



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

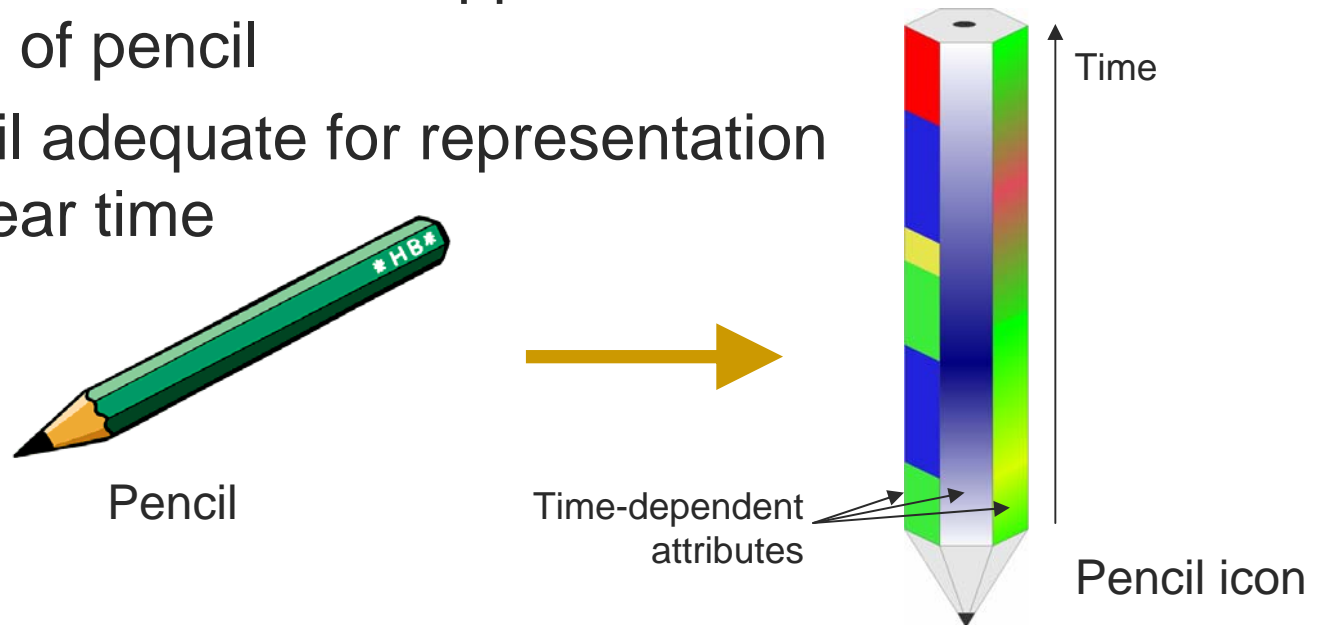
■ Two different types of icons

- 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



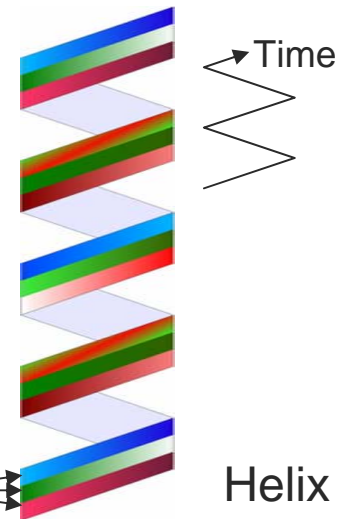
Helix Icons

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



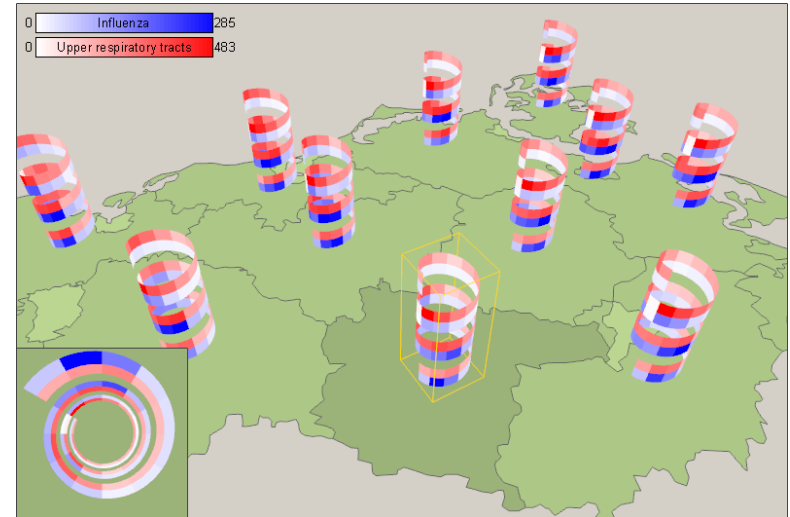
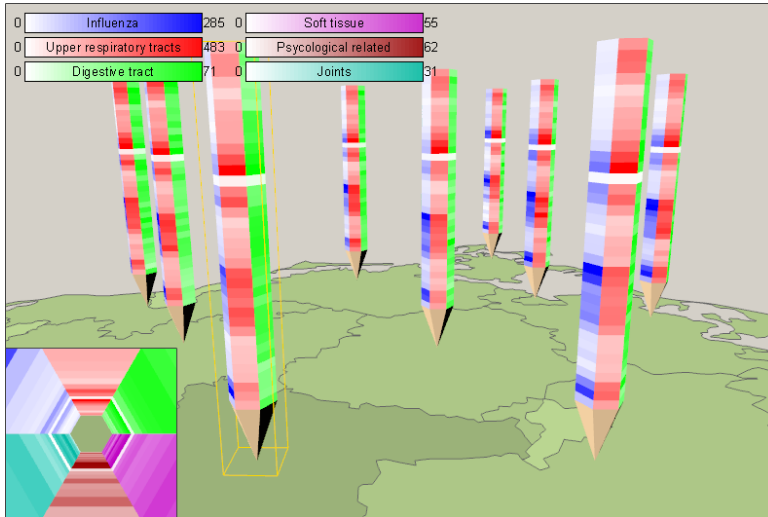
Helix icon

