

Perception and Gestalt

Alex Endert
CS4460
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Recall from last time

- Learned basic visual primitives, visual encodings
- Learned basic charts to use for multivariate data
 - line, bar, scatterplot
 - parallel coordinate, star plot, scatterplot matrix

Today

- Basic intro to **perception** and **cognition**
 - understand why visualization is effective
- Introduction to Gestalt Principles
- See the application of these principles

Relevant Disciplines

- Psychophysics
 - Applying methods of physics to measuring human perceptual systems
 - How fast must light flicker until we perceive it as constant?
 - What change in brightness can we perceive?
 - We will not cover these in this course.
- Cognitive psychology
 - Understanding how people think, here, how it relates to perception
 - Some of this in this course, but with very limited depth

Perceptual Processing

- Seek to better understand **visual perception** and **visual information processing**
 - Multiple theories or models exist
 - Need to understand physiology and cognitive psychology
- This is **how we see**, therefore the “**inputs**” to the brain for visualization

One (simple) Model, Colin Ware

- Two stage process
 - Parallel extraction of low-level properties of scene
 - Sequential goal-directed processing



Stage 1 - Low-level, Parallel

- Neurons in eye & brain responsible for different kinds of information
 - Orientation, color, texture, movement, etc.
- Arrays of neurons work in parallel
- Occurs “**automatically**”
- **Rapid**
- Information is transitory, briefly held in iconic store
- Bottom-up data-driven model of processing
- Often called “**pre-attentive**” processing

Stage 2 - Sequential, Goal-Directed

- Splits into subsystems for object recognition and for interacting with environment
- Increasing evidence supports independence of systems for symbolic object manipulation and for locomotion & action
- First subsystem then interfaces to verbal linguistic portion of brain, second interfaces to motor systems that control muscle movements
- **Slow serial processing**
- Involves working and long-term memory
- More emphasis on arbitrary aspects of symbols
- Top-down processing

Preattentive Processing

- How does the human visual system analyze images?
 - Some things seem to be done preattentively, **without the need for focused attention**
 - Generally less than 200-250 msecs (eye movements take 200 msecs)
 - Seems to be **done in parallel by low-level vision system**
 - think of this as a “**mental shortcut**” that your mind can (and does) use

Drawn from
C. Healey web article

How Many 3's?

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
90910302099059595772564675050678904567
8845789809821677654876364908560912949686

Why does this take a long time?

- No features that leverage preattentive processing
- Have to scan sequentially
-

Which tasks does pre attentive processing work well for?

- Target detection
 - Is something there?
- Boundary detection
 - Can the elements be grouped?
- Counting
 - How many elements of a certain type are present?

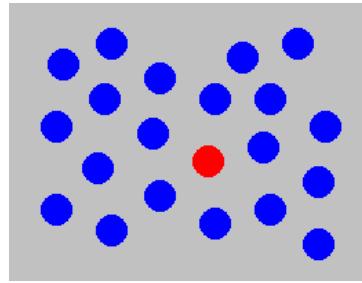
In contrast – how many 3's?

12817687561**3**8976546984506985604982826762
980985845822450985645894509845098094**3**585
90910**3**02099059595772564675050678904567
8845789809821677654876**3**64908560912949686

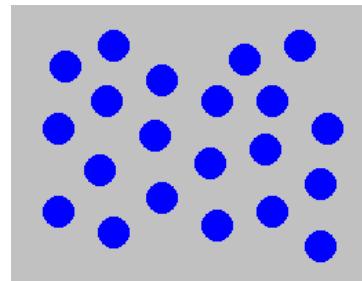
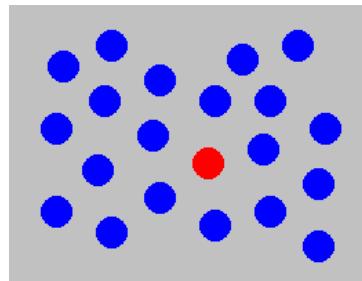
Example

- Determine if a red circle is present

Hue



Hue

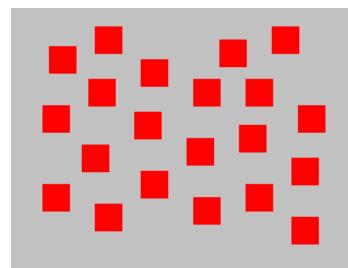


Can be done rapidly (preattentively) by people
Surrounding objects called “distractors”

