

Towards a Better Understanding of Graph Perception in Immersive Environments

Lin Zhang, Yao Wang, Ying Zhang, Wilhelm Kerle-Malcharek,
Karsten Klein, Falk Schreiber, Andreas Bulling

University of Stuttgart and University of Konstanz

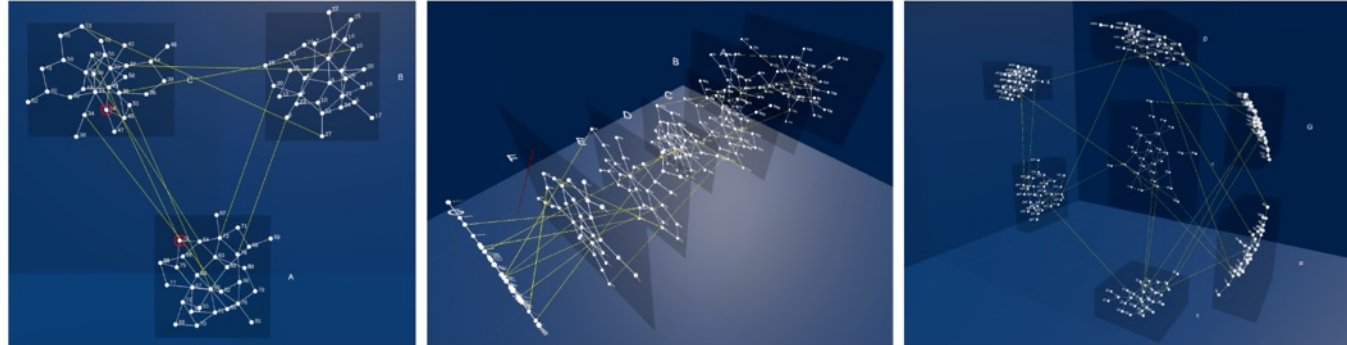
Research Background & Motivation

Towards a Better Understanding of Graph Perception in Immersive Environments

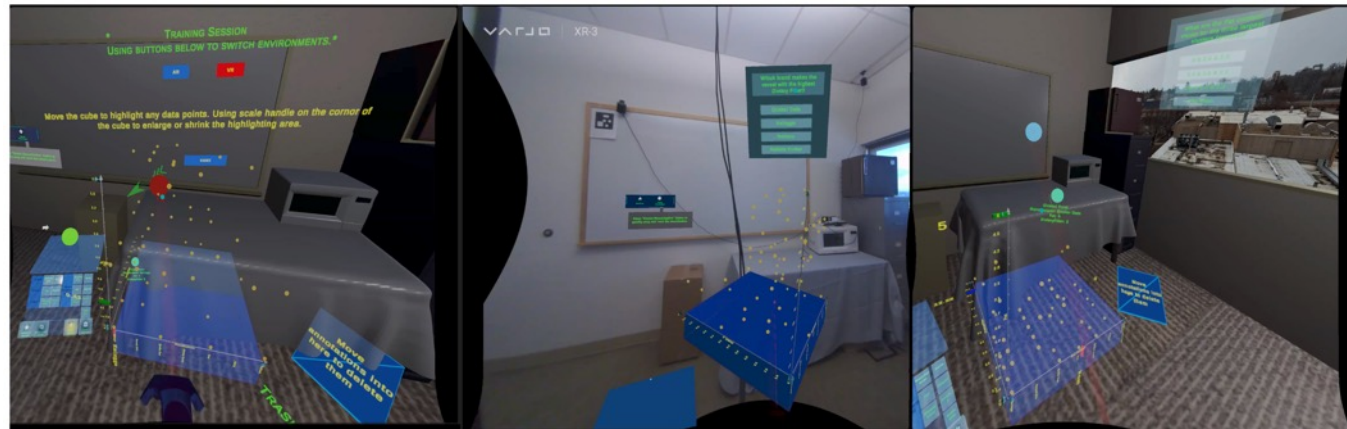
Immersive Analytics



[Whitlock et al., 2020]



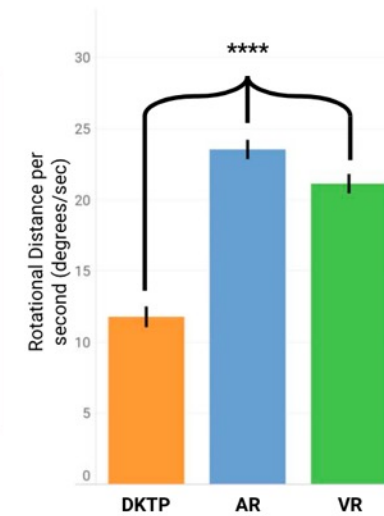
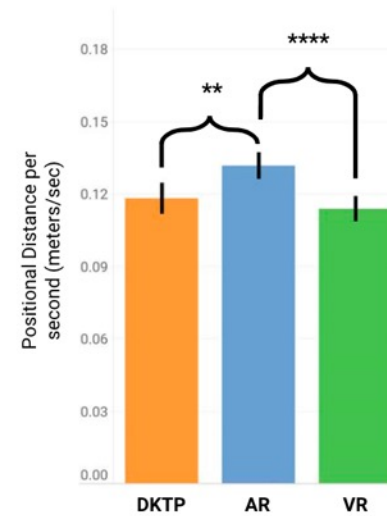
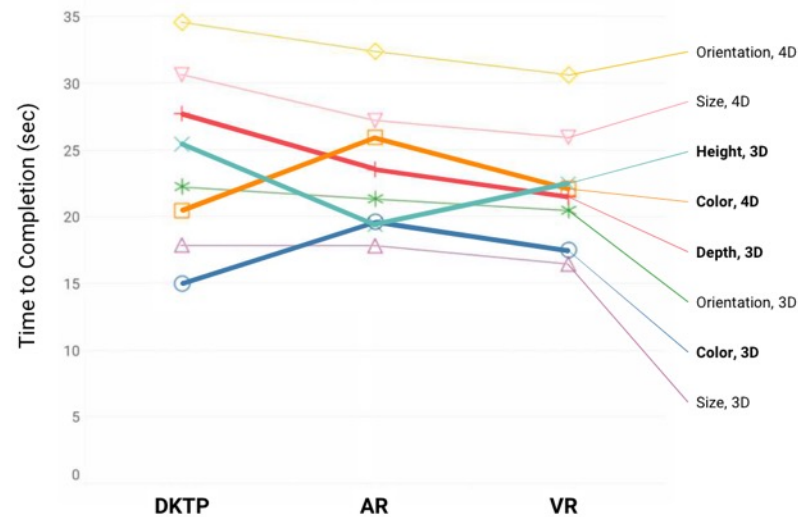
[Feyer et al., 2024]



