Visualization Design Patterns for Ultra-Resolution Display Environments

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Large, ultra-resolution displays
(big displays)

- Size and resolution closely matched to the sphere of perception and influence of the human-body (Andrews et al., 2011)
- Typical computer monitors stimulate 1/9 of our visual field
- Big displays allow us to reclaim the scalability of visual thinking
- Visual instruments to deal with scale and complexity

How people use big displays

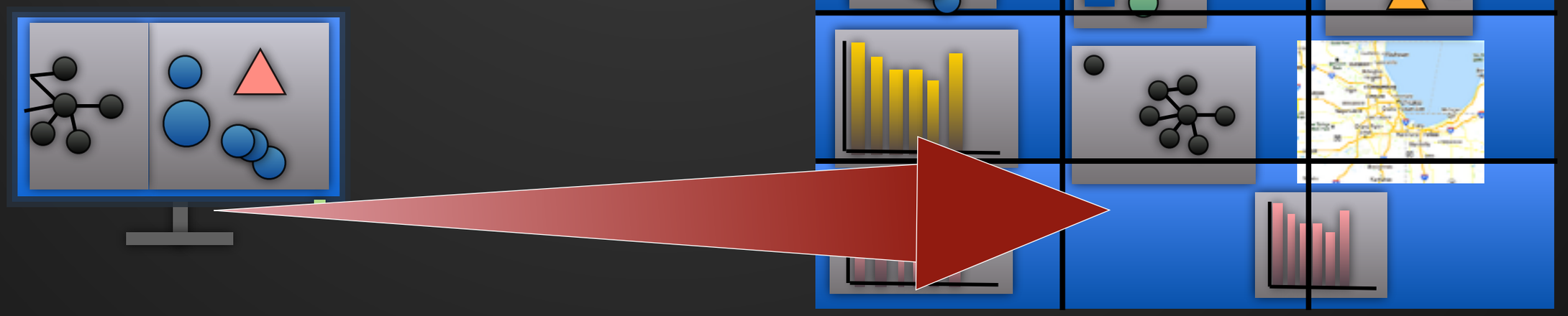
Complexity

Number of representations

Visualization design patterns

- We want application independent design guidelines
- **Visual Thinking Design Patterns:** Task + visual structure (Ware et al., 2013*)
  - Solutions to commonly recurring problems in visual analytics
  - Take perceptual and cognitive limitations in account

- What happens when we **stretch** the visualization to a big display and show more data?
- Can we accomplish said **tasks** more efficiently?
- Focus on exploration and discovery!



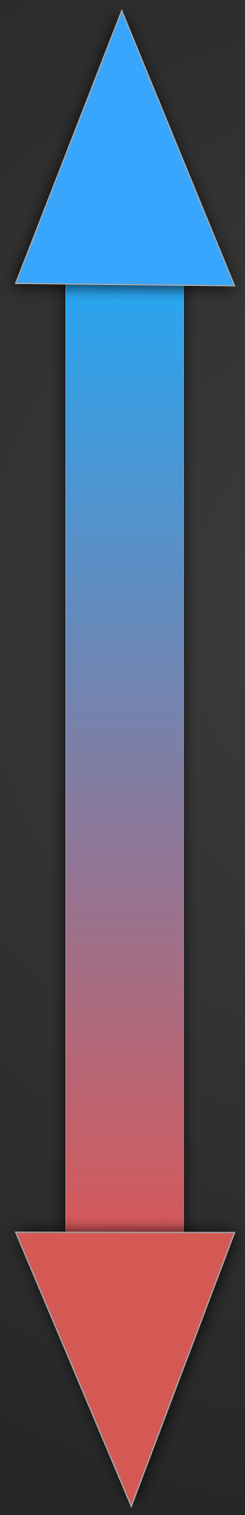
* http://ccom.unh.edu/vislab/VTDP_web_pages/VTDP_HomePage.html

Visual query

Visual aggregation

Comparison in large information spaces

Lateral exploration



Perception

High-level cognition

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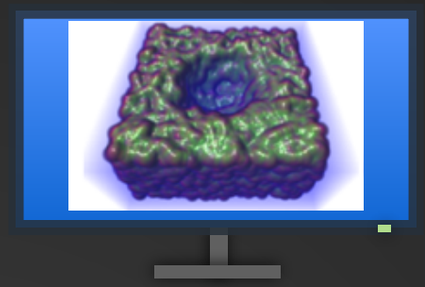

