Assignment 2: Creating Visualizations

Use existing software to formulate & answer questions

First steps
- Step 1: Pick a domain
- Step 2: Pose question
- Step 3: Find data
- May need to iterate

Create visualization
- Interact with data
- Question will evolve
- Tableau or Spotfire DXP

Make wiki notebook
- Keep record of all steps you took to answer the questions

Due before class on Sep 24, 2007
Cleveland and McGill

Figure 4. Graphs from position–length experiment.

[Cleveland and McGill 84]
Figure 3. Graphs from position–angle experiment.

[Cleveland and McGill 84]
Relative magnitude estimation

Most accurate
- Position (common) scale
- Position (non-aligned) scale
- Length
- Slope
- Angle
- Area
- Volume

Least accurate
- Color hue-saturation-density

Mackinlay’s ranking of encodings

<table>
<thead>
<tr>
<th>QUANTITATIVE</th>
<th>ORDINAL</th>
<th>NOMINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Position</td>
<td>Position</td>
</tr>
<tr>
<td>Length</td>
<td>Density (Val)</td>
<td>Color Hue</td>
</tr>
<tr>
<td>Angle</td>
<td>Color Sat</td>
<td>Texture</td>
</tr>
<tr>
<td>Slope</td>
<td>Color Hue</td>
<td>Connection</td>
</tr>
<tr>
<td>Area (Size)</td>
<td>Texture</td>
<td>Containment</td>
</tr>
<tr>
<td>Volume</td>
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<td>Density (Val)</td>
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<tr>
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<td>Color Sat</td>
</tr>
<tr>
<td>Color Sat</td>
<td>Length</td>
<td>Shape</td>
</tr>
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<td>Color Hue</td>
<td>Angle</td>
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<td>Containment</td>
<td>Volume</td>
<td>Area</td>
</tr>
<tr>
<td>Shape</td>
<td>Shape</td>
<td>Volume</td>
</tr>
</tbody>
</table>

Conjectured effectiveness of visual encodings
Preattentive vs. Attentive

How many 3’s

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
909103020990599595772564675050678904567
8845789809821677654876364908560912949686

[based on slide from Stasko]
How many 3’s

[based on slide from Stasko]

Visual pop-out: Color

http://www.csc.ncsu.edu/faculty/healey/PP/index.html
Visual pop-out: Shape

http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Feature conjunctions

http://www.csc.ncsu.edu/faculty/healey/PP/index.html
Preattentive features

More preattentive features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line (blob) orientation</td>
<td>Julesz &amp; Bergen [1983]; Wolfe et al. [1994]</td>
</tr>
<tr>
<td>Length</td>
<td>Triesman &amp; Gormican [1988]</td>
</tr>
<tr>
<td>Width</td>
<td>Julesz [1985]</td>
</tr>
<tr>
<td>Size</td>
<td>Triesman &amp; Gelade [1980]</td>
</tr>
<tr>
<td>Curvature</td>
<td>Triesman &amp; Gormican [1988]</td>
</tr>
<tr>
<td>Number</td>
<td>Julesz [1985]; Trick &amp; Pylyshyn [1994]</td>
</tr>
<tr>
<td>Terminators</td>
<td>Julesz &amp; Bergen [1983]</td>
</tr>
<tr>
<td>Intersection</td>
<td>Julesz &amp; Bergen [1983]</td>
</tr>
<tr>
<td>Closure</td>
<td>Enns [1986]; Triesman &amp; Souther [1985]</td>
</tr>
<tr>
<td>Intensity</td>
<td>Beck et al. [1983]; Triesman &amp; Gormican [1988]</td>
</tr>
<tr>
<td>Flicker</td>
<td>Julesz [1971]</td>
</tr>
<tr>
<td>Direction of motion</td>
<td>Nakayama &amp; Silverman [1986]; Driver &amp; McLeod [1992]</td>
</tr>
<tr>
<td>Binocular lustre</td>
<td>Wolfe &amp; Franzel [1988]</td>
</tr>
<tr>
<td>Stereoscopic depth</td>
<td>Nakayama &amp; Silverman [1986]</td>
</tr>
<tr>
<td>3-D depth cues</td>
<td>Enns [1990]</td>
</tr>
<tr>
<td>Lighting direction</td>
<td>Enns [1990]</td>
</tr>
</tbody>
</table>

http://www.csc.ncsu.edu/faculty/healey/PP/index.html
Preattentive conjunctions

Spatial conjunctions are often preattentive
- Motion and 3D disparity
- Motion and color
- Motion and shape
- 3D disparity and color
- 3D disparity and shape

