figure 9: Count of user actions in questions

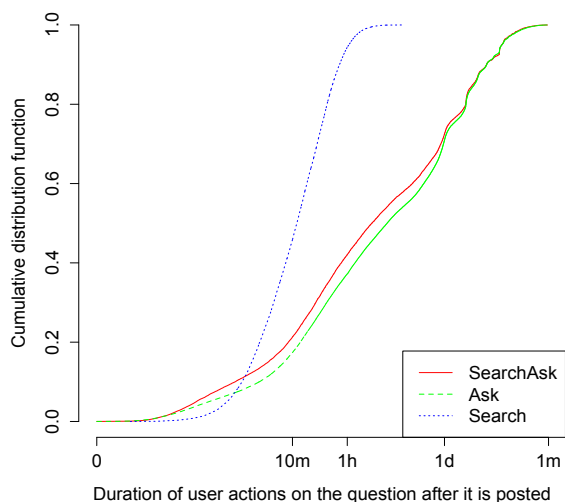


Figure 10: Duration of user actions in questions

an interactive search session and an offline asking session, a difference that is clear to the searchers, since they are willing to spend several hours waiting for an answer to arrive, compared to a few minutes actively searching.

In summary, we showed that searchers are expecting a faster response time for their questions, which often aim to address practical problem solving tasks. On the other hand, general Yahoo! Answers askers are willing to put more effort in following up their questions. One possible reason for this behavior is that Yahoo! Answers site is often viewed by users from a more social perspective, as indicated by many users asking socially-focused (e.g., conversational) questions.

6. RELATED WORK

As we study the transformation of unsatisfied searches into questions posted on a popular CQA site, our work is related to the work on query log analysis, searcher behavior and satisfaction prediction, and CQA question analysis.

On the search side, significant research has been done on analysis of queries and searcher behavior based on query logs. For example, understanding query intent and user goals has attracted much research effort [22][6]. Difficult queries [9][8], long and tail queries [4][5], and question-like

queries [21] have also received special research attention. Besides, searcher satisfaction and frustration [11][15][2][16] has also been actively studied, which utilized query log information for satisfaction prediction, such as relevance measures, as well as user behavior during the search session, including mouse clicks and time spent between user actions.

Donato et al. [10] identified the research missions that often associate with complex information needs and require collecting information from many pages. In our work we focused on studying the types of queries that arguably are difficult for a web search engine to satisfy, often require human to answer [19][20][18], and thus could be better handled by CQA sites. Liu et al. [18] argued that some of these needs can be satisfied with existing answers from CQA archives by harnessing the unique structure of such archives for detecting web searcher satisfaction. Our work in this paper further observed that many searchers not satisfied with search results finally posted a related question on a CQA site, which inspired our analysis of how searchers become askers.

White and Dumais [24][12] studied search engine switching behavior and developed models to predict the switching and its rationale. Although different types of searchers are focused on (they focused on searchers who turn to another search engine and issue more queries, while we focused on searchers who turn to CQA sites and post questions), we are both interested in characterizing the types of queries and searcher behavior that lead to the switchings. Our analysis shows both similar (e.g. longer sessions are more likely to involve a switch) and different characteristics (e.g. different last action before switching) compared to their study.

On the CQA side, there is also research effort devoted to question analysis, e.g. distinguishing conversational and informational questions [14], identifying high quality questions [3], and investigating the effects of contexts in questions on answer quality [23]. In our work, we use their classification of contextual factors to analyze the semantic difference between the query and question posted by the same user for the same need. There is also some previous work related to asker behavior analysis. For example, Adamic et al. [1] analyzed the content properties and user interaction patterns across different Yahoo! Answers categories. Gyongyi et al. [13] studied several aspects of user behavior in Yahoo! Answers, including users' activity levels, interests, and reputation. Yet, they did not study the effort that askers spend in tracing their posted questions as we studied in this paper.

7. CONCLUSIONS

Web search needs are becoming increasingly sophisticated, and the expectations have grown accordingly. As a result, quite a few search sessions end in posting a question in a Community Question Answering service, as the searcher realizes that such a service could better answer her need.

This work studies the unique properties of SearchAsk sessions: search sessions that turn into question composition. To the best of our knowledge, this paper presents the first large-scale analysis of the user transition from searching to asking. What makes our work unique is the study of the explicit connection between the search query and the corresponding question from the *same user* for the *same need*. It provides insights into some specific needs that searchers try to express on search engines, yet are not satisfied by search results, and turn to human answerers instead. We analyzed the various aspects of SearchAsk sessions, includ-

ing the differences between general search-engine queries and those belonging to a SearchAsk session, the transformation of a query into a natural language question and the question composition patterns, as well as other asking behavior of searchers, compared to general askers in a CQA service.

Our findings may contribute both to search-engine optimization, as well as to better user experience in CQA sites. For example, we found out that searchers are not as patient as regular askers when waiting for answers to their questions. This finding may influence CQA sites to promote questions coming from searchers, if they want to retain their engagement. As another example, our analysis of the transitions between user actions in SearchAsk sessions, and especially the fact that question asking is typically preceded by viewing a CQA page, may help search engines. They might decide to detect such cases and explicitly promote the option of asking a question to the searcher, even before she resorts into doing it on her own. Furthermore, as this paper demonstrates, modeling the transformation of a query meant for an automated search engine into a fully specified question meant for human, provides a valuable tool for query intent and satisfaction analysis.

In future work, we intend to develop some of the directions mentioned above. One of the most intriguing ones in our view is for search engines to automatically trigger a dialog for posting questions in the right CQA forum, whenever a SearchAsk need is detected. This is just one application made possible by our study, which lays a foundation for more effective integration of automated web search and social information seeking.

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