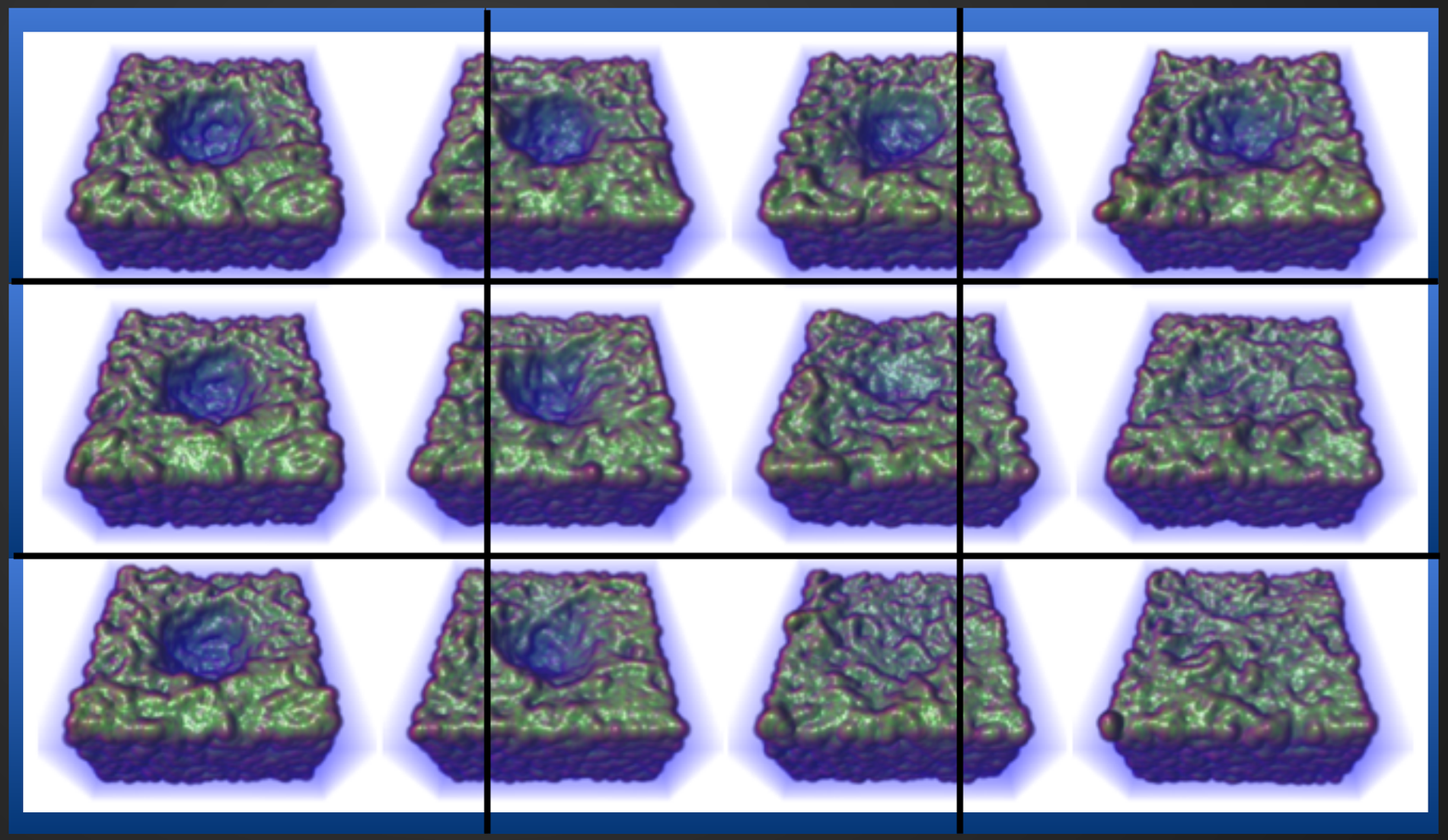

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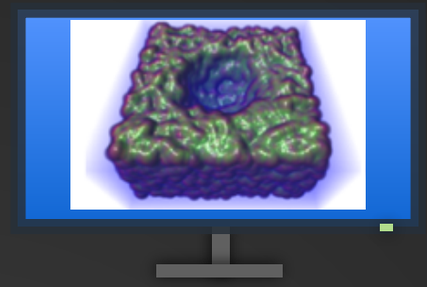

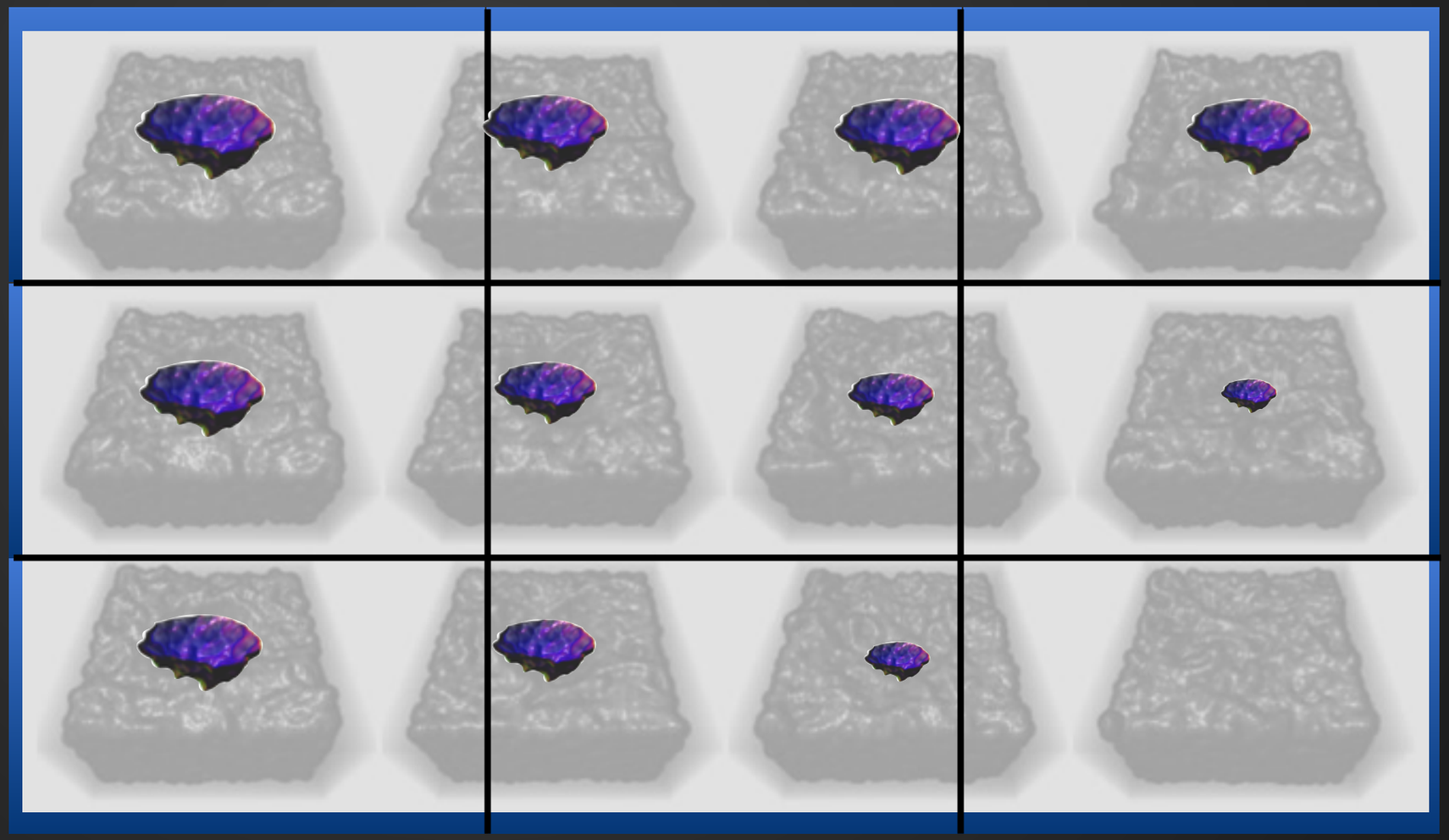

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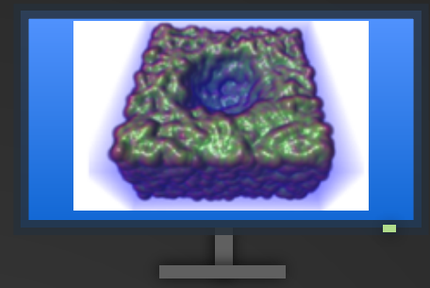

