Supplementary Materials for IEEE VIS Full Paper - **submission 1026** entitled

“Revealing Interaction Dynamics: Multi-Level Visual Exploration of User Strategies with an Interactive Digital Environment”

This supplementary material details the iterative design process of the presented visual analytics (VA) prototype system, VISID. We document how our VA prototype system has evolved through various stages, and elucidate the major modifications made at each iteration. For a detailed description as well as the distilled system design requirements and design tasks, please refer to our manuscript.

System Designs Iterations

This section describes and illustrates previous versions of our VA prototype system, providing insights into the design decisions and refinements made throughout the development. For a detailed system description, please refer to our manuscript.

VISID Version 0 – Initial Data Exploration

Prior to formal analysis, we conducted an exploratory investigation of the logs, as we had no idea what the logs generated by the SiN interface contained. This phase marked our preliminary exploration into the nature of information contained within the logs, aiming to discern and establish connections with the experimental tasks. Specifically, we sought to interpret the occurrences within these tasks and determine how the log data could be correlated with the events observed.

In our exploration, we experimented with the visualization of interaction sequences and sequences of interface elements (i.e., infopanels), which were logged separately by the SiN interface. For detailed descriptions and definitions on the different sequences, please refer to our manuscript. These event sequences appeared disconnected, and we were not able to establish an accurate connection between them. The interaction sequences and attribute sequences are linked, however.

Consequently, we developed two distinct views early in our study: one displaying interactions alongside attributes, as shown in Figure 1, and another displaying interface elements (i.e., infopanels), as shown in Figure 2.

Figure 1: VISID version 0.1, Individual View.

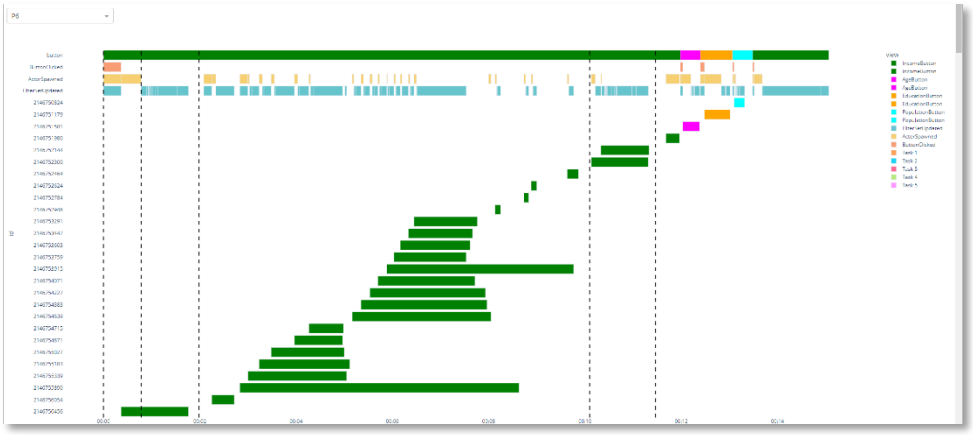

Figure 2: VISID version 0.2, Individual View.

VISID Version 1 – Initial Mock-Up

Following an initial discussion and workshop with the Visual Learning and Communication (VLC) group, we recognized the necessity of sequence comparison. The logs exhibited multiple levels of granularity. Here, we were experimenting with what made sense to visualize and compare, as shown in Figure 3 and 4.

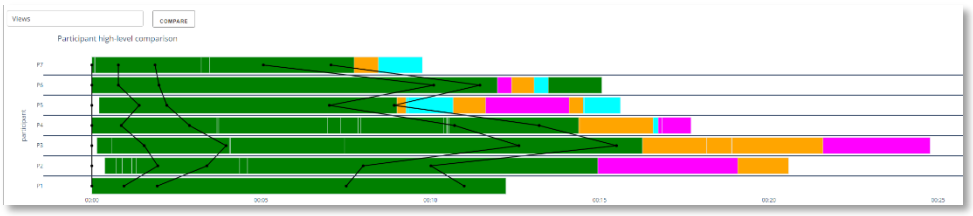

Figure 3: VISID version 1, Comparison View showing statistical category change sequences.

