Zest Based Visualization for Requirements Negotiation

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Abstract: *Win-Win is one of the most common models which help systems stakeholders resolve conflicts during system Requirements Negotiation (RN). Solving conflicts, however, is barely dependent on visualizing the negotiation itself. The Zest algorithm was invented to visualize a standard e-mail discussion and demonstrate a concise overview of the discussion to facilitate a more productive one. This research sought to use this algorithm in visualizing the RN process in groupware. We have formulated a conceptual diagram on which to base the design and development process of the groupware for implementing the Zest algorithm. Our implementation of the algorithm has later been enhanced to produce more types of visualizations in relation to RN.*

Keywords: *Win-Win model, Requirements negotiation, visualization, Zest algorithm, and groupware*

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1. Introduction

Requirements Negotiation (RN) has always been a complicated task due to its iterative processes, as a change of requirements may occur at any stage of the software life cycle. Furthermore, confliction of the objectives and goals of stakeholders of the application will tend to occur since each of them is likely to have a different goal and interest in developing the application. RN has many models that help resolve conflicts, such as the Easy-Win-Win model and the Win-Win-Spiral model [4]. Both are extracted from the Win-Win model, which helps to identify and resolve requirements conflicts. The Win-Win model aims to be a method of making all critical stakeholders winners; these stakeholders are meant to meet regularly in a certain place at a certain time to produce success in order to avoid win-lose and lose-lose situations in RN for system projects [10]. Face-to-face gathering has a remarkable tendency to slow down the development of the application since stakeholders have to meet physically in one place at a certain time. Therefore, many applications have appeared on the market to support discussion from different geographical places. Groupware applications are the most commonly used to support project teamwork from different places at different times [13, 14]. However, it is not always easy for groups of members to communicate effectively during discussions in groupware [3, 7]. Media richness is the medium's capability to assist communication and the organization of the flow of vast discussions. Factors such as the ability of the medium to organize vast discussions with deep conflicts and the similarities among arguments affect its media richness. The medium's capability to organize RN and solve deep conflicts is barely dependent on visualization capability. This research works towards enriching the media by enhancing groupware to better support productive discussion for RN through visualization means.

2. Related Work

Text based discussion visualization has been quite widespread in past and current research. Many researchers have documented techniques and algorithms for text based discussion visualization. Our aim is to use such an algorithm/technique to visualize the Requirements Negotiation Process (RNP) sessions in groupware. We aim to find the closest one to the RN process.

Several techniques classify discussion elements into node types like issue, position, or argument and define a designated categorization of liaisons to link the nodes into a tree [5]. Other techniques pioneer the use of a coordinator that provides one of 11 action types from which users can choose (such as request, promise, or offer) for every conversational "move" [6]. The Reasonable approach [8] and Tree Trellis approach [9] allow users to build a tree of supporting and opposing arguments. The SenseMaker approach [2] provides the user with a way of arranging claims into rectangles and placing colour-coded dots into relevant rectangles to represent evidence. The Rich Trellis approach enables users to highlight fragments of arbitrary Web documents and sort them into an analytical tree along with indicators of the perceived reliability of each source [9]. The Zest algorithm is a breakthrough in the world of email text discussions visualization [11]. It processes an email list folder

which contains hundreds of messages and organizes them into a conversation-like overview to make it easy for users to understand and follow up such a topic, thus facilitating a productive discussion within the email list system. This research uses the Zest visualization algorithm to present multiple visualizations for RN in groupware.

3. Zest Algorithm

The Zest algorithm is a typographical convention which is made of four textual symbols to classify users' arguments in email list discussions [11]. The four textual symbols are: [?] representing a question, [#] representing an informative statement, [+] representing a supporting argument, and [–] representing an opposing argument [11]. This way the algorithm reaches the maximum coverage of a stray debate as there is no alternative position that can ever be propagandized by any user in any discussion.

