C-GROUP: A Visual Analytic Tool for Pairwise Analysis of Dynamic Group Membership

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ABSTRACT

C-GROUP is a tool for analyzing dynamic group membership in social networks over time. Unlike most network visualization tools, which show the group structure within an entire network, or the group membership for a single actor, C-GROUP allows users to focus their analysis on a pair of individuals of interest. And unlike most dynamic social network visualization tools, which focus on the addition and deletion of nodes (actors) and edges (relationships) over time, C-GROUP focuses on changing group memberships over time. C-GROUP provides users with a flexible interface for defining (and redefining) groups interactively, and allows users to view the changing group memberships for the pair over time. This helps to highlight the similarities and differences between the individuals and their evolving group memberships. C-GROUP allows users to dynamically select the time granularity of the temporal evolution and supports two novel visual representations of the evolving group memberships. This flexibility gives users alternate views that are appropriate for different network sizes and provides users with different insights into the grouping behavior.

1 INTRODUCTION

There is a growing interest in tools that allow users to navigate, understand, manipulate and analyze the huge influx of complex, heterogeneous data with which today's data analyst is faced. The best of these tools combine powerful visualizations with useful analytic tools that are suited to the task at hand. Often by focusing on a specific analytic task, the visualization can be designed in a way that focuses attention of the relevant information, and supports the appropriate task-specific navigation and manipulation primitives. In this paper, we describe C-GROUP, a visual analytic tool for pairwise analysis of dynamic group membership over time. The tool supports the analysis of affiliation networks. Affiliation networks are a commonly occurring form of social network in which there are two types of entities, actors and events, and a single relationship, a participates relationship, which relates actors to events. These two-mode social networks are sometimes viewed as bipartite graphs, although we will propose an alternate visualization that we believe is well-suited to pairwise analysis. Examples of affiliations networks include: bibliographic networks describing authors and their publications, with coauthor representing the participation relationship; communications networks describing people and the communication event (email, phone call or meeting), with the action of communication among people representing the participation relationship; and organization networks, describing people and their memberships in different organizations, with membership representing the participation relationship.

2 CONTRIBUTION

One novelty of C-GROUP is its focus on the relationships and group memberships in which a *pair* of actors participates. This is

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in contrast to the majority of social network visualization tools which either show the whole network (but allow filtering and selection so that users can, through a series of operations, reach a desired subgraph), or show an ego-centric view of the network, centered around a single individual. Our choice to focus on an actor pair was motivated by our earlier work on D-DUPE[1], a visual analytic tool for entity resolution in social network data.
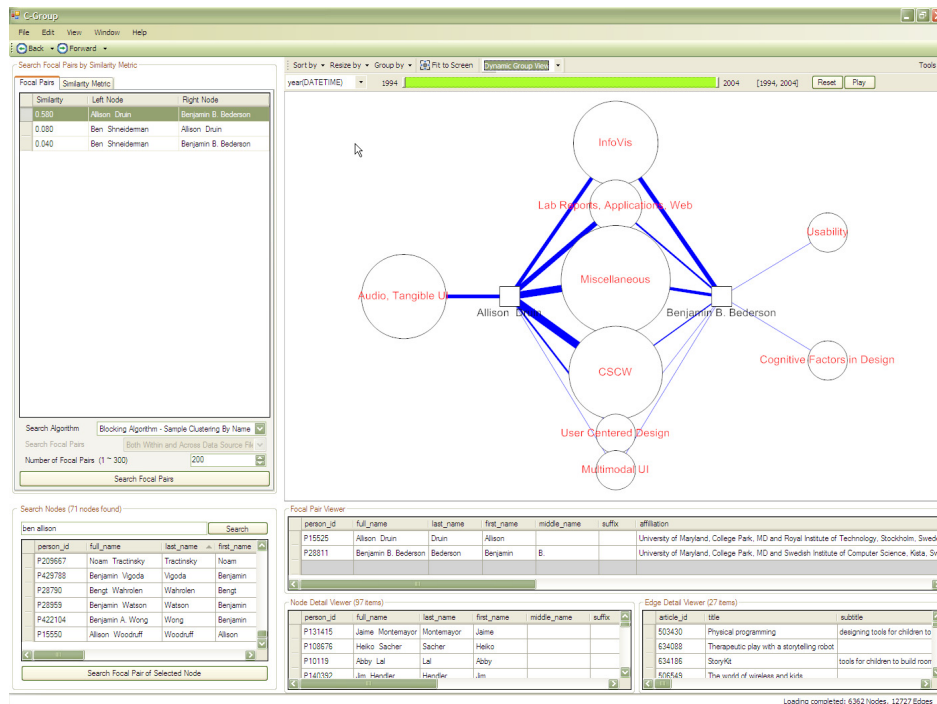
While the pairwise view of C-GROUP was inspired by D-DUPE, because of the richness and complexity of dynamic group analysis, significant new developments and changes were required in the design of C-GROUP. One of the more straightforward changes was in the support for the choice of the *focal pair*; we allow users flexibility in how they search for the focal pair, either by direct search, similarity search, or a combination. A second more fundamental design development was in the definition of groups; while this is often straightforward for networks describing a single entity type, in the context of an affiliation network, especially a dynamic affiliation network, there is a great deal more flexibility in how groups may be defined. C-GROUP supports several options for defining groups which we have found useful.

