

# Analysis of Question and Answering Behavior in Question Routing Services

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## Abstract.

With the development of Web 2.0 technologies, social question and answering has become an important venue for individuals to seek for information that are important to their everyday lives. While prior literatures studying social question answering have suggested the possibility of routing questions to potential answerers for assistance, still little is known about how effective these question routing services are, and how individuals behave within such collaborative question answering environments. With the aim to advance the present knowledge about collaborative question answering that happens on social networking sites, in this study we collected questions and answers posted on Wenwo, a Chinese question routing service based on microblogging sites, over a ten-month period. We conduct various analyses to study individual's question and answering behavior from multifaceted perspectives, including the contributors effort in providing helps to others, the questioner's and the answerer's topical interests, and their connectedness with others through the question answering processes. Our results revealed the effectiveness of Wenwo in routing social Q&A questions to potential answerers and, in the meanwhile indicated the possible bottlenecks exist in the design of the current question routing services.

**Keywords:** social question and answering, social search, collaborative information seeking

## 1 Introduction

Social networking sites (SNS), including as Facebook, Twitter, and Google+, have been widely adopted for online communication [1, 2], Besides using them for relationship formation and maintenance [3], many people also rely on SNS for information seeking [4, 5], a behavior referred to as social questioning and answering (social Q&A). Although not intentionally designed for questioning and answering, social

Q&A has become a new form for online information seeking due to better search experiences over conventional information retrieval methods, such as allowing individuals to ask natural language questions to their online connections, as well as providing more personalized answers. Due to such advantages, social Q&A has attracted many researchers' attention and has motivated the creation of models and tools to facilitate the information seeking process [6].

Among the proposed information seeking methods are several question routing algorithms that mostly involve expert finding techniques to solve the problem of non-guaranteed responses in a social context [7, 8]. It is assumed that question routing services, in general, can help improve the problem of low response rate in social Q&A [9], as it provides stimulus to users' participation [10]. However, still little is known about how effective these question routing services are, and how individuals behave within such collaborative Q&A environments.

To address this issue, in this study we perform detailed measurements of Wenwo, a Chinese question routing services based on microblogging sites, by conducting multifaceted analyses on over 300,000 questions and answers posted on it during a ten-month period. We report preliminary results to identify, first, the effectiveness of question routing services in stimulating users' participation in social Q&A; second, the behavioral patterns of individuals on Weiwo, including their roles, their topical interests, and their connectedness with others through the question answering processes. Our preliminary findings indicate that Wenwo performs well in routing social Q&A questions to potential answerers. However, it relies heavily on a small number of active users and demonstrates strong separation of the roles between askers and answerers. In addition, we notice that individuals exhibit very low connectedness within the community formed by the question routing service.

## **2 Related Work**

### **2.1 Analysis of Popular Community Q&A Sites**

There has been a wide range of interests in understanding individual's information seeking behavior on popular collaborative portals, such as Yahoo!Answers, Stack Overflows, Quora, etc. One line of these studies has focused on utilizing quantitative methods to analyze the real-world Q&A data. For instance, Adamic et al. [11] in their study characterized the knowledge sharing behavior that occurred on Yahoo!Answers by analyzing the question categories and cluster them according to cross-categorical user interactions. Liu et al. [12] investigated the temporal patterns of knowledge contribution on Yahoo!Answers. In addition, they also successfully identified factors that affect individual's tendency to choose the questions to answer. Wang et al. [13] conducted detailed measurement on Quora using three connection networks, a graph connecting topics to users, a social graph connecting users, and a graph connecting related questions. Furtado et al. [14] categorized contributors into ten different types through a clustering analysis based on how much and how well users contribute different types of content over time.

