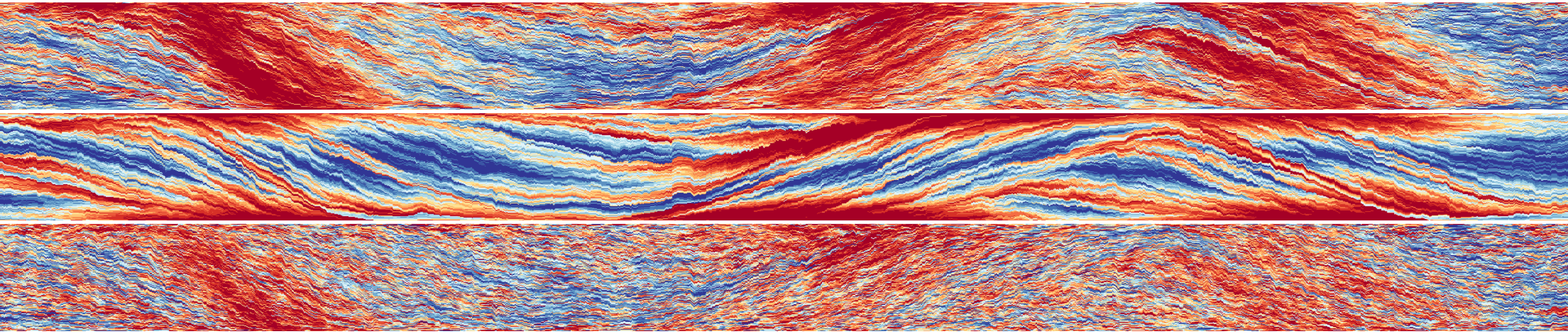
MotionRugs

Visualizing Collective Trends in Space and Time



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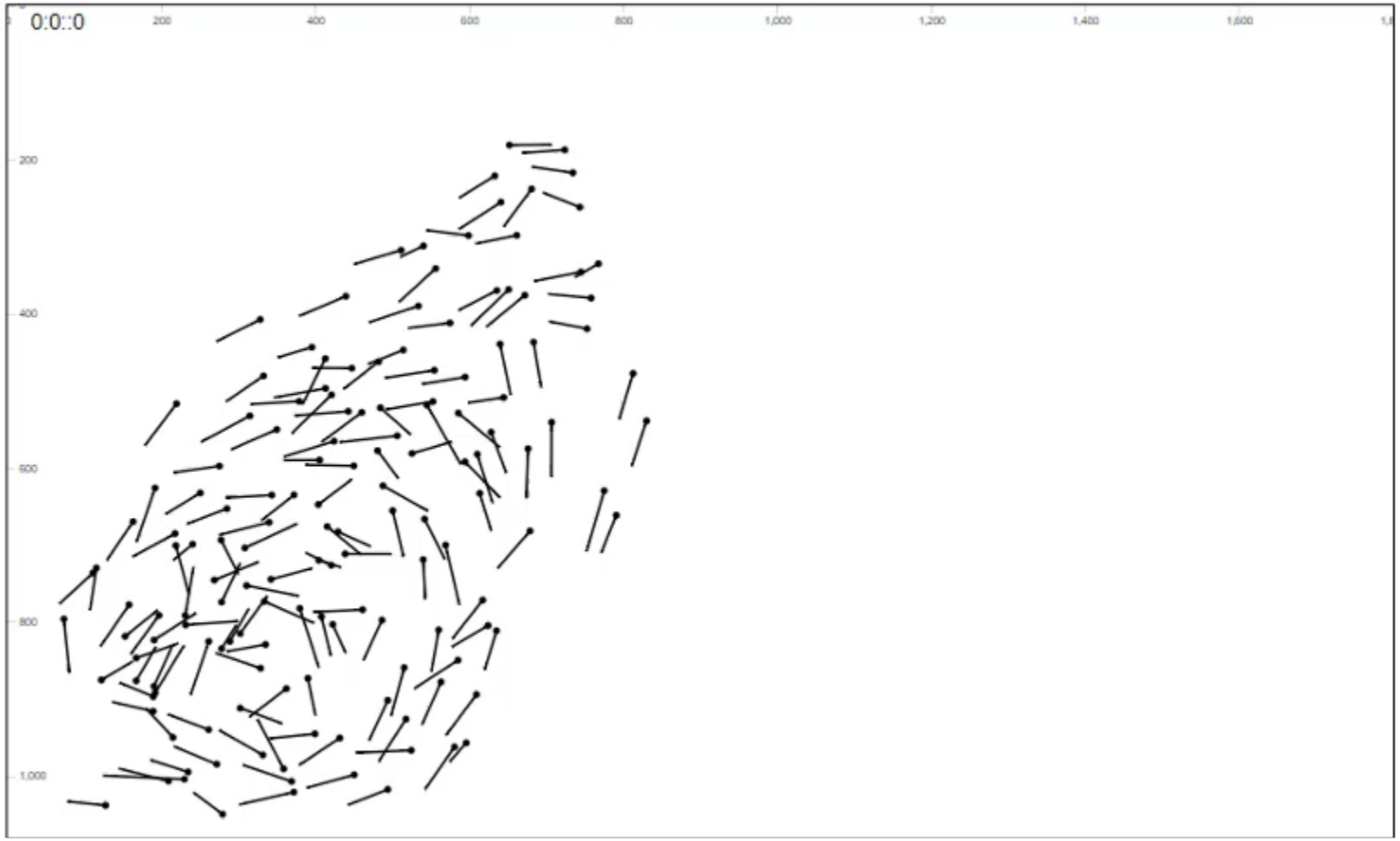
Movement
Collective Behavior
Sensing