[Zhou et al., 2024]

Previous works measured:

- Task accuracy
- Task completion time
- Head movements



[Whitlock et al., 2020]

but NO previous works have examined...

- which graph component(s) participants look at during what period of time **Temporal distribution of visual attention**
- which graph component(s) received the most visual attention overtime **Spatial distribution of visual attention**

Knowing where participants looked at is crucial for...

- using gaze metrics as indicators of the **influence** of different **graphs** and **tasks** to human perception
- calculating **temporal** and **spatial** distribution of visual attention
- identifying the graph reading strategy

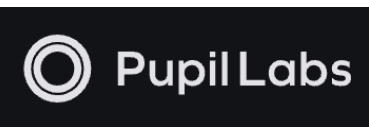
Study Design

Towards a Better Understanding of Graph Perception in Immersive Environments

Immersive Environment:



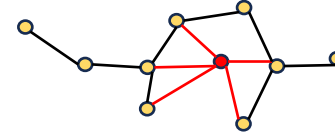
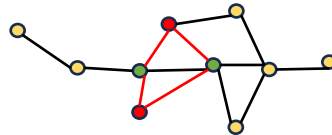
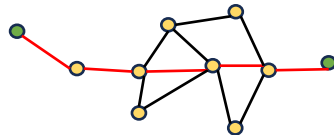
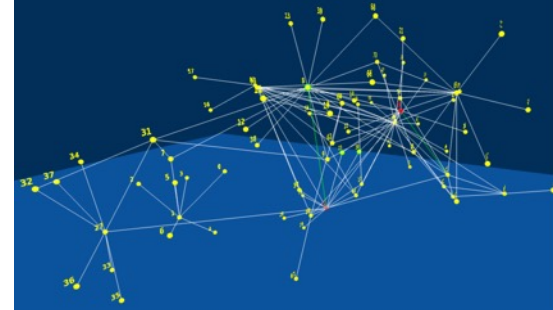
Hardware:

- Quest 3  Meta
- NeonXR eye tracker 

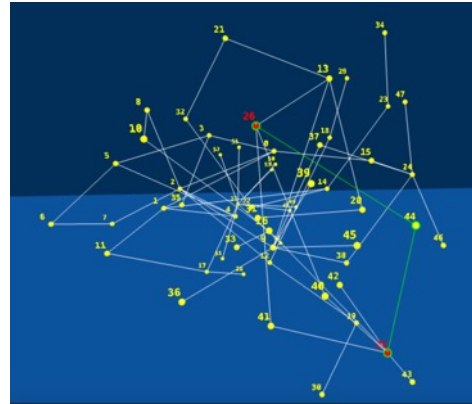
Graph

X

Task

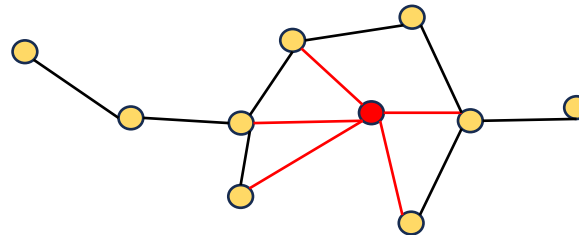
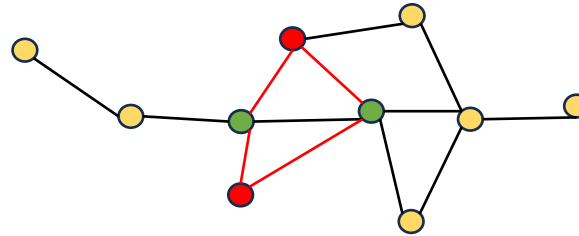
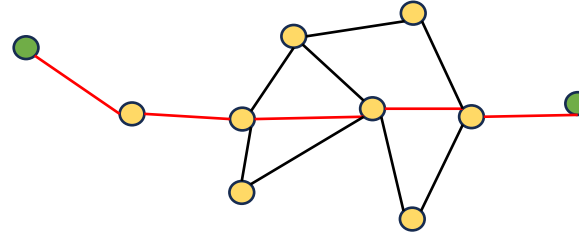


