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Mapping trajectories and flows: Facilitating a human-centered approach to movement data analytics

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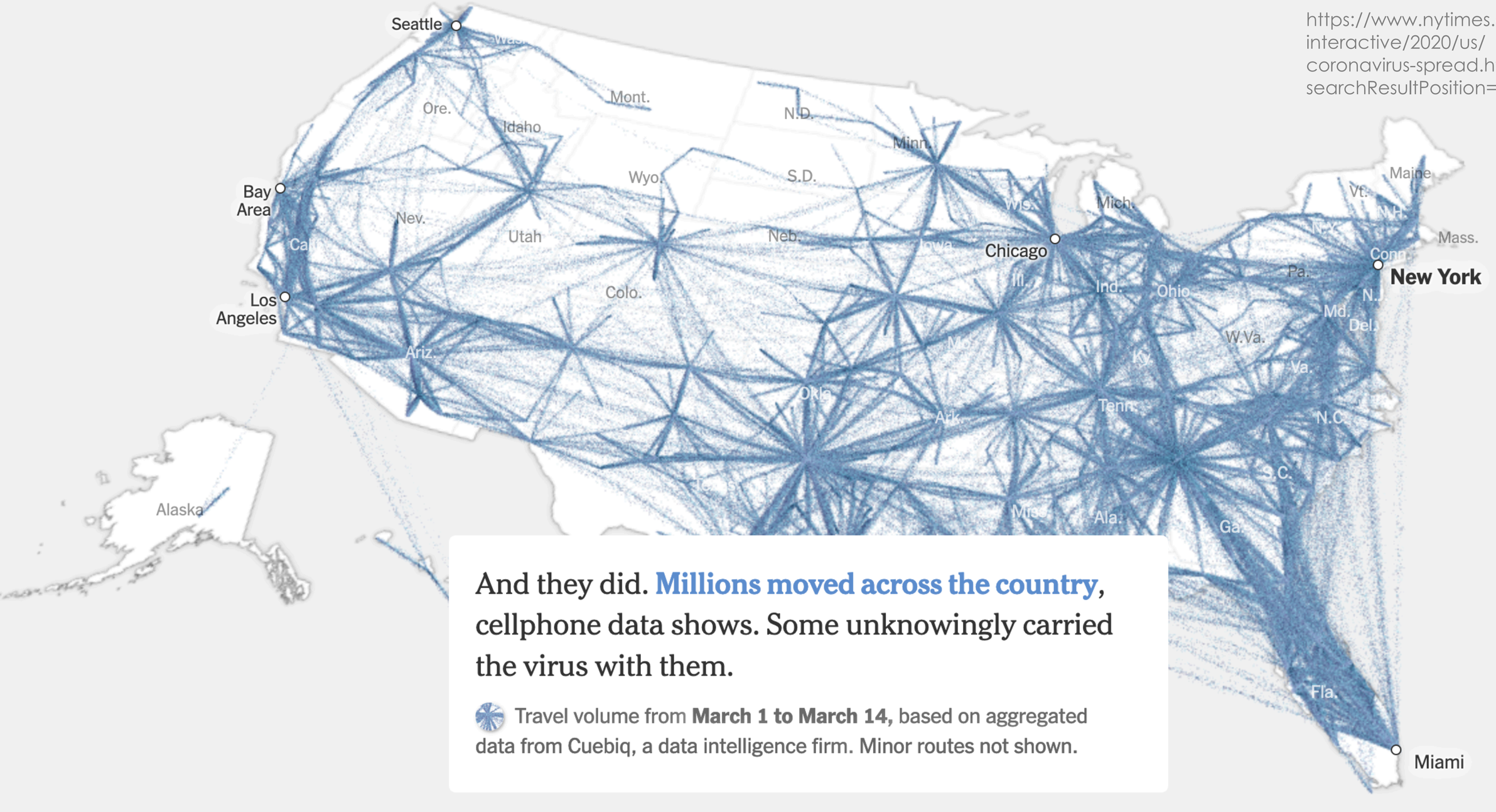
Dodge S., & Noi, E.(in press), **Mapping trajectories and flows: Facilitating a human-centered approach to data-driven movement analytics.** *CaGIS*

Movement is central to understanding human mobility

Source: **NYTimes**
How the virus won.

https://www.nytimes.com/interactive/2020/us/coronavirus-spread.html?searchResultPosition=5

