Data Visualization (DSC 530/CIS 568)

D3 and Marks & Channels

Dr. David Koop
Tasks

**What?**

- Analyze
  - Consume
    - Discover
    - Present
    - Enjoy
  - Produce
    - Annotate
    - Record
    - Derive

- Search
  - Target known
    - Lookup
  - Target unknown
    - Locate
    - Explore

- Query
  - Identify
  - Compare
  - Summarize

**Why?**

- All Data
  - Trends
  - Outliers
  - Features

- Attributes
  - One
    - Distribution
    - Extremes
  - Many
    - Dependency
    - Correlation
    - Similarity

- Network Data
  - Topology
    - Paths
  - Spatial Data
    - Shape

[Munzner (ill. Maguire), 2014]
Memorability

[Figure 6.2: Policy shifts and interventions to enable wetland practices in sustainable ecologies of ecosystem services and human health]

[M. Borkin et al., InfoVis 2015]

D. Koop, DSC 530, Spring 2019
Memorability of Visualizations

• S. Few: "Visualizations don’t need to be designed for memorability – they need to be designed for comprehension. For most visualizations, the comprehension that they provide need only last until the decision that it informs is made. Usually, that is only a matter of seconds."

• B. Jones (paraphrased): People make decisions using visualizations but this isn't instantaneous like robots or algorithms; they often chew on a decision for a while

• R. Kosara: there are cases where people benefit from remembering a visualization (e.g. health-related visualization)

• Are there tradeoffs between the characteristics?
Original Data

Derived Data

trade balance = exports − imports

[Munzner (ill. Maguire), 2014]
Visualization for Production

- Generate new material
- Annotate:
  - Add more to a visualization
  - Usually associated with text, but can be graphical
- Record:
  - Persist visualizations for historical record
  - Provenance (graphical histories): how did I get here?
- Derive (Transform):
  - Create new data
  - Create derived attributes (e.g. mathematical operations, aggregation)
### Actions: Search

<table>
<thead>
<tr>
<th></th>
<th>Target known</th>
<th>Target unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location known</td>
<td></td>
<td>Browse</td>
</tr>
<tr>
<td>Location unknown</td>
<td>Locate</td>
<td>Explore</td>
</tr>
</tbody>
</table>

- What does a user know?
  - Lookup: check bearings
  - Locate: find on a map
  - Browse: what’s nearby
  - Explore: where to go (patterns)

[Munzner (ill. Maguire), 2014]
Number of targets: One, Some (Often 2), or All
Identify: characteristics or references
Compare: similarities and differences
Summarize: overview of everything

[Munzner (ill. Maguire), 2014]
Assignment 2

• Create a stacked bar chart using three different tools: Tableau, Vega-Lite, and D3

• Due Monday, Feb. 25
D3.js is a JavaScript library for manipulating documents based on data. D3 helps you bring data to life using HTML, SVG, and CSS. D3’s emphasis on web standards gives you the full capabilities of modern browsers without tying yourself to a proprietary framework, combining powerful visualization tools with a familiar JavaScript environment.

See more examples.
Data-Driven Documents (D3)

• JavaScript Library
• http://d3js.org/
• Original Authors: Mike Bostock, Vadim Ogievestky, and Jeff Heer
• Open Source
• Focus on Web standards, customization, and usability
• Grew from work on Protovis: more standard, more interactive
• By nature, a low-level library; you have control over all elements and styles if you wish
• A top project on GitHub (over 80,000 stars as of 2/8/2017)
• Lots of impressive examples
  - Bostock was a New York Times Graphics Editor
  - http://bost.ocks.org/mike/
D3 Key Features

- Supports data as a core piece of Web elements
  - Loading data
  - Dealing with changing data (joins, enter/update/exit)
    - **Correspondence** between data and DOM elements
- Selections (similar to CSS) that allow greater manipulation
- Method Chaining
- Integrated layout algorithms, axes calculations, etc.
- Focus on interaction support
  - Straightforward support for transitions
  - Event handling support for user-initiated changes
D3 Introduction

• Ogievetsky has put together a nice set of interactive examples that show off the major features of D3

• http://dakoop.github.io/IntroD3/
  - (Updated from original for D3 v5 with new joins)

• https://beta.observablehq.com/@dakoop/d3-intro

• Other references:
  - Murray’s book on Interactive Data Visualization for the Web
  - The D3 website: d3js.org
  - Ros's Slides on v4: 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: \texttt{s.enter()}, update: \texttt{s}, exit: \texttt{s.exit()}
Merge vs. Join

• 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!
  - Useful when enter+update have similar transitions

• Join allows you to modify different parts of the selection in a single statement
  - Also will create the final selection
  - Does enter+append and exit+remove automatically
  - Pass functions to modify the enter, update, and exit parts of the selection
Transitions

- Nested transitions (those that "hang off" of a parent transition) follow immediately after the parent transition
Data In Tableau

- Categorical data = Dimension
- Quantitative data = Measures
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?

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<th>Life Expectancy</th>
<th>Income</th>
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Potential Solution

[Gapminder, Wealth & Health of Nations]