QSIA: Online Knowledge Items In the Service of Learning Communities

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Our research integrated computerized social collaborative systems known as **Recommender Systems**, with **distance learning**. The relationships among collaborative filtering and scientific literature, distant learners and organizational learning are quite new, applying 'high risk', knowledge-intensive domains to the "next generation" of recommender systems. Noting that computer-based learning, like other learning methodologies, does not present equal benefits for everyone, we conducted a longitudinal field study in which, for two years, our research tool, QSIA (at: http://www.qsia.org), a web-based Java-programmed collaborative system for collection, management, sharing and assignment of knowledge items for learning, was free for use on the web and was adopted by various institutions and classes of heterogeneous learning domains.. The option of testing and online assessment at any time and in any site is a flexible method to mentor progress and focus difficulties in learning along with analysis of online computerized tasks. The system enables creating and editing of the knowledge items and conducting online educational tasks and includes a recommendation module that assists the students and teachers in filtering relevant information. QSIA was implemented in over ten courses of academic institutions. At the time of this analysis, QSIA's database and logs were comprised of approximately 31,000 records of items-seeking actions, 3,000 users (mostly students) and 10,000 items (mainly in the field of medical pathology). The main findings of this study were that users acquire a tendency to seek recommendations from 'friends groups' and there was a significant positive difference in the acceptance level of recommendations by users when they asked for 'friends groups' recommendations. The choice of one's own group was the most important characteristic for users to assign to the advising group members. We also noted that the majority of users sought recommendations from teachers rather than from students. Users chose participants with either higher or equal grades to their own to populate the advising group.

Recommender Systems

Our research concerns computerized social collaborative systems known as **Recommender Systems**. The main task of a recommender system is to recommend, in a personalized manner (Rashid, Albert, Cosley, Lam, McNee, Konstan and Riedl, 2002; Im and Hars, 2001), relevant items to users from large number of alternatives (Oard and Kim, 1998; Resnick and Varian, 1997; Todd and Benbasat, 1994), for example: web resources (Konstan, Miller, Malt, Herlocker, Gordon and Riedl, 1997; Maltz,

1994; Bollacker, Lawrence and Giles, 1999), movies (Basu, Hirsh and Cohen, 1998), books (Freedman, 1998) and ski resorts. The field of recommender systems has undergone a great expansion during the last decade (Soboroff, Nichols and Pazzani, 1999) and has become an integral part of many e-commerce web sites (Balabanovic, 1998; Schafer, Konstan and Riedl, 1999). This domain is still considered to be immature (Resnick and Varian, 1997): systems are mostly incomparable in their performance, lacking standard metrics and datasets. Developers of recommender systems approach the task of helping a user to find preferred items mainly by using an algorithm known as the 'top-N neighbors' (Karypis, 2000) that selects the 'neighbors group' (Terveen and Hill, 2001), namely the population whose tastes and preferences are highly correlated with those of the user, and this group is considered to be most 'qualified' to serve as recommendation providers for the user (Avery, Resnick and Zeckhauser, 1999; Avery and Zeckhauser, 1997; Resnick, Zeckhauser, Friedman and Kuwabara, 2000; Miller, 1982).

Research Questions

We chose to concentrate on the social aspects of user involvement in the recommendation process, specifically, in the formation of the advising groups (Shardanand and Maes, 1995). We introduce the term "friends group" (Adamic and Adar, 2003a; Adamic and Adar, 2005; Adamic, Buyukkokten and Adar, 2003b) to describe a sub-group of the neighbors group that is not solely rank-dependent, as opposed to "neighbors" that are assigned by rating similarity. The 'friends group' is unique because of the user's involvement in its formation and the user's ability to choose the characteristics of its members. The latter aspect is in accordance with the "Social Comparison Theory" (Festinger, 1954; Wheeler, 1991) and the derived behavioral studies (Byrne, 1965, 1974; Rokeach, Smith and Evancs, 1970; Stein, Hardyck and Smith, 1965) suggesting that 'neighbors' (like-minded group) are relevant for 'low-risk' domains whereas 'friends' (similar on personal characteristics) are more relevant for 'high-risk' domains.

Our first research question was concerned with users' preferences concerning control over the recommendation process as opposed to acceptance of recommendations from a "computerized oracle". The second research question examined whether the attitude of the recommendation seeker obeys social rules, specifically, the "Social Comparison Theory" (Im and Hars, 2001). The last research question was concerned with the characteristics of the members of the 'friends group' that are chosen by the user. Our basic concept stated that users will prefer to assume control over the recommendation process (Bacon, 1995), especially the composition of the recommendation group. This will be reflected in higher levels of acceptance of recommended items when the recommendations originated from 'friends groups', controlled by the user (Ahituv and Ronen, 1988). We also assumed that given the option, users will choose similar-to-themselves 'friends' for their advising group.

