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Social Network Analysis using Interest Mining: A Critical Review

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Abstract

Background/Objectives: Social Networking has been entertaining people for sharing their common ideas and proposals which are analyzed through social relations among them. The problem in the field of social network analysis is the absence of adequate computing resources to handle huge amount of data on World Wide Web. Therefore, users are unable to gather needed information correctly and thereby, the aim is to locate right information at the right time and delivering it to distinct group of people. **Methods:** Present paper gives the insight into the existing deployment of social network analysis and various ranking techniques which have been devised by various researchers for the social networking capabilities over the network. In order to accomplish the aim, virtual environment can be created for social network analysis. This analysis can be performed by various mining methods such as opinionmining, expert mining, etc. and ranking techniques like object average rating, neighbour variance rating, random rating and many more. Although these techniques optimize the information overload problem accordingly, still there is a need for expert identification. **Findings:** The future enhancement for social network analysis includes collaborative thinking. Social Network Analysis gathers people having similar interest by creating collaboration among users. This collaboration leads to resource sharing in an efficient manner after the creation of virtual environment. Furthermore, the field of social network analysis may take a turn to link analysis and its various algorithms like Page Rank, Weighted Page Rank and Weighted Page Content Rank which will further help in finding the expert and enhances the information effectively. **Application/Improvements:** The application to social network analysis is to discover the network of innovators in a regional economy, enhancing dark web analysis and spam behaviour detection. The arduous task of expert identification is an upcoming trend that can be implemented through virtual environment.

Keywords: Expert Mining, Interest Mining, Social Network, Virtual Community, Web 2.0

1. Introduction

A social network is connected through friendship, knowledge, common idea, financial deals, etc. Social Network Analysis (SNA) enhances social relationships in terms of connections of people within the networks. SNA is an upcoming key technique in modern sociology. With the brisk diversification and wide fame of Internet and electronic commerce (e-commerce), the emergence of Web, version 2.0 is growing day-by-day[1]. Web 2.0 comprise of services including social-network websites such as linkedin.com, twitter.com, facebook.com, blogs, wikis, websites, podcasts, vodcasts, VoIP, RSS and various other web applications as shown in Figure 1[3-7].

Now-a-days, the most critical aspect is to use these social networks in a certain collaborative context which give rise to the "virtual community system", most commonly referred as "on-line communities". Virtual community describes the people, those forming groups and are in touch with one another due to their common knowledge or idea through collaborative process[2]. It adopts the specifications of Web version 2.0 and its basic features include sharing of knowledge, transmission of knowledge and co-operation among its participants. It enhances the usage of social network tools including wikis, blogs etc. These are the tools which help in the development of the virtual team. While defining and selecting the tool for virtualization, the team need to begin by reckoning the activity and only then determining the relevant tool for each and every situation[3]. Chats, information gathering tools, wikis, collaborative software suites, blogs, etc are the various collaborative tools used in such situation.

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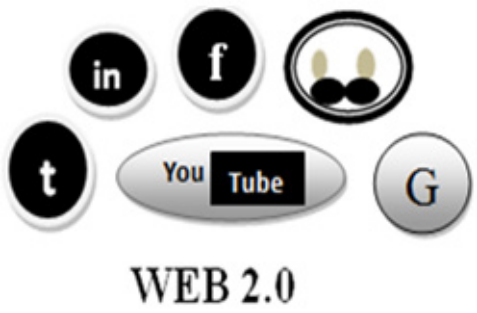

Figure 1. Web 2.0.

As the web is growing complex on a continuous basis, the information overload problems faced by the users are also increasing at a rapid pace[1-28]. People are moving towards recommender system to recognize the information that is most valuable to them based on their similar tastes and preferences, thus acquiring right information at the right time.

Virtual communities facilitate people to interact with each other, forming virtual Environment through collaboration and form interest groups where people have same interest in a particular topic[2]. Once interest group is formed, the expert is chosen out of interest group according to the ranking given to each member of the interest group, with the corresponding blog and thereby enhancing the quality of learning on web[27]. Thus, implementing pedagogical or didactic system.