Most conjunctions are not preattentive

Feature-integration theory

Treisman’s feature integration model [Healey04]
Multiple Attributes

One-dimensional: Lightness

White  White  White  White
Black  Black  Black  White
One-dimensional: Shape

- Square
- Circle
- Circle
- Square
- Circle

Correlated dims: Shape or lightness

- Circle
- Circle
- Square
- Square
- Circle
- Circle
- Square
- Square
- Circle
- Circle

Orthogonal dims: Shape & lightness

Circle  
Square  
Circle  
Square

Speeded classification

Redundancy gain
Facilitation in reading one dimension when the other provides redundant information

Filtering interference
Difficulty in ignoring one dimension while attending to the other
**Speeded classification**

- **Response Time**
- **Interference**
- **Gain**

Types of dimensions:

**Integral**
- Filtering interference and redundancy gain

**Separable**
- No interference or gain

**Configural**
- Only interference, but no redundancy gain

**Asymmetrical**
- One dimension separable from other, not vice versa

Stroop effect – Color naming influenced by word identity, but word naming not influenced by color
Correlated dims: Size and value

W. S. Dobson, Visual information processing and cartographic communication: The role of redundant stimulus dimensions, 1983 (reprinted in MacEachren, 1995)

Othogonal dims: Aspect ratio

FIGURE 3.38. An example of the use of an ellipse as a map symbol in which the horizontal and vertical axes represent different (but presumably related) variables.

[MacEachren 95]
Summary of Integral-Separable

Each card has 4 features:
- Color
- Symbol
- Number
- Shading/Texture

A set consists of 3 cards in which each feature is the SAME or DIFFERENT on each card.

Adrien Treuille’s applet
http://www.cs.washington.edu/homes/treuille/rese/set
Gestalt

Principles

- figure/ground
- proximity
- similarity
- symmetry
- connectedness
- continuity
- closure
- common fate
- transparency
Figure/Ground

Principle of surroundedness

http://www.aber.ac.uk/media/Modules/MC10220/visper06.html

Figure/Ground

Ambiguous

Unambiguous

http://www.aber.ac.uk/media/Modules/MC10220/visper06.html
Proximity

Similarity

Rows dominate due to similarity [from Ware 04]
Symmetry

Bilateral symmetry gives strong sense of figure [from Ware 04]

Connectedness

Connectedness overrules proximity, size, color shape [from Ware 04]
Continuity

We prefer smooth not abrupt changes [from Ware 04]

Connections are clearer with smooth contours [from Ware 04]

Continuity: Vector fields

Prefer field that shows smooth continuous contours [from Ware 04]
**Closure**

We see a circle behind a rectangle, not a broken circle [from Ware 04]

**Illusory contours** [from Durand 02]

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**Common fate**

Dots moving together are grouped

http://coe.sdsu.edu/eet/articles/visualperc1/start.htm
Transparency

Requires continuity and proper color correspondence [from Ware 04]

Layering and Small Multiples
Signal and background compete above, as an electrocardiogram trace-line becomes caught up in a thick grid. Below, the screened-down grid stays behind traces from each of 12 monitoring leads.

Electrocardiogram tracelines [from Tufte 90]

Stravinsky score [from Tufte 90]
Layering: Color and line width

IBM Series III Copier [from Tufte 90]

Small multiples

[Figure 2.11, p. 38, MacEachren 95]
Small multiples

Operating trains. Redrawn by Tufte to emphasize colored lights. [from Tufte 90]

Change blindness

[Example from Palmer 99, originally due to Rock]
Change detection
Rensink’s demonstration

http://www.usd.edu/psyc301/Rensink.htm

Summary

Choosing effective visual encodings requires knowledge of visual perception

Visual features/attributes
  - Individual attributes often preattentive
  - Multiple attributes may be separable, often integral

Gestalt principles provide higher level design guidelines

We don’t always see everything that is there