Interface Design for Tracking Negotiations

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Abstract:
SCENS [1], the Secure Content Exchange Negotiation System, is an ongoing project at the Dartmouth Experimental Visualization Laboratory (DEVLAB) that aims to build a web-based platform for sharing sensitive data among different parties. In this paper, we describe the development of an interface for SCENS that enables a user to post requests, query stored datasets and conduct negotiations with other interdependent parties through the system. We will also present a tool to visualize and analyze the different aspects of negotiation over time. We visualize and analyze the temporal *Negotiation Communication Network* (NCN) in a negotiation simulation environment. We show results that reveal significant communication patterns and social network structures for different SCENS participants and datasets.

Keywords:
NCN (negotiation communication network), Negotiation, Visualization, SNA (social network analysis), Sliding time frame algorithm

1. Introduction

Data sharing of sensitive or highly valuable informational resources requires new models of negotiation to promote communication with built-in incentives, secure authentication, and new metrics of evaluation. The Secure Content Exchange Negotiation System (SCENS) has as goal facilitating on-line negotiations among distributed parties or organizations. The basic interface in SCENS is a traditional web-based platform, which allows human beings to interact with the system in order to conduct negotiations and get feedback on negotiation activities. Having tools to analyze electronic interaction logs and negotiation flows is important in finding the most important contributors of resources and in discovering how collaborative relationships evolve in order to promote better resource sharing between distributed parties. In this paper we propose a flexible and interactive interface to visualize user interactions in the negotiation process over time.

2. Related Work

Several electronic negotiation support systems are currently in use. SmartSettle [2] uses a central server to arrive at agreements without exposing confidential data. WebNS [3] is a prototype web-based negotiation system designed to facilitate remote negotiations on the Internet. INSPIRE [4] is a Web-based negotiation support system containing facilities for specification and assessment of preferences. However, these systems are primarily designed to support negotiation in E-commerce, and are unsuitable for handling complex resource sharing, such as sharing of scientific data, tools and services.

The analysis of social networks has become increasingly popular because of its many applications. Analysis of email communication flow can be used to study the structure of communities [5] and to identify communities automatically, based on the frequency of message exchanges between individuals [6]. Although negotiation is one of the most natural activities in social life, little work has been done so far to visualize or monitor it. It is straightforward to visualize static social networks as directed graphs or adjacency matrices [7, 8]; rare work has been done so far to visualize the evolution of social networks over time.

