Visualizing Origin to Destination Flows

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Why

- A visualization challenge
- A practical need

An anatomy of O-D Flow visualizations

Multidimensional Data

Total Flow:

The singular flow:
An Origin to many Destinations (O-D)
As Destinations to an Origin (D-O)

Many to Many flows:
Many Origins to many destinations

The direction of the flow

Geographic locations:
Origins
Destinations

Visualization approaches

Geo based map

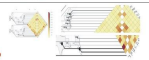
Not Geo based diagrams

Analyzing

Strength

Weakness

A taxonomy of visualizing O-D data

Approaches	Strength	Weakness	Total Flow	Singular Flow	Many to Many flows	The direction	Geo features	O-D vs D-O
Geo based: The O-D map								
Flow map							Interactivity	
Direct Mapping of Geographic Flow Vectors (Tobler, 1987) 	Has a strong visual identity and sense(familiar visual form) to depict a source to destination on geographic maps	Too many clusters; Not scale well to large numbers of flows	✓	✓		✓	✓ UI	
Edges-bundling Flow Map 	Reduce overlap by clustering edges into bundles	Hiding the identification of flow direction; Not scale well to large numbers of flows	✓	✓	✓		✓	
Flow Density Maps (Rae, 2009) 	Combined the edge bounded, directing flow map, and chorpleth map methods	Breake down the data into different layers of representain; Not scale well to large numbers of flows		✓	✓	✓	✓	
Flow motion Map 	The movement motion index the flow direction, also good for visual attraction	Because the motion effect, it's not clearly to tell the path of the flow; Too many clusters at one geo location	✓	✓	✓	✓	✓	
O-D Matrix								
O-D Matrix (Voorhees, 1955) 	Makes clusters more apparent, more readability	Space disproportional; Missing the source and destination; Needs some pre geo knowledge to recognize locations.	✓				✓	
O-D MapTrix(Yang et al., 2016)  Bubble map	Makes clusters more apparent, also compares the origin and destination at same time on the geo maps	Two geo maps paralleling with the heat map in the left is not easy to be read/flow; Not scale well to large numbers of flows	✓	✓	✓	✓	✓	✓
No-Geo Diagram: Statistical Summaries of Spatial Association								
Linear Diagram								
Arc diagram   *Variation*  A weighted network	Useful in finding the co-occurrence within the data; highlight clusters and bridges	Lost the visual representation of the geo features/locations; Too many cluster of lines, not scale well to large numbers of flows.		✓	✓	✓		
Sankey diagram    Alluvial diagram	Evolution: Connections show the evolution changes between different steps; Source to end: shows intermediate steps	Lost the visual representation of the geo features/locations; Hard to optimize the order of each node for large numbers of flow(takes up lots space for the layout)	✓	✓	✓	✓		
 Sankey Arc diagram	Better for visual layout							
Circular Diagram								
Chord diagram 	Eye catching visual form;; Show flows; One asymetric arc per pair; Bipartite: O-D and D-O	Lost the visual representation of the geo features/locations; Connections go between categories but not within categories.		✓	✓	✓		✓
Bar								
Partition diagram 			✓	✓	✓	✓		
 Sunburst diagram			✓	✓	✓	✓		
Text								
Word Cloud  network				✓	✓	✓		

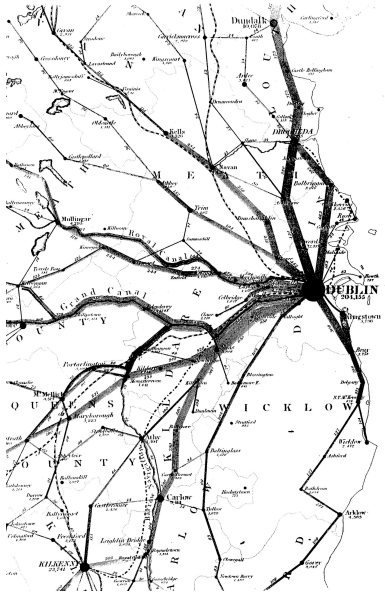
The timeline and evolving

The timeline or the evaluation of visualization approaches:
Direct mapping of geographic flow vectors (Tobler, 1987), Bounded flow map, flow density maps (Rae, 2009), origin-destination (O-D) matrix (Voorhees, 1955), O-D MapTrix(Yang et al., 2016),

