Exploring the Effects of Scale in Augmented Reality-Empowered Visual Analytics

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Research Questions

Q1. What are the common spatial relationships between the users and the different data visualization components projected onto a physical space?
Q2. How do users dynamically manage such spatial relationships in analytical tasks?
Q3. How would the answers to Q1 and Q2 vary when the Augmented Reality (AR) visualization is presented under different scales?

Approach

We study how users perform logical reasoning tasks on visualizations displayed with two different scales commonly employed by *Microsoft HoloLens*. By applying the think-aloud protocol, we seek to gain knowledge about how users dynamically position themselves with respect to the AR visualization during interactive analytics. For these, we conduct a within-subject controlled experiment with 16 participants (four female, $Mean_{Age}$ = 24.19, SD_{Age} = 3.37).

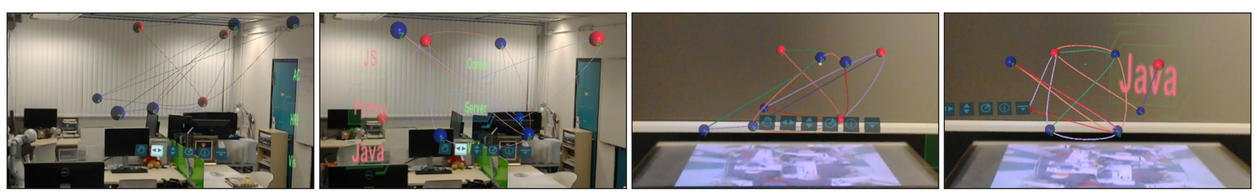
Design Details

Task Design

We design two classic logical reasoning puzzles of different backstories (i.e., a **school laboratory** and a **company office**) with similar level of complexity for all the analytical tasks.

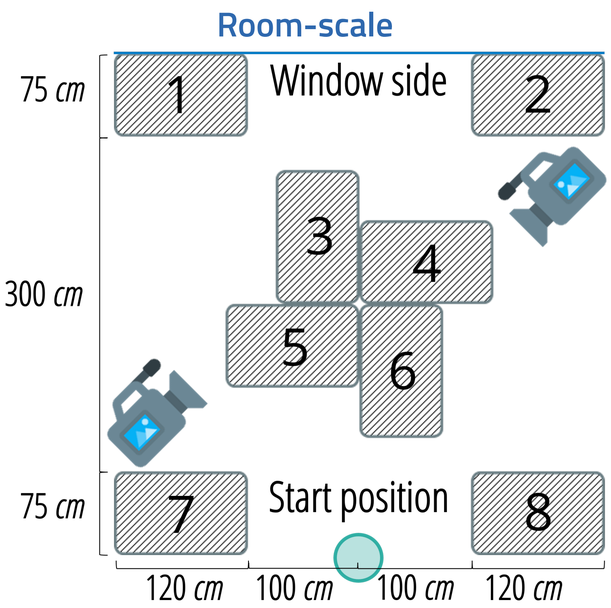
Visualization Design

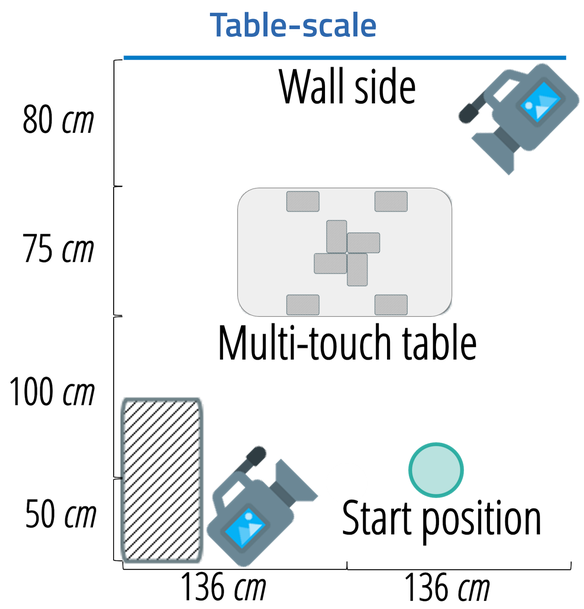
- A 3D node-link graph to visualize the clues.
- Each graph contains eight nodes to represent the characters.
  - Node color encodes the gender;
  - Position encodes the affiliation.
- The links encode the relationships among the nodes.
  - Link color encodes the corresponding features of the relationship.



Scale Design

We identify two commonly adopted size specifications (i.e., the **room-scale** and the **table-scale**) by using existing situated analytical systems in our daily life.





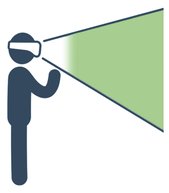
Result Analysis

We explore how scales and visualization design affect users' spatial preferences and exploratory behaviors.