In addition to the above-mentioned quantitative works, there are also studies using qualitative and mixed methods to understand individual's question and answering

behavior from a deeper level. Treude et al. [15] examined the data collected from Stack Overflow and coded the questions asked on it into 11 different categories using a qualitative approach. Nam et al.[16] analyzed over five years Q&A data collected from KiN and noticed that higher levels of participation correlate with better performance. They also interviewed twenty six KiN users for their motivations of answering others' questions and found that altruism, learning, and competency are the top motivations for active participants on KiN. Mamykina et al. [17] adopted a mixed method that combines statistical data analysis and user interviews to uncover the reasons behind Stack Overflow's success. Based on their results, the authors also provide insightful suggestions for future design of Q&A systems, such as making competition productive, building on existing credibility within the community, and adopting a continuous evolutionary approach to design, etc.

## **2.2 Analysis of Social Q&A Sites**

Although the terms “community Q&A” and “social Q&A” have been mixed up and used in literatures, according to Morris et al. [4], Social Q&A is defined as the process of finding information online, especially on SNS, with the assistance of social resources. Many of the prior studies in social Q&A investigate factors that motivate people to seek information via social platforms. They found that individual's trust in friends over strangers, as well as non-urgent information needs were the major reasons that people turn to social networks to seek for information [4, 18, 19]. Besides, studies analyzing social Q&A questions also noticed more subjective questions over objective questions were asked on SNS [18].

Besides the studies of questions asked in social Q&A, there are other works examining the answers received. Paul et al. [9] noted that the majority of questions posted on Twitter received no response. They also observed that distinct question types lead to different response rates. For instance, they found that some rhetorical questions received a relatively large number of replies as compared to personal and health-related questions. In addition, the response rate was strongly related to some of the characteristics of the question askers, such as the size of their networks. Nichols and Kang [8] further confirmed this finding in their online experiment of sending questions to strangers for help. In their results, less than half of the questions received responses from strangers. Liu and Jansen [6] studied the social Q&A responses posted on Sina Weibo, the largest Chinese microblogging site. They found that the question's topic could effectively affect its response rate. For instance, they noticed that questions on the topics of Entertainment, Society, Computer, etc. received fewer responses as compared to questions from the other categories.

## **2.3 Question Routing in Collaborative Q&A**

The concept of question routing refers to routing newly posted questions to potential answerers. According to previous studies [10, 20], the appropriateness of potential answerers was mainly measured based on their expertise as demonstrated by the archives of their previously answered questions. Numerous algorithms have been proposed to solve the problem of routing questions to appropriate answerers within the

context of community Q&A. Li et al. [20] incorporated question category into their question routing model to sift out irrelevant questions in profile of an answerer for expertise estimation. Zhou et al. [21] considered the problem of question routing as a classification task, and developed a number of features that capture different aspects of questions, users, and their relations. Guo et al. [22] recommended questions to potential answerers by discovering latent topics in the content of questions as well as latent interests of users.

Given the relative low response rate in social Q&A, several studies have suggested the possibility of routing questions to potential answers to increase their response probability. Through online experiments, Nichols and Kang [8] explored the feasibility of users responding to questions sent by strangers. They found that fewer than half of the people answer questions posted by strangers. Pan et al. [23] offered a more in-depth analysis on potential answerers by leveraging users' non-Q&A social activities. Through their analysis of an inter-organizational CQA site, they found that some of the non-Q&A features can effectively predict the likelihood of one answering others' questions. Luo et al. [24] built a Smart Social Q&A system based on IBM Connected that recommends both active and inactive users for a given question based on their abilities, willingness, and readiness.

### 3 Research Questions

Although routing questions to potential answerers has been proposed as an effective way in solving the low response problem in social Q&A [20-24], very few studies have actually assessed the performance of the question routing method within practical context. To overcome this gap, we conducted this work evaluating a real-world question routing service called Wenwo from two perspectives:

**RQ1.** *How effective is the question routing service in social Q&A?*

**RQ2.** *How individuals behave within the question routing community?*

For our first research question, we evaluate the effectiveness of the question routing service that Wenwo offers to its users by performing some aggregated analyses on individual's question and answering behaviors. We address the second research question by analyzing individual's topical interests and their connectedness with others within the Q&A process.

