Lecture 17 – Data Objects

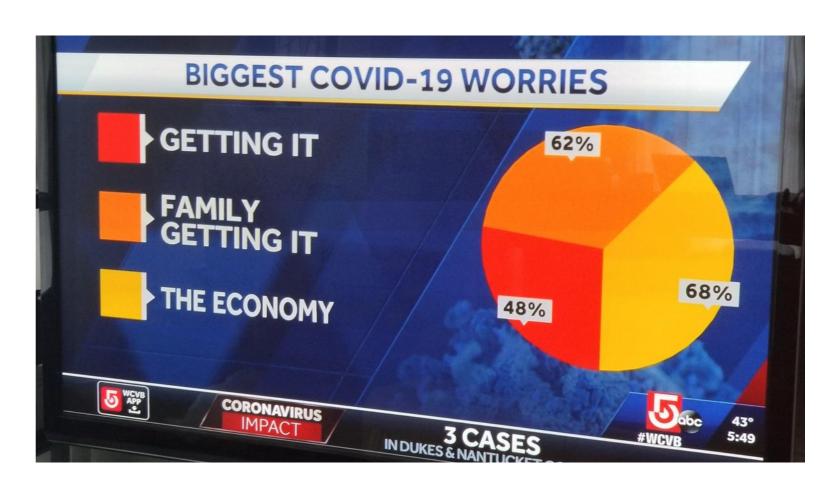
Today's Learning Objectives:

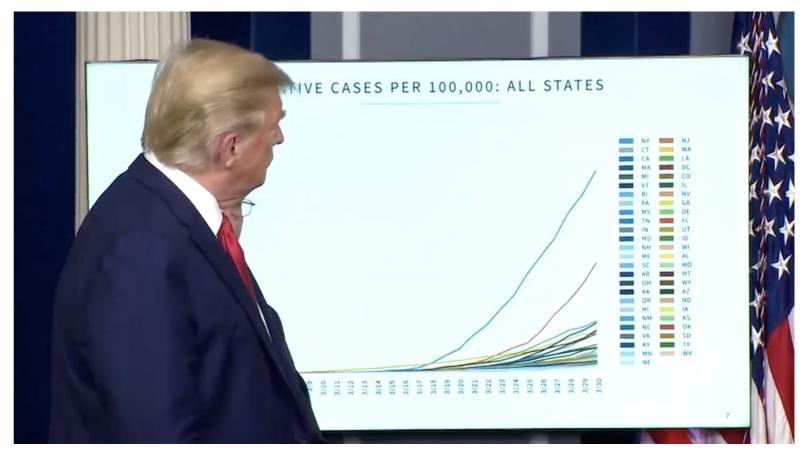
- 1. Describe the two main theories behind object recognition.
- 2. Discuss how priming can work to speed searching and object recognition.
- 3. Describe geon theory of recognition.

COVID-19 Visualization Wins and Losses

Wrong

Bad





COVID-19 Visualization Wins and Losses

Brilliant

This is how you do Data Viz, folks.



Model of Visual Perception

Stage 1: Parallel

- First pass processing

Stage 2: Patterns

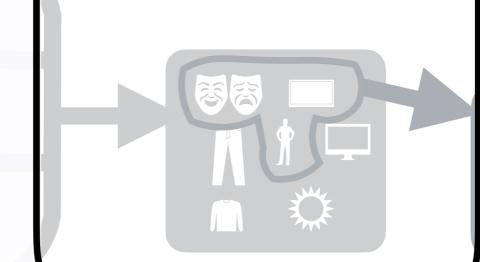
- Visual field is divided up, used for pattern finding
 - Top-down attention

- Flexible
- Slower
- Serial
- Where/ what split

Stage 3: Visual **Working Memory**

- VVVM
- VWM by active
- of WM "slots"





below

awareness





Object Recognition

Stage 1: Parallel

- First pass processing

Stage 2: Patterns

- Visual field is divided up, used for pattern finding
- Top-down attention

- Flexible
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Stage 3: Visual **Working Memory**

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- We don't really know how the brain recognizes objects.
 - Two theories:
 - image-based
 - structure-based