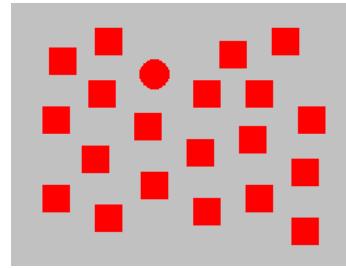
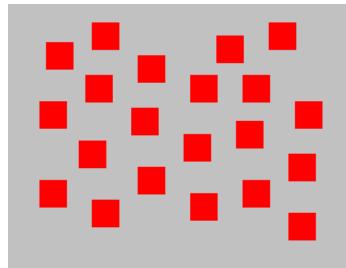
Example

- Determine if a red circle is present

Shape



Shape

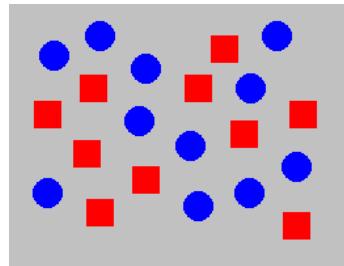


Can be done preattentively by people (shape works in this case)

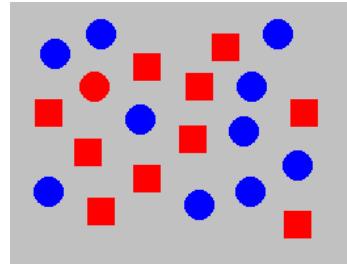
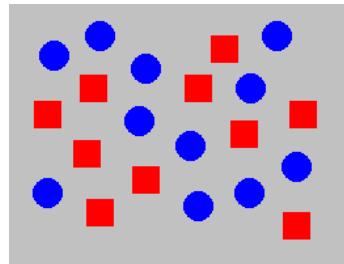
Example

- Determine if a red circle is present

Hue and Shape



Hue and Shape

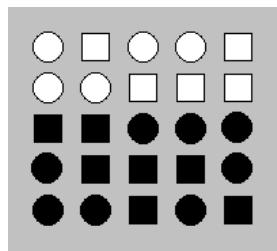


Cannot be done preattentively
Must perform a sequential search
Conjunction of features (shape and hue) causes a problem

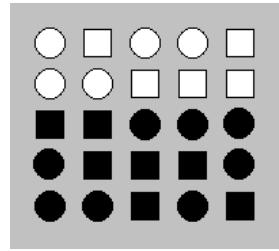
Example

- Is there a boundary in the display?

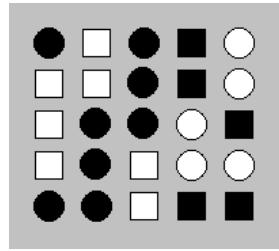
Fill and Shape



Fill and Shape



can be done preattentively since each group contains one unique feature



cannot (there is a boundary!) since the two features are mixed (fill and shape)



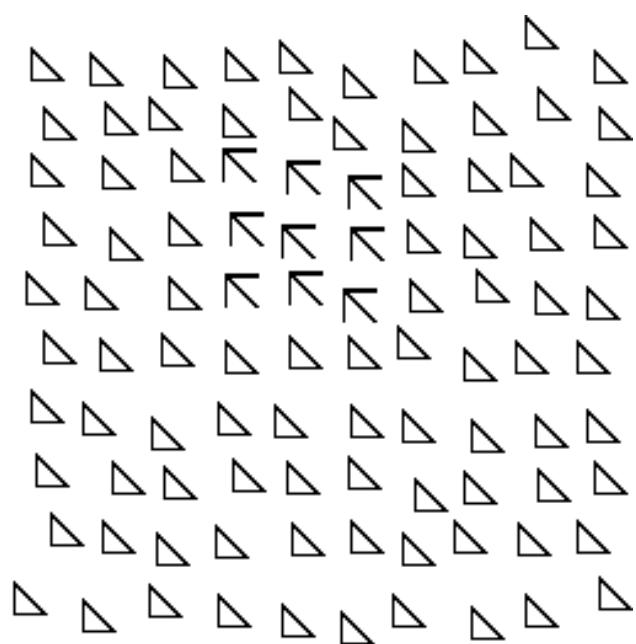
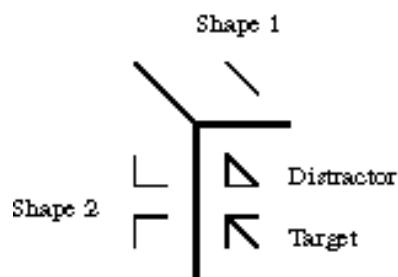
Example Applet