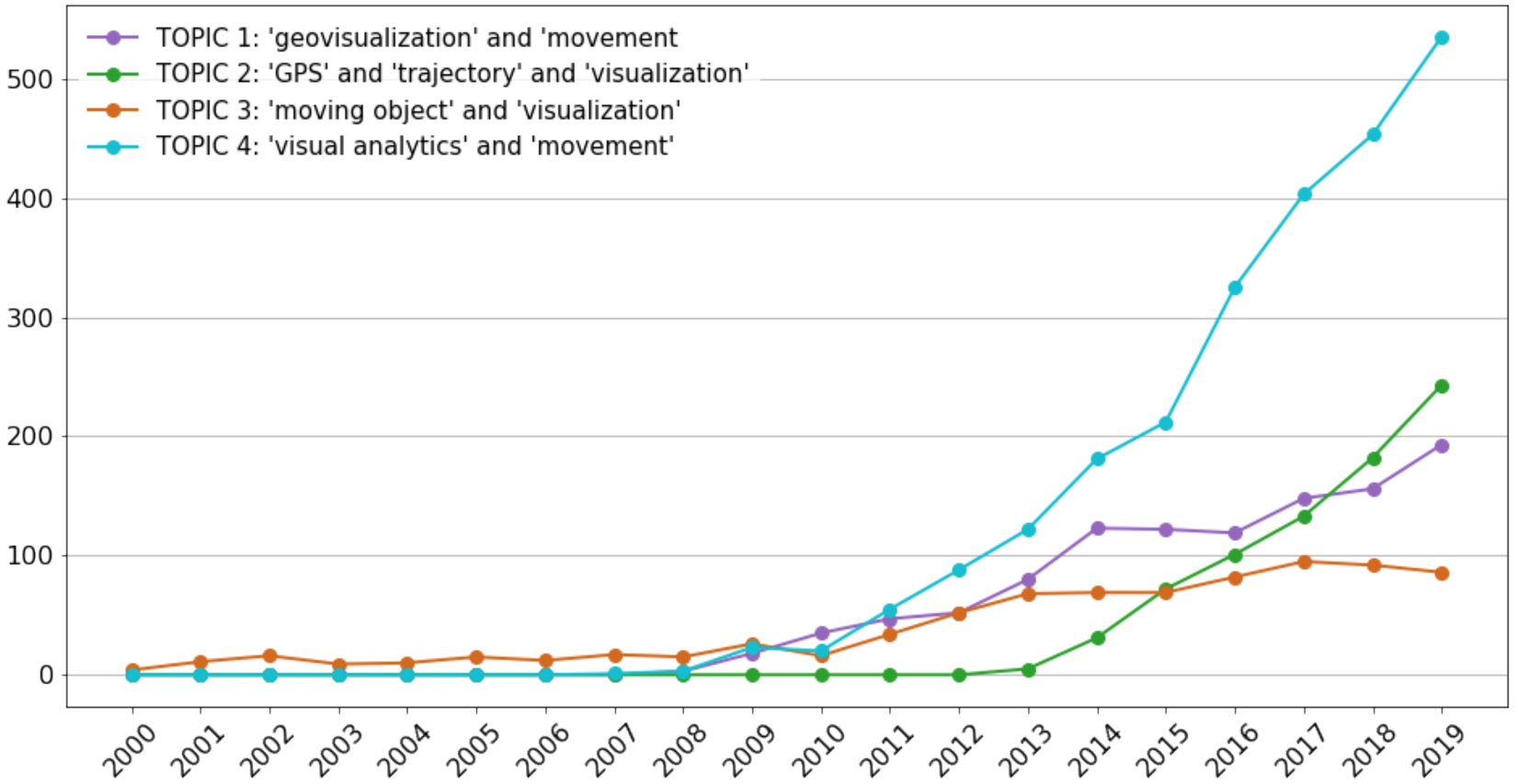


And they did. **Millions moved across the country**, cellphone data shows. Some unknowingly carried the virus with them.

Travel volume from **March 1 to March 14,** based on aggregated data from Cuebiq, a data intelligence firm. Minor routes not shown.

Using visualization to facilitate knowledge discovery from Movement data

Web of Science



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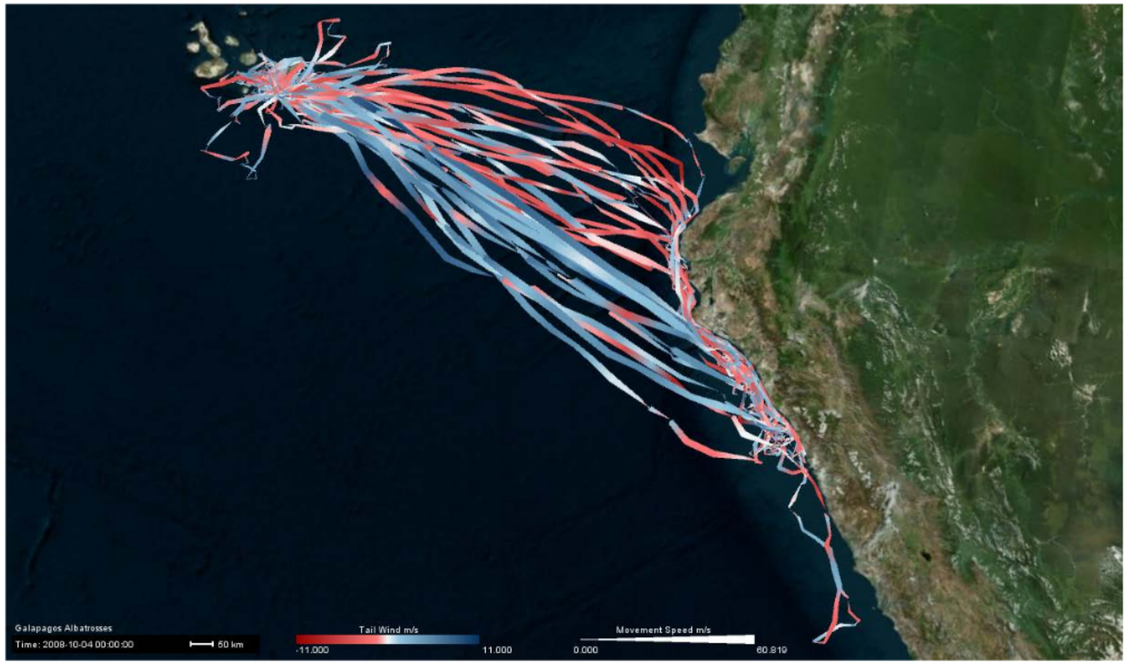
Movement data

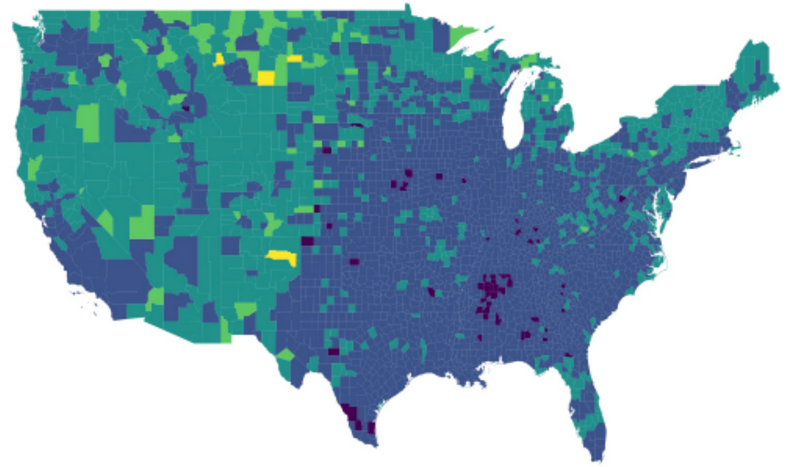
Individual Trajectories (Lagrangian perspective)