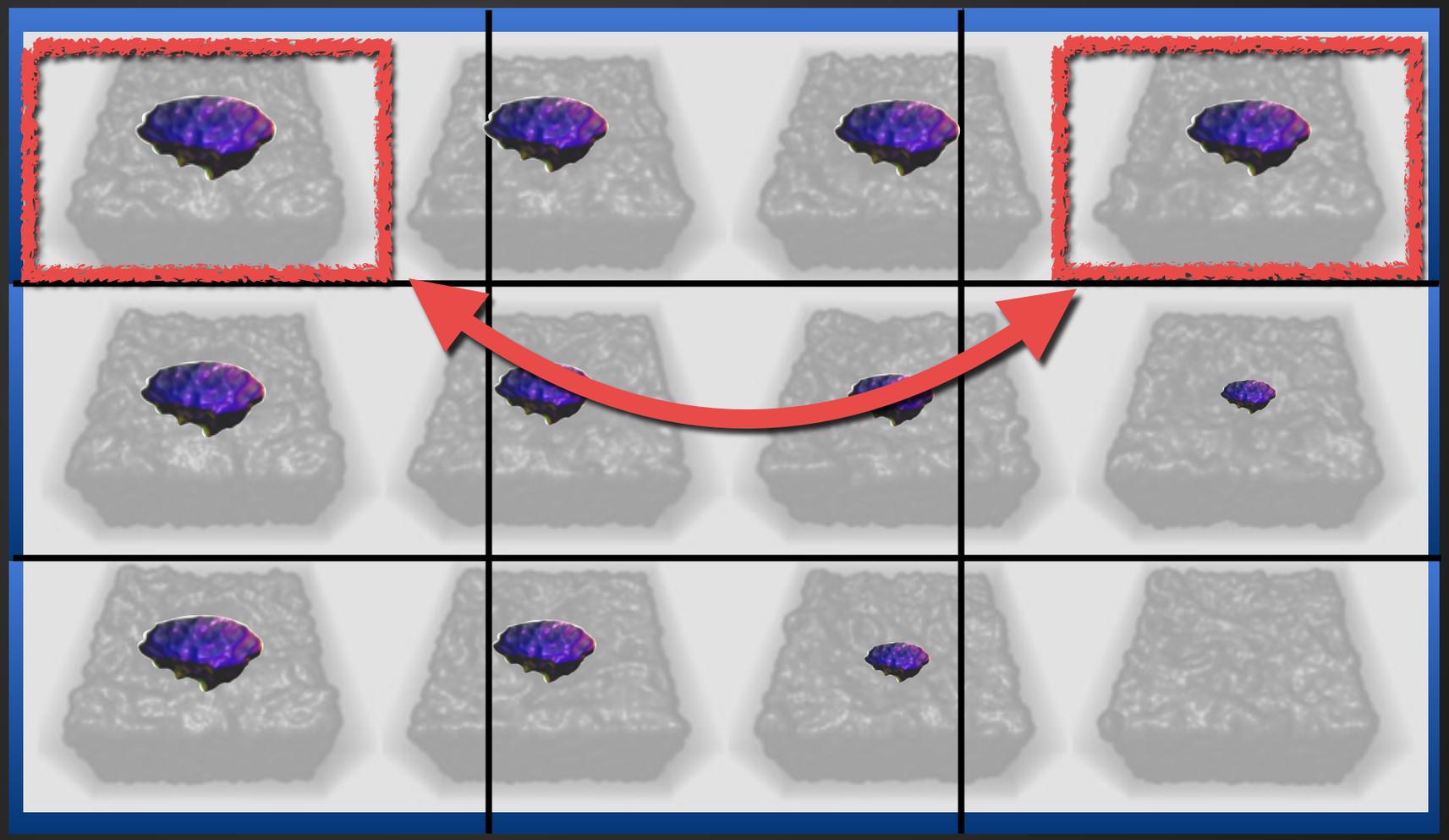

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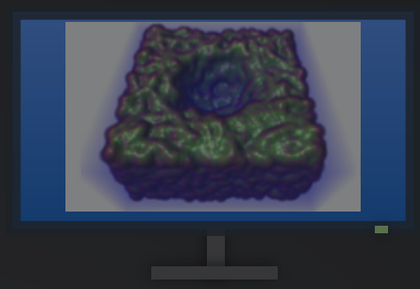
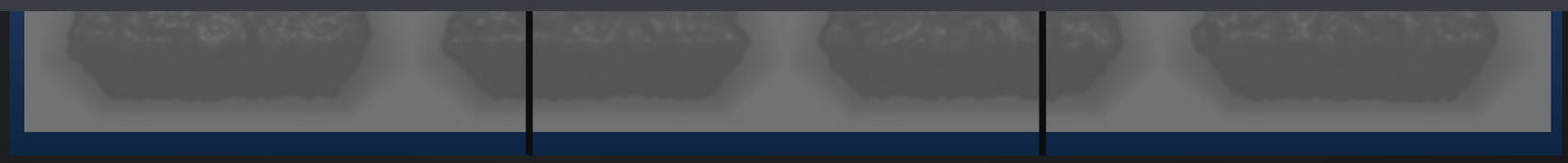


- Visual comparison is far more effective when done with eye movement
- Juxtapose datasets / windows side-by-side
- Pre-attentive focusing: Allow the user to brush and highlight relevant subsets in place

Lateral exploration



Visual query

Visual aggregation

Comparison in large information spaces

Lateral exploration

How can we encourage users to laterally explore multiple hypothesis and follow up on different narratives?

