

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



علوم شناختی

جلسه ۸ (الف)

گسترش مدل سازی محاسباتی به مغز

Extending Computational Modeling to the Brain

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PART 1: HISTORICAL LANDMARKS



Chapter 3: The Turn to the Brain



Chapter 3.3: Extending computational modeling to the brain



Connectionist information-processing

Basic principles

- 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 rely on explicit rules (other than those governing how activation flows through the network)

Features of connectionist networks

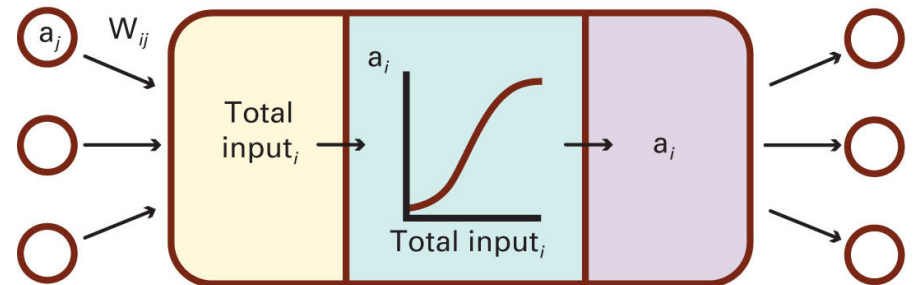
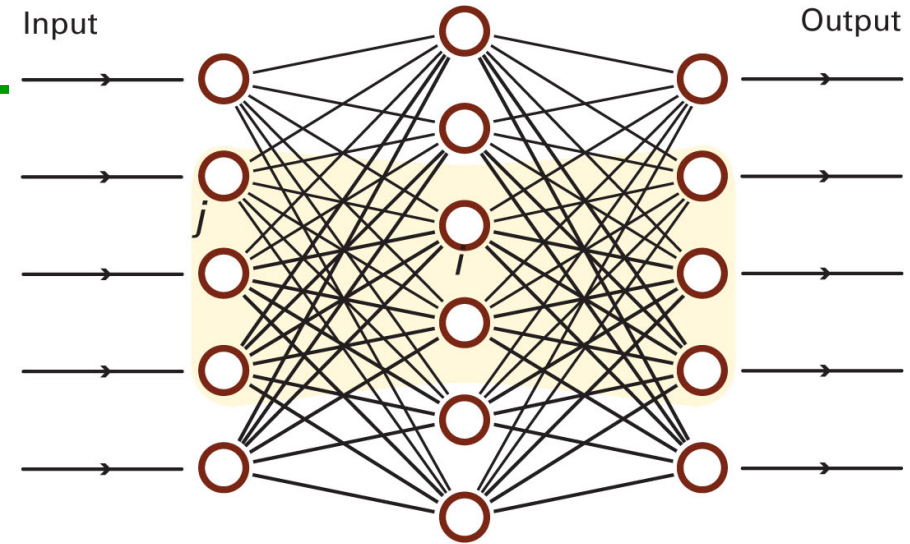
- Exploit parallel processing
- Exhibit graceful degradation
- Intended as models of information-processing at the algorithmic level
- Capable of learning

Parallel processing

The basic principle of connectionist networks is that many different units are active at a given time

- If we think of each unit as performing an information-processing step, this vastly increases the number of steps that can be performed in a short time-span.
- The information processing steps in a network don't map straightforwardly onto the stages of a symbolic computation.

Flow of activation



Integrate input from previous layer

Transform total input to activity level (a_i)

Transmit activity level to units in next layer

Backpropagation

- **Information** is transmitted forwards through the network
- **Error** is propagated backwards through the network
- The **backpropagated error signal** is used to adjust the weights to/from the hidden units

Backprop

- The algorithm needs to find a way of calculating error in hidden units that do not have target activation levels
- It does this by calculating for each hidden unit its degree of “responsibility” for error at the output units
- This error value is used to adjust the weights of the hidden units

Serial processing

- Processing in physical symbol systems is step-by-step
 - Turing Machine can only read one cell at a time
 - each line of machine table only applies one instruction
- Can the brain actually work this slowly?
 - Distinction between computability in principle and practical computability
 - Practical computability imposes real-time constraints