QSIA System and the Field Study

We conducted a two-year long field study, using QSIA (at: http://www.qsia.org), a web-based Java-programmed collaborative system for the collection, management, sharing and assignment of

knowledge items for learning (Rafaeli, Barak, Dan-Gur, and Toch, 2003; Rafaeli, Barak, Dan-Gur, and Toch, 2004; Rafaeli, Dan-Gur and Barak, 2005). QSIA was developed in the Center for the Study of the Information Society with the support of the Caesarea Edmond Benjamin de Rothschild Foundation Institute (CRI) for Interdisciplinary Application of Computer Science at the University of Haifa. The system enables the creation and editing of the knowledge items and conducting online educational tasks (Rafaeli and Tractinsky, 1991) and includes a recommendation module that assists the students and teachers in filtering relevant information (Barak and Rafaeli, 2004). We developed a five-stage conceptual model of users' interaction with the recommendation module of QSIA that describes the processes of 'neighbors' and 'friends' recommendations seeking that the system supports (Campbell, Schwartz and Sechrest, 1966). QSIA was implemented in over ten courses of academic institutions, the main one being general and systematic pathology course in the Faculty of Medicine, Tel-Aviv University; Israel. Additional institutions and courses that implemented QSIA were:

- Nesher High school, Nesher, Israel;
- Electronic Commerce course, Graduate School of Business, the University of Haifa, Israel;
- Electronic Commerce course, Industrial Engineering, Technion, Haifa, Israel;
- Organizational Behavior course, Technion, Haifa, Israel;
- MIS course, the school for practical engineering, Ruppin College, Israel;
- Turkish Language course, the Faculty of Humanities, University of Haifa, Israel;
- Electronic Commerce course, the Cyprus International Institute of Management, Nicosia, Cyprus;
- Electronic Commerce course, the University of Michigan, USA.

QSIA's database and logs comprised of approximately 31,000 records of items-seeking, 3,000 users (mostly students), 10,000 items (mainly medical pathology), and 3,000 rankings by 300 users and knowledge items from 30 domains. Only about 3% of these figures were relevant for our study of recommendations (Leuthold, 1998; Shapira, Kantor and Melamed, 2001): 895 recommendations sought by 108 users. The rest of the data were related to self-browsing, which is beyond the scope of the current research. QSIA is unique in three aspects: to the best of our knowledge this is one of the first recommender systems that enables user's involvement in the determining the set of the 'neighbors group' for an automated collaborative filtering recommendation (Swearingen and Sinha, 2001); QSIA is one of the few systems that enable immediate usage of the "liked" recommended items in the *same* system as the *next step* that follows suggestion of recommendations; and QSIA applies recommender technology to a novel domain – knowledge items for distance learning (Beller, 1997; Beller and Or, 1998) and online tests - that are not "natural" for recommender systems that are mostly applied to entertainment, commerce and news.

Variables and Analysis

Our main dependent variables were the "source of recommendation - SoR" (namely either 'friends group' or 'neighbors group'), the ratios of accepted and rejected items in each recommendations seeking instance, and the users' choices of the friends' characteristics (group, grade level, and role). The independent variables were the iteration number of the recommendations seeking and the SoR (Agresty, 1996). We analyzed alternative hypotheses concerning the choice of the role of members of

the 'friends group' (users will choose teachers' recommendations because of their authority and knowledge expertise) and the choice of grade level (the "reference group" will be comprised of students with higher grades). The main statistical methods and tests we used were the Wilcoxon signed-rank test, logistic regression, the GEE models for correlated binary data in logistic regression, and the Runs tests (Diggle, Liang and Zeger, 1994; Kerlinger, 1986; Liang and Zeger, 1986; Siegel and Castellan, 1988).

Findings

The main findings of this study were:
H_1: The results of the GEE longitudinal models suggested that users acquire a tendency to seek recommendations from 'friends groups' and the probability increases as more recommendations are sought by users.
H_2: We noted a significant positive difference in the acceptance level of recommendations by users when they asked for 'friends groups' recommendations. In addition, the same items were more accepted when offered to the user by the 'friends group' than when offered by the 'neighbors group'. The difference in acceptance was higher for items that were recommended frequently.
H_3: The choice of one's own group was the most important characteristic for users to assign to the advising group members (Festinger, Pepitone and Newcomb, 1952). We also noted that the majority of users sought recommendations from teachers rather than from students (Wyeth and Watson, 1971). About half the time users chose participants with higher grades than their own to populate the advising group and about half the time users chose participants with similar grades to their own.

Limitations

Our research has many limitations apart from the known drawbacks of any field study: the most important one is that we did not find a relevant comparable field study with which to triangulate our results. Because of its uniqueness, we detailed the weaknesses and limitations that we did recognize in the *research method* (the main one being that we did not inquire about users' motivations for their behavior), the *research tool*, QSIA (which is hard to compare to other recommender systems and allows processes that result in missing data), and the collected *data* (of which only minor part was relevant to our study, and its sparseness can cause other limitations).

Summary and Implications

The main novel finding is the relationship between the perceived quality of the recommendation (measured in terms of "usage actions"), and users' involvement in the formation of the advising group. We included literature review from a variety of domains to detail how our findings fit with previous research. We point out many studies and papers that can be linked to our findings, mainly studies on accepting advice from an automated machine, HCI, transparency of systems, applying social rules and expectations to computers, and the nature of human taste. The findings may be of interest for further interdisciplinary research on collaborative filtering, bridging the gap between "computerized oracles"

and social behavior, relating computerized collaboration and social theories, economical implications of higher acceptance level of recommendations, and a motivation to conduct additional field studies, especially within the 'high-risk' items domain.

We concluded by proposing questions for future research that emerged from our research findings, in addition to several a priori questions we posed prior to conducting the research. Our proposed questions for future research can be classified into behavioral motivations, linkage between attitude and behavior, recommender systems' design, human-computer interaction, and acceptance of advice and recommendations from a machine.

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