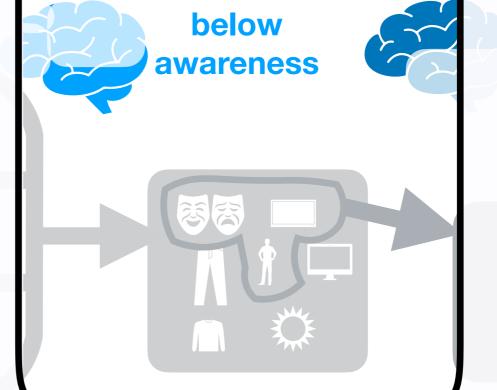


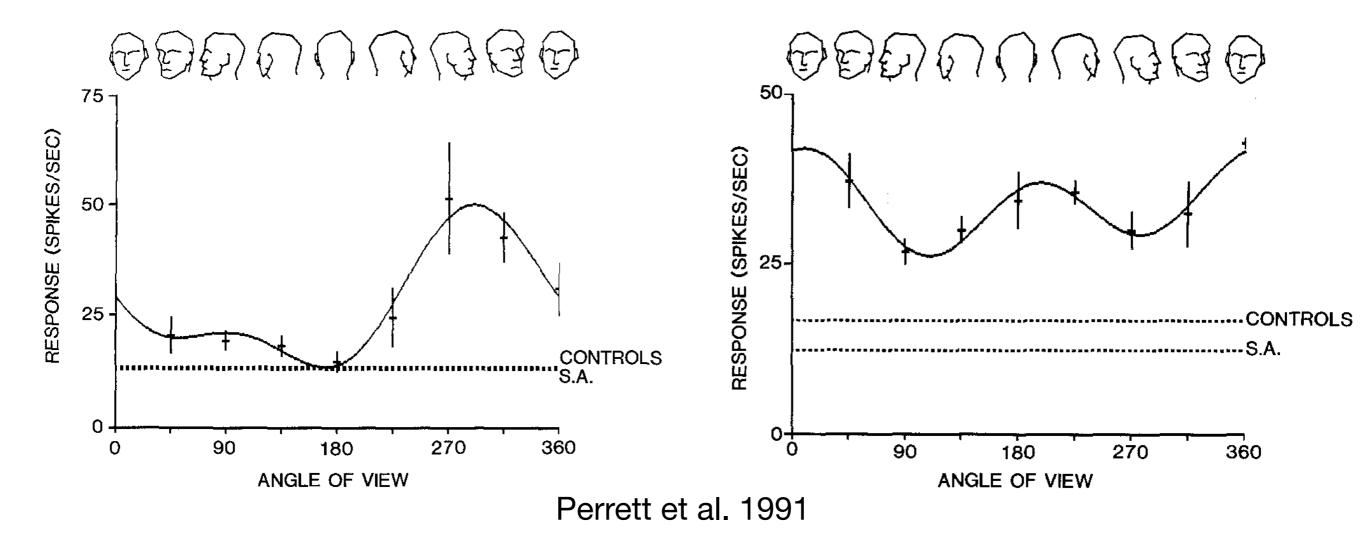


Image-based Recognition

- Our visual systems are really, really good at recognizing pictorial image representations.
 - Recognition is different (and faster) than recall. (Recall takes longer and we're less good at it.)
 - In rapid serial visual presentation, subjects can identify specific objects in pictures presented 5 times a second reliably!
 - Attention blink: if another object of the same type follows within 350 ms of the first, the second is not noticed.
 - Subjects do the best if a 3D object is presented in the same orientation as they are initially seen.
 - Objects are recognized by scanning a known picture database.

Image-based Recognition

- Experimental evidence for image-based recognition



- Specific neurons in monkeys will respond to specific orientations of faces.
- Supports multiple-view, image-based theory of recognition

Image-based Recognition: Viewing size

Viewing size affects recognition





Image-based Recognition: Viewing size



Viewing size affects recognition

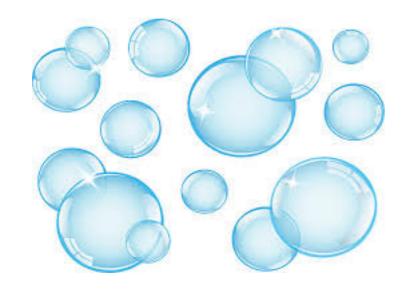
 For optimal identification, make important patterns and complex objects so they have a size of 4-6° of visual angle.