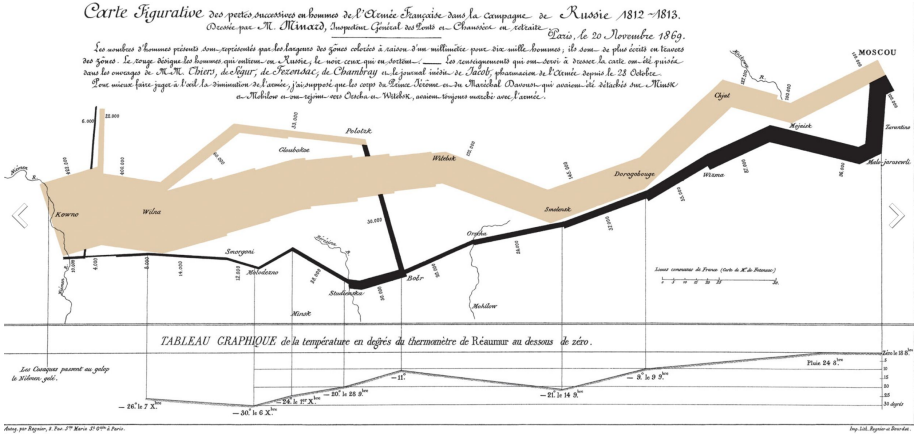
Flow maps are an established cartographic method to depict movements over time and space.
Visually, A line or a path connects the origin to destination across geographical regions.
The term “flow map” has a strong visual identity and sense (as a familiar visual form) to depict the source to destination on geographic maps.

Weakness: Too many overlapping and intersections

Flow map

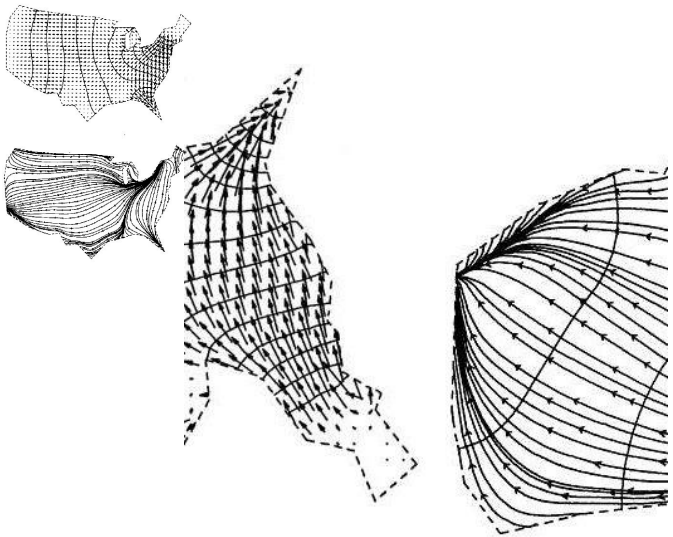


The earliest known flow map was created by Henry Drury Harness in 1837 to show rail usage. *(Henry Drury Harness, 1837)*



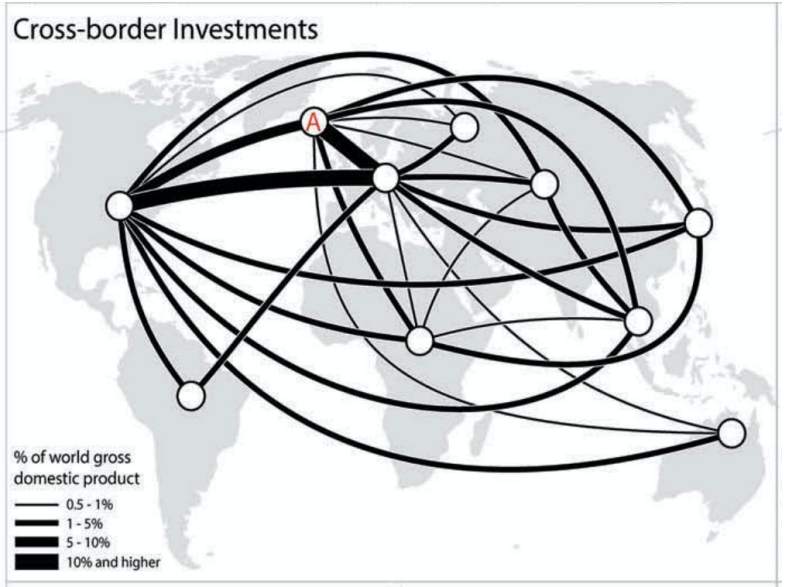
Napoleon's 1812 March *(Charles Joseph Minard, 1869)*