### 4 Background on Wenwo

Wenwo<sup>1</sup> is a question routing application based on Sina Weibo, which is China's largest microblogging site, attracting over 600 million registered accounts by September 2014 [25], accounting for 93.60% of the total Internet users in China. Each month, over 2 billion statuses are posted on Sina Weibo. At the time of the study, Weibo

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<sup>1</sup> <http://wenwo.weibo.com/>

essentially adopted the same operating concept and provided very similar functions to its users as Twitter.

As a question routing service, Wenwo operates in a different manner compared to traditional community Q&A sites, such as Yahoo! Answers and Baidu Knows, in which people passively wait for the potential helpers to see their questions and to respond. In contrast, in Wenwo, individuals can either post questions directly to the site, or they can post their questions on Weibo by mentioning @微问 (@Wenwo). After receiving the questions, Wenwo will next identify a number of potential respondents based on their expertise and experience as demonstrated on their Weibo profiles, using machine-learning techniques. By routing questions to those “qualified” respondents, Wenwo effectively increases the probability of obtaining high quality response. A graphical demonstration of the question routing procedure of Wenwo is shown in Figure 1.

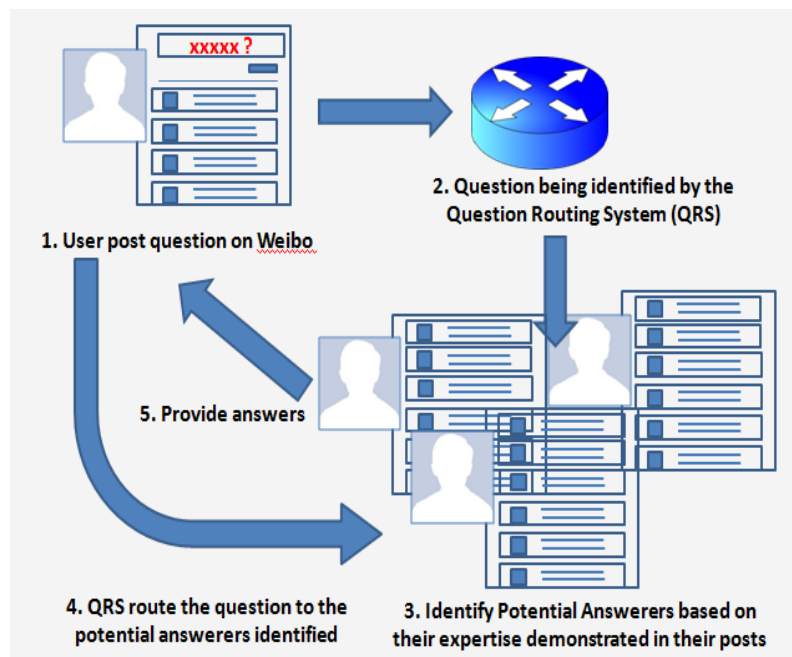


Fig. 1. Illustration of the question routing procedure of Wenwo.