The Zest algorithm was made to assume the user will type in the textual symbol before each paragraph that he or she wants to write, thus stating his or her position against each portion of the message, which may contain multiple threads that have already been marked by other users. All messages are classified with four different positions. This method makes it easy for visualization tools to arrange and organize rigid discussions in a very formalized interface. It also makes it easy for users to follow up previous threads in each message, thus determining the positions of all users in the listing of threads.

The Zest algorithm has been used by Hearst [12] to processes messages as they arrive, producing and revising a Web-based display to help categorize arguments and evidences in a more productive way. The Hearst method of visualization follows the Zest assumption in recording arguments by users, as it expects the user to type in the textual symbols at the start of each message in the first place. Hearst added colour coding to represent each symbol of the Zest algorithm, thus making the discussion more deliberate in terms of visualization. There are many other visualization implementations which can be introduced using the Zest algorithm.

4. Zest Algorithm for Requirements Negotiation

We have used the typographical convention of the four-parameter scheme of the Zest algorithm only to utilize the Zest algorithm for RN visualization. The four-parameter scheme of the Zest algorithm is relevant to RN because it somehow interrelates with the Win-Win negotiation model in the sense that it uses four arguments to broadly describe a stakeholder's point of view against a particular requirement. This particularly helps to identify conflict spots and bring together consents and winning solutions. However, our process is user-independent as there are no textual symbols inserted in any message, unlike in the Hearst process of visualization [12]. We guide users to record their RN sessions in three easy steps as illustrated in Figure 1. The user's first step is to select a requirement, the second step is to choose the preferred argument through the four parameter-scheme of the Zest algorithm, and the last step is to post a message. The preferred argument of the user along with the posted message will be recorded in a database for future reference as users may change views and perceptions from time to time due to negotiation cognition flows.

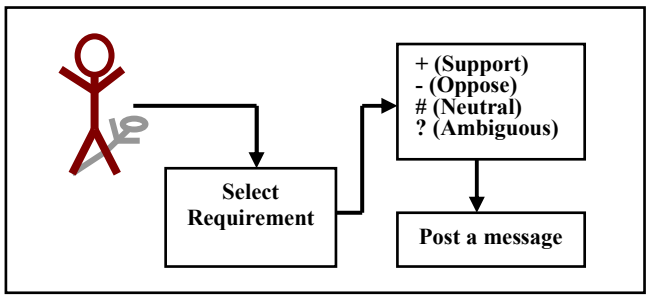

Figure 1. Using the Zest algorithm for RN visualization.

Adopting the Zest algorithm in this way offers many interesting possibilities for visualizing the RN process. With regard to the RN process itself, there are important criteria to consider as far as visualization is concerned, such as the stakeholder's role and working experience. The number of years of working experience of each stakeholder involved in an RN session is not merely important to consider, but is also believed to have a major effect on the RN process. Talented debaters can play a major role in dominating the negotiation by arguing for lose-lose conditions to make them seem like win-win conditions to others, while experienced stakeholders may be neglected just because they do not have the ability to convince others about whatever interest they have. Consideration of the stakeholder's level of experience whenever RN visualization is needed is among the issues discussed in this paper.

The stakeholder's role is also an important factor to consider according to a study carried out by Boehm and Egyed [3] on the behavioural aspects of the RN process for many projects to examine the factors which have a major effect on the RN process. The result showed that the role of stakeholders can certainly affect the negotiation result. Different stakeholders come to a project with different goals and interests [1]. It is very common that the role of the stakeholder is subject to the project requirements as a whole.

