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

The Psychophysics of Sensory Function, S. S. Stevens,
Sensory Communication, MIT Press, 1961, pp 1–33.

Graphical Perception: Theory, Experimentation and the
Application to the Development of Graphical Models
William S. Cleveland, Robert McGill, J. Am. Stat. Assoc. 79:387, pp. 531–554, 1984.

Human Perception

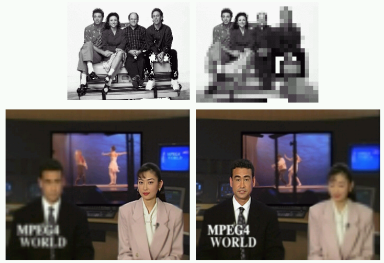
sensors/transducers
- psychophysics: determine characteristics

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.html]

Equal Legibility

if fixated on center point

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

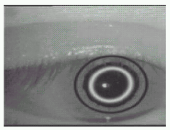
Foveal Touch

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

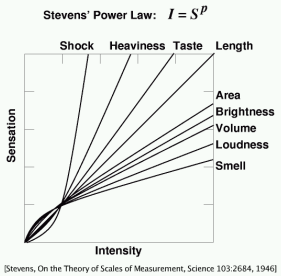
increment where human detects change

average to create "subjective" scale

low-level perception more uniform than high-level cognition across subjects

Nonlinear perception of magnitudes

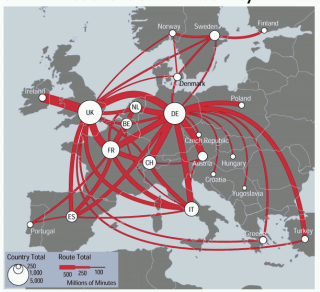
sensory modalities not equally discriminable



[Stevens, On the Theory of Scales of Measurement, Science 103:2684, 1946]

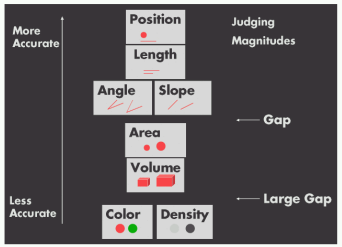
Dimensional dynamic range

linewidth: limited discriminability



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

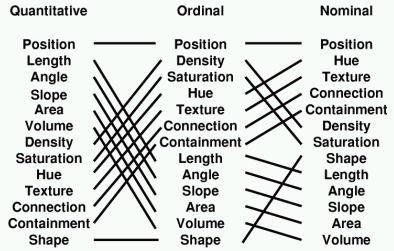
Dimensional ranking



[graphics.stanford.edu/courses/cs448b-02-spring/lectures/encoding/walk015.html]

Dimensional ranking varies by data type

spatial position best for all types



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

Cleveland vs. Mackinlay

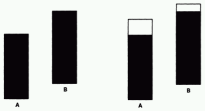
Mackinlay	Cleveland
Position Length Angle Slope Area Volume Density Saturation Hue Texture Connection Containment Shape	position along common scale positions along nonaligned scales length, direction, angle area volume, curvature shading, color saturation

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

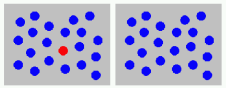
dot chart over pie or bars

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

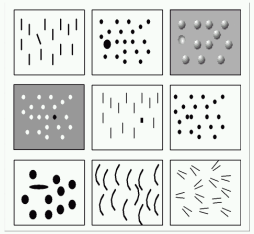


[Chris Healey, Preattentive Processing, www.csc.ncsu.edu/faculty/healey/PP/PP.html]

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



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

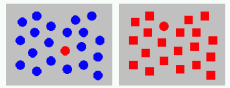
Non-preattentive: parallelism

many preattentive dimensions of visual modality

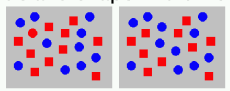
- hue
- shape
- texture
- length
- width
- size
- orientation
- curvature
- intersection
- intensity
- flicker
- direction of motion
- stereoscopic depth
- lighting direction

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]

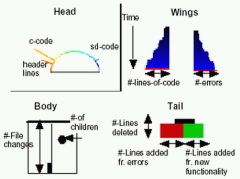
Integral vs. separable dimensions

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

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

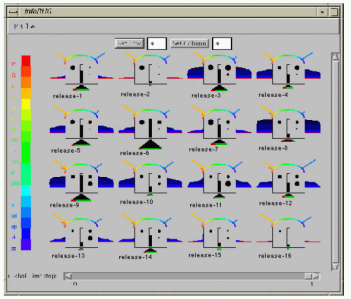
Glyphs: InfoBug

software management



[Information Rich Glyphs for Software Management, IEEE CG&A 18:4 1998, www.cs.cmu.edu/~sage/Papers/CGAglyph/CGAglyph.pdf]

Glyphs: InfoBug



[Information Rich Glyphs for Software Management, IEEE CG&A 18:4 1998, www.cs.cmu.edu/~sage/Papers/CGAglyph/CGAglyph.pdf]

Small multiples

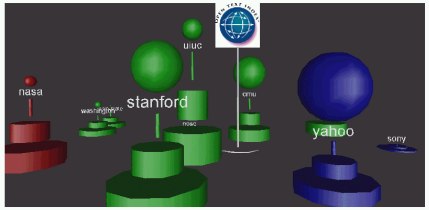
show array of similar items

side 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

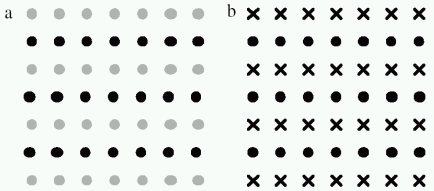
Gestalt Principles

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

figure/ground, relative sizes

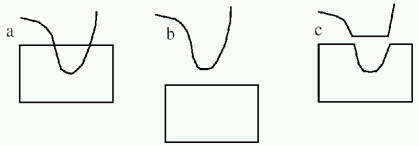
Proximity

Similarity



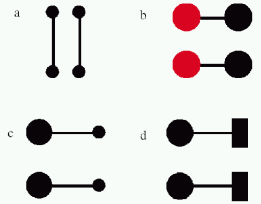
Continuity

smooth not abrupt change
overrules proximity



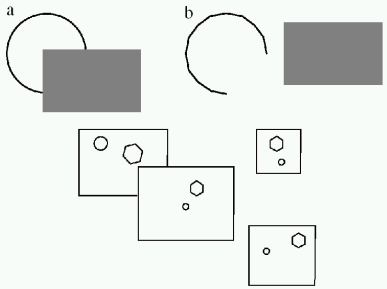
Connectedness

can overrule size, shape



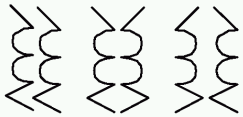
Closure

overrules proximity

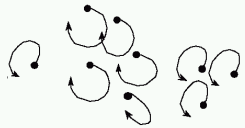


Symmetry

emphasizes relationships

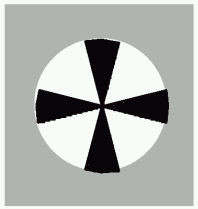


Common Fate



Relative Size

smaller components perceived as objects



Figure/Ground

determined by combination of previous laws

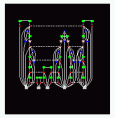
Graph Drawing Tension

node placement

close
- proximity

far
- visual popout of long edge

either
- connectedness



[www.research.att.com/sw/tools/graphviz]

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