Graph Selection

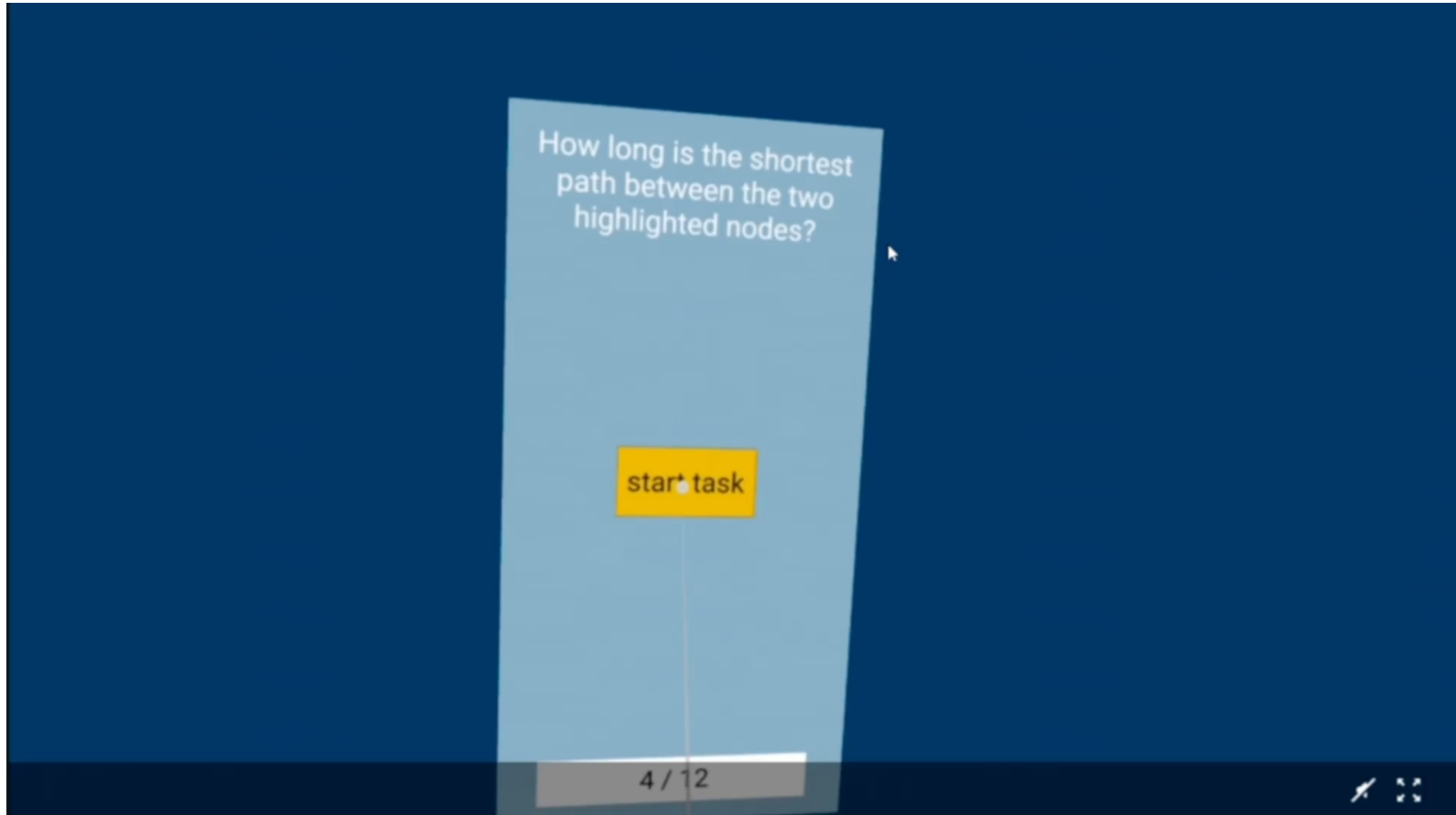


Name	Edit-bmwikiquote (G_{ed})	Synthesised (G_{sy})	Iceland (G_{ic})
Nodes	56	50	75
Edges	65	100	115
Mean Degree	2.32	4	3.04
Diameter	11	6	6
Mean Clustering Coefficient	0 (<i>bipartite</i>)	0.07	0.286
Mean Shortest Path	3.19	2.86	5.2

- Shortest path
- Common neighbours
- Highest node degree



Study Environment



- Task Correctness
- Task Completion Time
- **Task Fixation Ratio**
 - With annotated task-related graph components under each task
- **Gaze statistics**
 - Saccade length
 - Saccade velocity