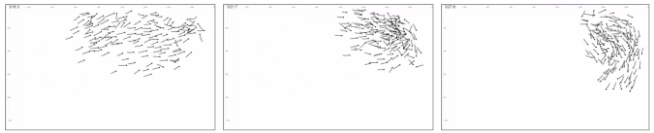
1 | Exploring collective movement datasets



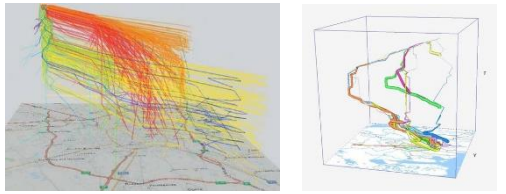
How do we find what is interesting?

Animation?

Aggregation?



Small Multiples?



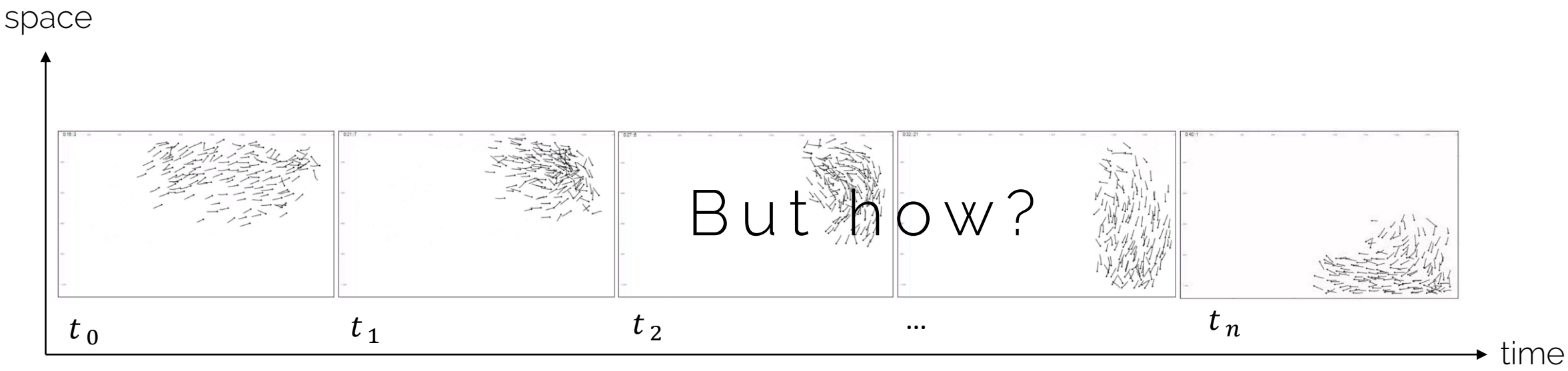
Space-Time-Cubes?