In terms of visualization, the major contribution of C-GROUP is its dynamic context window, which shows the evolution of group membership for the focal pair over time. Most tools which support the visualization of changes in social networks over time are designed for the task of understanding the entire network, and are focused on the additions and deletions of nodes and edges in a single-mode social network. C-GROUP, on the other hand, is concerned with the evolution in relationships and group membership over time for the focal pair. This leads to two novel visualizations, one which highlights the change in the shared actors with which the focal pair participates, and another which highlights the group movements. In both cases, C-GROUP provides an appropriate and stable layout, and uses animation in a way that truly brings attention to relevant portions of the changing network.

3 OVERVIEW OF C-GROUP

Figure 1(a) shows the overall C-GROUP interface, which is composed of three coordinated windows: the focal pair viewer, the dynamic group context viewer, and the data detail viewer. The focal pair viewer (on the left) allows users to navigate the affiliation network and select focal pairs of interest. Users can select a pair in the focal pair viewer, and then the group context viewer (on the upper right corner) provides two visualizations of the group membership context between the focal actors: the fixed entity layout and dynamic group layout. Figure 1 shows a dynamic group layout which represents the co-authorship relation between the two focal authors, "Allison Druin" and "Ben Bederson", two professors at the University of Maryland. By placing the shared groups in between them and non- shared groups on the sides, users can easily get an overview of their shared and non-shared groups. Users can resize, sort, filter, and brush the nodes and edges in the viewer to gain a better understanding of the relationship between the focal authors. The authors displayed in the viewer can be grouped either by an author's attributes or by a publication's attributes using the "Group By" menu in the tool bar. In addition, the changes of authors' group membership over time can be explored using the time range slider located in the toolbar.
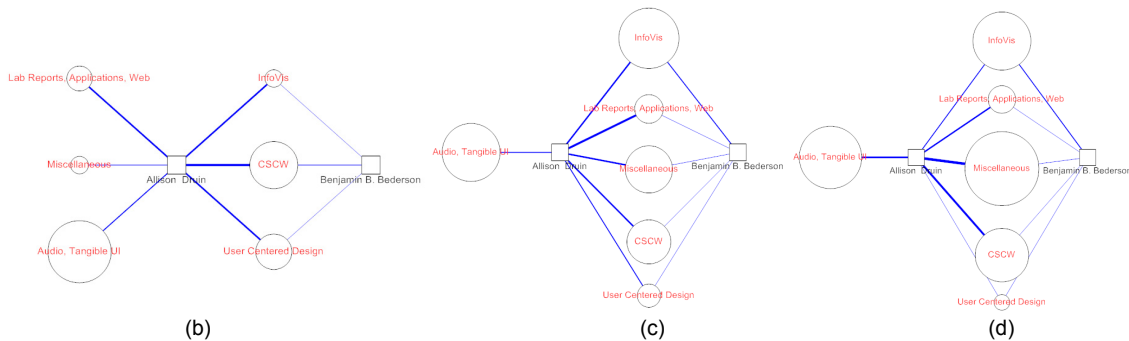
Figure 1. (a) Overview of C-GROUP (b)-(d) The evolution of author groups in the dynamic group layout view

Finally the data detail viewer (in the lower right corner) shows all the attribute values of actors and events displayed in the group context viewer. The data detail viewer is tightly-coupled with the group context viewer so that users can easily choose actors or groups in the network layout and observe the corresponding attribute values of any node or group.

4   EXAMPLE ANALYSIS ON PUBLICATION NETWORK

One of the most compelling features of C-GROUP is display of group membership dynamics via animation. We briefly describe the analysis of the group memberships for Drs. Druin and Bederson, the two authors selected above. Because they are also married, the evolution of their shared publication record is interesting to analyze. Figure 1(b)-(d) shows the network for Drs. Druin and Bederson grouped by the event attribute publication topic. We attempt to convey the animation using a series of figures taken at different times. Figure 1(b)-(d) show the focal pair after they arrived at University of Maryland. The visualization highlights a change in the network structure. While Dr. Druin's areas of publications are similar to her previous publications areas, Dr. Bederson has expanded his publication areas; therefore, the shared area has more topics in it. Also, as time progresses, all the topics begin to enter the shared area and the size of the groups also grows. The evolution of topics on which each of the authors publishes is highlighted by animation

during actual analysis using C-GROUP. An alternative layout, not shown here, keeps the groups fixed, and animates only the edges linking the focal pairs to groups.

5   CONCLUSION

C-GROUP allows users to visually explore dynamic affiliation networks. It allows users to select a focal pair and explore their shared relationships. Users have flexibility in defining groups based on attributes of either the actors or events in the network. Users can choose from a number of different views that highlight different aspects of the group evolution: the views can highlight the actors in the groups or the groups; the views can hold certain elements static, or animate them; the views allow users flexible control over the time granularity of the visualization; and the views support the selection of a static snapshot of a time-slice, or users can play an animation which shows the evolution of the dynamic group context. While the design of task-specific visual analytic tools for heterogeneous dynamic social networks is challenging, C-GROUP is a step toward more task-specific visual analysis.

REFERENCES

[1]   M. Bilgic, L. Licamele, L. Getoor, and B. Shneiderman. D-Dupe: An interactive tool for entity resolution in social networks. In *Visual Analytics Science and Technology (VAST)*, Baltimore, October 2006.