- Nice on-line tutorial and example applet
 - <http://www.csc.ncsu.edu/faculty/healey/PP/index.html>
 - Chris Healey, NC State
 - Prior pictures taken from site

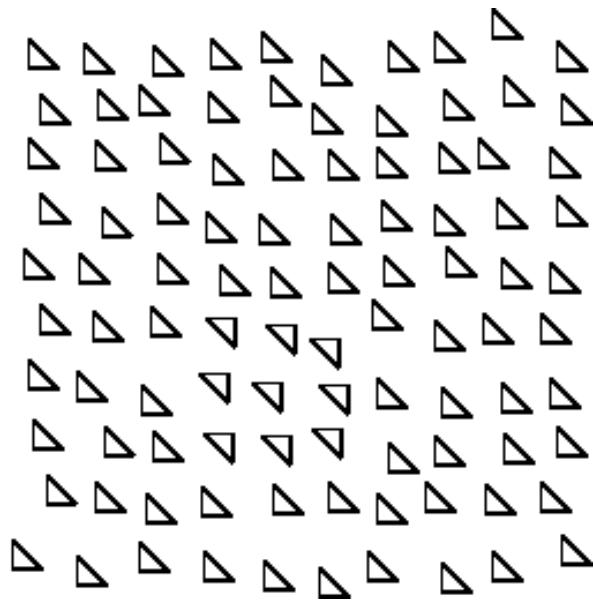
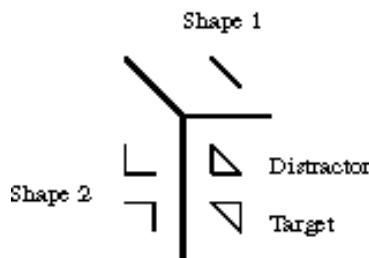
Preattentive Features

- Certain visual forms lend themselves to preattentive processing
- Variety of forms and other data marks seem to work

Emergent Features



Emergent Features



Discussion

- What role does/should preattentive processing play in information visualization?
 - Potential danger:
 - Put too much saliency to that particularly specific aspect.
 - Distract the viewers from the overall picture you intended to present.
- Talk with 2 people around you (groups of 3).
 - Come up with **1 reason to use pre attentive processing**
 - Come up with **1 potential danger in using it** (what should you be careful about)

Gestalt Principles

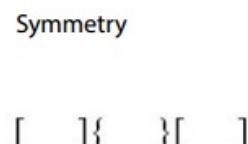
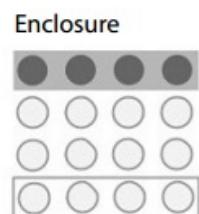
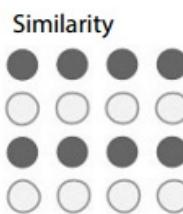
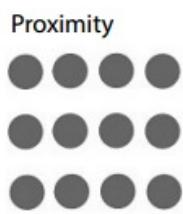
Gestalt Laws

- Background
 - German psychologists, early 1900's
 - Attempt to understand pattern perception
 - Founded Gestalt school of psychology
 - Provided clear descriptions of many basic perceptual phenomena
- Gestalt Laws of Pattern Perception

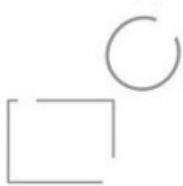
The Gestalt Principles

- Proximity
- Closure
- Similarity
- Symmetry
- Continuity
 - (aka Good Continuation)
- Common Fate
- Figure/Ground
- Connectedness
- German: Gestalt – "essence or shape of an entity's complete form"