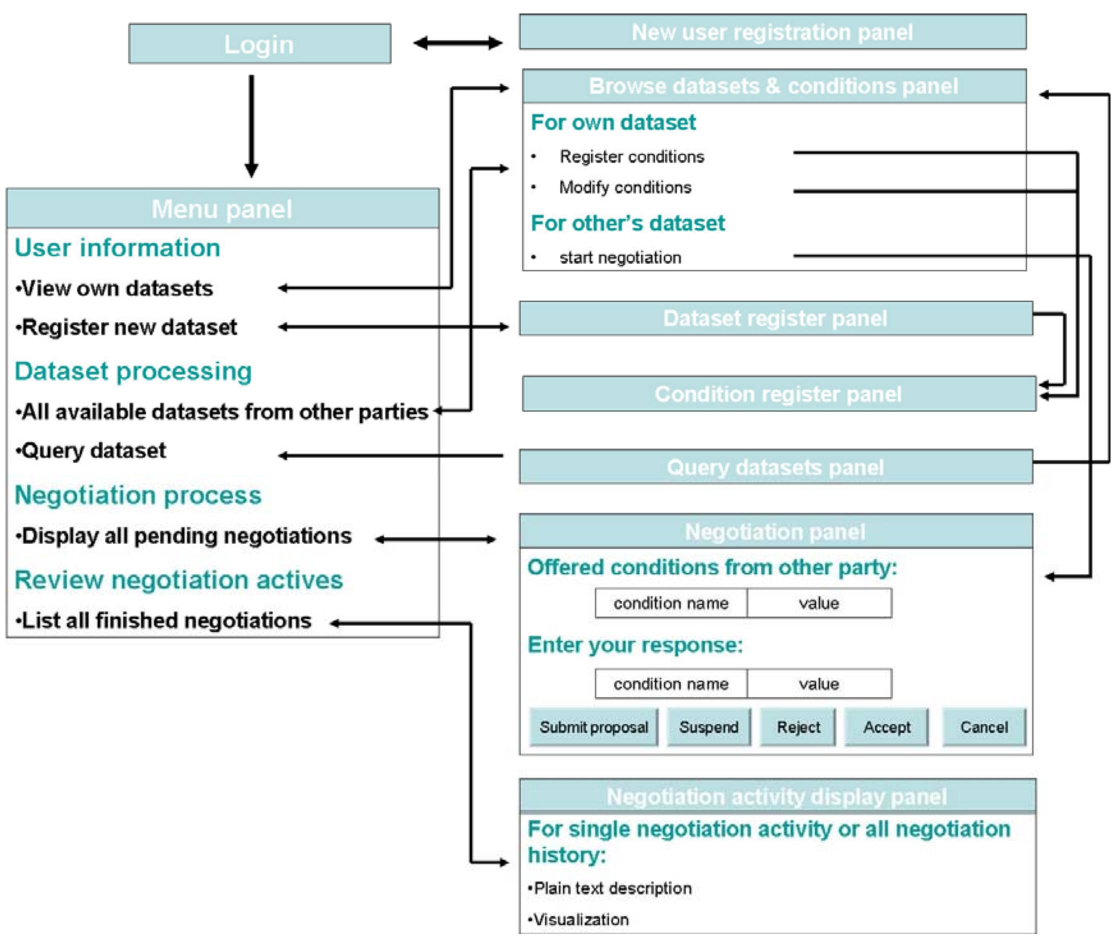

Fig 1. Flowchart of SCENS, showing interaction between different panels

3. The Negotiation Interface

The fundamental interface (see Fig. 1) in SCENS is web-based, and allows two or more parties to complete their negotiation and receive feedback. A user interacts with this web-based system using the following components [12]:

1) **User Registration,** where a user can get an account to become a valid user of SCENS.
2) **Dataset Registration,** where a dataset owner can register his datasets in order to publish them.
3) **Negotiation Conditions Registration,** where the dataset owner can register his conditions for sharing, based on estimated benefits (such as price, usage time, etc.) for dataset exchange or sale.
4) **Negotiation Process Support,** where a user can accept, reject, or create counter offers for proposals using several operations, such as suspend, cancel, reject, accept etc.
5) **Negotiation Activity Display,** where a user can review any single prior negotiation in the history of his activities or analyze his negotiation communication networks through static and dynamic visualizations.

Given all possible ways to interact with SCENS, a user can benefit from having a means to examine, monitor and review the visualization of his/her interactions with the system at different stages and levels of interaction.

4. NCN analysis tool

In this section we introduce NCN analysis tool, a tool used to uncover patterns of human interactions in the context of negotiations for data sharing and exchanging. NCN is based on the philosophy that the way an individual lives depends in large part on how this individual is tied into the larger web of social connections. Moreover, another assumption is that the success or failure of a person's social behavior often depends on his knowledge of the outside world. There are two popular approaches in current work on Social Network Analysis (SNA) [11]: formal theory organized in mathematical terms, and systematic analysis of empirical data. Our NCN tool discovers organizational or inter-organizational relations, tracking the spread of data or resources. It does this by visualizing NCN in static and dynamic ways. It helps a user develop better negotiation strategies in terms of efficiency, benefit, etc. There is a clear value in being able to examine the social connections of potential negotiation partners.

4.1. Methodology

Just as Google is very effective at finding pertinent documents based on linking patterns, we believe analysis of communication interaction logs will enable us to discern the structure of networks and identify core contributors of useful knowledge resources, such as datasets, tools, etc. We propose a new methodology: *mining negotiation logs to trace* *the characteristic features in the negotiation communication network* that are relevant to extracting knowledge from particular datasets or particular participants, as negotiations progress over time. Our tool computes and visualizes the structure of existing participants by automatically generating a directed graph of communication flows.

