

Object Recognition with Artificial Neural Networks

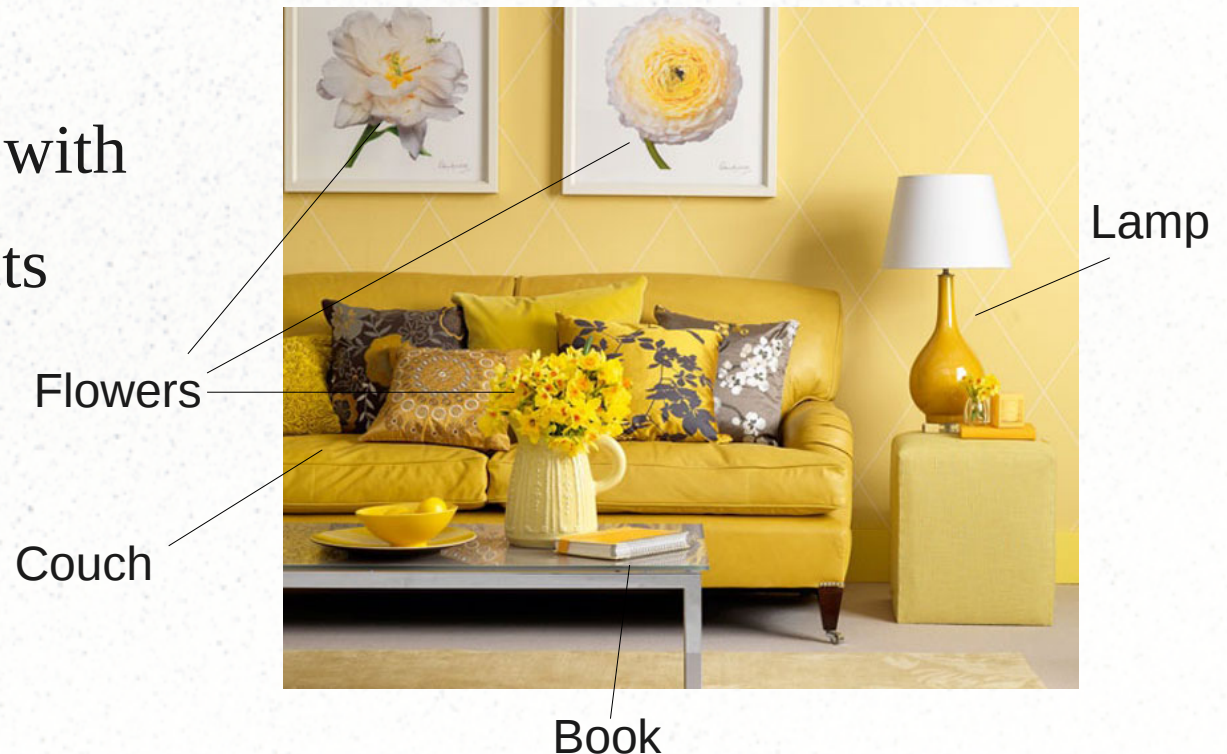
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Outline

- Object recognition in humans
- Object recognition in computers
- Parallel Distributed Processing
- Application: Artificial Neural Networks
- Evaluation

Object Recognition in Humans

- Bottom-up/top-down process
- Impressively quick (150-200ms)
- Accurate
- Very successful with unfamiliar objects

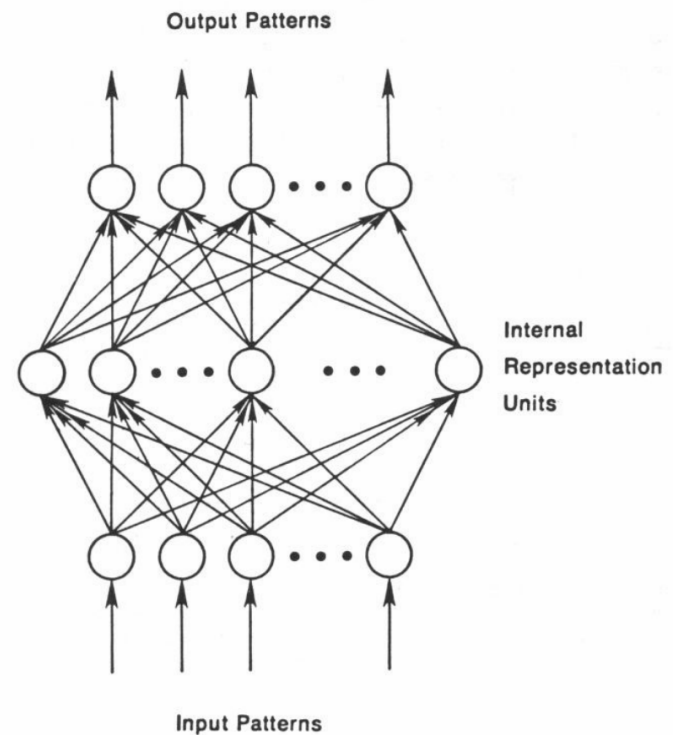


Object Recognition in Computers

- Many approaches
- Less successful than biology
- Major problem: variation
 - Viewing angle
 - Lighting
 - Different types of objects
 - Background
 - Etc.

