Information Visualization

Geospatial Visualization

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Paper

A Declarative Rendering Model for Multiclass Density Maps

Jaemin Jo, Frédéric Vernier, Pierre Dragicevic, and Jean-Daniel Fekete, *Senior Member, IEEE*

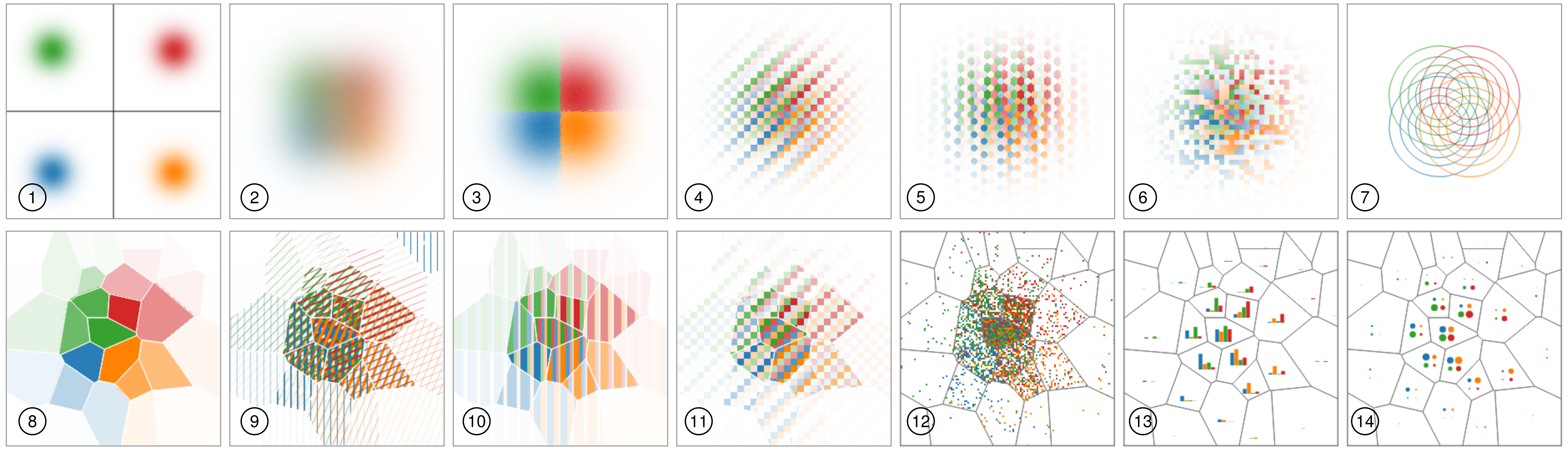
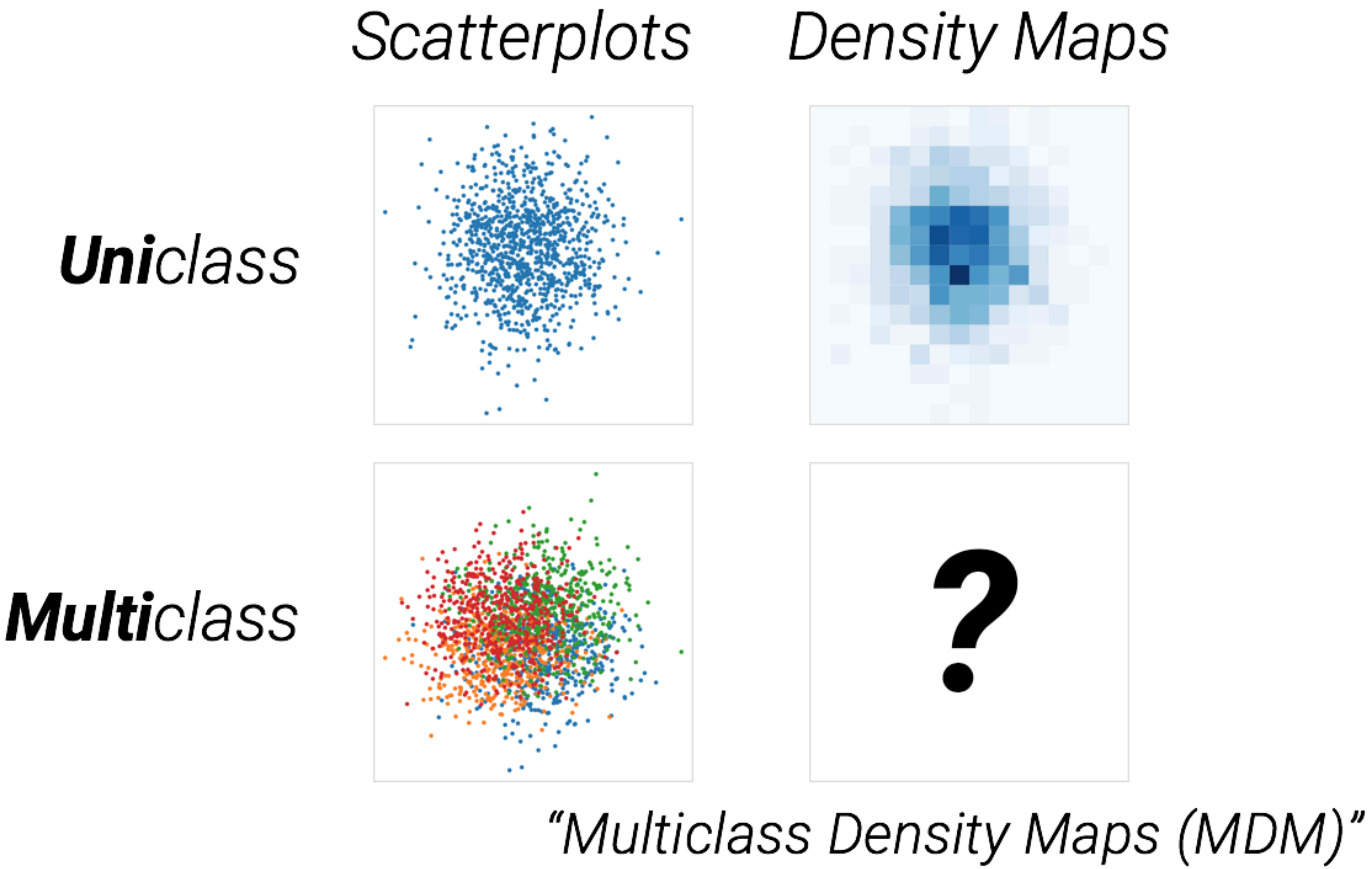


Fig. 1: Design alternatives for a four-class density map. (1) shows small multiples where each density map is individually presented with a unique color; (2) stacks the density maps and blends the color at each pixel; (3) shows the color of the pixel with the highest density; (4)-(6) use regular and irregular weaving patterns; (7) shows a contour plot for each class; and (8)–(14) use rebinning (binning and aggregation over the density maps) with tiles produced by a random Voronoï tessellation. The aggregated values are rendered in (8) with a flat color showing the highest density, (9) with hatching, (10) with proportional bars, (11) with regular weaving, (12) with a dot density plot, (13) with bar-chart glyphs, and (14) with circle sizes.

Abstract—Multiclass maps are scatterplots, multidimensional projections, or thematic geographic maps where data points have a categorical attribute in addition to two quantitative attributes. This categorical attribute is often rendered using shape or color, which does not scale when overplotting occurs. When the number of data points increases, multiclass maps must resort to data aggregation to remain readable. We present *multiclass density maps*: multiple 2D histograms computed for each of the category values. Multiclass density maps are meant as a building block to improve the expressiveness and scalability of multiclass map visualization. In this article, we first present a short survey of aggregated multiclass maps, mainly from cartography. We then introduce a declarative model—a simple yet expressive JSON grammar associated with visual semantics—that specifies a wide design space of visualizations for multiclass density maps. Our declarative model is expressive and can be efficiently implemented in visualization front-ends such as modern web browsers. Furthermore, it can be reconfigured dynamically to support data exploration tasks without recomputing the raw data. Finally, we demonstrate how our model can be used to reproduce examples from the past and support exploring data at scale.

