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Scalable Visual Queries for Data Exploration on Large, High-Resolution 3D Displays

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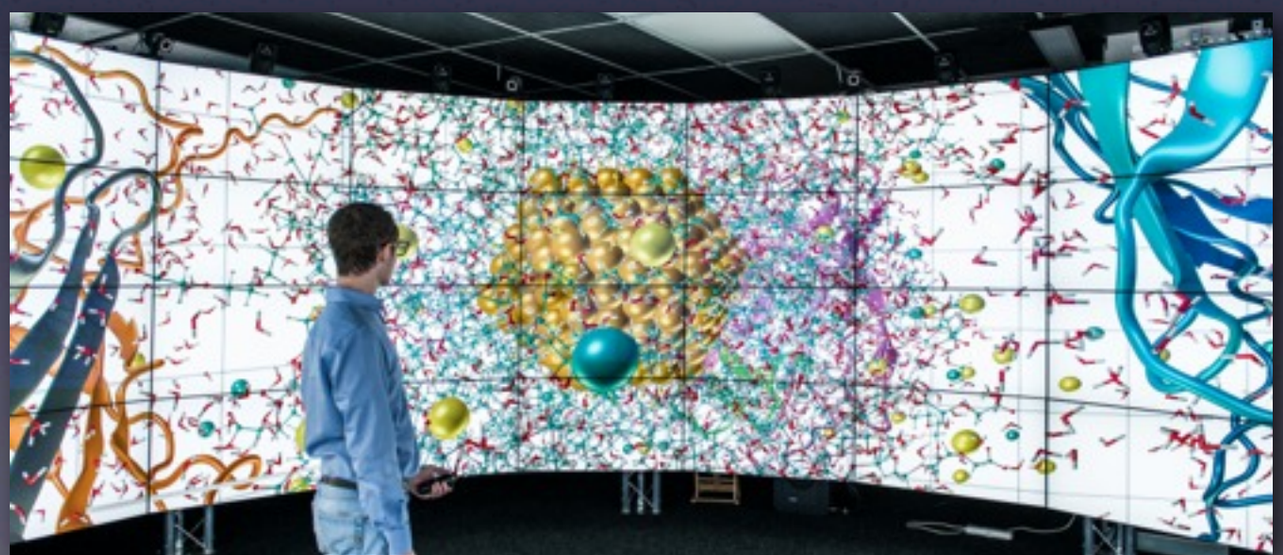
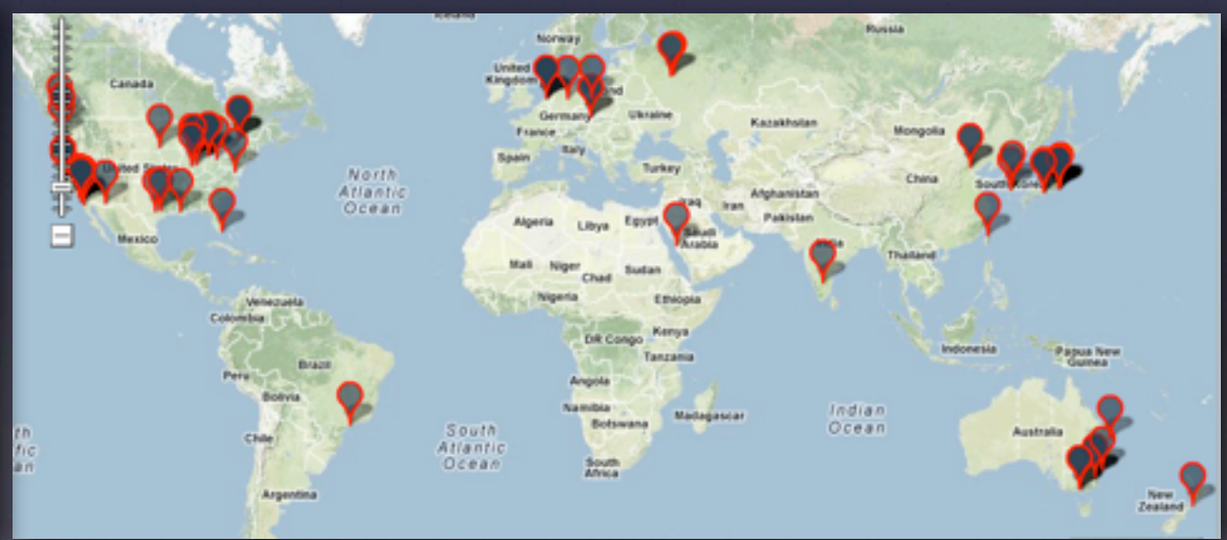
Summary

- Large, High-Resolution are becoming increasingly common in universities and research labs
- These displays have the potential to change scientific workflows
- Case study: making sense of insect behavior using Large, High-Res 3D display
- A *Visual Query* approach to data exploration
- We need a human-centered approach to develop next generation visual interfaces for these displays



CAVE2 - University of Illinois at Chicago



Institutions utilizing Large, Hi-Res displays for data visualization and analysis

Lenses for big data

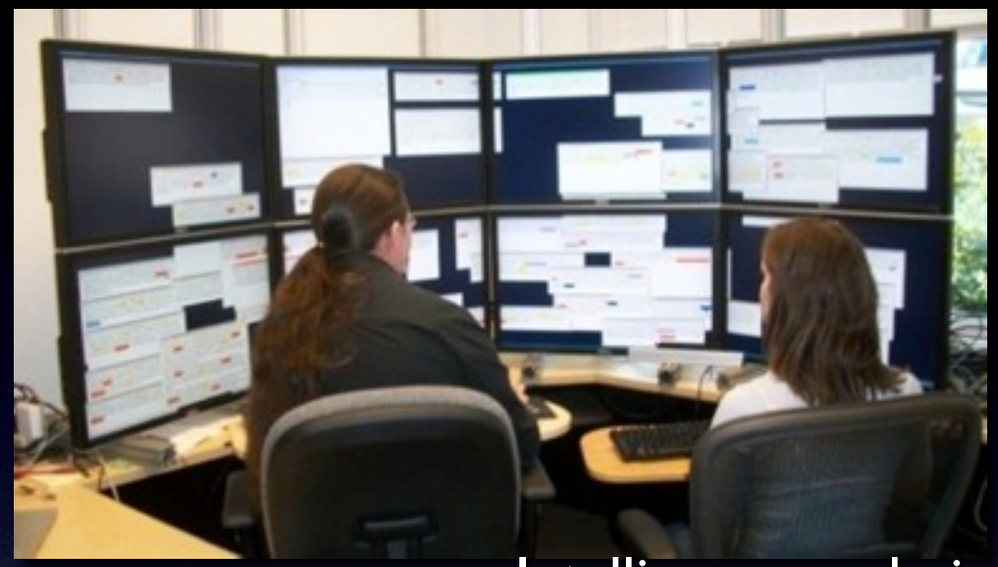
- Context + detail by walking up to or away from the display
- Juxtapose lots of views
- Promotes embodied cognition

