

Detailed User Relation Visualization on Moodle

Ping LI & Siu Cheung KONG

*Department of Mathematics and Information Technology
The Hong Kong Institute of Education, Hong Kong
{pli, sckong}@ied.edu.hk*

Abstract: To enhance the learners' performance and learning efficiency on e-learning platform is an essential issue in current teaching and learning engagement. This paper applies IT techniques and analysis methods to visualize the learners' user relationship on the discussion board of Moodle based on the replying order and times they made in the selected topics/forum in a Moodle course, which will be very useful in the future for embedding the visualization into large-scale systems and further development of related applications. We mainly first extract the inner relation of users' participation in one/several selected discussion topics or a whole forum of a certain course. Then we visualize the user participation relation using Scalable Vector Graphics (SVG) provided by D3.js with aesthetic graph visualization. Our visualization with directed graph (digraph) structures provides easy understanding of users' network connections in topics/forum, and the weights of the connections indicating the replying times are shown both numerically on edges and visually by the thickness of edges. Digraph is applied here to indicate different replying order. We propose to perform visualization construction and representation via PHP with latest advanced programming libraries of jQuery and D3.js, while easy control of tree-structured menu for user relation visualization is realized by jsTree. In the experiments, our method consistently demonstrates high-quality detailed visualization of users' underlying relation structure they belong to, which may benefit the further study of improving the learning efficiency on e-learning platform.

Keywords: User relation analysis, graph visualization, directed graph, Moodle platform

1. Introduction

The trend of teaching and learning in digital classrooms with the help of social network platforms (SNPs) and learning management systems (LMSs) requires the teacher to transform from traditional pedagogical practices to advanced and creative ones. Although it is the fact that more and more accessible learning data are produced and available in the e-learning systems during the teaching and learning periods, yet there are so many data generated throughout the formal and informal learning process. Hence it becomes much harder for teachers to understand the students' performance within and after the teaching periods. To enhance the teaching and learning effects, students are encouraged to utilize the discussion forums embedded in the e-learning platforms (e.g. Moodle) for sharing ideas and helping each other in learning, which, in one aspect, helps to improve the teaching quality of the teachers, however, in another aspect, makes the user relation of the students in a course becomes more and more complicated. If such problems cannot be solved and the user relation information cannot be well extracted to inform the teachers to understand the students' interactions in the discussion forums of the e-learning platforms, the teaching quality online may decrease and the teachers may fail to understand the students' performance and guide the students' learning directions.

To enhance the learners' performance and learning efficiency on e-learning platforms and promote academic/teaching performance accordingly are essential issues in current teaching and learning engagement on e-learning platforms like Moodle. This paper aims at applying advanced IT techniques and analysis methods to study the learners' user relationship on the discussion board of Moodle based on the comments, replying order and times they made in the discussion, hence the information extracted will become useful materials for future analysis of learners' behavior online and even for providing suggestions to teachers as references for improving teaching quality in accordance to the needs of certain discussion topics and courses. The inner reason why we want to discover the user relation of a course or a topic online is that it will offer us better understanding of the key

interactions of the discussion for finding out related actions for steer the direction of the discussion while discussing. Again, visualizing the user relation also can let the teachers know the activeness and participation of the students during and after the discussion, hence the teachers can guide and help the students with special needs better in the e-learning process (Participation Map, 2013; Forum Graph, 2014). Through visualizing discussing topics with replying order and other related information such as replying times in discussion, it is possible to discover the underlying inner relation of users on related topics discussion or a course forum for learning enhancement purpose. In this paper, we apply hypertext preprocessor PHP with advanced programming libraries including jQuery, jsTree and D3.js to realize our detailed user relation visualization in the Moodle discussion forum.

2. Background of Study

Recently, researches about online relationship detection, analysis and visualization are becoming more and more popular. Our paper is made possible by the inspiration of previous work. Method for self-assessment in online discussion and co-occurrence relation discovery between keywords and learners are presented to analyze the content-based contribution making (Mochizuki et al., 2005), discussion relation is visualized through a Bulletin Board System. In addition to face-to-face participation relation researches, user relation on social media-platforms are investigated (Yndigegn, 2010), social encounters are found and can be extended by including them into online social networks. A boosting-based learning approach is presented to find and determine participation relation (Esuli, Marcheggiani, & Sebastiani, 2010), participation rather than selection of rich set features is preferred, and classification methods are utilized to decide correct assignment of relations. Given the observation of groups participated in similar tasks on online discussion community, participation relation frameworks are studied, and high online frequencies are found to be important to group relation cohesiveness (Chen, 2004). Framework that can be applied to scope eParticipation is proposed to study the participation areas and techniques online, and the framework enables better understanding of electronic participation (Tambouris, Liotas, Kaliviotis, & Tarabanis, 2007). In addition to participation user relation analysis, participation relation design is also studied. Engagement with dynamic relation design and applications provides new forms of participation online and offline (Hagen & Robertson, 2010). Platforms that allow social participation are investigated in (Kang et al., 2009), the relation between people and digital society are studied which will benefit participation platform architecture design based on user relation. Methods that can interactively and adequately model the relation in discussion forums based on social networks and dynamic information contents are required nowadays (Kim & Galstyan, 2010). Mainly, most methods currently focus on design and analysis of the relation of people on online platforms. However, the relations they process are mostly general-purpose relations of users in large-scale manner. There are very few methods specially designed to analyze the detailed user participation relation (user relation that keeps as much information as possible existed in the discussion) on certain topics and the whole forum on discussion board of e-learning platforms like Moodle, which is essential for enhancing reflective engagement of learners and promoting e-learning performance.

