Q&A Communities as Collective Intelligence

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Imagine you’re sitting around with other graduate students at 8pm, and someone mentions she’s thinking of applying for a faculty position at the University of Pennsylvania. Someone else says public universities have problems with state budgets, and he’d prefer a private university for a position. There’s a rejoinder in the room that Penn is private. No one knows for sure. One person scurries off to google the question, another looks at the wikipedia page for Penn, and another asks the question on Aardvark of his social network. What would be the fastest way of finding out?

If you assume that the question has been asked before, and if the answer were easily findable by a search engine (such as Google), then the jump to the answer is only a single hop.

Today, many people’s decentralized activities – asking questions and providing answers -- lead to knowledge provisioning. This is the goal of collective intelligence applications, and Question-and-answer (Q&A) communities are one of the oldest forms.

Q&A facilities have been around, in some form, for many years. They are critical to what has become standard organizational practice; yet, relatively little is understood about them as sites for knowledge production and use. (The exception to this is in customer support, which is sometimes mined for re-engineering and marketing products.) Similarly, while there is a long history of HCI and CSCW explorations of CMCs and other forms of distributed help, we know relatively little about large-scale Q&A communities, although this has begun to change recently.

Moreover, with some augmentation, the decentralized questioning and answering could become a true source of informal information. This would lead to new CI-based forms of knowledge production.

I, along with Lada Adamic, George Furnas, and our students, have been examining how knowledge could be collectively garnered through Q&A communities. Our emphasis has been to explore ways to create new forms of knowledge provision, and one of the ways to do this is to transform Q&A sites into new forms of CI.

Q&A communities serve as exemplars in four ways for CI research:

- First, Q&A communities clearly have an enormous capability for generating informal information. At a basic level, this is what we want (and need) from CI applications.
- Second, Q&A communities have the same problems as other online communities. They need to maintain their user base and keep social order. In addition to these issues, Q&A communities need specific kinds of users, especially those who will answer questions. We need to know more about the social requirements for augmentative technical, social, and incentive-based mechanisms for people in this role.
- Third, relatively little reuse of the informal information occurs. Search engines only sometimes find previous answers, and often answers are partial or contradictory. Therefore, Q&A communities are a potential source for other CI applications that consolidate or distill that enormous flow of informal information. This suggests the need for additional augmentative mechanisms.
Finally, because of their construction, Q&A communities and any re-use applications built upon them are exemplars of social-technical design, and they can be studied from this viewpoint. So are any CI applications, but Q&A communities already exist and are in heavy use. We should examine Q&A communities for the kinds of social and technical issues that might generalize to other CI applications.

Our work has involved many different studies, and below I attempt to summarize some of the studies and their findings. Below, I describe some of the projects involved and their findings. I present them in order of our explorations, although another reasonable way to view them would be as system and social analysis projects. System development was always guided by informal and formal social analyses, and in turn, these social analyses were guided by the insights gained by the system building (including the need for detailed requirements understanding).

In our projects we have already seen many CI issues emerging – motivations, incentives and rewards, creating suitable incentive systems, and maintaining use and users over time. The issues we hope to facilitate, and believe are also critical CI issues with insufficient technical support currently, are learning, distribution of expertise (and avoidance of expert burn-out), and information reuse.

**Arkose: Community knowledge distillation**

This project examined how to distill the large amounts of information and discussions left over at the end of a brainstorming or other community-based discussion. It serves as the basis for understanding technically how to consider knowledge production in informal environments, such as Q&A communities.

In this project, called Arkose, we presented (in Nam and Ackerman 2007) two design principles:

- Incremental diagenesis: the gradual transformation of an information space from unorganized bramble of raw information to more tightly organized summaries
- Incremental summarization: the gradual construction of summaries through collaboration

These abstractions build upon Shipman and Marshall’s incremental formalization.

The project also developed the Arkose system itself, a set of augmentative tools, which supported these two design principles in helping editors distill informal information. The Arkose system also had an innovative visualization tool, the Keyword Farm, to help editors or other users determine what messages and topics still had to be distilled or could be placed in an existing distillation.

The construction of this prototype distillation system demonstrated that such a system is feasible (although complex).
At the same time, we also investigated expertise provisioning and distribution in Q&A communities. We wanted to support how people help one another in online communities, particularly help-seeking or technical support communities, as part of their knowledge production. To do this, we wished to augment what we call the expertise network – the way that expertise is distributed and deployed in a given environment. (This work is joint work with Lada Adamic as well as our graduate students, especially Jun Zhang.)

**Java Forum**

This portion of the work (Zhang et al. 2007) examined the provision of expertise for knowledge sharing in an online Question-and-Answer (Q&A) forum named Java Forum. The Java Developer Forum is an online community where people come to ask questions about Java. It has 87 sub-forums that focus on various topics concerning Java programming. There is a large diversity of users, ranging from students learning Java to the top Java experts. Users usually can get an answer relatively quickly because of the large number of participants. In this study, we used the Java programming sub-forum (called here "Java Forum"), which is a place for people to ask general Java programming questions. The Java Forum had a total of 333,314 messages in 49,888 threads.

