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VIRGINIA TECH

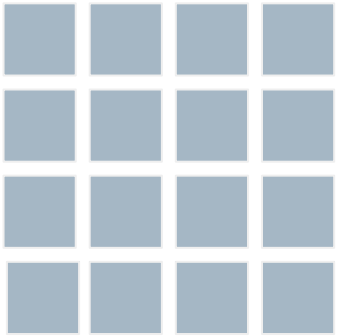
# Evaluating the Benefits of Explicit and Semi-automated Clusters for Immersive Sensemaking

**Ibrahim A Tahmid,**

Lee Lisle, Kylie Davidson, Chris North, Doug A Bowman

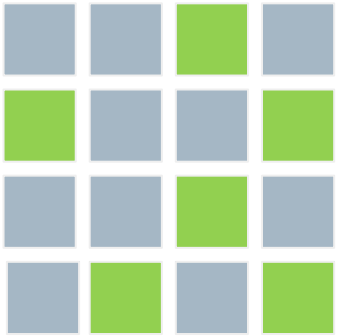
IEEE COMPUTER SOCIETY vgtc

# Sensemaking



Raw Data

# Sensemaking

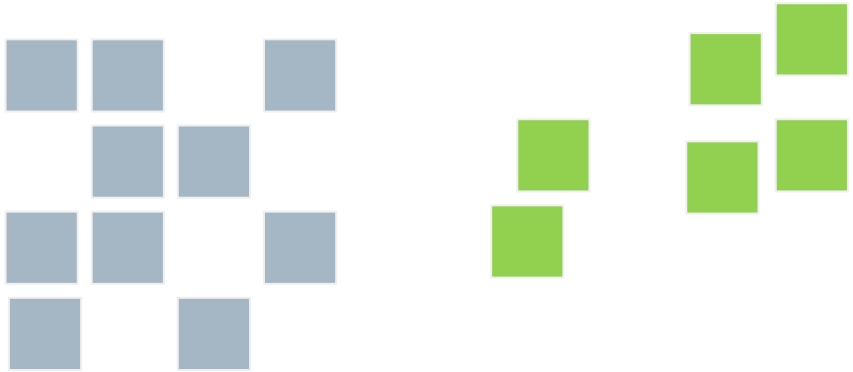