- H1: graph & gaze behaviour
- H2: task type & gaze behaviour

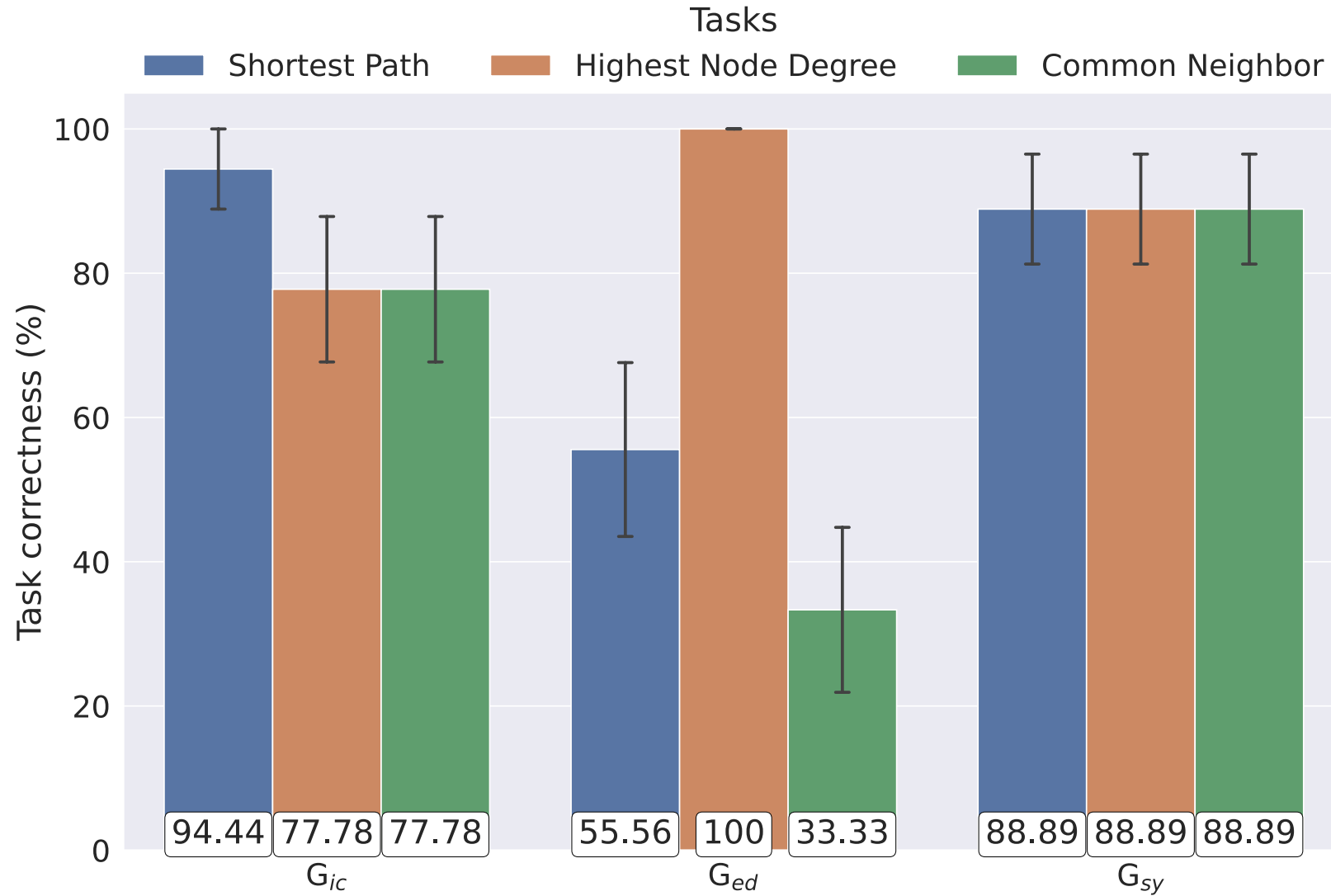
Sub-hypotheses on Gaze Behaviour Metrics:

- a: Saccade velocity
- b: Saccade length
- c: Task-related fixation ratio

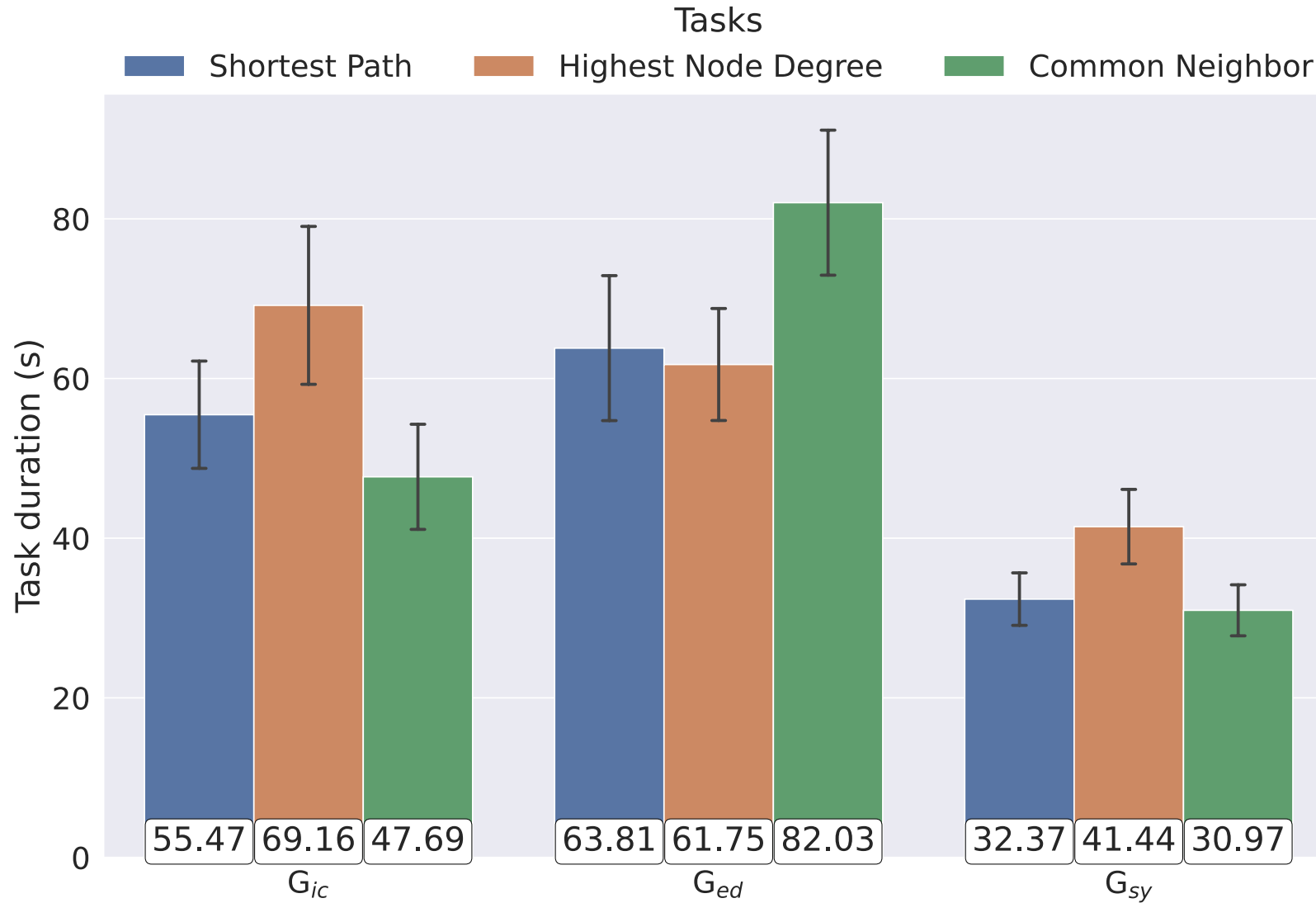
Results