This allows users with similar interest and expertise to collaborate among themselves, and thereby carry out their collaborative work and resource sharing in an efficient manner. Because of this it is of key interest to set up a collaborative interest group and then identify an expert from each group who will be the centre of the group, and providing relevant recommendation in the form of good (positive), bad (negative) or neutral(impartial) opinion based upon the expert's reviews in his respective blog[27]. This would overcome the information overload problem and provide users with the suitable recommendation[8].

2. Evolution of Web

The World Wide Web (WWW) has turned into a wide global web as declared by abundant of computer specialists, during the last few decades. Many people agree on Web evolution, but few people have gone through its principles, i.e. why and how the Web evolves.

With the constant inflation of the WWW[11] and the attachment of the web users with the net, has made it the first milestone to be crossed be user in order to use basic Internet as a generic exchange platform for exchanging contents among users[12].

This came with the advancement of Web 2.0, which is also known as Register/Display Web. In 2004, Tim O'Reilly devised Web version 2.0 which assist the desired users to contribute and "The content is itself a user" is its most popular slogan. The popularity of Web version 2.0 evolves within all its applications. The web version 2.0, evolved like a new collaborative Web, which was extended by 'collaboration-ware' tools (web based) like blogs[14], articles, wikis[15], comments and also presents successful websites like facebook.com, twitter.com or orkut.com which allow to build common goal based social networks.

The word 'Web version 2.0' is the modernization of the WWW to expand social and business relations and to traverse communal surveillance from the community[1]. It exhorts the Web architecture that entails users' participation and collaboration and acts as a basic platform for users to dispense and explore information resources[2]. Flickr and YouTube provide virtual collaborative unlimited media repositories for users to dispense static and dynamic images respectively. Collaboratively edited by any Web users, Wikis[14] has become one of the most resourceful encyclopaedias in the world. The use of blogs, Wikis, Vodcasts and Socialism form social network[13].

Figure 2 symbolizes the web evolution as, Web version 1.0 links people to the WWW. Web version 2.0 connects users who deploy the World Wide Web. The future semantic web, however, will have the connection between virtual initiators of real people who communicate with the World Wide Web[16].

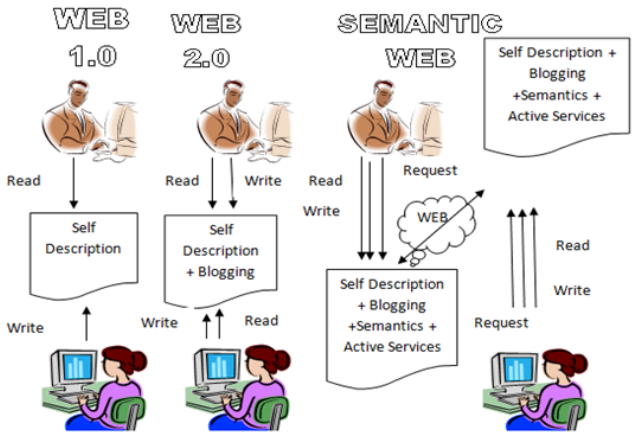

Figure 2. Framework of web evolution.

2.1 Web 1.0 – The World Wide Web

The first level and the oldest version of web evolution is WWW which is also known as Web 1.0 which involves original information-oriented web[30]. This Web 1.0 is also called as Register-or-Display Web in which owners of static pages pen down their relevance and then online display and share it.

2.2 Web 2.0 – The Social Web

Second level evolves as Web 2.0 which brings out in fame by Tim O'Reilly and was coined by Dale Dougherty. It is reflected through social web[5]. In Web version 2.0, both writers and readers can register and display to a shared web space which allows the formation of cordial social communication among web people[30]. It's a platform for grouping of newer generation social technologies, where users communicate and collaborate with one another as they build communities across the web[20]. It is called as a Read/Write Web in which both readers and writers can register and display to a shared web space. This allows building neighborly and healthy, social as well as business links among web users[13].