Molecular visualization for large nanoscale structures
~5 Million atoms +
electron charge density

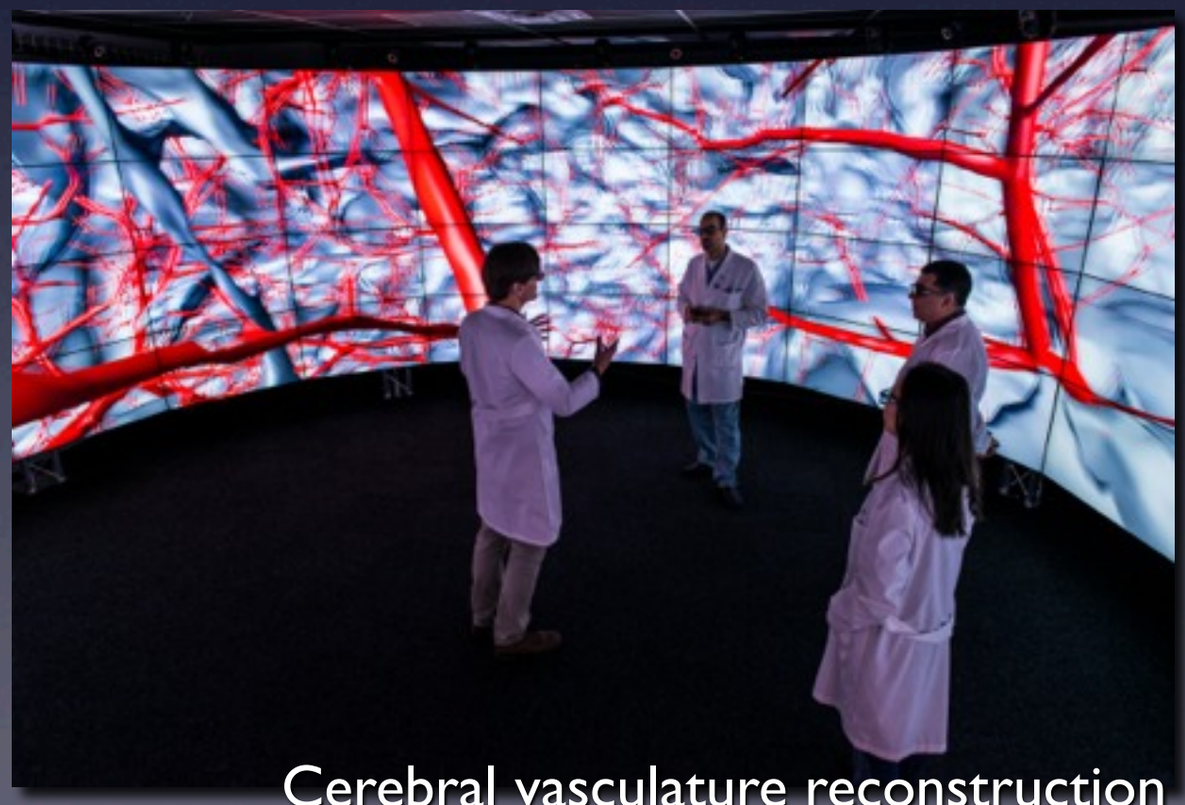
Visualization of cerebral blood vasculature
~80K vessels

Lenses for big data

- We know little about how users utilize these environments in complex sensemaking scenarios
- Most applications treat these displays as a giant Desktop
- We need a new generation of scalable visual interfaces to enable scientists to explore and make sense of their data using big displays



Intelligence analysis
Bradel et al, 2011



Cerebral vasculature reconstruction
Thomas Marrinan, EVL

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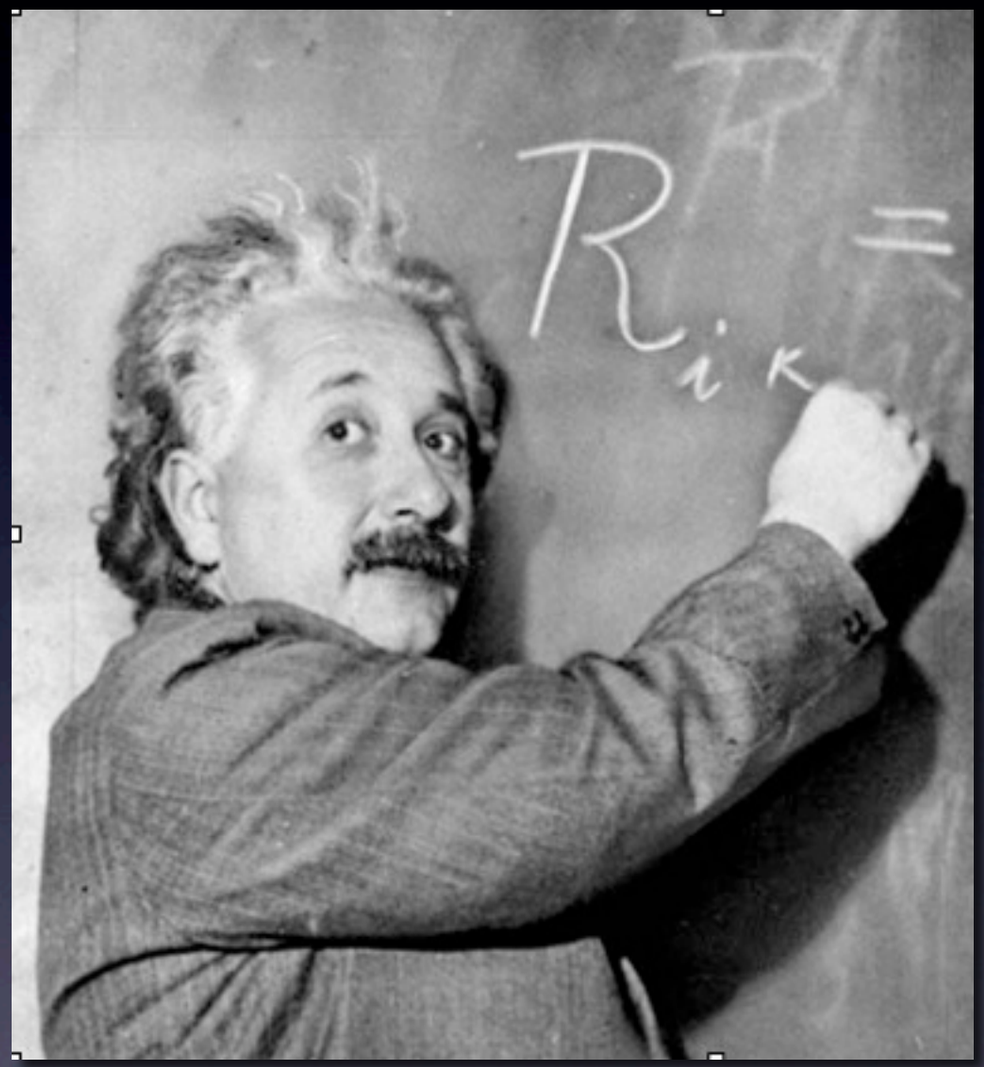

