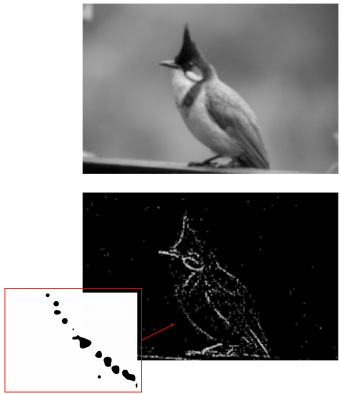
IIT Jodhpur

Biological Vision and Applications
Module 04-02: Perceptual grouping

Hiranmay Ghosh

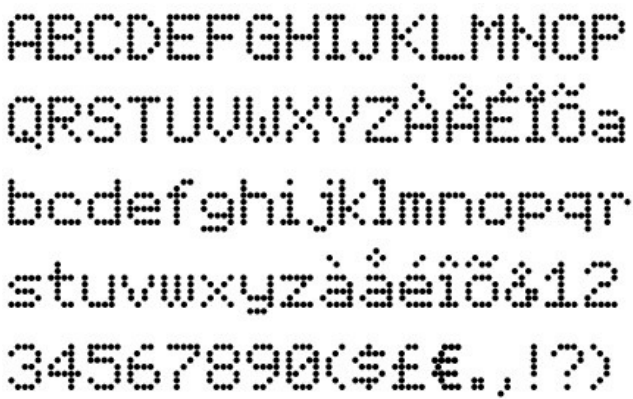
Reconstruction from fragmented contours

- Convolution in eyes result in edge detection
- The process is noisy
  - We do not identify neat object contours
  - Contours are fragmented
  - There are spurious edges
- Human Vision System constructs the object contours through **perceptual grouping**



Seeing the whole, rather than the parts

Dot-matrix printer



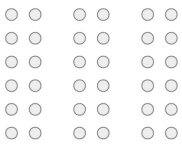
Gestalt psychology

Whole before the parts

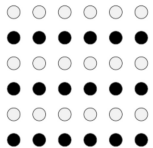
- Do you see the trees first or the forest first ?

Principles of perceptual grouping

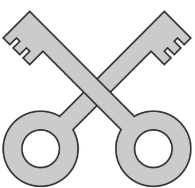
Experiments by Gestalt scientists



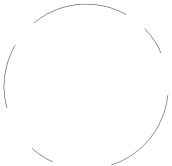
By proximity



By similarity



By continuity



By closure

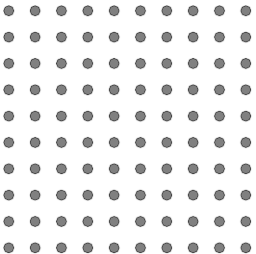
Generic Bayesian formulation [sketch]

for hierarchical perceptual grouping

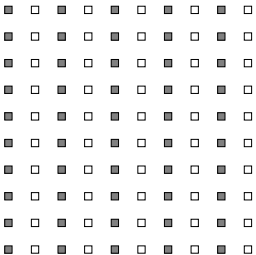
- Data is assumed to be generated by a set of K independent processes c_k
  - Each process represents a "concept" materializing into visible data elements
- Hypothesis space: $\mathcal{H} = \{h_1, h_2, \ldots, h_n\}$
  - Each hypothesis is about assignment of data elements to a set of processes
  - Principle of parsimony guides prior probabilities: $P(h_i)$
    - Guided by natural statistics
- Observed data: $d = \{(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)\}$
  - Goodness of fit: $P(d \mid h_i)$
- By Bayesian formulation
  - $P(h_i \mid d) = k.P(h_i).P(d \mid h_i)$
  - Choose $h* = \text{argmax}_i P(h_i \mid d)$

What is there is a conflict?

Our experiments



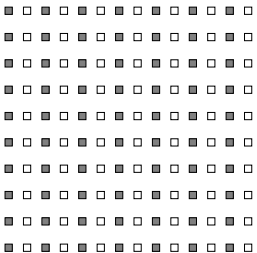
- Equal horizontal and vertical gaps
- 11/21 (52.4%) of you have reported horizontal grouping



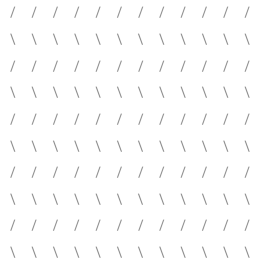
- Equal horizontal and vertical gaps
- 18/21 (85.7%) of you have reported vertical grouping

What is there is a conflict?