Maybe.
But does it scale?

2 | The ideal solution?

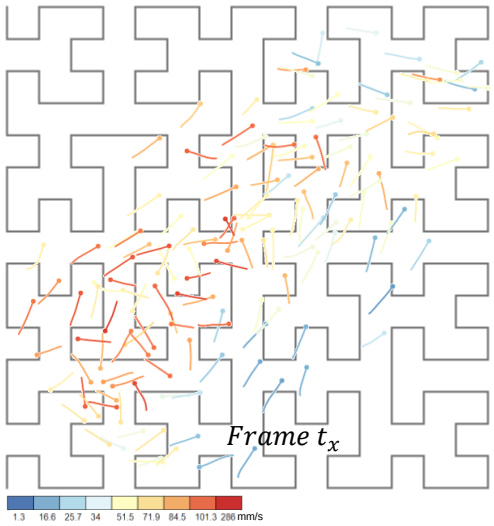
Ideally, a visualization for spatiotemporal collective movement data would:

- Include time and space
- Be compact
- Allow comparisons
- Emphasize change

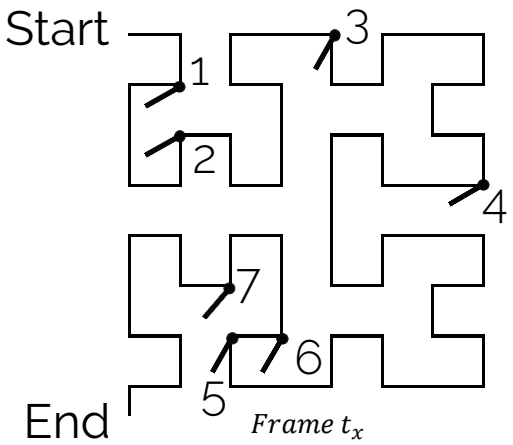


3 | Leveraging Spatial Index Structures

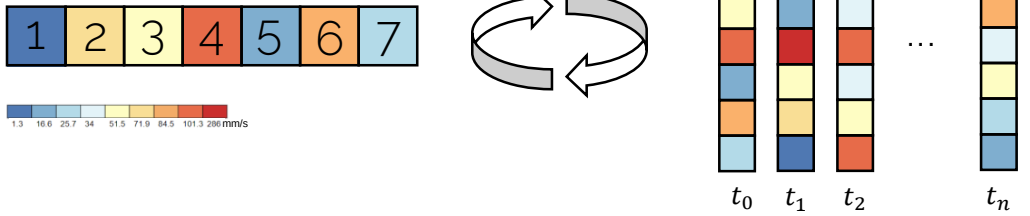
Spatial indexing functions try to linearize multidimensional data to one dimension while preserving the spatial relations between inserted points



