Agent-Based Social Network Information Management Mechanism

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***Abstract*—Social Network Service (SNS) plays a significant role in everyday life; it provides online interpersonal relationship networks for Internet users. With the rapid spread of interpersonal relationship through various social network sites, Internet users seem overwhelmed by mass data, and it turns out that the truly important information is difficult to gather. Therefore, this paper proposes an Agent-Based information management mechanism in charge of gathering users' interacting data, such as post status, pictures, blog interactive content, people response ways and frequency in network, then, using linear programming approach to obtain maximum value bases on relationship function. This information management mechanism enables substitute into relationship function values as key factors of data mining during user processing data search. Finally, the paper provides a timeline visualization methodology to show efficiently and effectively the result for users.**

Keywords-Social Networks; Multi-Agent System; Information Management Mechanism; Relationship Function

I. INTRODUCTION

Social Network Service has almost become essential for most of people in daily life, who often share their individual ideas, feelings with family, friends and colleagues in virtual network. And it builds a whole new generation social relations among people by way of sharing and interacting over the Internet. During recent years, Facebook becomes a most famous Social Network Service, its popularity to lie in innovative ideas and makes users contact with each other in new ways. Facebook is a platform of establishing relations among of people and create user's own social network by user self-described profile.

Meanwhile, social networking growth continues to surge in the world wide, its composition becomes more and more complication. Since the growth of social networks, each user had existed between one or more specific types of interdependence, which becomes more complex than before. Moreover, it comes with deriving more indirect, hidden and easily ignored information and relationship problems. Therefore, it is absolutely necessary to design a mechanism in order to effectively find these hidden information and relationships. The two main objectives of this paper are: i) Design a suitable information management mechanism for social network, in order to users quickly and efficiently find accurate information they need. ii) The former results illustrated by visualized timeline graph.

II. LITERATURE REVIEW

A. Social network service

The main role of Social Network Service (SNS) is to provide a group of people who have common interests and activities to create online community in network. Most of social networks offer users various ways to interacted with others, for example, information exchange, feelings sharing, chat, video or file sharing, blogs, discussion groups, it provides a new way to exchange and share information. Nowadays the social networking service has not only changed the ways of communicating, but also almost become a necessary item in people's everyday lives.

Currently, there are many websites providing social network services in the world, the most of well-known sites are including Facebook, MySpace, Orkut, Twitter, Flickr and more. In 2006, Facebook lunched an API to allow third party developers to use and develop related applications, thus that Facebook has emerged a fastest growing social networking site in the world.

The development of social service site verification "Six degrees of separation theory" (Six Degrees of Separation) [1], namely "interpersonal context all people on Earth are connected to one another by no more than six separate individuals." The individual social circle will continue to

enlarge and overlap and eventually forming a large social network.

B. *Multi-agent system*

Multi-Agent System (MAS) is not only a rapidly increasing research field but also one of fastest-growing IT industries. Agent is a set of programs; aim to act for user and working autonomously. Multi-agent system is a distinguished system consisting of a set of interacted agents.

Agent is a communication and cooperation mechanism. There are many international technical units or organization set up standards, such as: FIPA (Foundation for Intelligent Physical Agents) [2] and the OMG (Object Management Group) [3].

Agents generally have the following features: (1) Adaptive, (2) Autonomy, (3) Collaborative behavior, (4) Inferential capability, (5) Knowledge-level communication ability, (6) Mobility, (7) Personality, (8) Reactivity, (9) Temporal continuity.

Based on the above observations, there are some characteristics in the Multi-Agent System, like adaptively, autonomy, personality; we know MAS is well suited to deal with social networks related issues. Multi-agent system, is a reticular system, formed by weakly coupled linked, and it contains many different problem solvers in different processing stages. The problem-solving ability of these merged problem solvers is much better than individual solvers. Thus, multi-agent system contains various combinations of automatic components.

C. *Social information management mechanism*

With the amount of data of social network increasing to handle huge data becomes more complex and difficult. Although, everyone gets needed information through social network every day, How to improve the quality of search and provide users useful information with timely and efficient is an issue requires sustained effort. The important key point is not searching no information, but may not be able to provide information which user really wanted or interested in. Therefore, the search in online social network is still a very time consuming task now. The disadvantages of search engines include: A query may return a large number of results and lack of personalization. In generally, a same query from different users should be based on characteristics of different users and comes out different results.

The recommender system has been an important application tool to effectively extract useful information. The following three categories are mostly followed in the literature:

- Content-based system： With analyzing data by browsing website and similar content webpage for generating recommendations.
- Collaborative filtering system：With calculating the similarity of different users and provides recommend items that those similar users like.
- Hybrid system: With an appropriately mixed these two approaches above.