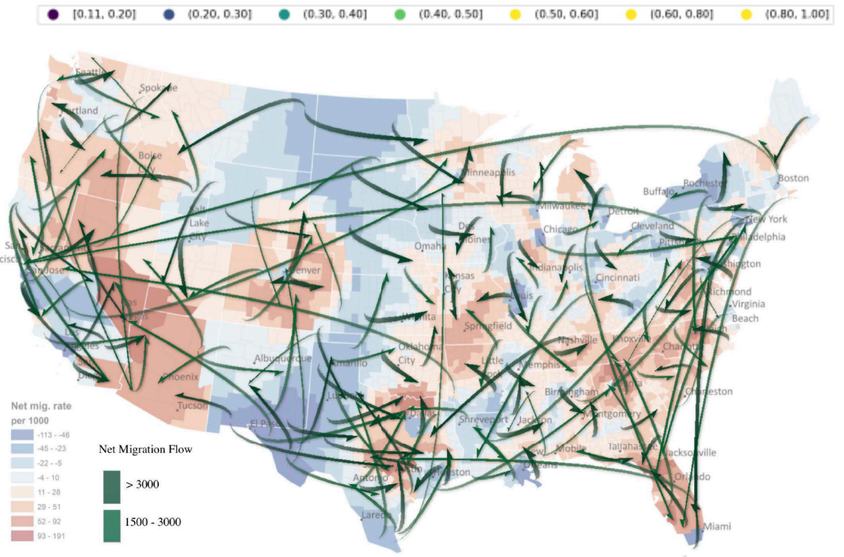


Xavier & Dodge (2014)

GPS Trajectories of 9 adult albatrosses (90 min resolution), annotated with wind speed (m/s) and wind direction, 6-hour, 2.5°, U/V-wind components NCEP Reanalysis 2 using Env-DATA

Aggregate Movement / Flows (Eulerian perspective)
March 1, 2020

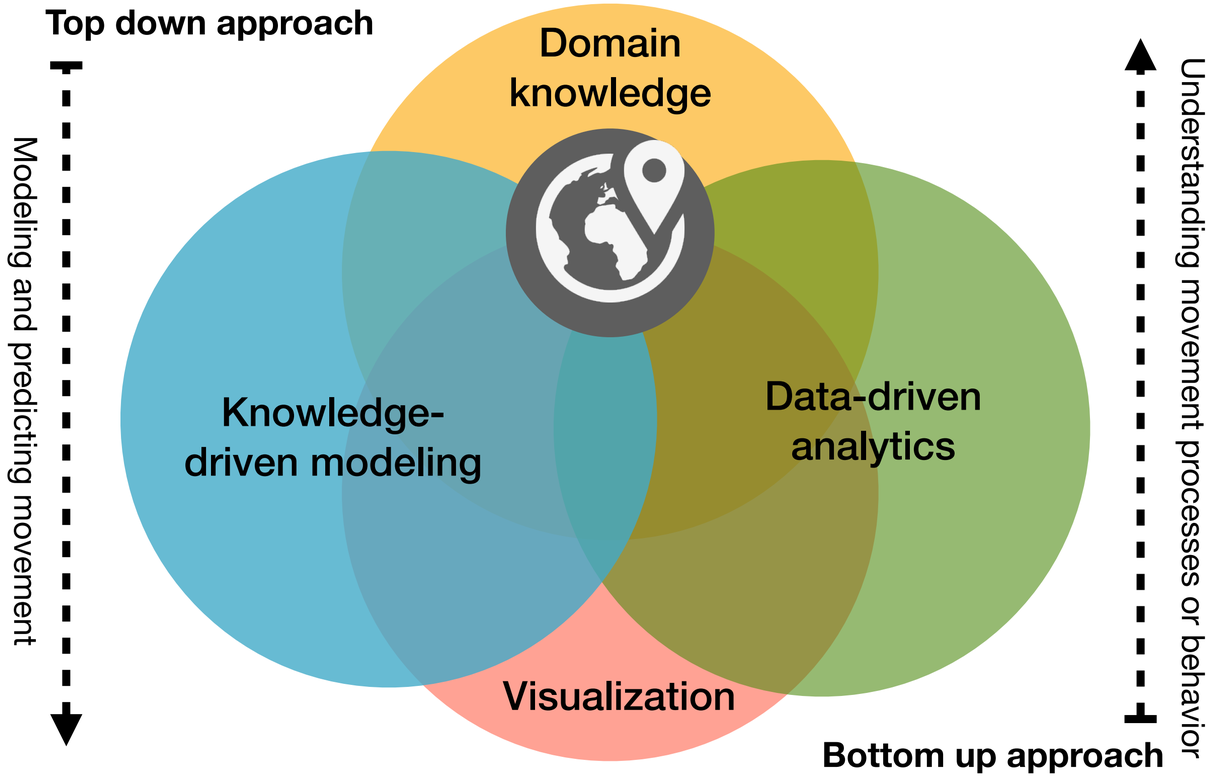




US Migration: “Smoothed net migration flows for age 25-29, with population threshold = 1,000,000. The background map shows the net migration rate for age group 25-29.” Guo, 2014

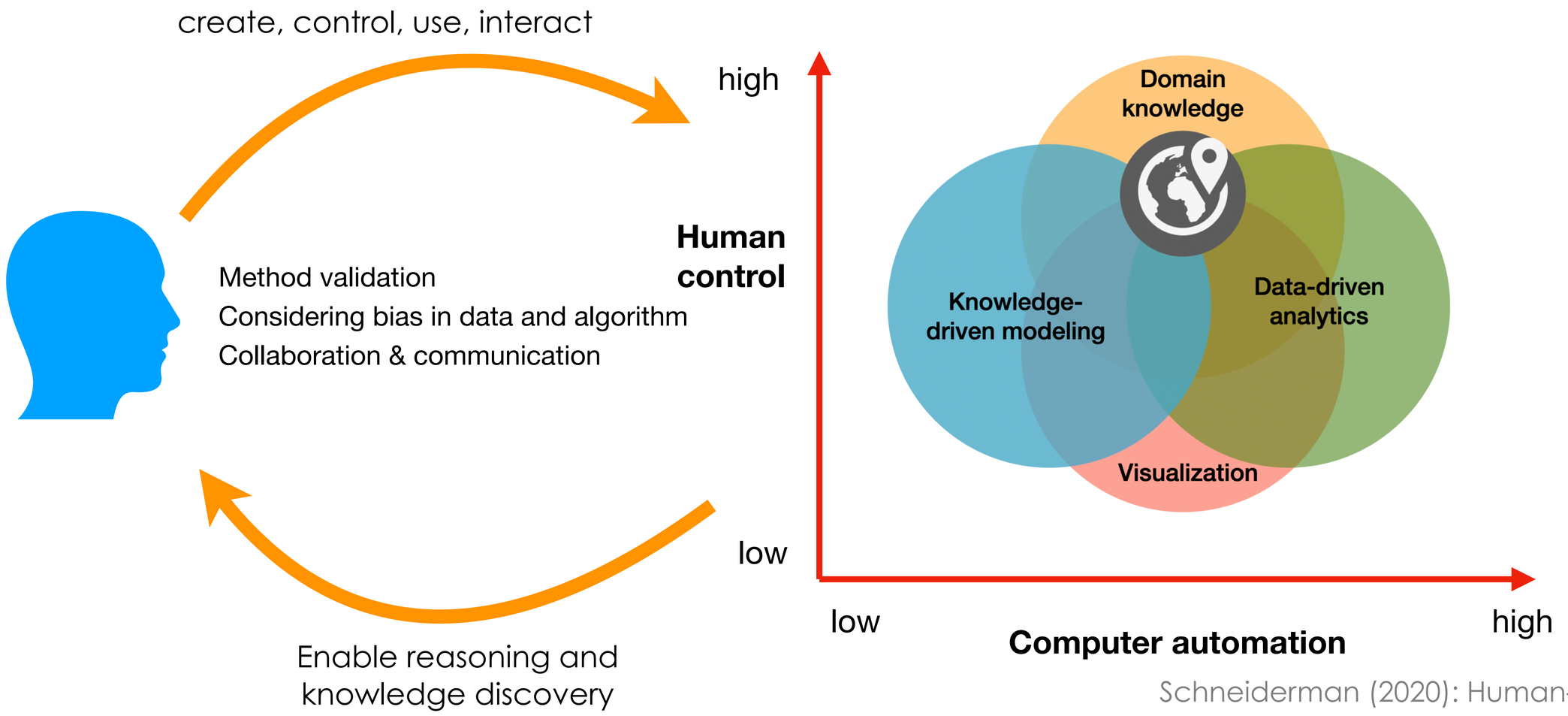
A human-centered approach to movement analytics