2.3 Web 3.0 - The Semantic Web

The third level which is currently evolving version of web evolution is Web 3.0. There are different aspects of Web 3.0 as they are varying with the usage done by the users[29]. Web 3.0 known to be the semantic web by some people, as a personalization (eg. iGoogle) by few and some consider it as an intelligent web, where softwareagents will collect and combine information to give "intelligent" responses to user.

It has been reviewed from evolution of Web, that out of the three versions of Web, Web 2.0 has been chosen as the basic platform for user interaction with one another, using social network. And Web version 2.0 is used for the formation of collaborative interest groups and providing recommendations.

3. Literature Review

A Web version 2.0 enable web users the freedom to interact and power to amalgamate with one another which leads to sharing of information among themselves[1]. It provides interactive worldwide data dispensing, interoperability, and user-centric design. Web version 2.0 commonly referred to as 'The Participatory Web' or 'The Social Web' or 'The User- Focused Web'[30]. Users can post their comment on news stories, can give their reviews on any information provided online, and can share and explore their ideas and thereby forming virtual communities whose main focus is to gather people of same interest in a same group and this process is named as interest mining.

Using Web 2.0 as a platform, Interest mining can be accomplished by the collaboration of the people sharing common interest and hence forming the 'collaborative interest groups'. These groups communicate through the virtual communities so as to form a collaborative communication among them and enhancing their existence through collaborative and participative process.

3.1 Collaboration

Collaboration refers to an algorithmic process where group of people work together to realize same ideas. It is an intensive and aggregated determination to reach a shared goal. It provides origin for conducting the information, skill and experience of each member of a team to add essence in the advancement of information much more efficiently than individual member of the team performing their individual jobs, hence creating collaborative interest groups[17]. Collaboration is a framework developed for collecting, organizing and reusing a huge amount of information flooding on the Internet through group collaboration[18].

Qun JinI et al.[19] proposed a prototype system called Collaborative Information Browser, which provides functions such as real-time collaborative information browsing, information organizing through adding comments, view-focused information retrieval and reusing and a platform for direct interaction among users.

John M. Linebarger et al.[20] designed an object-oriented framework named as Shared Simple Virtual Environment (SSVE) for collaborative section which was highly suitable for closely associated small class formation in virtual environment which is highly dynamic. The SSVE framework entitles a huge feature set of collaboration, awareness techniques and concurrency constraint that reinforce closely associated small collaborative classes. The usage of SSVE in a small pilot testing acts as a proof to practicality of the framework for evolving new applications that enhance the existence of collaborative group.

Lidan Shoul et al.,[21] proposed a Web-based Structure for On-line Learning in collaborative groups where

the structure named as the Coco-Web (Collaborative Course-ware enhancing the Web) for designing of course information related to on-web collaborative intellect where courseware is grasped in a duplet of local documents and remote interlinks.

Yu- Feng Lan et al.,[22] gave a methodical amalgamated teaching structure to build a consensus-based framework using the heterogeneous method and binary tree structure namely "Co-Tree" to organize the collaborative group. It uses the web-based CSCL approach, which is based on improving the amalgamated teaching by encouraging trainers' contribution in learning tasks which improves peer-interaction and leads to high learning satisfaction.

Yu-Feng Lan et al.,[22] Evren Eryilmaz et al.,[23] proposed the multiple fronts that promotes effective collaboration which refines the information,

- Resourcefulness
- Teamwork
- Process
- Technology of collaboration

3.1.1 Resourcefulness

Collaboration requires an early involvement of team members ensuring that appropriate number of resources must be available to the team members in time in order to collaborate effectively. For an instance, consider a situation in which a team is assigned with a manufacture Engineer, but he or she is very busy in managing resources that's why he or she does not have enough time to effectively collaborate or participate.

3.1.2 Teamwork

Collaboration requires efficient teamwork and proper cooperation among them. Each member of a team must respect and trust each other and there must be an open communion and a readiness to accept views from other members of the team. There should be defined team member responsibilities based on collaboration.

3.1.3 Process

The term process is defined as what all activities are performed, by whom are those activities performed, the time when they are performed, and the process how they are performed. It requires early exchange of data and provide feedback to the other team members input, review and approval.