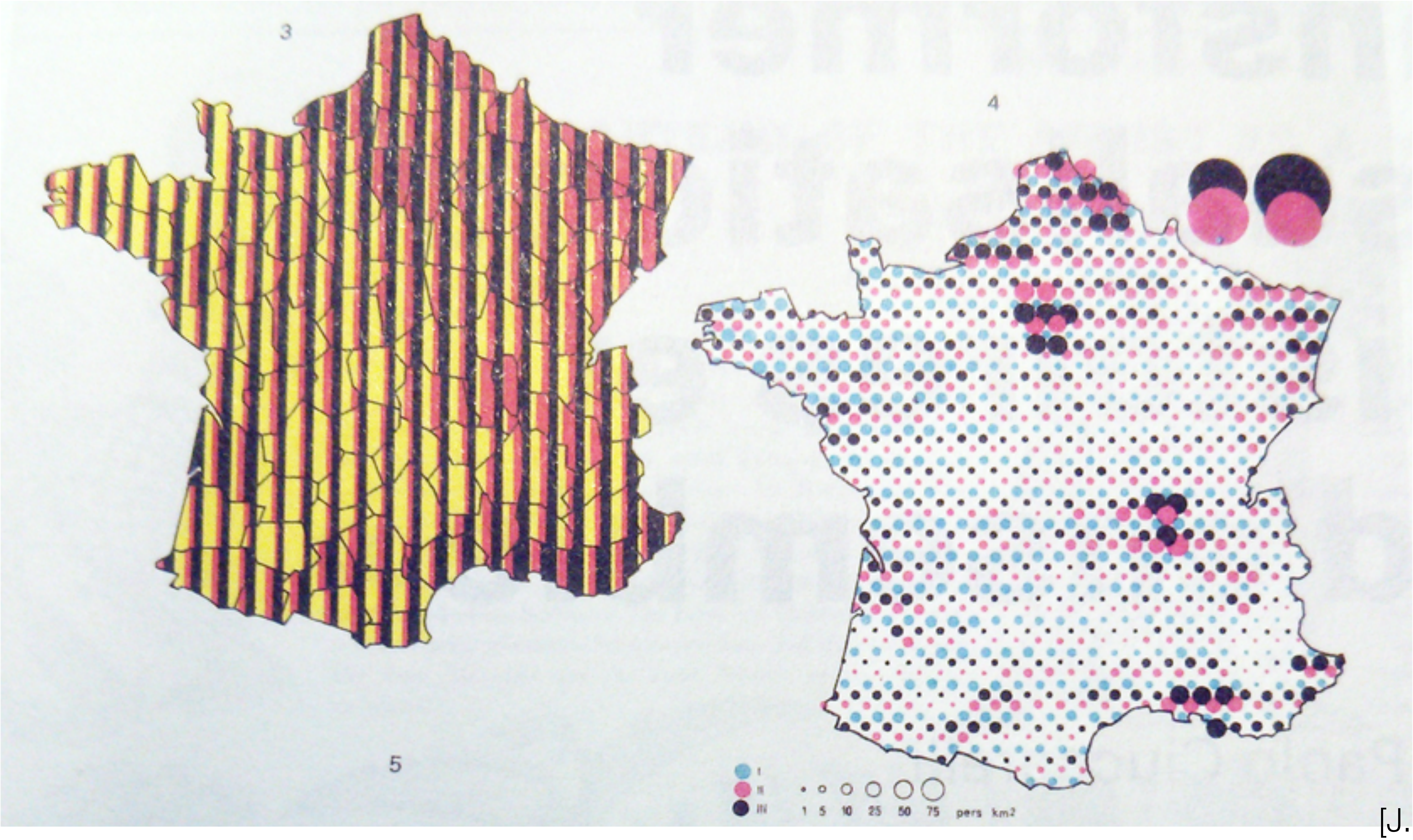
Index Terms—Scalability, multiclass scatterplots, density maps, aggregation, declarative specification, visualization grammar

Multiclass Density Maps (MDMs)



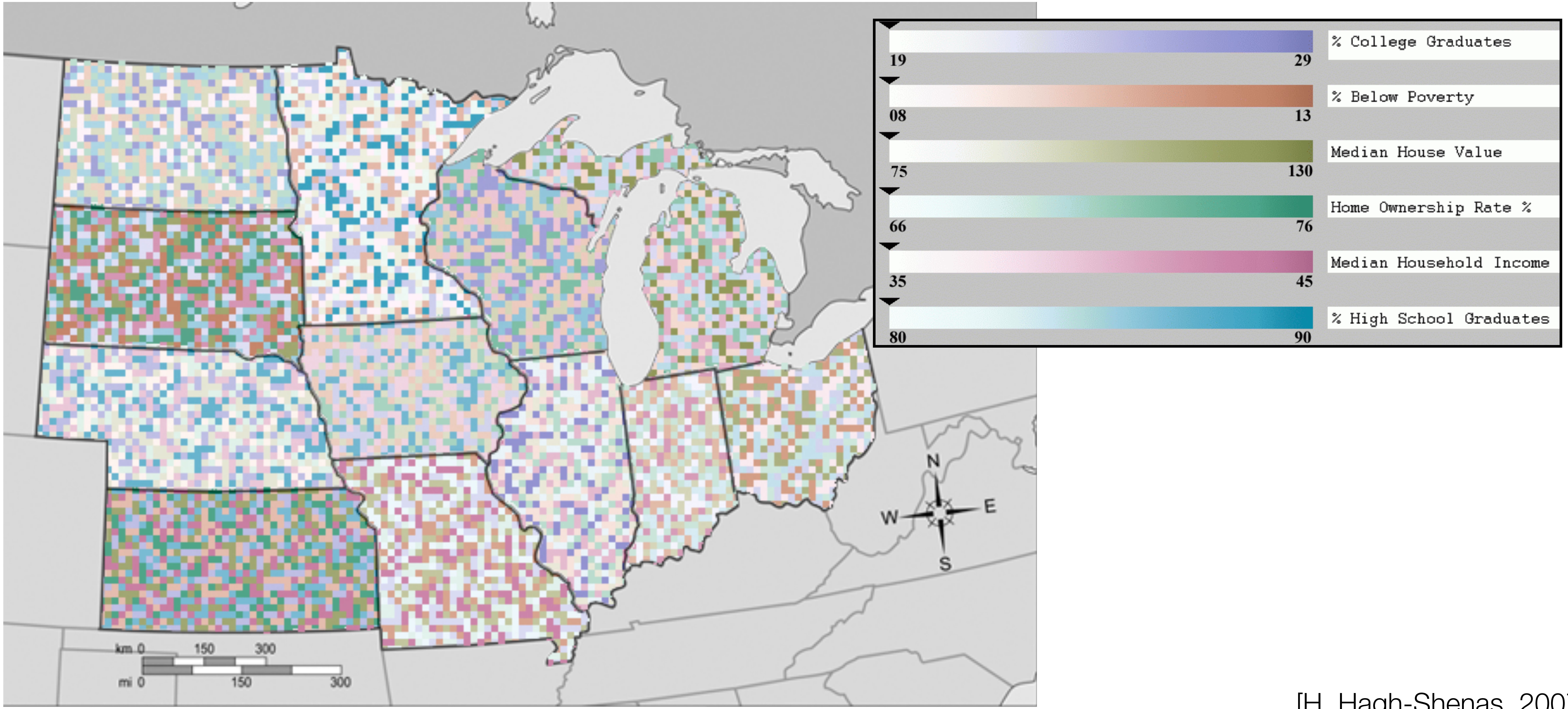
[J. Jo et al.]