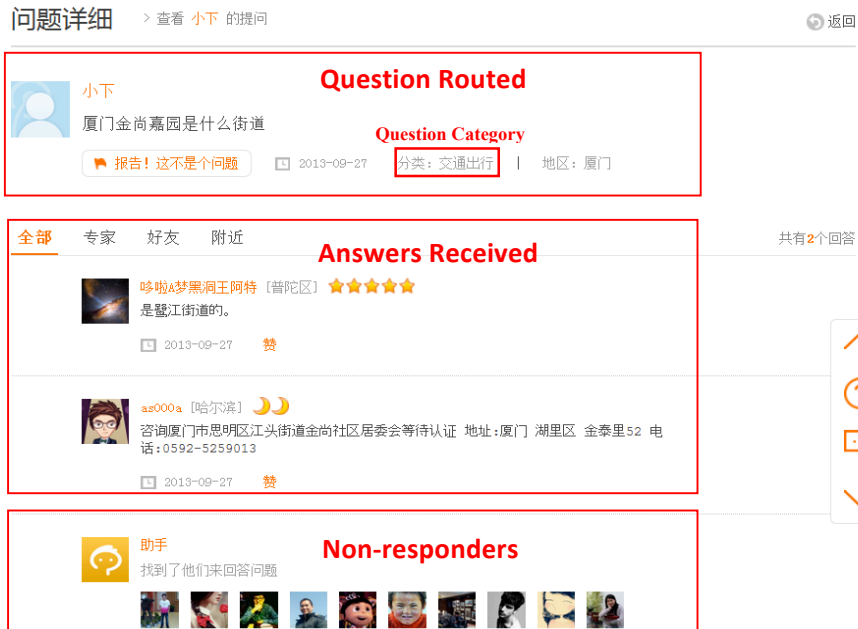


Fig. 2. Screenshot of Wenwo with the major sections highlight

Figure 2 is a screenshot of Wenwo with major sections highlighted. An question entry is created for a user if he/she posted a question either directly on Wenwo, or on Weibo by mentioning Wenwo. To better organize questions according to user's interests, Wenwo grouped all questions posted on it according to a topical hierarchy containing 13 top level categories, including: "Arts", "Business", "Computer", "Digital Electronics", "Education", "Entertainment", "Game", "Healthcare", "Life", "Resource Sharing", "Society", "Sports", and "Vexation". Under each top category, there are a number of sub-categories. All answers to the current question are listed below in a chronological thread, which makes discussions among participants easy. Another difference between Wenwo and other community Q&A sites is that, in addition to presenting the answers received, in most cases, Wenwo also informs the users to whom the question has been routed. This allowed us to know who responded a question and who did not.

## 5 Data Collection

Since Wenwo limits the number of questions that one can view to only popular questions or questions routed to him / her, we decomposed our data collection process into two steps: identify the questions and automatically crawl the identified questions along with their answers using a web-based crawler.

To identify the questions asked or extracted by Wenwo, we adopted a tricky method by searching Sina Weibo with the keyword "I just posted a ques-

tion on [Wenwo]" (我刚刚在【微问】提了一个问题). We selected this keyword because once someone successfully posts a question to or on Wenwo, as a marketing strategy, the service will generate an automatic post to the asker's Sina Weibo timeline, with the templated phrase "I just posted a question on [Wenwo]". With this keyword and Sina Weibo API, we collected 340,658 questions posted during a ten-month period from January 24, 2013 to October 18, 2013, along with the URLs linking to their Wenwo pages. Then with a Perl-written web-based crawler, we collected the question category, posting time, as well as all answers and non-responders for each identified questions. In this way, we in total collected 1,754,280 replies and 585,359 unanswered records.

## 6 The Performance of the Question Routing Service

To evaluate the effectiveness of the question routing service, we first conducted some aggregated analysis on the Q&A performance of Wenwo. Based on an initial examination of the dataset, we noticed that 339,878 out of all 340,658 questions in our collection received at least one answer, yielding a response rate of 99.77%. On average, each question received 5.14 answers (standard deviation, 2.56 answers per question). Comparing with the relatively low number of answers received in natural social Q&A settings, our dataset revealed the potential of question routing in a real social Q&A service.

In order to examine the patterns of knowledge exchange in social Q&A, we further analyzed the roles that individuals played in Wenwo. In total, 671,501 Sina Weibo users participated in the social Q&A process. Among them, 22,203 (3.31%) individuals both asked and answered questions while 221,060 (32.92%) asked at least one question but provided no answer. In contrast, 472,644 (70.39%) users posted no question but replied at least once on Wenwo. The 340,658 questions were asked by 243,263 unique individuals and were answered by 494,847 ones.

