Perception

Lecture 7 CPSC 533C, Fall 2005

3 Oct 2005

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Readings

Ware, Chapter 5: Visual Attention and Information That Pops Out

Ware, Chapter 6: Static and Moving Patterns


Graphical Perception: Theory, Experimentation and the Application to the Development of Graphical Models
Human Perception

sensors/transducers
  · psychophysics: determine characteristics

relative judgements: strong
absolute judgements: weak
  · continuing theme

different optimizations than most machines
  · eyes are not cameras
  · perceptual dimensions not nD array
  · (brains are not hard disks)
Foveal Vision

thumbnail at arm's length
small high resolution area on retina

[www.cs.nyu.edu/~yap/visual/home/proj/foveation.html
svi.cps.utexas.edu/examples_foveated.htm]
Equal Legibility

if fixated on center point

[psy.ucsd.edu/~sanstis/SABlur.html]
Foveal Touch

star-nosed mole

[www.nature.com/nsu/010329/010329-6.html
brain.nips.ac.jp/event/work131030/Catania_and_Kaas,_1997.pdf]
Eyes

saccades [video]
- fovea: high-resolution samples
- brain makes collage
- vision perceived as entire simultaneous field
- fixation points: dwell 200–600ms
- moving: 20–100ms

[vision.arc.nasa.gov/personnel/jbm/home/projects/osa98/osa98.html/]
Ears

perceived as temporal stream
  · but also samples over time
  · hard to filter out when not important
    visual vs auditory attention

implications
  · harder to create overview?
  · hard to use as separable dimension?

'sonification' still very niche area
  · alternative: supporting sound enhances immersion
Other Modalities

barrier: lack of record/display technology

haptics maturing
  · "haptic visualization" very new

smell, taste
  · out-there SIGGRAPH ETech demos
  · characterization possible after technology barriers fall
Psychophysical Measurement

JND: just noticeable difference

increment where human detects change

average to create "subjective" scale

low-level perception more uniform than high-level cognition across subjects
Nonlinear perception of magnitudes

sensory modalities not equally discriminable

Stevens’ Power Law:  \[ I = S^p \]
Dimensional dynamic range

linewidth: limited discriminability

[mappa.mundi.net/maps/maps_014/telegeography.html]
Dimensional ranking

[graphics.stanford.edu/courses/cs448b-02-spring/lectures/encoding/walk015.html]
Dimensional ranking varies by data type

spatial position best for all types

[Markinlay, Automating the Design of Graphical Presentations of Relational Information, ACM TOG 5:2, 1986]
Cleveland vs. Mackinlay

Mackinlay

- Position
- Length
- Angle
- Slope
- Area
- Volume
- Density
- Saturation
- Hue
- Texture
- Connection
- Containment
- Shape

Cleveland

- position along common scale
- positions along nonaligned scales
- length, direction, angle
- area
- volume, curvature
- shading, color saturation
Weber's Law

ratio of increment threshold to background intensity is constant
- relative judgements within modality

\[ \frac{\Delta I}{I} = K \]

Cleveland example: frame increases accuracy
Cleveland suggestions

dot chart over pie or bars

direct differences over superimposed curves

framed rectangles over shading on maps
Preattentive visual dimensions

- color (hue) alone: preattentive
  - attentional system not invoked
  - search speed independent of distractor count

[Chris Healey, Preattentive Processing, www.csc.ncsu.edu/faculty/healey/PP/PP.html]
Preattentive visual dimensions

many preattentive dimensions of visual modality

- hue
- shape
- texture
- length
- width
- size
- orientation
- curvature
- intersection
- intensity
- flicker
- direction of motion
- stereoscopic depth
- lighting direction
Non-preattentive: parallelism

many preattentive dimensions of visual modality

- hue
- shape
- texture
- length
- width
- size
- orientation
- curvature
- intersection
- intensity
- flicker
- direction of motion
- stereoscopic depth
- lighting direction
Preattentive visual dimensions

color alone: preattentive
shape alone: preattentive

combined hue and shape: multimodal

- requires attention
- search speed linear with distractor count

[Chris Healey, Preattentive Processing, www.csc.ncsu.edu/faculty/healey/PP/PP.html]
Integral vs. separable dimensions

red–green  x–size  size  color  color  color
yellow–blue  y–size  orientation  shape  motion  location

[Colin Ware, Information Visualization: Perception for Design. Morgan Kaufmann 1999.]
Glyphs: InfoBug

software management

Glyphs: InfoBug

Small multiples

show array of similar items

dside by side comparison

- better than temporal comparison
Glyphs: Bray

Web sites circa 1996

- # pages: base diameter
- # outlinks: globe diameter
- # inlinks: height
- domain: hue

[www5conf.inria.fr/fich_html/papers/P9/Overview.html]
[Bray, Measuring the Web, WWW5, 1996.]
Glyphs

integral vs. separable issues

when do they help?

big-scale individual glyphs vs. small-scale texture fields
  · grouping into large-scale patterns
Gestalt Laws

principles of pattern perception
  · "gestalt": German for "pattern"
  · original proposed mechanisms wrong
  · rules themselves still useful

Pragnatz
  · simplest possibility wins

subsequent examples from
  · Information Visualization: Perception for Design
  · Colin Ware
  · Morgan Kaufmann, 2000
Gestalt Principles

proximity, similarity, continuity/connectedness/good continuation closure, symmetry common fate (things moving together)
[psychlab1.hanover.edu/classes/Sensation/sld013.htm]

figure/ground, relative sizes
Proximity
Similarity

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Continuity

smooth not abrupt change
overrules proximity
Connectedness

can overrule size, shape

a

b

c

d
Closure

overrules proximity
Symmetry

emphasizes relationships
Common Fate
Relative Size

smaller components perceived as objects
Figure/Ground

determined by combination of previous laws
Graph Drawing Tension

node placement

close
  · proximity
far
  · visual popout of long edge
either
  · connectedness

tradeoffs abound in infovis!

grammars
  · node–link graphs
  · maps
Motion

works for preattentive/grouping

less studied than static dimensions
  · Michotte on causality
  · more recent infovis/motion work by Lyn Bartram

biological motion

[www.psy.vanderbilt.edu/faculty/Blake/biowalker.gif]
More Perception

Rensink grad course next term
  · last time taught through CS
  · this time taught through Psych

old course URL
http://www.cs.ubc.ca/~rensink/courses/cpsc532E/
Presentation Topic Choices