Visual query

Visual aggregation

Comparison in large information spaces

Lateral exploration

Vis

Single ‘vis’ state

Vis

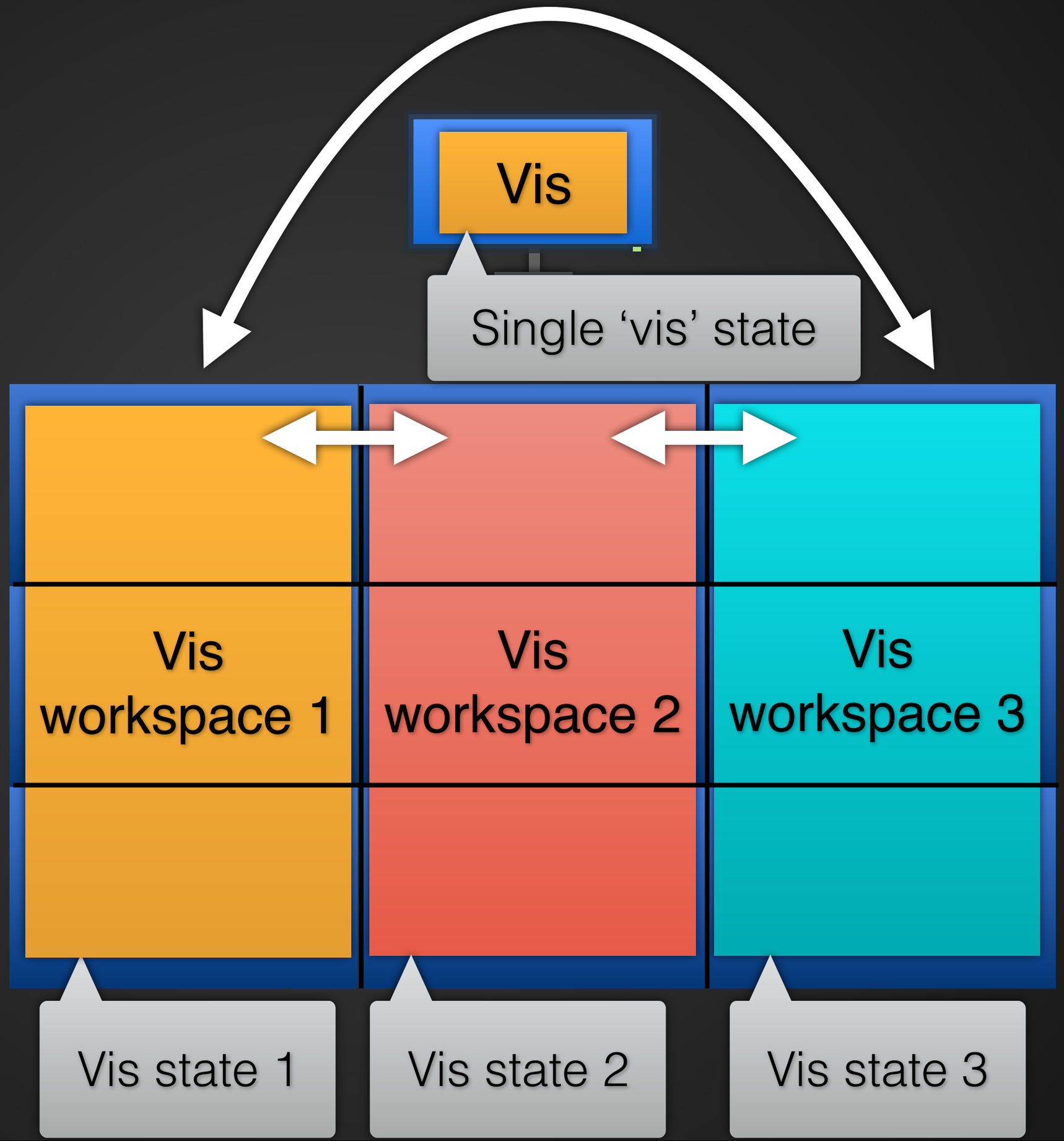
Single ‘vis’ state

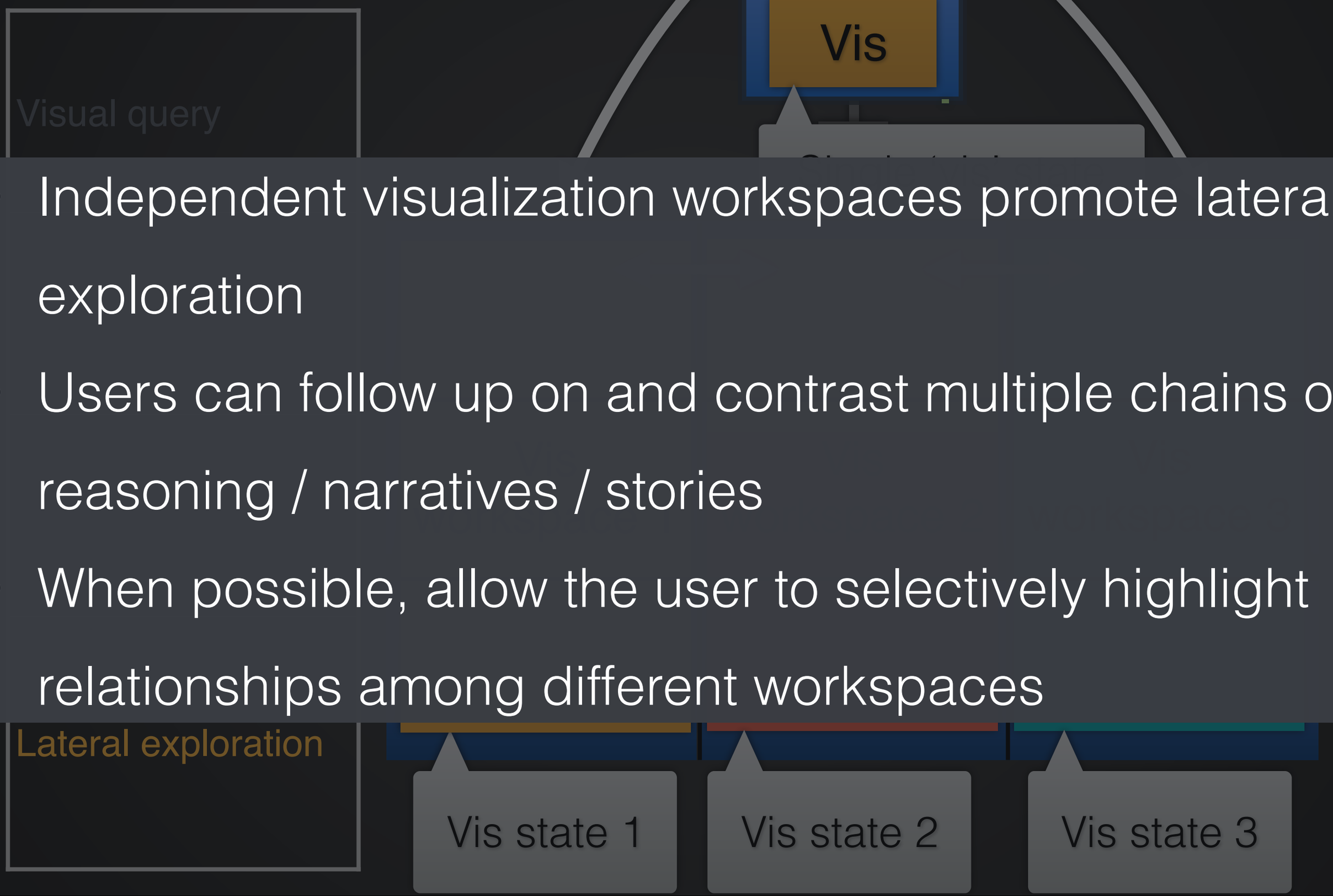
Visual query

Visual aggregation

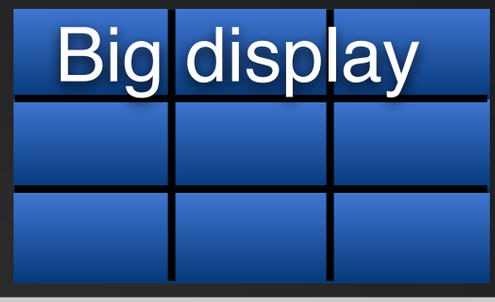
Comparison in large information spaces

Lateral exploration





- Independent visualization workspaces promote lateral exploration
- Users can follow up on and contrast multiple chains of reasoning / narratives / stories
- When possible, allow the user to selectively highlight relationships among different workspaces

	Single monitor 	Big display 
Visual query	• Few items • Fast search • Zoom + pan to see more	• Display larger sets of items • Visual query remains fast if glyphs can be processed pre-attentively
Visual aggregation	• Hierarchal layout — click to expand and drill down	• Use a flat layout — show everything at once • Aggregation achieved by walking away from display
Comparison in large information spaces	• Zoom + pan • Context + Focus lenses	• Window juxtaposition • Highlight elements / aspects of comparison in place
Lateral exploration	• Start with a seed of information • Fan out and explore	• Juxtapose fully-functional visualizations • Explore and contrast multiple narrative and hypotheses