In Figure 3, we plotted the distributions of the number of questions asked and the number of answers provided by each Wenwo user collected in our dataset. Surprisingly, we noticed that there were more contributors (users who posted more answers than questions) than consumers (users who posted more questions than answers) on Wenwo. Considering the large number of contributors, the high response rate on Wenwo is not surprising. Besides, while comparing our results on contributors versus consumers with the findings presented in Shah et al.'s [26] and Gyongyi et al.'s [27] observations based on Yahoo!Answers, again, we noticed the power of question routing in social Q&A context. We plotted the cumulative probability distribution of the total number of questions answered on a log-log scale and noticed that the number of questions answered on Wenwo followed a power law distribution, as the points fell closely on the straight line in the log-log plot. This indicated an uneven participation in Wenwo, where a small number of individuals contributed to a large proportion of questions and a large proportion of users only answered a few number of questions.

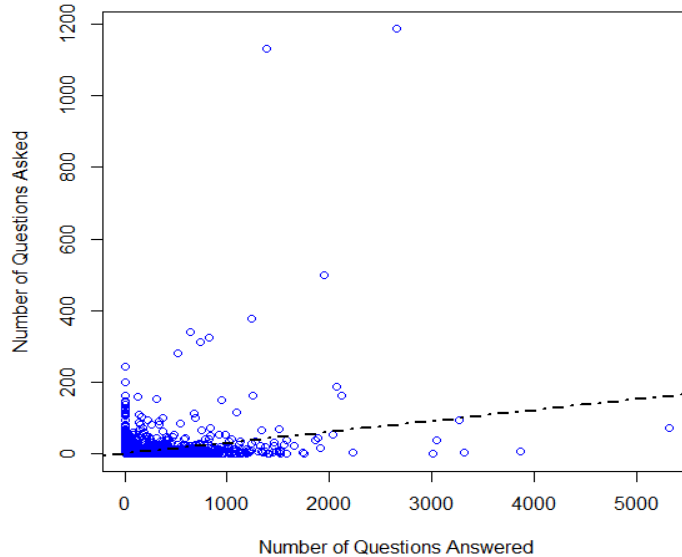


Fig. 3. Distributions of the number of questions posted and the number of answers provided

## 7 Question and Answering Behavior within the Question Routing Community

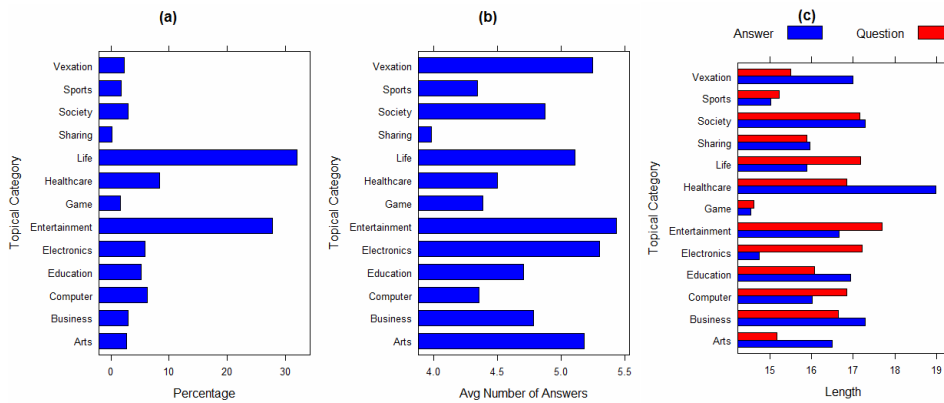
In addition to our analysis on the overall performance of the question routing service, we also explored individuals' question and answering behavior within the Wenwo community from two aspects: their topical interests, and their connectedness with others via the Q&A processes.