Multiclass Density Map "Examples"



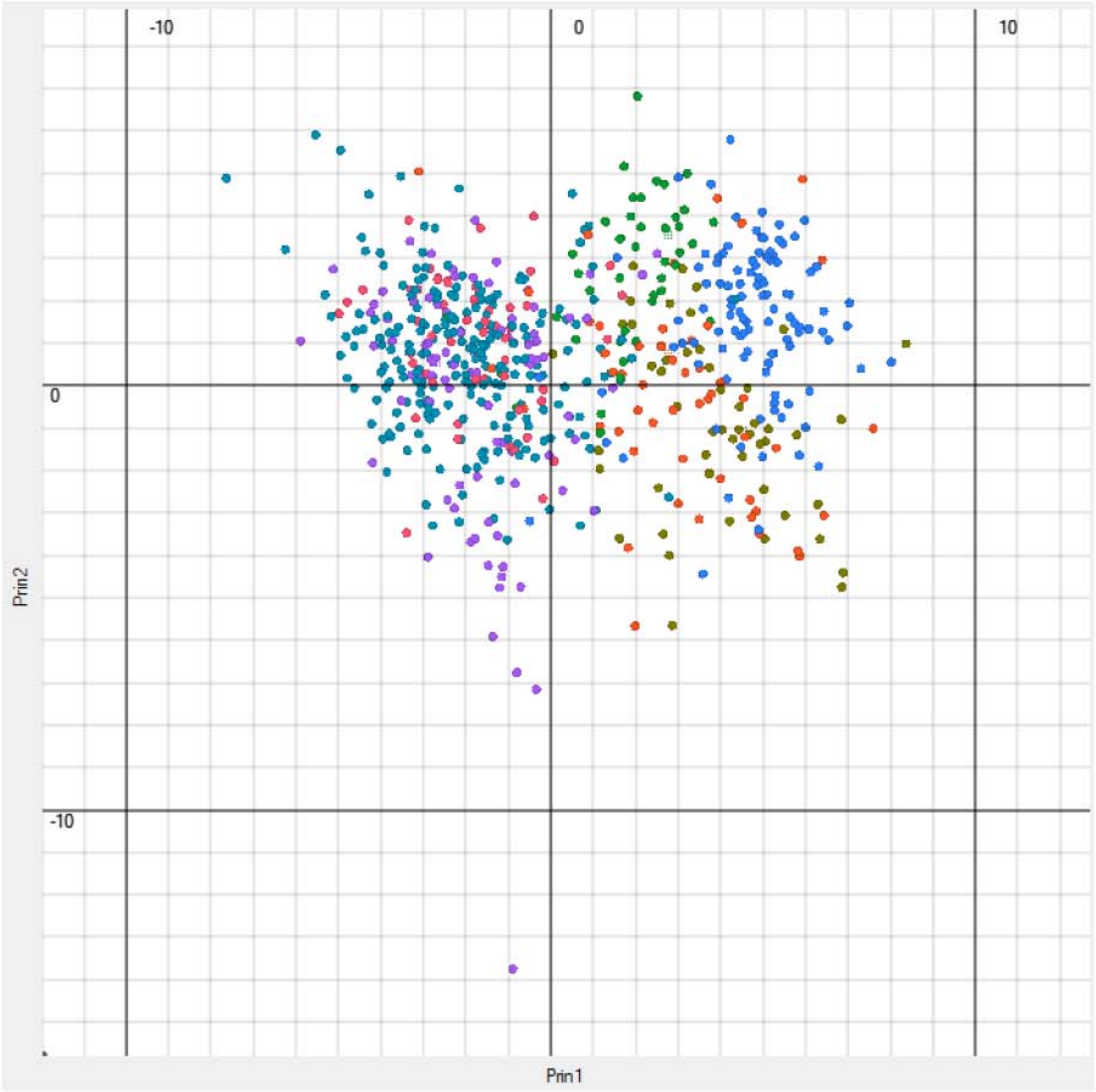
[J. Bertin via ICACI]

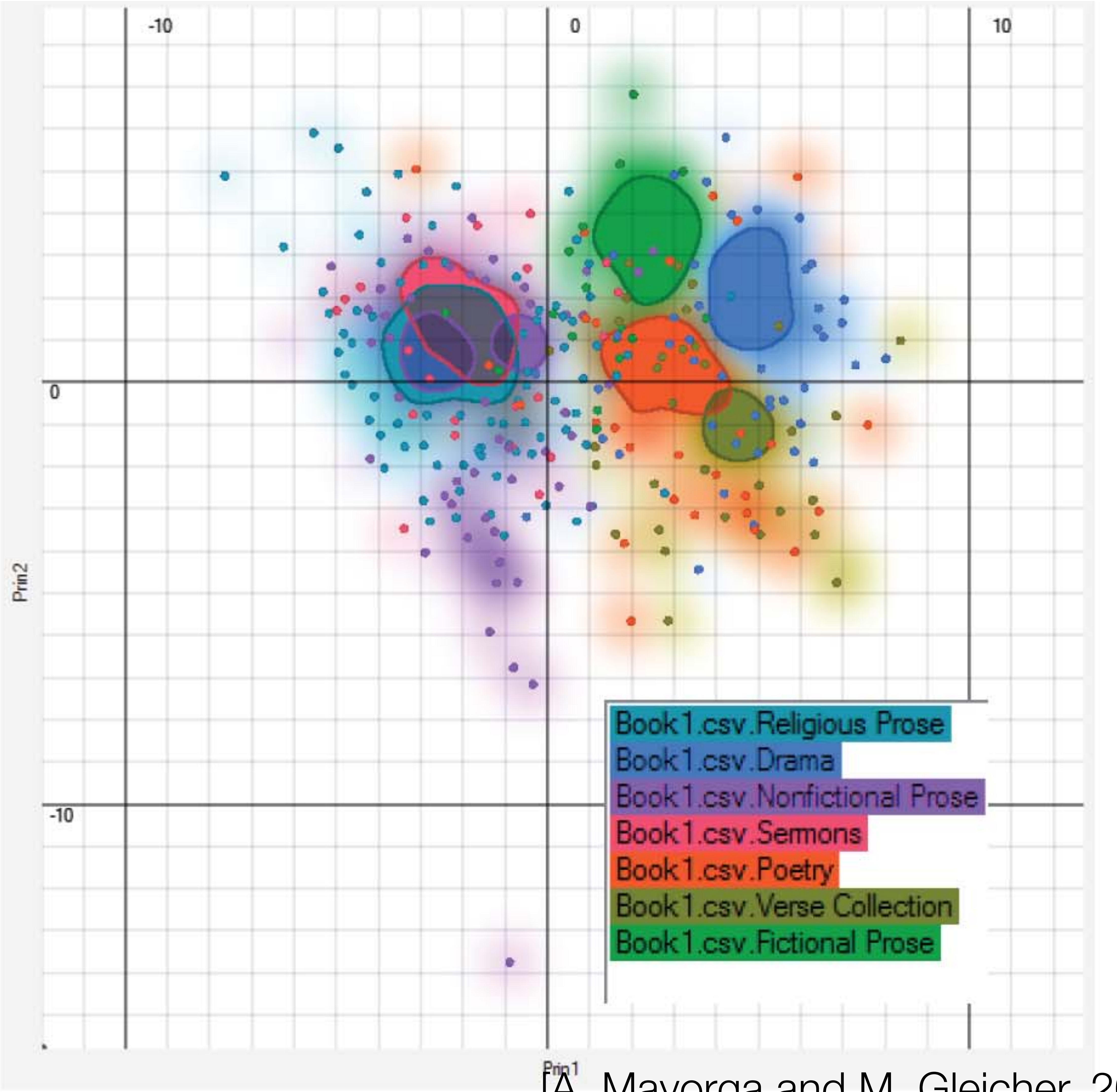
Multiclass Density Map "Examples"



[H. Hagh-Shenas, 2007]

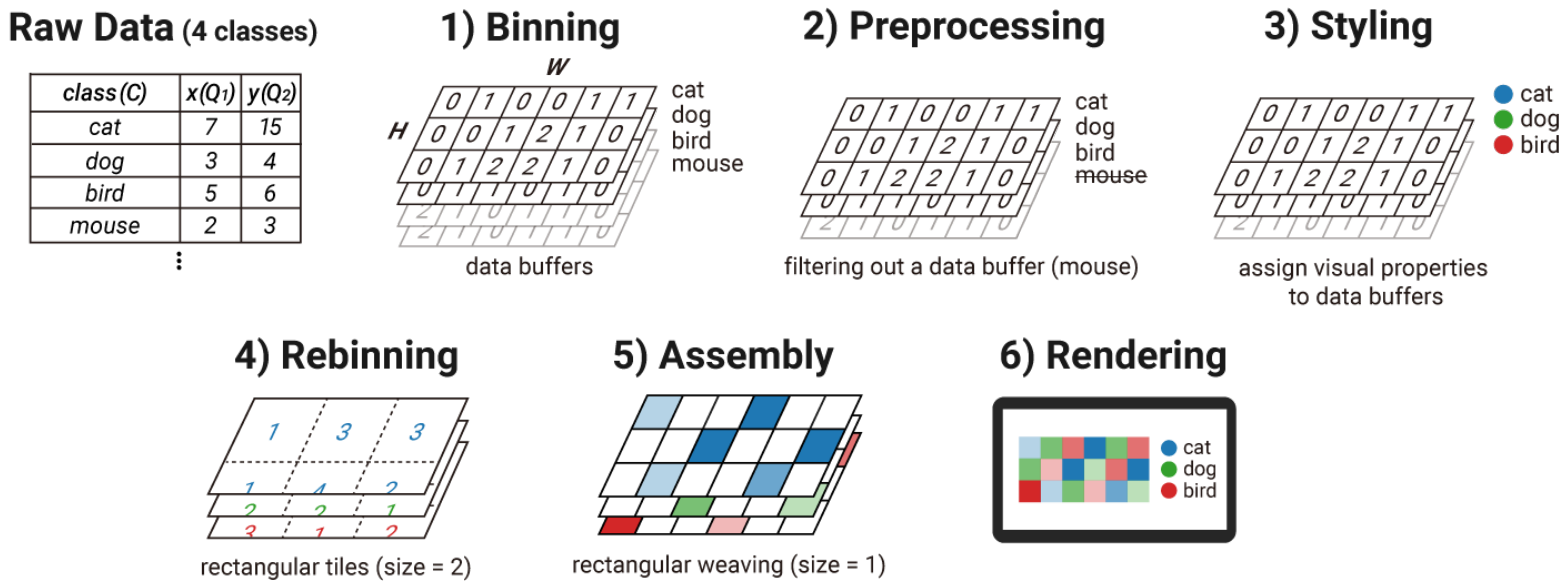
Multiclass Splatterplots Using Color Blending





