

SNS에서 사회연결망 기반 추천과 협업필터링 기반 추천의 비교*

박상언**

Comparison of Recommendation Using Social Network Analysis with Collaborative Filtering in Social Network Sites*

Sangun Park**

■ Abstract ■

As social network services has become one of the most successful web-based business, recommendation in social network sites that assist people to choose various products and services is also widely adopted. Collaborative Filtering is one of the most widely adopted recommendation approaches, but recommendation technique that use explicit or implicit social network information from social networks has become proposed in recent research works. In this paper, we reviewed and compared research works about recommendation using social network analysis and collaborative filtering in social network sites. As the results of the analysis, we suggested the trends and implications for future research of recommendation in SNSs. It is expected that graph-based analysis on the semantic social network and systematic comparative analysis on the performances of social filtering and collaborative filtering are required.

Keyword : Social Filtering, Collaborative Filtering, Social Information, Social Network Site

1. Introduction

Social network services has become one of the most successful web-based business, and there are hundreds of social network sites (SNSs) supporting a wide range of interests. A large number of companies are using SNSs as their marketing channels. Recently, recommendation which uses a social network is growing fast because recommendation in SNSs can give new chances for attracting and retaining customers. Traditionally, collaborative filtering (CF) was used a lot for recommendation of products and services. CF is a method of making automatic recommendation for a user by collecting preferences from other neighbors who bought similar products. The underlying assumption of CF is that if users X and Y have similar buying patterns, then they will have similar taste on other items too [1].

Neighbors in CF mean users who have similar buying patterns or rating patterns on items as mentioned before, and recommendation is made from the preferences of neighbors. In social networks, the friends can substitute the neighbors. The important issue of using friends instead of using neighbors is that recommendation with the friendship of a social network could outperform that of traditional CF. Lerman [2] showed that users tend to like products which friends posted or liked. Moreover, Domingos [3] insisted that the network value of customers is important. Moreover, there exist customers who are more influential than others, and the influence recursively work through the entire network. Therefore, the use of a social network could enhance the performance of recommendation in SNSs. Furthermore, it is possible to apply various network analysis methods on the social network because it can be represented with

a graph where nodes are users and links are relationships. Therefore, network analysis and graph theories can be utilized in various ways to improve the performance of recommendation in SNSs. The purpose of our research is to identify the state of the art of recommendation using social network analysis by comparing it with CF and draw implications from the comparison. As SNSs become popular, research about recommendation using social information is growing fast. We expect that implications from the current literature will help to develop new recommendation applications in SNSs.

In this paper, we will review and compare research works on recommendation using social network analysis and CF in SNSs, also will categorize them with criteria defined in the paper and draw implications from the results. Furthermore, we will analyze the trends of recommendation in SNSs from the review results, and postulate implications for future research of recommendation such as the use of social semantic web and graph theories in SNSs.

The rest of this paper is organized as follows. Brief overview of social network analysis and collaborative filtering are described in section 2. Section 3 analyzes recommendation with SNA and CF including hybrid of SNA and CF, and categorized them with our criteria. Section 4 proposes research trends of recommendation in SNSs and implications for future research. Conclusion is presented in the last section.

2. Overview of Social Network Analysis and Collaborative Filtering

This section describes brief overview of related works on social network analysis and collaborative

filtering. A number of network analysis methods are described in section 2.1 and review on survey papers on collaborative filtering was described and traditional limitations of collaborative filtering were explained in section 2.2

2.1 Social Network and Network Analysis

Ellison and Boyd [4] defined SNSs as “web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system.”

The Major SNSs started with SixDegrees.com at 1997 and there were LiveJournal, AsianAvenue, and BlackPlanet before 2000. The SNSs such as Cyworld, Skyblog, LinkedIn, MySpace, Last.FM, Flickr, Facebook, YouTube, and Twitter are very popular. A number of SNSs such as Facebook and MySpace are general-purpose while other SNSs such as Last.fm and Flickr that focus on one interest of users such as music, photo, movie, and story are special-purpose.