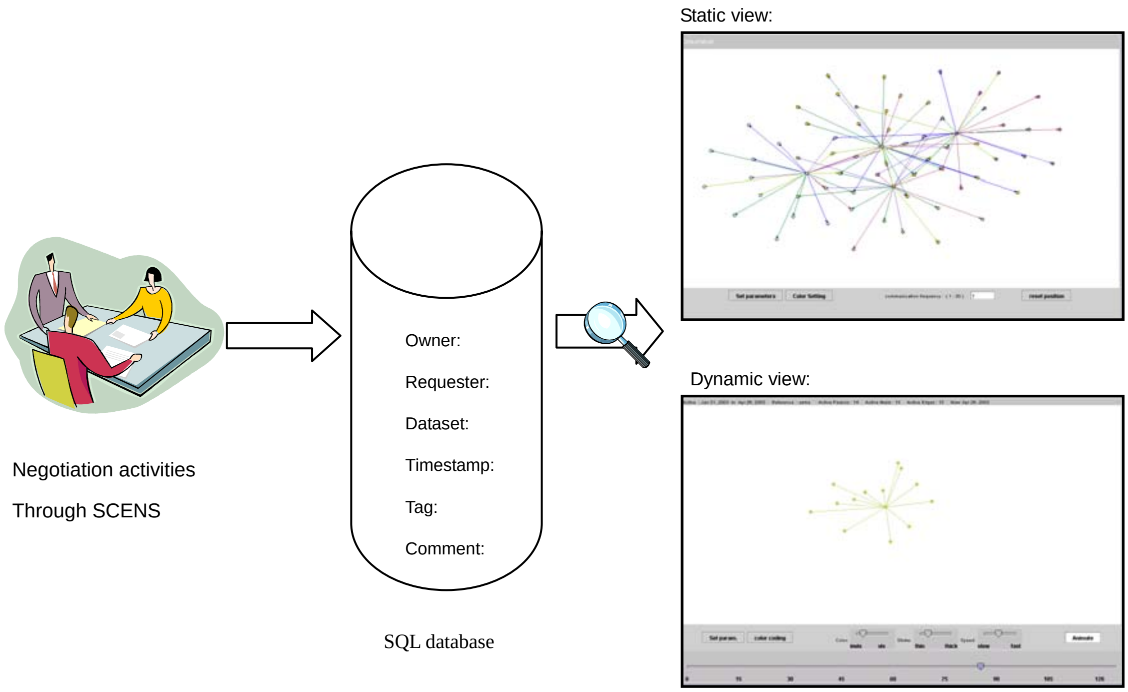

Fig. 2. Negotiation communication network (NCN) analysis tool architecture

We implement a flexible three-step process for NCN analysis tool. (Figure 2): In the first step, the negotiation activities are stored in an SQL database. In the second step, the database is queried to select successful or failed negotiations participated by some specified user(s) in a specified time period for specified datasets. In the third step the selected communication flows are displayed using our SNA visualization tools in static and dynamic views. The NCN analysis tool architecture also provides a testbed that exhibits scalability and flexibility: the number of negotiations to be analyzed is only limited by the size of the database, and temporal queries can run in a modular way. We have experimented with different visualization formats for the retrieved communication network structure. The tool can also be applied to analyze E-mail logs in a prior Collaborative Knowledge Networks (CKN) project [9].

We simulate SCENS negotiations using the following components:

- 50 simulated datasets (not differentiated by types or content), denoted as ds_000, ds_001 …
- 100 simulated users belonging to 15 different organizations, denoted as user_000, user_001, …
- Thousands of simulated negotiation communication flows in the form “user002

requested a negotiation with dataset ds_000's owner (user_000), and this ended on May, 5, 2003 successfully".

We store these records in the MySQL database and use them to demonstrate the application of our visualization tool to analyze negotiation interactions. Although the negotiations are not based on real data, they still contain interesting patterns in communications that we can find and characterize. .

4.1.2. The Basic Algorithm

We base our algorithm on the Fruchterman-Reingold graph drawing algorithm [10] for force-directed placement, which is commonly used to visualize social networks. This method compares a graph to a mechanical collection of electrically charged rings (the vertices) and connecting springs (the edges). Every two vertices reject each other with a repulsive force, and adjacent vertices (connected by an edge) are pulled together by an attractive force. Over a number of iterations, the forces modeled by the springs are calculated and the nodes are moved in a bid to minimize the forces felt.

Social network graphs attempt to represent the strength of social ties between parties. In our algorithm, we treat the occurrence of negotiations and dataset exchanges between participants as an approximation of social ties. In our visualization a negotiation initiated by actor A to actor B is represented as a directed edge from B to A, since B is the owner of a dataset and A is the requester of it. The more interaction between actors A and B, the closer the two representing vertices will be placed. The owners of datasets are normally placed in the center of the graph.

We offer both static and dynamic visualizations. And we propose a new algorithm, called the *sliding time frame algorithm* (see section 4.1.4), in dynamic visualization. While these two views have some common features, they work independently and give observers different information.

To flexibly create graphs for different goals, users can set separate parameters and colors through "set parameters "and "color coding" panels in each view [Figure 3_1, 3_2, 3_3, 3_4]. In this way, the user can filter the negotiation communications using a series of checkboxes, such as "datasets", "months", and "success"/"fail". They can also filter individuals according to their communication frequency.

We use several different color coding schemes to help users study NCN, depending on their specific purpose.