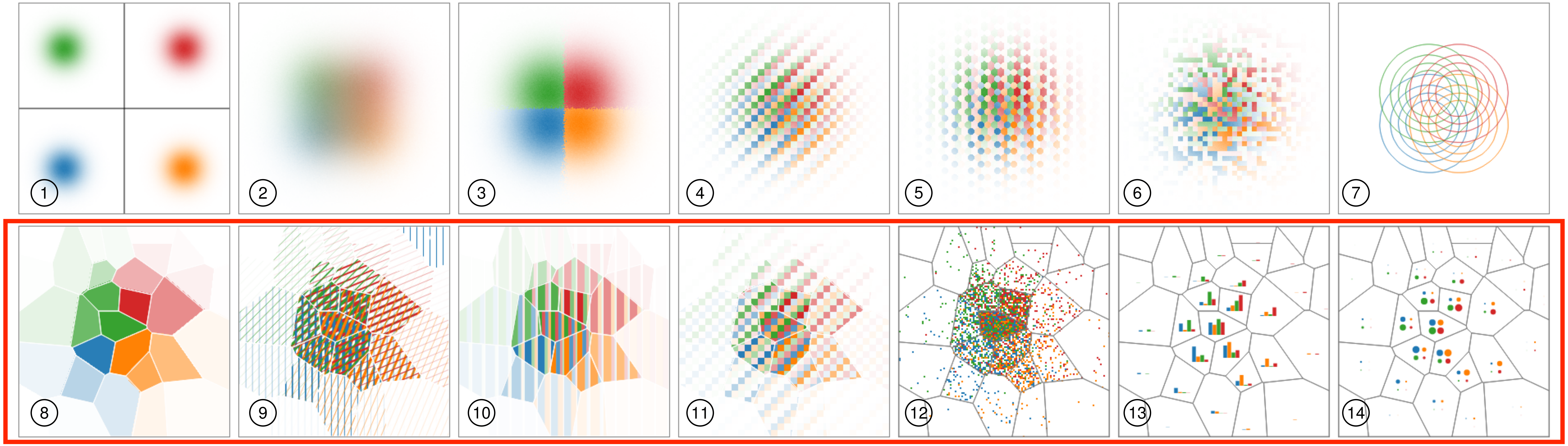
[A. Mayorga and M. Gleicher, 2013]

Class Buffer Model



[J. Jo et al.]

MDM Gallery



Rebinned and Aggregated

[J. Jo et al., 2019]

Paper Presentations

- Primary: Provide necessary background, present core ideas, step through techniques, discuss experiments and results
  - Channel the original authors as much as possible
- Secondary: Provide critique: what is problematic, what could be improved, where could techniques be extended
  - Channel the reviewers as much as possible
- Everyone: Read the paper, come with questions and discussion points

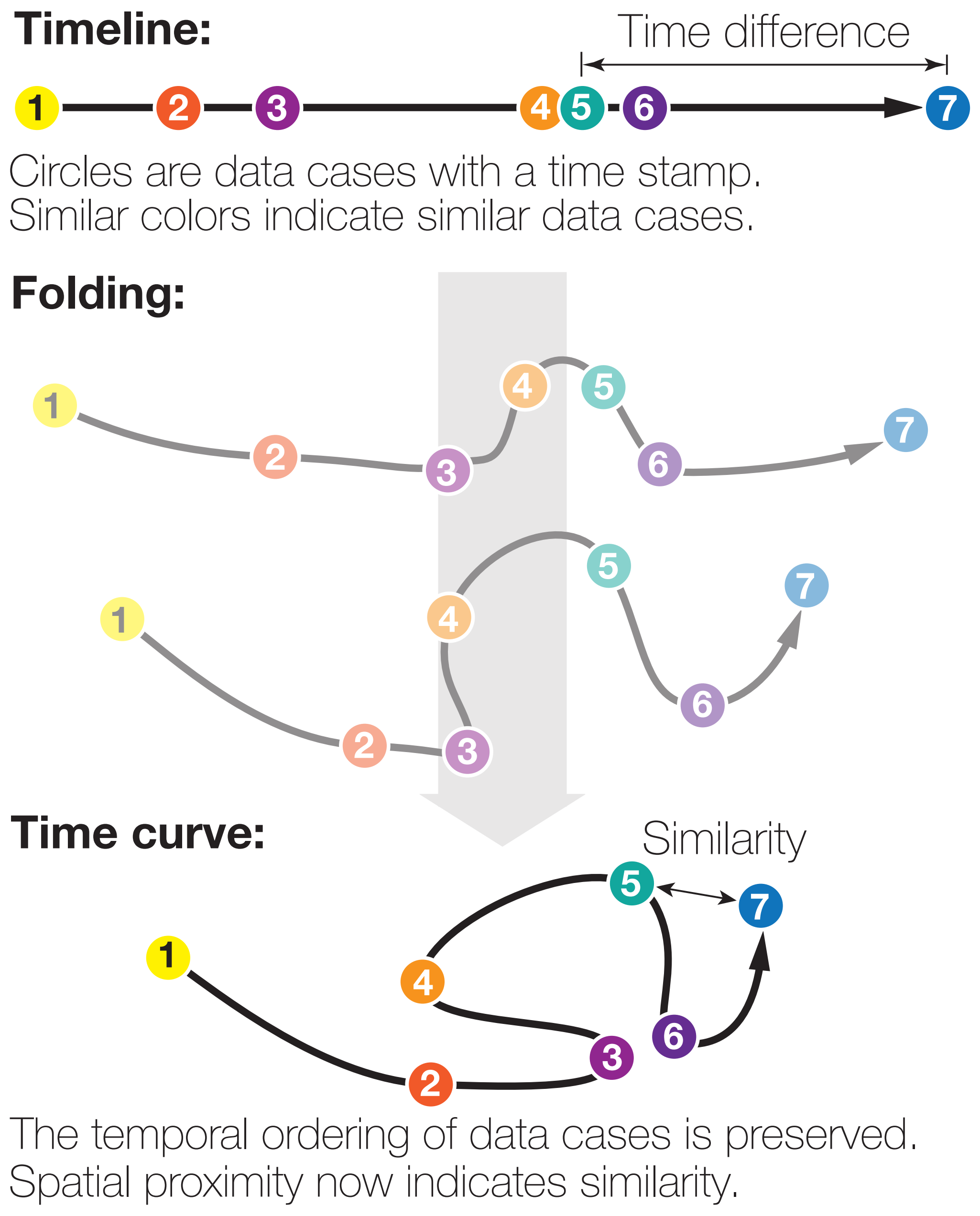
Annotated Bibliography

- Likely related to your project, but can be another subject area
- Wider breadth than just the related work of your project
- Find 30-40 references, and write a few sentences on how they relate to your work/ideas
    - Ok to include papers that show novel variations of a technique, even if the paper is not mostly about the subject area!
    - Your annotations are not the abstract of the paper, include relationship with the subject area you're focusing on
- Due next Thursday