We used the network constructed upon these threads to evaluate the usefulness of our expertise-ranking algorithms. The Java Forum network had 13,739 nodes and 55,761 edges.

In analyzing the Java Forum, we went through three steps. First, we wanted to know what went on socially in a typical help-seeking community. We analyzed the network representing asker-helper interactions in an online community, the Java Forum. Among them were highly skewed degree distributions, much like the graph of the World Wide Web. But unlike the Web, specific dynamics governing this particular forum produce a different bowtie structure and degree correlation profile.

We then ran an evaluation of expertise ranking algorithms – algorithms to analyze the relative expertise of different users – in this community. We found that two human raters had approximately .8 inter-rater correlation. Therefore, we could expect that any automated algorithm would at best achieve around a 0.8 correlation with the human raters. For each of these users, in the data analysis below, we summed the ratings from the two raters together as the standard human rating (HR). Figure 5 shows the statistical correlations between various algorithms and the human ratings of the 124 users. (A sensitivity analysis including all 134 users showed insignificant differences.)
From Figure 5, one can see that all of these ranking algorithms give a relatively high correlation with the human-assigned ratings. This tells us that, indeed, structural information could be used to help evaluate users’ expertise in online community networks.

**QuME**

Consistent with studies of other forums, we found that on the Java Forum:

- More than 55% of users usually only ask questions, while there are about 25% of users who are core users who regularly ask and answer questions.
- Many questions are answered by few advanced users while a majority of users only answer a few.
- Top repliers answer questions for everyone. However, less expert users tend to answer questions of others with a lower expertise level.

These findings led us to consider whether the Java Forum’s current form is the best way for a community to work, or whether we could build new mechanisms and interfaces to improve the current functionality. In particular:

- Could we motivate those users who have not answered questions to answer a few?
- Could we help expert users make better use of their time?

QuME (Zhang et al. 2008) is a personalized Java Forum web interface (and the underlying engines that are required) for online Q&A communities. We used Java Forum for our prototype. In this new interface, the order of the questions is customized for users according to their expertise profiles.

One interface is to reorder and re-present the questions based on people’s expertise. However, completely re-ordering the questions for each user may be too aggressive. Figure 7 shows a less aggressive interface design using the QuME system. In this interface, the order of the questions are the same as the original Java Forum. However, the questions with a matching score above a threshold are highlighted. Thus, it can help helpers quickly locate questions that they are capable of answering.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Author</th>
<th>Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Java error: IncorrectException</td>
<td>javasoulhunter</td>
<td>0</td>
</tr>
<tr>
<td>How would you...</td>
<td>Donnato</td>
<td>1</td>
</tr>
<tr>
<td>Beginning JAVA programmer</td>
<td>Joe</td>
<td>0</td>
</tr>
<tr>
<td>using a classes method without knowing the name</td>
<td>ReelCatheter</td>
<td>2</td>
</tr>
<tr>
<td>reading and using Flinkout data?</td>
<td>NullUgotHelp</td>
<td>0</td>
</tr>
<tr>
<td>Create a data to a specific Timezone</td>
<td>Internsmo</td>
<td>6</td>
</tr>
<tr>
<td>Please Help while long quick question</td>
<td>Multiconvolving</td>
<td>2</td>
</tr>
<tr>
<td>get help , its a urinary</td>
<td>jur6</td>
<td>18</td>
</tr>
<tr>
<td>java all Calendar bug?</td>
<td>joho</td>
<td>4</td>
</tr>
<tr>
<td>runtime in memory big objects.</td>
<td>kish</td>
<td>1</td>
</tr>
<tr>
<td>array II II</td>
<td>Chilli</td>
<td>0</td>
</tr>
<tr>
<td>Machine Problem Problems</td>
<td>TofikFtoK</td>
<td>0</td>
</tr>
<tr>
<td>Modifying object in Arrays</td>
<td>shaokk</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 7: Screenshot of personalized interface in QuME.
Using QuME, one can allocate questions more efficiently to various users in the community. An advanced user’s question will have a higher probability of being viewed by more advanced users, thus increasing its chances to be answered faster.

**Expertise sharing – Studies of Internet-scale Q&A sites**

We followed up with a number of studies examining issues in the provisioning of expertise. Lada Adamic, graduate students (especially Jiang Yang and Kevin Nam), and I were especially interested in ways that already occur in augmenting the expertise network within a Q&A community.

**Yahoo! Answers**

We followed up the analysis of Java Forum and the development of QuME with a number of studies. The first was of Yahoo Answers, a large-scale and diverse question-answer forum, that acts as a medium for sharing technical knowledge as well as a place where one can seek advice and gather opinions. (Figure 8 shows its familiar front page.) In Adamic et al. (2008), we analyzed the forum categories and clustered them according to content characteristics and patterns of interaction among the users. While interactions in some categories resembled expertise sharing forums, others incorporated discussion, everyday advice, and support.