Recent advancement in online relation analysis provides ever-expanding possibility for studying the user participation relation on a discussion board. A discussion board is one type of social media, which is a good platform for investigating users' daily performance and interests. Users' performance on discussion forums are studied as reflection of their participation toward rich information world in (Shi, Zhu, Cai, & Zhang, 2009), different forum datasets are applied in their methods. In a cold-start problem, users only participate in some social relation, multi-relational factorization techniques are applied in (Krohn-Grimberghe, Drumond, Freudenthaler, & Schmidt-Thieme, 2012) for extracting the underlying unknown user relation out of the social relation. A new social relation is investigated (Yuan, Chen, & Zhao, 2011), and the relation is combined with friendship, thus heterogeneous relations are fused together providing efficient recommendation over the networks online, which can further facilitate online discussion participation relation analysis. The structure of community is related to the social context of users' activities online, a method is presented to detect community structure in social networks by analyzing time-based multi-relational datasets on discussion forums (Lin et al., 2011). As proposed long ago by Koll (1980), users' behavior and comments are applied as concept relation for information retrieval and analysis, and knowing the

user participation relation on e-learning discussion board will help a lot in enhancing future teaching and learning activities. Currently, there are actually a few learning analytics and forum visualization tools like SNAPP (Bakharia & Dawson, 2011; Dawson, Bakharia, & Heathcote, 2010), Participation Map (2013) and Forum Graph (2014) that can provide simple relation visualization of the Moodle discussion forums. However, these tools mainly focus on simple user connection relation visualization of the whole discussion forum only, and many useful aspects in addition to the connection are not kept well. To the best of our knowledge, there is no method specifically designed to visualize the detailed user relation with rich additional information for both one/several discussion topics and the whole forum. On the contrary, detailed user relation visualization for both discussion topics and forums provides deeper participation relation analysis of learners engaged, and will further make the teachers understand the interactions among learners better in order to let them have sufficient interactions in e-learning communication, and can steer the steps of the students' learning process.

3. Method

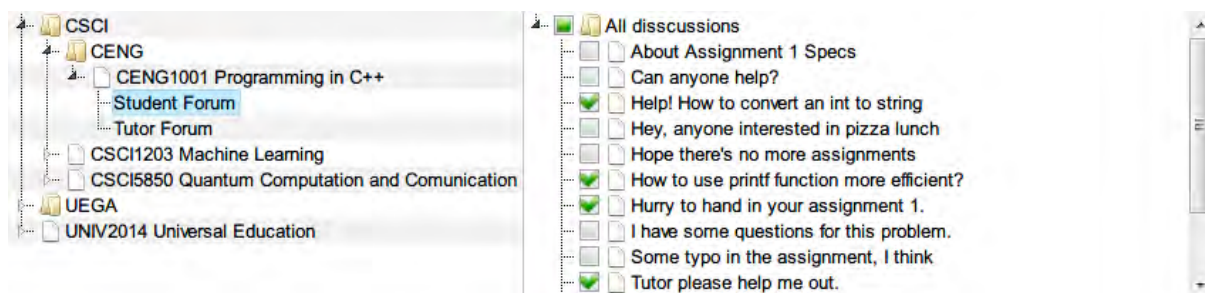


Figure 1. The tree-structured control menu of our user relation visualization in Moodle using jsTree.