Wei et al. [7] initially proposed a market-based recommender system that provides a multi-agent system represented as a user, and can display recommendations on the slide bar. As to other involved agents, display in sequence recommendations on the slide bar as well, and then the agent-initiator choose content to the user. The agent will be rewarded if the user accepts the options. The agent adopts a recommend method with multi-layer to ensure that the best recommenders are presented. A multi-agent recommendation system is proposed by Yu et al. [8], they proposed a MARS knowledge management referral system, which in charge of assigning software agent to each user. The Agent uses an interactive way to generate answers for the queries of their users. This system uses a predefined ontology and shared among all the agents, so it can easily share knowledge and solve problems together.

Degemmis et al.[9] present a recommender system that is combination of collaborative filtering techniques and user-profile based learning recommender system. In addition, this system also combines collaborative and content-based strategy, with the knowledge of the user can be stored in user profile, as well as collaborative filtering recommendation algorithm to reduce generation time. Chau et al.[10] propose a collaborative multi-agent web mining system, Collaborative Spiders, designed to extract Web content, perform post-retrieval analysis, interact with users, share information among different user agents and enable across-user collaboration in Web search and data mining.

III. PROPOSED MECHANISM

The goal of this paper is to design suitable information management mechanism based on multi-agent systems in the social network and to collect and analyze user relative information and interests, which facilitate user search quickly and efficiently for information they required. We present a multi-agent system architecture shown in Figure 1, which contains three types of agents: Graphic User Interface Agent (GA), User Agent (UA), and Social Agent (SA).

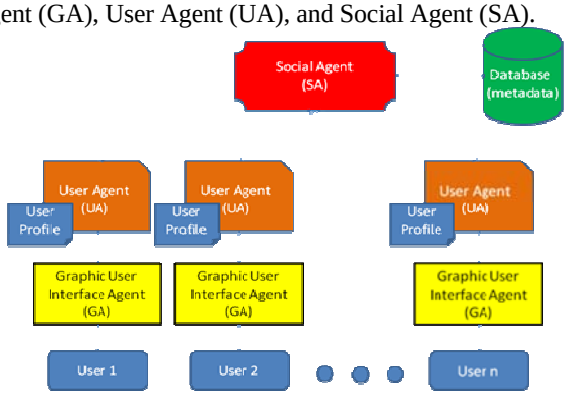

Figure 1. Multi-agent system architecture

Each user has a UA and a GA accompanied with. In the multi-agent system, UA is designed by representing the user. The function of GA is an interface between user and UA. GA provides a graphical interface that allows users to communicate with other users and uses the graphical interface show the relevant information and personal message to the user. The role of SA is providing all the necessary support and assistance for social network service.

SA plays as a manager for the entire system. SA integrated handling about data storage, management of existing user groups and coordination of messages exchanged between UA in system and so on.

This paper is based on two key concepts, similar interests, common topic, to build the system architecture which shown in Figure 2.

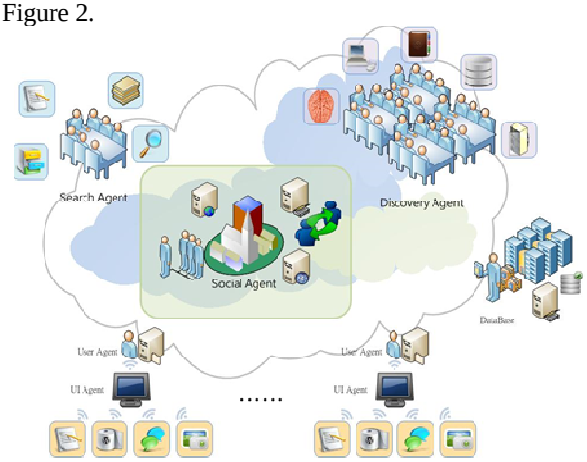

Figure 2. System architecture

A. *The relationship function*

The multi-agent system developed UI Agent, UA Agent and SA Agent, they collect user related information and interacting states by mutual communication and cooperation, and then they learn, modify and adjustment individual data modular via a feedback mechanism.

In the most widely-used social networking, for example Facebook, user can setting friend's relationships into different categories as "Family", "Friend", "Acquaintances", "College", "High school ", or "Colleague of current company". The agent keeps records of Facebook user interaction state with friends, and then analyze and learn which friend or group is interact with user most closely.

Assuming that vector r is represented as a factor of friendship setting in Facebook, in addition, the vector x_{ij} where i represents recent contents, photos, blogs, where j denotes praise for i click like box, messages response ,the number of like and respond messages at the same time, s_k expressed user click like box for the recent post, messages response ,the factor of like and respond messages at the same time, b_k is a factor express for release by praise, messages response, the coefficient of like and respond messages at the same time in blog page. In term of description above, we present the following relationship function in degree:

$$S = s_1x_{11} + s_2x_{12} + s_3x_{13} \quad (1)$$
$$P = p_1x_{21} + p_2x_{22} + p_3x_{23} \quad (2)$$
$$B = b_1x_{31} + b_2x_{32} + b_3x_{33} \quad (3)$$
$$R = rS + rP + rB \quad (4)$$

Then, we use linear programming approach to find the maximum value:

