Time Series visualizations

Information Visualization – CPSC 533c

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March 10th 2004

Papers presented

- ThemeRiver: Visualizing Thematic Changes in Large Document Collections, *Susan Havre, Elizabeth Hetzler, Paul Whitney, Lucy Nowell*
- Interactive Visualization of Serial Periodic Data, John Carlis, Joseph Konstan
- Visual Queries for Finding Patterns in Time Series Data, Harry Hochheiser, Ben Shneiderman + *Demo*

Time series

- Data elements are a function of time
- $D = \{(t_1,y_1),(t_2,y_2),\ldots,(t_n,y_n)\}$, where $y_i=f(t_i)$
- Equal / non-equal time steps

Time series, Interesting ?

- Fundamental data type
- Time dependent data
- Found in many domains such as finance, meteorology, physiology and genetics

The purpose of visualization

- Detect and validate properties of an unknown function *f*
- Temporal behavior of data elements
- When was something greatest/least?
- Is there a pattern?
- Are two series similar?
- Do any of the series match a pattern?
- Provide simpler, faster access to the series

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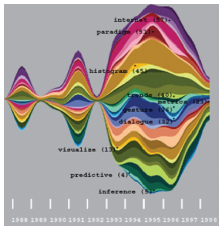
ThemeRiver

- Visualize themes over time in large document collection
- Suitable for presenting multiple attributes over time
- Relying on basic perception rules

River Metaphor

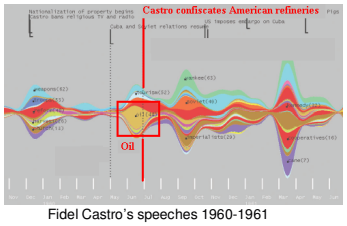
- River metaphor: Each attribute is mapped to a "current" in the "river", flowing along the timeline



A company's patent activity

Visual cues

- Current width ~= strength of theme
- River width ~= global strength
- Color mapping (similar themes – same color family)
- Time line
- External events

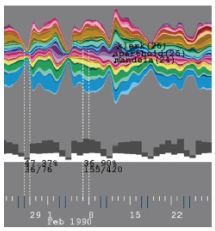


Fidel Castro's speeches 1960-1961

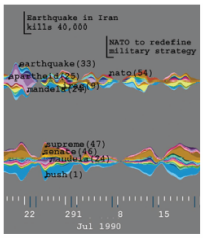
Cognitive rational

- Humans perceive complete "packages" and not individual element (Gestalt theory).
- Smooth continuous curves and colors
- Stacking the patterns facilitates comparisons
- Careful interpolation, refrain from "lying"

Extended expolration



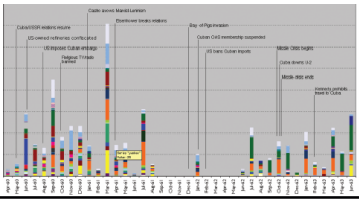
Linking a river to a histogram



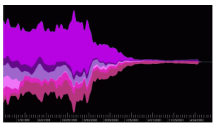
Comparing two rivers

Evaluation

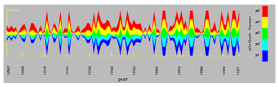
- Comparison with a histogram view
- Users liked the connectedness of the river
- Missed the numerical values



Presenting other data types



dot.com stocks 1999-2002



Climate changes

Critique

Strong points:

- Intuitive exploration of temporal changes and relations
- Evalutation + improvements
- Applicable to general attributes

Weak points:

- Limited number of themes / attributes
- Interpolated values / outer attributes misleading
- No ability to reorder currents
- Performance issues

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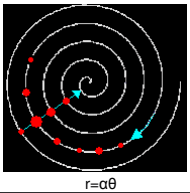
Interactive Visualization of Serial Periodic Data

- Simultaneous display of serial and periodic attributes (e.g. seasonality)
- Traditional layouts exaggerate distance across period boundaries
- Focus+Context / Zoom unsuitable

Spiral !

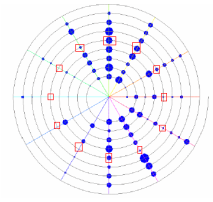
- Spiral axis = serial attributes
- Radii = periodic attributes
- Period = 360°
- Focus on pure serial periodic data (equal durations of cycles)



$r=a\theta$

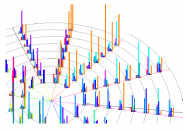
Spiral Example (for primatologists)

- Spokes (months) and spiral guide lines (years)
- Planar spiral
- Distinguishable patterns (rainy season / 1984)

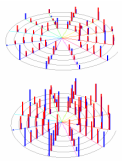


Chimpanzees Monthly food consumption 1980-1988

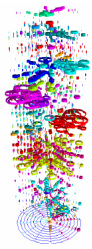
Using 3D for multiple data sets



•12 common food types
•Consistent ordering
•Boundary lines



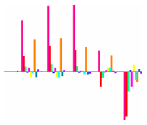
Muliple linked spirals:
2 chimpanzees
group avg size / max size

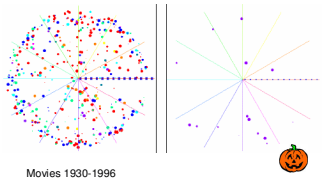


Helpful ?
112 food types

Supporting exploration techniques

- One data set at a time
- One spoke at a time / animation
- Dynamic query (Movie database)





Movies 1930-1996

Supporting exploration techniques

- Changing lap rate (periodicity known / unknown)

Critique

Strong points:
- Seasonality is fundamental
- simple concepts / easy to understand
- Real data examples and tasks / different disciplines
- Good analysis of the unsuitability of other solutions

Weak points:
- Labels ?
- Exaggerated use of 3D
- Scalability ?
- Expert users did not “drive” the tool
- No assistance in guessing period length

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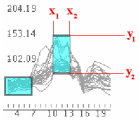
TimeSearcher

- Visualization alone is not enough (when dealing with multiple entities, e.g. stocks/genes)
- identifying patterns and trends
- Algorithmic/statistical methods
- Intuitive tools for dynamic queries (e.g. QuerySketch)

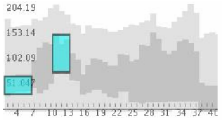
TimeSearcher - Timeboxes

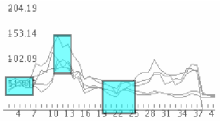
- Visual query operator for time series (e.g. 1500 stocks)
- Rectangular region drawn on the timeline display
- X-axis of the box = time period
- Y-axis of the box = constraint on the values
- Multiple timeboxes = conjunctive queries



TimeSearcher – Dynamic query

- Results on mouse up ($O(w*\log(MN)+k)$)
- A data envelope & a query envelope provide an overview for the query
- Linked views





Extended queries

- Relative changes
- Small interval patterns during a long time period
- Querying for “leaders and laggards”
- Disjunctive queries

TimeSearcher – Demo time !

http://www.cs.umd.edu/hcil/timesearcher/

- Entity display window
- Query space
- Controlling multiple boxes together
- Query by example
- linked updates between views

Critique

Strong points:
- Simple and intuitive
- Queries and results have immediate context
- Highly dynamic exploration

Weak points:
- Query power may be limited and simplistic
- Limited scalability for long time lines
- Envelope may be misleading
- No Undo / Redo
- Minimal report on evaluation

Summary

- There are not too many task specific visualization tools for time series
- Focus on multivariate data
- Support exploratory viewing
- Integrate with other tools / views