3.1.4 Technology of Collaboration

Communication and collaboration can be facilitated by the variety of tools and technologies. Collaboration can occur synchronously or asynchronously. In synchronous collaboration, all participants view information and/or meet at the same time, whereas in asynchronous collaboration, all participants view information and provide feedback at different points in time.

3.2 Participation

Participation refers to sharing something in common with others. For example, users can interchange videos, audios, images, but the ultimate motive is not to achieve the shared goal.

Luigi Colazzo et al.,[2] defined participation as the mechanism of exploring different ideas and opinions public collaborative among collaborative users. Participation works in both centralized and decentralized way by taking inputs like user data or information, opinions, applications and provides output in the form of centralized refined information through processing of collaborative filtering, software technologies, etc.

Figure 3 explains the mechanism of collaboration and participation, which works on various inputs including user data, opinions, applications etc. to produce outputs in the form of collective intelligence and formation of virtual communities. This mechanism works on various technologies and properties such as decentralization, openness, modularity, etc. and collaborative filtering.

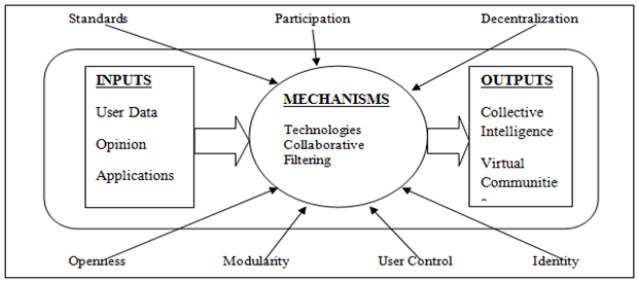

Figure 3. Framework of collaboration and participation.

3.3 Virtual Community

Jacek M. Zurada et al.,[26] defined the extant expansion in the area of Wide Area Network (WAN) associativity assures vastly distributed opportunities for resource sharing and collaboration. So often and then, various social network

websites like myspace.com, gmail.com, orkut.com and YouTube.com have raised their usage to such an extent that we cannot disregard them. These become most popular approach of Web version 2.0. They grant mob to constitute association web with other mobs in a simple and felicitous way and entitle them to dispense various sort of facts and Figures by using a group of amenities such as image sharing, blogs, etc[2].

Now, the most critical aspect is to use these social networks in certain collaborative information. This gives rise to the "Virtual Community System", most commonly referred as "On-line Communities". The Web net now constructs the constitution of online communities using the services of Web version 2.0 that follow a participatory approach. These online communities proposed a variety of functionalities, in order to prove themselves to be worth full for academics and didactic pedagogical goals[23].

Howard Rheingold et al.,[25] defined Virtual Community as a nexus of users who share domain of interest through which they communicate online. Virtual community comprises of social aggregations that arise from the interactions done on net where huge lot of people carry on public deliberations which model webs of individual relationships over cyber web. Virtual community aim is to fulfil the required necessity of a virtual collaborative system with self ruling and amalgamated pedagogical benefits, by reinforcing people to be in group that share common ideas. In other words, virtual community refers to mob of people who all are in touch because they dispense similar sort of knowledge and ideas, in a cooperative process. It refers to the aggregation of people who have got similar interest and who work together to achieve same objective. It adopts the specifications of Web version 2.0 and provides three basic features viz. sharing of knowledge, transmission of knowledge and cooperation among its participants.

Overview of the processing of virtual environment has been carried out, which describes various steps as shown in Figure 4.

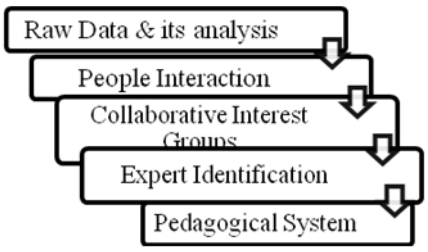

Figure 4. Overview of virtual environment.