“ To raise new questions, new possibilities, to regard old problems from a new angle requires creative imagination and marks real advance in science ”

- Albert Einstein & Leopold Infeld

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Making sense of insect behavior

Making sense of insect behavior

To food

To nest

Kenyan Seed Harvester ants

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Making sense of insect behavior

Off-trail ant

To food

To nest

On-trail ant

Kenyan Seed Harvester ants

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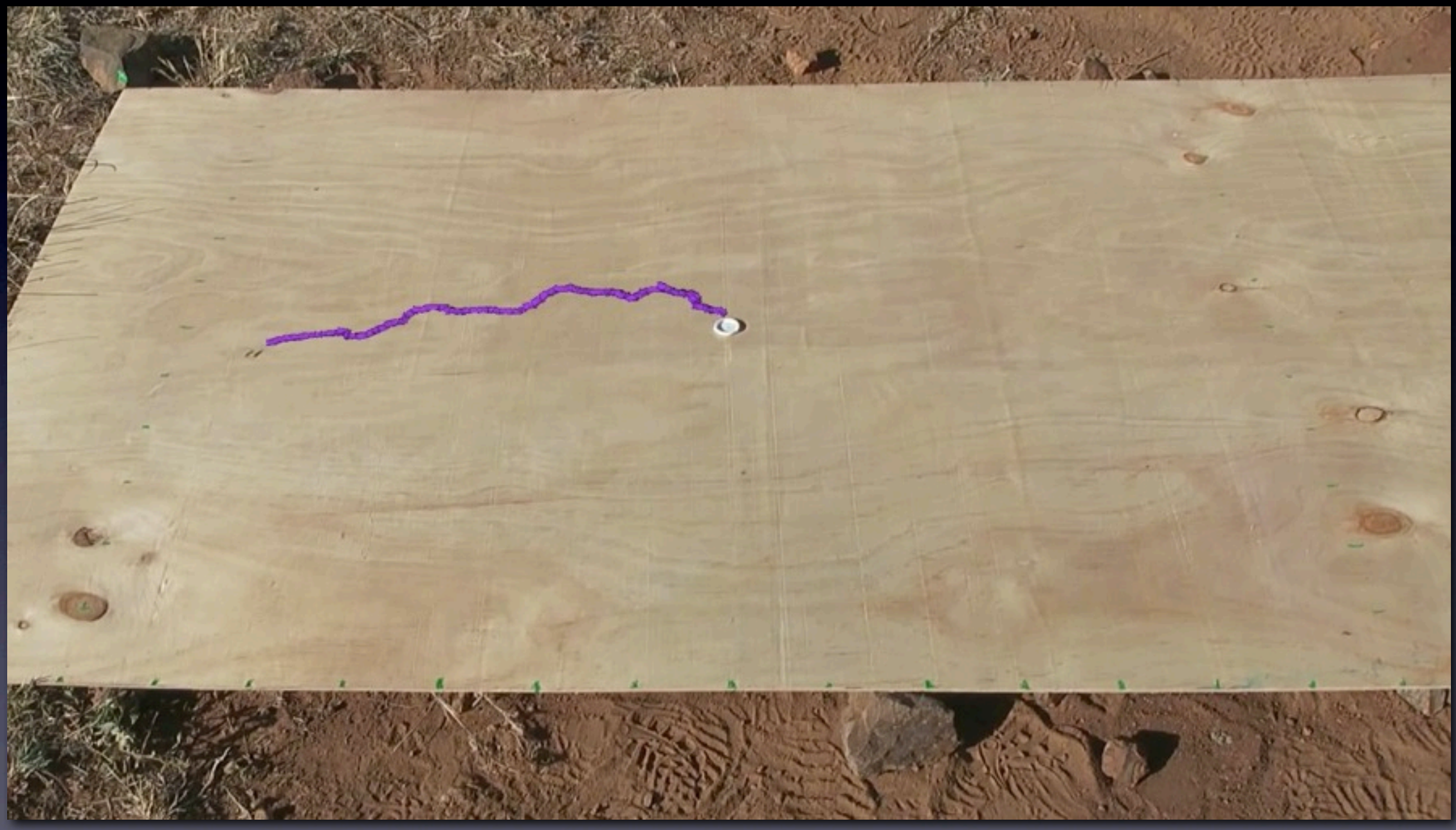
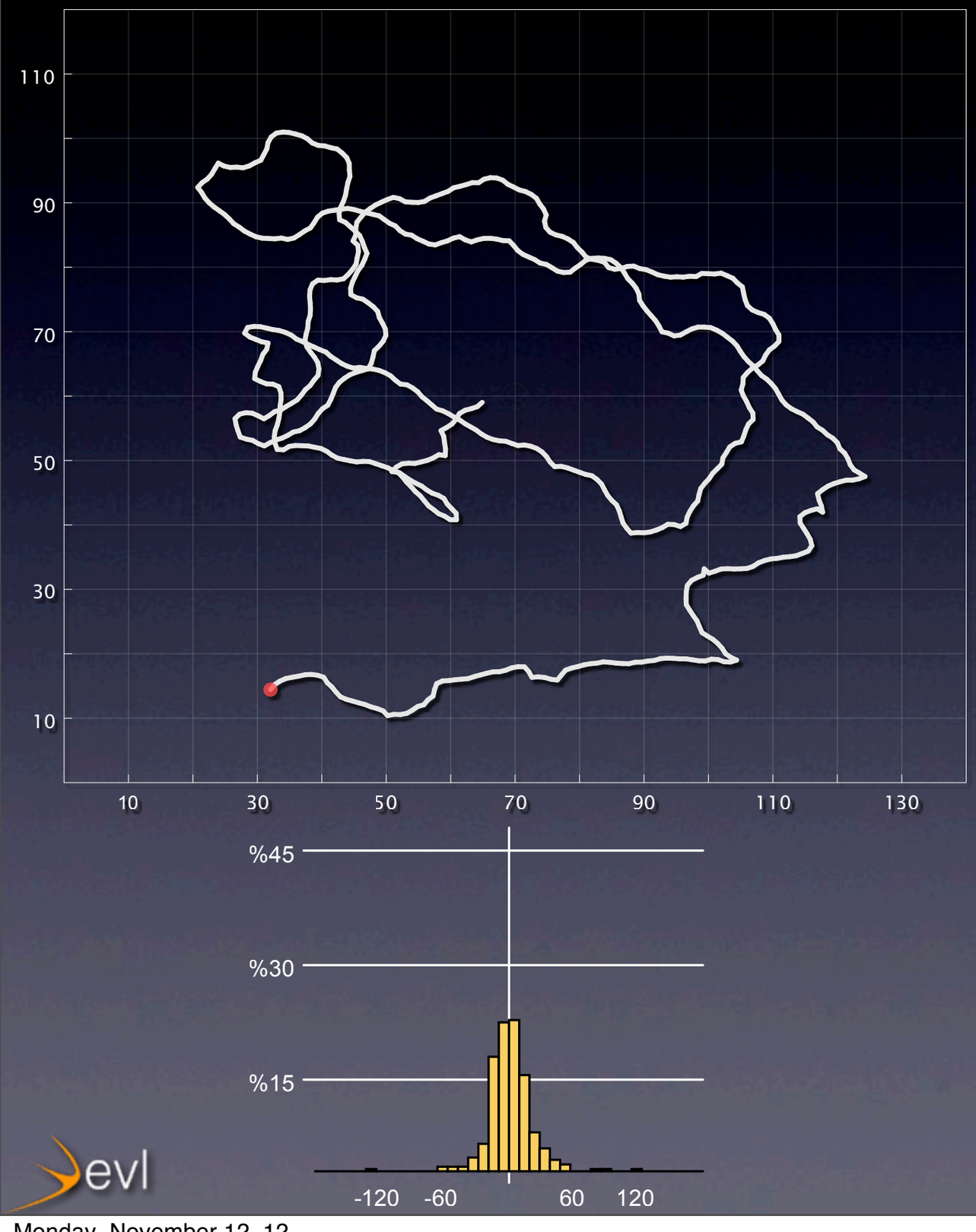
Data