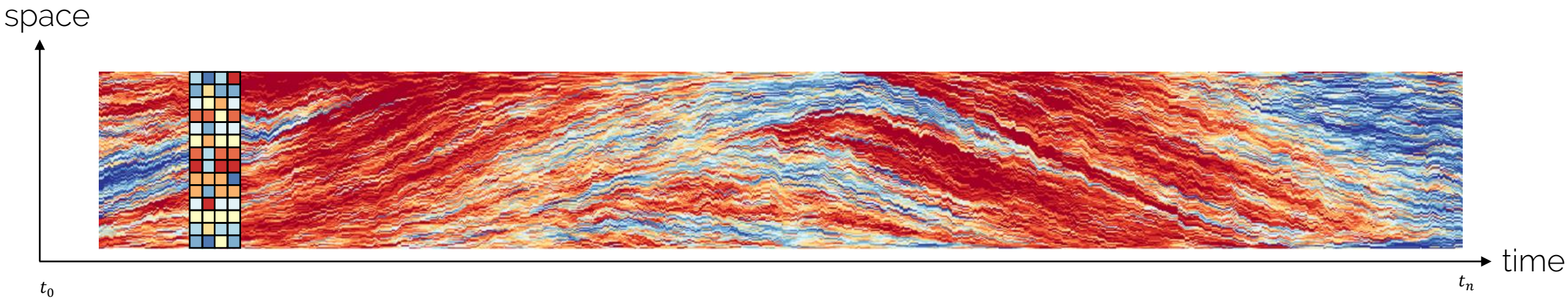
Any numeric feature: speed, acceleration, etc…



Apply spatial linearization to entities of a frame
In this example, we use a ***Hilbert Spacefilling Curve***

