V2-26: High-Productivity Analytics

Mission-Critical Computing
NSF CENTER FOR SPACE, HIGH-PERFORMANCE, AND RESILIENT COMPUTING (SHREC)

SHREC Annual Workshop (SAW25-26)

University of Pittsburgh
BYU BRIGHAM YOUNG UNIVERSITY
VIRGINIA TECH
UF UNIVERSITY of FLORIDA

January 13-14, 2026

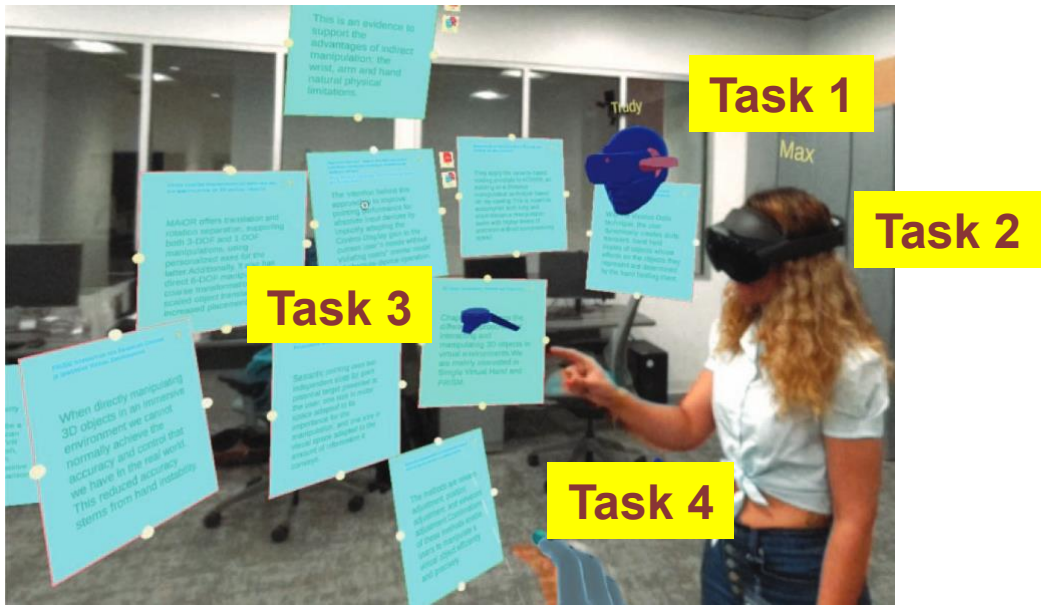
Faculty: Chris North, Doug Bowman
(Professors of Computer Science at Virginia Tech)

Students: Cherelle Connor, Wei Liu, Ayush Roy, Xuxin Tang

Number of requested memberships ≥ 4

V2-26 Tasks

- Task 1: Collaborative Immersive Analytics (Ayush Roy)
- Task 2: Cognitive Load in Immersive Analytics (Cherelle Connor)
- Task 3: Steerable Interactive Projections (Wei Liu)
- Task 4: Interactive Sensemaking with LLMs (Xuxin Tang)



