Ch 5: Marks and Channels
Paper: Polaris

Tamara Munzner
Department of Computer Science
University of British Columbia

CPSC 547, Information Visualization
Day 2: 15 September 2015

http://www.cs.ubc.ca/~tmm/courses/547-15
News

• Three copies of physical book available in Reading Room (ICICS/CS 262)
• Signup sheet: mark last column with new probabilities
  – add yourself at end if you weren’t here last time
• Waitlist update: 38 registered so 2 slots open; 2 on waitlist
• Questions/comments were due at 1:30pm today
• Guest lecture from Robert Kosara on Tableau at 2:20
  – my section only 20 minutes
VAD Ch 5: Marks and Channels

Channels: Expressiveness Types and Effectiveness Ranks

**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

[VAD Fig 5.1]
Encoding visually

• analyze idiom structure
Definitions: Marks and channels

- **marks**
  - geometric primitives

- **channels**
  - control appearance of marks

**Marks**
- Points
- Lines
- Areas

**Channels**
- Position
  - Horizontal
  - Vertical
  - Both
- Color
- Shape
- Tilt
- Size
  - Length
  - Area
  - Volume
Encoding visually with marks and channels

• analyze idiom structure
  – as combination of marks and channels

1: vertical position
mark: line

2: vertical position
horizontal position
mark: point

3: vertical position
horizontal position
color hue
mark: point

4: vertical position
horizontal position
color hue
size (area)
mark: point
Channels

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)

Spatial region
Color hue
Motion
Shape

Ordered Attributes
Magnitude Channels:
Identity Channels:
Categorical Attributes
Channels: Rankings

**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

- **effectiveness principle**
  - encode most important attributes with highest ranked channels
- **expressiveness principle**
  - match channel and data characteristics
Accuracy: Fundamental Theory

Steven’s Psychophysical Power Law: $S = I^N$
Accuracy: Vis experiments

Discriminability: How many usable steps?

• must be sufficient for number of attribute levels to show
  – linewidth: few bins

[mappa.mundi.net/maps/maps_014/telegeography.html]
Separability vs. Integrality

Position
+ Hue (Color)

2 groups each

Fully separable

Size
+ Hue (Color)

2 groups each

Some interference

Width
+ Height

3 groups total: integral area

Some/significant interference

Red
+ Green

4 groups total: integral hue

Major interference
Polaris

A System for Query, Analysis and Visualization of Multi-dimensional Relational Databases

Chris Stolte, Diane Tang, Pat Hanrahan

http://www.graphics.stanford.edu/projects/polaris/
Polaris: Stolte, Tang, and Hanrahan

• infovis spreadsheet
  – table cells have graphical elements, not just numbers
  – wide range of channels and marks

• example
  – marks: circles
  – color channel: saturation
  – size channel: area
  – partition: state x product:month
  • ord x ord

Table Algebra :: Interactive Interface

• drag and drop actions map to formal language underneath
  – partitioning using shelves
  – different results for ord vs quant

\[ O \times Q = \text{Quarter} \times \text{Profit} = \{(\text{Qtr1, Profit}), (\text{Qtr2, Profit}), (\text{Qtr3, Profit}), (\text{Qtr4, Profit})\} : \]

![Diagram showing partitioning of data with ordinal and quantitative fields.](image)

Polaris

- example
  - marks: Gantt chart bars
  - color channels: nominal / categorical
  - spatial position channels: country x year
  - ord x quant

Polaris

- example
  - views: scatterplots
  - marks: points
  - spatial position channels: profit x month
    - quant x (2 ord)

Terminology I: Now and Upcoming

• Marks and Channels
  – retinal variables/properties: visual channels
  – mark: mark

• Data Abstraction
  – column or field: attribute
    • nominal: categorical
    • ordinal: ordered
    • quantitative: quantitative
  – row or record: item
  – dimension / independent / ordinal: key attribute
    • all ordinal fields treated as dimensions in Polaris
  – measure / dependent: value attribute
    • all quantitative fields treated as measures in Polaris
Terminology II: Upcoming

• Data Abstraction
  – deriving data

• Map Color and Other Channels
  – hue: hue
  – value: saturation
  – brightness: luminance

• Manipulate View
  – sorting

• Facet Into Multiple Views
  – pane: view
  – partitioning
  – brushing: linked highlighting

• Reduce Items and Attributes
  – aggregation, filtering
Polaris: Pre and post

• influences
  – Mackinlay’s APT paper/system (1986)
  – Cleveland’s Visualizing Data book (1993)

• Stolte and Hanrahan commercialized as Stanford spinoff Tableau Software
  – major success story in vis, $2B IPO in 2013
  – Mackinlay joined in 2004, Wilkinson joined in 2014

• Tableau use in this course
  – very useful for analysis projects
  – possible sandbox for experimentation when starting programming projects
  – you can request free student license, good for one year
    • http://www.tableau.com/academic/students
Further reading: Articles

- **Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design.** Jeffrey Heer and Michael Bostock. Proc. CHI 2010


Further reading: Books

  – Chap 5: Marks and Channels


Next Time

• to read
  – VAD Ch. 1: What’s Vis, and Why Do It? (review, mostly covered in first class)
  – VAD Ch. 2: Data Abstraction (new material)
Now

• Guest lecture/demo from Robert Kosara on Tableau