These are:

- "color by dataset" in both visualizations: Set colors for participants according to dataset(s)
- "color by organization " in both visualizations: Set colors for participants according to organization(s) they are in
- "color by month" in static visualization : Set colors for time period communications occurred in
- "color by person" in dynamic visualization: set colors for individuals in order to

track them
For example, if a user prefers to focus on analyzing relationships between organizations rather than individual persons, it will be better for him to group individuals of one group together. In this case, the "color by organization" schema can allow a user to set all the people from the same group to one color and treat them as one node. As Figure 4_1 shows, negotiation users, whether they are data / resource owners or data/resource requestors, are in different colors according to the dataset they are associated with: blue for ds_000, green for ds_001, or black for both ds_000 and ds_001.

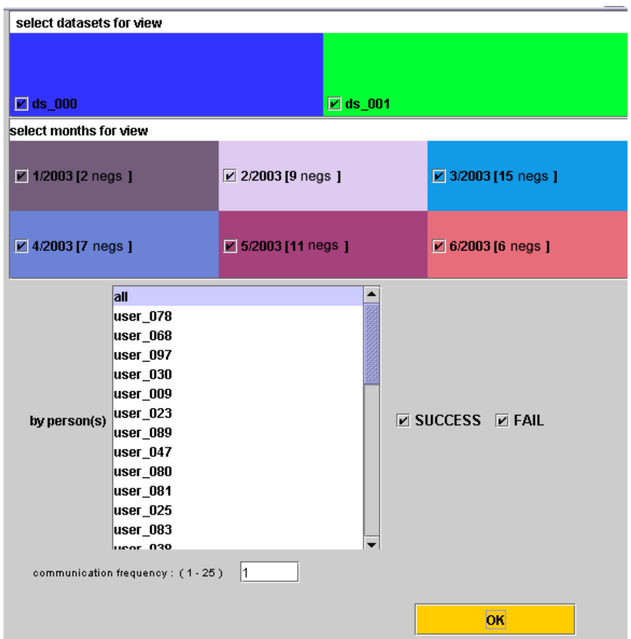

Fig 3_1. "Set parameters" panel in static vis.

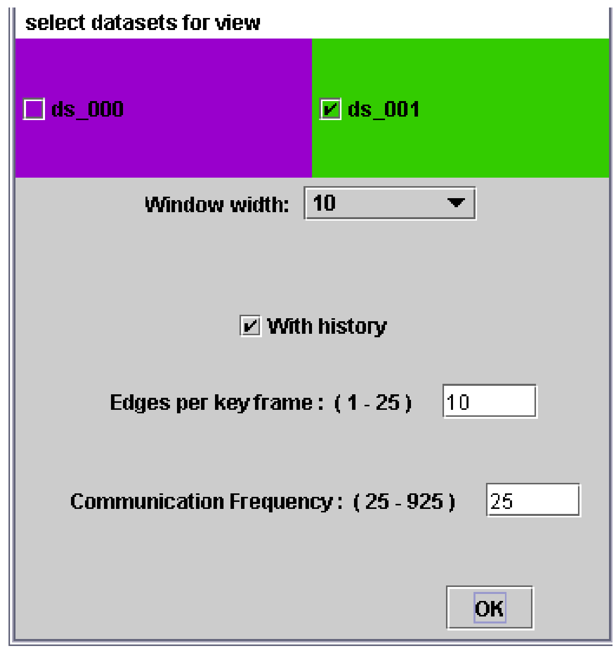

Fig3_3. "Set parameters" panel in dynamic vis.

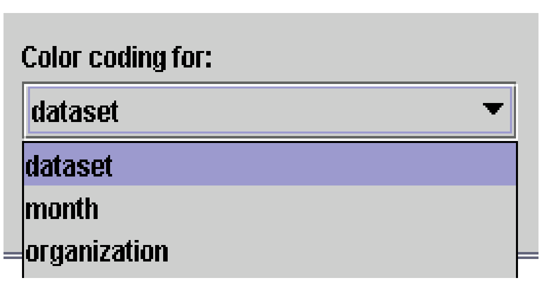

Fig3_2. "Color coding" panel in static vis.

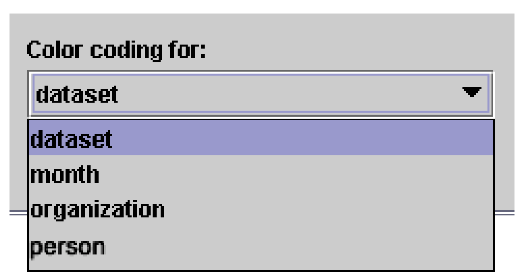

Fig 3_4. "Color coding" panel in dynamic vis.

4.1.3, Static Visualization

Figure 4_1 shows the default static visualization display for the negotiation communication network for datasets ds_000 and ds_001, which includes all relationships. Fig. 4_2 only displays relationships for user_031, who is the owner of ds_001.