The most important feature of SNSs is that they provide a list of friends who are also users of the site, so a social network can be simply defined as a network connected with friendship links. Friendship is explicit social information and there are also implicit information obtained in a social network. Both explicit and implicit information can be used for recommendation in SNSs. Sometimes, implicit information can be used in order to alleviate the explicit friendship or as a method to estimate the degree of friendship. Moreover, it is possible to distinguish whether a friendship is real or fake by using implicit information.

Social network analysis (SNA) was developed to investigate the interaction among members of a community to understand the structure of social networks [5]. In social network analysis, nodes represent individuals of the social network and links represent a single or multiple types of relationships among the individuals [6].

One of the important analysis methods in SNA is centrality, which shows how influential an individual is in a network. There are three important centrality measures, which are degree centrality, closeness centrality and betweenness centrality [5]. Degree centrality measures how many nodes are directly connected to a node. The degree of the node means centrality and power. Closeness centrality calculates the distance of a node to all other nodes while degree centrality counts only the number of immediate links. Betweenness centrality is defined as the number of shortest paths between pairs of other nodes that run through a node. It means that the node with high betweenness centrality potentially could be a broker or gatekeeper in the network.

There are other SNA methods such as vertex similarity and cohesive subgroups. Vertex similarity is based on the structure of a network, and jaccard similarity and cosine similarity are the widely adopted similarity measures. Vertex similarity can be used to measure the similarity between customers. That is, customers with high vertex similarity to a target customer can be considered as the neighbors for recommendation [5]. For example, Huang et al. [7] proposed CF algorithms that use various vertex similarities. The concept of subgroup can be used group customers with similar preferences for recommendation. All members of cohesive subgroup should be reachable from each other. There are various types of subgroups such

as cliques, N-cliques, k-plexes, and k-cores.

A social network can be represented with a graph, so it is possible to apply various graph theories for recommendation in addition to SNA methods. For example, Konstas et al. [8] used Random Walk with Restarts for recommendation and Cantador and Castells [9] used preferences spreading on multi-layered semantic social networks. Semantic social network can be described as a social network where the components are represented with Semantic Web standards such as RDF and OWL. Therefore, various Semantic Web techniques can be used in the analysis of semantic social network. The spreading-activation algorithm also can be applied in recommendation with social networks [10].

2.2 Collaborative Filtering

In the Internet environment, recommendation is widely used to assist people to choose various products and services, and Collaborative Filtering (CF) is one of the most widely adopted recommendation approaches. Many new CF techniques have been developed to enhance the performance of recommendation in various situations. The basic idea of CF is to recommend items which are consumed by the people who have similar consumption style with the user.

Huang et al. [10] investigated the CF algorithms which are popular in e-commerce applications. Six algorithms (the user-based algorithm, the item-based algorithm, the dimensionality-reduction algorithm, the generative-model algorithm, the spreading-activation algorithm and the link-analysis algorithm) were reviewed in the article. The user-based algorithm computes a consumer similarity matrix and recommends items based on a set of

similar consumers while the item-based algorithm computes product similarities and recommend products which are similar to the purchased items. The dimensionality-reduction algorithm condenses the similarity matrix and recommends based on the less-sparse matrix in order to alleviate the sparsity problem. The generative-model algorithm also alleviates the data-sparsity problem by using latent class variables that represent the patterns of consumer-product interactions. The spreading-activation algorithm explores the consumer-product graph which represents consumers and products as nodes, by using the spreading-activation algorithm. It also addresses the sparsity problem. The link analysis algorithm utilizes social-network analysis and Web page ranking. In the article, the link-analysis algorithm and spreading-activation algorithms showed the best performance and the second respectively, in precision, recall, F-measure, and rank score measures. It is interesting that the graph based algorithms showed high performances.