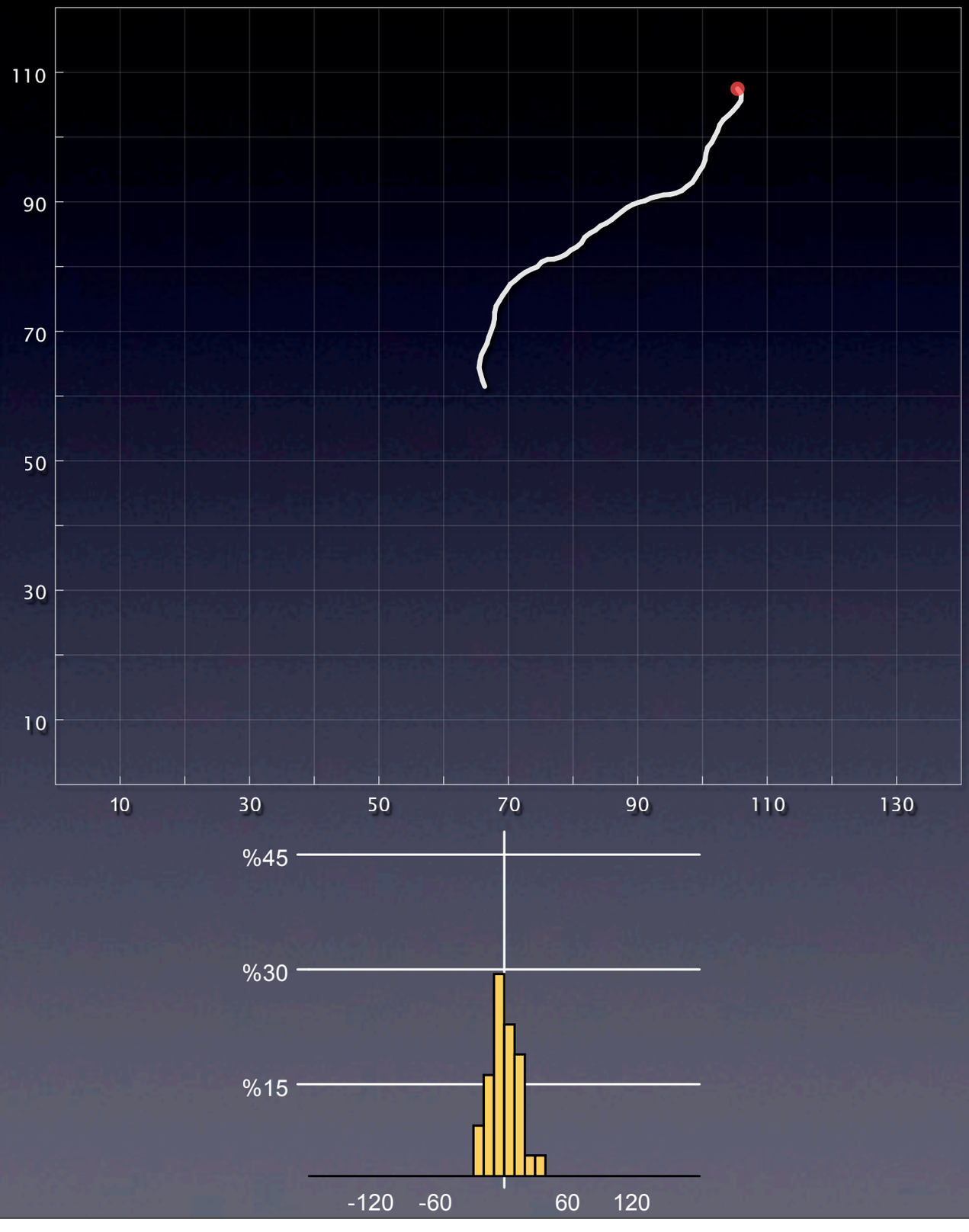


Statistical analysis

On trail - ant #183



East of trail - ant #52



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Making sense of insect behavior

- Lots of trajectories ~500
- Stochastic individual behavior
- Impossible to make inferences on a case-by-case basis
- Complex hypotheses space - many possible theories / narratives
- Ecologists want to see entire trajectories