Based on the Zest algorithm and these two issues, we have generated six types of Zest-based visualization to provide multiple options to enable the

user to decide rationally and build an accumulated justification for each RN session. These types are:

- To produce a Zest view visualization (zesty) by dividing the RN page into two sections. The right section contains supporting and neutral arguments while the left section contains opposing arguments only. Questions and answers concerning arguments are to be placed anywhere whenever they appear since they may represent responses to supporting, neutral, or opposing arguments.
- To sum up the number of working years of experience before the stakeholder selects a requirement. This is to allow more weight to be given to those who have more experience and vice versa with respect to the RN session.
- To classify the stakeholders' roles whenever a requirement is selected as shareholders are more important than end users in some situations and vice versa. A different role for each stakeholder is assigned to a single requirement. This measure is taken due to the fact that certain stakeholders such as marketing managers find out more about the customers' and users' requirements, while developers find out more about what is technically achievable and reasonable.
- To give a mixed visualization that can incorporate the working experience and the stakeholder's role together.
- To give a grid view visualization of the Zest algorithm by showing RN in two columns. Column X shows hours while column Y shows the dates of stakeholders' posts. This visualization type helps to determine the flow of strength and weaknesses of each requirement as time goes on and stakeholders keep on negotiating a particular requirement.
- To include a statistical view visualization of the Zest algorithm by showing the number of supporting, opposing, and neutral responses and statements for each requirement.

Subsequently, we have formulated a conceptual model on which to base the design and development process of our groupware for implementing the Zest algorithm.

5. Conceptual Diagram of Zest Algorithm and RN Visualizations

Figure 2 presents a conceptual diagram which illustrates the Zest algorithm, types of visualizations, and the RN. All of these elements are linked and coupled together to be incorporated in a groupware application called the VRN (Visualizing Requirements Negotiation) system with a back-end database.

The front-end application classifies the stakeholder's role and sums up the number of years of working experience before the stakeholder selects a requirement or an alternative. Once the stakeholder has selected a requirement, he or she has to determine the position of his or her argument as directed by the Zest algorithm. At this stage, the front-end application processes the zesty visualization as clearly disclosed in the Zest algorithm. It also processes a statistical visualization which only presents the number of occurrences of each one of the Zest arguments chosen by each stakeholder. The statistical visualization generates a simple report of stored chosen arguments from the database. The report presents the number of stakeholders who have chosen to support, oppose or remain neutral to the requirement. It also shows the ambiguity level of the requirement. Subsequently, the stakeholder is allowed to start the RN session by posting messages, while the grid visualization is recorded concurrently by the front-end application. Grid visualization is a grid view of Zest arguments organized in rows and columns for every week of RN.

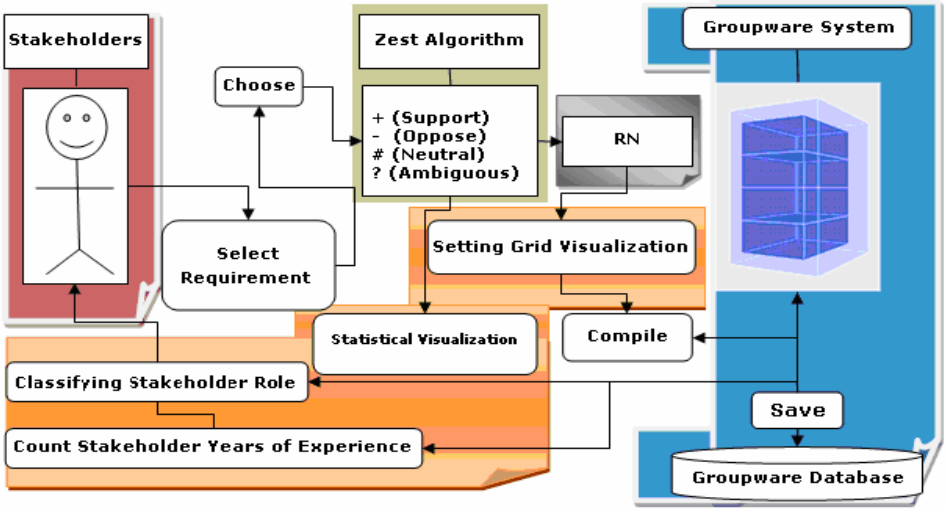

Figure 2. Proposed conceptual diagram of Zest algorithm and RN visualizations.