Our experiments

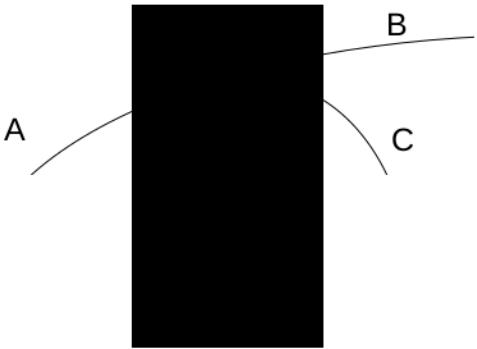


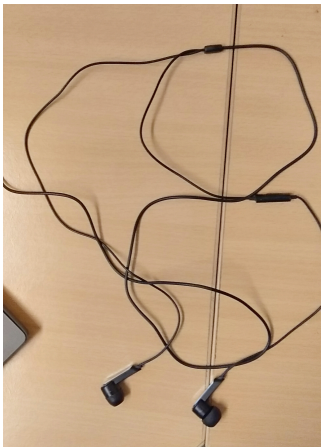
- similarity vs. proximity
  - horizontal gap $<$ vertical gaps
- 15/21 (71.4%) of you have reported verical grouping



- Continuity vs. shape
- 11/21 (52.4%) of you have reported vertical grouping

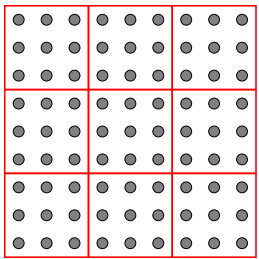
Grouping by continuity



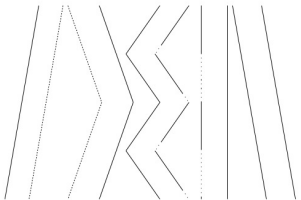


- A $\rightarrow$ B, or A $\rightarrow$ C?

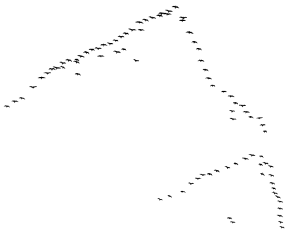
More grouping principles



- Grouping by region
- (x x x)(x x x)



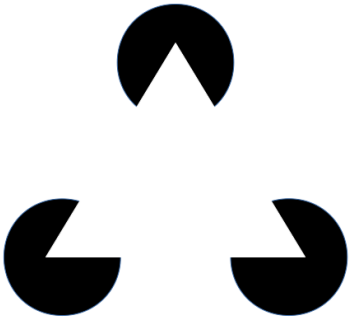
- Grouping by parallelism



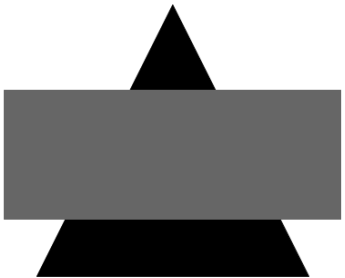
- Grouping by common fate (movement)
- Edpuzzle

Closure (completion)

Illusion

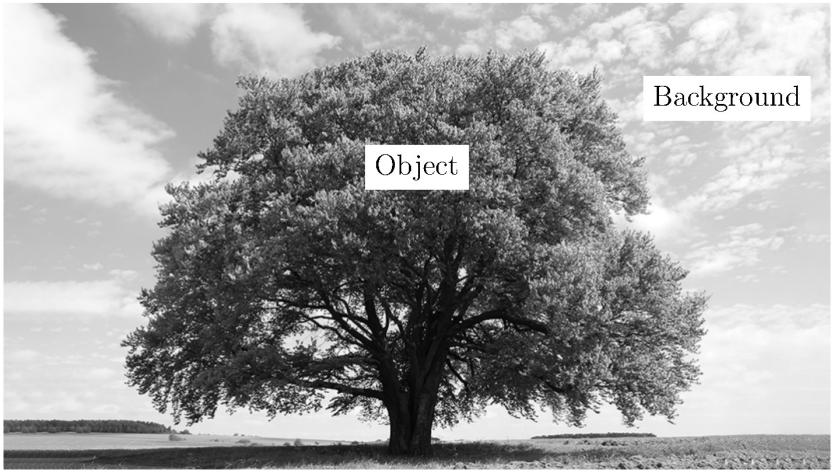


- Modal completion
- The white triangle does not exist!
- Kanitza triangle



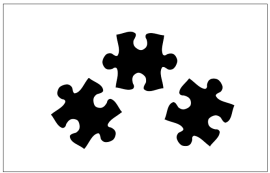
- Amodal completion
- The black triangle is occluded!

Object-ground separation

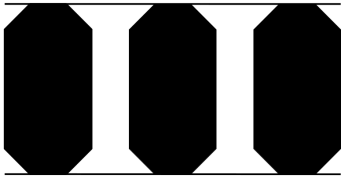


Object-ground separation

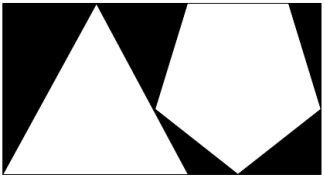
General rules



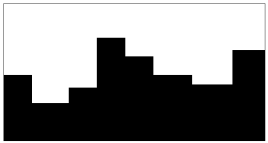
Closed shapes are objects



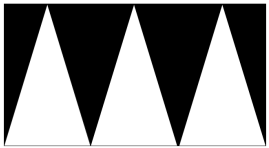
Convex shapes are objects



Symmetric shapes are objects



Shapes at bottom are objects



Shapes with fat bottom are objects

Known shapes are objects

Object-ground separation

Illusion

- Which area is object (foreground) and which area is ground (background)

Bistability

What do you see in the picture ?

See What You See ...

Quiz

Quiz 04-02

End of Module 04-02