Su and Khoshgoftaar [1] suggested three categories of collaborative filtering techniques: Memory-based CF, Model-based CF, and Hybrid recommenders. Memory-based CF techniques are the most common CF techniques. The techniques identify neighbors of a user by using the user-item database, and predict the preference of the user from those of the neighbors. The algorithms consist of similarity computation, prediction and recommendation computation, top-N recommendation. Model-based CF techniques have been suggested to complement the shortcomings of memory-based CF algorithms. The design of models such as data mining algorithms and statistical methods were used to recognize complex patterns from item-user data in the model-based CF techniques [1]. Hybrid CF systems combine CF with other recommen-

dation techniques such as content-based recommendation. Moreover, two different CF techniques can be combined. It is interesting that Su and Khoshgoftaar [1] insisted that the future CF techniques should be effectively applied in fast-growing mobile applications, and the social network application is one of them.

The well-known limitations of CF are scalability, sparsity and cold start [11, 12]. Scalability problem means that CF has serious computational complexity increment as the number of user increases. Sparsity problem is that there are few items having ratings while there is huge number of items. Cold start problem is that it is difficult to identify a user's neighbors when the user does not evaluate enough number of items. Most recent studies on CF tried to overcome the limitations by adopting new methods such as social information and social network analysis.

3. Analysis on Recommendation using SNA and CF in SNSs

A literature survey approach has been employed as the research methodology in this research. The literature search was conducted using various combinations of keyword such as: recommendation SNS, collaborative filtering SNS, recommendation social network, social filtering, social network analysis collaborative filtering. In addition to Google Scholar and NDSL which are general purpose journal paper search engines, the search services of journal publishers such as Springer Link, Elsevier Science Direct, and IEEE Xplore were used to collect the literature. Twenty two papers were chosen for the literature survey from the eighty two papers of the search results. Reviews on recommendation in SNSs are divided into four sections. The first section describes recommendation using SNA in-

cluding just social information in SNSs. The second section reviewed recommendation using social information and CF at the same time in SNSs. The third section reviewed hybrid recommendation that used SNA and CF. The last section categorized and organized them with a table, and propose brief implications from the results.

3.1 Recommendation using SNA in SNSs

The term Social Filtering (SF) or social information filtering was used as the same meaning with CF in the earlier studies, which means the approach that recommends items based upon values assigned by other people with similar taste [13]. However, the recent studies defined SF as the recommendation technique that use explicit or implicit social network information from community networks or affinity networks [14]. Bobadilla et al. [14] suggested trust and reputation are closely related to the social information used in trust-based SF such as trust propagation mechanisms, 'follow the leader' approaches, trust networks, etc. Most of the studies on SF aimed to obtain improvements in recommendation by using social information [15, 16], and showed that SF outperforms traditional CF in the used scenarios.

There are two ways of using social network information. The former is using social information directly from a social network, and the latter is using results from network analysis on the social network. There are two types of social information: explicit and implicit as mentioned in Section 2.1. A number of studies built their own social networks for recommendation while the others use general-purpose or special-purpose existing SNSs. We reviewed research works about recommendation in SNSs based on the above three features.

Mesnage et al. [16] suggested the idea of the social shuffle, which recommends tracks and diffuse discoveries through the social network. Star-net application on Facebook was used in the work, so an existing general-purpose SNS was used. They showed that social recommendation that recommends a track randomly from the tracks that have been rated by friends of the subject were better than non-social recommendation. Explicit friendship was directly used in the algorithm. Golbeck and Hendler [15] used the social network Film Trust where users can rate their trust on friends, and used it for movie recommendation. They used not only explicit friendship but also implicit trust to alleviate explicit information. Kautz et al. [17] constructed its own social network by using co-occurrence of names in any documents publicly available on the WWW, and recommended experts with the social network. Implicit social information was directly used in building the social network and recommendation.

There are studies that tried to use various types of social information through various SNA methods. Huang et al. [7] used six linkage measures employed in social network link prediction for the measures calculating similarity between users instead of traditional similarity measures, where links were user-item relationship. It is interesting that the study used SNA methods without an existing social network.