Therefore, providing six visualization pages functioning simultaneously has overcome the iteration problem which may occur in two different scenarios. The first scenario concerns the number of stakeholders

involved in a particular RN session, for instance, N number of stakeholders may want to participate in the RN session. According to the conceptual diagram, stakeholders must select a requirement first and then go through the Zest algorithm box as the arrow shows in Figure 2. There is no counter set for counting the participating stakeholders because they will initially be invited and thus counted by the VRN in the first place. If the number of stakeholders is odd, for example if there are nine stakeholders, it would be easy to end the negotiation with at least one stakeholder per side at the end of the day. However, even numbers do have a possible probability of forcing the RN to iterate more times as long as the four Zesty arguments lead to equal results. The second scenario is interrelated with the first one in terms of the result driven by the pursued RN session itself, as one particular visualization result may interfere with the interests of a particular participating stakeholder, causing the stakeholder to ask for another session of RN until his or her interest is fulfilled. Thus, the visualization module has taken a place in the conceptual diagram, providing six different visualization results for each RN session to orchestrate the optimum solution to match all interests as well as possible.

6. Visualization Pages of the VRN System

There are six visualization pages of the VRN system which comprise all of the types disclosed in section 4. These pages are database-generated Web-based documents which can be accessed anytime, anywhere. The visualization of each page concurrently changes according to messages being posted to the database. Therefore, deciding on a generated result at one time may increase the anxiety factor at a later time. The visualization pages were made to differ from each other in terms of results and concerns to back up anxiety regression with multiple results whenever a decision is made absolute. In this section, we present four visualization pages which concern the stakeholder role and working experience along with producing a productive discussion with its grid view to accumulate the options from which for the user can choose. The definition of each page, purpose, and method of implementation are broadly disclosed.

6.1. Zesty visualization page

Figure 3 exemplifies a recorded RN session in the VRN after it has been visualized by the Zest algorithm. The main purpose of this page is to allow stakeholders to concentrate more on arguments that they need to discuss, with easy distinctive access to each argument as it is set in a different box in a section with its header coloured differently, which accumulates a productive discussion. The colours used are as follows:

- Green represents support.
- Red represents opposition.
- Grey represents neutral.
- Orange represents questions or answers.

The page is meant to organize stakeholders' Zest-based arguments by dividing the page into two sections. The left section contains supporting and neutral arguments while the right section contains opposing arguments only with respect to a certain requirement. Questions and answers can appear in both right and left sections. Nonetheless, if there is an appearance of a supporting statement in the right box, this is referred to as a supporting statement for an opposing argument. Moreover, if an opposing statement appears in the left section, it is referred to as an opposing statement against a supporting argument. For instance, argument number 19 is neutral to argument number 4, whereas argument number 20 opposes argument number 3.