Gestalt Principles in Images



Closure



Continuity



Connection

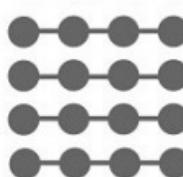


Figure & ground

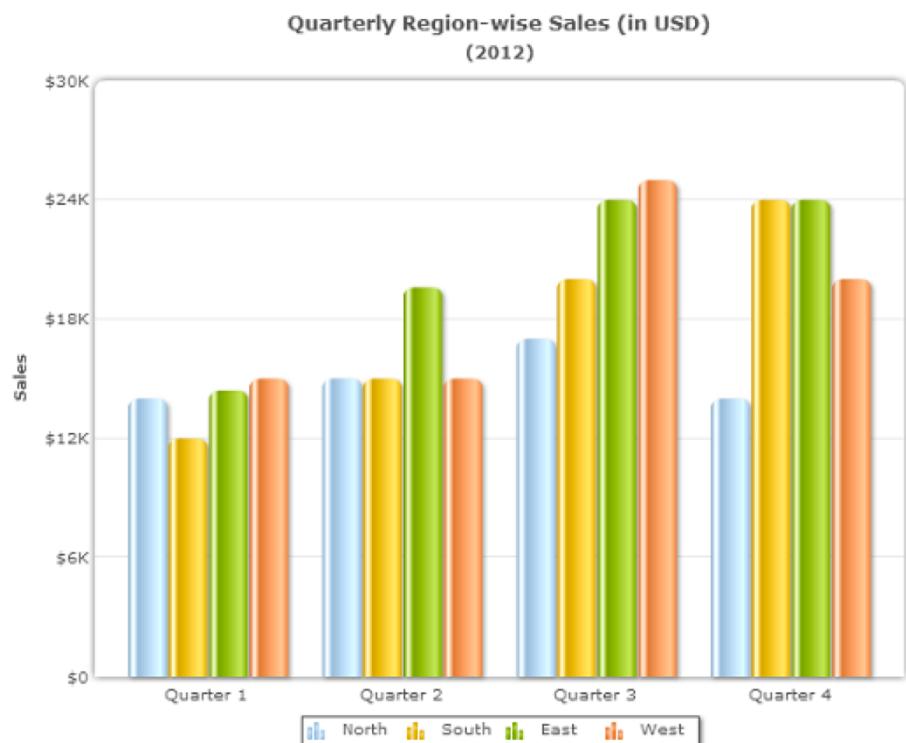


Proximity

- We **group together** ‘proximate’ objects
 - Use this grouping to show similarity, membership, or as an encoding for a data variable being visualized

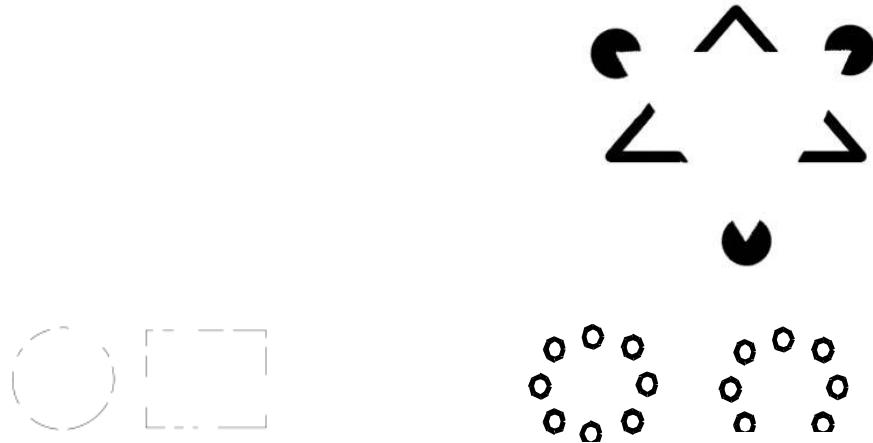


Proximity in Vis



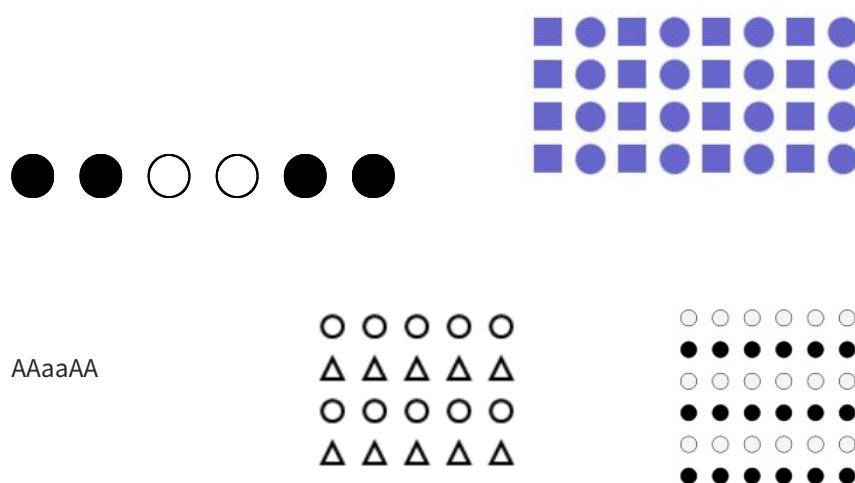
Closure

- We try to see collections of objects as **creating a larger, more complete object**