Maximize $R = rS + rP + rB$

Subject to

$$s_1x_{11} + s_2x_{12} + s_3x_{13} = S \quad (5)$$
$$p_1x_{21} + p_2x_{22} + p_3x_{23} = P \quad (6)$$
$$b_1x_{31} + b_2x_{32} + b_3x_{33} = B \quad (7)$$
$$x_{i1}, x_{i2}, x_{i3} \geq 0 \quad (8)$$
$$s_1, s_2, s_3 \geq 0 \quad (9)$$
$$p_1, p_2, p_3 \geq 0 \quad (10)$$
$$b_1, b_2, b_3 \geq 0 \quad (11)$$
$$r_1, r_2, \ldots\ r_n \geq 0 \quad (12)$$
$$\mathrm{S} \geq 0, \mathrm{P} \geq 0, \mathrm{B} \geq 0 \quad (13)$$

The larger of value of we obtained via above function that indicate a degree of relations more closely, on the contrary, the smaller of the value of the degree of relationship more distant. So while a user search for information, it will be a searched priority rule, and search information from the big value to small value in sequence. In this way, the information content we obtained is also relatively closer relationship.

B. *Timeline visualization methodology*

Facebook currently does not provide the function of searching content. In this paper besides searching for message content published by users and providing user can always search for historical information, the other main objective is to provide users with fast, efficient and accurate search mechanism. Therefore, we develop suitable social network of search mechanism base on previously described the relationship status between users. Meanwhile, the topic of discussion in the community or the focus will constantly change at different time points. In the microscopic point of view, some of the time interval, talking topics in the social networking should favor certain specific topics, however, in microscopic point of view, at some time interval, people in social networking where talking subject should tend to some certain topics. Thus, we apply the concept of clustering time and observe a close relationship with the user groups in the time interval, what topics are discussed more in order to improve the search results of user desires to. In summary, the easiest and most effective way is that combined with the visual representation and the timeline, which allows user clear to see the intensity of search results from visualized graphic display in the timeline.

IV. System Implementation

A. *Relationship function assignment*

According to the close degree of relations, we bring the status of the user interact with each other into the following formula to calculate and obtain the value by:

Maximize $R = r_iS + r_iP + r_iB$

Subject to

$$0.1x_{11} + 0.6x_{12} + 1.0x_{13} = S \quad (14)$$
$$0.1x_{21} + 0.6x_{22} + 1.0x_{23} = P \quad (15)$$
$$0.1x_{31} + 0.6x_{32} + 1.0x_{33} = B \quad (16)$$

The following describes the status of and representatives each coefficient weights :

r_j coefficients as follows:

r_1=1.0 , friend

r_2=0.8 , specific lists

r_3=0.5 , family relations

r_4=0.2 , unclassified list

s_1, p_1, b_1=0.1 , the weight of like

s_2, p_2, b_2=0.6 , the weight of message response

s_3, p_3, b_3=1.0 , the weight of both like and message response

The larger value we obtained by calculated that indicate the degree of relations is more closely, on the contrary, the smaller value of the degree of relationship is less. Finally, the values we obtained through the closely related degree of function as the primary basis for searching data.

B. Timeline visualization display

We place previous search results in a horizontal timeline. In this technology, we use SIMILE Timeline Project release by BSD license and JavaScript methods to present the data in the horizontal timeline. Besides, it also has two different kinds of time scales, which allow the user sliding axis scale when viewing the search results.

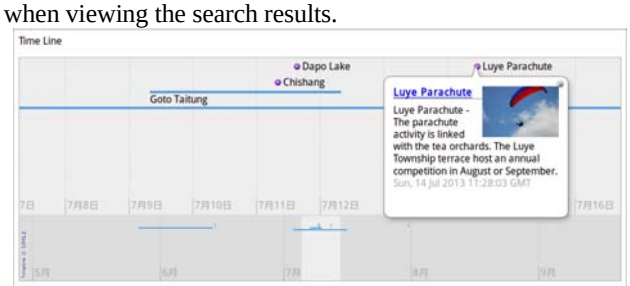

Figure 3. The search result represented by timeline of visual display

V. CONCLUSION

With rapidly increasing social network users accompanied mass data generated, dealing with such a huge number of data becomes a complex and difficult issue. Therefore, in a user-oriented social network, it should enable users to quickly and accurately find information they need instead of blindly groping or query from mass data, in which requires an effective processing mechanism to filter and extract what information users really need.

This paper proposes a multi-agent mechanism in charge of regular collecting users' interacting data, such as personal status of updates, pictures, friends response status, and storage those status and contents into database we established. Then, we bring the status of the user interact with each other into the formula of relationship function and calculate by linear programming approach to obtain maximum value. In addition, when users use the system built in this paper for data search, the system will import the close degree which it get into the searching process to ensure that the search results is more meet user requires. Finally, the system presented search results in a visualized graphic display in the timeline which helps users to see result clearly. The system proposed in this paper can provide users find information has closely related with them while they search mass data in social network.

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