Marks & Channels, Rules of Thumb

Ex: Decoding

Marks and channels
• marks – basic geometric elements
• channels – control appearance of marks

Channels: Rankings
• Magnitude Channels: Ordered Attributes
• Identity Channels: Categorical Attributes
Spatial... channels differ in accuracy of perception
• distinguishability
– match available levels in channel w/ data

Marks for links
• containment
• connection
• proximity
– same spatial region
• similarity
– same values in some categorical channels

Marks: Constrained vs encodable
• math view: geometric primitives have dimensions
• constraint view: mark type constrains what else can be encoded
• quick check: can you size-code another attribute, or is size/shape in use?

Grouping
• proximity
– same spatial region
• similarity
– same values in some categorical channels

Quiz: Name those marks & channels
• B: Tax Rates

Plan for today
• 45 min: Marks & Channels
  – mini-lecture
  – examples & discussion
  – further Q&A
• 30 min: Rules of Thumb, Design Study Methodology
  – further Q&A
• 5 min: upcoming
  – next week: async reading, sync project pitches
  – (break)
• 75 min small groups exercise: Decoding
  – 45 min: breakout groups
  – 30 min: reportbacks

Math view: geometric primitives have dimensions
• sends stronger message
• but uses up channels

Quiz: Name those marks & channels
• A: Shooting Media Coverage

Quiz: Name those marks & channels
• C: Sunsquatch

Quiz: Name those marks & channels
• D: UFC fights

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

Logistics
• new room! (FSC 2330)
  – if door isn’t unlocked, DFP admins on 3rd floor can open (FSC 3641)
• to hear about Designing for People seminars
• to hear about Designing for People seminars for synops

Redundant encoding
• multiple channels
– sends stronger message
– but uses up channels

Marks as Items/Nodes
• Points
  • Size
  • Shape
• Lines
  • Length, Position, and Value
• Areas
  • Curvature

Examples

Areas can be nested

Quiz: Name those marks & channels
• A: Shooting Media Coverage

Mini-Lecture

Quiz: Name those marks & channels
• B: Tax Rates

http://www.cs.ubc.ca/~tmm/courses/547-21

University of British Columbia

Department of Computer Science

Tamara Munzner

Oct 13 12-1  
Charles Perrin, UVic 
The case for more flexible data visualization interfaces

Ex: Decoding

Examining Data In Graphics & Design 2013
Definitions: Marks and channels
- marks
  - geometric primitives
- channels
  - control appearance of marks
- control appearance of marks
  - proportional to or based on attributes
- many names
  - visual channels
  - visual variables
  - retrieval channels
  - visual dimensions

Marks for items
- basic geometric elements
  - Points
  - Lines
  - Interlocking Areas
- 0D 1D 2D
- Interlocking Areas
- 3D mark: volume, rarely used

Marks and Channels
- how to systematically analyze idiom structure?

Visual encoding
- how to systematically analyze idiom structure?
- marks & channels
  - marks: represent items or links
  - channels: change appearance of marks based on attributes

Q&A/Backup Slides
- Q: Yet More Alpen Forest Fires
- H: More Alpen Forest Fires
- G: Yet More Alpen Forest Fires
- F: Netherlands Commuters
- E: Alpen Forest Fires

Visual encoding
- Points
- Lines
- Interlocking Areas
- 0D 1D 2D
- Interlocking Areas
- 3D mark: volume, rarely used
- marks & channels
  - marks: represent items or links
  - channels: change appearance of marks based on attributes
**Visual encoding**
- analyze idiom structure as combination of marks and channels

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

**Spatial Positioning**
- identity for categorical
- magnitude for ordered

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

**Marks as constraints**
- points: 0 constraints on size, can encode more attributes w/ size & shape
- lines: 1 constraint on size, can still size code other way (width)
- interlocking areas: 2 constraints on size (length/width), cannot size or shape code
  - quick check: can you size-code another attribute
  - or is size/shape in use?

**Visual encoding**
- analyze idiom structure as combination of marks and channels

**Channels: Expressiveness Types And Effectiveness Ranks**
- expressiveness
  - match channel and data characteristics
- effectiveness
  - channels differ in accuracy of perception

**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)

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

**Channels:** Rankings
- Position on common scale
- Position on unaligned scale
- Length (1D)
- Tilt/angle
- Color saturation

**Length, Position, and Luminance**
- Length (3D position)
- Position on unaligned scale
- Position on common scale
- Area (2D size)
- Tilt/angle
- Color luminance

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

**Scope of analysis**
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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

Serial search for (almost all) combinations
– speed depends on number of distractors

Channel effectiveness
• accuracy: how precisely can we tell the difference between encoded items?
• discriminability: how many unique steps can we perceive?
• separability: is our ability to use this channel affected by another one?
• popout: can things jump out using this channel?

Discriminability: How many usable steps?
• must be sufficient for number of attribute levels to show
  – linear/few bins

Separability vs. integrality

Factors affecting accuracy
• alignment
• distractors
• distance
• common scale

Accuracy: Vis experiments

Crowdsourcing Graphical Results
1.03.01.52.52.0
Log Error
1.03.01.52.52.0
Log Error

Hue (Color)
Size
Width
Height
Red
Green

Height
Width

Popout
• find the red dot
– how long does it take?

Popout
• find the red dot
– how long does it take?

Popout
• find the red dot
– how long does it take?

Popout
• find the red dot
– how long does it take?

