Object recognition and categorization

BCS153 Week 14.1
4/16/19
Roadmap

• Cognitive processes involved in object recognition
• Gestalt principles
• Categorization vs. Identification
• Problem in object recognition
  ➢ View-invariant vs. View-dependent features
• Models of object recognition
• Face recognition
Object recognition

- Object broadly defined...
  - Pattern
  - Symbol
  - Letter
  - Character
  - Face
What cognitive processes are involved in object recognition?

• Perception
• Attention
• Categorization
• Identification
• Memory retrieval
Why do we tend to recognize this dot pattern as a triangle rather than 9 dots?
Early attempt: Gestalt principles- what does each of the following examples represent?
Categorization vs. Identification: which task is easier?

• How would you categorize these two kinds of fruit?
Categorization vs. Identification: which task is easier?

• Can you identify this fruit?
Categorization vs. Identification: which one is easier? Why?

What strategies did you use in categorization?
Now can you categorize these two objects?
How do we recognize an object from a different view?
View-invariant vs. View-dependent features

• What features are view-invariant?
• What features are view-dependent?
Variability in input – a problem in recognition

• Incomplete rendering of the whole object

• Generalizability of one exemplar (view) to another

• Within-category variability
A simple model of object recognition

• Riesenhuber & Poggio (2000)
View-based approach: a more sophisticated version

- How is an object in a novel view recognized?

→ Interpolation of the old view

Riesenhuber & Poggio (2000)
Incorporation of both view-dependent and view-invariant features

Riesenhuber & Poggio (2000)
How many features/units are needed in view-based models

• The more the better?
  ➢ A model with the most crucial features
  ➢ A model with “overcomplete” set of features

→ Which one can best account for “exceptions” (i.e., a novel view of an object)?
Feedforward and feedback in recognition

• *Analysis-by-synthesis*

Stored representations

input
Object-centered approach: Recognition by Components (RBC) (Biederman 1987)
- View-invariant features (geons)
Biederman (1987)

Figure 2. Presumed processing stages in object recognition.
Face recognition

WHEN YOU NEED TO CALL THE POLICE

AND THE NEW IPHONE FACE-ID DON'T RECOGNIZE YOU
Automated face recognition – one example

How facial identification works

1. Image is captured
2. Eye locations are determined
3. Image is converted to grayscale and cropped
4. Image is converted to a template used by the search engine for facial comparison results
5. Image is searched and matched using a sophisticated algorithm to compare the template to other templates on file
6. Duplicate licenses are investigated for fraud

Source: Iowa Department of Transportation

https://www.eff.org/pages/face-recognition
Face recognition and object recognition

• Both can be accounted for by RBC

• Both have view-invariant features

• Similar 3D rendering of a face from different views

→ What about a typical object, say, a baseball? Where is the “front side” of the baseball?
Specialized neural circuits for face recognition

Rossion & Jacques (2008)
Development of face recognition

Kuefner et al. (2010)

Object categorization task (object vs. non-object)
Development of face recognition

Kuefner et al. (2010)

Adults

4 – 6 yrs

6 – 8 yrs

8 – 9 yrs

9 – 11 yrs

11 – 12 yrs

12 – 14 yrs

14 – 16 yrs

16 – 17 yrs
Take-home messages

• Categorization is typically easier than identification.

• One potential problem in object recognition: generalization of one exemplar to another

• Both view-invariant and view-dependent features are needed for object recognition

• Development of face recognition is not done at birth!