ThermalPlot: Visualizing Multi-Attribute Time-Series Data Using a Thermal Metaphor

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https://thinkh.github.io/paper-2015-thermalplot/#publication

ThermalPlot Technique

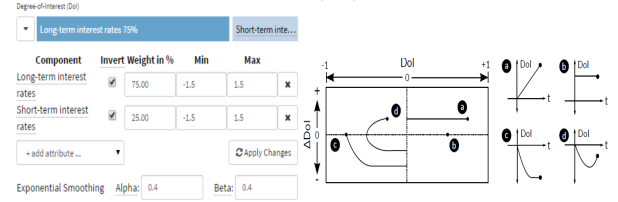
- Multi-attribute time-series data
  - Large number of items with multiple attributes changing over time
    - Economics, sensor networks
- Challenges
  - Overview of items showing *Interesting* temporal developments
  - Integrating multiple heterogeneous attributes of a collection of items
  - Multiple levels of temporal dynamics
- Solution?
  - ThermalPlot visualization technique!
    - Encoding changes in attributes into an item's position
      - Position based on a degree-of-interest (DOI) function

Previous work

- Multi-attribute item comparison
  - Across multiple attributes of a single item
  - Across a single attribute of multiple items
    - Superimposing multiple curves in a line chart
- Temporal dynamics
  - Mapping time to time
    - Animations, *Gapminder Trendalyzer*
  - Mapping time to space
    - *Cycle Plot*
    - Small multiples, *LiveRac*
  - Trajectories
    - *DimpVis*

ThermalPlot Concept

- Fundamental idea
  - User-specified degree-of-interest (DOI) value



Math behind the DOI

- DOI

$$DoI_{raw}(t) = \sum_{i=1}^{n} w_i \times v_i(t) \mid \sum_{i=1}^{n} w_i = 1.$$

$$DoI(t) = \alpha \times DoI_{raw}(t) + (1-\alpha) \times (DoI_{raw}(t-1) + DoI_{trend}(t-1)).$$

$$DoI_{trend}(t) = \beta \times (DoI(t) - DoI(t-1)) + (1-\beta) \times DoI_{trend}(t-1).$$

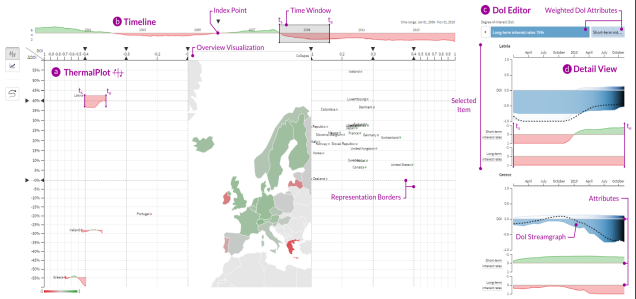
- Delta(DOI)

$$\Delta DoI(t) = DoI(t) - DoI(t-\Delta t).$$

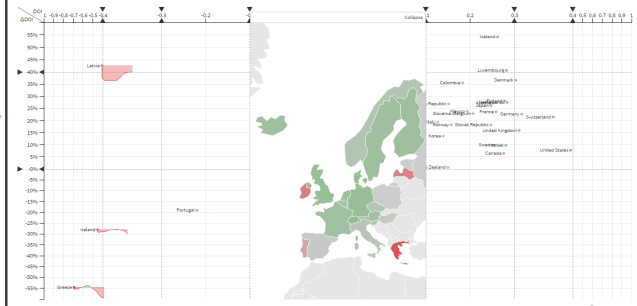
- Normalization

$$v_{rel}(t) = \frac{v(t) - v(t_{index})}{v(t_{index})}.$$

- User tasks
  - Monitor the development of multiple items in a certain time window
  - Select attributes and define their interestingness
  - Detect items that are most interesting
  - Understand why the items are considered to be interesting
  - Monitor the development of a single item

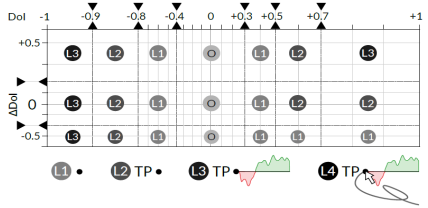


Problem?!

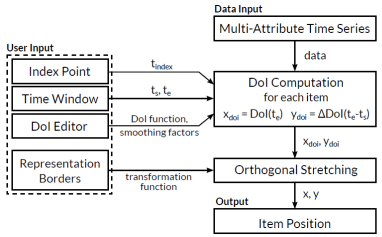


Clutter Reduction Strategies

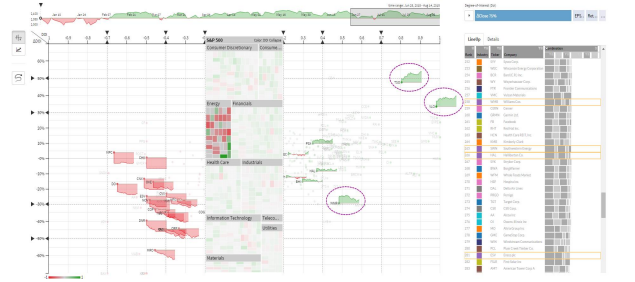
- Semantic Zooming
- Orthogonal Stretching

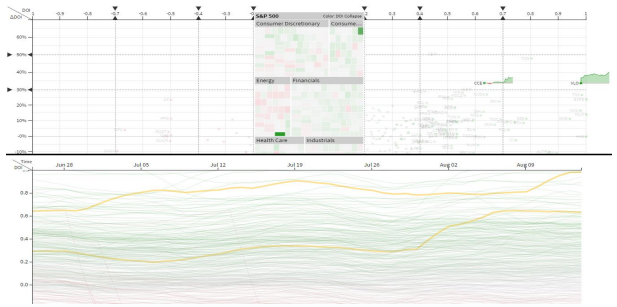


Data Flow



Use case





Analysis Summary

- What: data
  - Time-series, multiple attributes, multiple items
- What: derived
  - DOI and Delta(DOI) values based on user input
- How: encode
  - Item's position
  - Diverging colors
- How: Manipulate
  - Select
- How: Facet
  - Juxtapose
- How: Reduce
  - Focus+Context

- Why: Action
  - Discover
  - Browse
  - Identify
- Why: Target
  - Trends
  - Distribution

Critique

- Strength
  - Wise choice of item's position
  - Capability to handle large data sets
  - Use of overview and details on demand
- Weakness
  - No look-up scenarios anticipated
  - Animation for live data streaming
  - Adjusting the representation borders

THANKS !