Identify

# Sensemaking

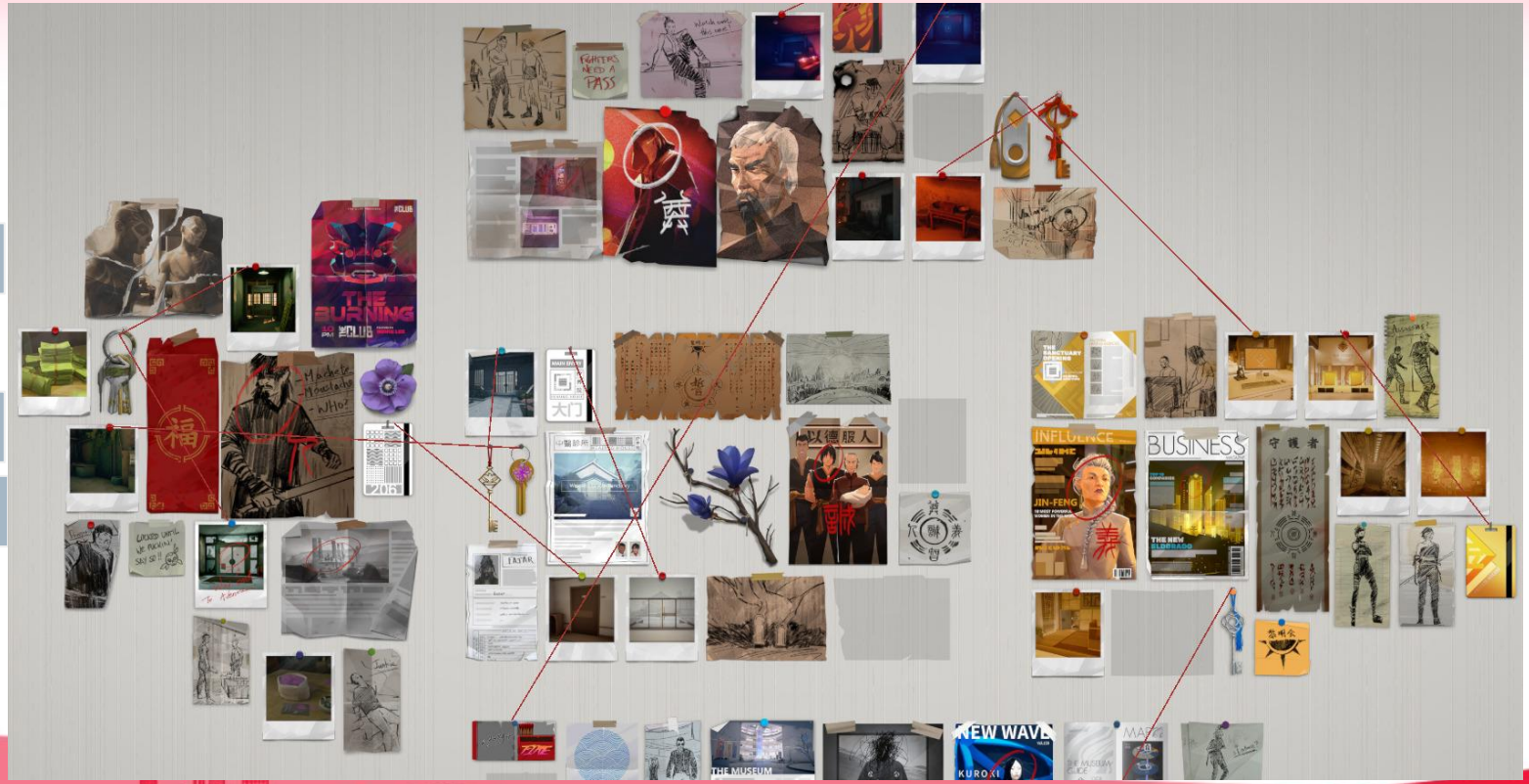
Extract

# Sensemaking



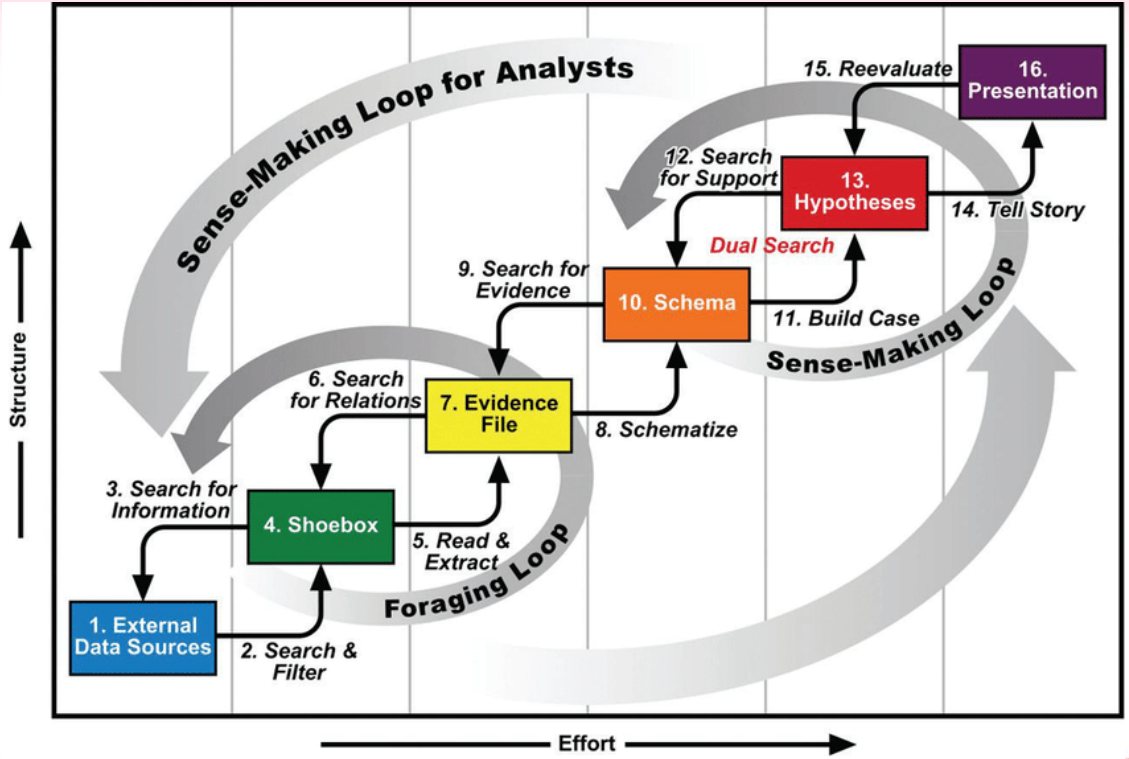
Organize

# Sensemaking



# Sensemaking

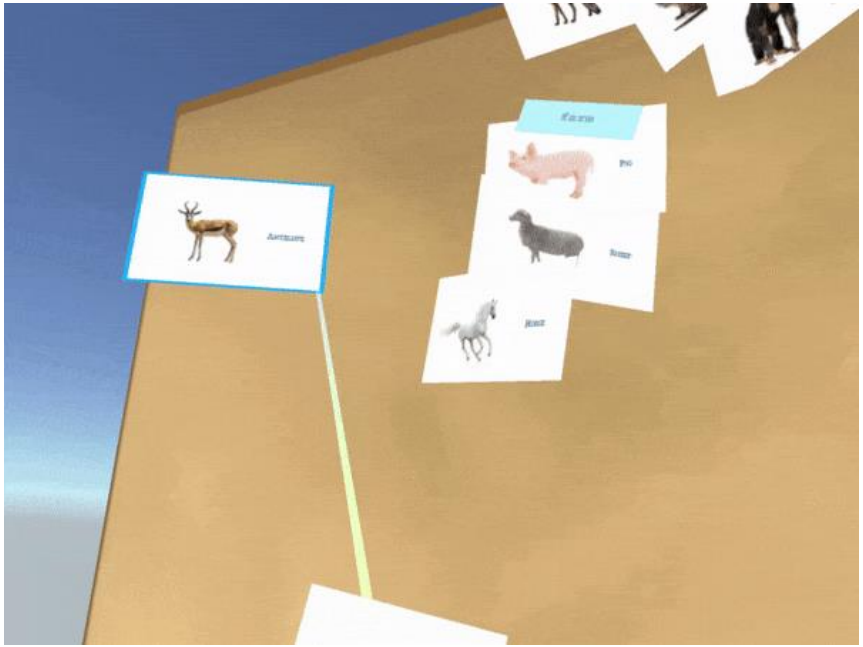
- Sensemaking loop by Pirolli & Card
- Effort => Structure
- The process is cognitively stressful
- What if the visual analytic system could share some of that stress?



