

Visualizing Group Affective Tone in Collaborative Scenarios

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Abstract

A large set of complex datasets require the use of collaborative visualization solutions in order to harness the knowledge and experience of multiple experts. However, be it co-located or distributed, the collaboration process is inherently fragile, as small mistakes in communication or various human aspects can quickly derail it. In this paper, we introduce a novel visualization technique that highlights the group affective tone (GAT), also known as the presence of homogeneous emotional reactions within a group. The goal of our visualization is to improve users' awareness of GAT, thus fostering a positive group affective tone that has been proven to increase effectiveness and creativity in collaborative scenarios.

Categories and Subject Descriptors (according to ACM CCS): H.5.3 [Information Interfaces and Presentation (e.g., HCI)]: Group and Organization Interfaces—Computer-supported cooperative work, H.1.2 [Models and Principles]: User/Machine Systems—Human factors

1. Introduction

Large and highly complex datasets require the knowledge and experience of multiple agents in order to gain insights or detect patterns. Collaborative solutions, in particular in the field of visualization, take this process one step further, allowing experts to build upon each other's conclusions and knowledge. Yet, the collaboration process is very fragile and can be easily derailed through misinterpretations, miscommunication, or even affective human aspects.

One element that suggests a healthy collaboration process is the *group affective tone* or GAT [Geo90, Geo96]. The group affective tone is defined as the consistent emotional reactions of the members of a group. While not all groups have an affective tone, positive GAT has been linked to higher effectiveness and creativity during collaboration sessions [Cum98, IDN87]. On the other side, affect visualization approaches include abstract representations [MKK*12], avatars and affective icons [GFM99, HvHvD*13, LSN10], as well as custom interface widgets [LSN10]. While some of these techniques are also focused on emotional self-awareness, there are few that consider the particularities of representing emotions in collaborative visualizations. For example, Cernea et al. [CWEK13] suggest an emotion visualization that is aimed at enhancing standard GUI widgets with the purpose of improving awareness and supporting distributed collaboration.

In the following, we introduce a novel visualization technique for representing group affective tone in collaborative applications and visualizations. The goal of this representation is to improve user awareness of the overall affective tone with the purpose of supporting the collaboration process by allowing users to react to divergent or negative affective tone levels.

2. The GAT Visualization

In order to represent the group affective tone, we first need to interpret the users' emotional states. This can be achieved through the use of electroencephalographic (EEG) devices that are positioned on each user's head and are capable of measuring electrical signals generated by the brain. With the use of the Emotiv software framework and Russell's model of affect [Rus80], these electrical signals are interpreted as the user's current affective valence (i.e., positive emotions or negative emotions), mapped into the domain $[-1, 1]$. A detailed presentation of the Emotiv EPOC headset, its use in the field of visualization [APM*11, CEK11] and its abilities in measuring subjectivity [COEK11, COEK12] have been covered in other publications and are not the topic of this paper.

Further, we generate a mapping between the one-dimensional valence space and a segment of predefined fre-

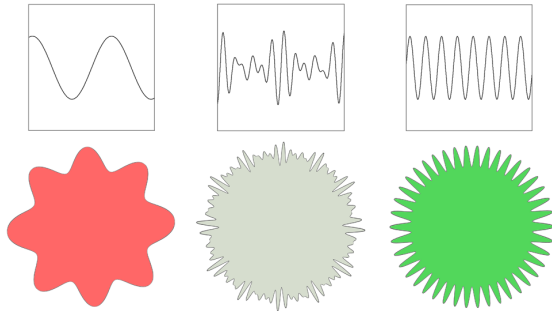


Figure 1: Sum of multiple sine functions (top) and the GAT representation for their mapping to a circle contour (bottom). The examples can be described as: sum of low, identical frequency sinusoids (left) encoding a negative group affective tone; sum of sinusoids with varying frequencies (center) suggesting the absence of a group affective tone; sum of high, identical frequency sinusoids (right) encoding a positive group affective tone.

quencies. As such, each valence value in the domain $[-1, 1]$ will be uniquely connected to a certain frequency. These frequencies are then used for generating sine waves, such that for each valence value we define a frequency and thus also a unique sine wave. The sine waves obtained from all the users that are participating in the collaborative session are then added up, generating a new signal. Based on the frequencies of the summed sinusoids, the resulting signal may or may not have a shape that is similar to a new sine wave. If the frequencies of the individual sine waves are similar, the resulting signal will be close to a sinusoid. Otherwise, the signal shape will be less homogeneous (see Figure 1).

In order to obtain the GAT visualization, the final signal that results from the sum of the user sinusoids is mapped to the contour of a circle (Figure 1). In this representation, the homogeneous contour suggests the presence of a group affective tone. Furthermore, the existence of such a tone is also captured by the saturation levels of the representation, as desaturated colors suggest the lack of an emotional consensus. At the same time, the colors red and green are present in cases when a group affective tone exists and they encode a negative or positive valence, respectively.

A preliminary study was executed with 12 participants divided into 4 groups (see Figure 2). The groups had to search for a particular piece of information in a time-series visualization on a tabletop. Each group had to execute two such similar tasks, once with the GAT representation and once without it, in random order. Our initial results have shown that the GAT visualization can raise users' awareness of the group affective tone. For tasks where the GAT visualization was available, users communicated more and actively engaged in supporting the collaboration process (e.g., "Does



Figure 2: Users collaborating on a tabletop visualization while wearing EEG headsets. The visualization incorporates the GAT representation.

everyone agree to proceeding this way?"). Moreover, groups that were given feedback through the GAT representation were more likely to produce a team leader and solved the assigned tasks faster than the unaided group ($AVG = 28$ sec, $SD = 14$).

3. Discussion and Future Work

Improving the awareness of the group affective tone in collaborative visualization is only one of many aspects that can positively influence the short and medium-term cooperation. Our visualization approach allows team members and leaders to increase awareness of the group's mood, better evaluate the flow of the collaboration and to pro-actively engage in conflict management. As such, the GAT visualization approach can be employed in a wide set of collaborative applications and visualizations, especially in scenarios where unanimous decisions are vital.

One concern when visualizing user emotions is related to privacy. While users need to agree to share their EEG readings, the convoluted data that is displayed through our approach does not reflect the emotional valence of any single individual, but rather the group-level tone. As a result, the GAT visualization also avoids isolating certain team members as a source of discrepancy in the tone of the group. At the same time, one needs to consider that achieving a positive GAT does not ensure successful collaboration, as the excessive focus on obtaining a positive group tone can even distract team members from the task they are performing.

In the future, we plan to further evaluate our approach in a larger study, both in co-located and distributed collaborative visualization. Additionally, we hope to integrate and adapt our initial design to domain-specific visualizations.

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