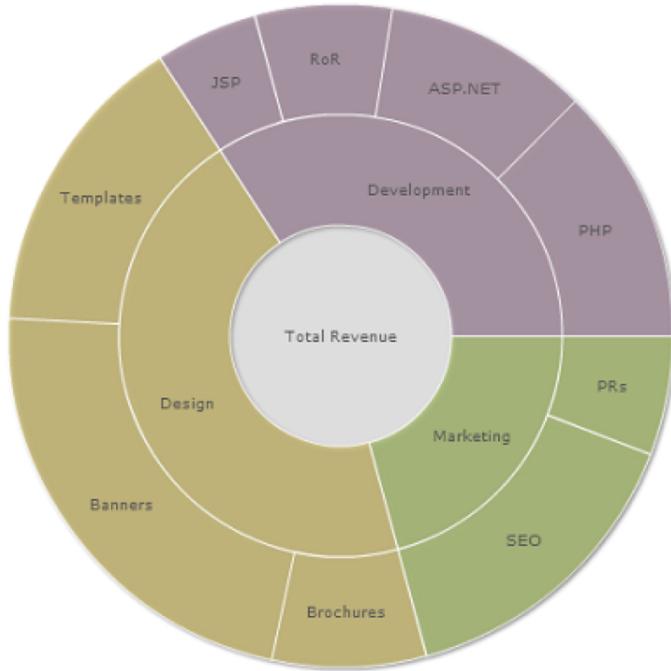
Similarity

- We **group similar objects** together



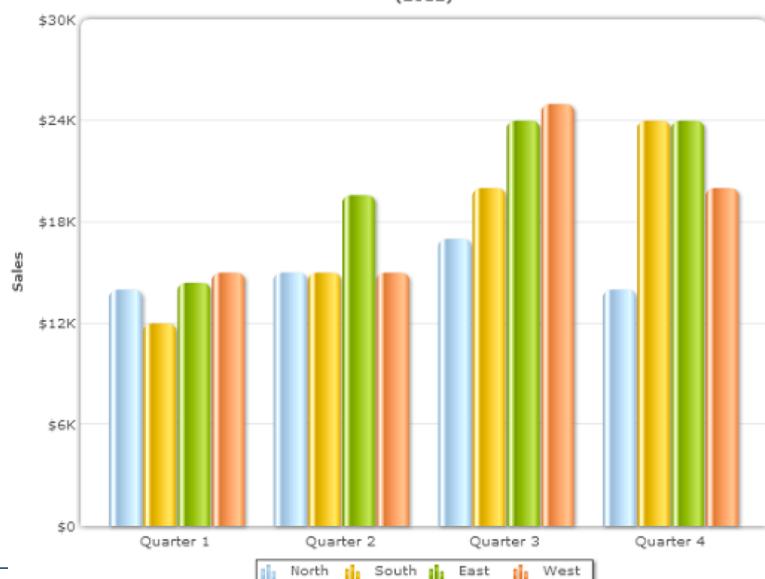
Similarity in Vis

Channel-wise Revenue Breakup (in %)
2012

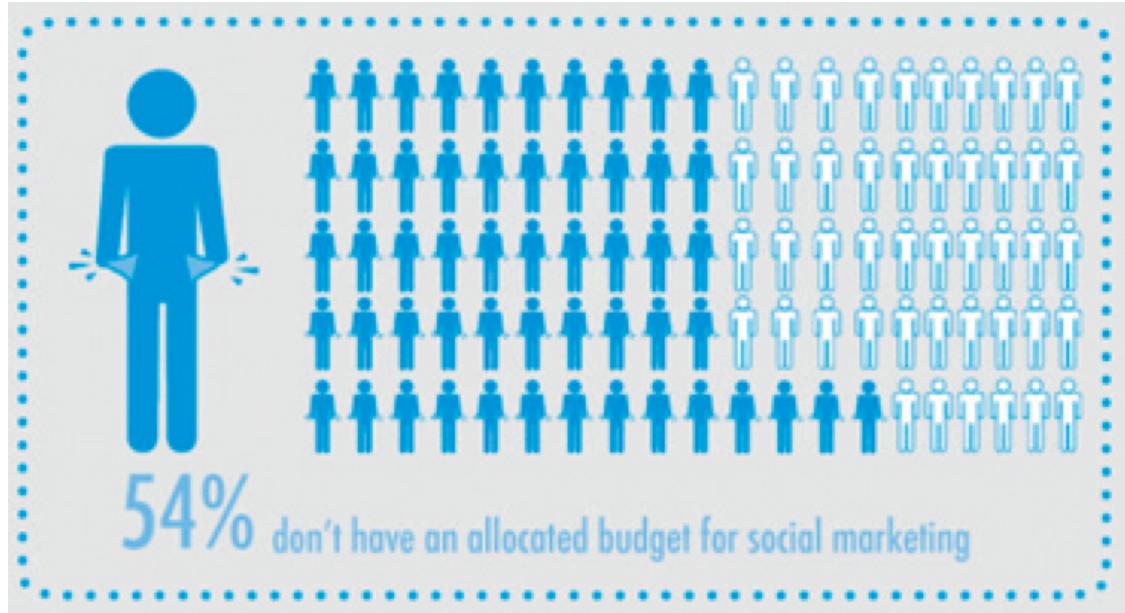


Similarity (Colors & Grouping)

Quarterly Region-wise Sales (in USD)
(2012)

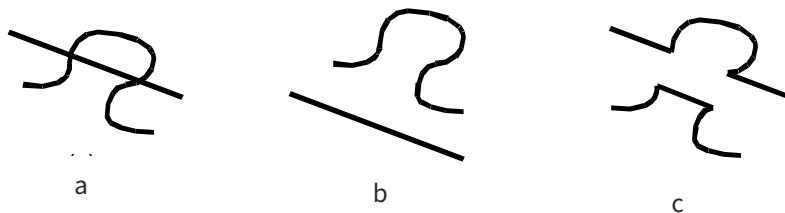


Similarity (and Closure)



Continuity (Good Continuation)

- We separate (parse) overlapping objects to give them a ‘smooth’ interpretation



- How do we interpret the left figure (a)? Is it (b) or is it (c)?
- Most of us will interpret (a) as having the two elements shown in (b).

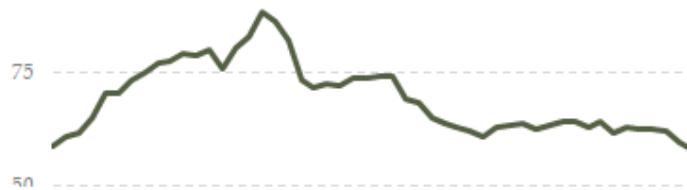
Continuity (noticed this during a faculty meeting)



Continuity – “Fill in the Blanks”



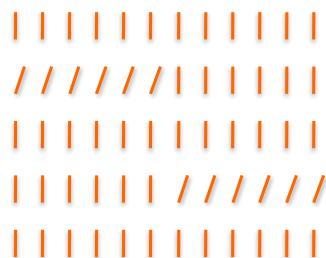