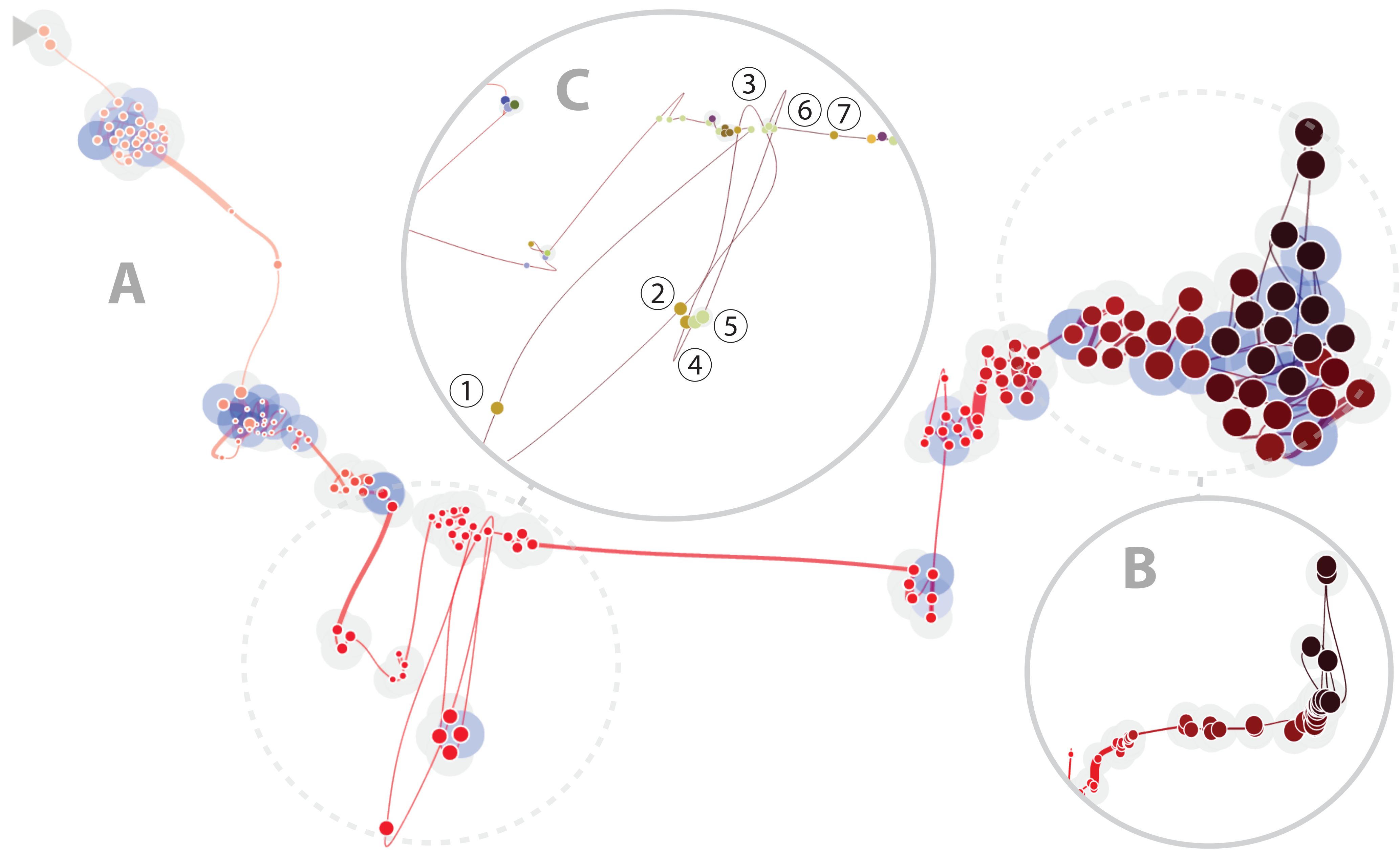
Next Paper

Time Curves: Folding Time to Visualize Patterns of Temporal Evolution in Data

Benjamin Bach, Conglei Shi, Nicolas Heulot, Tara Madhyastha, Tom Grabowski, Pierre Dragicevic



(a) Folding time



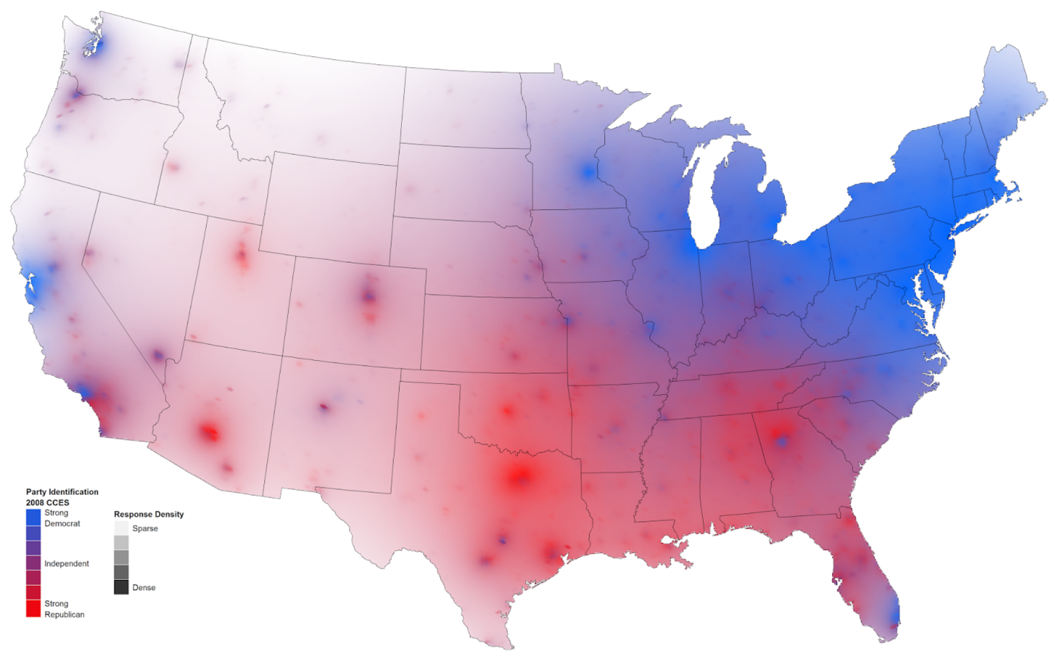
(b) History of the Wikipedia article on Palestine

Paper Critique

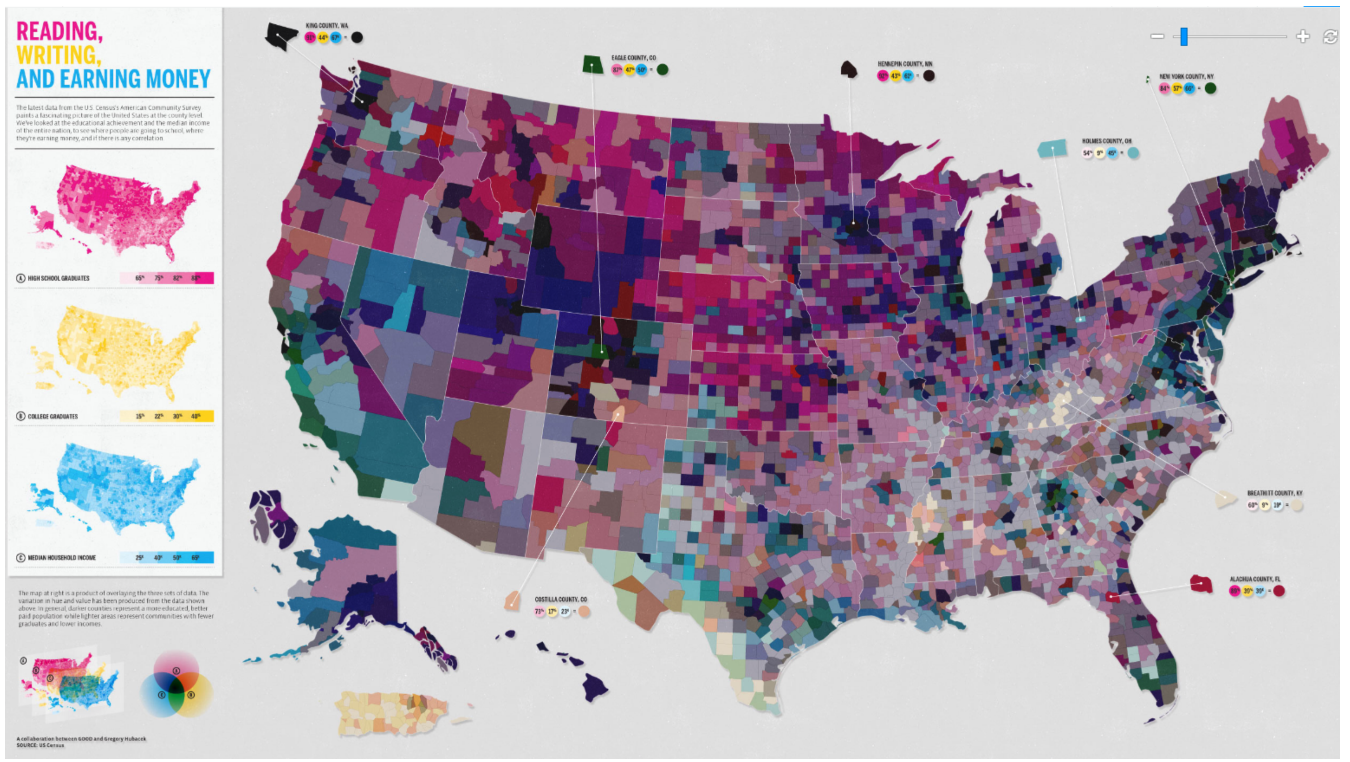
- Those not presenting (i.e. not primary or secondary) should prepare a short (1-2 paragraphs) critique of the Time Curves paper, and come with at least one question about it
- Submit via Blackboard **before class** on **Thursday**