So_p





So_p



COESIGNALIKIE



Wikipedia, *UserLdaisy*

- Geon theory: Objects are constructed of geometric objects we already understand.
 - Brain recognizes geons and then constructs them to recognize more complicated objects.

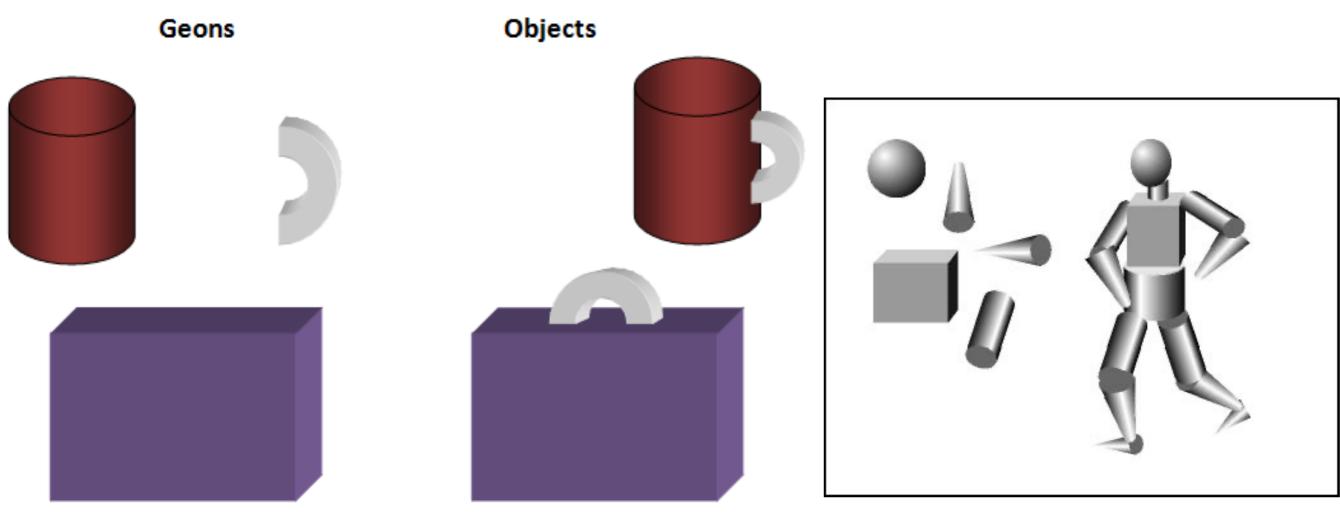


Fig. 8.5 Primitive geons constructing a more complicated human form.