TO UNDERSTANDING AND PREDICTING MOVEMENT



Dodge S. (2021), **A Data Science Framework for Movement.** *Geographical Analysis*, the GA 50th Anniversary Special Issue, 53 (1), pp. 855 –876.

A human-centered approach to movement analytics



Schneiderman (2020): Human-Centered AI

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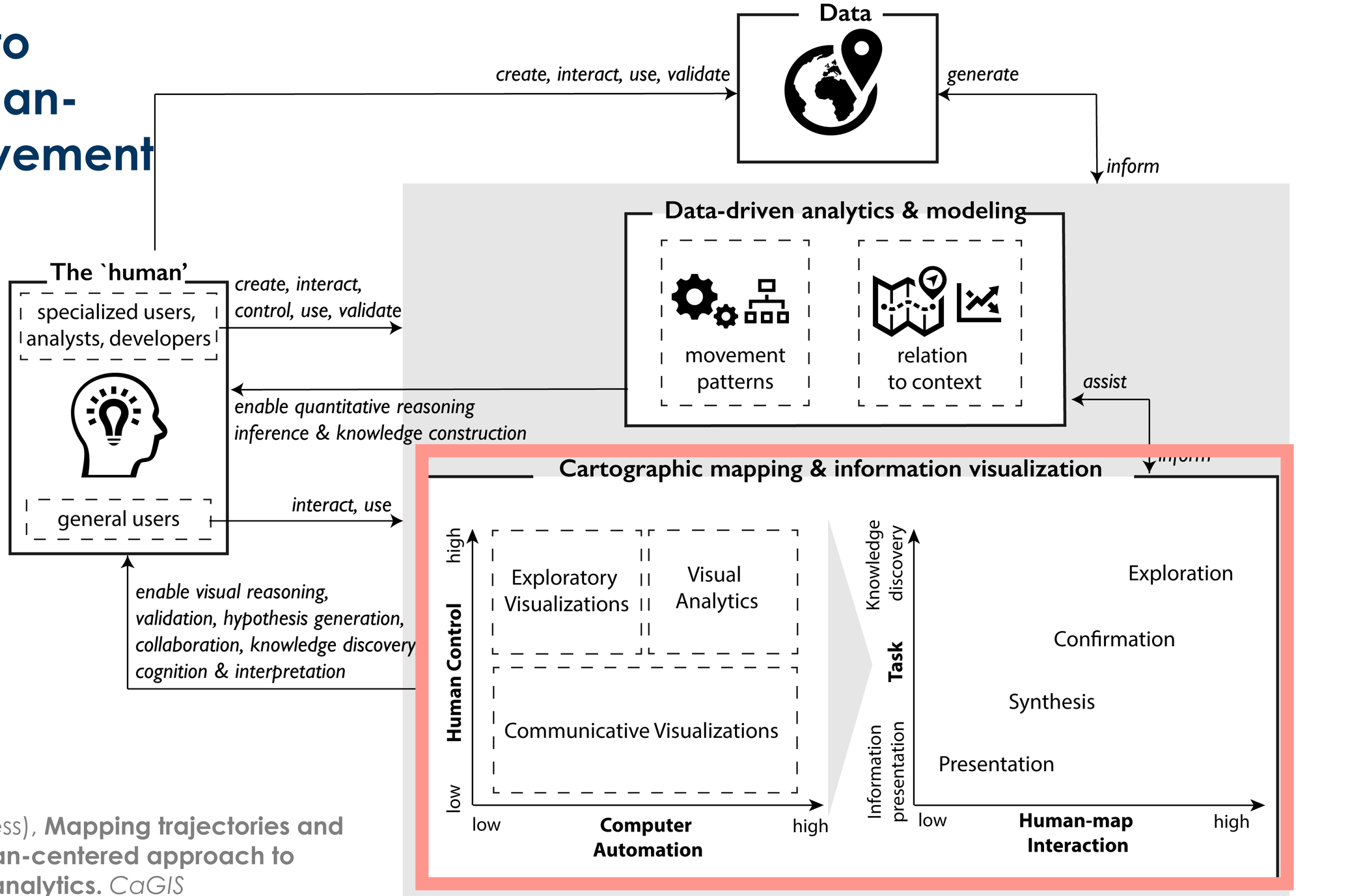
Visualization to facilitate human-centered Movement Analytics



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Schneiderman (2020), MacEachren et al., (2004), Roth (2013)