Direct Mapping

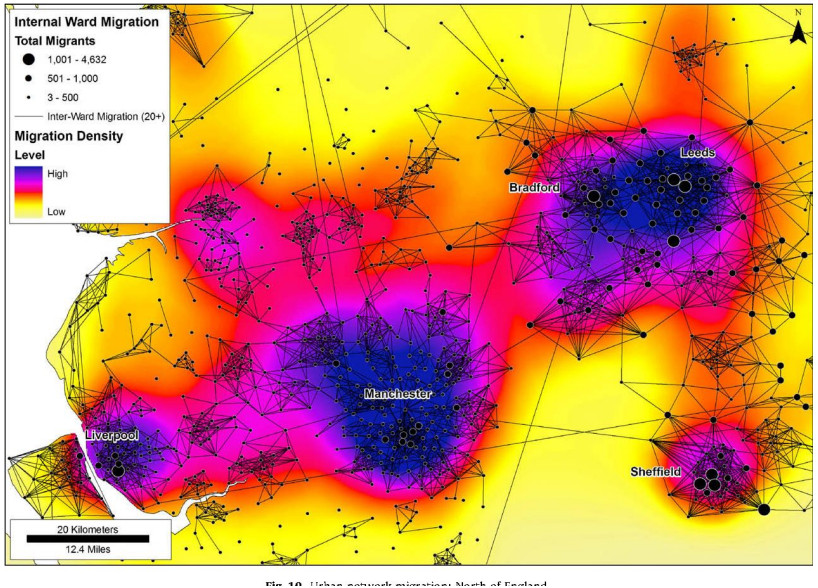


Direct mapping of geographic flow vectors (*Tobler, 1987*)

Edge Bounded

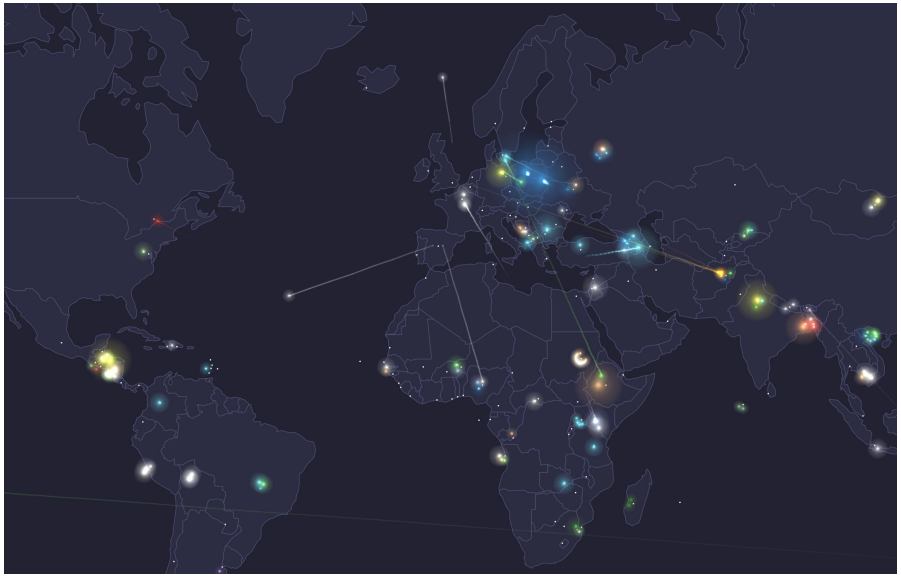


Flow density maps



(Rae, 2009)