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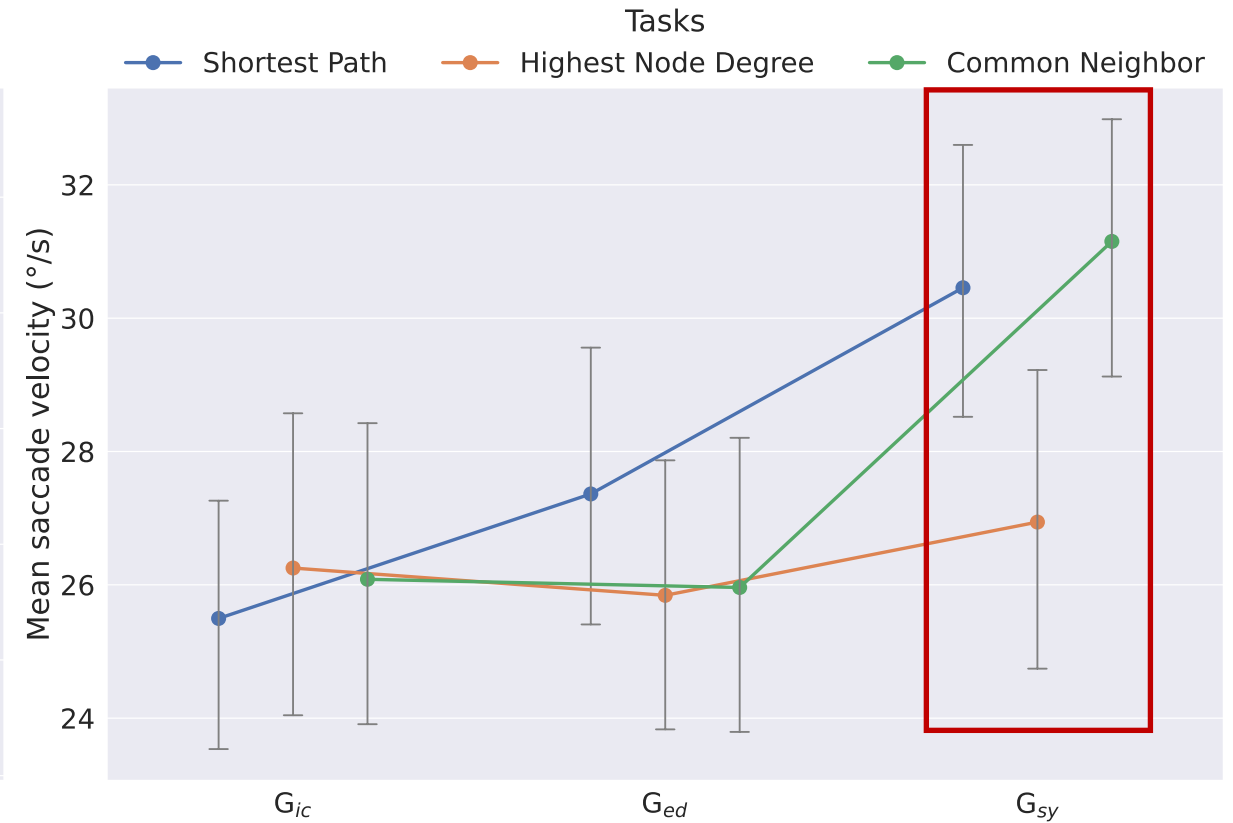
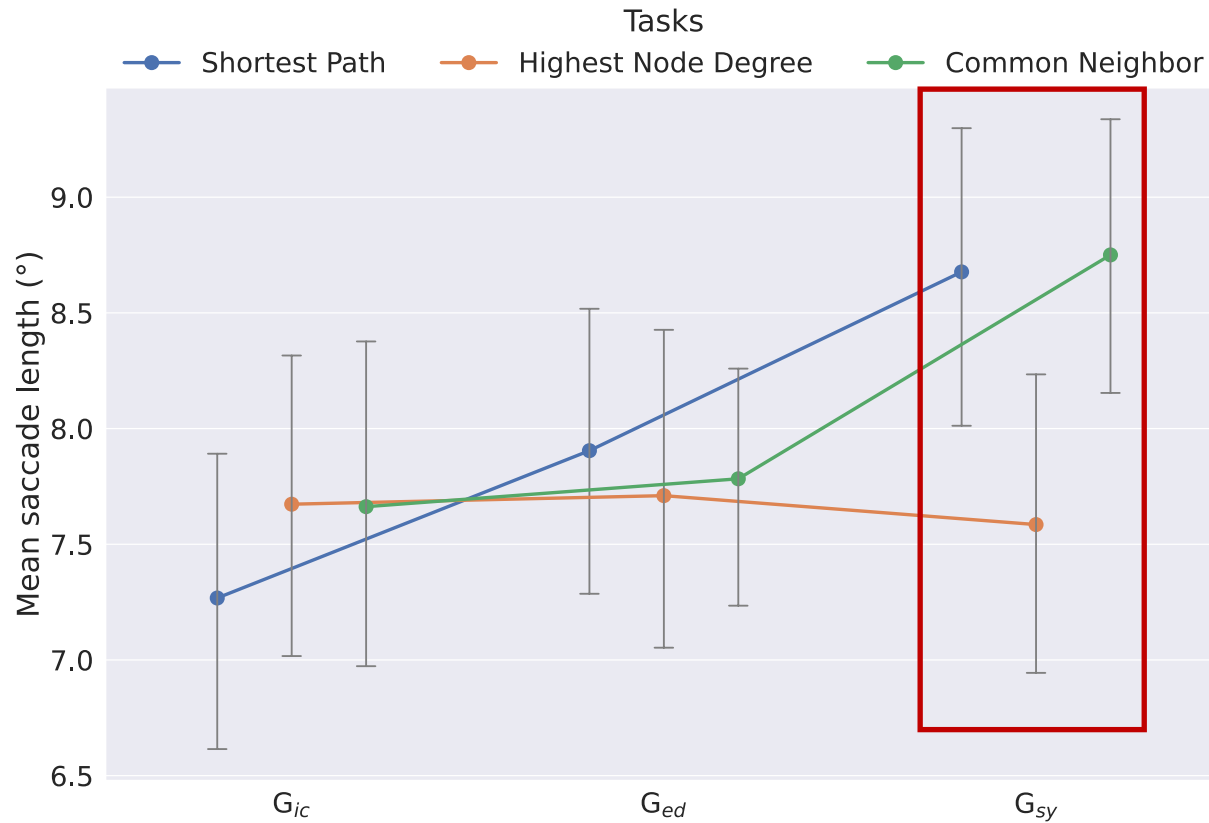
Task Correctness