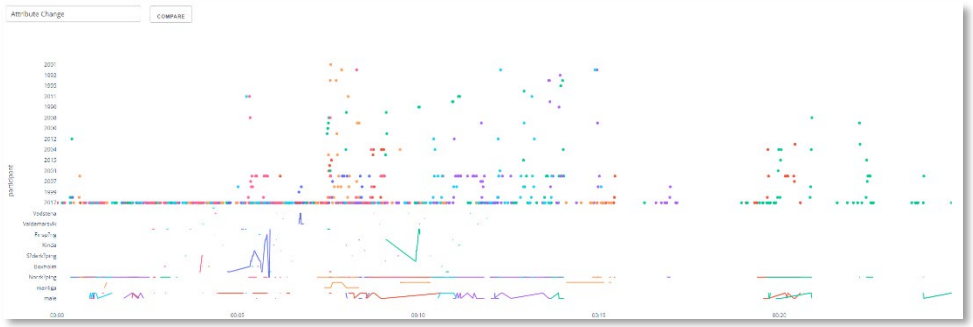

Figure 4: VISID version 1, Comparison View showing attribute change sequences.

VISID Version 2 – Interactions

In the subsequent phase of our development, we recognized the necessity for a control panel to facilitate interaction between the dataset and the system user. We focused on determining the most relevant features to include in this panel and experimented to see what made sense. Additionally, we explored algorithmic methods for participant comparison. However, the primary focus during this stage was on the visualization and system design, as shown in Figure 5.

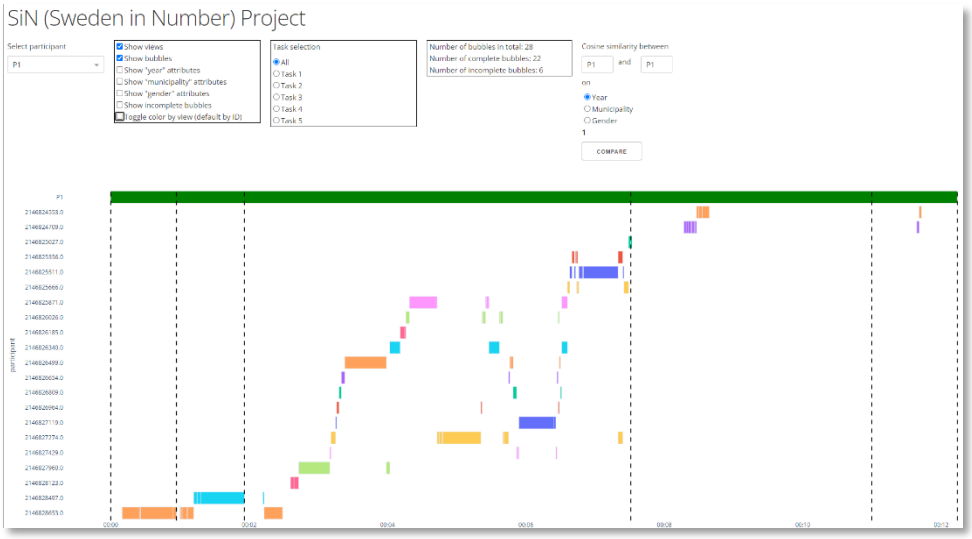

Figure 5: VISID version 2, Individual View with a Control Panel implemented.

Similarly for the *Comparison View*, a control panel was incorporated. We then focused on exploring techniques for superposing attribute sequences. This involved evaluating different orderings and arrangements to determine the most effective configuration for visual comparison, as shown in Figure 6.