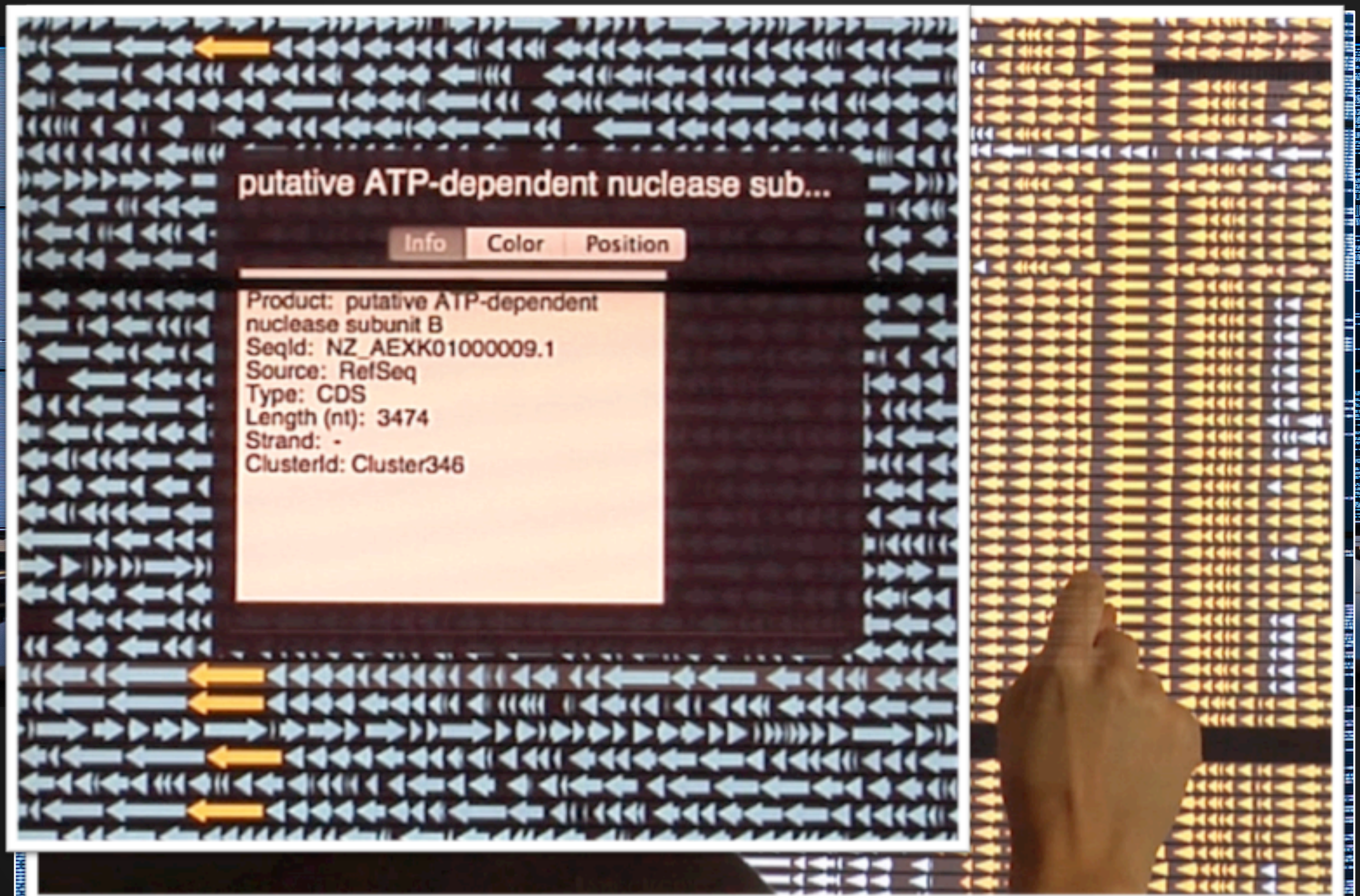
applications

Visual aggregation
Large-scale comparative genomics

- Explore conserved sets of genes in 600 *E. coli* species
- Layout the data around the question — create custom genomic maps

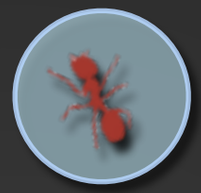
Visual aggregation

Large-scale comparative genomics



Lateral exploration / comparison in large info. spaces

Understanding insect behavior



Off-trail navigation?

To food

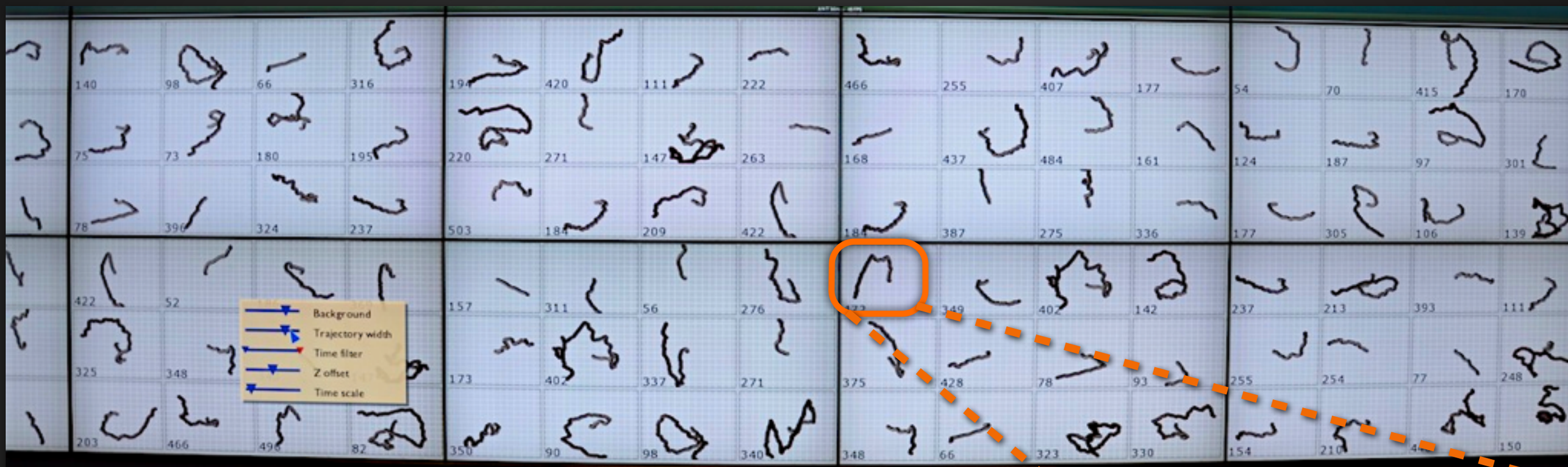
To nest

Lateral exploration / comparison in large info. spaces

Understanding insect behavior

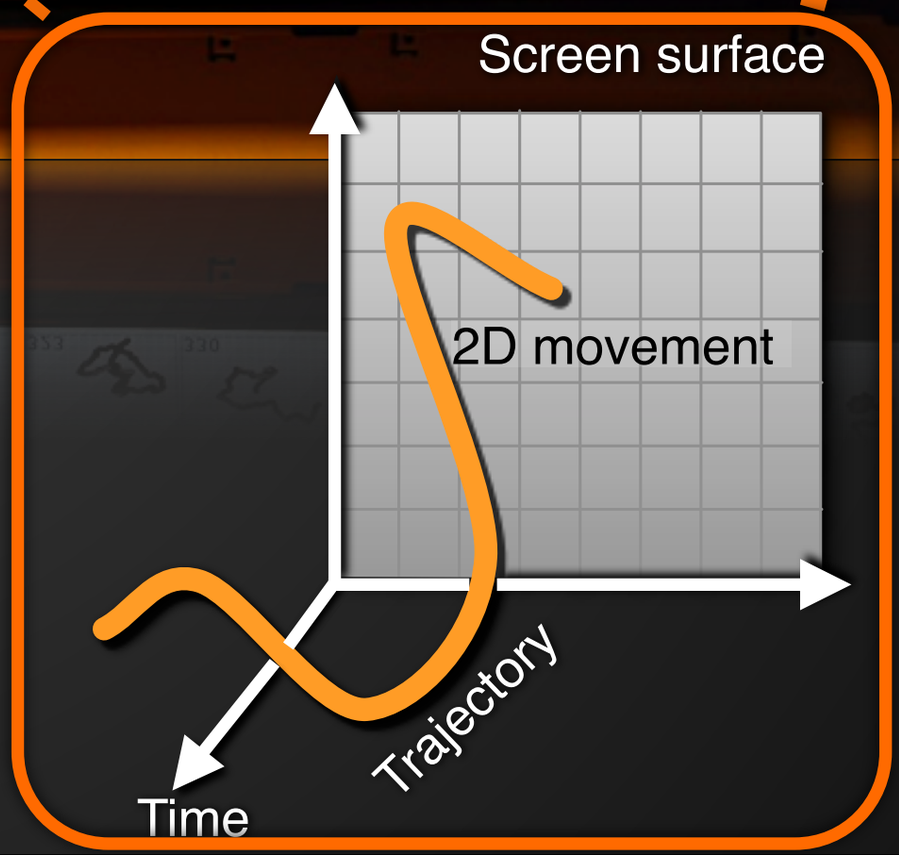
Lateral exploration / comparison in large info. spaces

