Adaptive Incentive Mechanism for Sustainable Online Community

Julita Vassileva

University of Saskatchewan, Computer Science Department, Saskatoon, Saskatchewan, Canada
jiv@cs.usask.ca

Abstract. Over the last three years, we have been incrementally designing incentive mechanisms to encourage user participation in online communities. Our target community was a relatively small-scale, centralized, peer-to-peer community for sharing links to class-related resources. The users were students in undergraduate computer science classes, typically between 30-35 users. We found that most of the users responded to the incentive mechanism as we intended, but some users attempted to game the system. The excessive contributions resulted in "information overload" and user withdrawal. To make the participation level in the community sustainable, we modified the incentive mechanism to discourage excessive contributions and elicit contributions with higher quality. This required adding a separate incentive mechanism to encourage users to rate each others' contributions and modifying the existing incentive mechanism so that it adapts to the users preferences and to the current needs of the community. The results showed that the timeliness, quality and type of contributions can be effectively influenced by the mechanism.

Comtella: an online community for sharing links

Comtella is a small-scale peer-to-peer online community, developed at the MADMUC lab at University of Saskatchewan, for sharing links to academic papers and class-related web-resources among students. Several versions of Comtella have been developed and deployed since 2002, one for sharing academic papers among graduate students at the MADMUC lab (approximately 15 users), and another one for sharing links to class topics in a 4th year undergrad class on Ethics and IT. The second version has been applied twice as a class support tool, in the winter of 2004 and 2005 (separate communities, each with 32-33 users) and once in a fourth-year class on Multi-agent systems (16 users). Comtella is now being re-designed to serve as a forum for the User Modelling Community (approximately 250 researchers) to share papers, links, teaching materials and news. Another version (called ComWest!) is currently being developed to support school-girls, teachers, parents, undergraduate and graduate students, female faculty and women in industry in sharing advice about careers in science and engineering.

Hypothesis

It seems that most research on participation in online communities is descriptive, i.e. taking an existing successful or failing online community and investigating the factors that contributed to its success or failure. In contrast, our goal is to *engineer* a successful community for a particular purpose. The main hypothesis underlying our research is that by incorporating appropriate incentive mechanisms in the community (these have to be supported by the software), it is possible to stimulate user participation, so that it reaches a critical mass and is sustainable.

Incentive mechanisms in Comtella

The problem of ensuring participation is very important for all online communities [1]. The "critical mass" hypothesis proposed by Hiltz et al. [2] states that a certain number of active users is needed for a virtual community to be sustainable. To address the problem in Comtella, we introduced an incentive mechanism [3, 4] based on status to stimulate users to contribute resources. While the mechanism was effective in increasing participation in terms of *quantity* of contributions, it led to a deteriorating *quality* of contributions and subsequent disappointment and withdrawal of some users. We realized that the mechanism should not encourage the user to contribute new links only, but also to contribute ratings, so that the community ratings can serve as a distributed measure of the quality of the shared links. Therefore, to make our community sustainable in the long term, we had to adapt our status-based mechanism to take into account the quality of user contributions. We also had to add an incentive mechanism to encourage explicitly the users to rate links. Finally, we had to incorporate adaptivity in the incentive mechanism towards the current needs of the community and to the preferences of the individual users. The next sections discuss these three main developments in the Comtella incentive mechanisms.

Incentive mechanism based on status to encourage participation

The main incentive mechanism for participation is based on hierarchical memberships in the community (gold, silver, and bronze and plastic), which are awarded to users depending on the number of their contributions [4]. A linear function computes the level of participation as a weighted sum of several participation components: number of shared links, number of ratings given to these links, number of comments given, and number of reads of the links shared by others. Depending on the participation level, users are classified into three memberships (statuses). The membership of each user is visualized in a community visualization using a star-sky metaphor [3] (see Figure 1).