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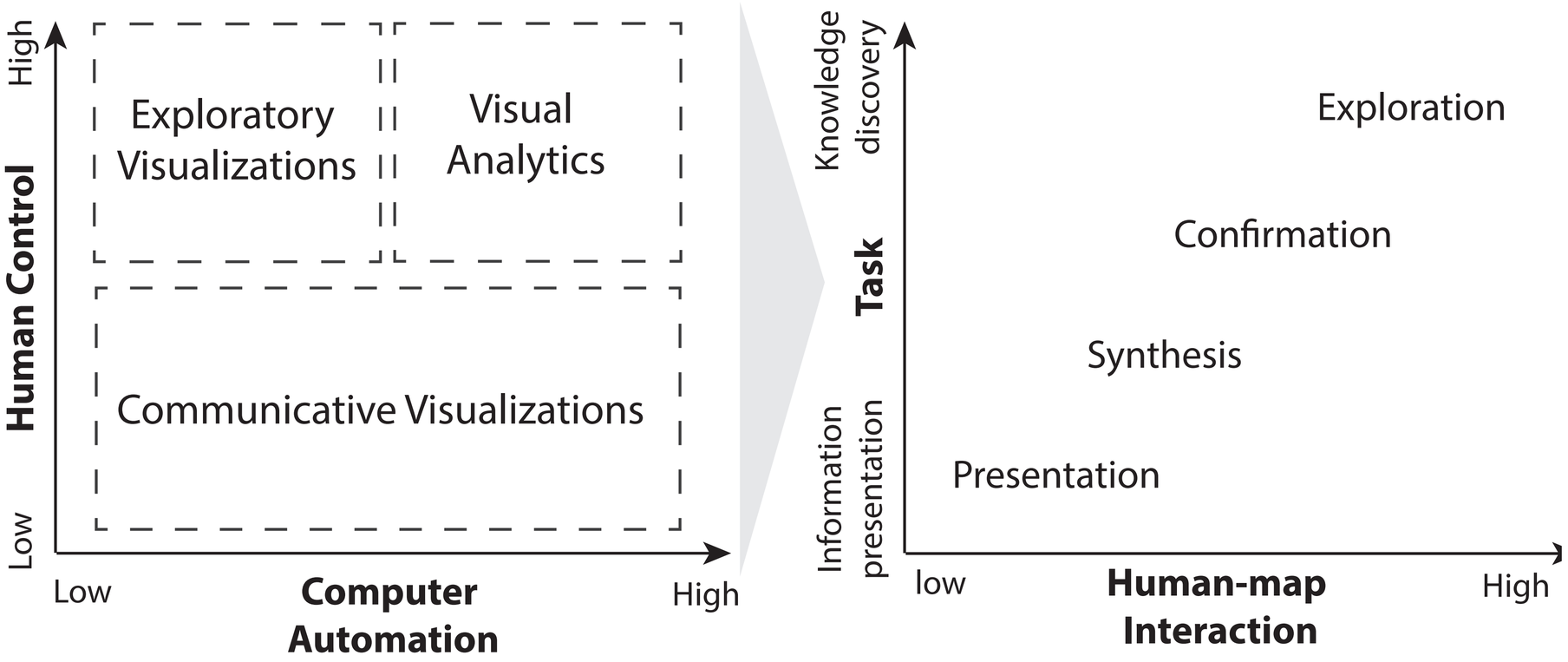
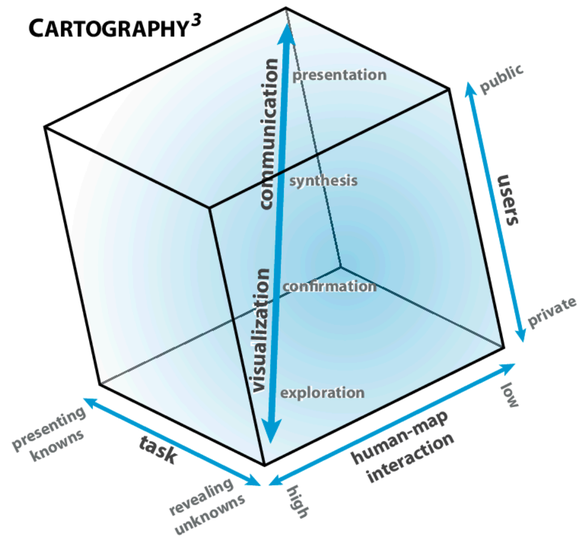
Visualization to facilitate human-centered knowledge Discovery





Schneiderman (2020), MacEachren et al., (2004), Roth (2013)

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Characterizing movement visualization

Geographic representation pyramid

Kraak (2014), Mennis, Peuquet, and Qian (2000)

150 —> 40 (from 2010-2020)