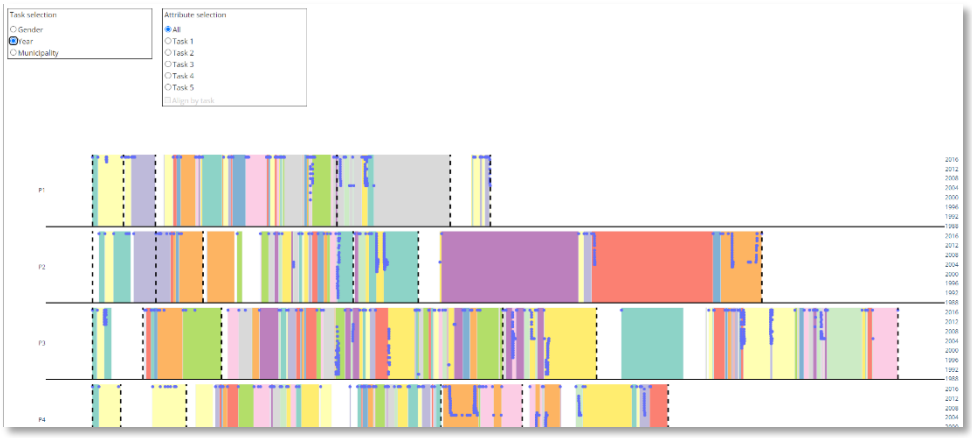

Figure 6: VISID version 2, Comparison View improved.

VISID Version 3 – Design Enhancement

We explored incorporating attribute sequences alongside interaction sequences within the *Individual View*, as shown in Figure 7. To mitigate potential information overload, we implemented a user-controllable option for including or excluding attribute sequences. Additionally, we further investigated the visual representation of attribute sequences within the *Comparison View*, as shown in Figure 8 and 9.

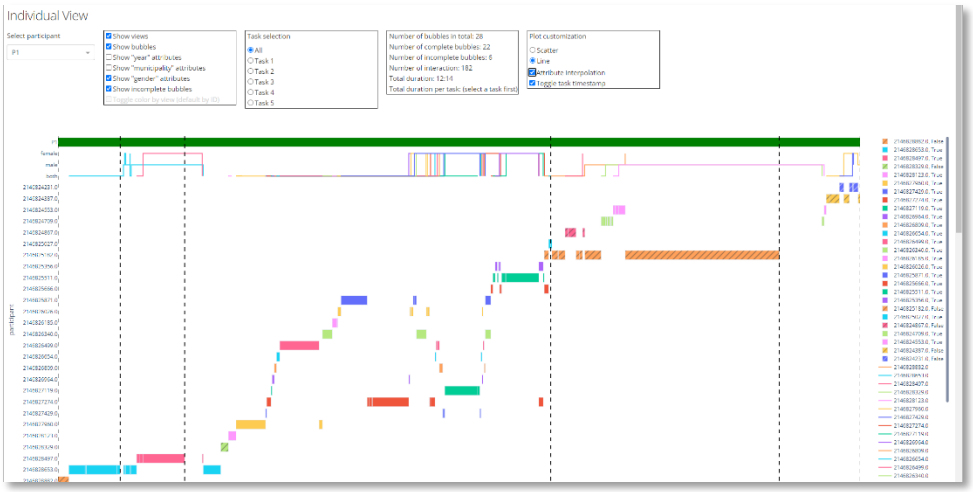

Figure 7: VISID version 3, Individual View improved.

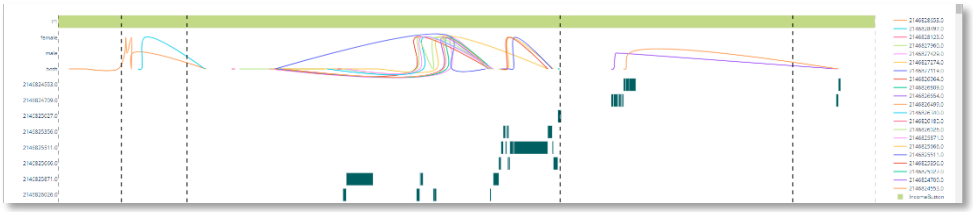

Figure 8: VISID version 3, Individual View alternative design.

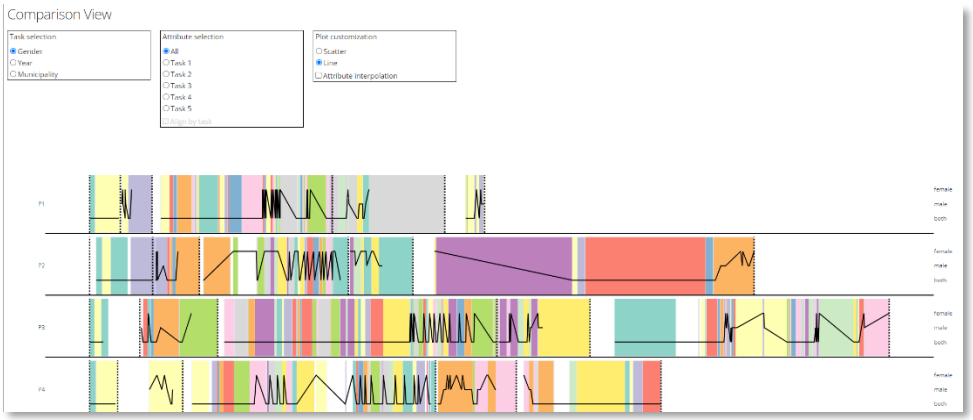

Figure 9: VISID version 3, Comparison View improved.