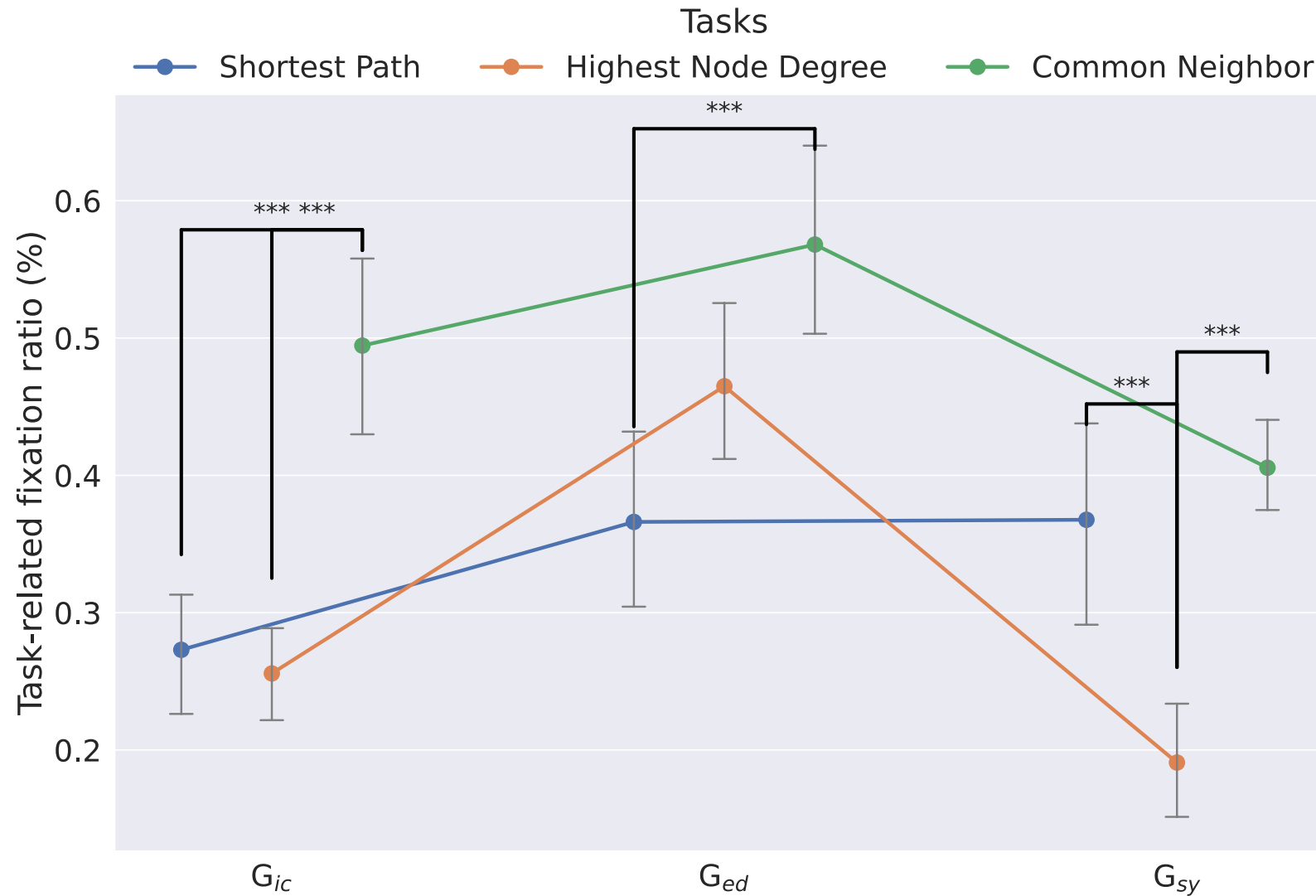
Task Completion Time



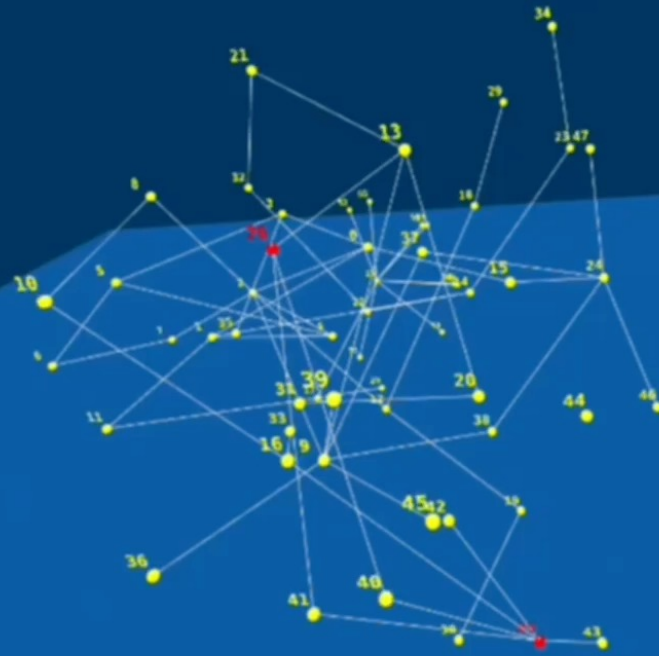
Saccade Length (H1.a, H2.a) and Saccade Velocity (H1.b, H2.b)



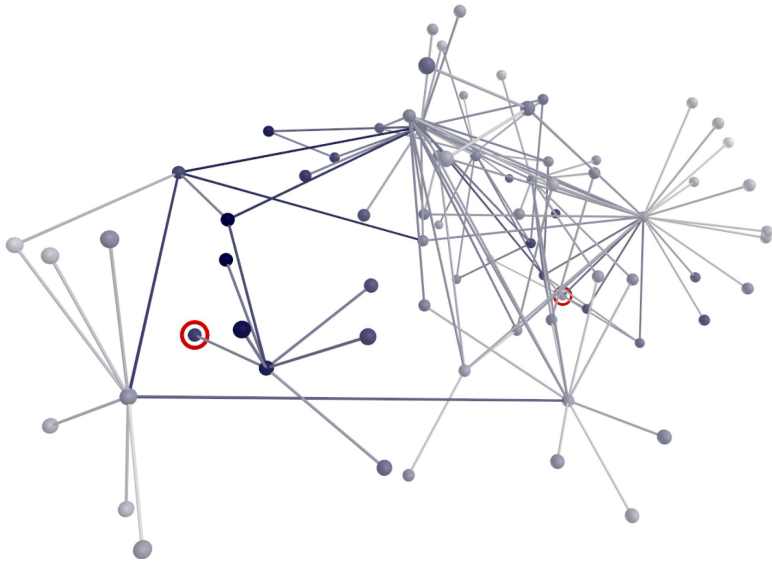
Task-related Fixation Ratio (H1.c, H2.c)