### 7.1 Topical Interests

To understand individuals' topical interests when choosing questions to ask and answer, we plotted the number of questions belonging to each topical category in a bar diagram in Figure 4(a). We observed that the topical category of "Life" contained the highest number of questions (32.05%), followed by the category of "Entertainment" (27.72%). These two categories accounted for more than half of the questions asked on Wenwo with the remaining 40% of questions distributed among the other 11 categories. While examine the average number of responses received across categories, we observed in Figure 4(b) that questions under the topics of "Entertainment", "Vexation", "Life", "Electronics", and "Arts" obtained the highest number of answers on average. We thought this might be due to the subjective nature of questions under these two topical categories, as well as the low expertise required to answer them. Examples of questions with higher number of responses from the abovementioned categories are: "Can anybody recommend any horror movie for me please?", "Has anybody used the Sony nex3n yet? Thoughts?", "Do girls really care about height that much? Like i'm 175cm so it's minor, just curious?", etc. Conversely, questions under



the topical categories of Sports, Education, and Computer received lower number of answers, indicating their relatively objective nature. Some typical factual-seeking questions under those categories include: “When should I register for the GRE test?”, and “So how can i get to the reach of root of locked iphone?”



**Fig. 4.** (a) Topical distribution of questions asked on Wenwo; (b) Number of answers received by topic; and (c) Word length of both questions and answers across topics.

We next explored the ways individuals ask and answer questions on Wenwo. We assume that one could infer the type of information needs under each topic by examining the average question and answer length within that category. As can be seen from Figure 4(c), which looks at length characters and terms, we noticed that questions under the topical categories “Entertainment”, “Life”, “Electronics”, and “Computer” were asked in a fairly specific manner, whereas were answered with many short replies. For example, the question, “My IPAD suddenly go dead and after reboot all my downloads disappeared, and now I can't even download anymore! I get a warning message saying 'Make sure SD card is writeable', isn't IPAD SD card internal, what's going on?” attracted many general answers, such as, “Reset to factory settings”, “Due to the loose connection of your SD card, get a replacement at Apple if within warranty”, and “Better contact Apple support”, etc.

In contrast, questions under the topical categories “Vexation”, “Healthcare”, “Education”, and “Business” were phrased in a relatively general manner; for example, “Why do my gums bleed when I brush my teeth?” received long replies such as, “First rule out the possibility of blood system disease and weak liver and spleen. Then if your bleeding is caused by an accumulation of plaque around gums, ultrasonic cleaning may provide some effective relief”, or “I would suggest to take a blood routine examination to check the common indices of coagulation. Most of times it is a symptom of gingivitis, pay attention to your oral health and the correct way of brushing your teeth, don't eat spicy food.”

## 7.2 Social Connectedness

Next, to evaluate the social connectedness of the question routing community, we applied the bow tie structure analysis [28] to our dataset. The bow tie structure captures complex network structures. The key idea of the method is that a network can be viewed as a bow tie that is connected with four different components: Core, In, Out, and Tendrils/Tube, as shown in Figure 8. The bow tie structure analysis has been used in previous studies analyzing the network structure of Yahoo!Answers [29, 30].

In order to fit our Wenwo data into the bow tie model, we created a questioner-answerer graph by connecting users who asked questions with users who responded to these questions. Each node within the graph represents a user who asked or answered a question, while each edge corresponded to the directed reply relationship between the questioner and the answerer. The graph contained a total of 715,209 nodes and 1,538,427 edges. The CORE component is the largest, most strongly connected component (SCC) of the questioner-answerer graph, in which any two users are mutually reachable by following the direct question-answering relationship. With the core component, we can detect the largest group of individuals who tend to help each other directly or indirectly on Wenwo. The IN component contains all nodes that are not part of the CORE but can reach it via directed paths. Users who always ask questions but rarely answer will primarily belong to the IN component. Similarly, the OUT component contains nodes that are reachable from the CORE via directed paths and, in our case, represents users who answer but infrequently ask. The Tendrils and Tube component (T&T) contains users who ask or answer only questions posted or responded by the users within the IN and OUT components.