VISID Version 4 – Algorithmic Support

We initiated the integration of an algorithmic approach, specifically employing Cosine Similarity, into the *Comparison View*. This phase involved experimenting with diverse visual representations, including glyphs, as shown in Figure 10. This exploration aimed to generate insights into how such algorithmic integration could support comparative analysis.

Figure 10: VISID version 4, Comparison View with similarity measure implemented.

Following the implementation of algorithmic support, we experimented with various visualizations to effectively communicate the comparison scores and results, as shown in Figure 11.

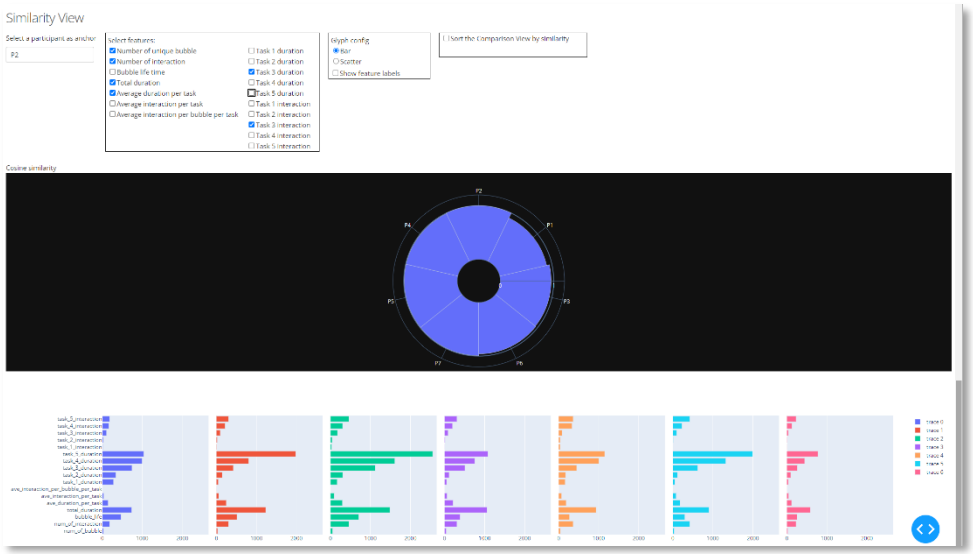

Figure 11: VISID version 4, Similarity View created.

VISID Version 5 – EuroVis Submission

Having determined what to visualize and the extent of customization and control to implement, we undertook significant improvement. We focused on finalizing the system for the EuroVis 2023 submission. Despite these advancements, the *Similarity View* was still underdeveloped in terms of features, leading to the decision to omit it. Nonetheless, the majority were kept and resemble the current version, as shown in Figure 12, 13, and 14.

Figure 12: VISID version 5, Individual View finalized for EuroVis.