3.3.1 Collaborative Interest Groups

A. Kumar et al.,[27] proposed a Collaborative Interest Group which is defined as a group, build by the interaction of users sharing the common interests. So, the formation of a group, led the users with particular interest similarity to club into the same group. The formation of group requires the group construction algorithm that works in two steps. Firstly, extracting the users' Interest Vector from their blog documents and secondly, calculating the interest similarity factor between two users. Using user's interest vector and interest similarity group, Interest group has been constructed in a certain way by clustering the users with similar interests into the same group and facilitates collaborative work as shown in Figure 5.

Figure 5. Collaborative interest group.

3.3.2 Expert Identification

Members of virtual community can share their idea through reviews, but the problem arises that which member is to be trusted most i.e., who will be the expert? The question leads to major issue of expert identification.

Expert Identification is an intricate task because experts and their expertise are rare, expensive, hard to qualify, continuously varying and often culture collaborative isolated.

Qingliang Miao et al.[7] aimed at the problem of expertise that arises while people are interacting among themselves. This problem can be resolved by the approach named as the Page Rank algorithm upgraded by techniques to integrate contextual link information. Particular approach consist of two steps: Offline determination of human connection considering tagged connecting links and arrangement configuration of ranking scores based

on performance. The connection analysis technique is derived from the Page Rank model.

Prevailing, one's expertise has been evaluated by the expert finding systems either focused on the information of user's data or one's social status within expertise knowledge community. Addition collaborative, virtual communities gain very less study focus where quality of the information is often worse than that in enterprise knowledge Database.

In this context, G. Alan Wang et al.,[31] offered a Page Rank Algorithm, a unique technique known as expert finding technique, which judges one's competence depending on both data-focussed relevance and people's dominance in knowledgeable community. Increasingly, people are turning to web to acquire review on any topic. People try to take opinions from expert about any topic before considering it. For this purpose, online communities in virtual environment are building for help.

3.3.3 Pedagogical Systems

Pedagogical Systems are the system that deals with the hypothesis and observation of education; it thus focuses on the study and practice of how best to teach. Its motive ranges from the general description to the narrower elaboration of education[24].

M. Katherine (Kit) Brown et al.,[3] explained that once the virtual environment through social networking sites is created, the users enhance their e-learning capabilities with added forms of more traditional learning in the form of blended pedagogy. In such situations, the system of pedagogy creates collaborative and participative virtual learning groups consisting of trainee, train and trainer.

Major problem of internet is huge amount of information on net. In order to provide an innovative way to utilize this information on the Internet effectively and efficiently, a new framework called pedagogical systems has been introduced.

Luigi Colazzo et al.,[7] defined the systems that collects, organizes and reuses information through group collaboration, and design and develop a prototype called Collaborative Information Browser (CIB) that provides a collaboration platform for direct interaction among users.

3.3.4 Recommender Systems

Recommender systems help in addressing this information overload problem by retrieving the information desired by the user based on his/her similar users' tastes and preferences[4].

K. Srikumar et al.,[6] gave an instance of Recommender systems that provide recommendations to customers based on their past purchases, tastes, and preferences. For instance, Amazon.com (www.amazon.com) site's features such as "Customers who bought" and "Book Matcher", and CDNow (www.amazon.com) site's features like "My CDNow" and "Album Advisor" are some of the typical examples of recommender systems. The "Customers who bought" feature of Amazon.com can bring into being on the instruction page for each and every book in their site. The basic principle of the "Customers who bought" feature is that: the recommendations are offered based on the frequently purchased books by purchaser who buy the selected book. Recommendations offered by recommender systems can be as simple as offering a web page (based on average ratings of web pages) to as complex as providing products in online shopping (by analyzing a customer's complex click and purchase histories).

4. Ranking Techniques

Gediminas A. et al.,[9-10] and Adomavicius et al.,[32] have introduced various ranking techniques that may be implemented in pedagogical and recommender system to improve aggregate diversity.