A social network naturally has the characteristics of a graph because users are connected to other users with friendship links. Therefore, it is possible and natural to use graph analysis methods in SF, which makes one of important differences with CF. Konstas et al. [8] recommended music tracks by using the framework of Random Walk with Restarts (RWR) in Last.fm which is an existing spe-

cial-purpose SNS. They used not only explicit friendship that is a User-User matrix, but also implicit information such as social tags which are User-Track, User-Tag, and Track-Tag matrices to build a social graph. Moreover, Huang et al. [10] suggested recommendation with spreading-activation. The algorithm in the paper traverses consumer-product graph from target consumer to calculate activation levels of all nodes, and determine recommendation of each product with the activation levels of the nodes.

3.2 Recommendation using CF in SNSs

Recommendation using CF in SNSs Considerable number of SF research works incorporated social information into CF in order to enhance the performance of recommendation, while a group of SF works made recommendation with pure social network information. The former will be reviewed in this section while the latter was reviewed in the previous section. Liu and Lee [18] suggested CF with combined neighbors consisted of nearest neighbors and friends, which showed the best performance among CF algorithms with traditional, social, combined and amplified neighbors. The algorithm made recommendation with explicit friendship in the general-purpose SNS, cyworld. You et al. [19] combined CF and social information from Facebook in order to alleviate the cold start problem. It proposed a technique that combines CF of users' rating and the users' genre interest extracted from 'Like' of the users on 'Facebook Pages' for movies. Actually, 'Like' is not explicit friendship between people, so the algorithm used implicit information of SNS to alleviate CF. Thay et al. [20] integrated social relationship from users' behavior in Facebook with CF. Two measures were com-

bined in the research work. The first measure was that of traditional CF and the second was the users' relationship with their friends by counting posts and comments which were implicit information.

3.3 Hybrid Recommendation using SNA and CF

Another interesting area of recommendation using social networks is hybrid of SNA and CF. Park et al. [21] built a customer network by linking customers who have similar buying preferences in order to solve the cold start problem. After that, products that had been bought by the customers whose centrality were high in the network were recommended for a new customer. Centrality is one of the representative methods of SNA. However, the constructed network is not a social network because the link is not friendship. They used similarity measures of CF in the construction of the network. Ohira et al. [22] integrated SNA and CF with the similar manner. They used collaborative filtering to calculate similarity between users for determining links of the social network. The links were visualized so that users could find and determine appropriate experts from the graph. The integration of SNA and CF proposed by Cantador and Castells [9] is interesting in the sense that it suggested a new CF method using network analysis on a semantic social network. Firstly, they made ontological representation for the user preferences and proceeded clustering on semantic concepts of the ontology. Based on the clustering results and the links between preferences and users, they clustered users and determine neighbors from the clusters.

3.4 Categories of Recommendation in SNSs

We reviewed and analyzed recommendation using SNA and SF so far. This section will categorize

the studies explained above, and suggest implications from the results. The purpose of categorization is to find important trends from literature. Firstly, the trend on the basic recommendation algorithm is moving from CF to SF, SNA and Graph based algorithm. Therefore, the first criterion is the algorithm which is categorized into CF, SF, SNA and Graph. CF is collaborative filtering without social information and SF is a recommendation algorithm with similarity calculated with only social information. SNA uses only the results of network analysis and Graph uses graph analysis method for similarity. Hybrid recommendation is represented with '+' and the composed algorithms such as CF+SNA which integrates CF and SNA.

Secondly, the studies were categorized with the type of social information used, which are explicit and implicit. The trend of this criterion is using more implicit information. Explicit information means explicit friendship and implicit information is other remaining social information of a social network. The last criterion of categorization is the type of the social network. There are three types which are 'General-purpose', 'Special-purpose', and 'Make own'. The type 'Make own' means that the study constructed its own social network for recommendation instead of using social information from existing SNSs. <Table 1> shows the results of categorization for 12 studies.

