The Big Picture

- Task: questions & hypotheses intended audience
- Data: physical type int, float, etc.
  abstract type nominal, ordinal, etc.
- Domain: metadata semantics conceptual model
- Processing algorithms
- Mapping visual encoding visual metaphor
- Image visual channel perception

Nominal, Ordinal and Quantitative

- N - Nominal (labels)
  - Operations: =, ≠
- O - Ordered (rank-ordered, sorted)
  - Operations: ≠, ≤, ≥
- Q - Interval (location of zero arbitrary)
  - Operations: ≠, ≤, ≥, -
  - Can measure distances or spans
- Q - Ratio (zero fixed)
  - Operations: =, ≠, <, >, ÷
  - Can measure ratios or proportions

S. S. Stevens, On the theory of scales of measurements, 1946
Visual Encoding Variables

<table>
<thead>
<tr>
<th>Position</th>
<th>Size</th>
<th>Value</th>
<th>Texture</th>
<th>Color</th>
<th>Orientation</th>
<th>Shape</th>
<th>Others?</th>
</tr>
</thead>
</table>

Design Criteria (Mackinlay)

**Expressiveness**
A set of facts is expressible in a visual language if the sentences (i.e., the visualizations) in the language express all the facts in the set of data, and only the facts in the data.

**Effectiveness**
A visualization is more effective than another visualization if the information conveyed by one visualization is more readily perceived than the information in the other visualization.

Mackinlay’s Ranking

Assignment 1 Review
Design Considerations

Title, labels, legend, captions, source!

Expressiveness and Effectiveness
Avoid unexpressive marks (lines? bars? gradients?)
Use perceptually effective encodings
Don’t distract: faint gridlines, pastel highlights/fills
The “elimination diet” approach – start minimal

Support comparison and pattern perception
Between elements, to a reference line, or to totals

In-Class Review Rubric

Expressiveness
- Prioritizes important information / Avoids false inferences
- Consistent visual mappings (e.g., respect color mappings)
- Make encodings meaningful rather than arbitrary

Effectiveness
- Facilitates accurate decoding / Minimizes cognitive overhead
- Highlight elements of primary interest

Grouping / Sorting

Data Transformation

Non-Data Elements
- Descriptive: Title, Label, Caption, Data Source, Annotations
- Reference: Gridlines, Legend

Design Space of A1 Submissions

Spatial Encoding
- Scatter plots, Bar charts, Line charts,
  Dot plots, Parallel Coords, Maps

Color Encoding
- Nominal, Highlights, Quantitative

Data Transformation
- Normalize (by pop), regression lines,
  grouping (threshold), medal weights

Sorting
- By medal count, or derived metrics

Labeling
- Title, Caption, Axis labels
  Annotations, Country flags

Transform data (e.g., invert, log, normalize)
Are model choices (regression lines) appropriate?
Reduce cognitive overhead
Minimize visual search, minimize ambiguity
- Avoid legend lookups if direct labeling works
- Avoid color mappings with indiscernible colors

Be consistent! Visual inferences should consistently support data inferences
Scatter Plots

Olympic Medal Count and GDP Per Capita

What's wealth got to do with it?

The relationship between GDP per capita and medal count

2012 London Olympics
Medal and Economic Efficiency at the London 2012 Summer Olympics by Country (Normalized)

Does Money Buy You Medals?

First World Medals

Legend

<table>
<thead>
<tr>
<th>First world</th>
<th>Second world</th>
<th>Third world</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>USA</td>
<td>Russia</td>
</tr>
<tr>
<td>Korea</td>
<td>Germany</td>
<td>Japan</td>
</tr>
<tr>
<td>UK</td>
<td>France</td>
<td>Italy</td>
</tr>
</tbody>
</table>

Multiple Plots
Socioeconomics of the Olympics
Reference Lines & Fitting Models

Trends in GDP and Gender Ratio of Olympic Athletes
Line Charts

Home Court Effect at the Olympics

China and USA Olympic Medal Efficiency from 1984 to 2012
Dot Plots
Parallel Coordinates & Bump Charts

The Bronze Medal Champions of the 2012 London Olympic Games

- 14.80 Jamaica
- 10.89 Mongolia
- 6.74 Georgia
- 3.51 Canada
- 2.36 Russia – highest bronze medal count
- 0.95 USA – highest total and gold medal count
- 0.77 China – second highest total medal count

2012 Olympic Relative Rankings by System
Visualization Design
In-Class Exercise

In-Class Design Exercise

Task: Analyze and Re-design visualization
- Identify data variables (N,O,Q) and encodings
- Critique the design: what works, what doesn't
- Sketch a re-design to improve communication
- Be ready to share your thoughts with the class

Break into groups with those sitting near you (~4 people per group)

Mackinlay’s Ranking

Conjectured effectiveness of the encoding

Source: The Atlantic 300 no. 2 (September 2007)
Number of Classified U.S. Documents