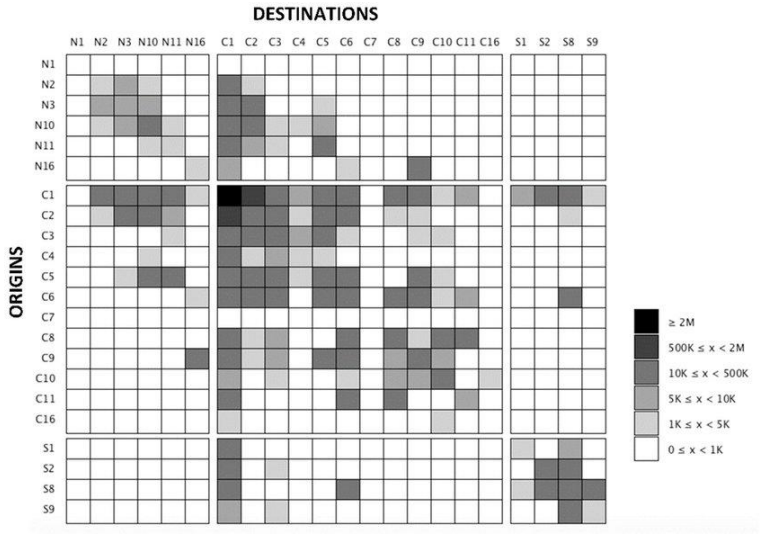
Flow motion



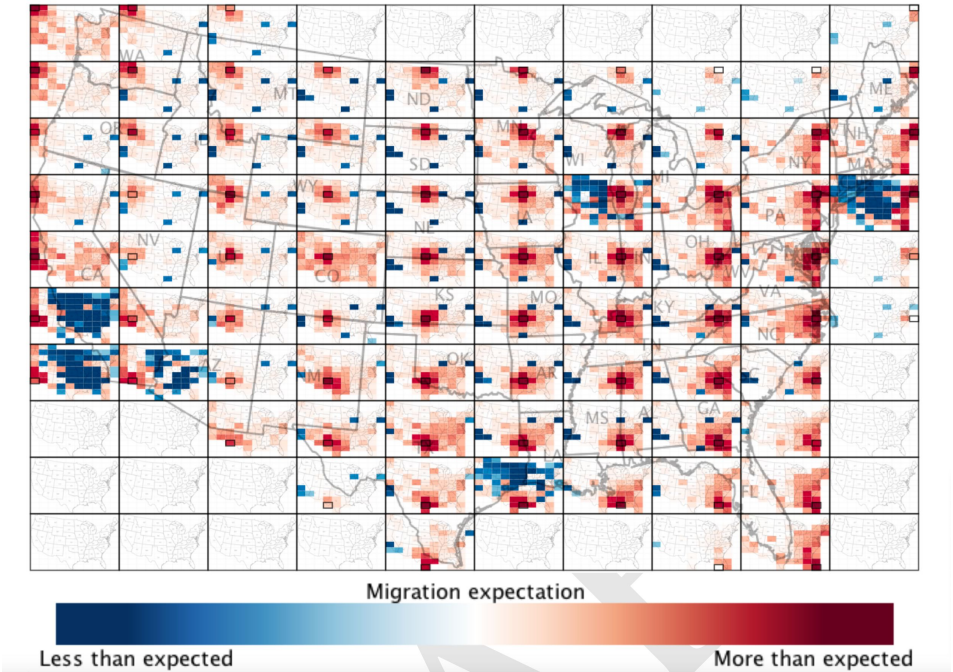
O-D Matrix

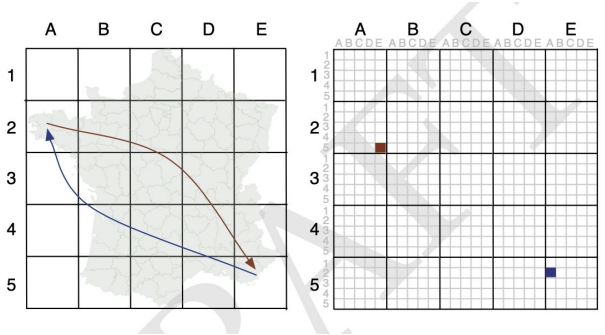
The main benefit of matrix sorting is to make clusters more apparent, famously illustrated by Bertin (1983). For the matrix approach, the most basic is the O-D matrix in which there is a row r for each source (origin), a column c for each destination, and a cell (r, c) shows the flow from source to destination.

Weakness: Firstly, it lost geo details in origin and destination location. Secondly, the color on the map does not reflect the underlying geographic structure can give rise to aliasing effects.