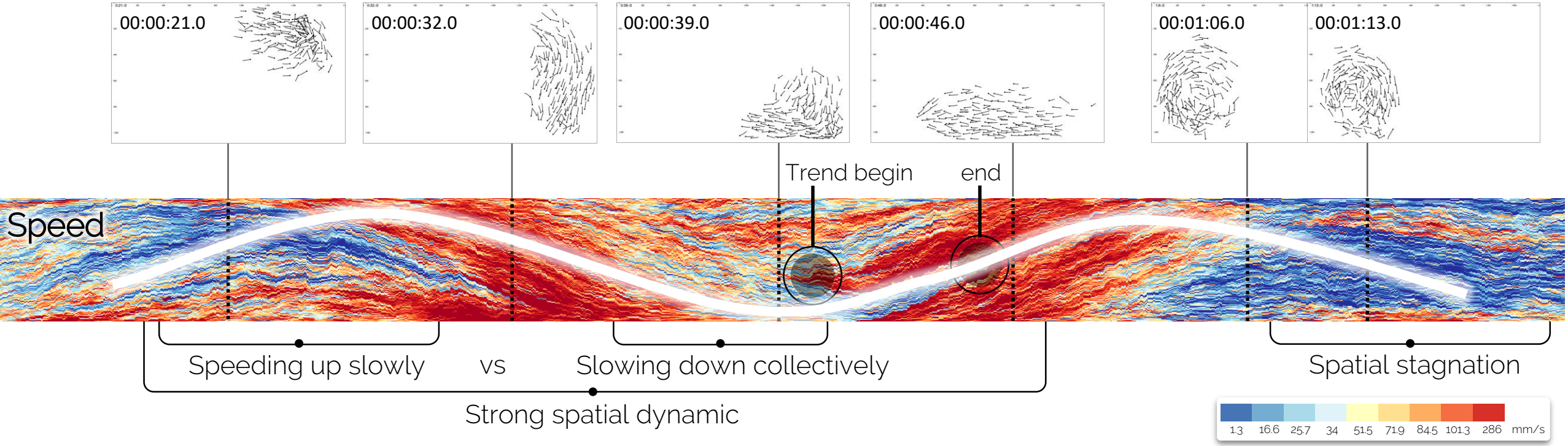


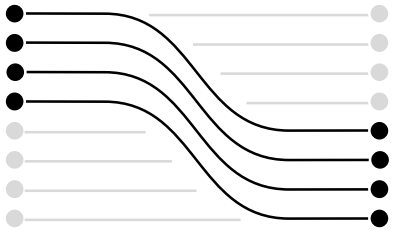
Repeat for all frames



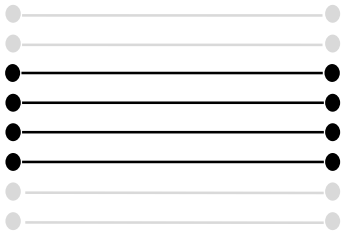
4 | Results and Interpretation

151 fish moving through a shallow tank over the course of ~130s

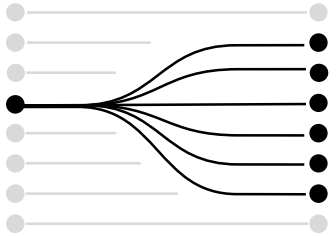




Spatial Dynamic

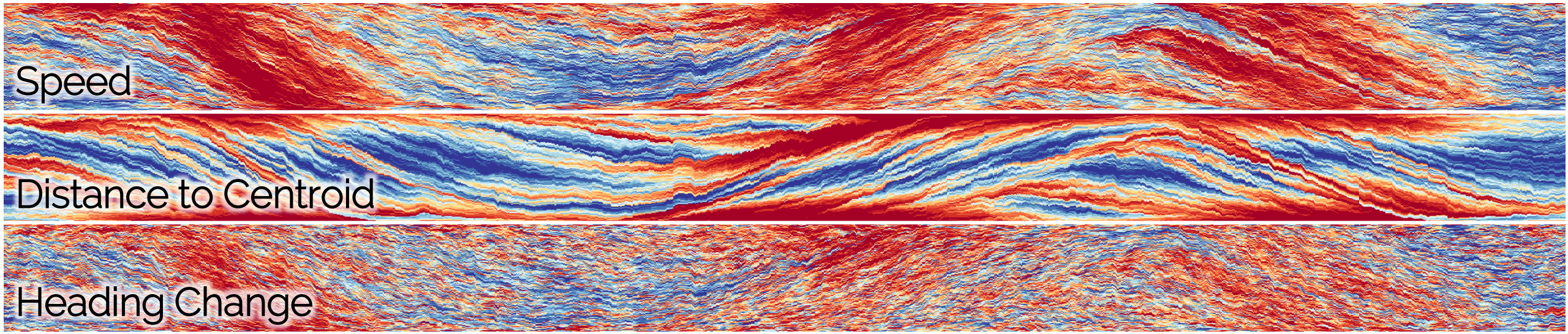


Spatial Stagnation



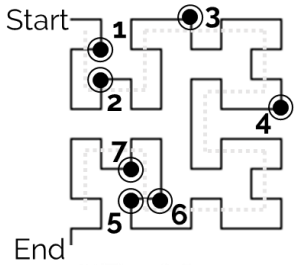
Trend Progression

5 | Putting Features in Context

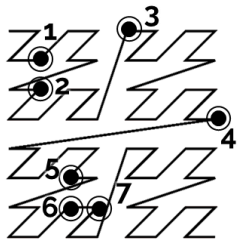


- Spatial Dynamics apparent in all features
- Choice of color map emphasizes semantic contrasts 
- Continuity of measured features determines continuity of the visualization

