Time Series Data Visualization
Time Series Data

- Fundamental chronological component to the data set
- Random sample of 4000 graphics from 15 of world’s newspapers and magazines from ’74- ’80 found that 75% of graphics published were time series
Data

• One of the variables can be the date and time of the event
• Examples: Baseball games, medicines taken, cities visited, stock prices, news, ...
Example

- Visualize the following datasets:
  - CO2 emission
    - Dimension 1: Year
    - Dimension 2: Country
    - Dimension 3: Income per person
    - Dimension 4: CO2 emissions per person
    - Dimension 5: Population
Visualization Approaches

- Animation
- Small Multiples
- Time-Series Plot
- Nested Visualization (embed time-series plot into other display)
- Brushing and linking
Small Multiples

- Sets of thumbnail sized graphics on a single page that represent aspects of a single phenomenon
  - Depict comparison
  - Use the same measures and scale
  - Represent motion through multiple images
Small Multiples

Three air pollutants in six counties in southern California 8 Los Angeles Times, 1979
Static State Replacement

- Treat time as a dimension hidden from the display
- Divide time into period (time frame, or time window)
- Generate a visualization for each time frame
- Replace a display of one time frame using that of another time frame
- Animations, trails
Gapminder Trendalyzer

- Animated bubble chart to show trends over time in three dimensions

See interesting video at http://www.gapminder.org/world
Change Blindness

- People do not notice changes in visible elements of a scene

Nowell et al. Infovis 01
Change Blindness

Possible reasons:

- Overwriting: Old scene is wholly replaced by the new one
- First impressions: Accurately encode details of first scene and fail to encode the details of the changed scene
- Nothing is stored: No need to develop any mental representation of the scene
- Nothing is compared: Need to focus on changed items to recognition of changes
- Feature combination: New scene and old scene are combined together
Study pre-attentive features

- Spatial layout
- Size
- Shapes
- Angles
- Line length
- Color progression (such as yellow to green to blue)
- Bright to dim progression
- Perspective depth
- Left to right spatial progression
Time Series Plot

• Inclinations of the planetary orbits as a function of time
• Part of a textbook of monastery schools, tenth century
Time Series Plot

New York City's Weather for 1980

- Annual Temperature
- Precipitation in Inches
- Relative Humidity

TimeSearcher

• Free software from UMD HCIL
  – Visualize multivariate long time series
  – Provide overview that can be zoomed in
  – Support interactive pattern search
  – Support search by example patterns

Figure 1: Two visualizations of sunshine intensity using about the same screen real estate and the same color coding scheme. In the spiral visualization it is much easier to compare days, to spot cloudy time periods, or to see events like sunrise and sunset.
Spiral Graphs

- Scale to large data sets
- Support identification of periodic structures in the data
- Compare multiple datasets
Periodic Pattern Identification

Figure 3: Visualizations of the same data with continuously changing cycle length. The period in the data can be found visually, i.e. the visual system is used to detect periodic patterns in the data exploiting the spatial layout on the spiral.
Multiple Spirals

Figure 4: Stock prices of Microsoft (yellow) and Sun Microsystems (red) in five years on parallel spirals.
## Pixel-Oriented Techniques

- Recursive pattern arrangements
Pixel Oriented Techniques

[Image of pixel-oriented techniques with graphs for IBM, DOLLAR, DOW JONES, and GOLD (USS)]

Dr. D. Keim’s tutorial notes in Infovis 00
Nested Visualization

- Embed time series plot into other displays
- Example: Time series plot embedded into a graph
Figure 5: Pathway visualizations in GeneSpring™ [7] are linked to multidimensional visualizations such as timeseries charts.
Space and Time

• Life circle of Japanese Beetles

L. Newman, Man and Insects, 1965
GeoTime Information Visualization

• A combined temporal-spatial space (X, Y, T coordinate space)
• Represent place by 2D plane
• Use 3rd dimension to encode time

[Kapler and Wright Infovis 04]
Figure 1: Individual frames of movement are translated into a continuous spatiotemporal representation.
Figure 6: Screenshot of GeoTime with time slider at bottom and moveable time scale at right. The green line traces one entity’s movement in time and geography.
Figure 7: Screenshot of GeoTime with overhead view and time slider advanced forward in time from Figure 6.
Interaction

- Drill down

- Annotation

Figure 12: Pointing at an Entity or Activity Drills Down to Additional Information.

Figure 13: Screenshot of GeoTime with ink annotation.
Example

Arm Deals: Countries linked via Money Transfers

From


Video:

Example

• GeoTime: H1N1 "Swine Flu" Visual Analysis

http://www.youtube.com/watch?v=Okghjb_oABM&feature=related
Text Collections and Time

• Constantly evolving text streams
• Each document has a time stamp
• Temporal dynamics
• Alignment problem: find real life events happen in parallel and drive the text
ThemeRiver: Visualizing Theme Changes Over Time

- **Background:** a user is less interested in document themselves than in theme changes within the whole collection over time
- **ThemeRiver** provides users a macro-view of thematic changes
- **Helps** users identify time-related patterns, trends, and relationships across a large collection of documents

[Havre et al. Infovis 00]
A histogram depicting thematic changes
Problem

• The position of a particular theme within the bars may vary considerably
• Users are required to integrate the themes across time
• Improvement: the river and currents metaphor -> ThemeRiver
ThemeRiver

- The river flows from left to right through time
- Colored currents flowing with the river narrow or widen to depict the strength of individual topics
Figure 3: AP data from July - August 1990. A wide current in the river indicates heavy use of a topic, while changes in color distribution correlate to changes in themes.
Figure 6: Parallel rivers let users compare AP data from Washington, D.C. and New York from the same time period.
PNNL research with Video

- http://infoviz.pnnl.gov/research_themeriver.stm

Major References

• Jing Yang, Lecture notes, UNCC
• Colin Ware. Information visualization, 2004
• Daniel Keim. Tutorial note in InfoVis 2000
• John Stasko. Course slides, Fall 2005