There are a number of implications from the categorization results. Firstly, most studies using SNA constructed their own social network for recommendation. Therefore, recommendation with SNA in existing SNSs will be interesting. Especially, implicit social information was used to construct the social networks so we expect that investigation of recommendation using explicit social information in the existing SNSs would give us valuable results.

〈Table 1〉 Categories of Recommendation in SNSs

Literature	Algorithm	Social Information	Social Network
Mesnager et al. [16]	SF	Explicit	General-purpose
Golbeck and Hendler [15]	SF	Explicit+Implicit	Special-purpose
Kautz et al. [17]	SF	Implicit	Make own
Huang et al. [7]	SNA	Implicit	Make own
Konstas et al. [8]	Graph (RWR)	Explicit+Implicit	Special-purpose
Huang et al. [10]	Graph	Implicit	Make own
Liu and Lee [18]	CF+SF	Explicit	General-purpose
Thay et al. [20]	CF+SF	Explicit+Implicit	General-purpose
You et al. [19]	CF+SF	Implicit	General-purpose
Park et al. [21]	CF+SNA	Implicit	Make own
Ohira et al. [22]	CF+SNA	implicit	Make own
Cantador and Castells [9]	CF+SNA	Implicit	Make own

4. Research Trends and Implications of Recommendation in SNSs

This section investigated research trends of recommendation in SNSs from the review results of section 3. Moreover, implications for future research in the recommendation area were drawn.

4.1 Research Trends of Recommendation in SNSs

4.1.1 Utilization of Implicit Social Information

Implicit social information such as the number of posts can be used in order to estimate trust between users and to quantify friendship and preferences for items. Konstas et al. [8] used social tags for recommendation by building a social graph using User-Track, User-Tag, and Track-Tag matrix. Golbeck and Hendler [15] integrated trust with friendship to alleviate explicit friendship. You et al. [19] tried to complement common preferences between users by using 'Like' in Facebook Pages.

4.1.2 Graph-based approaches

A social network can be represented with a graph where nodes represent users and links represent friendship between users, so it is natural to apply graph theories to analysis of friendship in the social network. Therefore, studies suggested recommendation using graph theories instead of traditional SNA. For example, Huang et al. [10] suggested recommendation with spreading-activation. Random Walk with Restarts by Konstas et al. [8] is another example of graph-based approach in recommendation.

4.1.3 Network Analysis without an Existing Social Network

Author names and affiliations are to be centered beneath the title and printed in Times New Roman 11-point, non-boldface type. Multiple authors may be shown in a two or three-column format, with their affiliations below their respective names. Affiliations are centered below each author name, italicized, not bold. Include e-mail addresses if possible. Follow the author information by two blank lines before main text.

4.2. Implications for Future Research

4.2.1 Recommendation with Graph theories in the Semantic Social Network

Cantador and Castells [9] constructed ontological representation for the user preferences and made recommendation by clustering the concepts. The study is interesting in the sense that it used semantic social network, but the ontology is limited in user preferences. Most SNSs provides only one link which is friendship in social networks. However, there are many other possible links such as 'Like' in Facebook. Therefore, various relations between customers and items can be represented in a social graph if the Semantic Web is utilized to represent the relationships. Moreover, the nodes in social networks could be connected to other ontologies in the Semantic Web. We expect that recommendation would be done in an extended semantic social network soon, and more diversified graph theories and traversing techniques would be used in the semantic social network because it consists of various types of resources and links. Furthermore, it is possible to represent and analyze not only the relationship between users but also between a user and an item with the Semantic Web techniques that includes various description languages such RDF and ontology reasoning techniques. We expect that it will help to make effective recommendation by considering both explicit friendship and implicit social information in the semantic social network.