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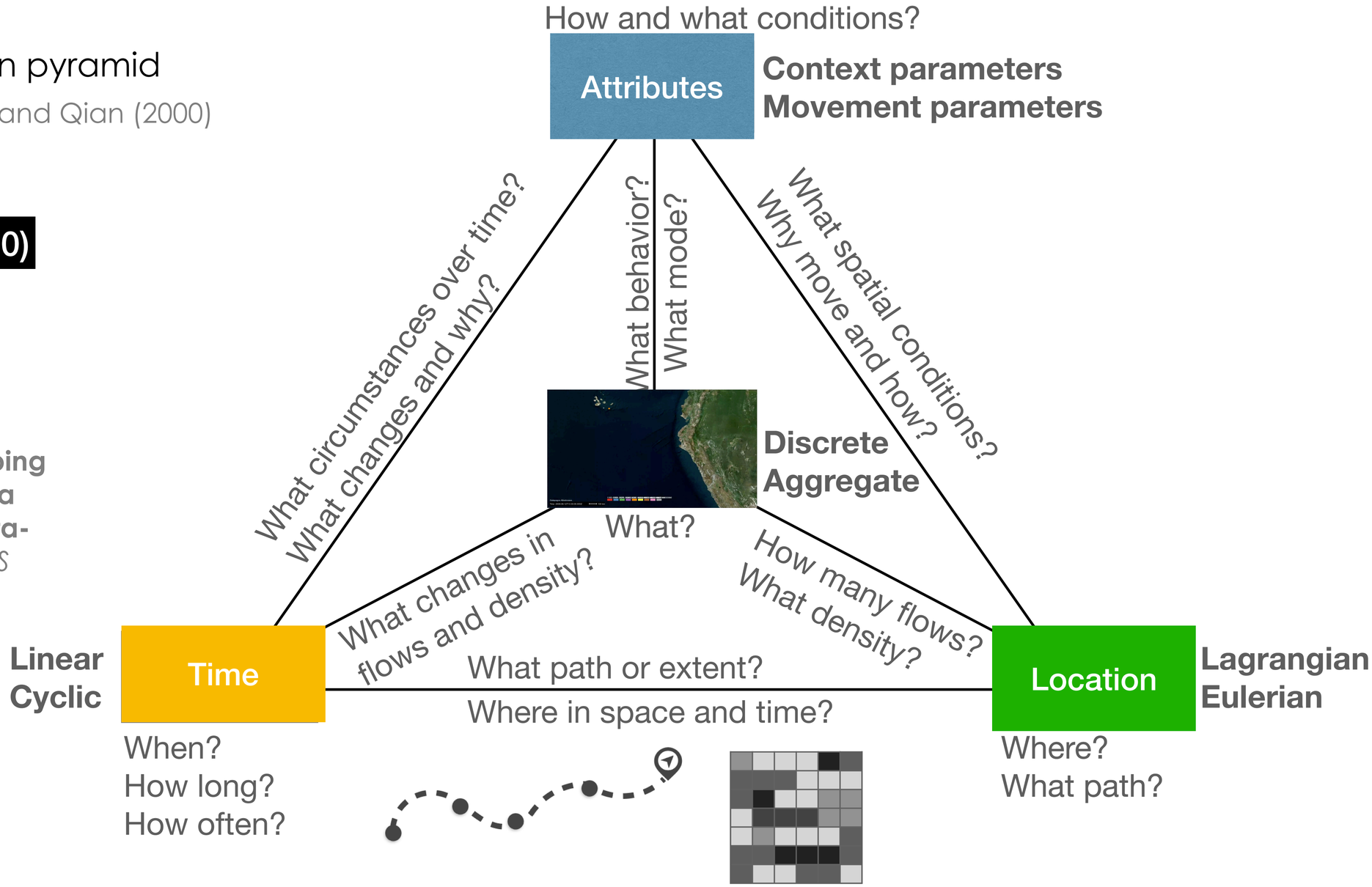
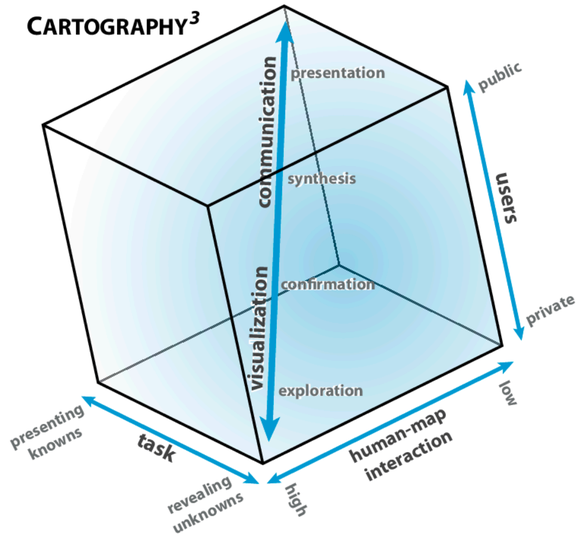


Characterizing movement visualization



MacEachren et al., (2004), Roth (2013)

	Category	#	Elements	Element type (encoding)
VISUAL ELEMENTS	Visualization perspectives	1	Lagrangian	binary (0/1)
		2	Eulerian	binary (0/1)
	Movement components	3	Discrete	binary (0/1)
		4	Aggregate	binary (0/1)
		5	Location	binary (0/1)
		6	Time	binary (0/1)
		7	Movement parameters	binary (0/1)
		8	Context parameters	binary (0/1)
	Movement data Representation forms	9	Vector	binary (0/1)
		10	Raster	binary (0/1)
	Cartographic features	11	2D	binary (0/1)
		12	3D	binary (0/1)
		13	Dynamic	binary (0/1)
		14	Static	binary (0/1)
FUNCTIONAL ELEMENTS	Dimensions of Cube[3]	13	Specialized users	binary (0/1)
		15	Public/novice user	binary (0/1)
		16	Interaction	ordinal (low/med/high)
		17	Knowledge construction	binary (0/1)
		18	Information presentation	binary (0/1)
	Advanced Exploratory Functions	19	Multiple coordinated views	binary (0/1)
		20	Dynamic querying	binary (0/1)
	Design Flexibility	21	Flexibility	ordinal (low/med/high)

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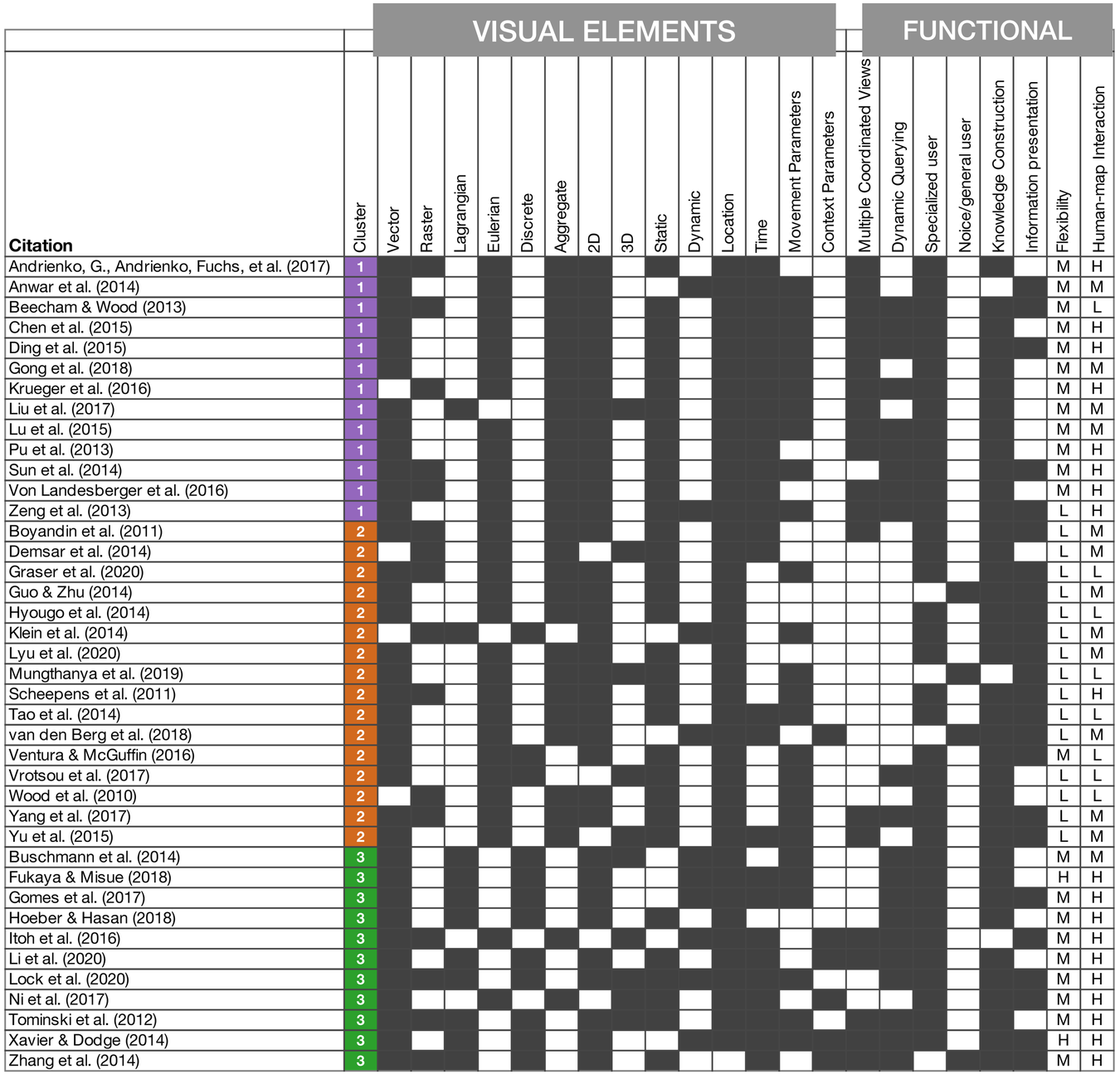
Characterizing movement visualization