In this paper, we utilize hypertext preprocessor PHP with latest advanced programming libraries including jQuery, jsTree and D3.js to realize our detailed user relation visualization for both one/several discussion topics and the whole discussion forum in Moodle with directed graph structure. Since Moodle is designed and implemented in PHP, we apply PHP as the main data-fetching programming language for the major framework design and realization of our user relation visualization tool/plugin for easy compatibility and high running speed purpose. We also apply the latest advanced programming libraries of jQuery, jsTree and D3.js to enhance the overall effects of our user relation visualization, which allow multi-browser performance. The library jQuery is applied here to provide lightened structure of simplified client-side implementation, which enhances the user experience and accelerates the speed of the user relation visualization through analysis of replying order and times within selected discussion topics and a whole discussion forum of a course in the database. The library jsTree is utilized for providing academic/teaching staff with easy interactive control of the user relation visualization system, and jsTree will create a cross-browser easy control tree-structured component as viewable menu for teachers' selection of interested topics/forum for user relation visualization. Figure 1 shows the tree-structured control menu of our user relation visualization in Moodle using the library jsTree. From Figure 1, we can see that the left side of our user relation visualization menu provides easily selection of Course Category, Course and Forum, and the right side of the control menu provides multiple topics selection within a Forum of a course, which enables easy control of user relation visualization for both one/several topics and a whole forum. The library D3.js (D3 for Data-Driven Documents) is applied here to provide our system with aesthetic scientific visualization of the user relation for display purpose using the Scalable Vector Graphics (SVG), which enables graphics scaling while preserving the shapes of the user relation vector image. And D3.js will apply the user relation data fetched to drive the creation and control of interactive user relation graphics in different web browsers providing us with aesthetic scientific display of user relation in directed graph visualization forms (See Figure 2). With all these advanced IT techniques embedded, we're able to discover the inner interactions of user participation in the

discussion forums, which can be further applied as guidance for directing user discussion activities on Moodle for enhancing students' e-learning effects.

4. Experimental Results

In our experiments, we have set up Moodle 2.6.1 using PHP 5.4.24, MySQL 5.5.32 and Apache 2.4.6 in a Microsoft Windows 7 64-bit system on a Intel Core i7 2.70GHz CPU PC with 8GB RAM for testing our detailed user relation graph visualization tool for discussion topics/forums. We invited volunteer students online for participating in the discussion of 14 forums within 6 testing courses in our Moodle platform. We have validated the correctness of the user relation visualization by comparing the visualization data with the user relation data in the database. Hence, we will only show the user relation visualization results of the discussion in the Student Forum of the testing course "CENG1001 Programming in C++" shown in Figure 1 as an illustration of the effectiveness of our detailed user relation visualization, and totally there are 10 users discussed in the Student Forum of this testing course.