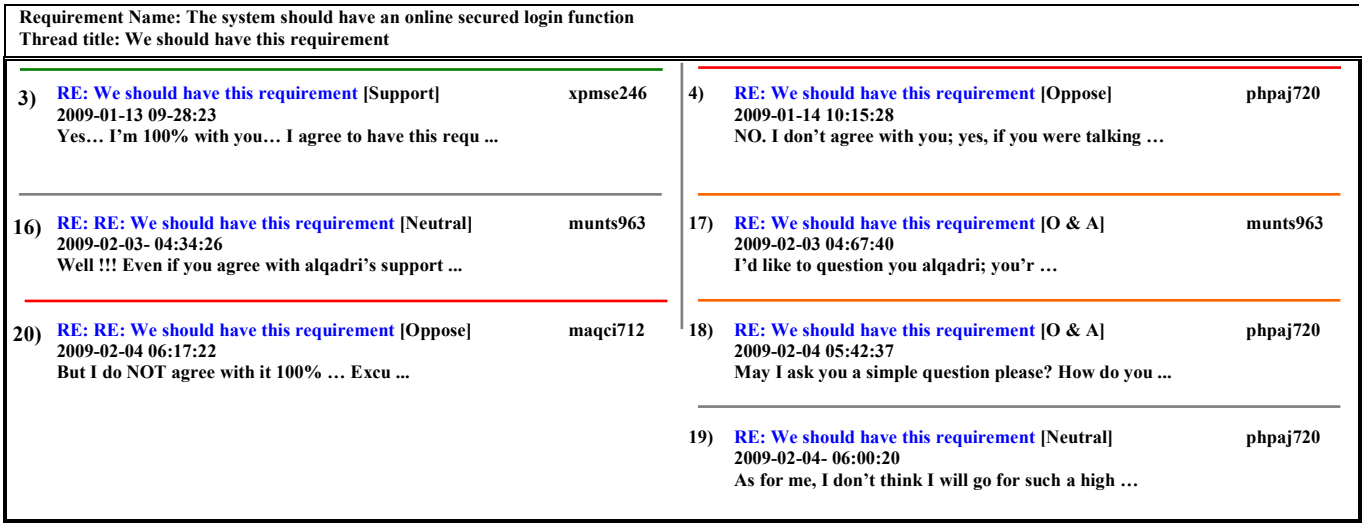

Figure 3. RN visualization page.

The name of the requirement is displayed at the top left corner of the page, while the RN session (discussion) is located underneath. All arguments are sorted by date. The stakeholder's identity is displayed next to his or her argument. Finally, clicking on any argument shows the discussion content of the argument, while keeping the content of all other arguments hidden.

6.2. RN Visualization Page Based on Work Experience

Figure 4 exemplifies a bar chart RN visualization based on the working experience of each stakeholder. This page is meant for looking at rather than reading. If we are to generally visualize and then pass our judgement based on whatever we read and perceive from the RN visualization page in Figure 3, and say that the requirement has been accepted or rejected, we might be wrong, because the majority of those who support or oppose may be end users or people who have no experience in that regard. Therefore, the use of visualization based on working experience is very important for a better and fruitful result.

The page is divided into two sections. The top section displays the requirement name with a simple report showing the number of statements recorded for each argument. The bottom section displays a graph-based chart to show the weight of working experience for each argument by summing up the total number of years of working experience of each stakeholder joining the RN session.

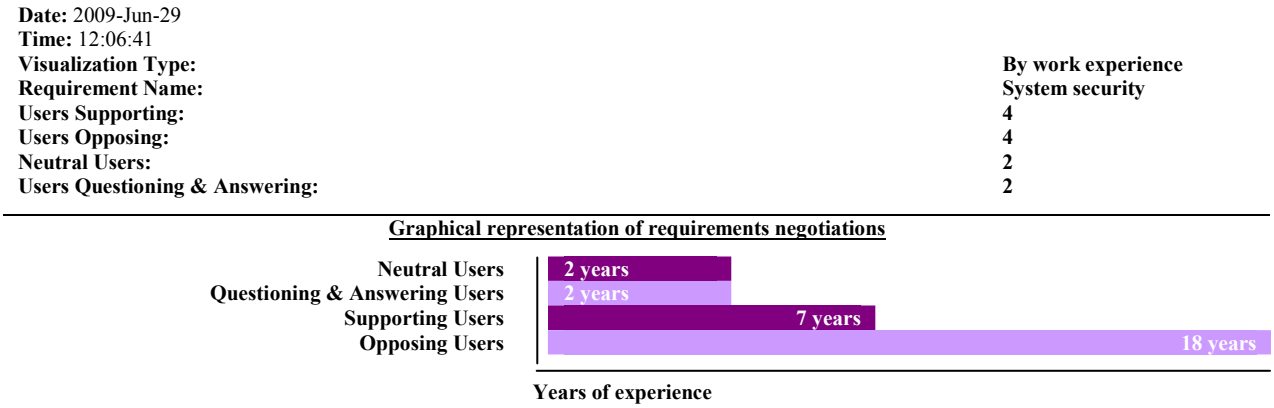

Figure 4. RN visualization page based on work experience.

