بسم الله الرحمن الرحیم

علوم شناختی

جلسه ۱۱ (د)

پردازش اطلاعات در شبکه‌های عصبی

Information Processing in Neural Networks

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http://courses.fouladi.ir/cogsci

PART 2:
MODELS AND TOOLS

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Chapter 5:
Neural Networks and Distributed Information Processing

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Chapter 5.4: Information processing in neural networks

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Level of analysis

Neural networks are models of information-processing at the algorithmic level

- alternatives to symbolic algorithms
- not implementations of symbolic algorithms

Modeling information-processing

- Neural networks are algorithmic in a limited sense
  - algorithms for updating activation levels
  - learning rules are algorithmic
- But not algorithmic in the same way as PSS
  - algorithms are not task-specific
  - algorithms do not operate over representations
    - Algorithms change weights and thresholds at the level of individual units

Representations

Representations in a neural network need not be located in distinct physical locations

- The network's "knowledge" lies in its pattern of weights and thresholds

- The power of distributed (as opposed to localist) networks comes from the fact that the network doesn't need a separate unit to code every feature to which it is sensitive

Problem

In what sense do neural networks actually contain representations?

Superpositional storage

- Once a network has been trained,
  all its knowledge is encoded in a single set of weights

- Each instance of information-processing involves
  an input vector and the weight vector

- This makes it difficult to think about the network's knowledge
  as composed of discrete items
  (e.g. particular beliefs)

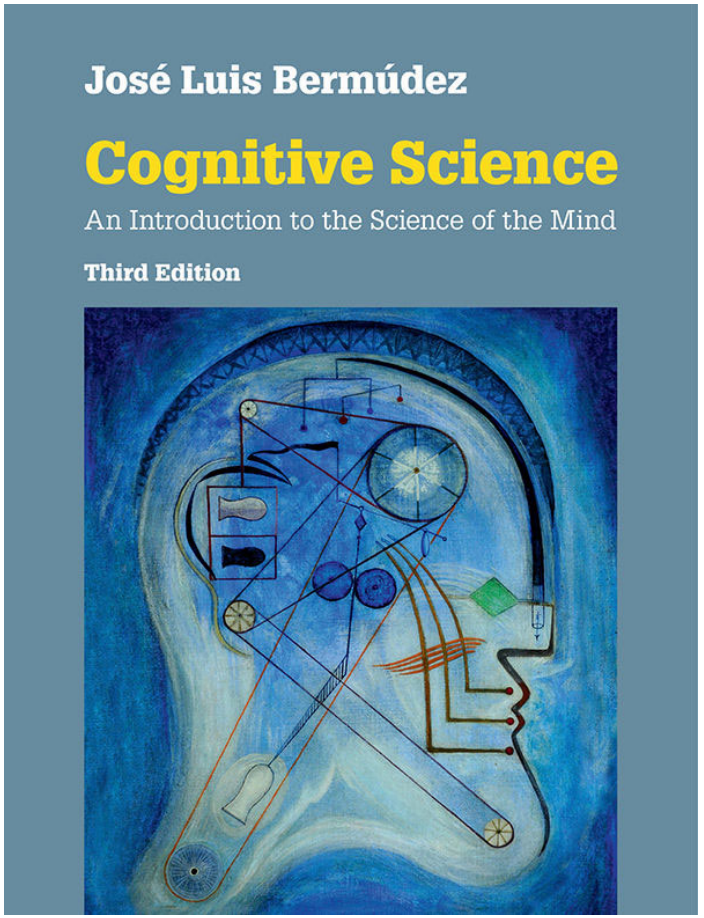
No clear distinction between information storage and information processing

- Parallel rather than serial processing as activation spreads through a network
- Knowledge distributed across a network (rather than stored in discrete symbol structures)
- Processing does not reply on explicit rules (other than those governing how activation flows through the network)