# Prior Work on Immersive Space to Think

Users tend to create 2.5-dimensional spatial structures in the immersive space

- Clusters of documents on 2D planes
- 2D planes are spread on different depths



# Design Approach

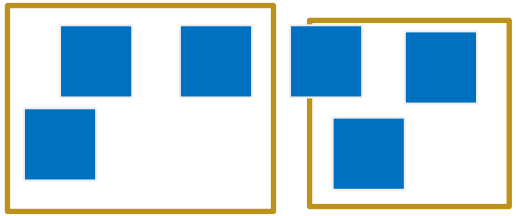
## CLUSTERS

Visualize and Interact with Explicit Clusters

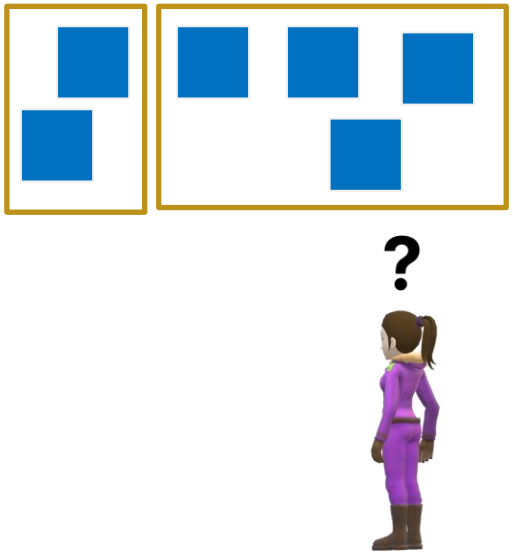
## SYSTEM ASSISTANCE

Human-AI Collaboration to Create Clusters

# Design Approach



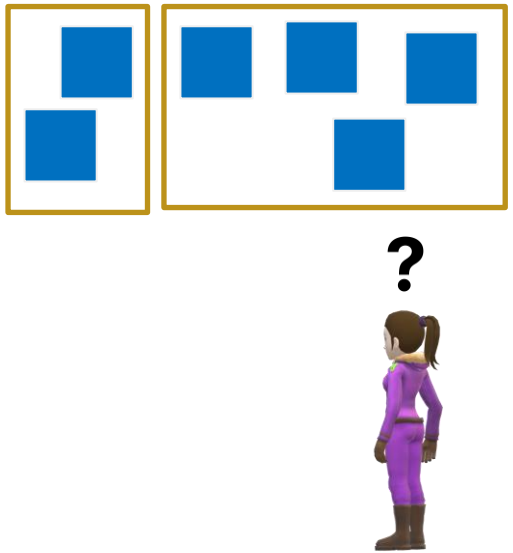
# Design Approach



# How Much Automation?

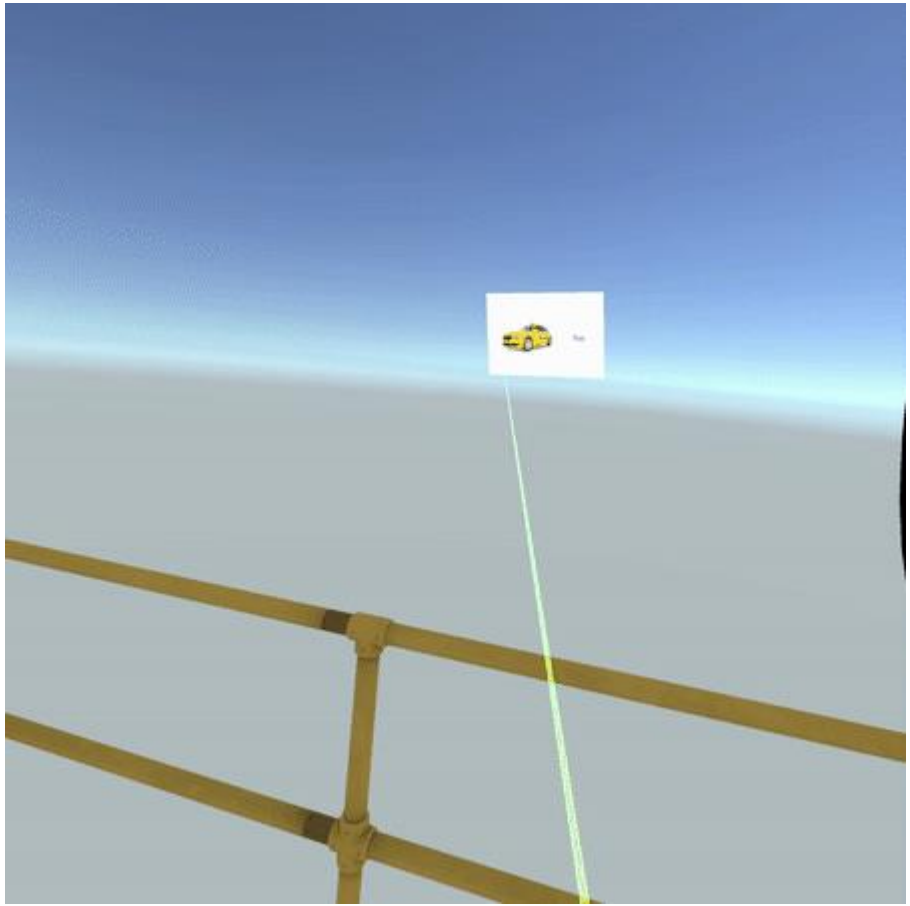
Pilot Study with Full Automation

- Algorithm outputs did not match user intentions
- Users were left **confused** and frustrated
- Spent more time on fixing **unwanted spatial structures** than the actual sensemaking process