4.2.2 Recommendation using SNA in the Existing SNSs

As discussed in Section 3.4, most studies using SNA constructed their own social network for recommendation instead conducting SNA in the exi-

sting SNSs. Therefore, we expect that recommendation with SNA in existing SNSs would be interesting. Moreover, the investigation of recommendation using explicit social information in the existing SNSs would be promising because implicit social information was used to construct the social networks.

4.2.3 Analysis on the Performances of SF and CF

Most research works using social information reviewed in this paper showed recommendation with social information outperforms traditional CF. It is suggested that users tend to like products or services that submitted by friends or friends liked. However, there is no deep analysis on the mechanism why the recommendation by social information is better. It is expected that more systematic analysis on the mechanism will be able to help more effective use of social information in recommendation.

5. Conclusion

Explicit and implicit social information of a social network is becoming widely used in research works about recommendation of products and services in various SNSs. Moreover, various analysis methods including social network analysis and graph theory are used in order to utilize the social information. Further, hybrid of SNA and CF is adopted in considerable number of recent recommendation studies. Therefore, we reviewed and compared research works about recommendation using SNA and CF in SNSs, and categorized them with the dimensions of algorithm, type of social information and type of the social network used in the studies.

As the results of the analysis, we suggested the

trends of recommendation in SNSs. Firstly, the utilization of implicit social information is increasing. Secondly, graph-based approaches using a social network are also increasing. Thirdly, most recommendation using SNA was not made in existing SNSs. Furthermore, we proposed implications for future research as follows : we expect that the semantic social network will be a promising tool of recommendation in SNSs. Moreover, we expect that recommendation with SNA in existing SNSs will be interesting because it is hard to find those studies. Lastly, comparative analysis on the performances of SF and CF that shows how and why the friendship is better than neighbors is required.

As SNSs become popular, a tremendous amount of data is gathered and new applications using the data are becoming introduced. Recommendation is one of the promising applications, so we analyzed trends, implications and future directions through the literature survey. We expect that various useful recommendation services will be studied and developed along the guide of our results. The most important limitation of our research is that in-depth analysis on graph based recommendation is not enough. Therefore, the future research will be analyzing methods how to represent social information based on graph and use it for recommendation in various ways.

참 고 문 헌

- [1] Su, X. and T. M. Khoshgoftaar, "A survey of collaborative filtering techniques", *Advances in artificial intelligence*, Vol.2009, No.1(2009), pp.1-19.
- [2] Lerman, K., "Social networks and social information filtering on digg", *arXiv preprint cs/0612046*, Vol.2006, No.1(2006), pp.1-8.
- [3] Domingos, P., "Mining social networks for viral marketing", *IEEE Intelligent Systems*, Vol.20, No.1(2005), pp.80-82.
- [4] Ellison, N. B. and D. M. Boyd, "Social network sites: Definition, history, and scholarship", *Journal of Computer-Mediated Communication*, Vol.13, No.1(2007), pp.210-230.
- [5] Xu, Yunhong, Ma, Jian, Sun, Yong-Hong, Hao, Jinxing, Sun, Yongqiang, and Zhao, Yongqiang, "Using Social Network Analysis as a Strategy for E-Commerce Recommendation", paper presented at the PACIS 2009, Hyderabad, India, 2009.
- [6] Freeman, L. C., "Centrality in social networks conceptual clarification", *Social networks*, Vol. 1, No.3(1979), pp.215-239.
- [7] Huang, Zan, Li, Xin, and Chen, Hsinchun, "Link prediction approach to collaborative filtering", paper presented at the Proceedings of the 5th ACM/IEEE-CS joint conference on Digital libraries, Denver, CO, USA 2005.
- [8] Konstas, Ioannis, Stathopoulos, Vassilios, and Jose, Joemon M., "On social networks and collaborative recommendation", paper presented at the Proceedings of the 32nd international ACM SIGIR conference on Research and development in information retrieval, Boston, MA, USA, 2009.
- [9] Cantador, I. and P. Castells, "Multilayered semantic social network modeling by ontology-based user profiles clustering : Application to collaborative filtering", *Managing Knowledge in a World of Networks* (Springer), (2006), 334-349.
- [10] Huang, Zan, Zeng, Daniel, and Chen, Hsinchun, "A comparison of collaborative-filtering recommendation algorithms for e-commerce", *Intelligent Systems, IEEE*, Vol.22, No.5(2007), pp.