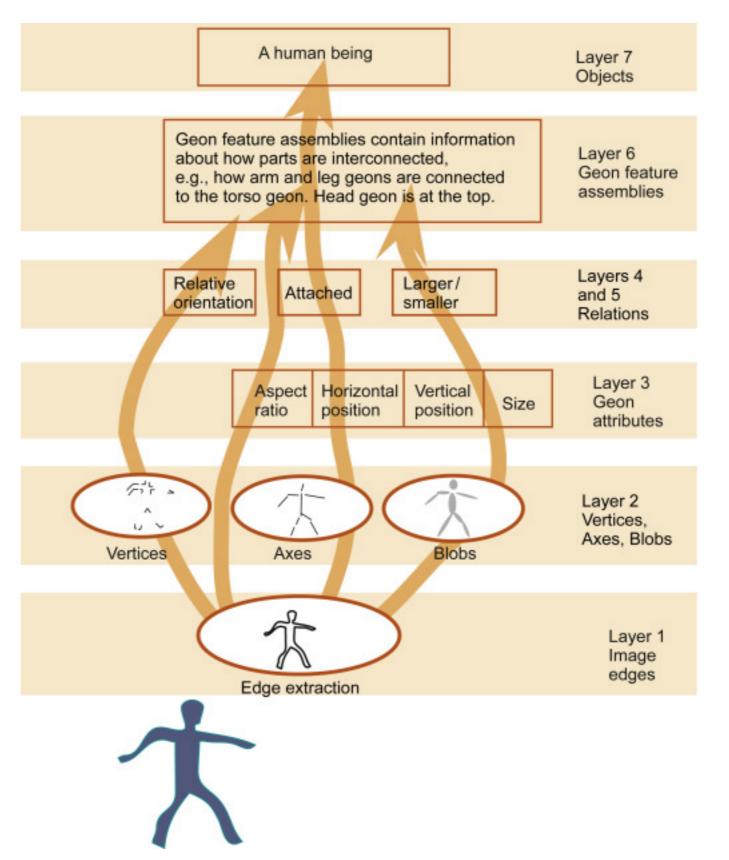
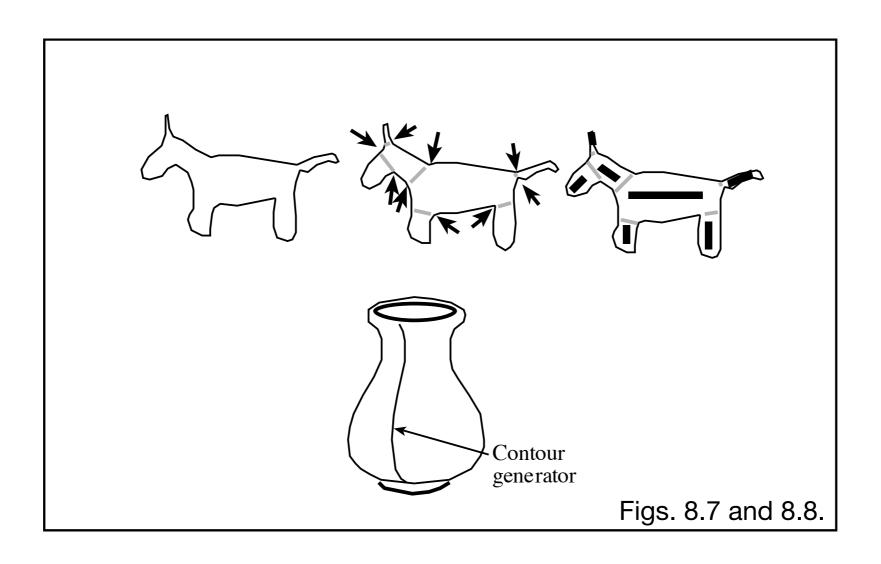


Fig. 8.4 A simplified view of Hummel and Biederman's (19920) neural network model of form perception.

- Brain finds geons by extrapolating shapes and contours from 3D cues.



- Silhouettes: important for determining objects and their structures.
 - Brain recognizes line drawings much faster than photographs of similar objects.

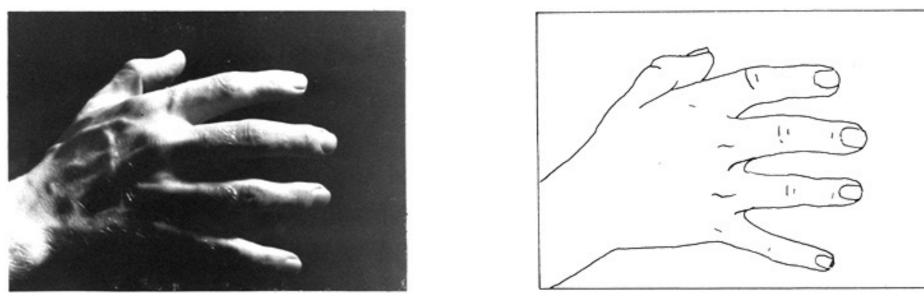
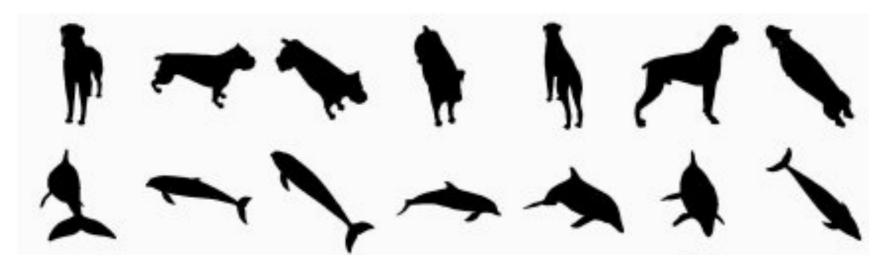


Fig. 8.9 A photograph and a simplified line drawing of a hand.