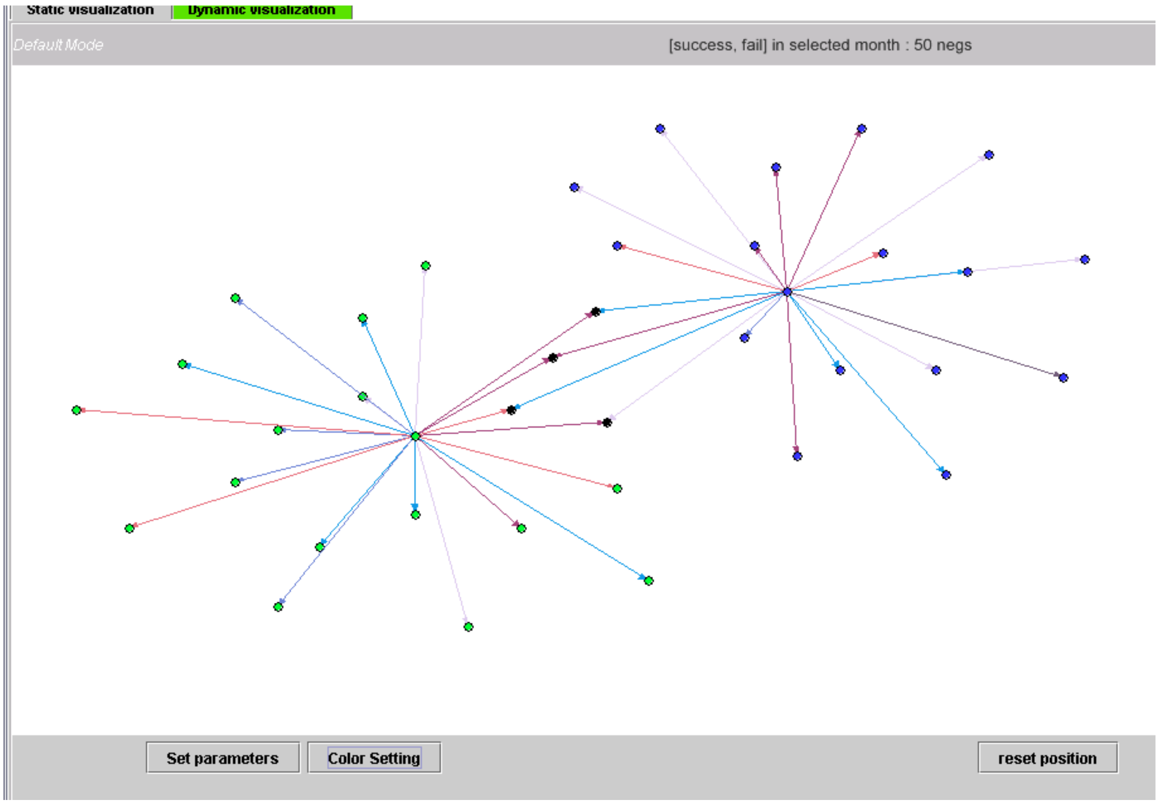

Fig4_1. Static visualization of NCN for two datasets (ds_000 and ds_001) in default mode. Node colors represent datasets and edge colors represent months.