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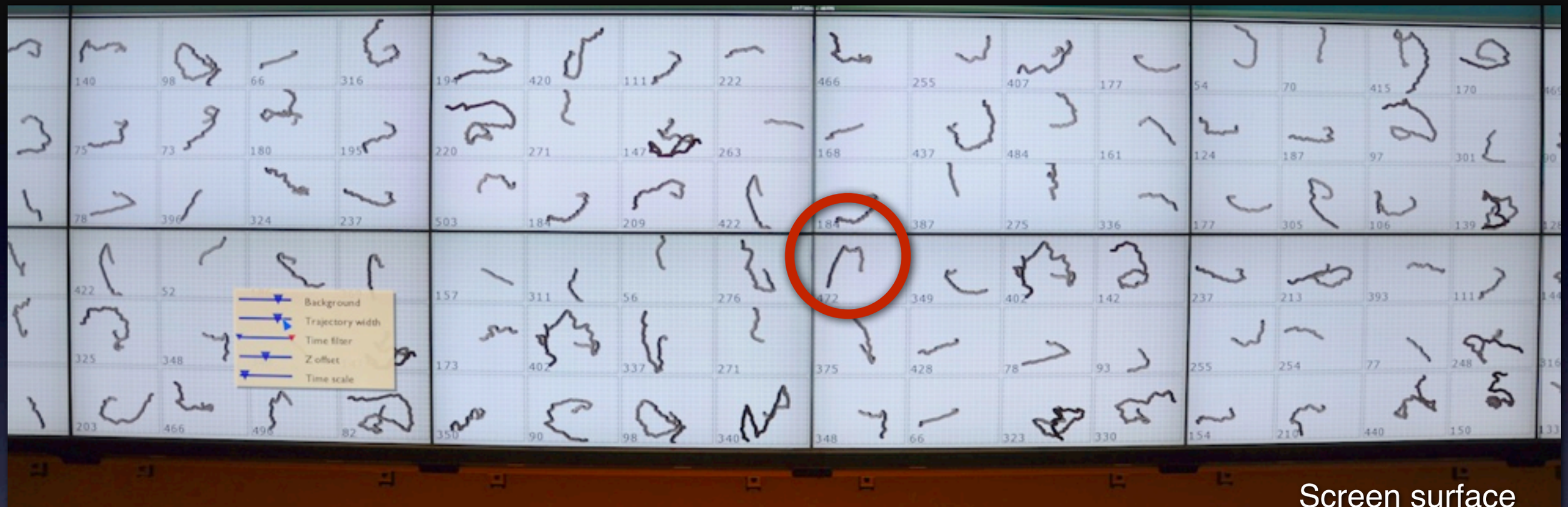
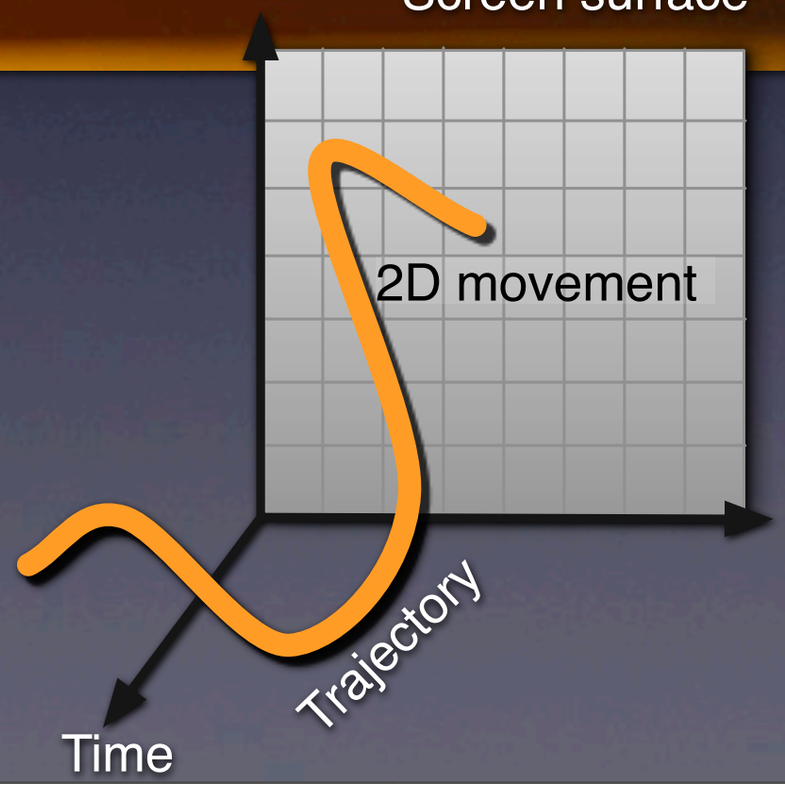
Visual exploration on a large 3D display



19 Megapixels, stereoscopic 3D
7 x 3 meters
22 x 10 feet



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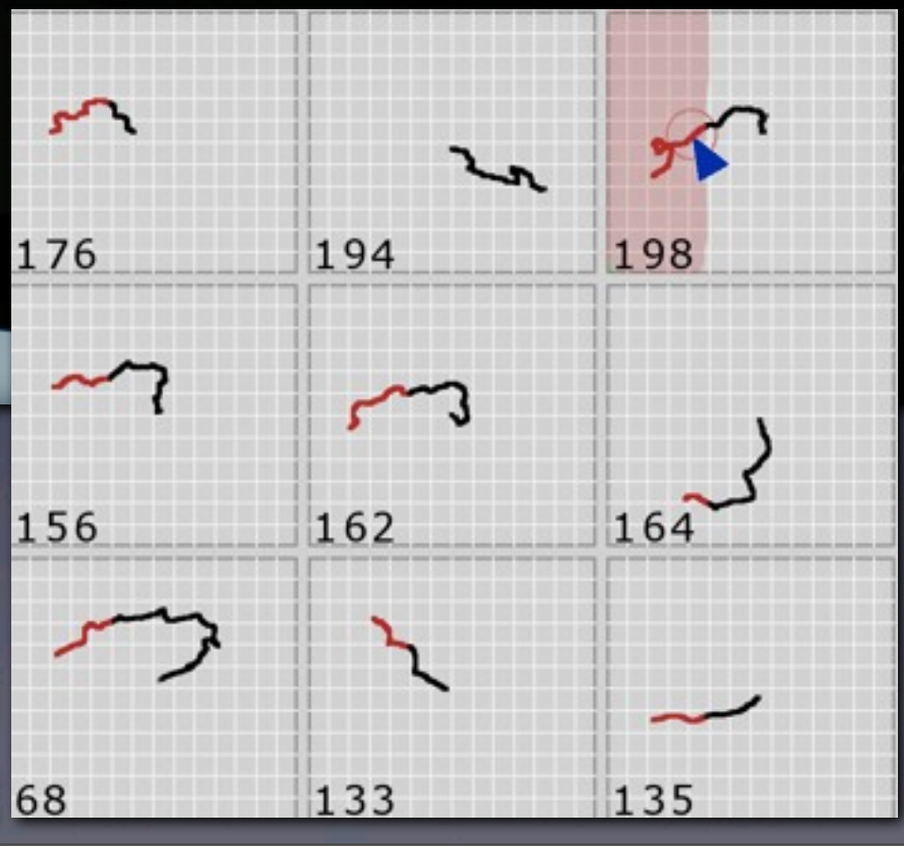
Scalable visual queries