Understanding insect behavior



400 experiments at 19 Megapixels —

stereo 3D to convey time



Lateral exploration / comparison in large info. spaces

Understanding insect behavior

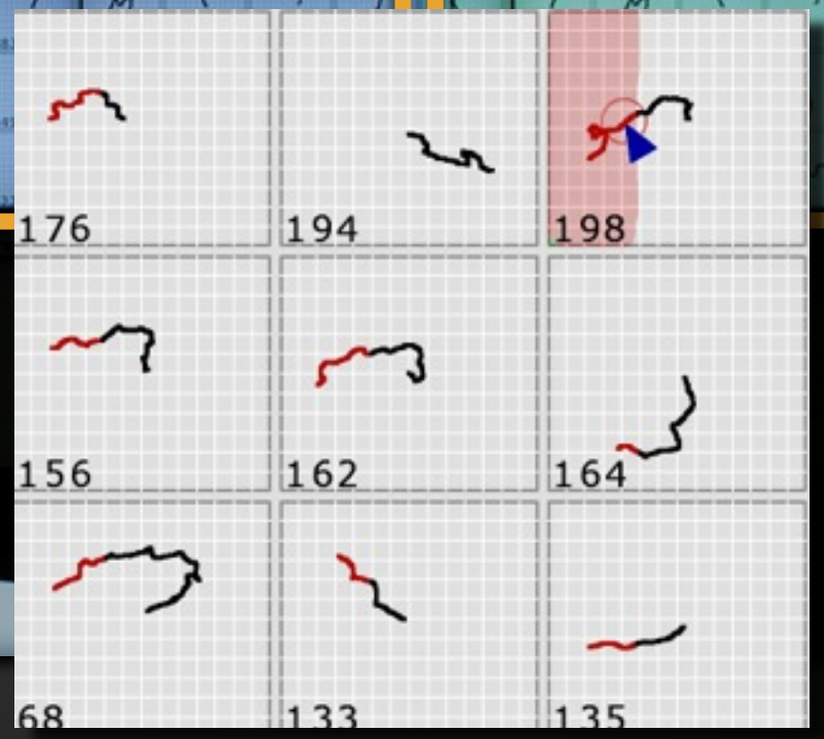
On-trail ants

West side ants

East

North

south



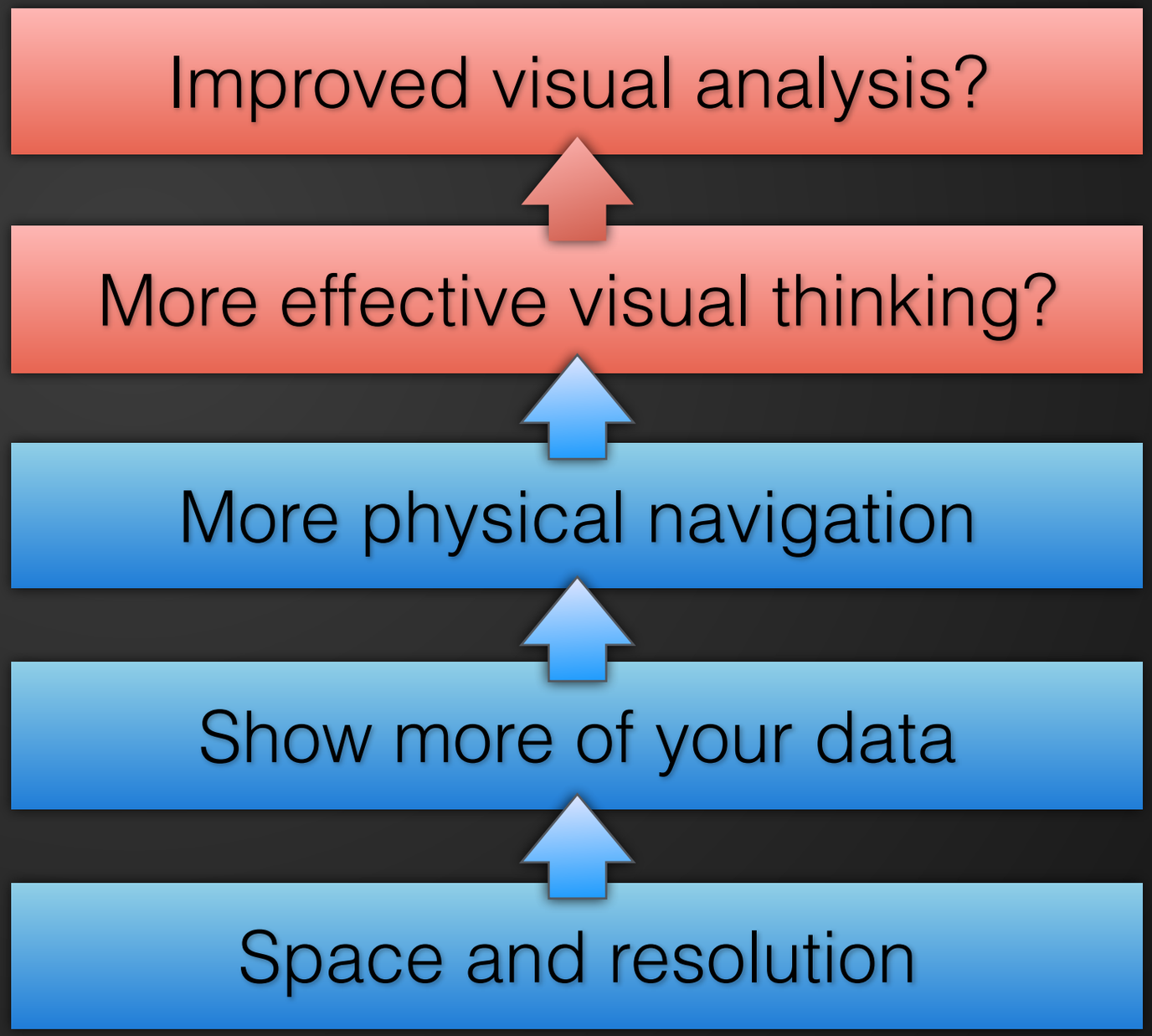
Hypothesis: ants captured EAST of the foraging trail will turn WEST when released.

Compare: brush WEST side with red

Verify: look for a red highlight

What makes ultra-resolution displays different?

- Discover more relationships in the data?
- Explore more hypotheses?
- Improve quality of analysis?
- Improve quality of outcome?



Thank you!

