Perceiving and Recognizing Objects

Chapter 4

• Finding edges
• Grouping and texture segmentation
• Figure–Ground assignment
• Edges, parts, and wholes
• Object recognition
• Objects in the brain
• Development of object perception

What Do You See?
What Do You See?

Do you think it is the same house you saw in the previous picture?

A more abstract house. Paul Cezanne's Château Noir.

Middle Vision

How do we organize simple lines and edges into shapes, planes and texture?

<table>
<thead>
<tr>
<th>Edges</th>
<th>Planes</th>
<th>Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Vision</td>
<td>Middle Vision</td>
<td>High Vision</td>
</tr>
</tbody>
</table>
Finding Edges

How does the visual system finds edges and puts them together to form shapes, surfaces and planes?

The computer does a poor job at identifying edges.

Creating Edges

Perception of edges when edges are not drawn are called illusory contours.
Many computer algorithms are available to translate into edges.

**Structuralists** suggested that atoms of sensation summed up to form perceptual contours.
Gestalt psychologists on the other hand suggested that perceptual whole was more than the sum of its sensory parts (atoms). And formulated what are called the rules of perceptual groupings (Wertheimer, Köhler, Koffka (1920s–1950s); Palmer and Rock (1990s).

**Occlusion:** The reason why an edge suddenly stops is because an object occludes it. The edge continues under the occluded object.

**Good continuation:** group elements to form smoothly continuing lines.
Gestalt Psychologists purposed that the brain had neurons that worked as committees that use rules, principles and good guesses to organize perception.

1. Group elements that are similar are perceived one.
2. Group elements that are proximal (close to each other) perceived together.
Parallelism/Symmetry

Somewhat weaker grouping principles—group parallel and symmetric elements together.

Modern Gestaltism

**Common region:** Elements perceived to be part of a larger region group together. **Connectedness:** Elements that are connected to each other group together (Palmer, 1992).

Dynamic Grouping Principles

**Common fate:** group elements moving in the same direction together.
**Dynamic Grouping Principles**

**Synchrony:** group elements changing at the same time together.

![Image of synchronized dots]

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**Camouflage**

Which principles of Gestalt are at work here?

![Images of camouflage patterns]

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**Pandemonium**

Simple model of letter recognition. “Demons” loosely represent neurons; each level represents a different brain area (Selfridge, 1959).

![Diagram of pandemonium model]

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Committee Rules: Honor physics and avoid accidents

Generally speaking committees come to coherent interpretation of objects in question, however decisions may not be final.

Necker’s Cube

Object Ambiguity

Some more examples of ambiguous pictures.

More Ambiguity: Accidental Views

Any slight shift in accidental viewpoint destroys the perception of the object above.
What is the to-be-recognized object and background?
Gestalt figure–ground assignment principles: surroundedness, size, symmetry, parallelism

Is brown or white the figure here?
Object recognition starts before figure–ground assignment finishes

Which circles are “figures” and which are holes?
Q: When should we complete edges behind occluders?
A: When the edges are relatable by an “elbow curve” (Kellman and Shipley, 1991)

Non-accidental features provide clues to object structure.


The first goal of the middle vision is to carve large-scale objects and then small scale ones.
Pairs of concavities indicate part boundaries (Hoffman and Richards, 1984).

What happens when cuts can go either way?

Object Recognition: High-Level Vision

Processes in object recognition:
1. Determine features present in image ("Low-level vision")
2. Group features into objects ("Middle vision")
3. Match perceived to encoded representations ("High-level vision")

What Is a Representation?

A thing that stands for another thing, for example:
Naive Template Theory

“Lock-and-key” representations. Templates for objects. Problem: You would need too many templates!

Structural Descriptions

So a capital A can be defined with three lines. Two forming an angle and the third connecting the two. This would be a case of structural description of a representation.

Structural Description Theory

Represent the structure of an object, not what it looks like from one view. Recognition-By-Components or geometric icons (RBC or Geons; Biederman, 1987).

Take a noodle and put it on to the side of a cylinder and it is a cup; on top it is a pail; put it on a brick and it is an attaché case.
The Effect of Viewpoint

RBC predicts viewpoint invariance. Many empirical studies have found viewpoint dependence.

Studies show that as the viewpoint of the second image is changed it takes more time to process. Thus objects may be represented as templates.

Levels of Object Categorization

What are these objects?
1. Entry level: birds
2. Subordinate level: sparrow-ostrich
3. Superordinate level: animals
The Entry Level

- Which label comes to mind first?
- The entry level term may be determined by a perceptual committee.

Face Recognition

What’s wrong with this picture?

“Special” processes may be involved in identifying individual faces. Prosopagnosia: Selective inability to recognize faces.
Objects in the Brain

“What” system: object identification and face recognition neurons (Inferotemporal cortex).

Grandmother Cells

Could a single neuron be responsible for recognizing your grandmother? Animal studies suggest it might be the case.