Progress Reports

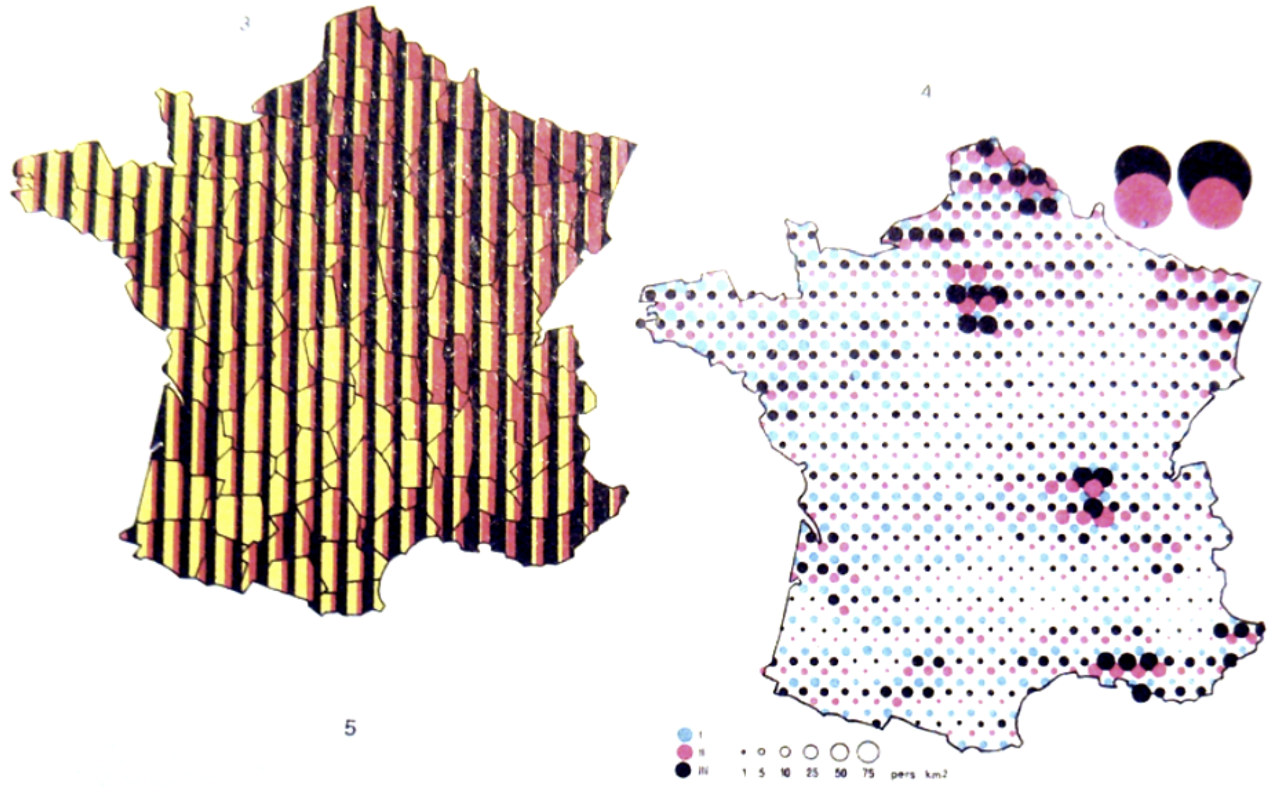
Original Examples



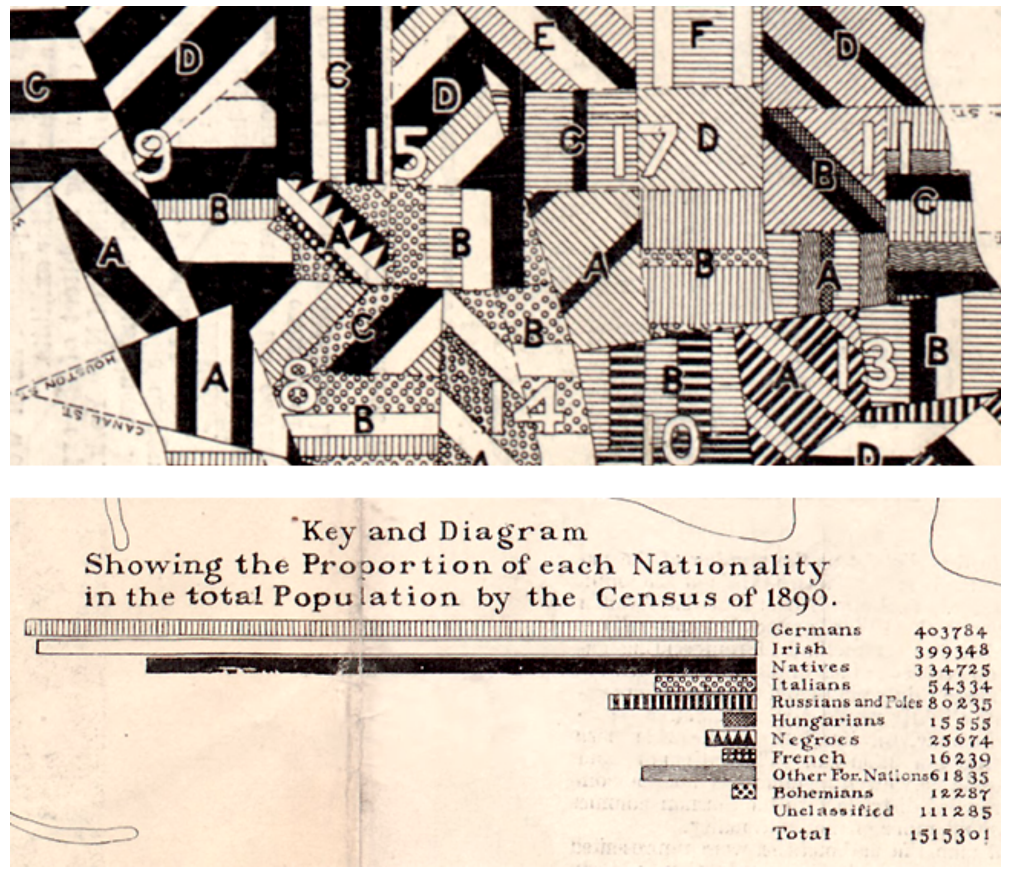
(a) Support for Democratic vs. Republican candidates in 2008 [46].