Clustering and Community detection analysis.



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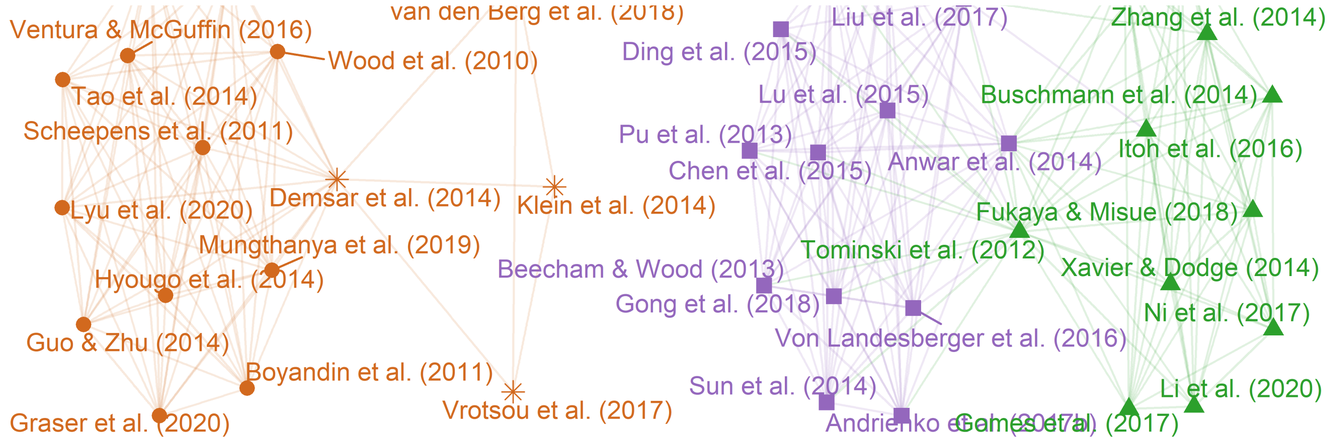
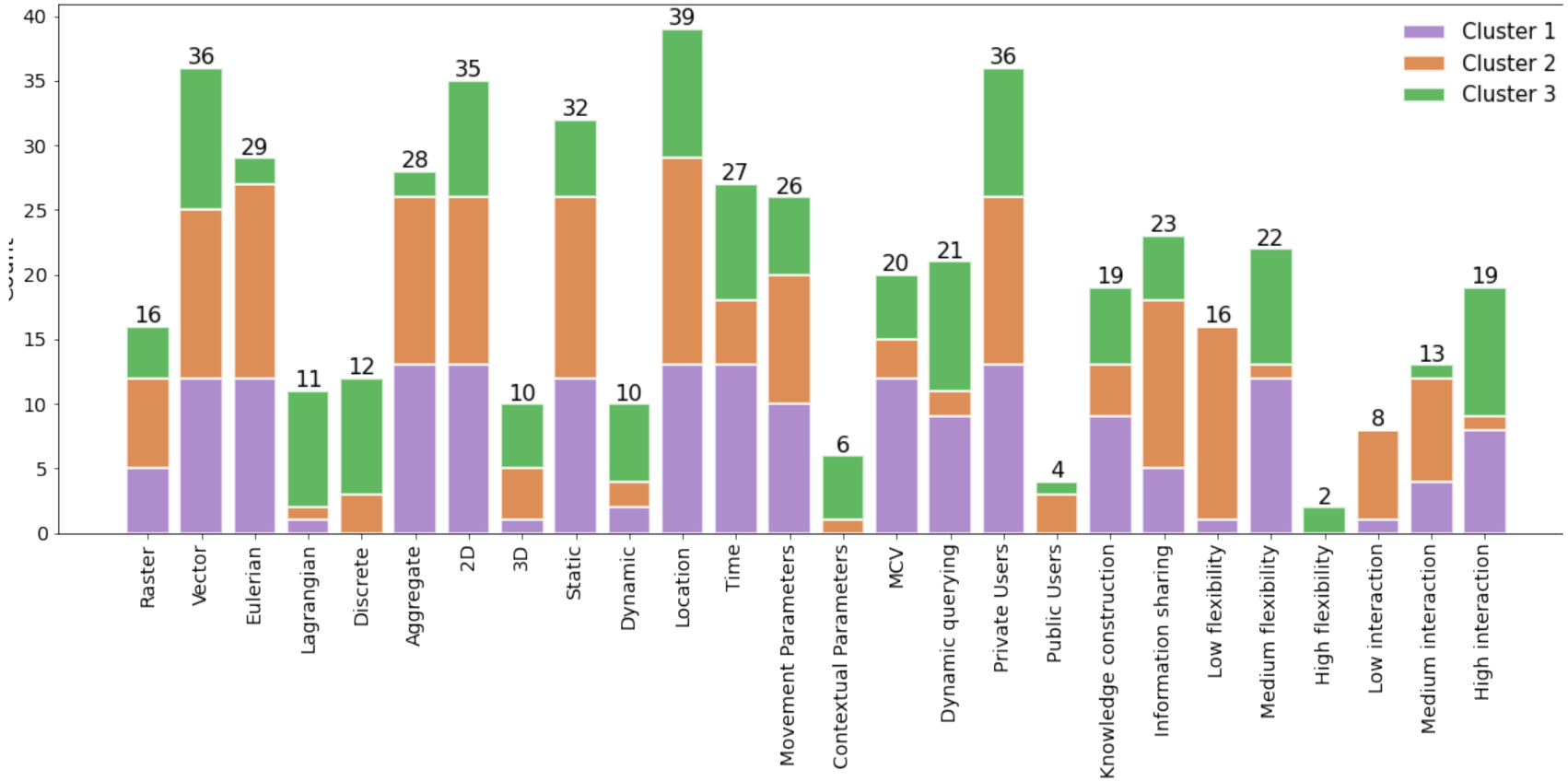
Categories of movement visualization