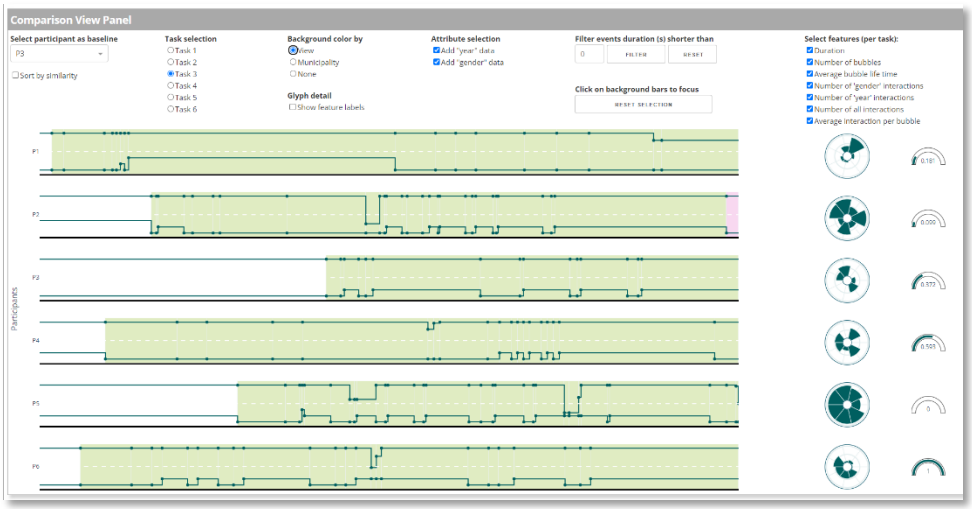

Figure 13: VISID version 5, Comparison View finalized for EuroVis.

Figure 14: VISID version 5, Similarity View discarded.

VISID Version 6 – IEEE VIS Submission

Based on the feedback received from the previous submission to EuroVis, we have made several revisions in line with the reviewers' suggestions. Primarily, we replaced the radial design of the similarity gauges and revised the similarity measure with another algorithm. Additionally, a new cluster view has been implemented.

Following the IEEE VIS submission, we recruited additional participants to perform the experiment with the SiN exhibit, resulting in a total sample size of 20 participants. The complete system is illustrated in Figure 15.

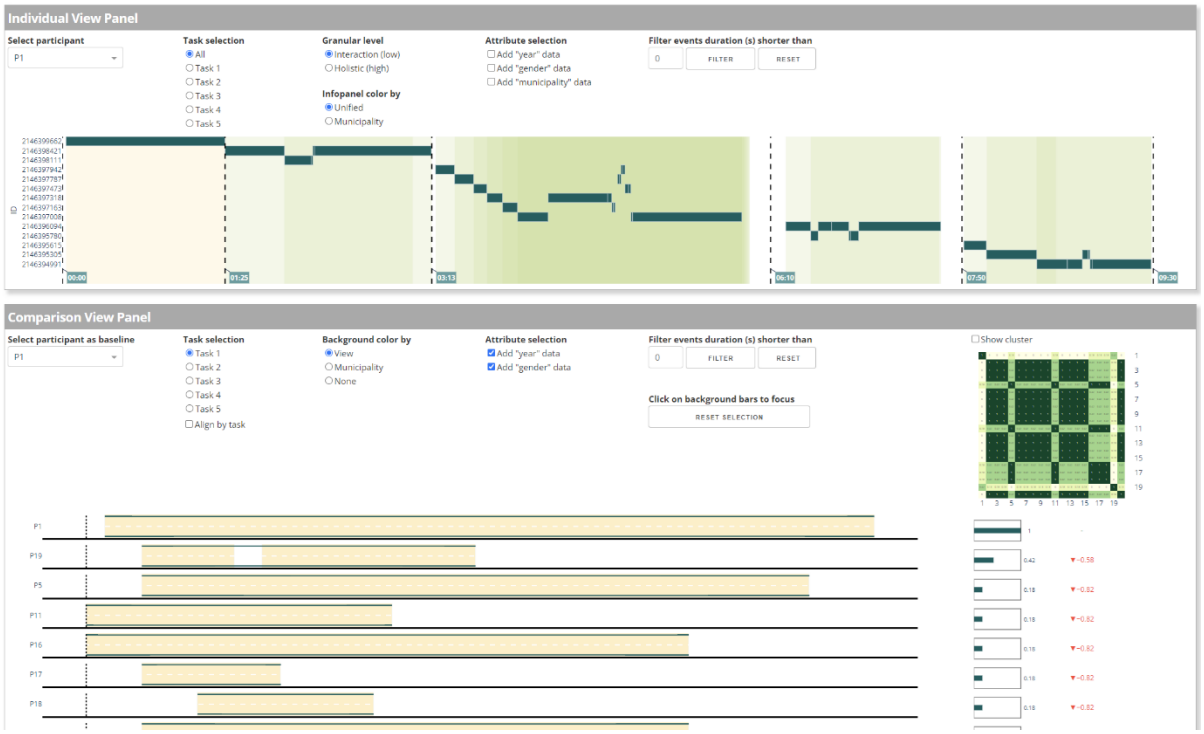

Figure 15: VISID version 6, a full screenshot of the system interface in its default state.