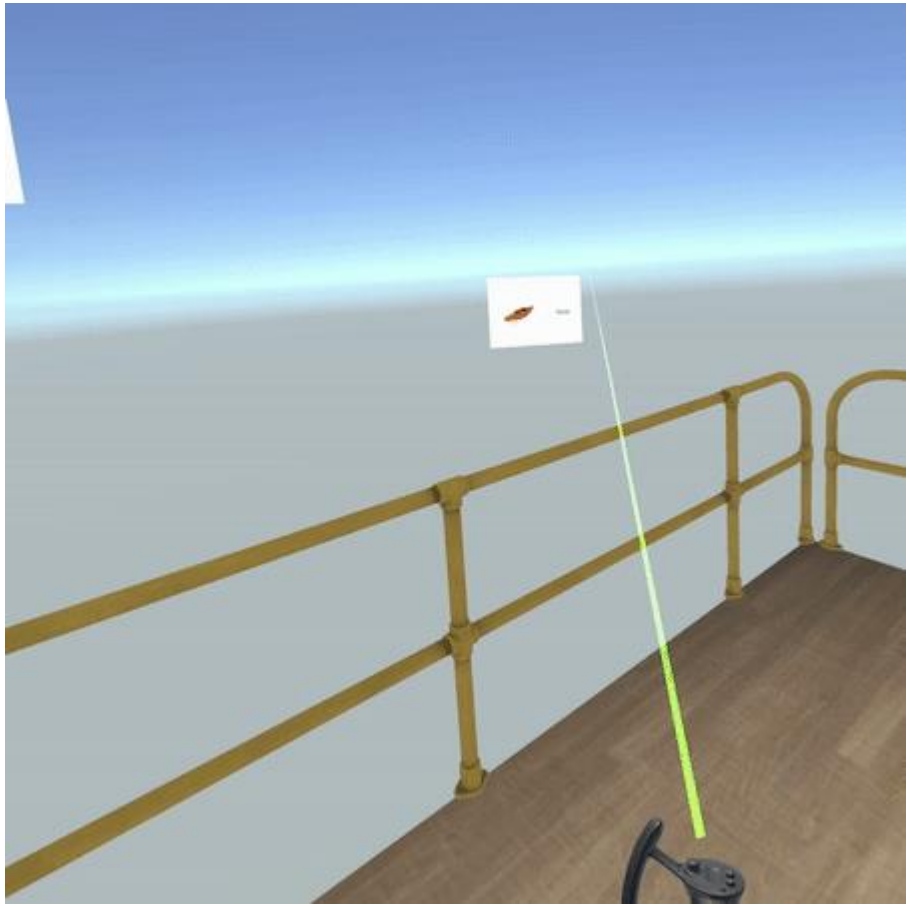

Semi-automated cluster assistance tool

- Assist in creating the clusters
- User controls everything else



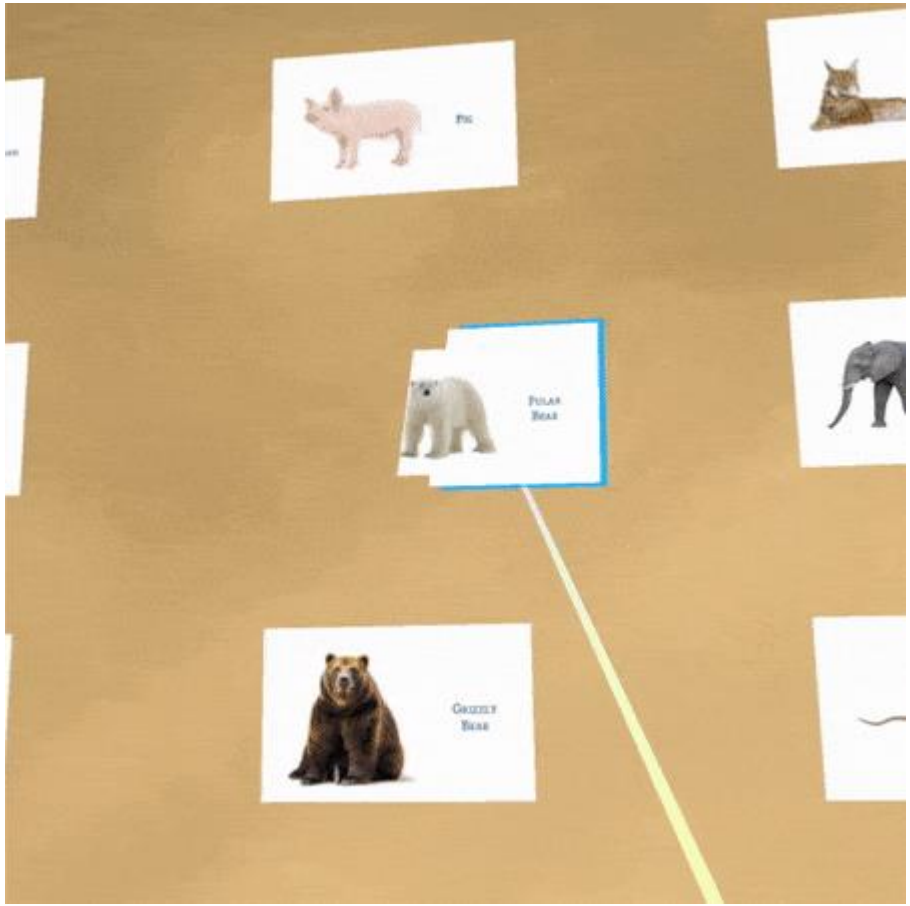
# PROXIMITY

Create clusters
with nearby documents using
Bayesian Gaussian Mixture Model



# OVERLAP

Create clusters
by overlapping two documents

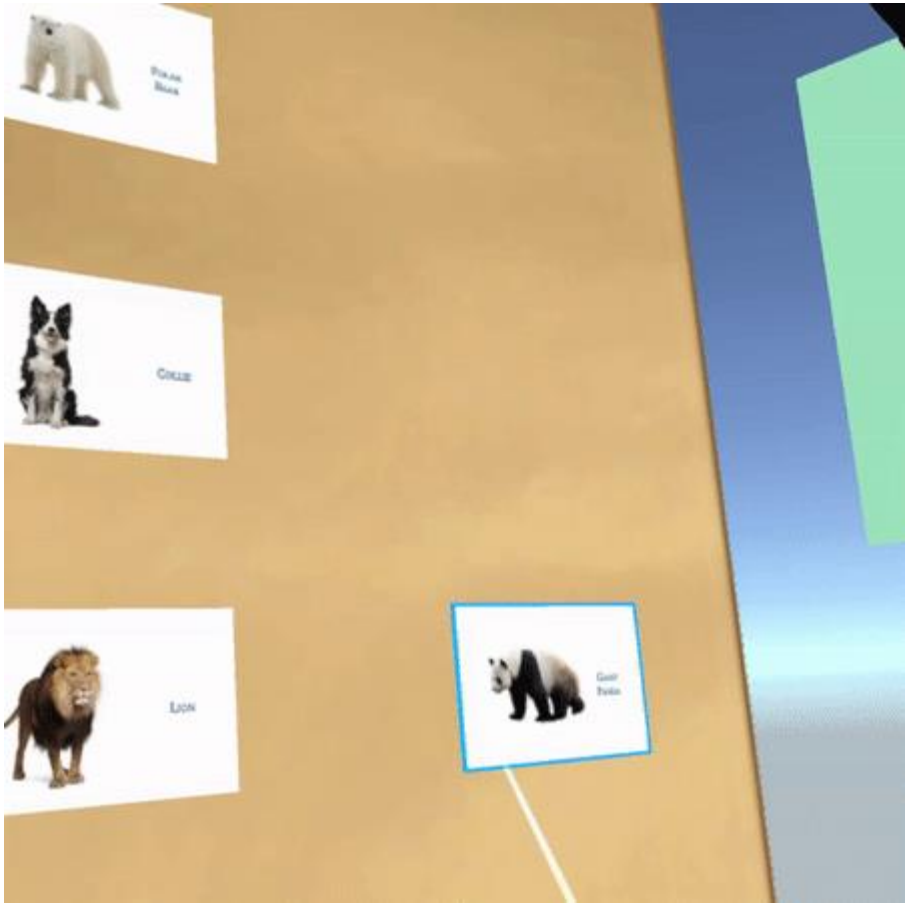