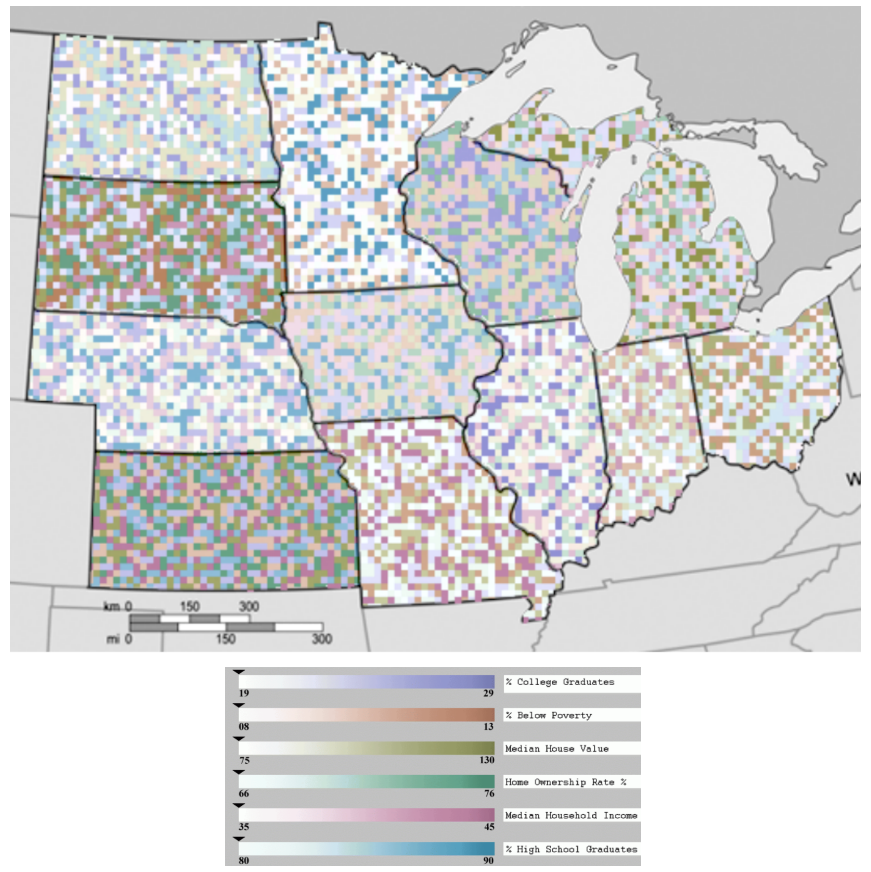
(b) Percentage of high school graduates, of college graduates, and median house income in 2009 [22].



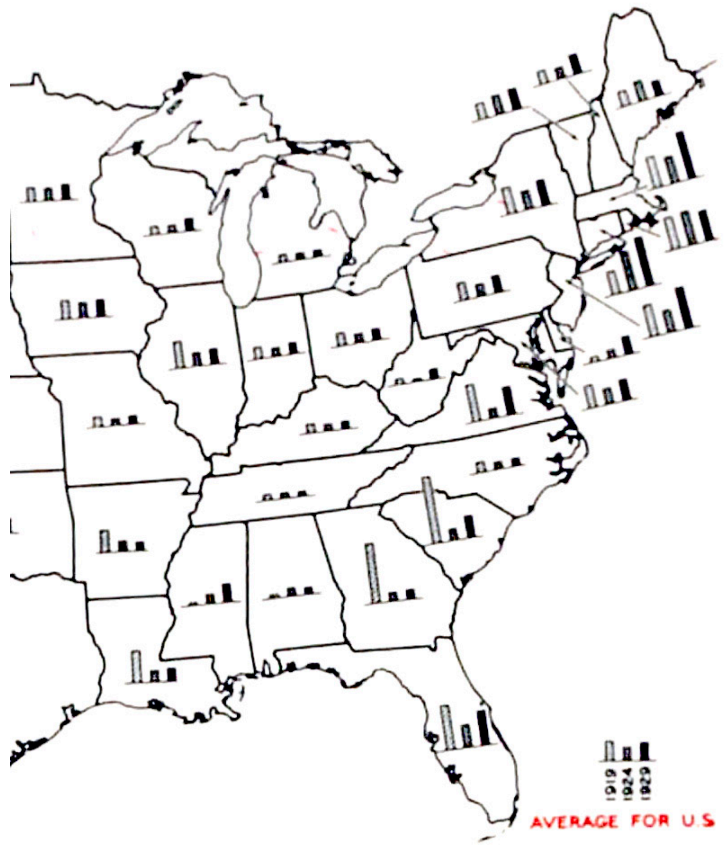
(c) Number of workers per sector of economy (primary, secondary, tertiary) in 1954 by Bertin [4].



(d) Detail of a map of New-York City showing the distribution of nationalities across districts in 1890 [25, 40].



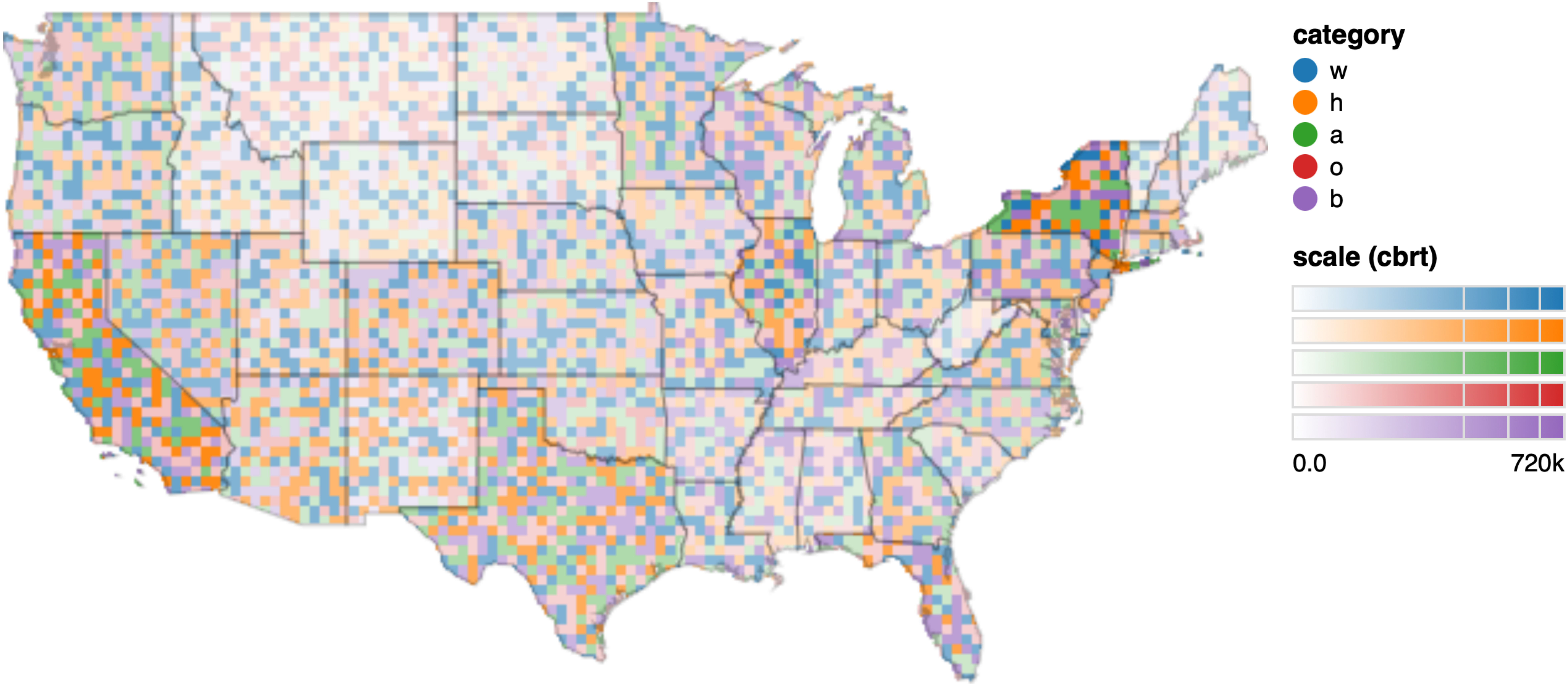
(e) Six socioeconomic indicators in each of the twelve Midwestern US states [19].



(f) Detail of a map showing average sales per farm for each US state in 1919, 1924, and 1929 [10].