Temporal filter



Coordinated Brushing

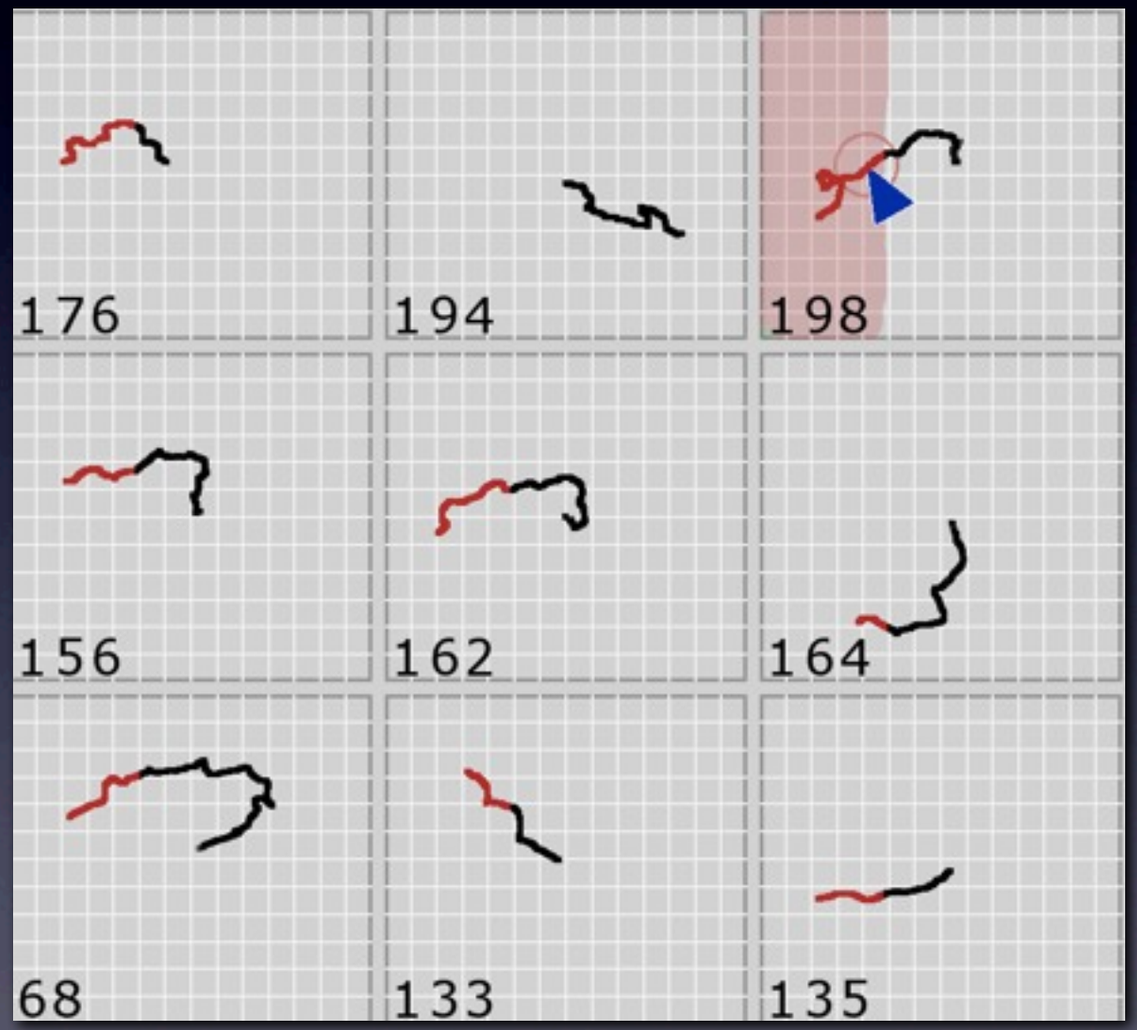
Scalable visual queries

Hypothesis

- Ants use celestial cues when navigating off-trail

Query

- Ants captured east of foraging trail exit from west side when released in attempt to go back to trail



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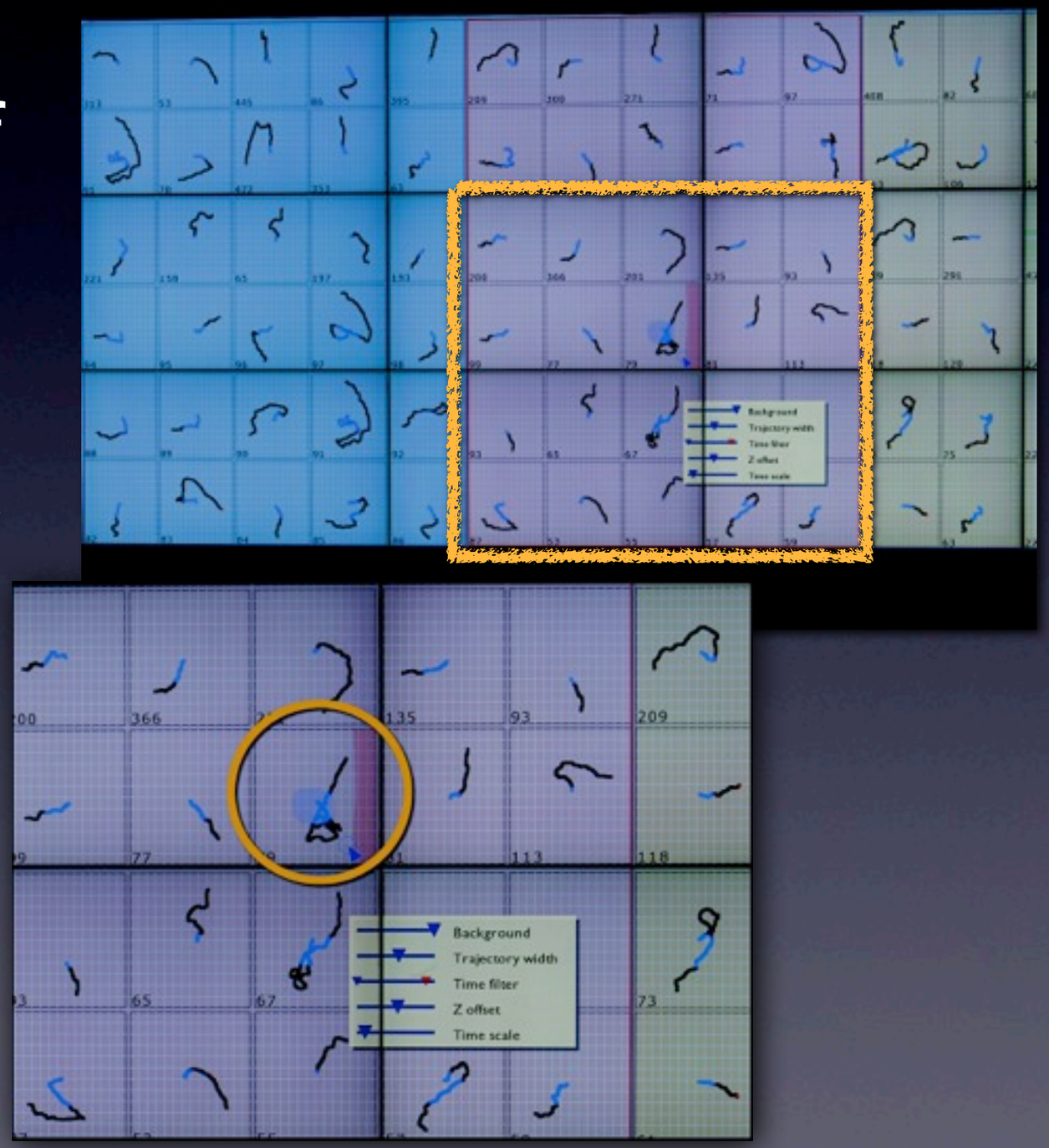
Scalable visual queries