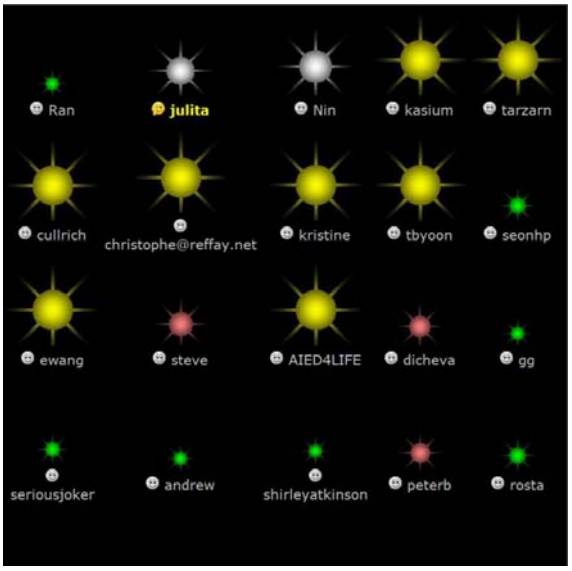

Figure 1: Visualization of the status of users in the Comtella community

While our case study [4] showed that the incentive mechanism was effective in increasing the number of user contributions, it also motivated a small number of users (4 users out of 32) to game the system to achieve higher membership levels. They shared many resources that were of poor quality or unrelated to the topic. This made it hard to find good resources in the system after a couple of weeks, resulting in the decreased level of participation towards the end of the study and disappointment reflected in negative user comments about the ease of cheating the system in the exit questionnaire. Our observations mirror those made in other online communities and reflect the *ageing of a community* [5], characterized by a small number of users providing a large proportion of the contributions, which are usually of poor quality, resulting in information overload [6]. Jones et al. [7] found that most common response of users is to stop participating in the community. Therefore, it is desirable to discourage excessive contributions in the system, to motivate users to contribute high-quality resources and simultaneously inhibiting the contribution of inferior ones.

The case study showed also that different users had different patterns of contribution. Some typically brought a lot of contributions, though of not very good quality. These contributions were still valuable, especially, when a new topic was introduced, since they created a critical mass and attracted more users to read and contribute. Other users contributed just a few very good links. Some users preferred to bring new papers, others preferred to read and rate the papers in the system. All of these styles of contributions are valuable for the community and have to be encouraged. A powerful incentive mechanism has to offer rewards for different types of users, and their preferred types and styles of contributions.

Incentive mechanism for rating

To measure the quality of shared links, it is necessary to have a lot of user ratings. As an incentive for users to rate contributions, we introduced a virtual currency, called “c-points”. A number of c-points are awarded to a user for rating papers, depending on her reputation of giving high-quality ratings. The c-points can be used to increase the initial visibility of the users’ postings in the search result list. Most users hope that their new contributions appear in salient positions, e.g. in the first place or among the top 10 in the search result list, because in those positions they will have a better chance to be read and rated by others. With the new mechanism, the Comtella search facility displays all the links that match a user query in a sorted list according to the number of c-points allocated by the contributor of the link. Thus the users can ‘sponsor’ some of their links (like the sponsored links in Google). This is especially useful when they find a good link fairly late, since otherwise, the chance that the link will be seen and rated by others is slim.

Adaptive incentive mechanism to the community and the individual

The needs of the community change in time. When the topic is new, it is important to have more contributions, but later, when there are many contributions, it is important to have more ratings to help users cope with information overload. At a certain stage, when the “critical mass” is reached, new contributions should be encouraged only if they are particularly good or original. Therefore, a motivational mechanism needs to adapt to the dynamic needs of the community and encourage users to contribute early.

We introduced a community reward function that can be adapted for a particular period of time. The function rewards highly the acts of sharing new links in the beginning of the period after introducing a topic and then smoothly declines the rewards as the number of contributed links in the community approaches a certain desired number. The rewards (participation points) that the user gets for particular form of participation are shown in the beginning of the session as the user logs in, in a personalized message, so that she is aware of how much she will gain by contributing during the current session..

Finally, to ensure that the rewards mechanism is adaptive to the user’s individual quality preference, a user model keeps statistical evaluations of the user’s previous contributions and ratings given and received. The summative rating received by all contributions of the user represents the user’s reputation in the system. If a user’ reputation is high, it indicates that the user tends to share resources of good quality and should be encouraged to contribute. In reverse, the reward for the users with low reputation should be decreased faster if they contribute many resources and if the expected total number of contributions for the current topic is close to being reached.