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Extras

Recent technology trends

Tiled LCD walls, 2004

2D

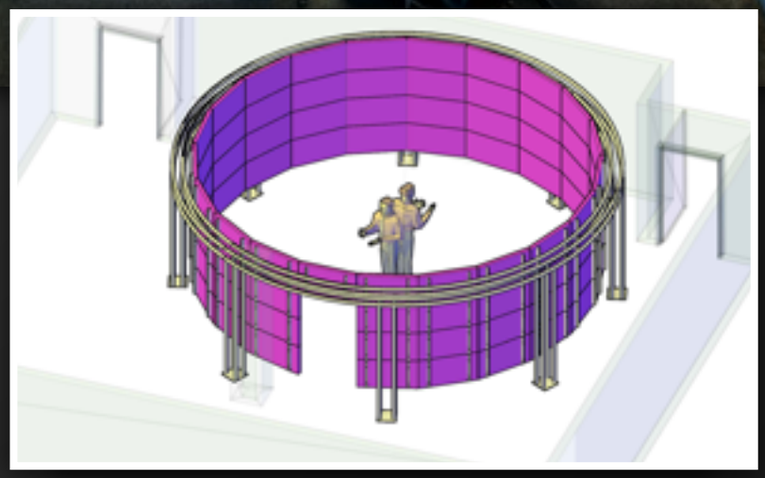
Thin-bezel LCD walls, 2009

Hybrid Reality environments, 2012 2D/3D

StarCAVE, 2009

CAVE, 1994

3D



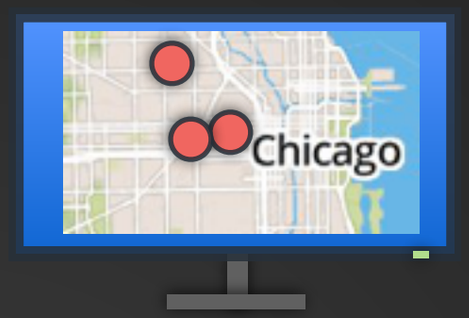
CAVE-2

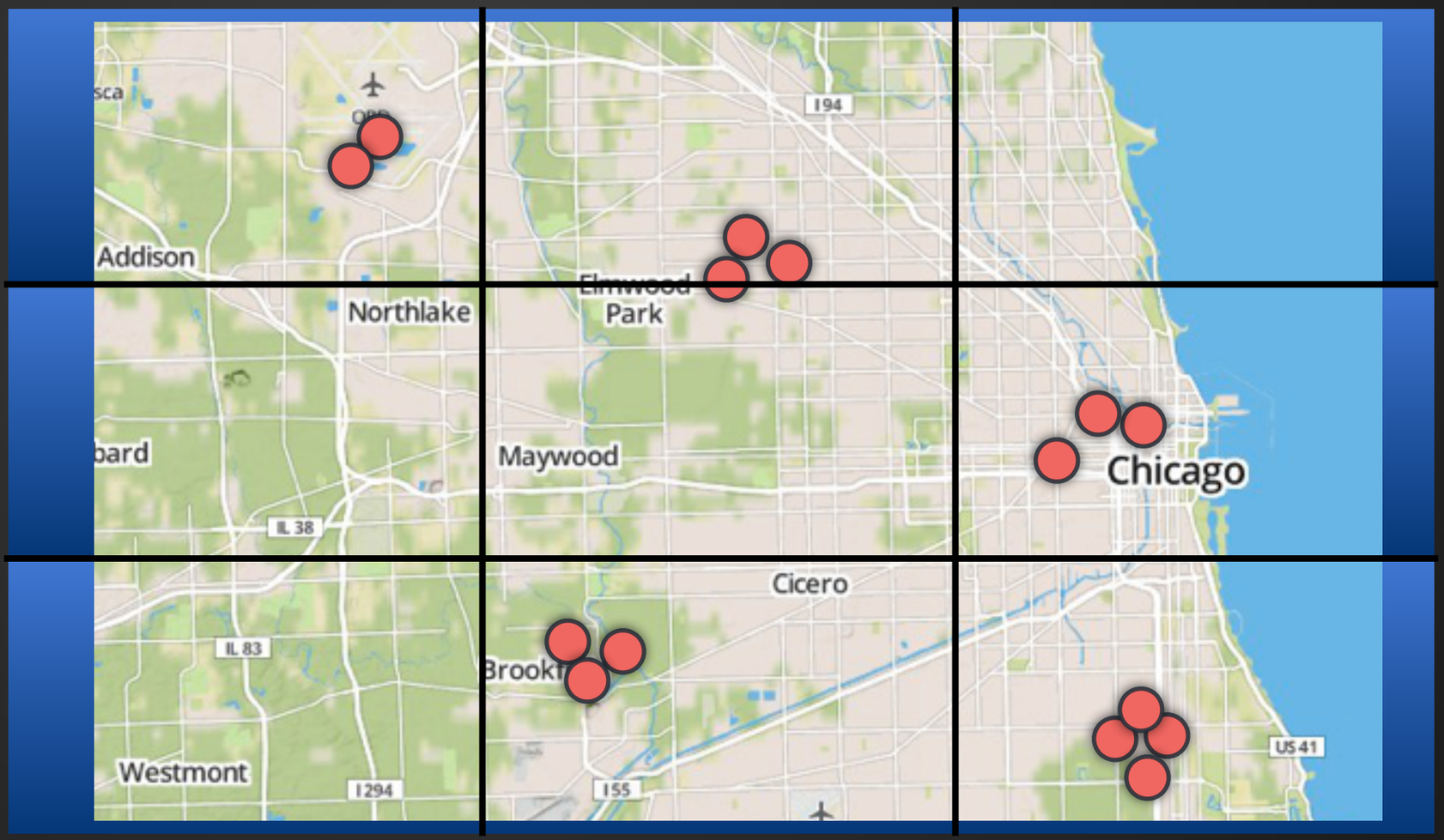
Visual query

Visual aggregation

Comparison in large information spaces

Lateral exploration





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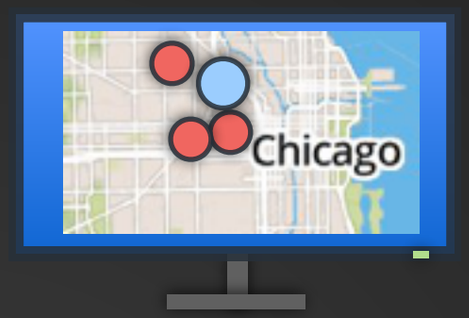

