Data Visualization (DSC 530/CIS 602-01)

Marks & Channels

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D3 Introduction

- Ogievetsky has put together a nice set of interactive examples that show off the major features of D3
  - (Updated from original for D3 v4)
- Other references:
  - Murray’s book on Interactive Data Visualization for the Web
  - The D3 website: [d3js.org](http://d3js.org)
  - Ros's Slides on v4: [https://iros.github.io/d3-v4-whats-new/](https://iros.github.io/d3-v4-whats-new/)
D3 Data Joins

- Two groups: data and visual elements
- Three parts of the join between them: enter, update, and exit
- enter: `s.enter()`, update: `s`, exit: `s.exit()`
D3 v4 vs. v3

• v4 breaks a lot of v3 code…
• v4 is more modular, can build libraries that include only the parts you care about
  - Why worry about this?
• Result is that there is a flat namespace now
  - d3.scale.linear => d3.scaleLinear
• More important change: selections are immutable now
  - Used to be that enter() modified the selection to include any appended items
  - Use merge to explicitly merge the enter and update selections
  - s.enter().append("rect")
    .merge(s)
    ...

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D3 v3 Selections

```javascript
var circleBinding = svg.selectAll("circle").data(data);

circleBinding.style("fill", "blue"); // UPDATE

circleBinding.enter()
  .append("circle") // ENTER; modifies UPDATE!
    .style("fill", "green");

circleBinding // ENTER + UPDATE
  .style("stroke", "black");
```
D3 v4 Selections

```javascript
var circleBinding = svg.selectAll("circle").data(data);
circleBinding.style("fill", "blue"); // UPDATE
circleBinding.enter()
  .append("circle") // ENTER; modifies UPDATE!
    .style("fill", "green");
  .merge(circleBinding) // ENTER + UPDATE
    .style("stroke", "black");
```
Merge

• Merge creates a new selection that includes the items from both selections
• If you want to update all elements (including those just added via enter), use merge!
Transitions

• Nested transitions (those that "hang off" of a parent transition) follow immediately after the parent transition
• In v3, they had to be delayed accordingly
Assignment 2

Data In Tableau

- Categorical data = Dimension
- Quantitative data = Measures
Project

• Choices:
  - [CreateVis] Create a complex, interactive visualization of a dataset
  - [Research] Research project that involves visualization (new technique, evaluation, etc.)

• Check with me if you're interested in the research project option

• Start:
  - [CreateVis] Looking for a dataset: Awesome Public Datasets, Kaggle, etc.
  - [Research] Surveying literature, identifying goals
Toward Reusable Charts

• D3 does not provide "standard" charts
• E.g. there is no barchart method
• What is a standard chart?
  - "Should you expose the underlying scales and axes, or encapsulate them with chart-specific representations?"
  - "Should your chart support interaction and animation automatically?"
  - "Should the user be able to reach into your chart and tweak some aspect of its behavior?"

[Towards Reusable Charts, M. Bostock, 2012]
## Visual Encoding

- How should we visualize this data?

<table>
<thead>
<tr>
<th>Name</th>
<th>Region</th>
<th>Population</th>
<th>Life Expectancy</th>
<th>Income</th>
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</table>
Potential Solution

[Gapminder, Wealth & Health of Nations]
Another Solution

Size: Population, total

[Gapminder, Wealth & Health of Nations]
What about change over years?
Another Solution showing trends over time

Income per person (GDP/capita, PPP$ inflation-adjusted)

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Visual Encoding

• How do we encode data visually?
  - **Marks** are the basic graphical elements in a visualization
  - **Channels** are ways to control the appearance of the marks

• Marks classified by dimensionality:

  🔄 Points 🔄 Lines 🔄 Areas

• Also can have surfaces, volumes
• Think of marks as a mathematical definition, or if familiar with tools like Adobe Illustrator or Inkscape, the path & point definitions
### Bertin’s Original Visual Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Examples</th>
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</thead>
<tbody>
<tr>
<td><strong>Position</strong></td>
<td>changes in the x, y location</td>
<td><a href="#">Diagram showing geometric shapes varying in position</a></td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>change in length, area or repetition</td>
<td><a href="#">Diagram showing bars, squares, and grids varying in size</a></td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>infinite number of shapes</td>
<td><a href="#">Diagram showing various geometric shapes</a></td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td>changes from light to dark</td>
<td><a href="#">Diagram showing squares in various shades</a></td>
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<tr>
<td><strong>Colour</strong></td>
<td>changes in hue at a given value</td>
<td><a href="#">Diagram showing squares in various colors</a></td>
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<tr>
<td><strong>Orientation</strong></td>
<td>changes in alignment</td>
<td><a href="#">Diagram showing patterns in various orientations</a></td>
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<tr>
<td><strong>Texture</strong></td>
<td>variation in ‘grain’</td>
<td><a href="#">Diagram showing various textures</a></td>
</tr>
</tbody>
</table>
Visual Channels

- **Position**
  - Horizontal
  - Vertical
  - Both

- **Color**

- **Shape**

- **Tilt**

- **Size**
  - Length
  - Area
  - Volume

[Munzner (ill. Maguire), 2014]
# Visual Attributes Survey

## Table of Visual Attributes

<table>
<thead>
<tr>
<th>Transform</th>
<th>Position</th>
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<th>Size (Area)</th>
<th>Orientation</th>
<th>Volume</th>
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<tbody>
<tr>
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<td>Shape</td>
<td>Angle</td>
<td>Curvature</td>
<td>Mark</td>
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<tr>
<th>Information Visualization Researchers</th>
<th>Vision Rsch</th>
<th>Shape Rsch</th>
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[Brath 2009/2011]

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More Visual Attributes

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</table>

Richard Brath
v. Sept 2013
Channels

• Usually map an attribute to a single channel
  - Could use multiple channels but…
  - **Limited** number of channels

• Restrictions on size and shape
  - Points are nothing but location so size and shape are ok
  - Lines have a length, cannot easily encode attribute as length
  - Maps with boundaries have area, changing size can be problematic
Cartograms

[Election Results by Population, M. Newman, 2012]
Channel Types

• Identity => what or where, Magnitude => how much

**Magnitude Channels: Ordered Attributes**
- Position on common scale
- Position on unaligned scale
- Length (1D size)
- Tilt/angle
- Area (2D size)
- Depth (3D position)
- Color luminance
- Color saturation
- Curvature
- Volume (3D size)

**Identity Channels: Categorical Attributes**
- Spatial region
- Color hue
- Motion
- Shape

[Munzner (ill. Maguire), 2014]
Mark Types

- Can have marks for items and **links**
  - Connection => pairwise relationship
  - Containment => hierarchical relationship

**Marks as Items/Nodes**
- Points
- Lines
- Areas

**Marks as Links**
- Containment
- Connection

[Munzner (ill. Maguire), 2014]