3D Information Visualization for Time Dependent Data on Maps

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Outline

- Introduction
- Approach
  - 3D information visualization
  - Information hiding
- Demonstration
- Conclusions
Introduction

- Modern database management systems capable of storing huge amounts of time dependent data
- Time dependent data everywhere
- Information visualization supports detection of temporal evolution, trends, outliers, …
- More and more multivariate time dependent data collected in geographic context (approx. 80% of collected data are geo-referenced)

Additional dependency to consider for the visualization
Introduction

Challenges

- Visualizing geo-referenced time dependent data
- Taking into account multiple dependent attributes
- Dealing with large datasets

Achieve goals by utilizing commonly accepted concepts

- 3D information visualization
- Information hiding
Approach overview

3D Information visualization

- 3-dimensional display space
- Advantage: additional dimension to represent additional information
- Two dimensions represent spatial frame of reference
  - 2D Map in 3D space
- One dimension depicts time
  - 3D Icons representing time dependency
Approach overview

Information hiding

- Hide non-relevant information, reduce amount of data to be visualized
- Emphasize relevant information, ease recognition of interesting information

Event-based approach
- Definition of interesting events
- Detection of events
- Representation of events instead of whole dataset
Map Display

- Hierarchically structured 2D map in 3D representation space
- Enables different levels of aggregation
- Usual intuitive interactions (rotation, zoom)
- Cartographic lens (GPU rendered)
Icon Design

3D icons to represent time dependent attributes

- Requirements
  - Represent multiple attributes
  - Embeddable into display space
  - Reflect different types of time

- Two different types of icons
  - Linear time: Pencil icons
  - Cyclic time: Helix icons
Pencil Icons

Pencil icons
- Utilize familiarity with geometric shape of a pencil
- Multiple attributes mapped to faces of pencil
- Pencil adequate for representation of linear time
Helix Icons

Helix icons

- Spiral designs intuitive metaphor for conveying cyclic characteristics
- Helix ribbon color codes multiple attributes
- Helix adequate for representation of cyclic time

Spiral stair

Helix icon

Time-dependent attributes

Time
Embedding Icons into Map Display

Icons are positioned perpendicular to map at center points of areas

- **Problem:**
  - 3D causes occlusion of information
  - Map interactions unwantedly cause change of data view as well

- **Solutions:**
  - Simple icon positioning algorithm
  - Decouple map and icon interactions
  - “Tunnel views”
Embedding Icons into Map Display

- Enhanced color coding scheme (automatic selection of suitable color scales, support of different comparison tasks)
- Open question: Scale color with respect to attribute, area, time step, or global maximum
Information Reduction

- Exploit spatial hierarchy and temporal hierarchy to provide information on different levels of spatial-temporal granularity
- Additionally, focus on relevant information only
- Consider events of interest

Follow event-based approach to reduce amount of information to be presented
Event-Based Approach

Basic approach
- Users specify relevant event types
- Event instance are detected from the data
- Event instances are visualized rather than the whole data set

Example: Maximum events detected from human health data
- For each time step only the highest data value is considered relevant
- Visualization of maximum events using a Space-time-path
Space-Time-Path Visualization

- Focus on relevant information
- Hide non-relevant information
- Reduce cognitive efforts required
Conclusion

- **3D information visualization**
  - 3D icons emphasizing either linear or cyclic character of the data
  - Reduce unwanted occlusion of information
    - Icon positioning algorithm
    - Decoupled icon interaction
    - “Tunnel view”

- **Information hiding**
  - Focus on relevant information only and omit non-relevant information by utilizing an event-based approach
  - Application of Space-time-path to visualize events in space and time
Future Work

- Visualizing other types of time: branching time, multiple perspective time
- Open color scale question
- Ordering of attributes on icons
- Advancing the event-based approach
- Conduct user and usability studies