![Figure 8: A portion of the front-page for Yahoo! Answers.](image)

With such a diversity of categories in which one can participate, we found that some users focus narrowly on specific topics, while others participate across categories. We found, however, a fairly low level of expertise of both questioners and answerers, although we found hints that there was more answering expertise on the site than was currently utilized. Augmenting what is often a discussion forum would likely be challenging. (Below we turned to other large-scale Q&A sites that we believed would be more fruitful to investigate.)

**Witkey sites**

We also examined Taskcn, a "Witkey" site, a rapidly growing web-based knowledge market in China. On Taskcn, a user who posts a task also offers a small fee, and other users submit their answers to compete. The Witkey sites fall in between aspects of the now-defunct Google Answers (vetted experts answer questions for a fee) and Yahoo Answers (anyone can answer or ask a question). We investigated one of the biggest Witkey websites in China, Taskcn.com.
In particular, we applied social network prestige measures to a novel construction of user and task networks based on competitive outcomes to discover the underlying properties of both users and tasks. Our analysis provided an understanding of the participation structure in Taskcn. We found a task's relative prestige was found to be negatively related to participation, which implies that people were able to perceive the difficulty of completing and winning a task, and adjusted their actions appropriately.

Over time, users tend to select tasks where they are competing against fewer opponents to increase their chance of winning. There is a very small core of successful users who manage not only to win multiple tasks, but also to increase their win-to-submission ratio over time. This core group proposes nearly 20% of the winning solutions on the site, and they contribute the majority of the solutions on the site. Winners and those who did not win have distinct strategies of participating. The group of winners has learned to find less popular tasks in which to participate and learned to submit later. As such, they have been able to slightly improve their performances.

**Naver Knowledge-iN**

We then turned to the Naver Knowledge-iN site, an online question answering community in South Korea that is roughly comparable to Yahoo! Users can ask questions and answer others' questions on any of over 3,000 topics such as singers, programming languages, law, finance, and so forth. KiN has accumulated over 60 million user-generated posts. It has an average of 110,000 answers to 44,000 questions daily and 4.5 million daily visitors. Users' activities are motivated, in part, by the point system that rewards people for answering and being selected as a best answerer.

We collected and analyzed over 2.6 million question/answer pairs from fifteen categories between 2002 and 2007, and also conducted semi-structured interviews with 26 users to understand their motivations, roles, usage and expertise.

We found that the users were largely divided into askers and answerers, with very few (5.4%) doing both in the same category. Users tended to specialize in just one or two topics, and a few top answerers in each category answered a large portion of the questions and produced higher quality answers.

Interviewees noted that KiN was useful for getting information on commonsense knowledge, current events, basic domain knowledge, advice and recommendations from people, and diverse opinions. Our examination of the site confirms this view.

In the qualitative portion of our study, we found altruism, learning, and competency are frequent motivations for top answerers to participate. When asked why they participated, many users said to help others, by providing knowledge that others did not have. Promoting a user's business through answers was also important. As well, many interviewees reported wanting to gain further understanding or to maintain their current understanding of a topic as an important motivation. This included reviewing what they knew before or extending their knowledge by explaining it to others. Interviewees noted that KiN was useful for getting information on commonsense knowledge, current events, basic domain knowledge, advice and recommendations from people, and diverse opinions. Our examination of the site confirms this view.

We also found that participation was often highly intermittent. Using a simple measure of user performance, we found that higher levels of participation correlate with better performance. We also observed that users were motivated in part through a point system to build a comprehensive knowledge database. These have significant implications for future knowledge generating online communities. However, the most interesting issue for Naver usage was use over time. Intermittency appeared to drive participation, as one might expect from a range of motivations. Many people saw it as a duty (altruism) or as a hobby, which led to the intermittent behavior we saw.

We are following up the question of use over time in subsequent studies, including that of Baidu, a similar, Chinese site.
**Arkose 2: Knowledge distillation for Q&A communities**

Subsequently, we (Kevin Nam and I) have begun construction of Arkose 2 to serve as a prototype collective intelligence system that allows flexible information distillation from Q&A sites. It builds on the lessons and ideas from the original Arkose and focuses on providing new user interfaces and interaction mechanisms. Arkose 2 helps users answer complex questions, organize and search information space, link generalized and contextualized information together, and customize information views. These features will help generate and accumulate quality information within an organization.

The major features of Arkose 2, in addition to those of Arkose 1, include better mechanisms to organize and search for questions and distilled answers, a categorization scheme that scales for distillers, and better displays for contextualized answers, allowing the consolidations of many questions over time. A proportional tagging system will allow a user to assign varying weights to the tags of a document in order to simulate the TF*IDF values (Term Frequency * Inverse Document Frequency values, as used in information retrieval). This should help better organize and search for documents. An organic categorization system will suggest new categories for a user’s documents as the number of the documents in a category grows. The user can then decide to re-categorize the documents in order to better organize them. Arkose 2 also allows the display of contextualized information, which should be more valuable than generic information when the context is appropriate for a user. By linking related contextualized information and general information together, and allowing personalized views, Arkose 2 will create a more useful information space for users.