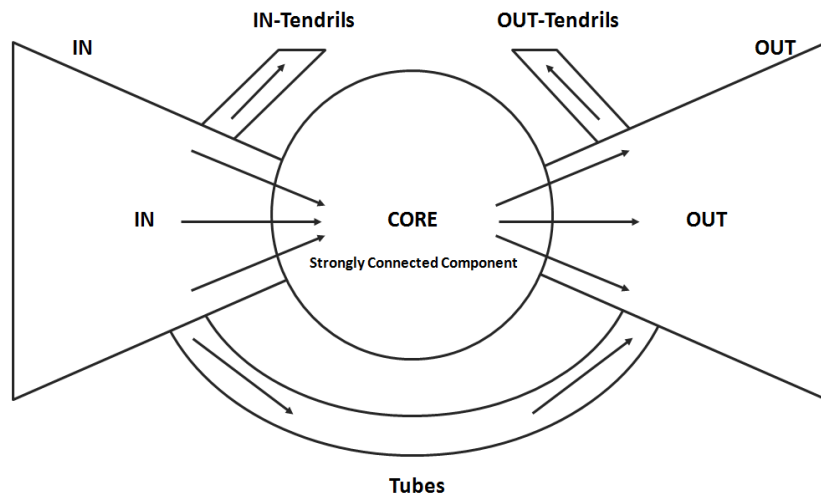


Fig. 6. The NPMI values between topic pairs (reference)

For the Q&A graph generated using collected dataset, the CORE component contains 9,552 nodes, which corresponded to 1.33% of all the users, which is quite differ-

ent from the results as reported in previous studies on Yahoo!Answers. This indicates that the question answering process on Wenwo is not as social as one expects. Only a small proportion of users are connected on Wenwo through question and answering activities, while most of the users are quite segregated. In addition, to evaluating the reciprocal relationships between the questioners and the answerers, we also counted the number of mutual edges in our created graph. We found that among all 1,538,427 edges, 9,313 (0.60%) were mutually connected. We believe this indicated the well-separated roles played by the contributors and consumers in social Q&A environments, like Wenwo.

To test whether user connectedness correlate with topical interest, we also measured the size of the largest SCC and the number of mutual edges within all 13 topical categories. Table 1 shows the results obtained. Compared with the SCC measurement as reported in Zhang et al.'s work [29], we observed in the table that the percentage of the nodes within the CORE for each individual category is much smaller that for the whole dataset. None of the topical categories in Wenwo were well connected, as all largest SCC contained less than 1% of the users within that topical category. We thought this might be due to the well-separated roles of contributors and consumers on Wenwo, as we discussed in earlier section.

Topical Category	# Nodes	# Edges	CORE (%)	IN (%)	OUT (%)	T&T (%)	DISC (%)	Mutual Edge (%)
Life	242,707	472,664	0.52	23.03	6.00	56.58	13.87	0.21
Entertainment	294,473	462,439	0.32	20.02	7.15	60.02	12.48	0.09
Healthcare	49,923	106,711	0.66	30.37	1.52	62.70	4.75	0.40
Arts	27,790	40,516	0.03	2.43	0.29	39.43	57.82	0.16
Sports	19,719	22,948	0.02	1.54	0.10	63.16	35.18	0.07
Society	25,820	41,869	0.30	11.63	1.14	90.26	3.33	0.27
Business	24,024	40,042	0.22	14.01	0.76	74.34	10.89	0.17
Electronics	41,708	88,703	0.34	16.90	1.18	75.57	6.01	0.19
Education	49,514	73,637	0.23	9.21	1.11	72.68	17.01	0.16
Computer	45,098	77,479	0.35	13.79	1.09	71.80	12.97	0.19
Game	13,704	18,720	0.28	5.11	0.76	77.10	16.76	0.30
Vexation	19,359	32,639	0.59	12.12	1.88	73.73	11.68	0.44
Sharing	1,364	1,254	0.01	1.32	0.07	28.74	69.86	0.16