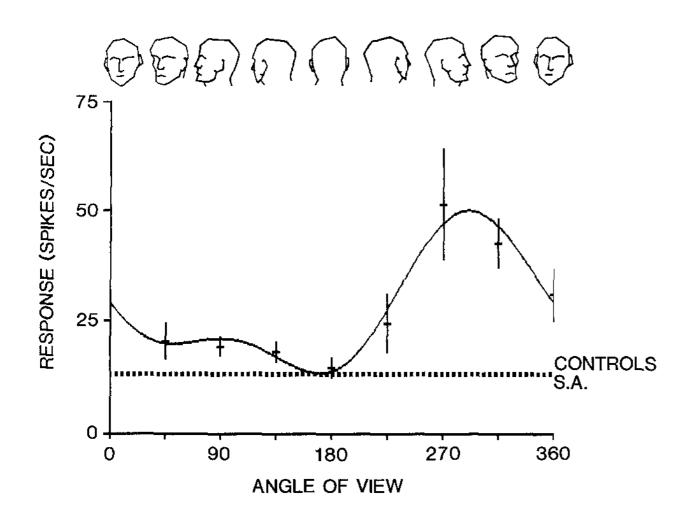
 Many shapes have canonical silhouettes defined viewpoints that are most easily recognized.

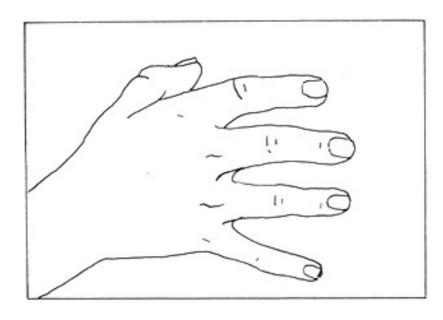


Macrinin et al. 2002

Object Recognition: how does it happen?

- Although some aspects of image-based and structure-based recognition theories are mutually exclusive, it's likely that **both types of cues** are important for object recognition.



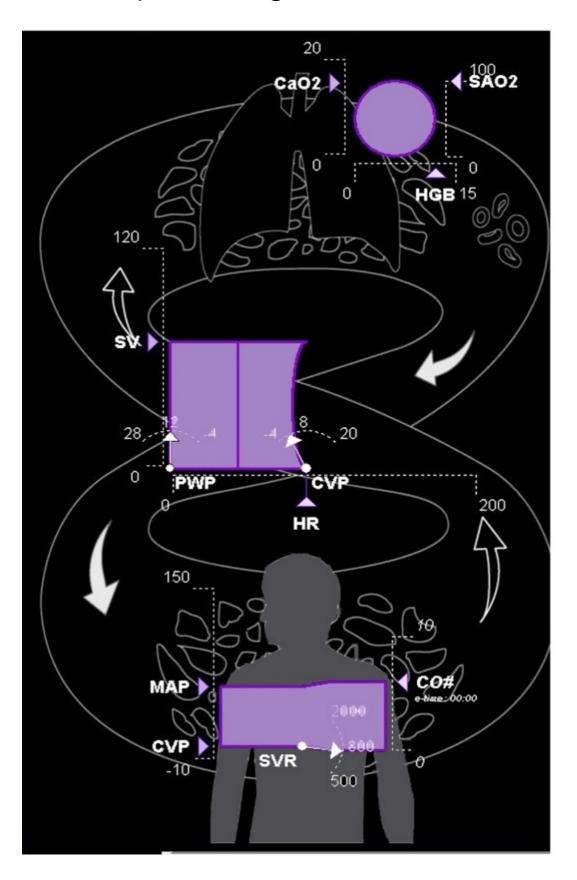


Building Object-based Diagrams

- Object displays and diagrams are a **powerful way** to communicate data **very quickly and accurately**.
 - "single contoured object" to integrate several separate variables
 - variable data will be processed together in parallel
 - far faster than separate, serial processing
 - uses fewer working memory spots
 - makes it possible to rapidly integrate several information sources
 - reduces visual clutter in display
- Object displays and diagrams are most effective when components of objects have natural or metaphorical relationship.

