**Information Visualization**

**Marks & Channels**

- **Visual encoding**
  - how to systematically analyze idiom structure?
  - marks & channels
    - marks: represent items or links
    - channels: change appearance of marks based on attributes
  - many names
    - visual channels
    - visual variables
    - visual channels
    - visual dimensions
  - control appearance of marks
    - proportional to or based on attributes
  - Containment can be nested
  - many possibilities!

- **Marks for items**
  - basic geometric elements
    - Points
    - Lines
    - Areas

- **Marks for links**
  - Containment
  - Connection
  - (Distinguishing Euler Diagrams, Riche and Dwyer, 2010)
  - many possibilities!

- **Redundant encoding**
  - multiple channels
    - sends stronger message
    - but uses up channels

- **What is wrong with this picture?**
  - should use channel proportional to data!

- **When to use which channel?**
  - **expressiveness**
    - match channel type to data type
  - **effectiveness**
    - some channels are better than others

- **Exercise: Two numbers**
  - 9 and 26
    - How can you visually represent these two numbers?
    - 9 and 26
    - 12 and 26
    - Many possibilities!

- **Channels: Matching Types**
  - length, position, and value
  - match channel and data characteristics
  - magnitude for ordered
    - how much? which rank?
    - identity for categorical
    - what?

- **Channels: Expressiveness types and effectiveness rankings**
  - expressiveness principle
  - match channel and data characteristics
  - effectiveness principle
  - encode most important attributes with highest ranked channels

- **Channels: Rankings**
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    - as combination of marks and channels
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    - Connection
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- **Munzner**
  - Department of Computer Science
  - University of British Columbia

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Quiz: Name those channels
• A: Inconvenient Truth

https://www.youtube.com/watch?v=9tkDK2mZlOo

Quiz: Name those channels
• B: Tax Rates


Quiz: Name those channels
• C: Alpen Forest Fires


Quiz: Name that mark
• E: Tax Rates


Quiz: Name those channels
• A: Shooting Media Coverage

https://twitter.com/MonaChalabi/status/1158779046693679106?s=20

Quiz: Name that mark
• D: More Alpen Forest Fires


Analyzing marks
• what type of mark?
  -- line?
  -- area?
  -- point mark with rectangular shape?
  -- yes!
  -- area?
  -- no, area/shape does not convey meaning

Quiz: Name that mark
• F: Alpen Forest Fires


Scope of analysis
• simplifying assumptions: one mark per item, single view
• later on
  -- multiple views
  -- multiple marks in a region (glyph)
  -- some items not represented by marks (aggregation and filtering)

Marks: Constrained vs encodable
• math view: geometric primitives have dimensions
• constraint view: mark type constrains what else can be encoded
  --points: 0 constraints on size, can encode more attributes w/ size & shape
  --lines: 1 constraint on size (length), can still size code other way (width)
  --areas: 2 constraints on size (length/width), cannot size code or shape code
• quick check: can you size-code another attribute, or is size/shape in use?

Reminder: Marks and channels
• marks -- basic geometric elements
• channels -- control appearance of marks

Quiz: Name that mark
• G: More Alpen Forest Fires


Points Lines Areas
0D 1D 2D
Todo this week

- D3 videos to watch this week
- Quiz 2 to do this week, due Fri Jan 17, 8am
- Labs start this week!
  - Fri 9-10, 11-12, 4-5
  - Strongly recommended but optional: we do not track attendance
  - TA office hours for individual consultation and help
  - "Tri" will typically alternate weeks
  - If you can’t register, try attending the one you want

Factors affecting accuracy

- Alignment
- Distractors
- Distance
- Common scale

Popout

- Find the red dot
- How long does it take?
- Parallel processing on many individual channels
  - Speed independent of distractor count
  - Speed depends on channel and amount of difference from distractors
  - Serial search for (almost all) combinations
  - Speed depends on number of distractors

Popout

- Many channels: tilt, size, shape, proximity, shadow direction, ...
- But not all! Parallel line pairs do not pop out from tilted pairs

Relative vs. absolute judgements

- Perceptual system mostly operates with relative judgements, not absolute
  - That’s why accuracy increases with common frame/scale and alignment
  - Weber’s Law: ratio of increment to background is constant
  - White rectangles differ in length by 1:2, easy judgement

Separability vs. integrality

2 groups each
- Fully separable
- Some interference
- Some-significant interference
- Major interference
3 groups each
- Integral area
- Integral hue
4 groups total
- Integral length
- Integral position

Relative luminance judgements

- Perception of luminance is contextual based on contrast with surroundings

Relative color judgements

- Color constancy across broad range of illumination conditions

Separability vs. integrality

Position
- Hues (Color)
- Width
- Red
- Green

Factors affecting accuracy

- Alignment
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- Common scale

Accuracy: Fundamental theory

- Length is accurate: linear
- Others magnified or compressed
- Exponent characteristics

Accuracy: Vis experiments

Discriminability: How many usable steps?

- Must be sufficient for number of attribute levels to show
  - Inseparable: few bins but salient

Factors affecting accuracy

- Alignment
- Distractors
- Distance
- Common scale

Categorical channels

- Magnitude
- Volume (3D size)
- Curvature
- Color luminance
- Length (1D size)
- Position on common scale

Ctetntment:

- Todays content:
  - Making a Bar Chart with D3 and SVG
  - Foundations Exercise 2 out, due Wed Jan 22
  - Programming Exercise 1 out, due Wed Jan 29

Credits

- Visualization Analysis and Design (Ch 5)
- Alex Lex & Miriah Meyer, http://dataviscourse.net/