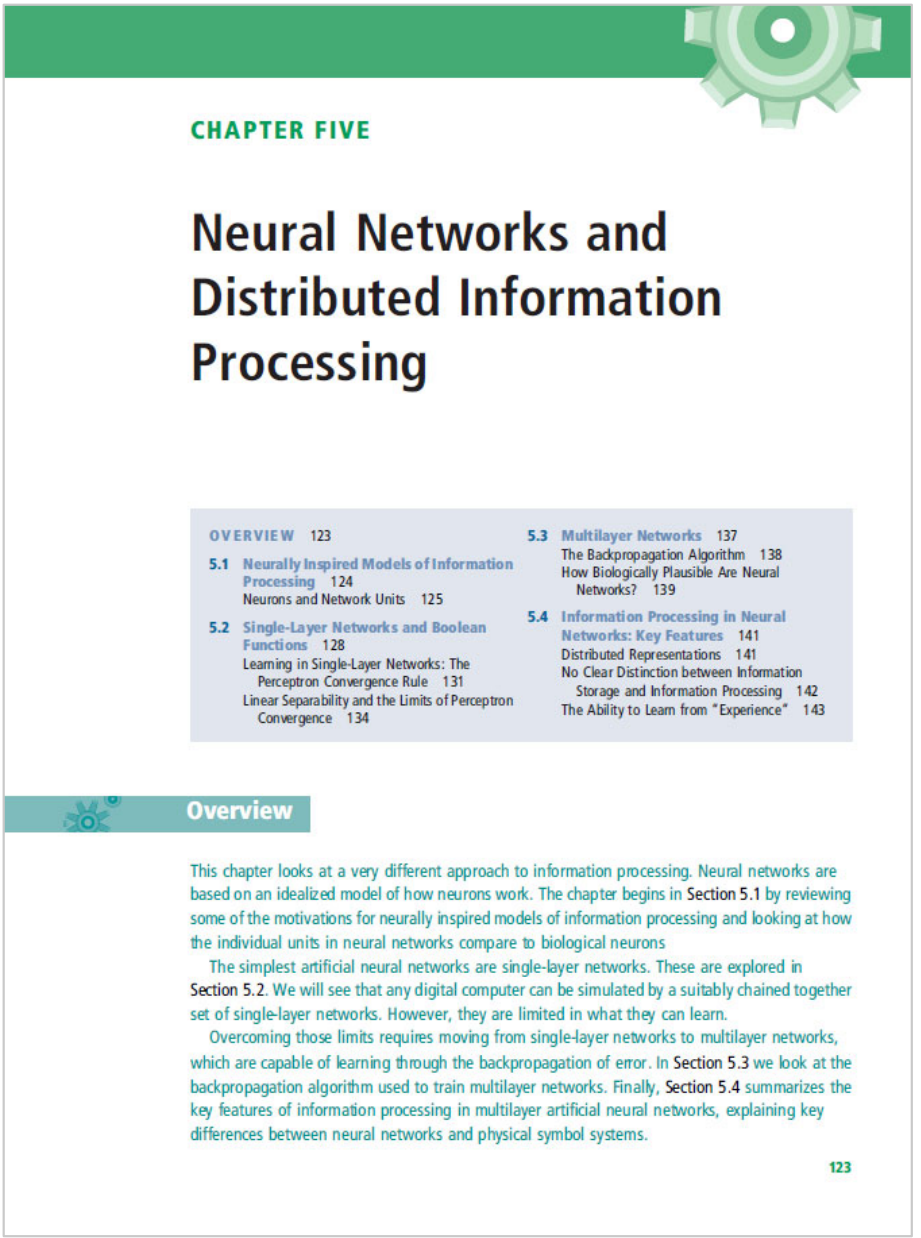
Biological plausibility: compare to PSS

- Many cognitive abilities are difficult to model in a rule-based way
    - Context effects in perception (explosion of rules)
    - Pattern completion
    - Language (particularly languages such as English with many irregular forms)
- Connectionist networks are very successful on pattern recognition tasks (e.g. mine/rock)

منبع اصلی



José Luis Bermúdez,
Cognitive Science:
An Introduction to the Science of the Mind,
3rd ed., Cambridge University Press, 2020.
Chapter 5 (Section 5.4)



CHAPTER FIVE

Neural Networks and Distributed Information Processing

Overview

This chapter looks at a very different approach to information processing. Neural networks are based on an idealized model of how neurons work. The chapter begins in Section 5.1 by reviewing some of the motivations for neurally inspired models of information processing and looking at how the individual units in neural networks compare to biological neurons

The simplest artificial neural networks are single-layer networks. These are explored in Section 5.2. We will see that any digital computer can be simulated by a suitably chained together set of single-layer networks. However, they are limited in what they can learn.

Overcoming those limits requires moving from single-layer networks to multilayer networks, which are capable of learning through the backpropagation of error. In Section 5.3 we look at the backpropagation algorithm used to train multilayer networks. Finally, Section 5.4 summarizes the key features of information processing in multilayer artificial neural networks, explaining key differences between neural networks and physical symbol systems.

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