Visualization Analysis & Design

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Outline
- Session 1: Principles 9:15-10:30am
  - Analysis: What, Why, How
  - Matric and Channel, Perception
- Session 2: Techniques for Scaling 10:55-11:45am
  - Manipulation: Change, Select, Navigate
  - Facet: Juxtapose, Partition, Superimpose

Defining visualization (vis)
Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Why?

Why have a human in the loop?
Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Why?

Vis designers must take into account three very different kinds of resource limitations:

- computational limits
  - processing time
  - system memory
- human limits
  - human attention and memory
- display limits
  - pixels are precious resource, the most constrained resource
  - information density: ratio of space used to encode info vs unused whitespace
  - tradeoff between clutter and wasting space, find sweet spot between dense and sparse

Why use an external representation?
Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- external representation: replace cognition with perception
- summaries lose information, details matter
- confirm expected and find unexpected patterns

Why represent all the data?
Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

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Validation methods from different fields for each level

Why analyze?
- imposes a structure on huge design space
- scaffold to help you think systematically about choices

Aggregation: Value in cell

Actions I: Analyze
- consume
  - discover vs present
    - classic split
      - also explore vs explain
      - enjoy
        - newcomer
      - also causal vs social
  - produce
    - annotate, record
    - derive

Dataset and data types

Actions II: Search
- what does user know?
  - target, location

Actions III: Query
- what does user know?
  - target, location
- how much of the data matters?
  - one, some, all
### Encoding visually

- Analyze idiom structure
- Encode manipulatively
- Reduce attributes

### Channels: Rankings

<table>
<thead>
<tr>
<th>Magnitude Channels: Ordered Attributes</th>
<th>Identity Channels: Categorical Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position (on unaligned scale)</td>
<td>Location (aligned or not)</td>
</tr>
<tr>
<td>Length (2D size)</td>
<td>Area (2D position)</td>
</tr>
<tr>
<td>Tilt/angle</td>
<td>Color saturation</td>
</tr>
<tr>
<td>Volume (3D size)</td>
<td>Curvature</td>
</tr>
<tr>
<td>• Effectiveness principle</td>
<td>• Encode most important attributes with</td>
</tr>
<tr>
<td>• Expressiveness principle</td>
<td>highest ranked channels</td>
</tr>
<tr>
<td>• Match channel and data characteristics</td>
<td></td>
</tr>
</tbody>
</table>

### Accuracy: Fundamental Theory

- **Stevens’s Psychophysical Power Law, 5-1**

### Discriminability: How many usable steps?

- Must be sufficient for number of attribute levels to show
  - Inwidth: few bins

### Separability vs. Intensity

- **Position**
  - Full separation
  - Some interference
  - Major interference
- **Size**
  - Fully separable
  - Some interference
  - Major interference
- **Width**
  - Fully separable
  - Some interference
  - Major interference
- **Red**
  - Fully separable
  - Some/similar interference
  - Major interference
- **Green**
  - Fully separable
  - Some/similar interference
  - Major interference

### Further reading

- Visual Thinking for Design. Ware, Morgan Kaufmann, 2008.

### Outline

- **Session 1: Principles**
  - Attributes, Why, How
  - Marks and Channels, Perception
  - Color
- **Session 2: Techniques for Scaling**
  - Manipulate: Change, Select, Navigate
    - FACets: Juxtapose, Partition, Superimpose
  - Reduce: Filter, Aggregate
Ordered color: Rainbow is poor default

- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - fine-grained structure visible and nameable
- alternatives
  - large-scale structure fewer hues

Viridis

- colorful, perceptually uniform, colorblind-safe, monotonically increasing luminance

Further reading

- Chip 12/10 Map Color and Other Chevills
  - http://www.colorbrewer2.org
  - http://www.stone.cs.yale.edu

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- Color

Coffee Break 10:30-10:50am

Session 2: Techniques for Scaling 10:50-11:40am

- Manipulate: Change, Select, Navigate
- Facet: Juxtapose, Partition, Superimpose
- Reduce: Filter, Aggregate

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Session 1: Principles 9:15-10:30am

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Session 2: Techniques for Scaling 10:50-11:40am

- Manipulate: Change, Select, Navigate
- Facet: Juxtapose, Partition, Superimpose
- Reduce: Filter, Aggregate
Derive Coordinate Multiple Side By Side Views
Share Encoding: Same/Different
Share Data: All/Subset/None
Share Navigation
Linked Highlighting
Attribute Reduction
Slice
Cut
Project

Idiom: Small multiples
- encoding: same
- data: subset shared

Idiom: Linked highlighting
- see how regions contiguous in one view are distributed within another
- powerful and pervasive interaction

Idiom: Animation (change over time)
- weaknesses
- dispersed changes
- disparate frames
- strengths
- choreographed storytelling
- localized differences between contiguous frames
- animated transitions between states

System: Cerebral
Coordinate views: Design choice interaction

System: LineUp
Partition into views

System: EDV
Outline
Idiom: Realign
- stacked bars
- easy to compare
- first segment
- total bar
- align to different segment
- supports flexible comparison
Further reading


More Information

- http://www.cs.ubc.ca/~tmm/vadbook
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