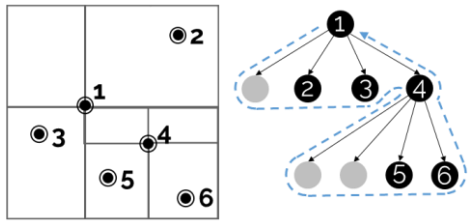
6 | Comparing strategies



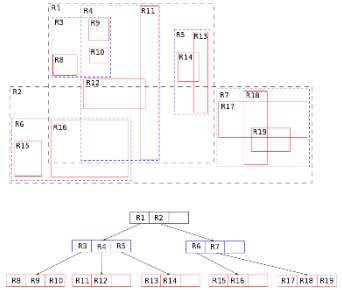
Hilbert Curve



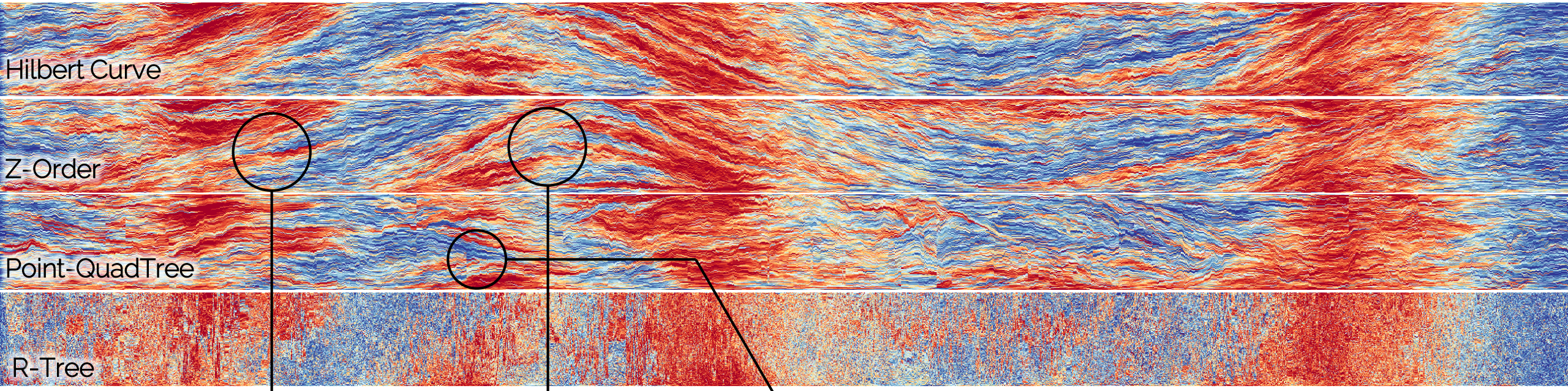
Z-Order

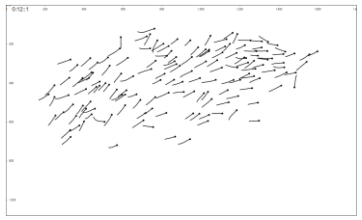


Point-QuadTree

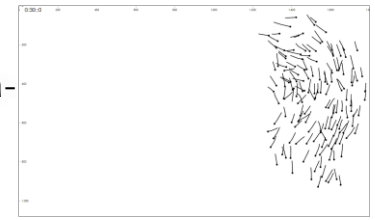


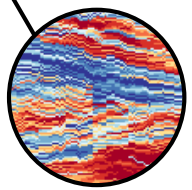
R-Tree



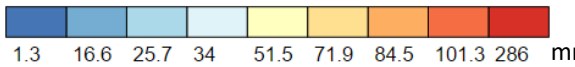


„Phantom-Splits“





Artifacts



7 | Measuring strategy quality

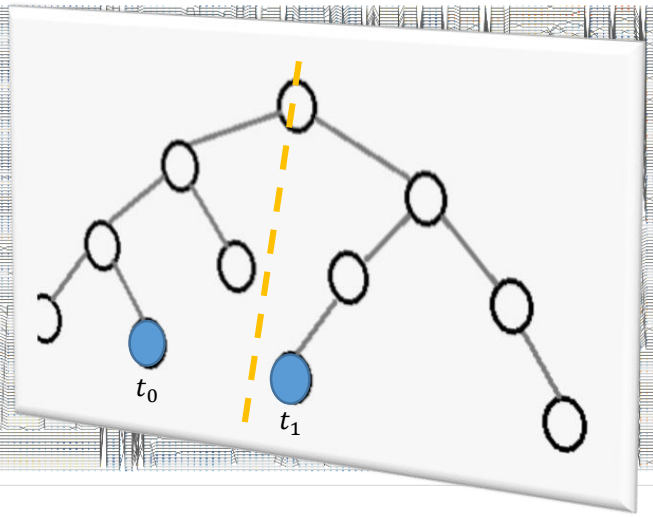
Crossing in the vis

Hilbert Curve

		Z-Order	QuadTree	Hilbert	R-Tree
Kendall's τ	Median	0.9922	0.9922	0.9912	0.9846
	Mean	0.9900	0.9899	0.9886	0.9090
	Max	1	1	1	1
	σ	0.0085	0.0094	0.0095	0.1609
Crossings	Median	44	44	50	87
	Mean	56.63	56.97	64.43	515.7
	Max	533	1154	433	6806
	σ	48.34	53.36	53.77	911.80
Skips	Median	82	82	94	160
	Mean	103.8	102.9	116.5	789.6
	Max	1810	742	672	9196
	σ	83.32	90.66	91.11	1322.19