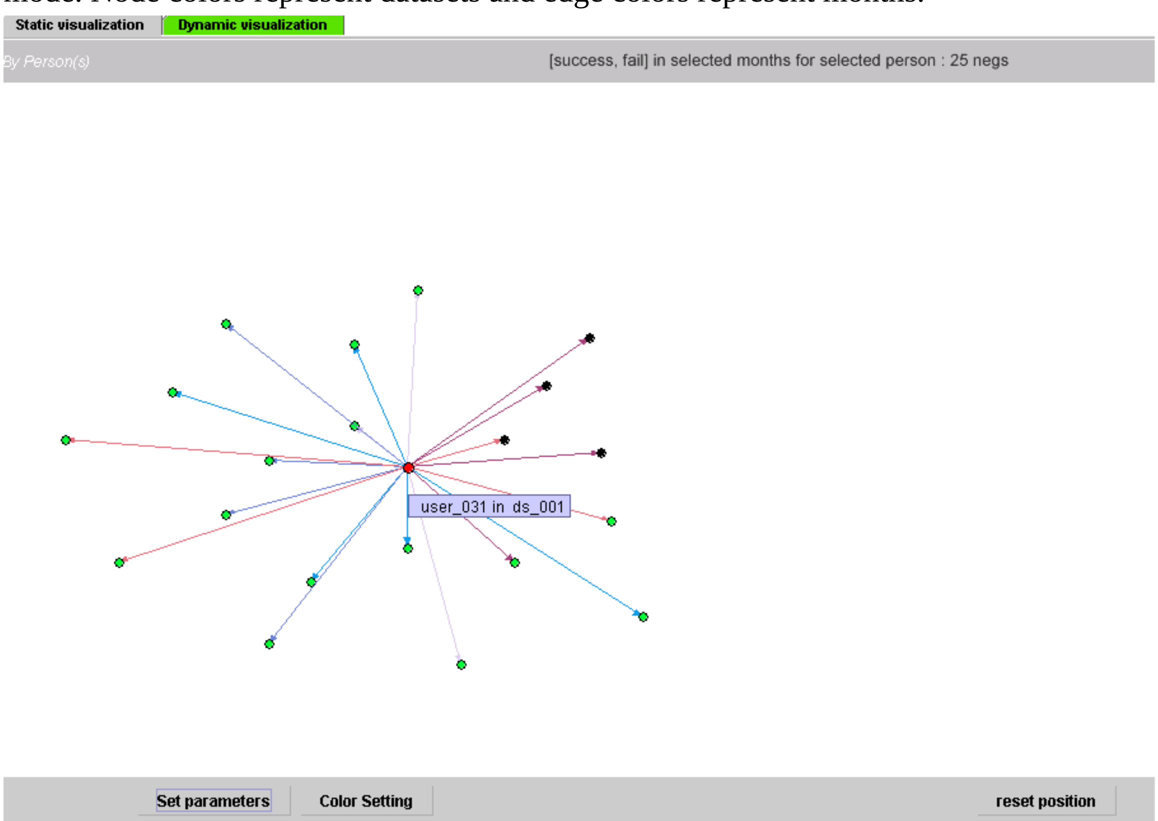

Fig4_2. Static visualization of NCN for two datasets (ds_000 and ds_001) in personalized mode (user_031 is selected). Node colors represent datasets and edge colors represent months.

4.1.4, Dynamic Visualization

We found it impossible to analyze NCN evolutions over time using a static visualization. Instead, we create dynamic visualizations where the graph is automatically updated on a daily basis.

Normally, for any day, the graph structure is based on the communications that occurred during this day. However, this approach does not take into account communications that happened before this day or after this day in a specific time-frame. For our dynamic visualization, we propose a new algorithm based on the FR algorithm: the *sliding time frame algorithm* [Fig. 5_1, 5_2].

The basic idea of the sliding time frame algorithm is to display active ties between actors in a sliding time frame covering a flexibly selected interval of *n* days starting from the specific day the visualization is showing. The window frame moves forward day by day, and new ties are subsequently added to the graph each day until the desired width *n* of the sliding time frame is reached. This time frame window allows users to foresee the activities happened inside the time frame after current day the visualization is showing. By default, all the old communication activities before the current time frame window are included in the graph when the checkbox “With history” is checked [Fig. 5_1]; if it is not checked, only the edges in the current window are included [Fig. 5_2].

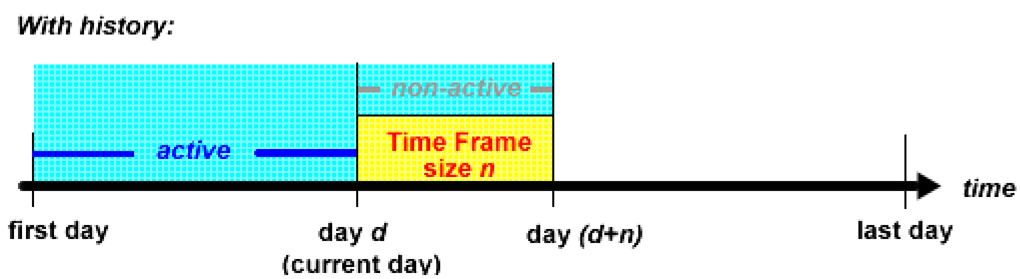

Fig5_1. Sliding time frame algorithm in “With history” mode: time frame moves to day *d* as the animation goes. Thus, day *d* is the current day the visualization is showing and current time frame is [*d*, *d*+*n*]. All communications through day (*d*+*n*) are counted and displayed, and if a communication takes place before or on day *d*, it is active.