- Flexibility in query formulation allows a variety of hypotheses to be explored and put to test quickly in parallel
- *Pre-attentive* encoding of query results allows for quick, ‘scalable perception’ of results
- A High-Resolution display allows a large portion of the data to be queries and displayed in parallel



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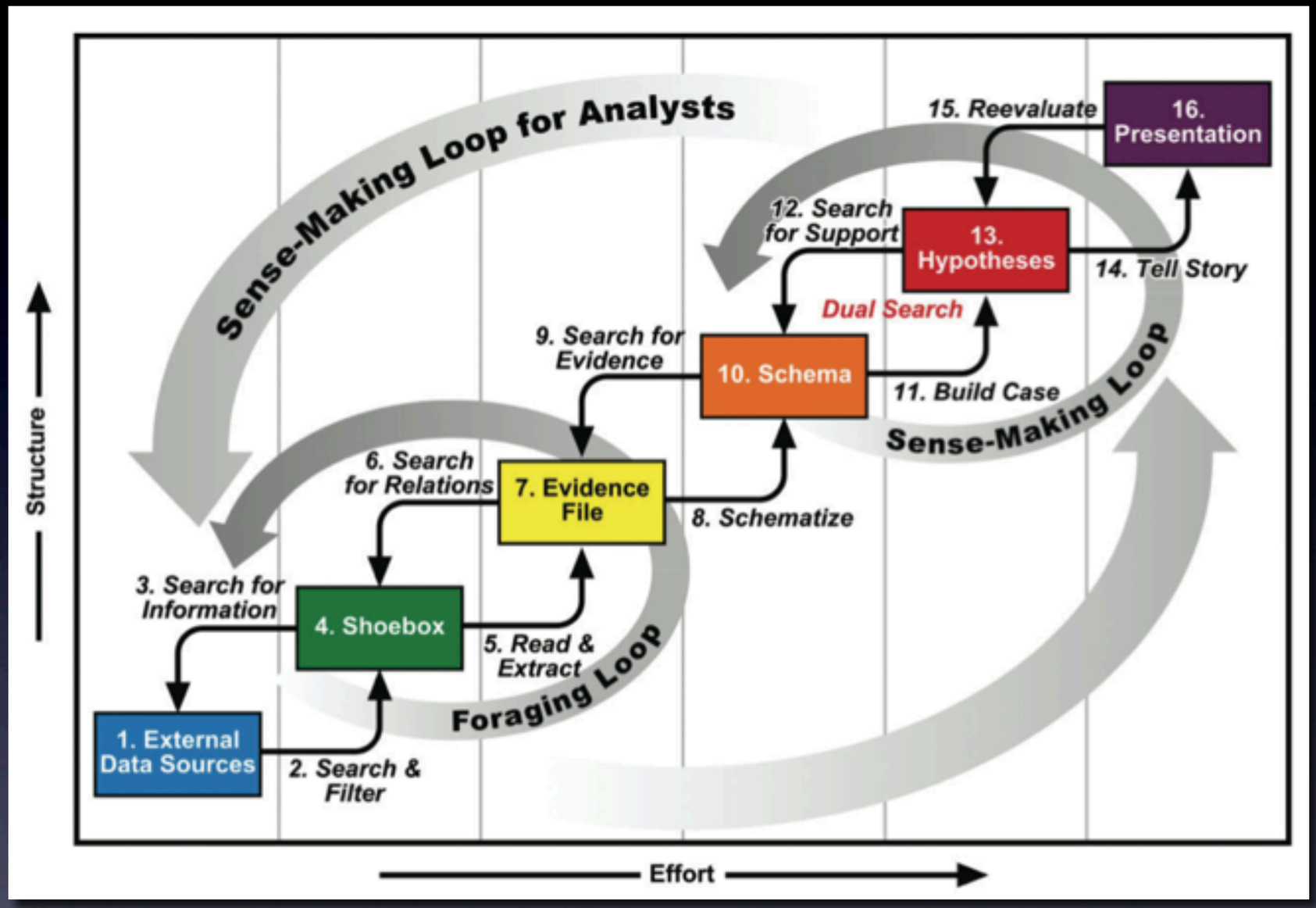
Sensemaking

Pirolli & Card. 2005



Sensemaking is the process of organizing scattered and incomplete pieces of information, extracting evidence from it, and combining that evidence into a presentation that provides a narrative and interpretation of how this data ties together