6.3. RN Visualization Page Based on Stakeholders' role

Figure 5 exemplifies a pie chart of RN visualization based on stakeholders' roles. The figure presents the effect of each role on each requirement. Knowing the role of the stakeholder in the requirement is necessary since the stakeholders' support, opposition or neutral to the requirement reflects the need for the requirement with respect to that project. Hence, more weight is given to their arguments. This is achieved by determining the requirement concern in the first place. Each requirement represents a particular role of the stakeholder. The VRN system currently determines three roles of stakeholders: shareholders, developers, and end users.

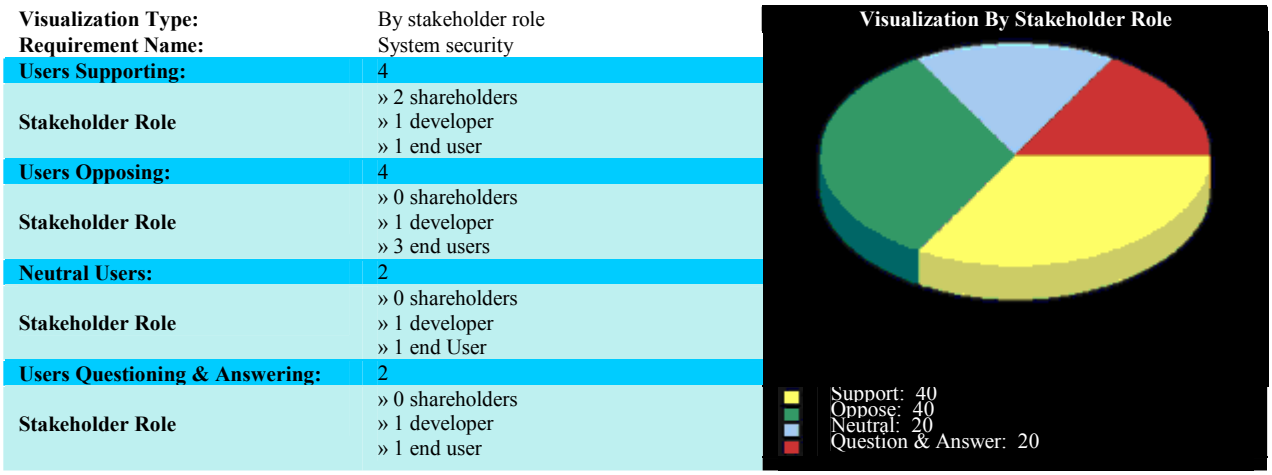

Figure 5. RN visualization page based on stakeholder role.

The page is divided into two sections. The left section displays the requirement name with a simple report showing the number of statements for each stakeholder's role recorded for each argument. The right section shows the pie chart representation. We assign 40% weight to whichever of the roles the requirement concerns. The rest of the roles will be given 30% of the weight. For instance, if the requirement is set to concern shareholders, they will be given 40% of the weight, while 30% will be given to each developer and end user who joins the RN session. Then we calculate the number of arguments and multiply it by the assigned weight of the stakeholder role owing to that argument. This process is repeated while the result is accumulated until the RN session expires. The result is generated in pie chart form.

6.4 Grid Visualization Page for RN

Figure 6 exemplifies a grid visualization for an RN session for a particular requirement. The figure shows the effect of each argument of Zest on each requirement among the participating stakeholders. It also helps determine the ambiguity level of the requirement. We determine the ambiguity level of a requirement through a definitive logic in which the more question and answer arguments appear against a particular requirement, the higher the ambiguity level of that requirement is, and vice versa. The process of grid visualization is done in a concurrent way in which at the time that stakeholders negotiate a certain requirement, the VRN system records arguments being sent to the database and converts them into colour-coded dots where each dot represents a single argument, and the colour-code follows the same classifications which were presented in Section 6.1. Then, it displays all dots on one page while differentiating each dot by its colour-code and its posted date and time. This particular method helps to expose argument alliances and responses toward each other by determining the flow of pressure spots of posts generally and winning positioning in particular.