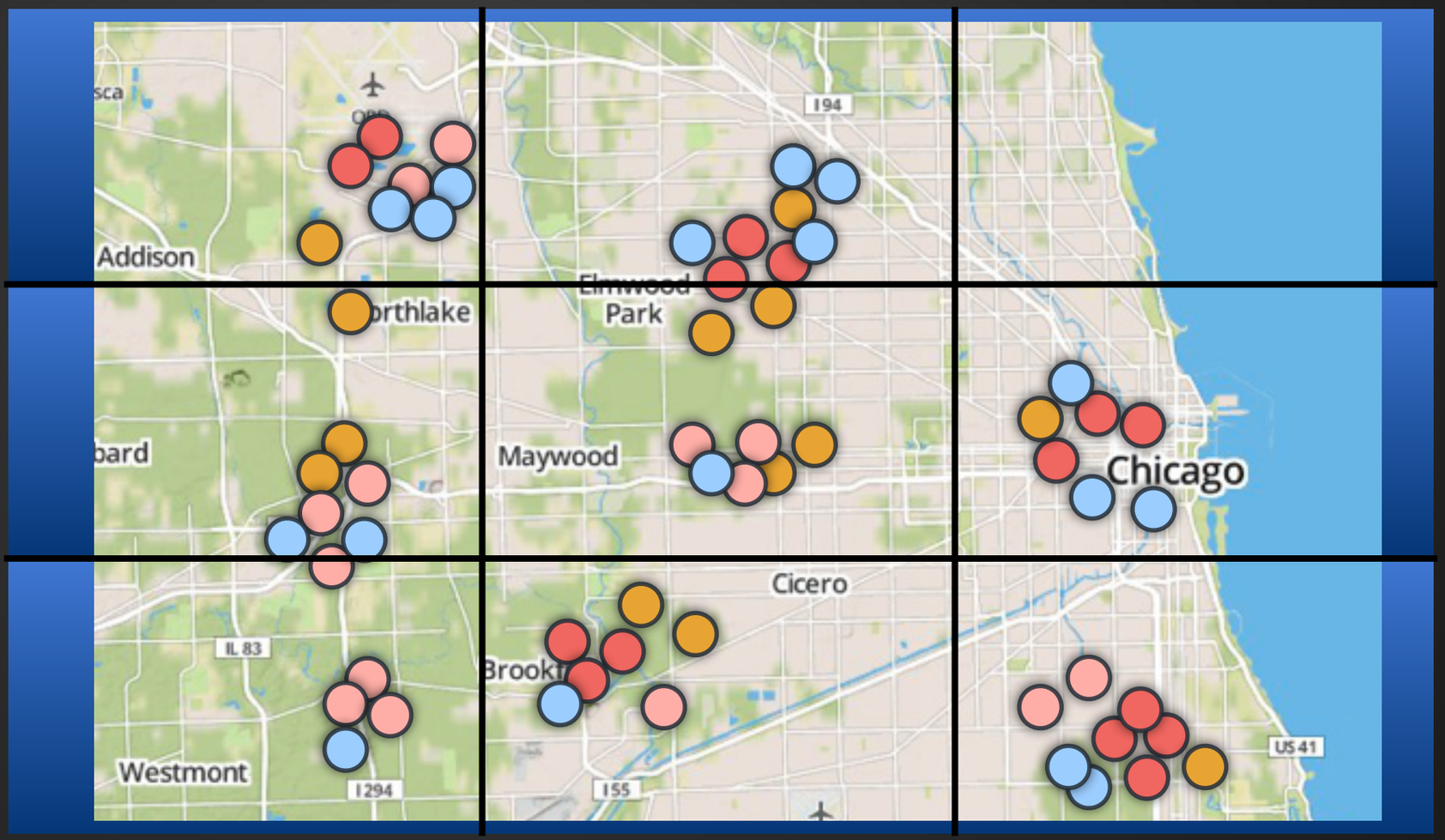

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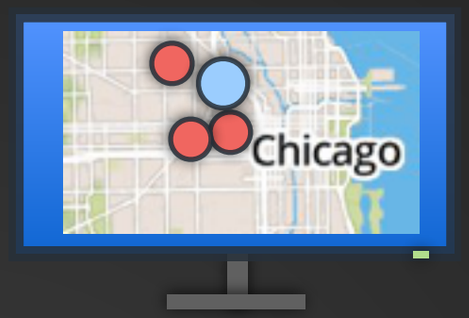

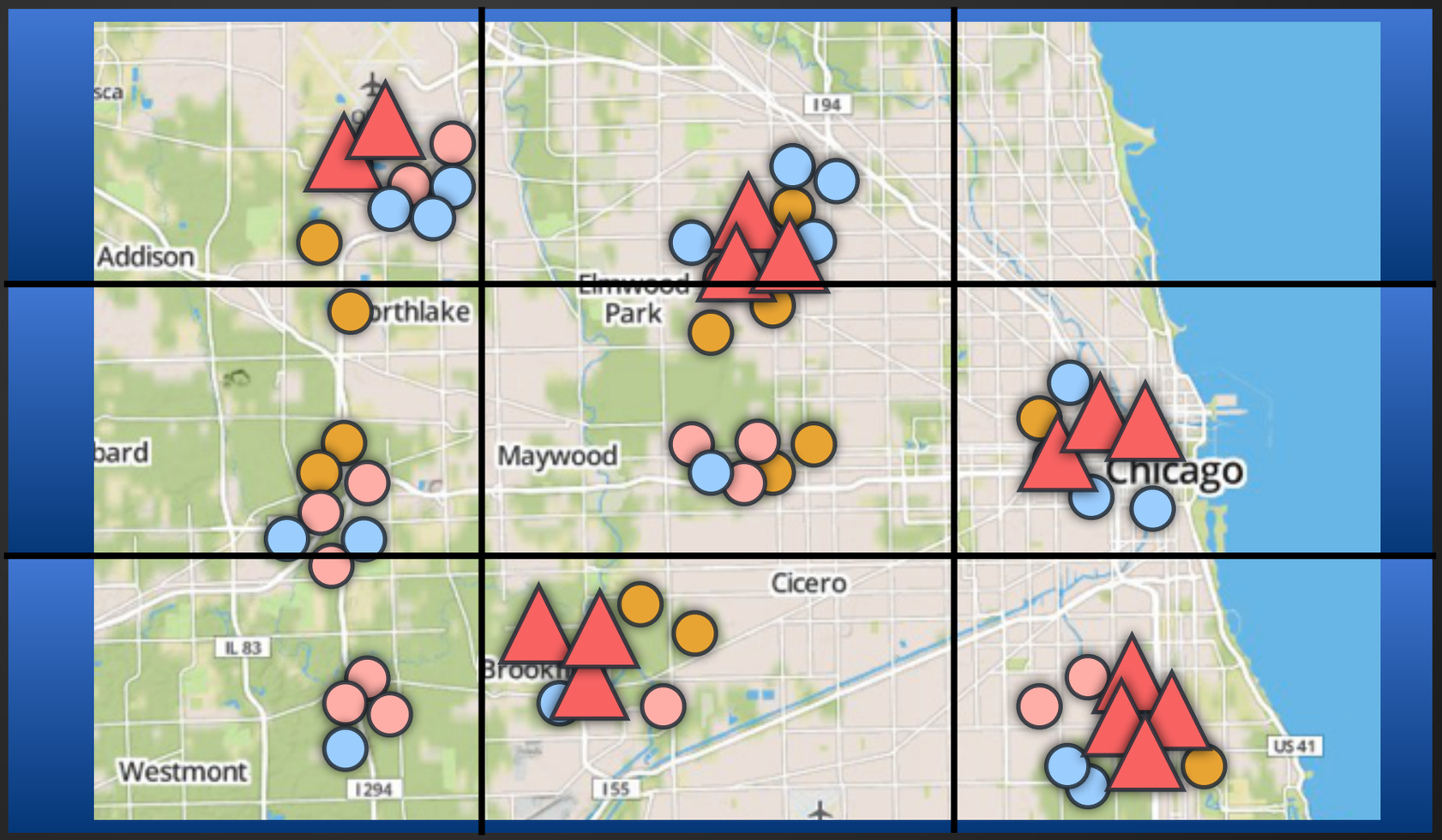

Visual query

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Co
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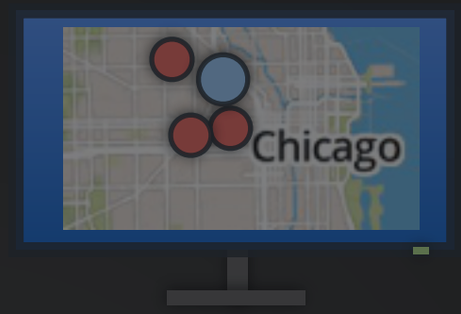
Lateral exploration



- Visual query is scalable with display size
- Leverage pre-attentive processing: design target glyphs to be perceptually distinguishable
- Employ physical navigation instead of pan and zoom