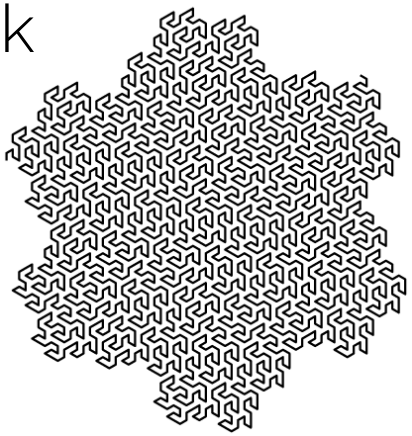
Crossing in the vis

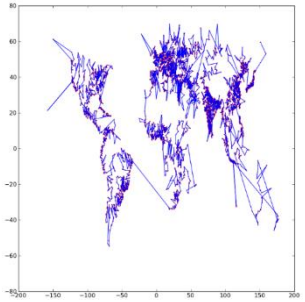
R-Tree



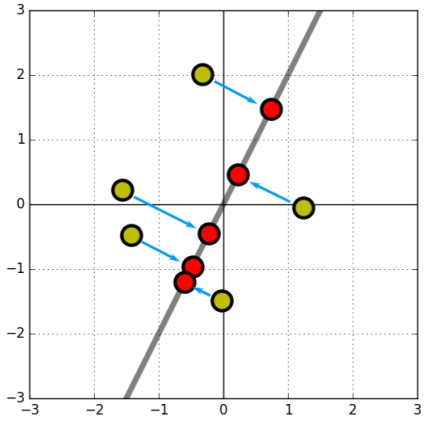
8 | Outlook

Gosper- / Peano- /
E- / Sierpinski Curves

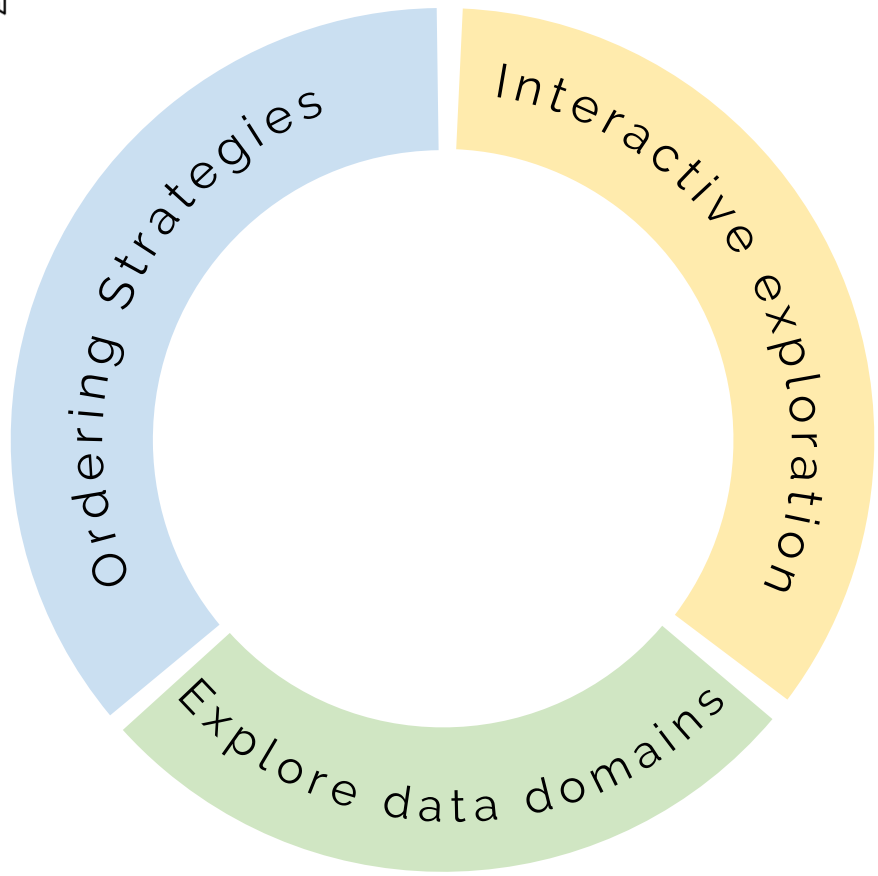


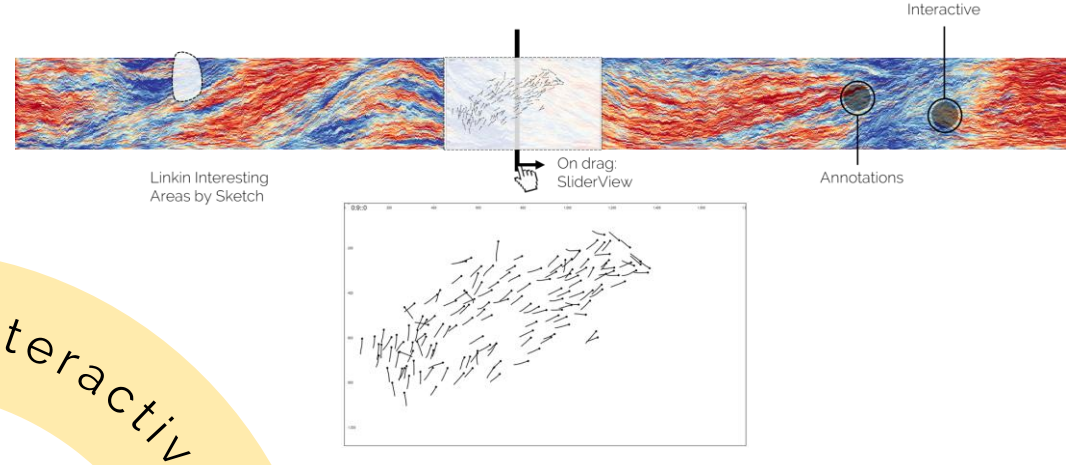


MDS-Projection

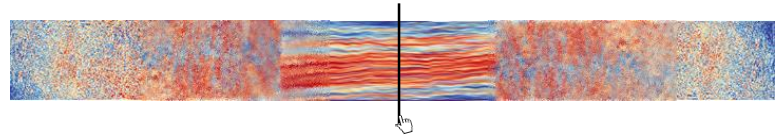


Johnson-Lindenstrauss Lemma

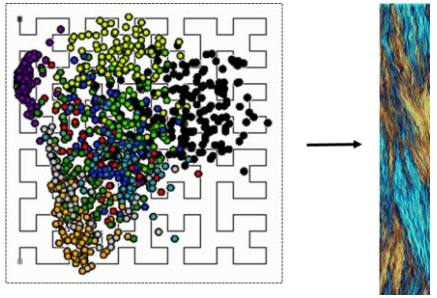




Linking&Brushing,
SlidingPreview



Fixing the slice-order to determine
the Collectives' stability



Using MotionRugs for temporal MDS plots

MotionRugs

compact | two-dimensional | overview-oriented

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