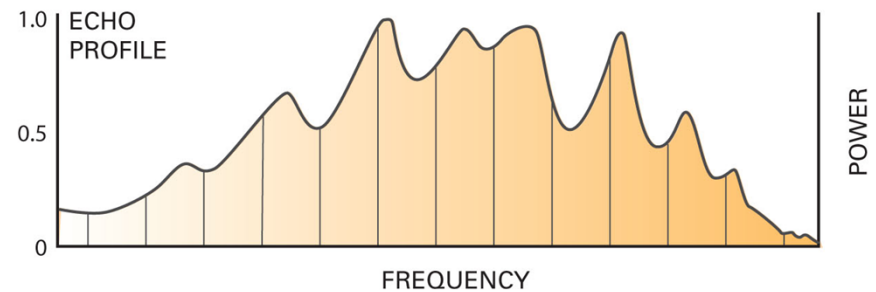
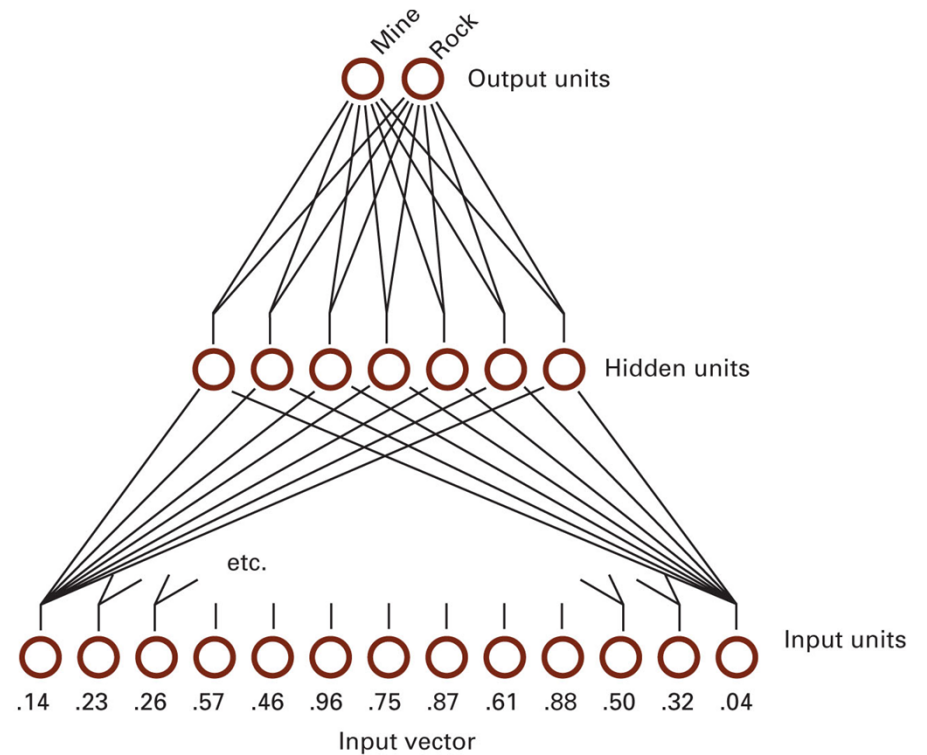
Graceful degradation

- Brains respond in distinctive and flexible ways to damage and impairment
 - characteristic partial breakdown patterns in response to local damage/lesions
 - graceful degradation when cognitive abilities slowly deteriorate
- Symbolic computer programs either work or they don't
⇒ brittle

Gorman & Sejnowski 1988

- Pattern recognition
 - Distinguish between the sonar echo produced by a rock and the sonar echo produced by a mine

- Pattern recognition



Level of analysis

- Connectionist networks are models of information-processing at the algorithmic level
- Means that connectionists still have to answer questions of how networks are implemented in the brain



CHAPTER THREE

The Turn to the Brain

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Pattern Recognition in Neural Networks: Gorman and Sejnowski, "Analysis of Hidden Units in a Layered Network Trained to Identify Sonar Targets" (1998) 78

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Overview

A striking feature of contemporary cognitive science, as compared with the 1970s for example, is the increasing centrality of the brain. This chapter reviews some landmarks in cognitive science's turn to the brain. There are several different strands here. One is the emergence of different techniques for studying the brain. These include brain studies and functional neuroimaging techniques. And then, distinct from these but no doubt related, is the development of neurally inspired computational models.

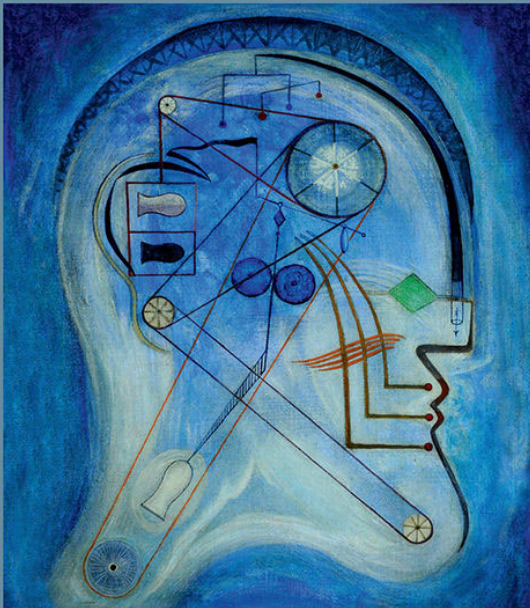
For both theoretical and practical reasons, neuroscience was fairly peripheral to cognitive sciences until the 1980s. We begin in Section 3.1 by looking at some of the theoretical reasons, particularly the influential idea that cognitive systems are functional systems, and so need to be studied in terms of their function – what they do and how they do it. Many cognitive scientists hold

José Luis Bermúdez

Cognitive Science

An Introduction to the Science of the Mind

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Chapter 3 (Section 3.3)