4.1 Object Average Rating

This approach simply ranks the object based on the average of the known ratings.

$$\text{rank}_{\text{AvgRating}}\ (\text{ob}) = \overline{\text{R(ob)}} \qquad (1)$$

$$\text{where } \overline{\text{R(ob)}} = 1\backslash|\,\text{U(ob)}\,|\sum_{u\,\epsilon\,\text{U(ob)}}\text{R(u,ob)} \qquad (2)$$

4.2 Neighbour's Variance Rating

According to the neighbours rating variance of a particular user for a particular object, this approach ranks objects. Among the users, the closest neighbours of user u, who rated the particular, object ob, denoted by u'.

$$\text{rank}_{\text{NeighbourVar}}\ \underline{(\text{ob})} = 1\backslash|\text{U(ob)}\cap\text{N(u)}|\sum_{u`\,\epsilon\ \text{UR(ob)}\cap\text{N(ob)}}(\text{R(ur`,ob)} - \text{Ru(ob)})^2 \qquad (3)$$

Where, N (u) is the set of nearest neighbours of user u.

4.3 Random Approach

Ranking the objects randomly can also improve the diversity equating to the standard ranking approach.

$$rank_{Random}(ob) = Random(0,1) \quad (4)$$

Where, Uniformly distributed random numbers in the [0, 1] interval is identifiedby a function named as Random (0,1).

4.4 Parameterized Approaches

The process of parameterization can be done with the help of several ranking approaches using "rating threshold" T_R which belongs to $[T_H, T_{max}]$.

Where, T_H is the predicted rating threshold and T_{max} is the maximum rating in the rating scale. T_R can be used for ranking and filtering purposes.

$$rank_x(ob, T_R) = rank_x(ob), \text{ if } R^*(u,ob) \in (T_{R,} T_{max})$$

OR

$$rank_x(ob, T_R) = \text{remove object, if } R^*(u,ob) \in (T_H, T_R) \quad (5)$$

5. Conclusion

Social networking is a collaborative and participative platform where users from all over the globe interact with each other and communicate. Information overload is one of the key issues in the era of internet and web 2.0. A properly formulated virtual environment may not only locate right information at the right time, but also help in accessing interest groups and thus finding experts out of them through miner system. Present paper surveyed various techniques for reducing information overload and also various ranking techniques for recommendation systems. Moreover, techniques such as opinion mining, expert mining may be well suitable for experimentation and validation and thereby implementing recommendations for pedagogical systems.

6. References

1. Kaldoudi E, Bamidis P, Papaioakeim M, Vargemezis V. Problem-based learning via Web 2.0 technologies. 21st IEEE International Symposium on Computer-based Medical Systems; Jyvaskyla. 2008. p. 391-6.
2. Colazzo L, Molinari A, Villa N. Collaboration vs. participation: The role of virtual communities in a web 2.0 world. International Conference on Education Technology and Computer; Singapore. 2009. p. 321-5.
3. Katherine BM, Huettner B, Tanny CJ. Choosing the right tools for your virtual team: evaluating wikis, blogs and other collaborative tools. IEEE International Professional Communication Conference; Seattle, WA. 2007. p. 1-4.
4. Ben Schafer J, Konstan J, Riedl J. Recommender systems in E-commerce. Group Lens Research Project; New York, NY, USA. 1999. p. 158-66.
5. Abram S. Web 2.0, Library 2.0, and Librarian 2.0: Preparing for the 2.0 World. SirsiDynix OneSource. 2008. Available from: http://www.imakenews.com/sirsi/e_article000505688.cfm?x=b6yRqLJ,b2rpQhRM
6. Srikumar K, Bhaskar B. Personalized recommendations in e-commerce. International Journal of E-Business. 2005; 3(1):4-27.
7. Miao Q, Li Q, Dai R. AMAZING: A sentiment mining and retrieval system. Expert Systems with Applications. 2009; 36(3):7192–8.
8. Liao HY, Chen KY, Liu DR. Virtual friend recommendations in virtual worlds. Elsevier Journal of Decision Support Systems. 2015; 69(5):59-69.
9. Gediminas A, Youngok K. Overcoming accuracy-diversity trade off in recommender systems: A variance-based approach. Proceedings of the 18th Workshop on Information Technology and Systems (WITS'08); Paris, France. 2008.
10. Gediminas A, Youngok K. Toward more diverse recommendations: Item re-ranking methods for recommender systems. 19th Workshop on Information Technology and Systems (WITS'09); Phoenix, Arizona. 2009.
11. Berners-Lee T, Cailliau R, Luotonen A, Nielsen HF, Secret A. The world-wide web. Communications of the ACM. 1994; 37(8):76-82.
12. O'Reilly T. What is Web 2.0: Design patterns and business models for the next generation of software. O'Reilly Website. 2005 Sep 30.
13. O'Reilly Media Inc. 2005. Available from: http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web20.html
14. Doctorow C, Dornfest F, Johnson Scott J, Powers S. Essential Blogging. O'Reilly. 2002.
15. Ebersbach A, Glaser M, Heigl R. Wiki: Web Collaboration. Germany: Springer-Verlag; 2006.
16. A simple picture of Web evolution. 2015 Jul 25. Available from: http://www.zdnet.com/blog/web2explorer/a-simple-picture-of-web-evolution/408
17. Ebner M. E-Learning 2.0 = e-Learning 1.0 + Web 2.0. IEEE 2nd International Conference on Availability, Reliability and Security (ARES); 2007. p. 1235-9.
18. Collaboration. 2015. Available from: http://www.npd-solutions.com/collaboration.html
19. Jin IQ, Furugori N, Hanasaki K, Asahi N, Ooi Y. Collaborative information browser: Collecting and organizing in-