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

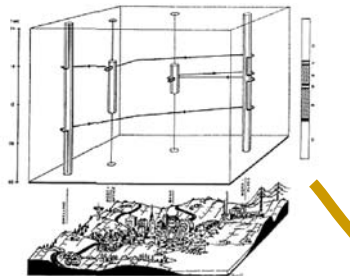
Event-Based Approach

Basic approach

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

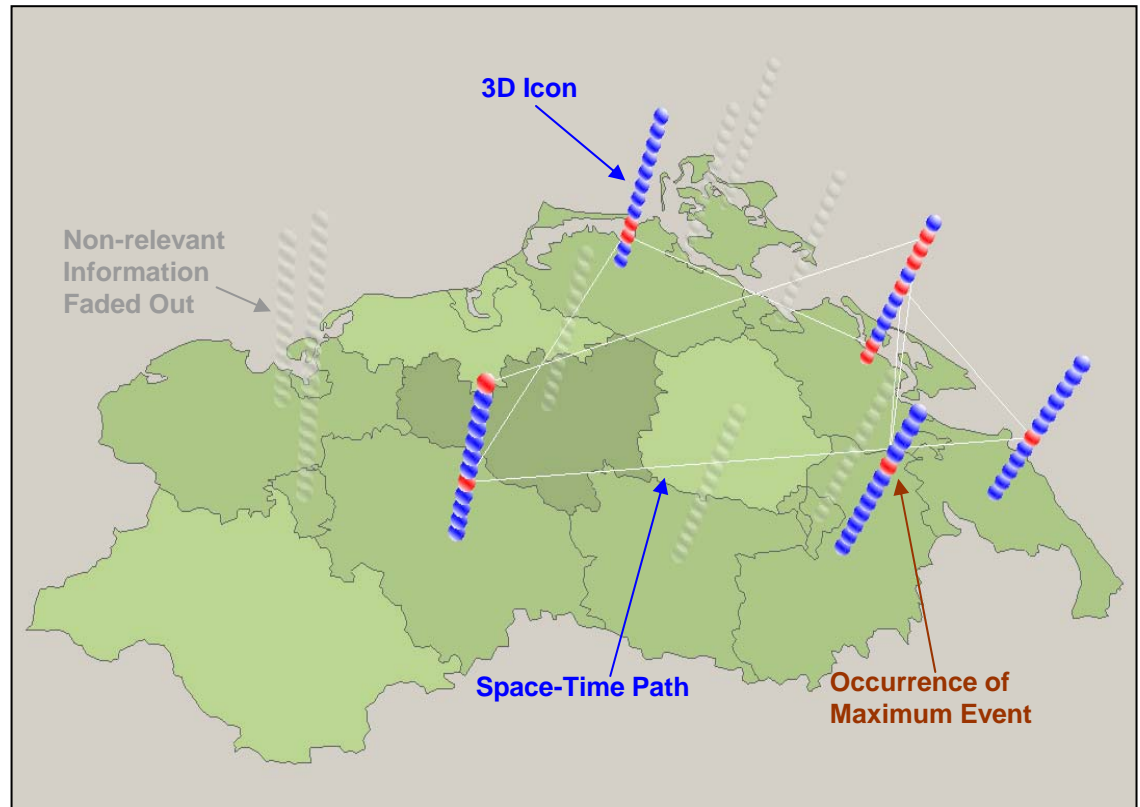
- Example: Maximum events detected from human health data
- For each time step only the highest data value is considered relevant
- Visualization of maximum events using a Space-time-path

Space-Time-Path Visualization



(Source: Carstein *et al.*, 1978, p.164)

- 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