Semantics-Space-Time Cube: A Conceptual Framework for Systematic Analysis of Texts in Space and Time

Text - Space - Time

- How does text semantics vary over space and time?
- Explore complex relationship between the three facets . E.g. trend of topic popularity
- Data example: geolocated social media posts

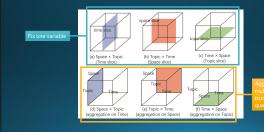


Proposed Visualization

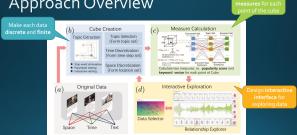
"Cube" metaphor

 $P \times S \times T$ toPics x Space x Time

Slices and Projections



Approach Overview

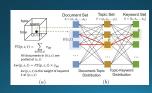


Cube Creation

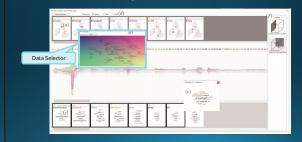
- TEXT: is represented by a vector of topic weights
- Topic is defined as a probability distribution over a given set of keywords
- Latent Dirichlet Allocation (LDA) a probabilistic topic modeling method
- Show all topics and let users select the ones they want to explore
- TIME: divide into intervals that are meaningful to humans e.g. weeks.
- SPACE: use individual and public activity locations, e.g. cities.

Measure Calculation

- At each point (p, s, t), we can derive meaningful information
- · Popularity score
- Keyword vector (list of <keyword, weight> pairs)



Interactive Exploration

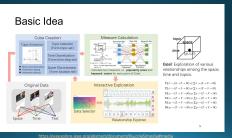


Interactive Exploration



Demo

Relationship Explorer



Analysis Summary: WHAT

- Data
 - A table where each item has 3 attributes

 - Location (spatial)
- Discretized and finite representation of each attribute
- · Popularity score and keyword vector

Analysis Summary: **HOW**

- Encode
 - Color-code objects based on position in a projection
 - · Use geographic map with glyphs
 - Size-code keyword based on importance
 - Indicate popularity score by linear ordering
- Manipulate
- Pop-up window
- 2D navigation
- Facet
- Superimpose streams in time view (extended mode)
- · Linked navigation
- Reduce
- Filter with "slices"
- Aggregate with "projection"

Critiques – Strengths 🕂

- · Good use of the metaphor
- A good conceptual model for developing database operations
- Filtering and aggregation allow for exploring large amount of data
- Responsive and well-organized view coordination
- Uniformity in visual design
- Flexible navigation that supports various topics and tasks
- Follow "Overview First, Zoom and Filter, Details on Demand"

Critiques – Weaknesses –

- Cannot observe the variation for all 3 dimensions, simultaneously (must slice or project first)
- The "cube" dimensions can't be too big (from paper)
- Information loss in discretization (from paper)
- Limited number of "cards" can be shown at a time
- Automated item sorting could create change blindness
- Spatial positions of keywords in keyword view is meaningless
- "Number of specific mentioned keywords may not really reflect the public opinions." (Expert feedback from paper)

Thank you for your attention

Any questions?