# FREESTYLE

No explicit clusters

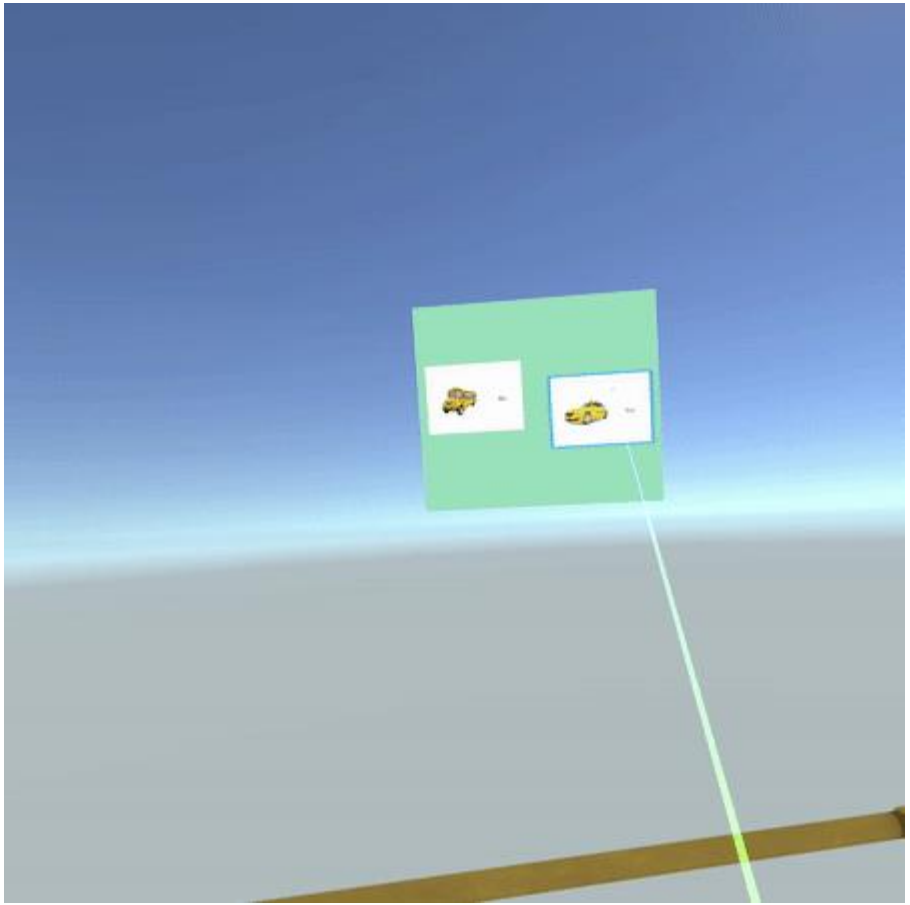
# CLUSTER INTERACTION

Extend clusters



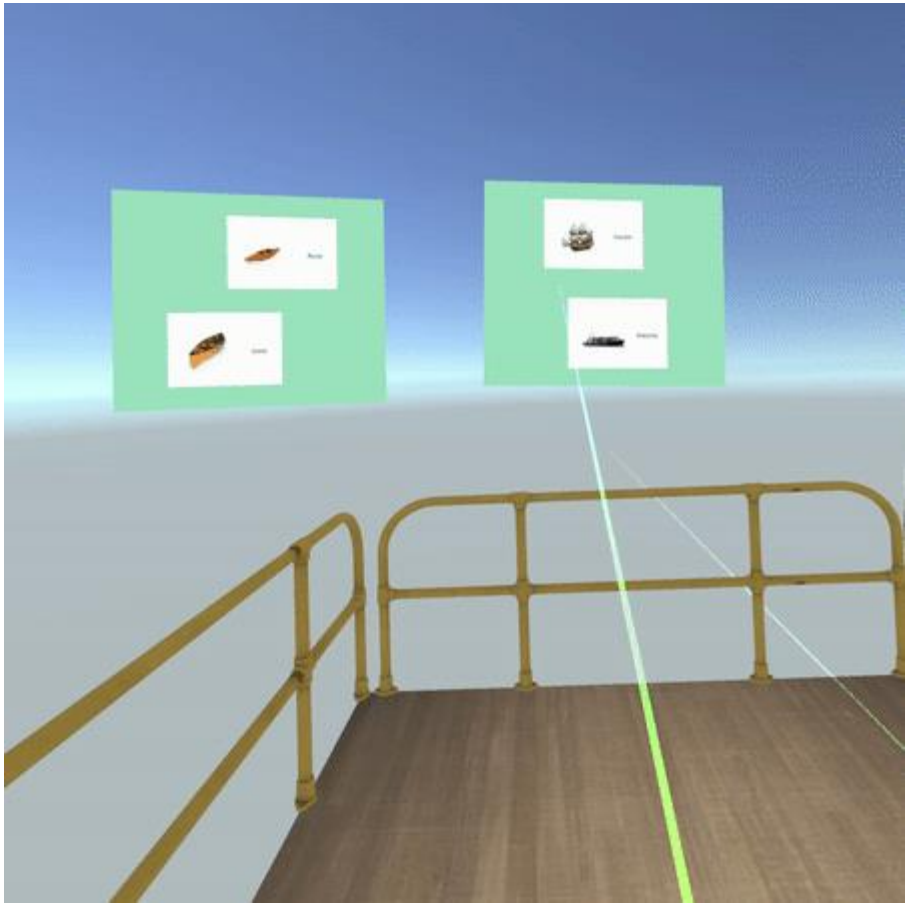
# CLUSTER INTERACTION

Remove clusters



# CLUSTER INTERACTION

Merge clusters



# RESEARCH QUESTIONS

01

RQ1

How does an explicit clustering feature help analysts organize an immersive workspace?

