ConsensUs: Visualizing Points of Disagreement for Multi-Criteria Collaborative Decision Making

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Abstract
Groups often face difficulty reaching consensus. For complex decisions with multiple latent criteria, discourse alone may impede groups from pinpointing fundamental disagreements. To help support a consensus building process, we introduce ConsensUs, a novel visualization tool that highlights disagreements in comparative decisions. The tool facilitates groups to specify comparison criteria and to quantify their subjective opinions across these criteria. ConsensUs then highlights salient differences between members. An evaluation with 87 participants shows that ConsensUs helps individuals identify points of disagreement within groups and leads people to align their scores more with the group opinion. We discuss the larger design space for supporting the group consensus process, and our future directions to extend this approach to large-scale decision making platforms.

Author Keywords
Multi-criteria decisions, group decision making, consensus building, information visualization

ACM Classification Keywords
H.4.2 [Types of Systems]: Decision support; H.5 [Information Interfaces & Presentation]

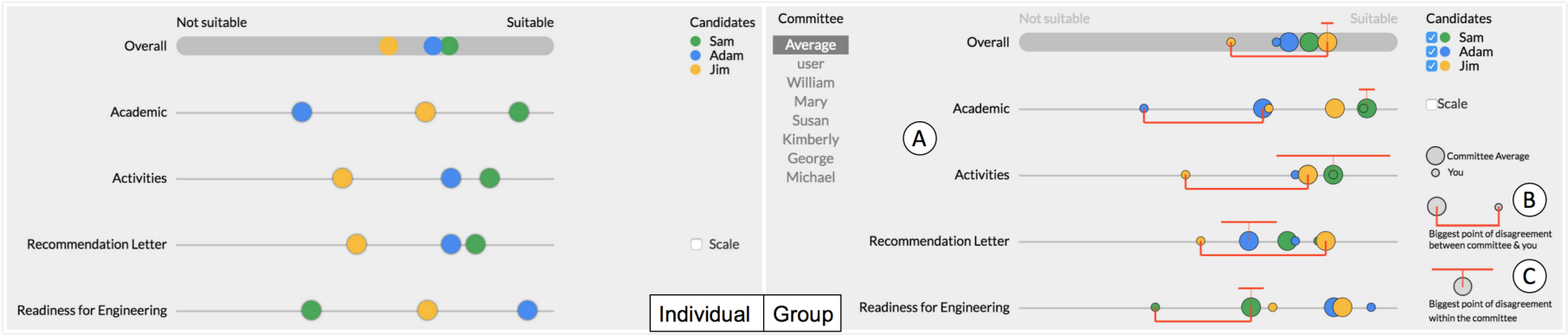

Figure 1: (Left) The ConsensUs independent opinion interface where users rank alternatives relative to each other on multiple criteria. **(Right)** The ConsensUs group visualization interface. (A) Average ratings of the group. (B) Legend of disagreement between the user and the rest of the group. (C) Legend of disagreement within the group.

Introduction and Related Work

Groups often make decisions that involve comparing alternatives with multiple criteria [2]. Families must agree on which house or car to buy; hiring committees must decide on which potential employee to hire; local government boards choose between different investments in their community. Typically groups communicate about such decisions through synchronous verbal discourse or through computer-mediated chat or email. However, verbal discussions can be dominated by one individual, either by means of conversation dominance [3] or social status, which may leave groups vulnerable to group-think, production blocking [6] or social loafing [7]. Individuals can be "anchored" to their initial impression [9], or conversely, could exhibit false consensus by avoiding or ignoring conflict within a group.

Researchers have explored how technology could meditate group decisions as a way to overcome barriers in face-to-face discourse. Tools for model-supported conflict management have sought to reconcile group differences, for example, by ensuring information sharing [5], fostering a positive tone [10] or by structuring group discussion. However, computer-mediated discussions are also known to increase delays, create more outspoken advocacy, decrease member satisfaction, and lead to riskier decisions [4].