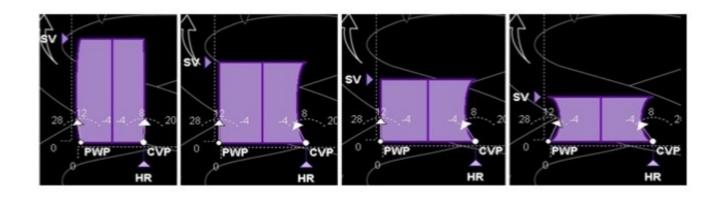
Building Object Displays: Example

- Example: George Blike's anesthesia instrument readout.



- Center represents heart, size and shape of glyph represents four measurements:
 - height: volume pumped by single heart beat
 - width: heart rate
 - size: emergent property showing heart throughput.
 - bowing: pulmonary wedge pressure and central venous pressure, representing right and left pressures of the heart.
 Reduced errors by 66%!

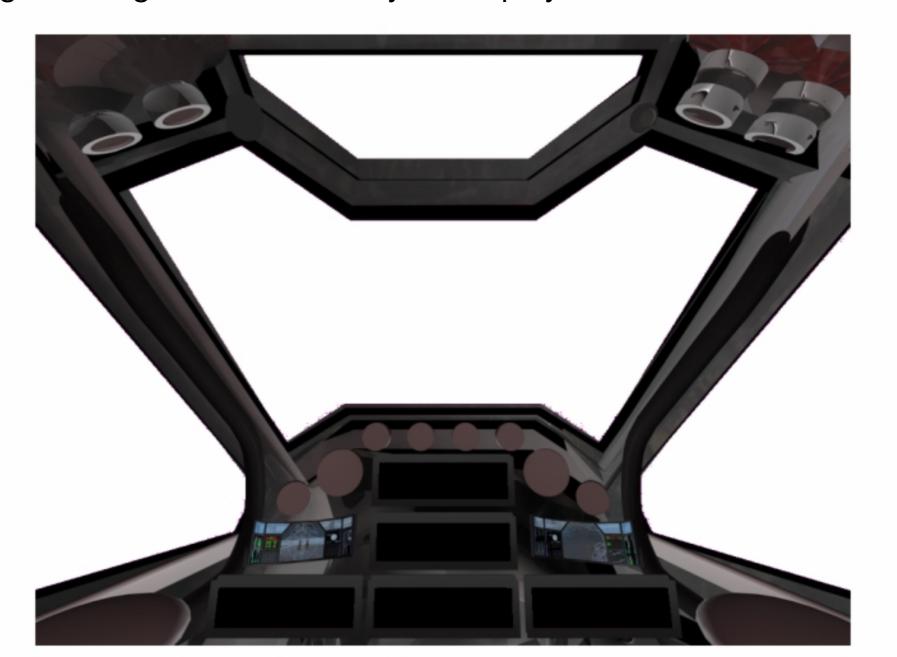
A hemorrhage in progress



Group work/Homework:

You are developing a video game of a spaceship fighter in which the user will have a cockpit view. Similar to plane dog-fights, the user will have to quickly navigate the ship so it can shoot down its opponent and avoid being shot down.

Design a cockpit visual display that will be projected into the screen that gives the user relevant information. Speed is key here, you can assume that the user will undergo training in order to read your display.



References

Blike GT, Surgenour SD & Whalen K. 1999. A graphical object display improves anesthesiologists' performance on a simulationed diagnostic task. J Clinical Monitoring Comp. 13: 37-44.

Perrett DI, Oram MW, Harries MH, Bevan R, Hietanen JK, Benson PJ, & Thomas S. 1991. Viewer-centered and object-centered coding of heads in the macaque temporal cortex. Exp Brain Res 86: 159-173.

Macrini D, Dickinson SJ, Siddiqi K, Zucker SW. 2002. View-based 3D object recognition using shock graphs. Object recognition supported by user interaction for service robots, IEEE vol 3: 24-28.