As the figure shows, the RN session started with two supporting arguments on Monday 5 January 2009. The next day, stakeholders started the flow by supporting the requirement. However, two stakeholders probably did not understand the requirement or had some doubts in judging the requirement immediately on the second day of the negotiation. Since there are very few orange dots on the page, the requirement is good and complete. On Wednesday 7 January 2009, some stakeholders opposed the requirement or probably disagreed with some supporting arguments. The first opposing argument is shown at the topmost position of the same day, which reveals that it is opposing the requirement itself. The location reveals that it was posted late in the morning. The other four red dots which appeared a little later than the first one are probably statements opposing supporting arguments around them. Also, it is possible that the two green dots which appeared right below the first red dot represent statements supporting the first opposing argument.

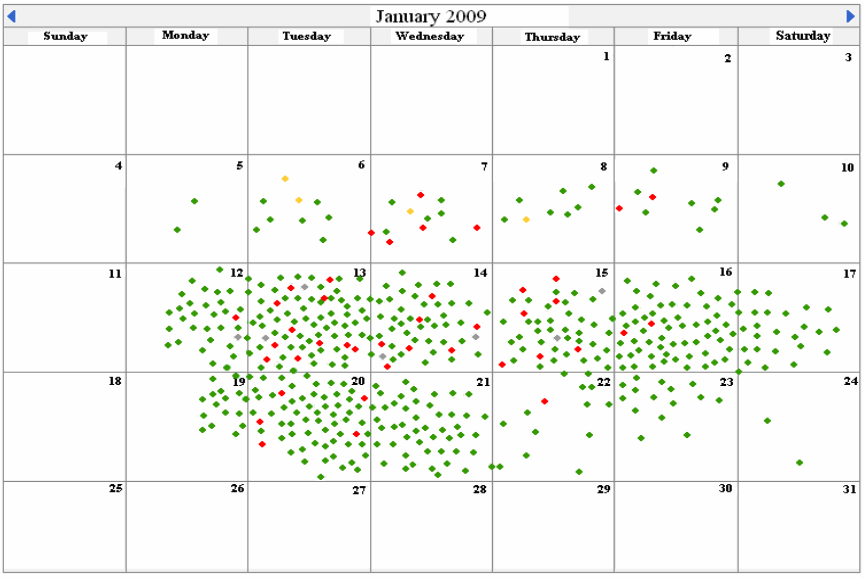

Figure 6. Grid visualization page for RN.

The overall look and feel of the visualization shows that the green colour is dominating the view, resulting in a positive decision on the requirement. The negotiation started early in the morning of Monday 12 January 2009 and continued until Saturday 24 January 2009. The closeness of the green dots to each other reveals perfect consensus among the participating stakeholders, which in turn, leads to the awaited win-win solutions. On the other hand, the discrepancy of the red dots shows that opposing arguments were not united and were unlikely to be assumed to be statements opposing supporting arguments. There were very few neutral arguments on days 14 and 15. Neutral arguments have a slight effect on the requirement's

approval and disapproval status decision. Finally, clicking on any dot displays the content of the argument, which helps verify whether it is an original argument or a respondent statement.

7. Significance and Conclusions

This paper aimed to present how the Zest algorithm can be adopted to visualize requirements negotiation. The research has discussed six types of visualizations to multiply the options for the user and build accumulated justifications for each requirement. The proposed Zest-based visualization types for solving conflicts during requirements negotiation among stakeholders are statistical, grid, by working experience, by stakeholder's role, and mixed (interrelation of working experience and stakeholder's role). With its focus on adopting the Zest algorithm on which to base the visualization in RN, this research is expected to contribute to RN by providing a visualization tool as a necessary feature in a groupware. In this way, the research works towards media richness in groupware through visualization means for solving conflicts during RN among stakeholders.

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