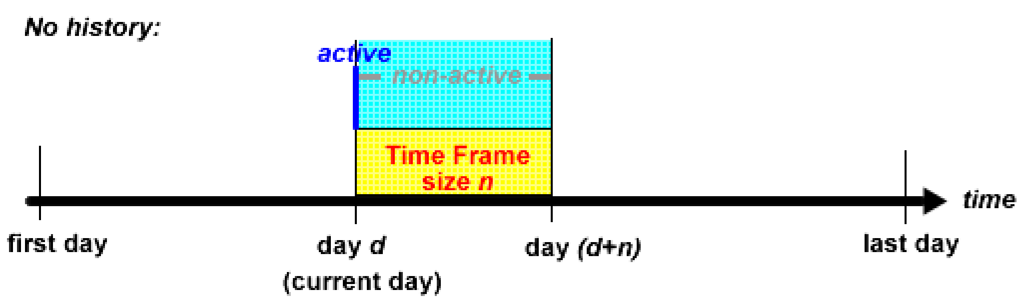

Fig5_2. Sliding time frame algorithm in “No history” mode: time frame moves to day *d* as the animation goes. Thus, day *d* is the current day the visualization is showing and current time frame is

[d, $d+n$]. Only communications inside current time frame are counted and displayed, and only communications on day d are active.

As shown in Fig6_1, if we set the time frame size to 10 days and use the “with history” option, then for the current day “May 27, 2003” the visualization is displaying, all the links from day “Jan 31, 2003” (when the first negotiation appears) to day “Jun 6, 2003” (which is the last day of current time window frame) are all displayed in either a normal or faded color—links through the current day (active links) are in the normal color, and links after the current day to the end of the time frame (inactive links) are in a faded color.

In “with history” mode, the animation is very smooth since the system remembers all the actors that have ever been active and uses their ties to calculate the location of each vertex.

Special Case: No history

Besides the previously described animation, where the locations of all previously active actors are cached in order to achieve smooth animations, we have also implemented a “no history” animation, where only the actors and ties active within the current time frame are considered in the visualization. Ties for the current day which the animation reaches are displayed in normal color, and inactive links are faded. This results in a jerky animation, but accurately reflects the current situation in the time frame without any influence from the past.

As Fig. 6_2 shows, for the current day “May 27, 2003”, links from this date to “Jun 6, 2003” are displayed in faded color. Vertices are placed only according to ties within the current time frame, and in this case there are no activities in “May 27, 2003” (no full-colored edges)