Figurative Space

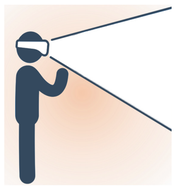
Users reduce the visualization size and manipulate it directly within a wide interaction space.

Vista Space



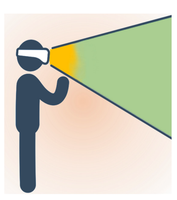
Users access the visualization by stretching visual elements and/or moving their position.

Panoramic Space

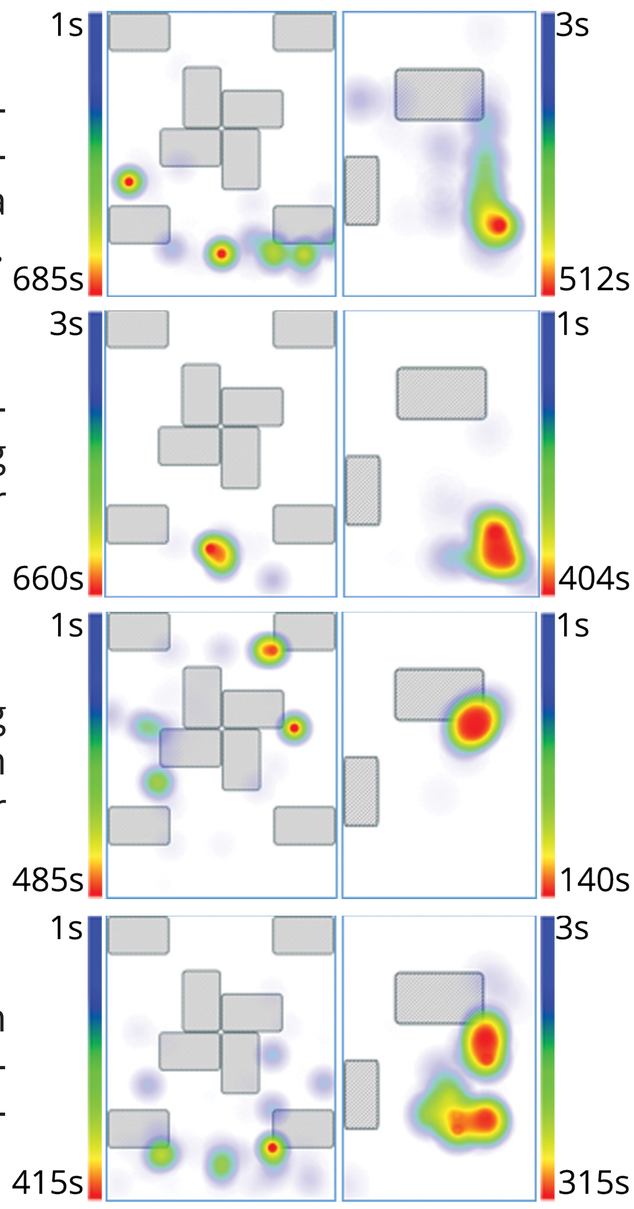


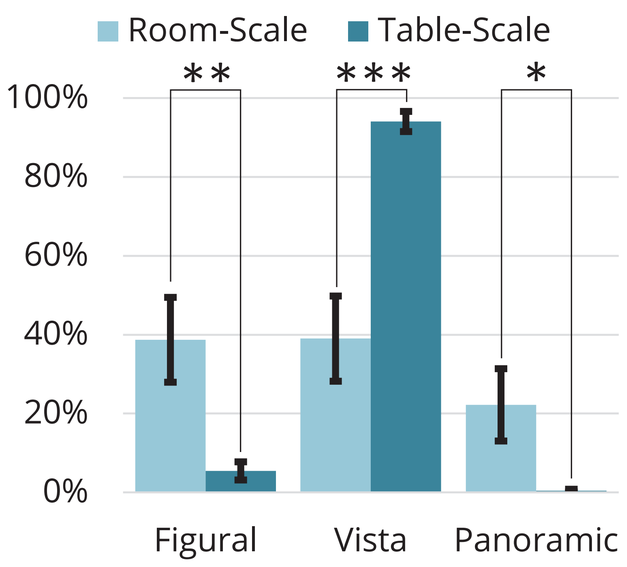
Users enjoy stepping into the visualization area to have a greater feeling of immersion.

Mixed Space



Users adopt more than one of the three spatial arrangements discussed above.





We identify three types of spatial arrangements (i.e., **figurative**, **vista**, and **panoramic** space) adopted while exploring the visualization in an AR environment.

Percentage (with standard error) of time spent in each spatial arrangement based on video coding.
***: $p \le 0.001$;**: $p < 0.05$;*: $0.05 \le p < 0.1$.

Conclusion

By investigating how users spatially interact with an AR visual analytical system in room- or table-scale, we identify:
1. the user preferences for spatial arrangements in different scales;
2. the pros and cons of conducting visual analytics in various interaction spaces.

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