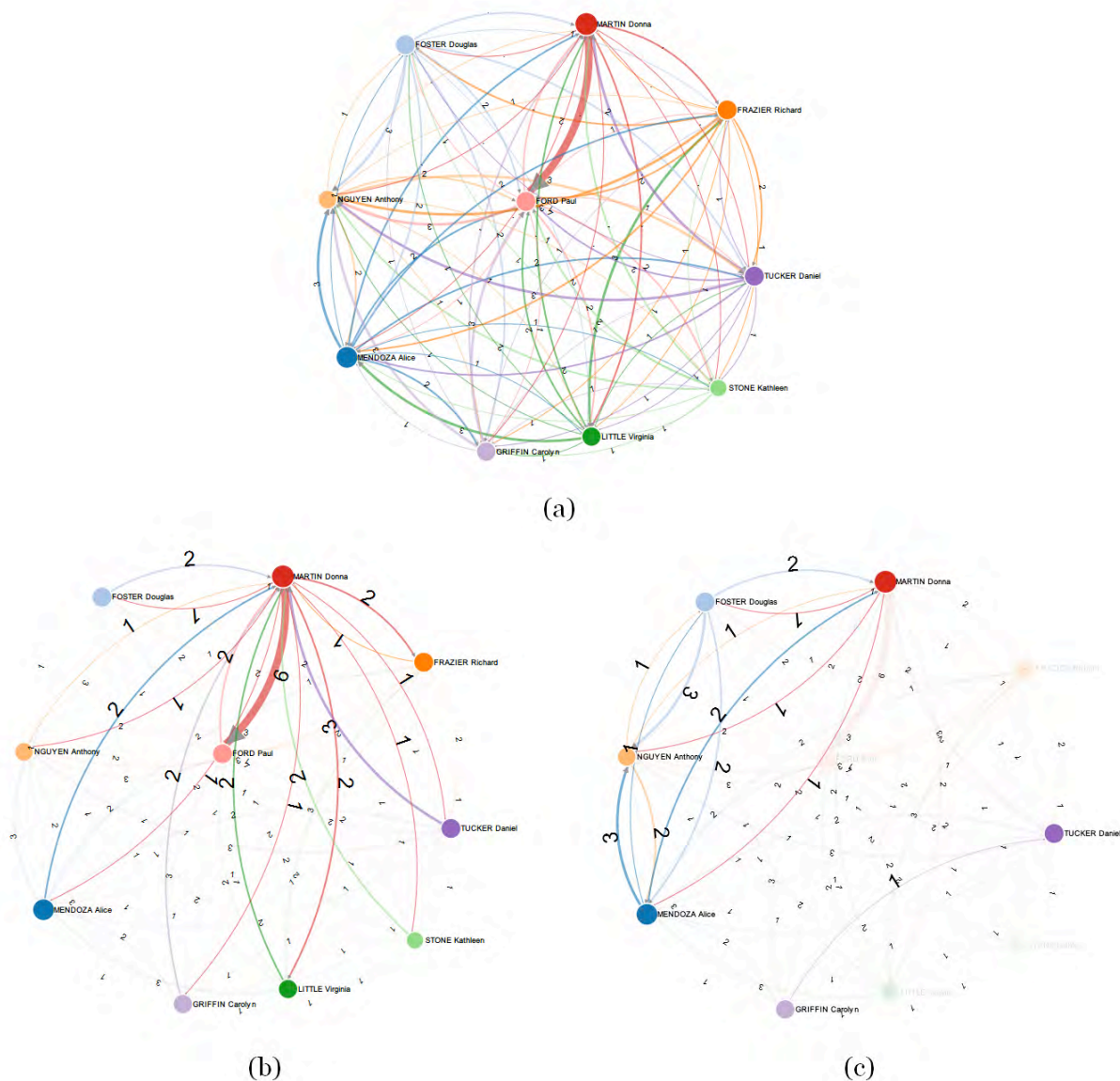


Figure 2. Graph visualization of our detailed user relation visualization. (a) Graph visualization of user relation for a whole forum, (b) graph visualization of a selected user and his/her relation with the other users in the forum, and (c) graph visualization of user relation for selected topics in Figure 1.

Figure 2 shows the graph visualization of our detailed user relation visualization method for the testing course “CENG1001 Programming in C++” shown in Figure 1. From Figure 2(a), we can see that the detailed underlying user relation of the discussion in the Student Forum of CENG1001 is explained well through graph visualization. We can see the 10 users participated in the Forum discussion and their detailed connections with each other. In our method, if A replied B, there will appear a directed edge from A to B in our visualization. Hence, with directed graph (digraph) visualization, we can keep and show more essential information in the discussion. There are numbers on the graph edges, which is the weights of the directed relation. If A replied B three times, there will appear a directed edge with the weight of 3 from A to B in the visualization. Therefore, actually we apply weighted digraph as the vehicle for our detailed graph visualization to keep more essential information. Figure 2(b) shows the case when applying mouse selection of a certain user, then all the users and connections that are related to the selected user in the Student Forum will be visualized by our method. This facilitates the easy viewing of specified relation for a certain user from complicated graph visualization for a whole forum. If there are a large amount of users in discussion, this will in addition enhance clear visualization of the user relation. Our approach provides the tree-structured menu for easy selection and browsing of user relation visualization for the user-interested topics within a forum. A practical application is that teacher may want to know the performance of students in certain discussion topics in e-learning. Figure 2(c) shows the graph visualization of user relation for selected topics in the Student Forum of CENG1001 shown in Figure 1. We can see from Figure 2(c) that there are generally two separated weighted digraphs in the visualization, which means there are groups of users discussed in the selected topics where inter-group discussion never happened. In summary, the graph visualization offers clear display of the network connections among academic/teaching staff and learners in the discussion using weighted digraph, where the weights of the graph edges are indicated with not only numbers on the edges but also proportional thickness of the directed graph edges. Thus, with our visualization, we can provide academic/teaching staff with advanced IT tool for detailed user relation visualization for discussion of certain topics or a whole forum in Moodle courses, which may be further applied to promote the learning efficiency and performance of learners on e-learning platforms.

5. Summary

Existing forum visualization methods and visualization functions provided in the learning analytics systems mostly deal with simple user relation visualization, and only visualization for the whole discussion forum is provided in the current system, which is obviously not enough for the purpose of analyzing the detailed user interactions and enhancing the learners’ efficiency and performance on e-learning platforms like Moodle for teaching and learning engagement. In this paper, we present to apply hypertext preprocessor PHP with latest advanced programming libraries of jQuery, jsTree and D3.js to realize our detailed user relation visualization for both one/several discussion topics and the whole discussion forum visualization in Moodle platform. Participation relation digraph visualization via Scalable Vector Graphics (SVG) by the library D3.js is provided in our approach. The visualization offers clear display of the network connections among academic/teaching staff and learners with weights, where the weights of the graph edges are indicated with both numbers on the edges and proportional thickness of the edges. Easy selection of target topics/forum for visualization is achieved via the latest light-weighted programming library of jsTree, where a tree-structured menu is provided for topic/forum selection to control the user relation visualization. The experiments have shown the high-quality scientific visualization of users’ underlying relation structure of our detailed user relation visualization based on their interactions among each other in the Moodle discussion forum. Our future work includes investigating different robust user relation analysis and visualization methods like graph theory, and extending the user relation visualization to more complicated social network structures with discussion content analysis. We will also apply our visualization in real course forum discussion study to promote and validate the usefulness of our method.

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