

Biological Vision and Applications

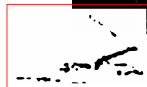
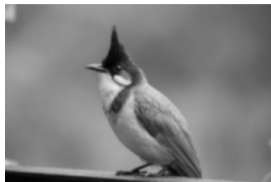
Module 04-02: Perceptual Grouping



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Reconstruction from fragmented contours

- Convolution in eyes result in edge detection
- The process is noisy
 - ▶ Contours are fragmented
 - ▶ There are spurious edges
- Human Vision System constructs the object contours through **perceptual grouping**



Gestalt psychology / Law of Prägnanz

Seeing the whole, rather than the parts

ABCDEFGHIJKLMNOPQRSTUVWXYZÀÁÊËÌÖä
bcdefghijklmnopqr
stuvwxyzàáêëìö&12
34567890(\$£€.,!?)

“whole is greater than its parts”

“Forest before trees”

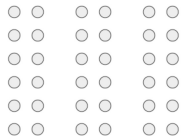


References:

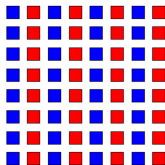
- Navon. Forest before trees: ...
- Grice, et al., Forest before trees: ... (criticism)

“Principles” of perceptual grouping

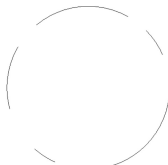
Empirical rules – Outcome of experiments by Gestalt scientists



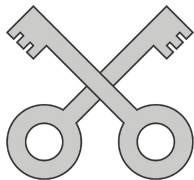
By proximity



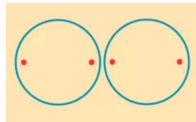
By similarity



By closure



By continuity



By common region

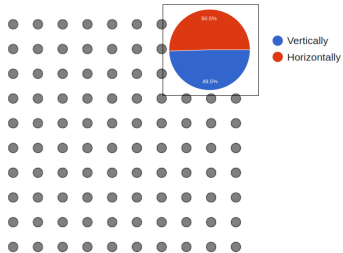


By parallelism

What is there is a conflict?

Our experiments

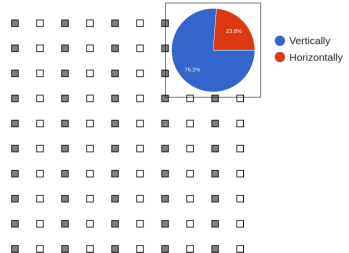
Experiment 1: Proximity – horizontal vs. vertical



Dots are equally separated horizontally and vertically.

Weak preference to horizontal grouping

Experiment 2: Similarity vs. Proximity



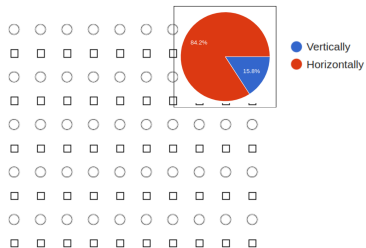
Dots are equally separated horizontally and vertically.

Strong preference for similarity than proximity

What there is a conflict?

Our experiments

Experiment 3



Dots are closer vertically then horizontally.

Strong preference for shape similarity than proximity

Experiment 4: Similarity vs. proximity



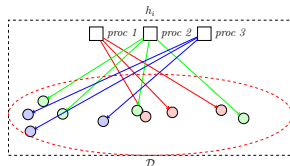
Dots are closer horizontally than vertically.

Strong preference for color similarity than proximity

Bayesian formulation for perceptual grouping

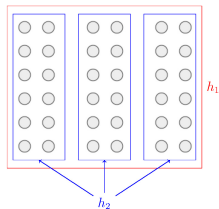
Based on the principle of Occam's razor

- Data is a set of visual elements $\mathcal{D} = \{d_j\}$.
- Data is assumed to be generated by a set of K independent processes $\mathcal{C} = \{c_k\}$
 - ▶ Each process represents a “visual object”
- Hypothesis space $\mathcal{H} = \{h_i\}$, where
 - ▶ A hypothesis h_i represents an association between the processes and data
 - ▶ Each hypothesis has a prior probability
 - ▶ The data represent “goodness of fit”
- Inference: $h^* = \mathbf{argmax}_i P(h_i \mid \mathcal{D})$



Bayesian formulation for perceptual grouping

Illustration

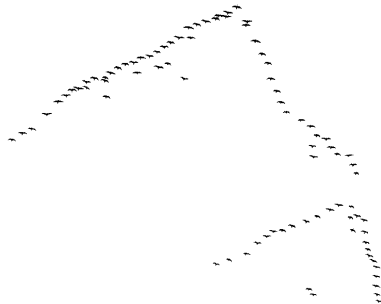


- h_1 : higher prior, lower goodness of fit (sparse)
- h_2 : lower prior, higher goodness of fit (dense)

Recall discussions in taxonomy learning

Grouping by common fate

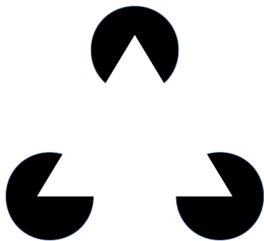
Moving together as a group



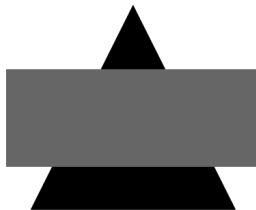
Example videos:

- [Common fate](#)
- [Starlings flying](#)

Closure and illusions



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

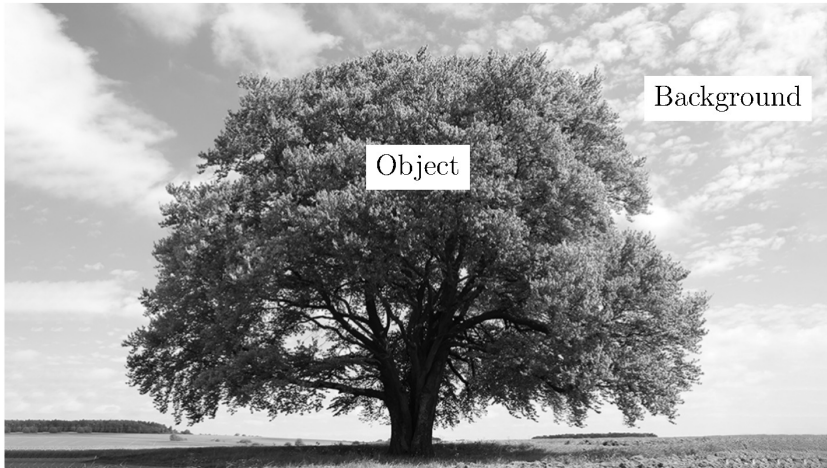


- Amodal completion
- The black triangle is occluded!

EdPuzzle: Application in design

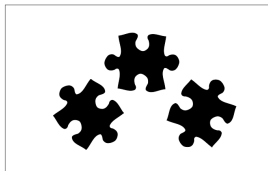
Object-ground separation

Foreground-background separation

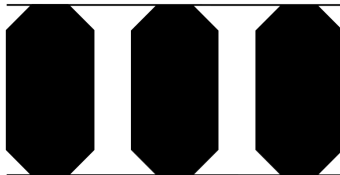


Object-ground separation

General rules: Can be explained with Occam's razor



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

Bistability

What do you see in the picture ?



Quiz 04-02

End of Module 04-02