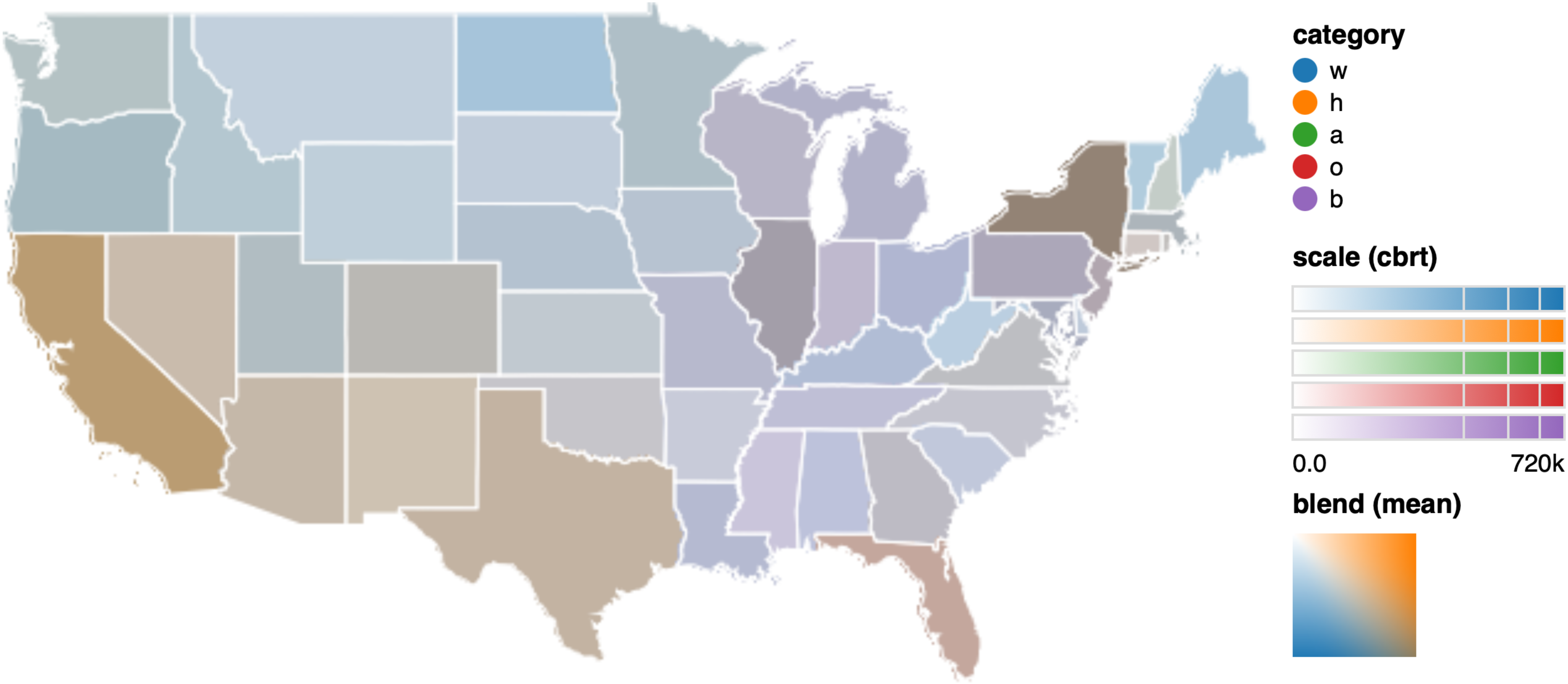
[J. Jo et al.]

Results



[J. Jo et al.]

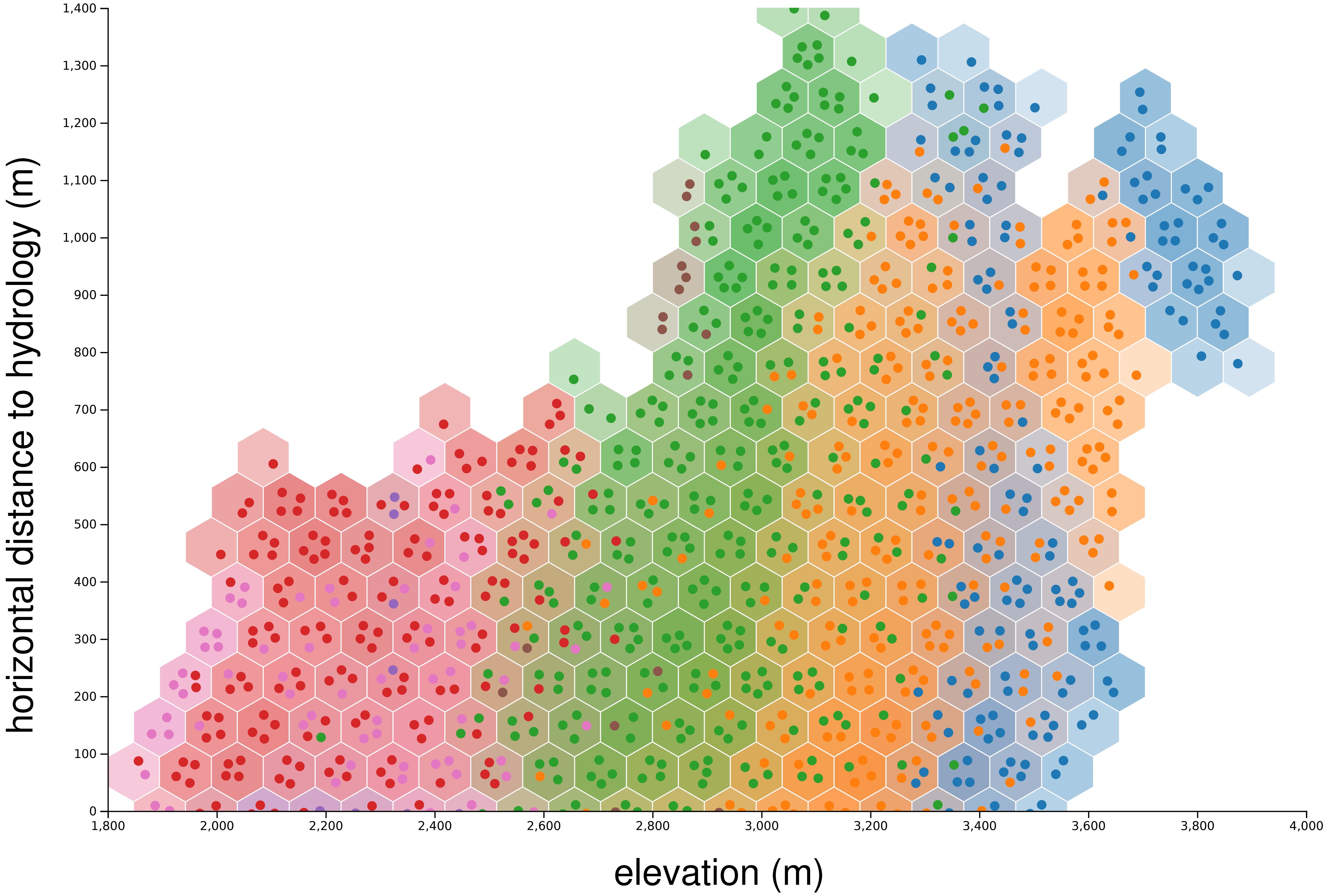
Results



[J. Jo et al.]

What about other techniques?

- Are there other possibilities?
- Does the grammar cover these?
- How do we evaluate how well these techniques work?



[F. Heimerl et al., Tech Report]

What about Tasks? (Bin and Class Tasks)

	Task		Bin-centric		Class-centric
browsing	Explore neighborhood	1	Explore properties of bins in a neighborhood	2	Explore properties of classes in a neighborhood
	Search for known motif	3	Find known pattern across bins	4	Find known pattern across classes
	Explore data	5	Unusual patterns within or across bins, global trends between bins	6	Unusual patterns within or across classes, global trends within or between classes
aggregate-level	Characterize distribution	7	Do bins close to each other have similar properties? Or within a certain area or range of values?	8	Does a class occupy certain areas of the plot? Does its distribution have a particular shape? Do classes correlate in certain areas?
	Identify anomalies	9	Identify bins that are outliers based on the general distribution	10	Identify classes or subsets of classes that are outliers in a certain region
	Identify correlation	11	Determine level of correlation of bin properties along both dimensions	12	Determine level of correlation for class members along both dimensions
	Numerosity comparison	13	Compare density in different regions of the space	14	Compare class density in different regions of the space
	Understand distances	15	Understand a given spatialization and the coverage of the bins	16	Understand a given spatialization and the coverage of classes

[F. Heimerl et al., Tech Report]