- 68-78.
- [11] Devi, MK Kavitha and Venkatesh, P., "Kernel based collaborative recommender system for e-purchasing", *Sadhana*, Vol.35, No.5(2010), pp. 513-524.
- [12] Sarwar, Badrul, Karypis, George, Konstan, Joseph, and Riedl, John, "Application of dimensionality reduction in recommender system—a case study", paper presented at the ACM WebKDD Workshop, 2000.
- [13] Shardanand, Upendra and Maes, Pattie, "Social information filtering: algorithms for automating "word of mouth", paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems, Denver, Colorado, USA 1995.
- [14] Bobadilla, Jesús, Ortega, Fernando, Hernando, Antonio, and Gutiérrez, Abraham, "Recommender systems survey", *Knowledge-Based Systems*, Vol.46(2013), pp.109-132.
- [15] Golbeck, J. and Hendler, J., "Filmtrust: Movie recommendations using trust in web-based social networks", paper presented at the Proceedings of the IEEE Consumer communications and networking conference, 2006.
- [16] Mesnage, Cédric S, Rafiq, Asma, Dixon, Simon, and Brixtel, Romain P., "Music discovery with social networks", paper presented at the Workshop on Music Recommendation and Discovery, Chicago, USA., 2011.
- [17] Kautz, Henry, Selman, Bart, and Shah, Mehul, "Referral Web : combining social networks and collaborative filtering", *Communications of the ACM*, Vol.40, No.3(1997), pp.63-65.
- [18] Liu, F. and H. J. Lee, "Use of social network information to enhance collaborative filtering performance", *Expert systems with applications*, Vol.37, No.7(2010), pp.4772-4778.
- [19] You, Tithrotanak, Rosli, Ahmad Nurzid, Ha, Inay, and G.-S. Jo, "Collaborative Filtering based on Clustering method using Genre and Interest in SNS", paper presented at the Proceedings of Korea Intelligent Information System Society, 2012.
- [20] Thay, Setha, Ha, Inay, and G.-S. Jo, "Collaborative Filtering Method based on User's Behavior in Social Network", paper presented at the Proceedings of Korea Intelligent Information System Society, 2012.
- [21] Park, J. H., Y. H. Cho, and J. K. Kim, "Social Network : A Novel Approach to New Customer Recommendations", *Journal of Intelligent Information Systems*, Vol.15, No.1(2009), pp.123-140.
- [22] Ohira, Masao, Ohsugi, Naoki, Ohoka, Tetsuya, and Matsumoto, Ken-ichi, "Accelerating cross-project knowledge collaboration using collaborative filtering and social networks", paper presented at the ACM SIGSOFT Software Engineering Notes, 2005.

◆ 저 자 소 개 ◆

**박 상 언 (supark@kgu.ac.kr)**

현재 경기대학교 경상대학 경영정보학과 부교수로 재직 중이며, 한국과학기술원 전산학과에서 학사, 한국과학기술원 경영공학과에서 석사 및 공학박사 학위를 취득하였다. 주요 관심분야는 웹기반 지능정보시스템, Semantic Web Mining, Semantic Web portal, 온톨로지 매핑, 지능형 웹서비스, 지능형 전자상거래 등이다. IEEE Transactions on Knowledge and Data Engineering, International Journal of Human Computer Studies, International Journal of Electronic Commerce, Journal of Intelligent Information Systems 등의 국제 저널 외에 국내외 학회 및 학술지에 논문을 발표하였다. 수상경력으로는 한국 지능정보시스템학회 우수논문상 수상 (2005년, 2006년, 2007년)과 지식정보산업 연합학회 우수논문상(2008년)이 있다.