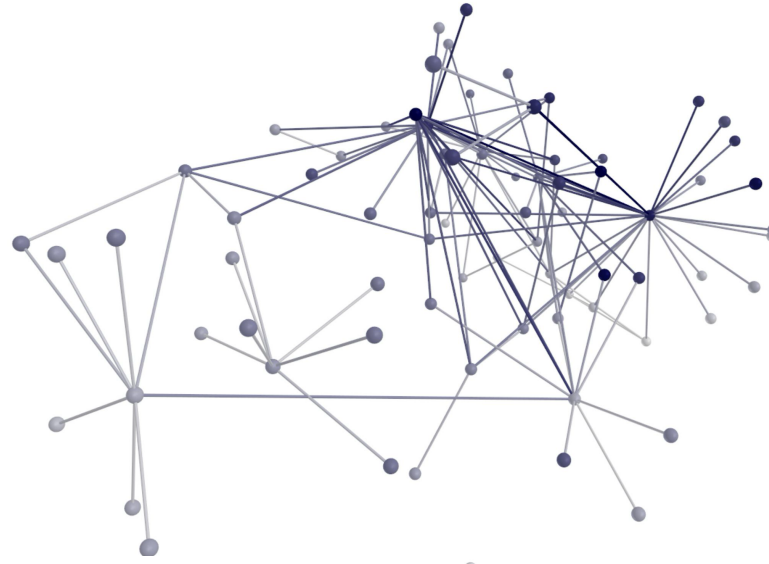
Common Neighbour



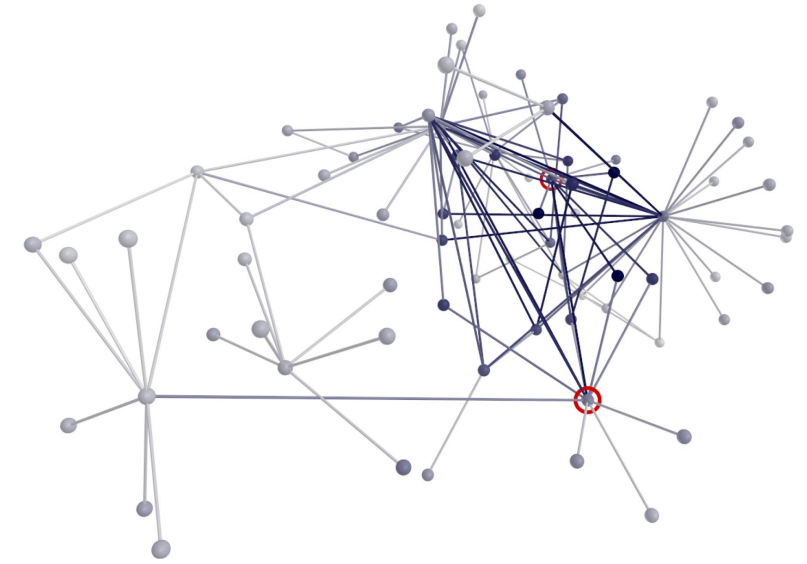
Graph Visual Saliency



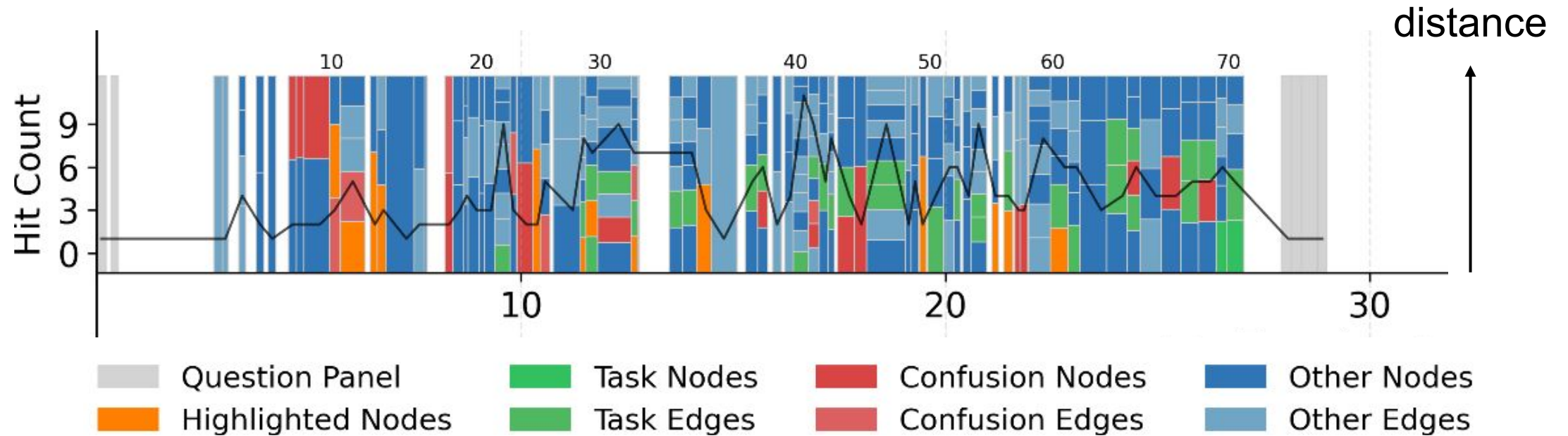
Shortest path



Highest node degree



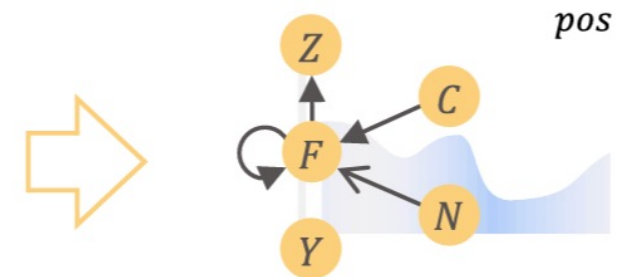
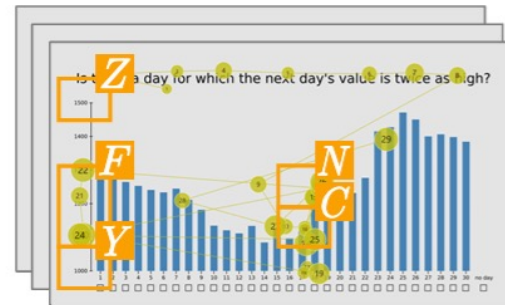
Common neighbours



- Attention gradually shifted from highlights (orange) / confusions (red) to answers (green)

- Different **tasks** significantly influence human perception on s3D graph visualisations
- **Eye tracking** metrics can serve as objective measures of **cognitive load** and **visual complexity** in exploring graphs
- Gaze **Scarfplot** and Visual **Saliency**: temporal and spatial distribution of visual attention

- Invited to TVCG journal extension
- More analysis on graph reading strategies
- Enhancing graphs by gaze behaviours (sequential visual cues)
- Follow-up eye tracking study on enhanced graphs



[Schlieder et al., 2025]

Any questions?



Yao (Marc) Wang

yao.wang@vis.uni-stuttgart.de

<https://www.collaborative-ai.org/people/wang/>