“Fill in the Blank” Might be Wrong



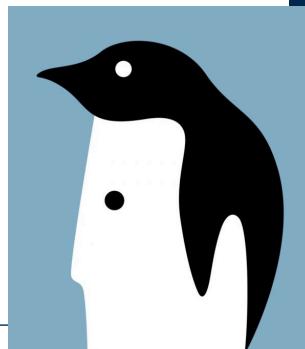
Common Fate

- We group together objects seen to be **moving in the same direction** (having a ‘common fate’)
- Also applies to movement toward perspective vanishing point

Imagine groups of planes



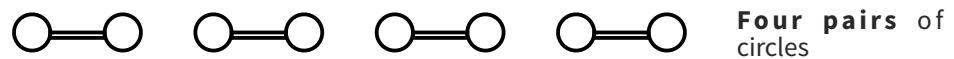
Figure/Ground



endert@gatech.edu

Connectedness

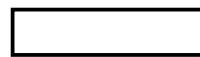
- Connected visual elements are **seen as a whole**



Proximity Example

- Items **close together** appear to have a relationship
- Greater distance implies no relationship

Time:



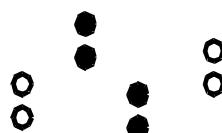
Time:



Combining Gestalt Principles

- Several Principles can be combined

- Proximity reinforces similarity



- Proximity reinforces closure/symmetry

- ...