Our research introduces an approach for multi-criteria group decision making, based on consensus building theory. Briggs et al. articulates consensus building as a social process [1] where diagnosing conflicts is a crucial step for groups to reach consensus. To support this within the context of multi-criteria decision making, we created a real-time web-based visualization tool that highlights points of disagreement and visualizes in real time how a group's opinions coverage and deviate based on their subjective ratings for across multiple criteria. To evaluate the tool, we did an

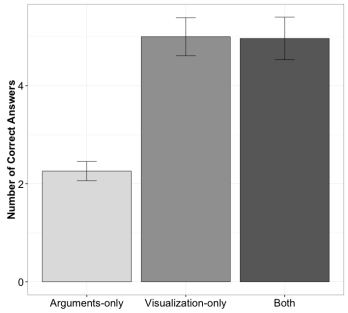

Figure 2: Participants in the Visualization-only and Both condition scored higher on the Disagreement Identification Test than the Arguments-only

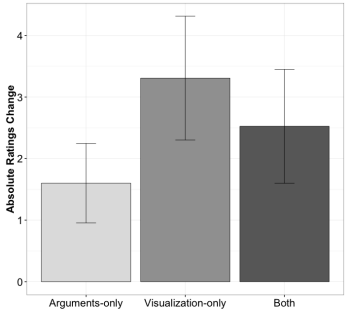

Figure 3: Absolute Ratings Change. Visualization-only changed their scores significantly more than Arguments-only condition

initial study with 87 participants on a candidate comparison task. The results show that visual support helped participants perform significantly better at identifying points of disagreement within the group. Visualization also led participants to change their opinions more towards the group. In the following sections, we will introduce the tool in details, summarize what we found on the experiment and outline future research.

System Description

Building on research that emphasizes the benefits of presenting group preferences only after group members have articulated their own [8], ConsensUs structures group decisions around these two key phases: 1) capturing independent opinions, and 2) representing group opinions. In ConsensUs' independent opinion interface, users rank alternatives relative to each other on a number of criteria. As depicted in Figure 1 (Left), users can click and drag the colored circles representing the different alternatives on to each criterion line. The criteria are organized as rows and can be customized to list as many criterion as the decision merits.

In ConsensUs' group visualization interface, users see an aggregation of all group members' opinions from the individual interface. The interface displays both written arguments and the average ratings for each criteria of the decision (see Figure 1 (Right) (A)). ConsensUs highlights two different types of disagreement: the variance present within the group as a whole (see Figure 1 (Right) (C)) and the explicit disagreement between the user and the rest of the group (see Figure 1 (Right) (B)). ConsensUs is interactive, allowing users to explore for more details. By clicking on the large group dots, users can explore how different group members rank alternatives relative to each other.

Evaluation

We evaluated ConsensUs in a between-subjects experiment with 87 participants that compared three conditions: written discourse only, visualization only, and written discourse plus visualization. We compared the participants' ability to identify disagreement as part of a mock decision committee and their subsequent changes to their individual opinions. We measured 1) participants' ability to identify disagreements through an objective test, 2) participants' change in ratings before and after viewing the group opinions. Our results show that providing visual support helps participants identify points of disagreement (see Figure 2) and leads to final assessments more aligned with the randomly selected group of confederate voters (see Figure 3). The results demonstrate the value of utilizing visualization to externalize and identify points of disagreement. Participants in the Argument-only condition expressed frustration when trying to identify disagreement, while the visualization provided an intuitive way to explore differences in the group. As one participant said, *"The interactive chart was very user friendly and allowed me to compare individual and group scoring. It made locating disagreements easy."*

Conclusion and Future Work

We introduced ConsensUs, a novel visualization tool for supporting groups in the consensus building process. ConsensUs explicitly highlights subjective points of group disagreement across multiple criteria while presenting participants with other group member's arguments. Based on our evaluation, providing visual support helps participants identify points of disagreement and leads to final assessments more aligned with the group.

Future work will focus on conducting studies with real-world groups to more deeply understand the value of a tool like ConsensUs. Real-world decision-making processes will be

more complicated and thus have more factors that will affect the results. For example, rather than having a default set of criteria, real-world groups need to first build consensus on potential criteria before considering candidates. How groups delegate, weight and choose different criteria can also be important for the decision results. We will employ lessons learned from these studies to extend ConsensUs to support large-scale deliberation on real-world problems such as civic issues. We believe that the visualization approach embodied by ConsensUs has potential to support asynchronous communication for distributed groups. However, as we extend our approach to more complex problem spaces, we will investigate alternative visualizations. We aim to address issues such as the accessibility of visualizations for a broad range of users, scalability, and flexibility (e.g. providing multiple visual encodings).

Another research direction would be addressing the complexity of large scale decision making systems by employing machine learning techniques, such as topic modeling to improve issue classification and clustering.

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