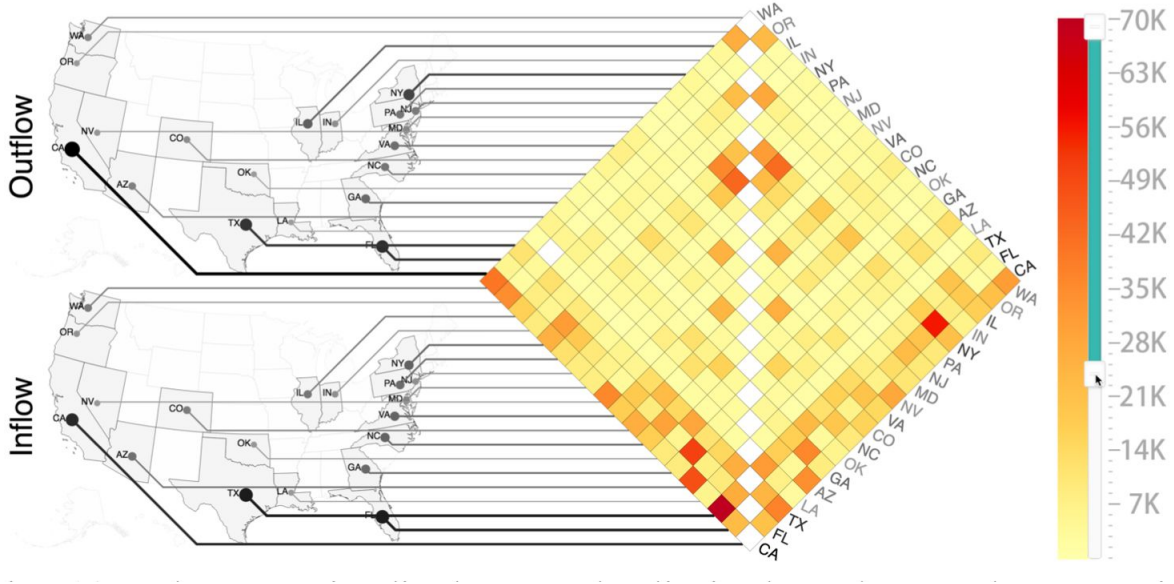
O-D Matrix





Chi statistic OF map
shows internal Migration in 2009- 2010

O-D MapTrix



Interactive Visual Analysis for Internal Migration (*Yang et al., 2016)*

Not Geo Based Diagram

Linear Diagram

Arc Diagram

Sankey diagram

Sankey Arc diagram

Circular Diagram

Chord diagram

Bar Diagram

Partition diagram

Sunburst Diagram

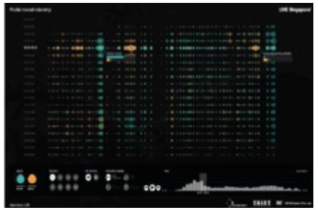
Network

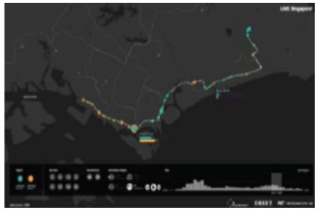
Word Cloud

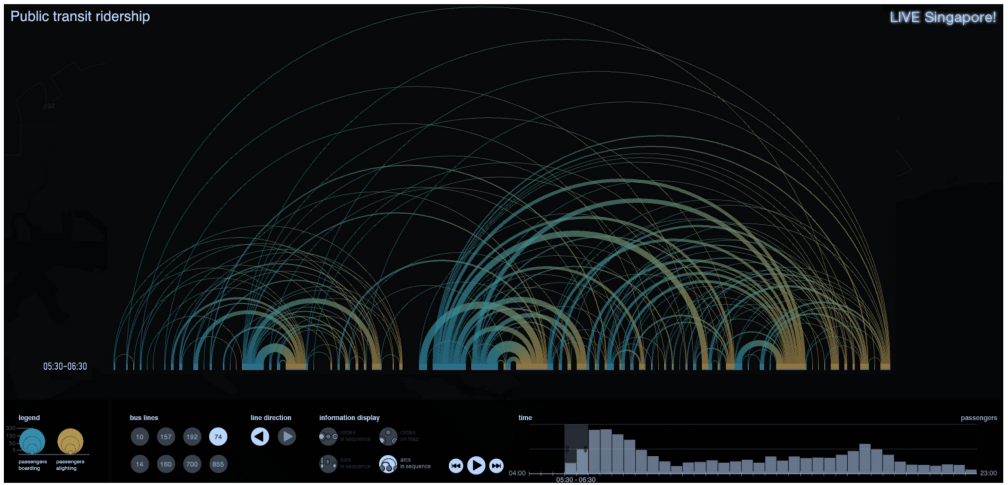
Visual Explorations of urban mobility

Interaction On a Multi-touch Table

Visualizing Bus Ride Data







A Case Study

LEHD TOOL

Testing

Does it apply sth from the taxonomy table?

Provide Insights?

Interesting?

What you want to know more about MA employees' work and home flow?