Combine Similarity and Connectedness

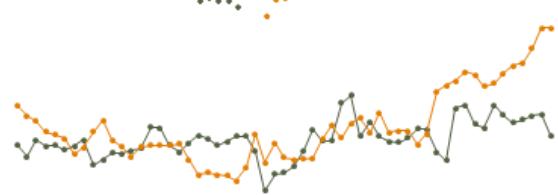
A bunch of dots:
no visual structure



Colored dots:
visual structure emerges

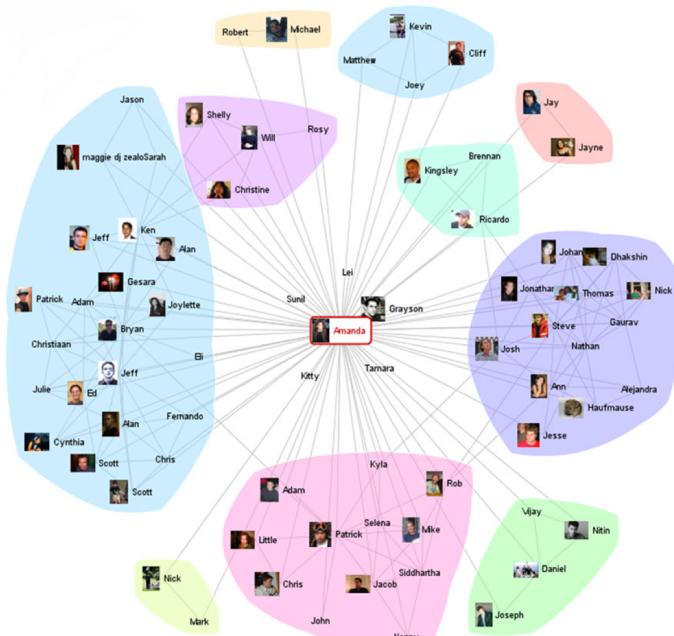


Colored & connected dots: strong
visual structure



Combine Proximity & Similarity

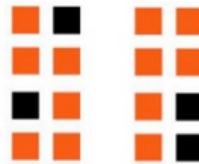
Grouping created by
Proximity
Similar background



Combinations of Principles

- Proximity + Similarity reinforce one another
- Similar to redundant (double) coding idea

Proximity stronger than similarity



Visual Structure Fights Logical

- Proximity counters alphabetization

ATE BAT
BIT CAT
DOG EAT
FAR FAT
GET GOT
HAT HIT
HOT LAP
MAP PAT

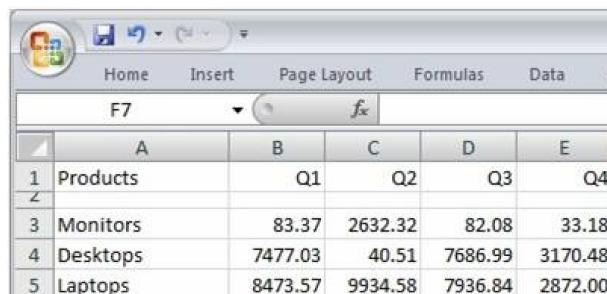
No one would be so
stupid as to actually
do this, right?

Visual Structure Fights Logical

Train Show Quick Search ▾ Click on a link below to run a search ▾		
Alabama (1)	Arizona (4)	Arkansas (1)
California (11)	Colorado (4)	Connecticut (9)
Delaware (3)	Florida (15)	Georgia (2)
Idaho (1)	Illinois (3)	Indiana (7)
Iowa (4)	Kansas (3)	Kentucky (2)
Maine (2)	Maryland (26)	Massachusetts (11)
Michigan (15)	Minnesota (1)	Missouri (5)
Montana (6)	New Hampshire (1)	New Jersey (20)
New York (22)	North Carolina (5)	Ohio (22)
Oklahoma (3)	Ontario (3)	Pennsylvania (46)
Quebec (1)	South Carolina (3)	Tennessee (3)
Texas (4)	Vermont (3)	Virginia (4)
Washington (8)	West Virginia (8)	Wisconsin (9)

Get Rid of “Chart Junk” 😊

more about what “chart junk” is later



	A	B	C	D	E
1	Products	Q1	Q2	Q3	Q4
2					
3	Monitors	83.37	2632.32	82.08	33.18
4	Desktops	7477.03	40.51	7686.99	3170.48
5	Laptops	8473.57	9934.58	7936.84	2872.00