02

RQ2

What are the benefits and challenges of having semi-automated clusters in an immersive visual analytic system?

# User Study

## PARTICIPANTS

Within-subject study
27 participants (10F)
6 with no prior VR experience

## DATASET

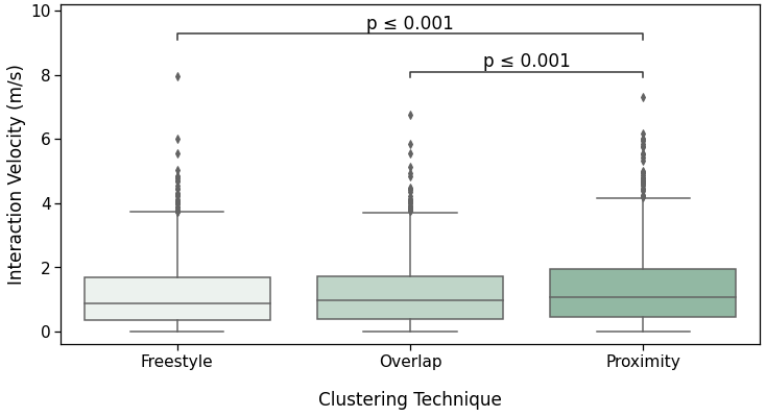
3 sets of 30 images (Foods, Animals, Vehicles)
Given in two session, 15 for each session