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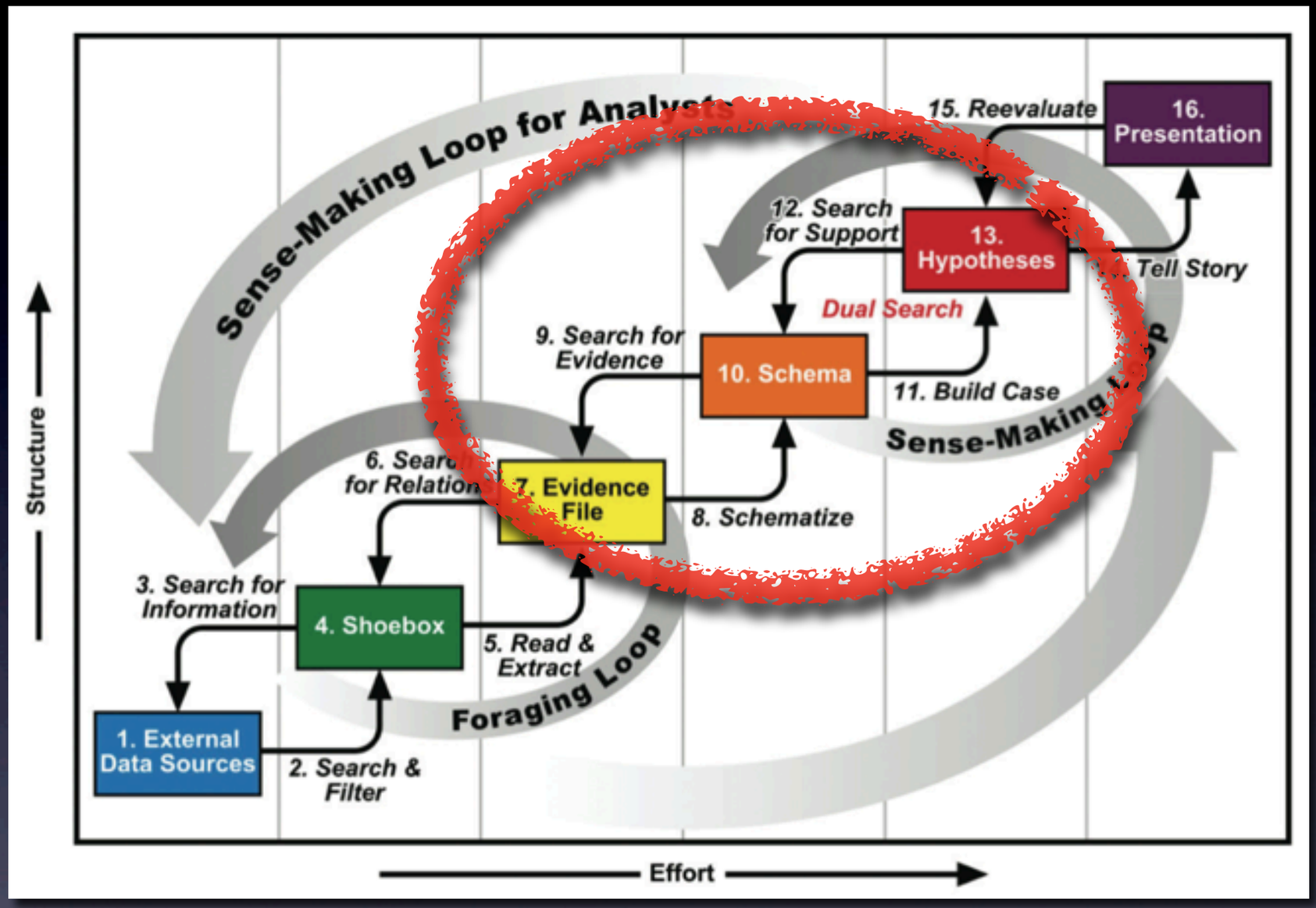
Sensemaking

Pirolli & Card. 2005



Sensemaking is the process of organizing scattered and incomplete pieces of information, extracting evidence from it, and combining that evidence into a presentation that provides a narrative and interpretation of how this data ties together

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Quick representational shifts

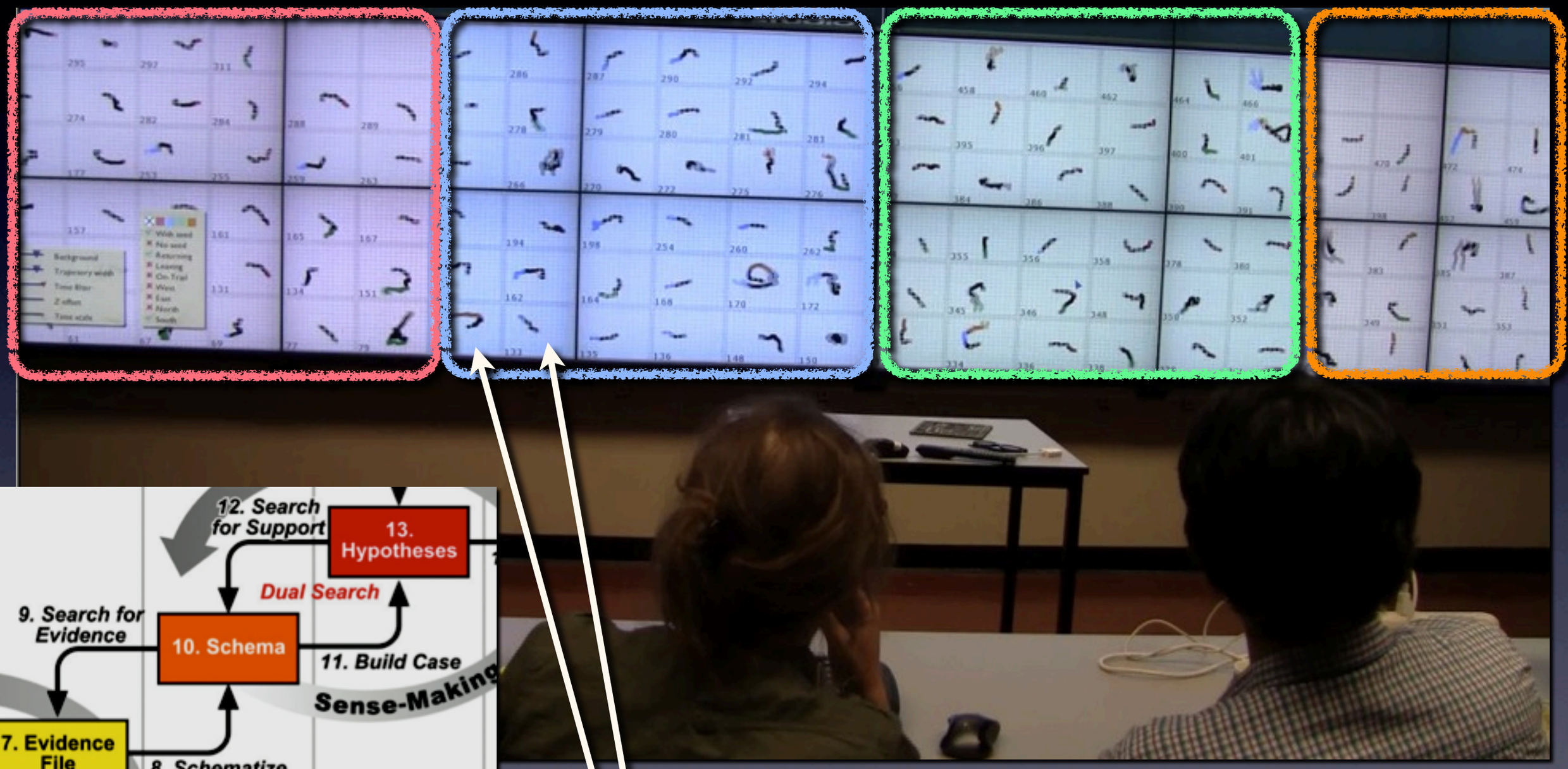
Quick representational shifts

West side

East side

north

south



Enrich representation

Evidence file = individual trajectories

Schema = groups of brushed trajectories

Key points

- Visual queries can be an effective approach for data exploration on High-Resolution displays
- Multiple hypotheses can be quickly explored and evaluated in parallel
- Stereoscopic 3D can be used as an extra perceptual channel even in 2D datasets, particularly when there's a temporal component

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