**Table 1.** Connectedness statistics for Q&A participants within 13 topical categories.

A further look at the results in Table 1 reveals that individuals who posted and answered questions under the topical category of Health, Vexation, and Life are relatively connected, with both a high percent of users within the largest SCC and a relatively large number of mutual edges. In other words, as compared to other topics, users focusing on those three categories were more likely to answer each other's questions. This indicated the existence of connected communities within the social Q&A process under those topics. We thought this might because of the common ground existed between individuals sharing either the same living background (as many of the Life questions were location specific, so only users from the same regions can answer those questions), or physical (individuals who experienced or known someone who had the diseases), or emotional conditions (individuals who had or known some-

one who suffered from the vexation). In contrast, users within the topical categories such as Arts, Sports, and Sharing were relatively less connected.

We also noticed that among all topical categories, there were more users contained within the IN component than in the OUT component, especially for the topical categories of Health, Electronics, Computer, and Business. This is consistent with the nature of Wenwo where users actively seek help; however, compared with our previous results as shown in Figure 3, we noticed that the majority of answers were provided by only a smaller number of active answerers.

## 8 Discussion and Conclusion

In this paper, we analyzed over 340 thousand questions and 1.7 million answers collected during a ten-month period from Wenwo, which is a question routing application based on China's largest microblogging site Sina Weibo. Through quantitative evaluations, we found that overall Wenwo performed well in routing individual's questions to appropriate answers. While analyzing the number of questions asked and answered, we noticed that there were more knowledge contributors than consumers on Wenwo due to its underlying question routing mechanism, and thus yielded a much higher response probability and rate than social Q&A in natural settings. Although Wenwo seems to be effective in improving the question response rate in social Q&A, we also noticed certain concerns of such question routing services in our further analysis. First, we noticed that there is a strong separation of the roles between askers and answerers on Wenwo. Also, the total number of questions answered for each Wenwo user followed a power law distribution, indicating that within the large group of contributors on Wenwo, only a small number of them provide answers to a large proportion of questions. This means that although currently Wenwo works well with the small number of active contributors, it may later suffer from the possibility of reduced performance when active users become inactive.

In addition to measuring the overall effectiveness of the Wenwo, we also explored individual's question and answering behavior within the community formed by the question routing service. From the topical perspective, we observed the majority of questions posted in social Q&A are life and entertainment-related. More answerers chose to respond to questions required low expertise, such as questions from the topical categories of "Vexation" and "Entertainment". Also, for questions under different topical categories, individuals choose to answer them with different levels of specificities. Moreover, through a bow tie structure analysis, we found that users within the Q&A community formed by the question routing service seemed less connected than users in traditional Q&A settings. We view this lack of reciprocity as against the interactive nature of social Q&A. So we think there needs to be a better design for future question routing services in social Q&A by addressing the connectedness between individuals participated in the Q&A processes.

We believe that as a preliminary study, this work could be beneficial as it advances previous knowledge of social Q&A in two major aspects. First, to our knowledge, this is one of the first studies with large-scale analysis of knowledge sharing behavior in social Q&A within the question routing context. Our results clearly quantify the necessity of question routing services for social Q&A tasks. Second, our

analysis also recognizes bottlenecks that exist in the current expertise-based question routing services, and can provide valuable suggestions for future design and development of more personalized question routing mechanisms.

Noticing the importance of the small number of active users in Wenwo, for future work, we will focus on those active contributors in order to understand in more depth and details about who they are, and what drives them to share their knowledge with strangers in social Q&A. With those information, we could later build a model to identify active contributors within collaborative Q&A environments.

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