Information Visualization

Visualization Motivation,
What: Data Abstraction

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5 January 2017

http://www.cs.ubc.ca/~tmm/courses/547-17
Before: In-class design exercise, in small groups

• Five time-series scenarios
  – A: every 5 min, duration 1 year, 1 thing: building occupancy rates
  – B: every 5 min, 1 year, 2 things: currency values (exchange rate)
  – C: several years and several things: 5 years, 10 currencies
  – D: 1 year, many things: CPU load across 1000 machines
  – E: 1 year, several parameters, many things: 10 params on each of 1000 machines

• Small-group exercise: 15-20 min
  – one group per table (3-4 people/group, 10 groups)
  – discuss/sketch possible visual encodings appropriate for your assigned scenario

• Reportback: 20-30 min
  – 3 min from each group

• Design space examples/discussion: 15-20 min
Case A: 3D Approach (Not Recommended)

- extruded curves: detailed comparisons impossible

[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]
Case A: Cluster-Calendar Solution

- derived data: cluster hierarchy
- juxtapose multiple views: calendar, superimposed 2D curves

[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]
Case B: Stack Zooming

https://youtu.be/dK0De4XPm5Y

Case C: ChronoLenses


https://youtu.be/k7pl8ikczqk
Case D: RankExplorer


https://youtu.be/rdgn1qcZ2A4
Case E: LiveRAC video

http://youtu.be/ld0c3H0VSkw

Ch 1. What’s Vis, and Why Do It?
Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Visualization is suitable when there is a need to augment human capabilities rather than replace people with computational decision-making methods.

• human in the loop needs the details
  – doesn't know exactly what questions to ask in advance
  – longterm exploratory analysis
  – presentation of known results
  – stepping stone towards automation: refining, trustbuilding

• external representation: perception vs cognition

• intended task, measurable definitions of effectiveness
Analysis: What, why, and how

- **what** is shown?
  - data abstraction

- **why** is the user looking at it?
  - task abstraction

- **how** is it shown?
  - idiom: visual encoding and interaction

- abstract vocabulary avoids domain-specific terms
  - translation process iterative, tricky

- what-why-how analysis framework as scaffold to think systematically about design space
### How?

#### What?
- **Encode**
  - **Arrange**
    - Express
    - Separate
  - **Order**
    - Align
  - **Use**
    ![Map](image)

#### Why?
- **Manipulate**
  - **Change**
    ![Change](image)
  - **Select**
    ![Select](image)
  - **Navigate**
    ![Navigate](image)

#### How?
- **Facet**
  - **Juxtapose**
    ![Juxtapose](image)
  - **Partition**
    ![Partition](image)
  - **Superimpose**
    ![Superimpose](image)

#### Reduce
- **Filter**
  ![Filter](image)
- **Aggregate**
  ![Aggregate](image)
- **Embed**
  ![Embed](image)

### Details
- **Encode**
  - **Map**
    - from *categorical* and *ordered* attributes
    - **Color**
      - Hue
      - Saturation
      - Luminance
    - **Size, Angle, Curvature, ...**
    - **Shape**
      - ![Shape](image)
    - **Motion**
      - *Direction, Rate, Frequency, ...*
VAD Ch 2: Data Abstraction

**What?**

**Datasets**

- Data Types
  - Items
  - Attributes
  - Links
  - Positions
  - Grids

- Data and Dataset Types
  - Tables
  - Networks & Trees
    - Items (nodes)
    - Attributes
  - Fields
    - Grids
    - Positions
  - Geometry
    - Items
  - Clusters, Sets, Lists
    - Items

**Attributes**

- Attribute Types
  - Categorical
  - Ordered
    - Ordinal
    - Quantitative

- Ordering Direction
  - Sequential
  - Diverging
  - Cyclic

**Why?**

**How?**

[VAD Fig 2.1]
Ch 2. What: Data Abstraction
Three major datatypes

### Dataset Types

<table>
<thead>
<tr>
<th>Tables</th>
<th>Networks</th>
<th>Spatial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attributes (columns)</strong></td>
<td><strong>Fields (Continuous)</strong></td>
<td><strong>Geometry (Spatial)</strong></td>
</tr>
<tr>
<td><strong>Items (rows)</strong></td>
<td><strong>Grid of positions</strong></td>
<td><strong>Position</strong></td>
</tr>
<tr>
<td><strong>Cell containing value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Node (item)</strong></td>
<td><strong>Link</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Tree</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Multidimensional Table**
- **Networks**
- **Spatial**

- **Trees**

- **Visualization vs computer graphics**
  - geometry is design decision
Attribute types

- **Attribute Types**
- **Categorical**
- **Ordered**
  - **Ordinal**
  - **Quantitative**

- **Ordering Direction**
- **Sequential**
- **Diverging**
- **Cyclic**
# Dataset and data types

## Data and Dataset Types

<table>
<thead>
<tr>
<th>Tables</th>
<th>Networks &amp; Trees</th>
<th>Fields</th>
<th>Geometry</th>
<th>Clusters, Sets, Lists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items</td>
<td>Items (nodes)</td>
<td>Grids</td>
<td>Items</td>
<td>Items</td>
</tr>
<tr>
<td>Attributes</td>
<td>Links</td>
<td>Positions</td>
<td>Positions</td>
<td></td>
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<tr>
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<td></td>
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</tbody>
</table>

## Data Types

- Items
- Attributes
- Links
- Positions
- Grids

## Dataset Availability

- Static
- Dynamic
Further reading: Articles


- The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. Ben Shneiderman, Proc. 1996 IEEE Visual Languages


Further reading: Books

  – Chap 2: Data Abstraction

• Information Visualization: Using Vision to Think. Stuart Card, Jock Mackinlay, and Ben Shneiderman.
  – Chap 1


• Visualization of Time-Oriented Data. Wolfgang Aigner, Silvia Miksch, Heidrun Schumann, Chris Tominski. Springer 2011.
Next Time

• to read
  – VAD book, Ch 3: Why: Task Abstraction
  – paper: Design Study Methodology