Products	Q1	Q2	Q3	Q4
Monitors	83.37	2632.32	82.08	33.18
Desktops	7477.03	40.51	7686.99	3170.48
Laptops	8473.57	9934.58	7936.84	2872.00

Grouping: Poor Dialogue Box Design

Align Objects

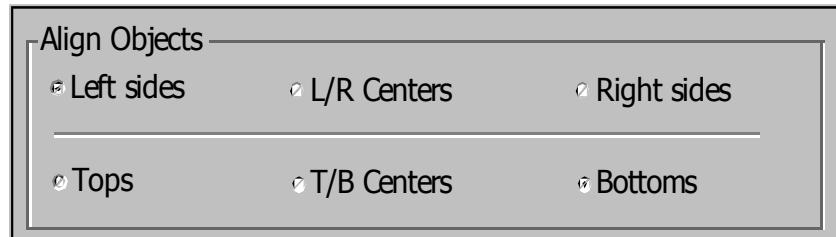
- Left sides L/R Centers Right sides
- Tops T/B Centers Bottoms

Grouping: Somewhat Better Dialogue Box Design

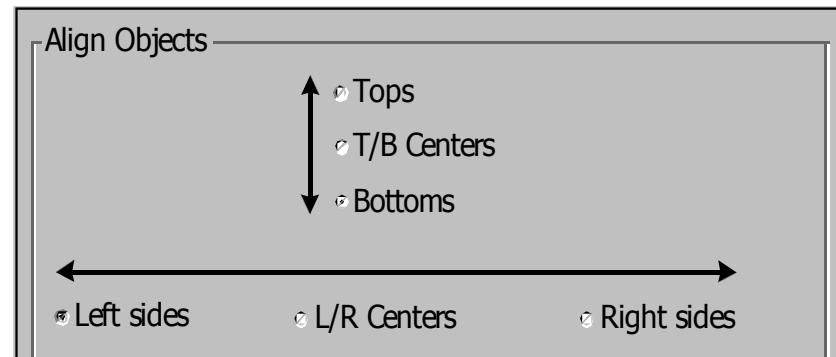
Align Objects

- Left sides L/R Centers Right sides
- Tops T/B Centers Bottoms

Grouping: Better Dialogue Box Design

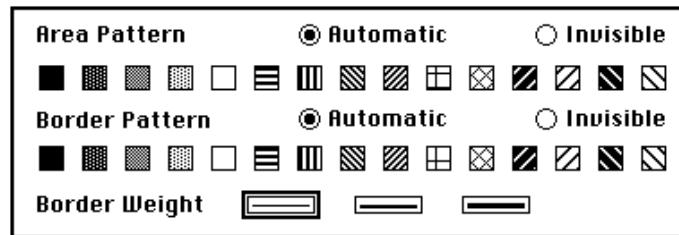


Grouping: Much Better Dialogue Box Design



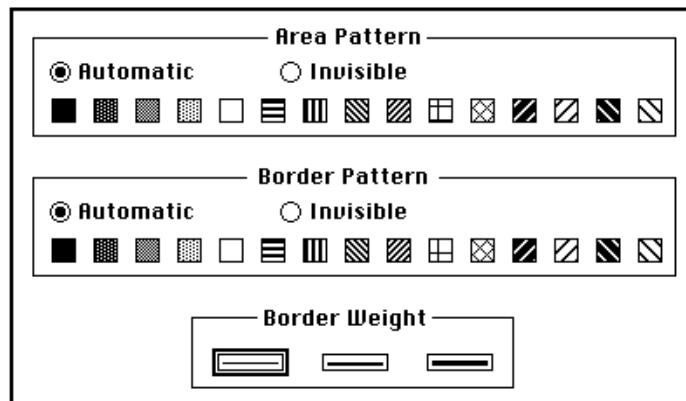
Grouping: Poor Dialogue Box

- Weak visual structure



Grouping: Improved Dialogue Box

- Strong visual structure



Using Gestalt Principles is REALLY Important

- Use visual structure to **reinforce** the underlying logical structure of your data
- Be careful that you **do not combine principles which negate each other.**
 - ok to “**double encode**” to reinforce when you find it necessary

covered today

- basics of visual perception
- Gestalt principles