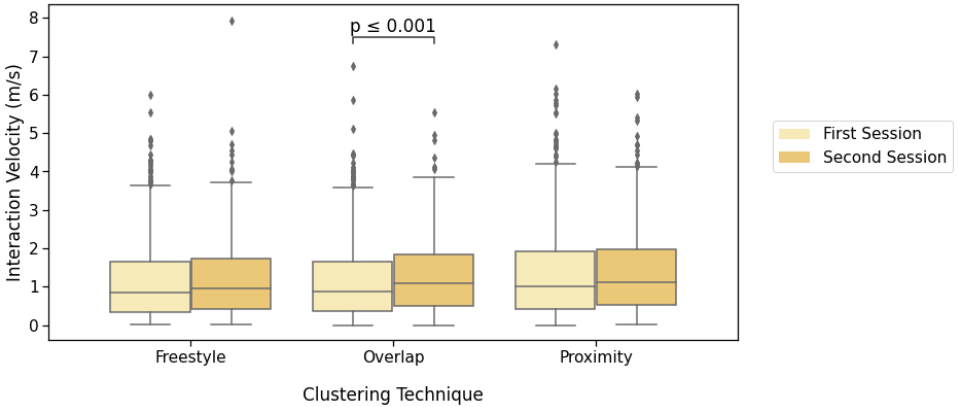
## TASK

Organize an exhibition space
with 3-8 clusters in 10 minutes

# Results

**H2a:** Explicit clusters would make analysts faster (Partially supported)

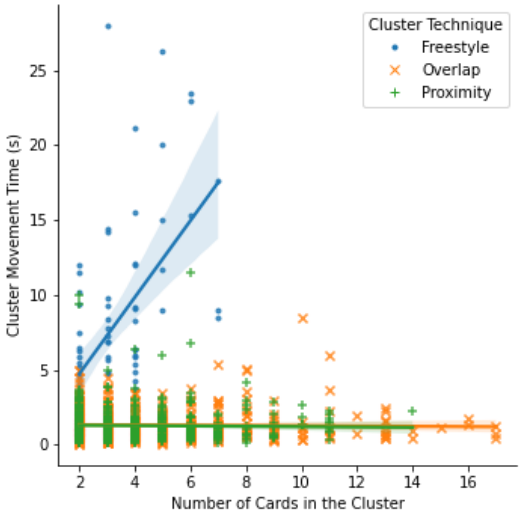


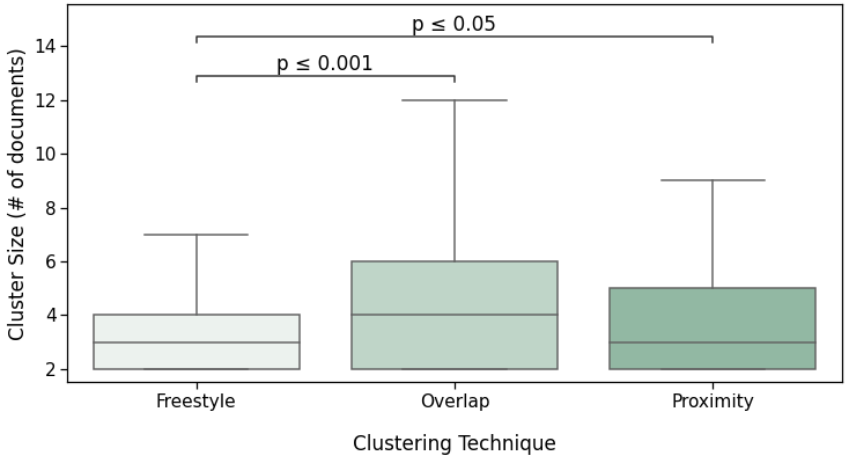




Proximity made participants faster
Overlap needed some time getting used to

# Results

**H2b:** Explicit clusters would speed up the process of reorganizing workspace (Supported)

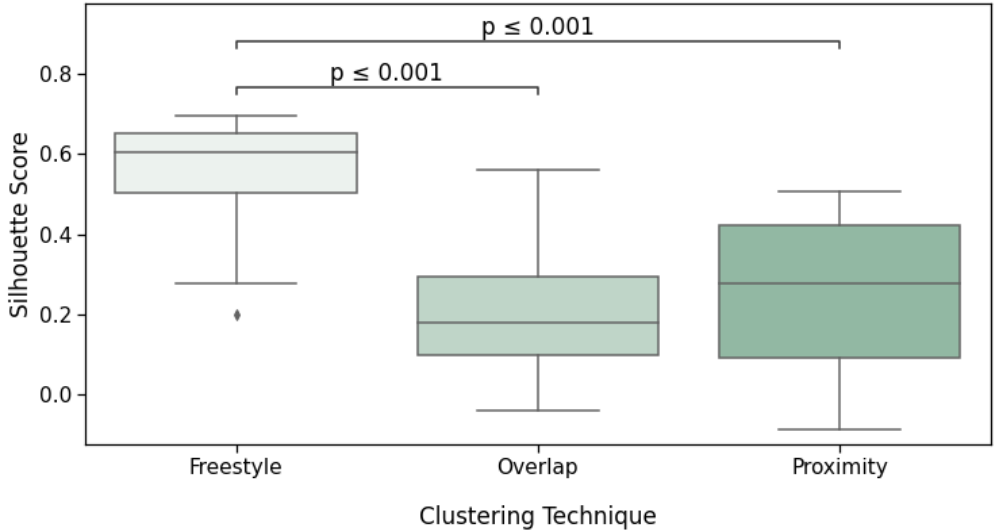



Cluster movement time stays constant for both Overlap and Proximity
Participants tend to create bigger clusters

# Results

**H2c:** Explicit clusters would make the final layouts less ambiguous (Partially Supported)




Participants used a tighter space in Overlap and Proximity

# Results

**H3:** Participants would prefer having more control over the clusters rather than depending on the semi-automated technique (Not Supported)

75% participants preferred Proximity over Overlap

> *“It [Proximity] was as easy as Freestyle, with the added benefits of the explicit clusters*

> *“As long as the cards were close enough, they grouped themselves. I was able to organize them much quicker.*

# User Preferences

Three participants were frustrated with Proximity because of losing control, deviation from user intent

Nine participants preferred Overlap as that gave them full control over their workspace

Even Freestyle was chosen by three participants who liked the amount of creativity it offered

- Having explicit clusters in the immersive system improved user interaction efficiency
- Semi-automated clusters made things easier, but lacked control
- Future work: Improving the semi-automated system with **better control**, and offering **more creativity** to the analysts
- Future work: Other semi-automated features needed for sensemaking in immersive space: **auto-labelling, sub-clusters, auto-alignment.**

# KEY TAKEAWAYS

# THANK YOU!

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