Cluster 1:
Interactive Visual Analytics of Aggregate Movement

Cluster 2:
Communicative Visualization Methods to Map Aggregate Movement

Cluster 3:
Exploratory & Dynamic Visualization of Trajectories



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Trends and Gaps in Movement Visualization

- Human-centered visualization tools
  - Combination of visual analytics tools and exploratory tools that is flexible enough to switch between representations (and data models)
- Mapping Context (weather, behavior, interactions)
  - Mapping movement vs contextualizing movement (the latter are rare)
- Bridging the interdisciplinary gap in tools
- Cognitive evaluation and usability studies

I would like to thank my advisor and co-author Somayeh Dodge, as well as MoveLAB at UCSB.

~~Beers~~ Questions?

Evgeny Noi

> If geography is a prose, maps are iconography.
> (Lennar Meri)

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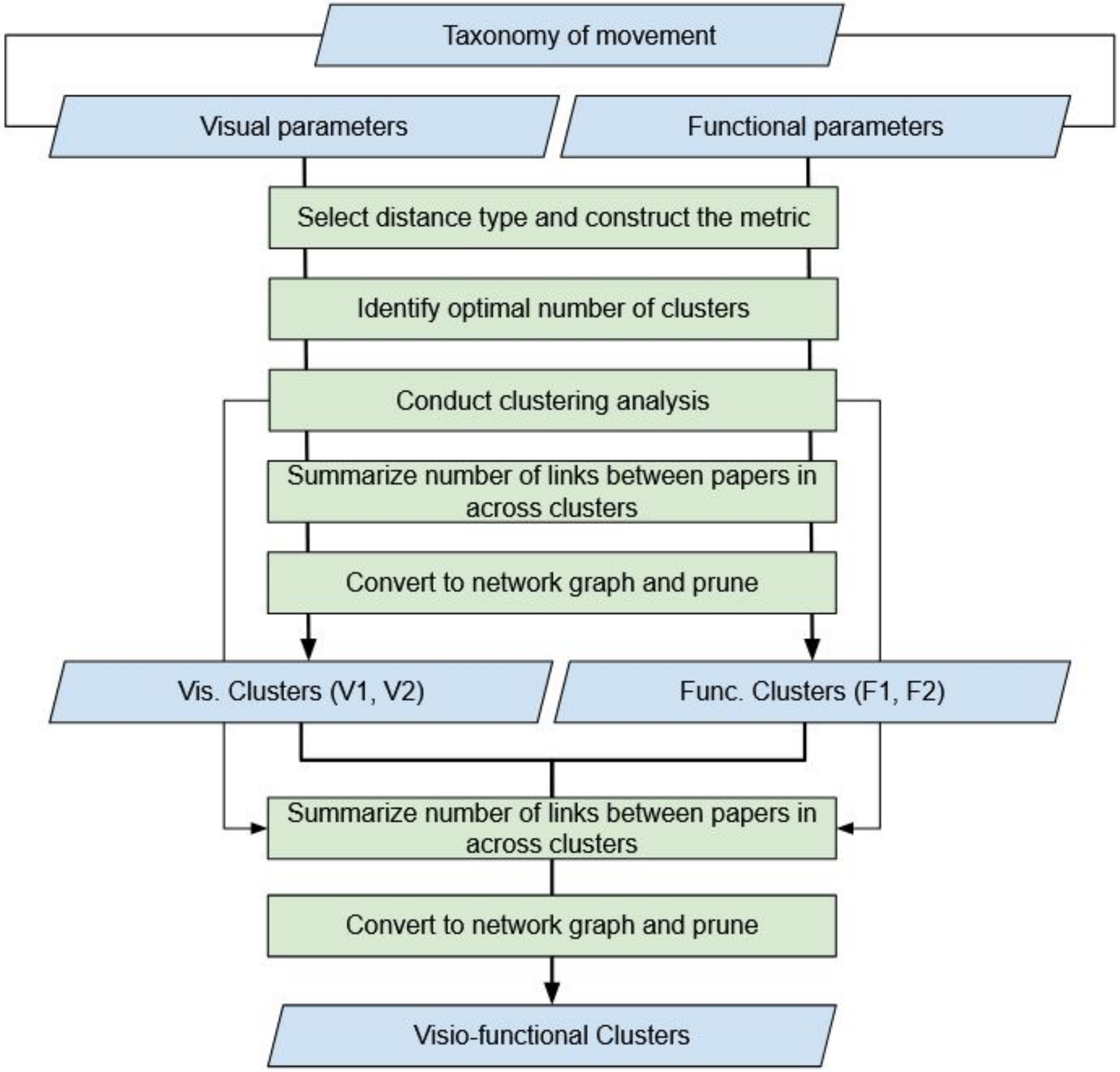
Appendix


Taxonomy of movement
Visual parameters
Functional parameters
Select distance type and construct the metric
Identify optimal number of clusters
Conduct clustering analysis
Summarize number of links between papers in across clusters
Convert to network graph and prune
Vis. Clusters (V1, V2)
Func. Clusters (F1, F2)
Summarize number of links between papers in across clusters
Convert to network graph and prune
Visio-functional Clusters