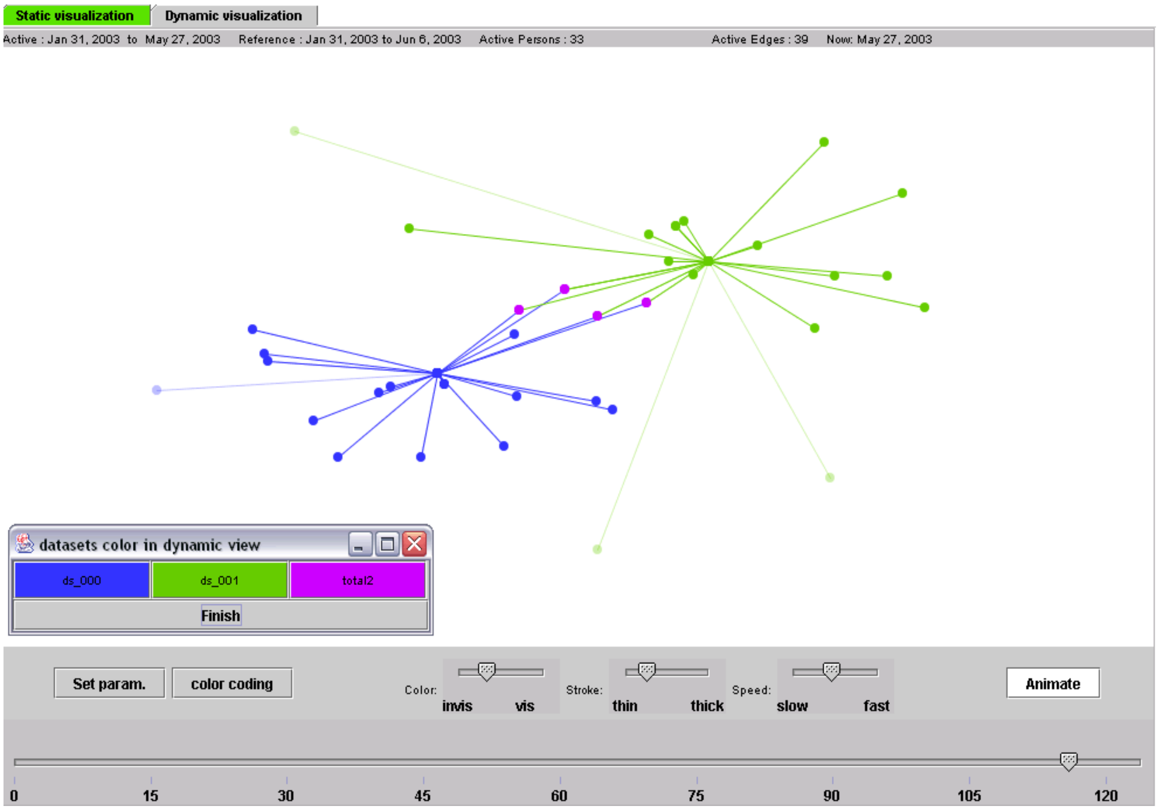

Fig6_1. Animation of NCN on two datasets (ds_000 and ds_001) with time-window frame of 10 days in “With history” mode where animation reaches day May 27, 2003

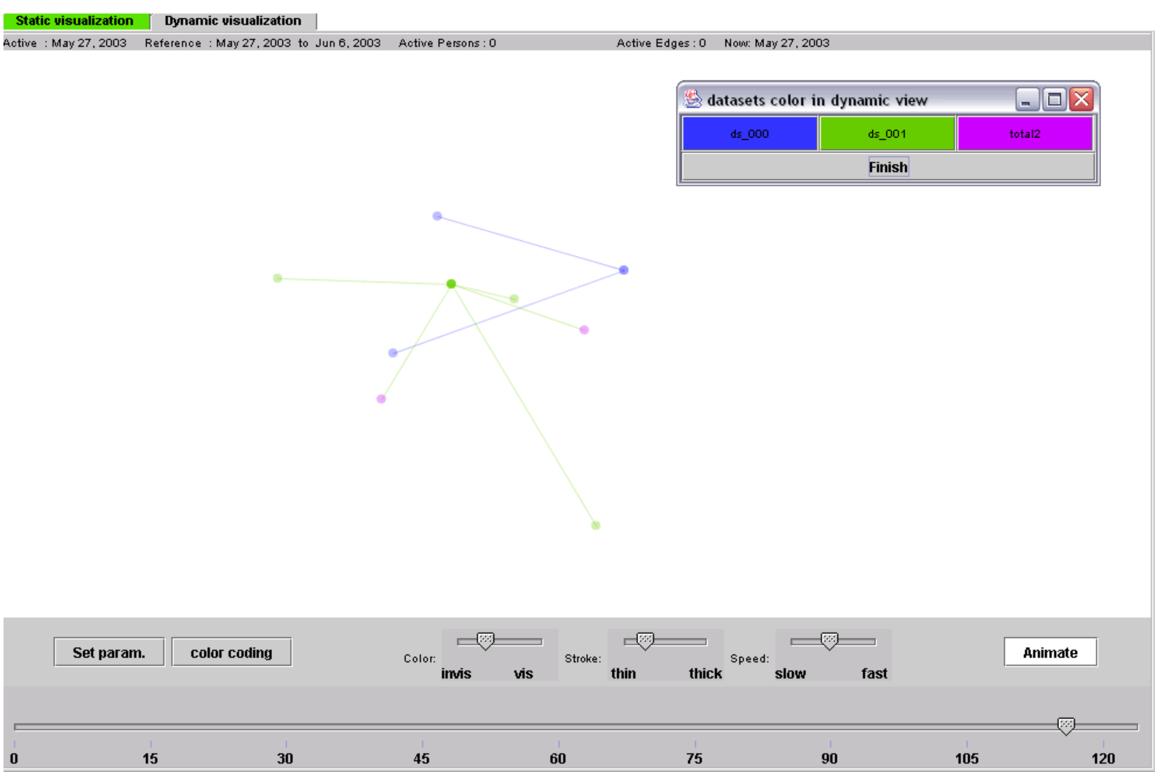

Fig6_2. Animation of NCN on two datasets (ds_000 and ds_001) with time-window frame of 10 days in “No history” mode where animation reaches day May 27, 2003

5. Conclusion and future work

Using the negotiation system SCENS [1], a system supporting the exchange or sharing of resources residing in distributed digital repositories, as a foundation, we have developed two interfaces for observe negotiation processes within a communication network structure.

These tools are important in that they can be used to reveal obstacles in communications during negotiations, as well as which persons or groups are active in resource exchanges or collaboration.

These tools may also enable us to detect new collaboration opportunities.

By making hidden opportunities in resource sharing apparent, we hope to improve mechanisms of collaboration, especially as they apply in scientific problem solving teams. We can also use these tools to make it easier to identify future negotiation goals and streamline communication processes. Future work will be the improvement of the analytic capabilities of our tools. We also hope to gain new insights into network evolution patterns and examine member roles in more detail as the growth of public usage of our SCENS system.

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