

Revealing Patterns and Trends of Mass Mobility Through Spatial and Temporal Abstraction of Origin-Destination Movement Data

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Problem statement

- Origin-destination (OD) flow data is hard to analyze because it is complex, high-dimensional, and high volume.
 - Numerous intersecting links
 - Long time series are problematic



Proposed solution

- Suggest analytical procedure to resolve issues of OD flow data complexity
 - How to simplify and analyze spatial data
 - How to simplify and analyze temporal data
- Allows for the creation of meaningful vis



Proposed solution

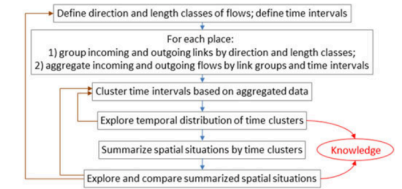


Fig. 1. The proposed analytical workflow.



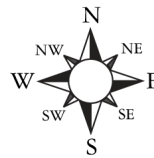
In context of VAD

- Flow data: Chapter 8
 - Similar to geometric flow (shows derived geometry from a set of seed points)
 - How many points of origin or destination?
 - How many glyphs to show?
 - Similar also to feature flow: partitioning fields in to subregions where behaviour is similar
- Dimensionality reduction: Chapter 13
 - Spatial aggregation (dimension-oriented)
 - Temporal aggregation (dimension-oriented)



Spatial Abstraction

- Aggregate links w/ common origin or destination based on
 - Direction
 - Suggest cardinal points on compass; more perceptually simple
 - Distance intervals
 - Normalized within dataset against longest trip



Spatial Abstraction

- Results in feature vector that describes trip
- Substantially reduces data, enables legible flow maps



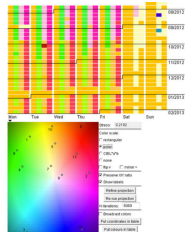
Temporal Abstraction

- Define time intervals
 - What is the range of the data, and what is a meaningful interval?
 - For example: commuting data
 - Day of the week
 - morning rush hour
 - business hours
 - evening rush
 - night



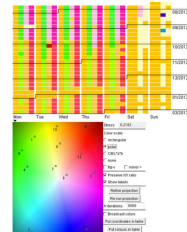
Temporal Abstraction

- Display of temporal clusters
 - Feature vector grouped by time interval, clustering applied
 - Cluster centres are projected onto color plane
 - Time arranger: like calendar view, but more flexible



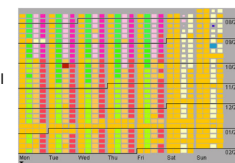
Temporal Abstraction

- Interactive visually supported clustering
 - Cluster iteratively; when clusters reveal outliers (singletons) rather than new groups, it's over



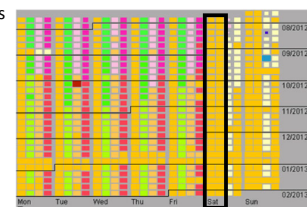
Temporal Abstraction

- Display of temporal clusters
 - Reveals periodic and temporal trends, as well as outliers



Temporal Abstraction

- Periodic trends



Temporal Abstraction

- Temporal trends



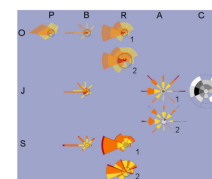
Temporal Abstraction

Idiom	Temporal abstraction
What: Data	Time data associated with travel
What: Derived	Time intervals, clusters of relevant time
How: Encode	Calendar-like views of time data, colors encode clusters, size encodes variability
How: Reduce	Semantically meaningful time aggregations
How: Manipulate	Interactive visually supportive clustering
Why: Tasks	Show trends and changes over time
Scale	Infinite time intervals. Reductions up to 95%



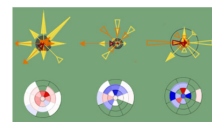
Spatial visualization

- Flow diagrams
 - Variety of possible representations
 - Directionality
 - Length/angle represents frequency
 - Color distinguishes distance of travel

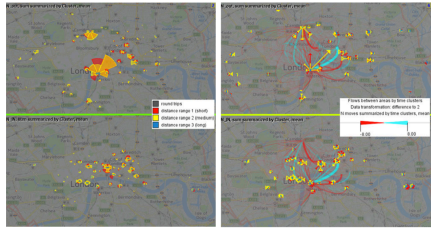


Spatial visualization

- Difference diagrams
 - Display data from all locations against:
 - Reference location
 - Different time interval
 - Height codes absolute difference
 - Fill/orientation codes +/-



Spatial visualization



Spatial visualization: user testing

- Hub identification, flow characterization
- No consensus on preferred diagram
- Some mutually exclusive criteria (too cluttered, not enough detail visible)
- Best option depends on task/data at hand
- Spatial aggregation requested

Spatial visualization

Idiom	Spatial abstraction
What: Data	Geographic flow data
What: Derived	Cardinal angles of travel, distance classes, frequency of trips
How: Encode	Flow glyphs (overlaid on maps)
How: Reduce	Data-based distance intervals, cardinal directions
How: Manipulate	Choose # clusters, filter
Why: Tasks	Find hubs of activity, show trends and changes over time
Scale	360 degrees of travel, infinite distances. Reductions up to 99%

Critique

- Strength
 - Big reductions in data complexity, increases legibility of large datasets
 - Multiple solutions– choose based on needs
 - Software independent: These design recommendations are not dependent on a particular suite of software, can be implemented in different ways

Critique

- Weaknesses
 - Software independent: don't provide a library for implementation, users presumably have to figure it out on their own
 - Color mapping doesn't appear to be linear
 - Even when a linear display is used, the 2-d color space isn't intuitive to me (how are these colors related or different?)

Critique

- Weaknesses
 - A lot of visual complexity in some of the graphs (such as difference diagrams)
 - Will the user be able to make meaningful interpretations?
 - No consensus in user testing—all designs they proposed had someone who ranked it as favorite, and someone as least favorite (suggests there's not a right answer)

Critique

- Useful framework for simplifying complex spatial/temporal datasets

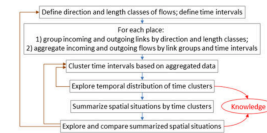


Fig. 1. The proposed analytical workflow.