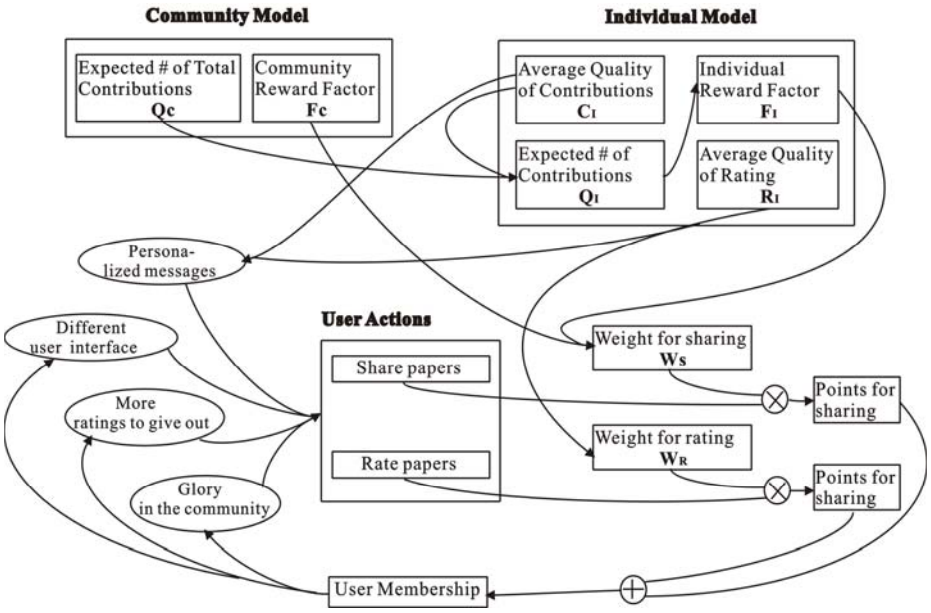

Figure 2. The Adaptive Incentive Mechanism at a Glance.

Case Study

The extended mechanism described in the previous section was tested in a new case study, in a class with similar number of students (32) divided in two groups (test and control). The results showed that the c-points were very successful in encouraging users to rate. The test group rated twice as many resources. The difference was significant (at a 0.05 level) throughout the 9 weeks of the experiment. The adaptive rewards encouraged users to contribute earlier. The users in the test group tended to share papers earlier in the week (71% versus 60%) and the result was significant at a 0.05 level over the 9 weeks. There was no significant difference between the total numbers of papers shared by the two groups; however, the overall number of contributions in the system was controlled and close to the desired number (as specified by the instructor). The students didn't report difficulty in finding good articles and there was no sign of cognitive overload. The users in the test group were significantly more active in terms of logging on the system and reading articles.

Theoretical underpinnings of the mechanism

Our mechanism was designed in line with three theories from social psychology. According to the *theory of reciprocation* [9], a community would not be sustainable unless it provides benefits that outweigh the costs of time, energy and

resources members contribute [10]. Our mechanism provides several types of benefits and rewards. First, as a result of active user contributions, everyone is rewarded with access to more resources with better quality. Second, our mechanism rewards users that rate regularly resources with c-points giving them more power and control in the community. Contributing users are rewarded with higher membership status, which gives them more rating power, a different interface and social visibility. According to the *theory of social validation* a group of people sharing some sort of similarity can influence each other's behaviours [9]. The community visualization in Comtella facilitates social comparison and validation, which influences users behaviour in the desired direction [11]. Finally, according to the theory of discrete emotions, specifically, the theory of fear [12], the threat of loosing something arouses fear which makes incoming messages containing reassuring information, more persuasive. Users who have gained higher status in the system would be more easily persuaded to maintain their level of activity of fear that they may loose their status and associated privileges.

Another theory that would be interesting to try to apply in future versions of Comtella is the *persuasiveness of liking theory*, according to which people are motivated easier by their friends. We are currently incorporating in Comtella a visualization of the mechanism modeling relationships proposed in [3] hoping to create a more tangible sense of community.

Comtella can be tried online at: http://svaroy.usask.ca:8080/aied

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