Cross-dimensional Visual Queries for Interactive + Animated Analysis of Movement

Chris Weaver
School of Computer Science and the Center for Spatial Analysis
University of Oklahoma
The North-East Visualization and Analytics Center
Penn State University
weaver@cs.ou.edu
REMO

• Relative motion patterns in geospatial data
• Algorithms for calculating derived motion attributes

• Developed by Patrick Laube (dissertation, etc.)
• Visited GeoVISTA Center for Fall 2006

• Adapted as a data query module in Improvise
• Can process batch-style or on-demand

• Inputs: entity, location, time
• Outputs: velocity, sinuosity, azimuth, others possible
herd movement

a visualization of movements of individuals in a herd of radio-tagged caribou

Data Source: Patrick Laube
Visualization Design: Chris Weaver and Patrick Laube
What Worked and What Didn’t

• Filtering with conjunctive combination of range filters over
  1. each raw and derived point dimension
  2. set containment in brushed group of individuals
• Peripheral views filtered on
  1. each others' range selections
  2. the spatial extent of the map itself
• The visualization overall embodies Shneiderman's mantra in a (nearly) symmetric, multi-D manner
  - A kind of “overview+detail mesh”
  - Every view is a detail view
  - Zoom and filter the “map” through interaction in other views

• Conjunctive semantics of interaction forces drill-down in multiple dimensions to follow a single path up/down; no “sideways” queries
• Reduces analytic utility by limiting space of possible questions/queries
Cross-Highlighting, Approach

• Multiple views support selection over sets or ranges of attribute values in multiple raw or derived data columns, across one or more tables.
• Attributes map into appropriate multi-D views, possibly on a many-to-many basis.
• Each view supports binary categorization of values (selected or not) by selection or navigation.

• Users can rapidly toggle highlighting between pairs of views to pose complex focus+context set queries.
• Analysts can form hypotheses and follow chains of evidence by successive selection/deselection and highlighting/unhighlighting of values.
Cross-Highlighting, Queries

**Grouping**

- $\phi_{oxyt} \rightarrow G_o \rightarrow \gamma_o \rightarrow G_o' \rightarrow \phi_o \rightarrow G'_o \rightarrow \pi_o \rightarrow V_o \rightarrow \sigma_o$

- $\gamma_{xy} \rightarrow G_{xy} \rightarrow \phi_{xy} \rightarrow G'_{xy} \rightarrow \pi_{xy} \rightarrow V_{xy} \rightarrow \sigma_{xy}$

**Derived Attributes**

- $\rho_v \rightarrow T'_v \rightarrow \phi_v \rightarrow T'_v \rightarrow \pi_v \rightarrow V_v \rightarrow \rho_v$

- $\rho_s \rightarrow T'_s \rightarrow \phi_s \rightarrow T'_s \rightarrow \pi_s \rightarrow V_s \rightarrow \rho_s$

- $\rho_a \rightarrow T'_a \rightarrow \phi_a \rightarrow T'_a \rightarrow \pi_a \rightarrow V_a \rightarrow \rho_a$

**Cross-highlighting**

- $\sigma_t$
health clinic evacuation

a visualization of movements of RFID-carrying health care workers and visitors

Data Source: VAST 2008 Challenge, Evacuation Mini-Challenge (synthetic)

Visualization Design: Chris Weaver and Anthony Robinson
Demo
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Improvise continues to be distributed under the GPL with many example visualizations and source code and as a Java Web Start (JNLP) application ... at http://www.personal.psu.edu/cew15/improvise/