Building a distributed XR immersive environment for data visualization

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Business School
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Session 5: Augmented reality and machine learning for future spatial applications and services

Paper S5.1: Building a distributed XR immersive environment for data visualization
What is Immersive Analytics?

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    • Visual Analytics
    • Virtual Reality
    • Computer Graphics
    • Human-computer Interaction
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  • To support data understanding.
  • For either individual or collaborative decision-making.
What is the problem we study?

• Using mixed-reality immersive technology, how to support more effective and higher quality decision-making in a business context that uses the richer structure of a network data set?
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- Collaboration:
  - Geographical distance, temporal distance
  - Multi-user environment
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• Combination of all these opportunities enhance the level of engagement in data-driven decision-making tasks.
• We conducted lab experiments to investigate the relative performance of subjects in an Aroaro’s IA facility vis-à-vis a traditional 2D data visualization approach.
Aroaro architecture

- Aroaro uses **Unity**.
- The **Microsoft Mixed-Reality Toolkit** is used to provide client services.
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- **Microsoft Azure Cognitive Services** is used for speech-to-text conversion.
- **PlayFab** is a backend tool to provide user management and to store scene objects.
- **Heroku** hosts the code that calculates network measures such as centrality and other degree-based network properties.
Network data visualization

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• Increasingly, more business activities and processes as well as human organizations and business structures can be described as networks.
• Useful features that support our network data visualization take:
  • Optimal spacing of nodes and links in the scene
  • Ability to “fly” around, over, below and into the network
  • Query-oriented menu
Experiment Design

- **Question**: Can a subject make better decisions in an immersive analytics-supported environment than on 2D visual platform?
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  - Aroaro: our XR environment
  - Gephi: a popular network data visualization platform
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  - First 3 questions: **low cognitive effort (LCE)**; remaining 3 questions, **high cognitive effort (HCE)**.
Experiment Snapshot
Results of Experiments:
Time Spent on LCE and HCE questions on each platform
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### Average Quality of Decision

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<thead>
<tr>
<th>Platform</th>
<th>LCE</th>
<th>HCE</th>
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<tbody>
<tr>
<td>Aroaro</td>
<td>0.81</td>
<td>2.21</td>
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<td>Gephi</td>
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<table>
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<tr>
<th>Participant Groups</th>
<th>Questions in Aroaro</th>
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<tbody>
<tr>
<td>Aroaro-first</td>
<td>1.44</td>
<td>1.33</td>
</tr>
<tr>
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<td>1.56</td>
<td>1.42</td>
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Concluding: What can network data visualization do for a decision maker?

- Aroaro’s network data visualization engine:
  - Enhances users’ understanding of relations between nodes and links.
  - Enhances users’ understanding of network connectivity.
  - Helps users to discover hidden information and relations.
- All of the above while providing multiple visual perspectives.
- Our results point at higher quality decisions when decision makers face High Cognitive Effort (HCE) questions.
- Also, it helps decision makers overcome cognitive roadblocks in the process of discovering associations, relations and features of the network data.
Thank you!

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