Popout
• many channels
  – tilt, size, shape, proximity, shadow direction, ...
• but not all
  – parallel line pairs do not pop out from tilted pairs

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Relative vs. absolute judgements
- perceptual system mostly operates with relative judgements, not absolute
- that's why accuracy increases with common frame/scale and alignment

Relative vs. absolute judgements
- perceptual system mostly operates with relative judgements, not absolute
- Weber's Law: ratio of increment to background is constant
- that's why accuracy increases with common frame/scale and alignment

Relative luminance judgements
- perception of luminance is contextual based on contrast with surroundings
- Weber's Law: ratio of increment to background is constant
- that's why accuracy increases with common frame/scale and alignment

Relative color judgements
- color constancy across broad range of illumination conditions
- Weber's Law: ratio of increment to background is constant
- that's why accuracy increases with common frame/scale and alignment

Depth vs power of the plane
- high-ranked spatial position channels: planar spatial position
- perceptual accuracy decreases with increased perspective distortion
- that's why accuracy increases with common frame/scale and alignment

Occlusion hides information
- occlusion
- interaction can resolve, but at cost of time and cognitive load

Rules of Thumb
- No unjustified 3D
- No unjustified 2D
- Function first, form next
- Perception of luminance is contextual based on contrast with surroundings
- Weber's Law: ratio of increment to background is constant
- that's why accuracy increases with common frame/scale and alignment

Perspective distortion loses information
- perspective distortion
- interferes with all size channel encodings
- power of the plane is lost!

Unjustified 3D all too common, in the news and elsewhere
- perspective distortion
- interferes with all size channel encodings
- power of the plane is lost!

Grouping
- containment
- connection

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Design Study Methodology

Reflections from the Trenches and from the Sticks

Best practices: Labelling
- meaningful & useful title, labels, legends
- use and generalization so should have labels
- everything that's plotted should have a legend
- use reasonable numerical formats

Methodology for problem-driven work
- definitions
- 9-stage framework
- 32 pitfalls & how to avoid them
- comparison to related methodologies

Rules of Thumb Summary
- No unjustified 3D
- Power of the plane
- Disparity of depth
- Occlusion hides information
- Perspective distortion dangers
- Titled text isn't legible
- No unjustified 3D
- Eyes boat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Responsiveness is required
- Function first, form next

Lessons learned from the trenches: 21 between us

Design study methodology: definitions

Design study methodology: suitable

I'm a domain expert?
Wanna collaborate?

If you are not satisfied, please try these alternatives:
- improve
- rewrite
- do both

If you need help, please try these alternatives:
- seek help
- try again
- change perspective

If you need an abstract, please try these alternatives:
- write
- cast
- winnow

If you need help with these considerations:
- Data
- Time
- Need

If you need help with two of these considerations:
- Have data
- Have time
- Have need

If you need help with three of these considerations:
- Have data
- Have time
- Have need

If you need help with all of these considerations:
- Have data
- Have time
- Have need

If you need help with none of these considerations:
- Have data
- Have time
- Have need

If you need help with one of these considerations:
- Have data
- Have time
- Have need

If you need help with five of these considerations:
- Have data
- Have time
- Have need

If you need help with six of these considerations:
- Have data
- Have time
- Have need

If you need help with seven of these considerations:
- Have data
- Have time
- Have need

If you need help with eight of these considerations:
- Have data
- Have time
- Have need

If you need help with nine of these considerations:
- Have data
- Have time
- Have need

If you need help with ten of these considerations:
- Have data
- Have time
- Have need

If you need help with eleven of these considerations:
- Have data
- Have time
- Have need

If you need help with twelve of these considerations:
- Have data
- Have time
- Have need
Are you a user???
... or maybe a fellow tool builder?

Roles

113

Metaphor
Winnowing

Collaborator winnowing

Initial conversation
Further meetings
Prototyping
Full collaboration

Example from the Trenches
Premature Collaboration!

Talk with many, stay with few!

PowerSet Viewer
2 years / 4 researchers
WikeVis
0.5 years / 2 researchers

Example from the trenches
Premature Collaboration!

Fellow tool builders
Data promised

Design study methodology: 32 pitfalls

Pitfall
Premature Design Commitment

Of course they need the cool technique I built last year!

Metaphor
Design Space

Know

Know

Know

Know

Know

Know

Propose

Consider

Consider

Consider

Consider

Consider

Consider

Consider

Consider

Consider

Consider

Consider

Consider

Consider

**METAPHOR**

**Design Space**

- think broad!
- good/okay/poor
- consider/proposal/select

**Horse Race vs. Music Debut**

- technique-driven
- problem-driven
- must be first!
- am I ready?

**EXAMPLE FROM THE TRENCHES**

**Don't step on your own toes!**

**First design round published**


**Subsequent work not stand-alone paper**

- AutobahnVis 1.0
  - Sedlmair et al., Smart Graphics, 2009

- AutobahnVis 2.0
  - Sedlmair et al., Information Visualization 10(3), 2011

**Reflections from the stacks: Wholesale adoption inappropriate**

- ethnography
  - rapid, goal-directed fieldwork
- grounded theory
  - not empty slate: vis background is key
- action research
  - aligned
  - intervention as goal
  - transferability not reproducibility
  - personal involvement is key
  - opposition
  - translation of participant concepts into visualization language
- intervention as goal
- researcher lead not facilitates design
- orthogonal to vis concerns: participants as writers, adversarial to status quo, postmodernity

**Next week**

- to read & discuss (async, before next class)
  - VAD book, Ch 7: Arrange Tables
  - paper: LineUp [technique]
  - paper: Revisiting Bertin Matrices [technique]
- sync class: project pitches!
  - 2 min each
  - if already have full or partial team, can combine your times together
  - up to you: prerecord video OR present live, need slides either way
- due by 1pm (Wed Sep 29)
  - if prerecorded, videos and slides. if live: slides
- video creation tips/resources
  - https://www.cs.ubc.ca/~tmm/courses/547-21/video.html
- near-realtime Q&A / discussion through dedicated Piazza thread

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