formation through group collaboration. IEEE SMC WAlR3; 2002.
20. Linebarger JM, Janneck CD, Drew KG. Shared simple virtual environment: An object-oriented framework for highly interactive group collaboration. Proceedings of the 7th IEEE International Symposium on Distributed Simulation and Real-Time Applications (DS-RT'03); 2003. p. 170-80.
21. Shoul L, Cui B, Chen G, Dong J. A web-based framework for on- line collaborative learning. IEEE Proceedings of the 10th International Conference on Computer Supported Cooperative Work in Design; Nanjing. 2006. p. 1-6.
22. Lan YF, Huang SM. Designing an efficient collaborative learning model to construct a consensus based on binary tree structure. IEEE 5th International Joint Conference on INC, IMS and IDC; 2009. p. 182-7.
23. Eryilmaz E, van der Pol J, Kasemvilas S, Mary J, Olfma L. The role of anchoring discussion in mediating effective online interaction for collaborative knowledge construction. IEEE Proceedings of the 43rd Hawaii International Conference on System Sciences; 2010. p. 1-10.
24. Spector M. Networked Learning: Perspectives and Issues. Springer-Verlag; 2002. p. 93-109.
25. Rheingold H. The Virtual Community: Homesteading on the Electronic Frontier. Rev. ed. The MIT Press; 2000.
26. Jacek M, Zurada JM, Wojtusiak J, Chowdhury F, Gentle JE, Jeannot CJ, Mazurowski A. Computational intelligence virtual community: Framework and implementation issues. IEEE International Joint Conference on Neural Networks (IEEE World Congress on Computational Intelligence); 2008. p. 3153-7.
27. Kumar A, Jain A. An algorithmic framework for collaborative interest group construction. Recent Trends in Networks and Communications. 2010; 90(3):500-8.
28. Carlson CN. Information overload, retrieval strategies and Internet user empowerment. In: Haddon L, et al., editor. Proceedings of the Good, the Bad and the Irrelevant; Helsinki, Finland: University of Art and Design. 2003. p. 167-73.
29. Zeldman J. Web 3.0. 2008. Available From: http://www.alistapart.com/articles/web3point0
30. Getting B. Basic Definitions: Web 1.0, Web. 2.0, Web 3.0. 2008. Available from: http://www.practicalecommerce.com/articles/464/Basic-Definitions-Web-10-Web-20-Web-30/
31. Alan WG, Jiao J, Abrahams AS, Fan W, Zhang Z. Expert Rank: A topic-aware expert finding algorithm for online knowledge communities. Journal at Department of Business Information Technology. 2013; 54(3):1442-51.
32. Adomavicius G. Improving aggregate recommendation diversity using ranking-based techniques. IEEE Transactions on Knowledge and Data Engineering. 2012 May; 24(5):896-911.