Task 1 : Collaborative Immersive Analytics

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Ayush Roy

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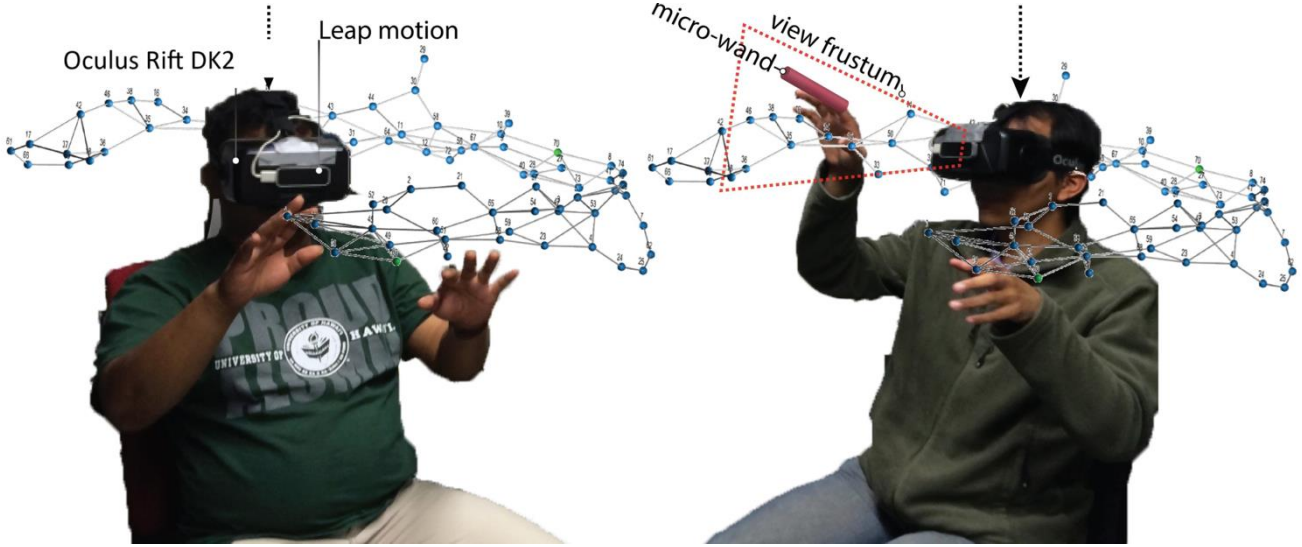
Study Plan

- How well does Space to Think enable asynchronous collaborative hand-off of sensemaking progress?
- What spatial strategies and encodings are most/least helpful?

- Workflow:
  - Analyst A: Initial sensemaking
  - Hand-off → Analyst B
  - Analyst B: Continues sensemaking
  - Hand-off → Analyst A
  - Analyst A: Final synthesis



Task 2 : Characterizing Cognitive Load in Immersive Spaces to Think

Cherelle Connor

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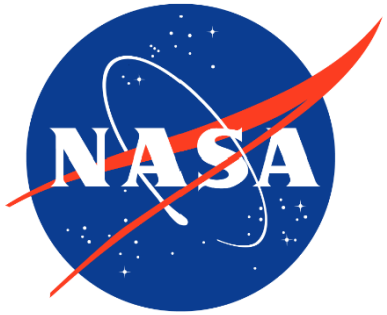
Understanding Cognitive Load in IST

- Poorly managed CL
  - Reduced attention
  - Slow information processing and reduced task performance

- Well managed CL
  - Improve task efficiency and task performance
  - **Important first step needed for identify mitigation strategies including:**
    - Summation
    - Minimizing distractions
    - Recovery intervals

Cognitive Load

- NASA TLX
  - Six subfactors:
    - Mental, Temporal, Physical, Performance, Frustration, Effort
  - Self-report administered post-task completion
  - Susceptible to recall bias
  - No continuous information provided



https://www.nasa.gov/history/symbols-of-nasa/

- Physiology data
  - Can provide objective, continuous measurements
    - Heart rate variability (HRV)
      - HRV ↓, CL ↑
    - Galvanic skin response (GSR)
      - GSR ↑, CL ↑
    - Eye-tracking
      - Blinks, fixation, pupil dilation
  - These measures have been shown to reliably indicate the CL associated with a task

Task 3 : Semantic Steering of Document Projections

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Wei Liu

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Research Plan

Problem

Document projections are passive

- Embeddings + projections are widely used
- Analysts often see **semantic misalignment**
- Fixing it requires:
  - retraining / fine-tuning
  - model-specific changes (expensive)

❑ ***Users can see problems, but cannot fix them.***

Research Question

How can users steer and reshape document projections interactively, without retraining models?

➢ LLMs as a semantic interpretation layer

Task 4 : Interactive LLM for High-Performance Sensemaking

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Xuxin Tang

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Research Plan

- **Shifting toward Bi-Directional Human-AI Sensemaking**
  - While our current work focuses on **Human-to-AI** augmentation via spatial layouts, the inverse—**AI-to-Human** augmentation—remains largely unexplored. To bridge this gap, we propose the following research questions:
  - **RQ1 (Transparency):** How does the workspace of the AI's intermediate cognitive steps benefit user understanding?
  - **RQ2 (Agency):** What mechanisms allow users to effectively supervise and intervene in AI-led sensemaking processes?
  - **RQ3 (Alignment):** How can iterative workflows support human-AI collaboration toward user-defined goals and intentions?
  - **RQ4 (Outcomes):** How does a collaborative sensemaking approach improve the quality and depth of the final analytical results?