VISID Future Version – Implementation in D3

Other future work includes implementing the proposed prototype system using D3 and making it accessible online. A preview is presented in Figure 16 and 17. In the long term, subsequent updates will be published and made available in repositories on GitHub and OSF. We encourage researchers interested in the latest developments to follow these repositories.

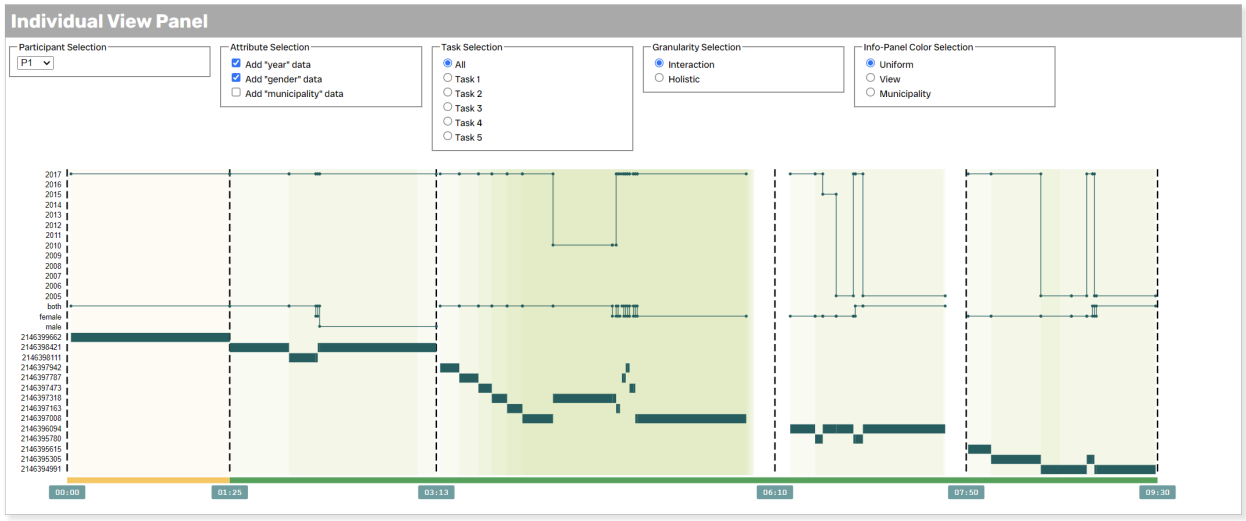

Figure 16: Preview of the VISID3 system, with "year" and "gender" data selected.

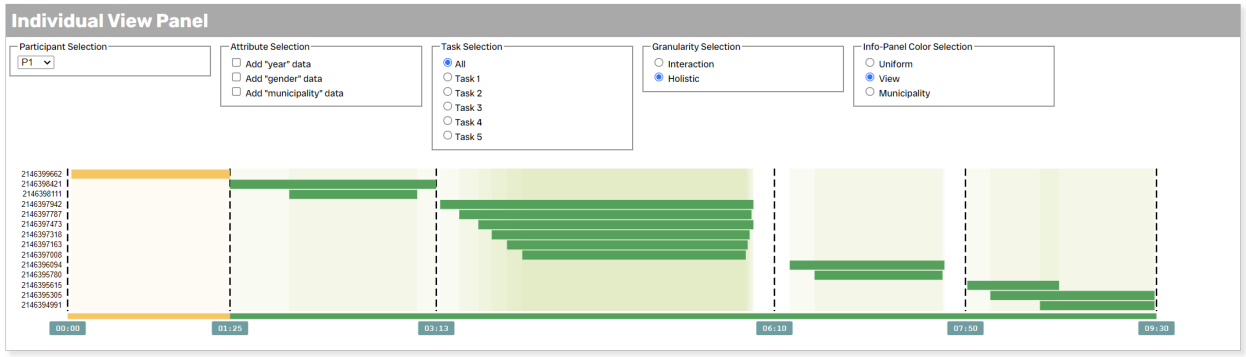

Figure 17: Preview of the VISID3 system, displaying the "Holistic" sequence and colored by "View".