Parallel Distributed Processing

- A low-level model of cognition
- Idea: the brain is a network of neurons
- Neurons are too slow to work sequentially → they must work in parallel!
- Computation is performed by activation flowing through the network



PDP (cont.)

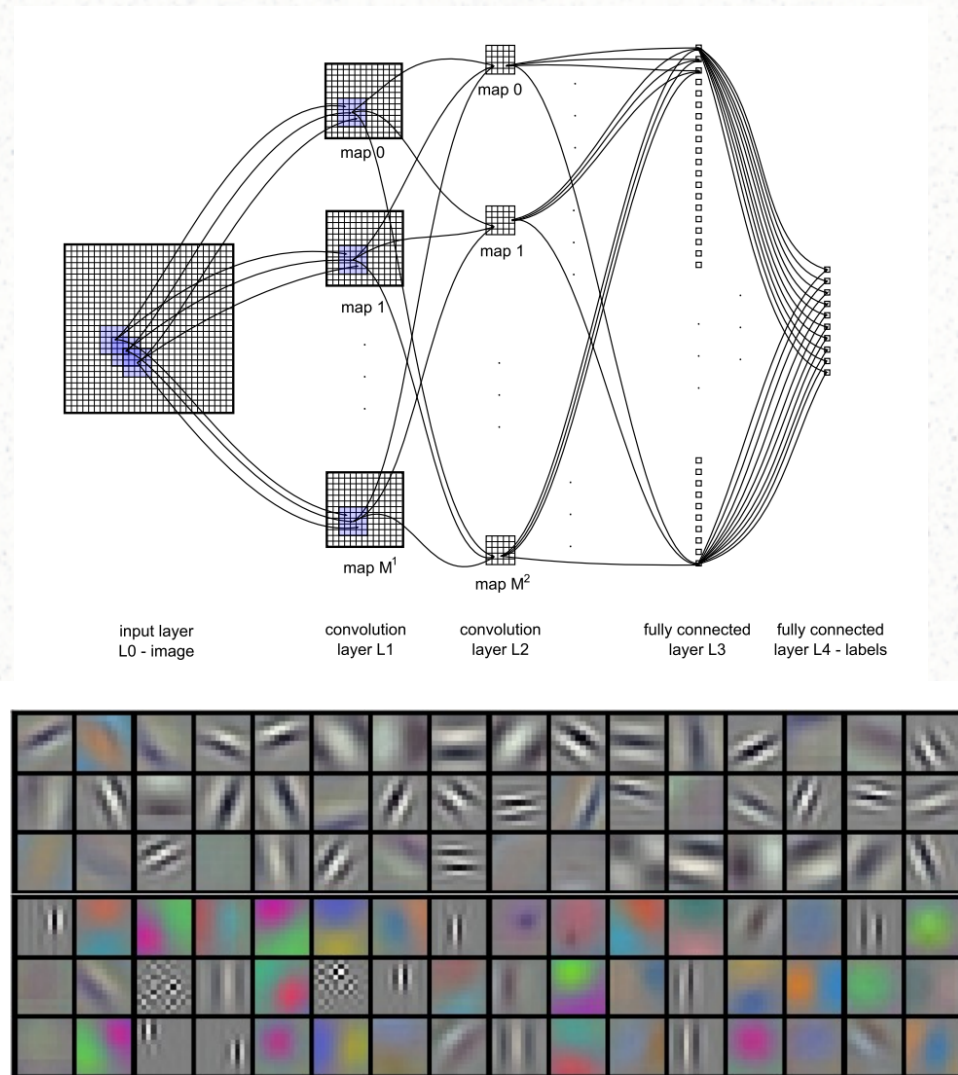
- Input-Output pairs are presented to train the network
- Various algorithms; all examples of Hebbian learning
- Network is then evaluated with new input
- Has been used to model:
 - Memory
 - Learning
 - Perception
 - Motor control
 - ...

Artificial Neural Networks

- Machine learning version of PDP networks
- Emphasis on performance over modeling
- Same ideas, just larger/more complex
- Many applications, including object recognition
- Convolutional networks (CNNs): try to mimic visual cortex
 - Split up image
 - Analyze basic features
 - Gradually merge these together and make a classification

Artificial Neural Networks

- Example:



Evaluation

- Do they work?
 - Yes!
- 2011: Ciresan et al achieve records for digit, 3D-object, and image recognition benchmarks
- 2012: Krizhevsky et al win ImageNet recognition challenge using a CNN
 - First place: 15.3% error
 - Second place: 26.2%
- But still below human performance

The End



lens cap

reflex camera
Polaroid camera
pencil sharpener
switch
combination lock



abacus

abacus
typewriter keyboard
space bar
computer keyboard
accordion



slug

slug
zucchini
ground beetle
common newt
water snake



hen

hen
cock
cocker spaniel
partridge
English setter



tiger

tiger
tiger cat
tabby
boxer
Saint Bernard



chambered nautilus

lampshade
throne
goblet
table lamp
hamper



tape player

cellular telephone
slot
reflex camera
dial telephone
iPod



planetarium

planetarium
dome
mosque
radio telescope
steel arch bridge