AI

Unit – 13

Connectionist Models

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Introduction

- Neural network architectures have been called connectionist architecture.
- They are characterized by having:
  - A very large number of simple neuron-like processing elements.
  - A large number of weighted connections between the elements. The weights on the connections encode the knowledge of a network.
  - Highly parallel, distributed control.
  - An emphasis on learning internal representations automatically.

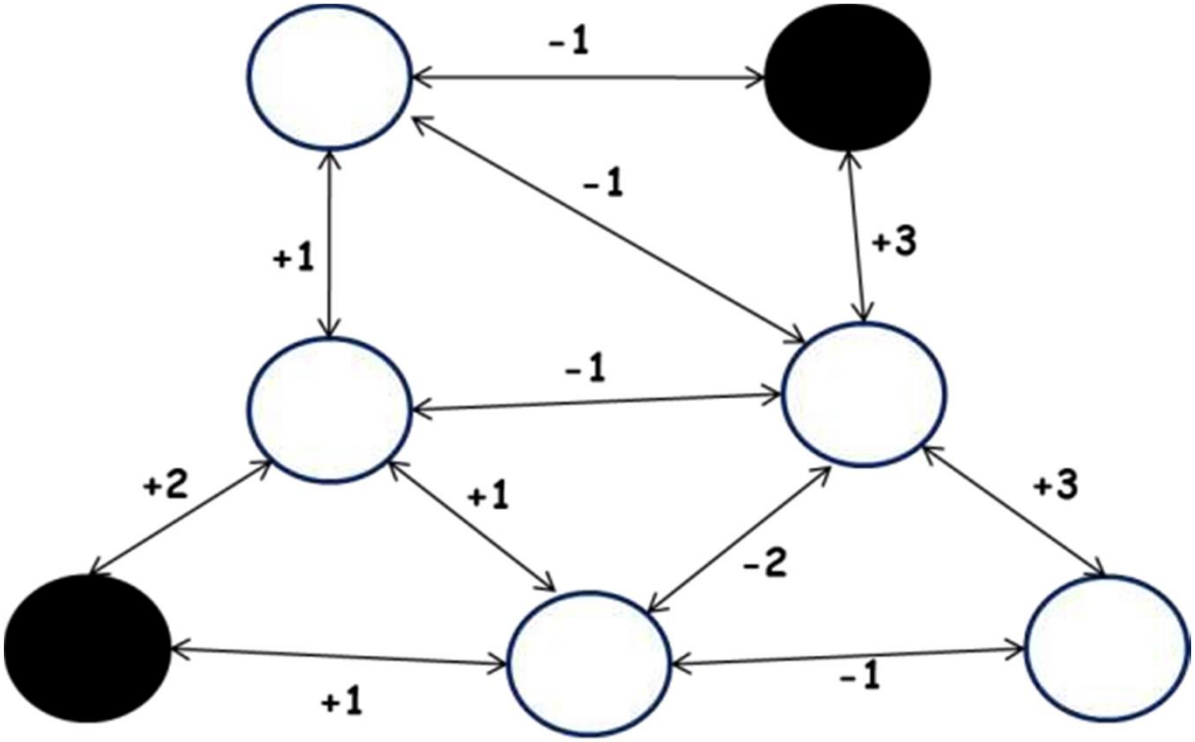
Hopfield Networks

- Hopfield [1982]: introduced a neural network as a theory of memory: Model of content addressable memory.

Hopfield Networks

- Features of a Hopfield Network:
  - Distributed representation
  - A memory is stored as a pattern of activation across a set of processing elements.
  - Distributed, asynchronous control
  - Content-addressable memory
  - A number of patterns can be stored in a network. To retrieve a pattern, a specific portion of it is specified and the network automatically finds the closest match.
  - Fault tolerance: If a few processing elements misbehave or fail completely, the network will still function properly.
  - Each processing element makes decisions based only on its own local situation.

Simple Hopfield Networks



Black → active

White → inactive

Hopfield Networks

- Processing elements or units are always in one of two states, active or inactive.
- Units are connected to each other with weighted symmetric connection a positive weighted connection indicates that the two units tend to activate each other.
- A negative weighted connection allows an active unit to deactivate a neighboring unit.

Supervised and Unsupervised Learning

Applications of neural networks

Recurrent Networks

- Recurrent Networks are used in temporal AI task such as planning, natural language processing, etc…
- A recurrent neural network (RNN) is a class of neural network where connections between units form a directed cycle.
- This creates an internal state of the network which allows it to exhibit dynamic temporal behavior.
- Unlike feed-forward neural networks, RNNs can use their internal memory to process arbitrary sequences of inputs.

Recurrent Networks

- This makes them applicable to tasks such as un-segmented connected handwriting recognition, where they have achieved the best known results.
- This is the basic architecture developed in the 1980s: a network of neuron-like units, each with a directed connection to every other unit.
- Each unit has a time-varying real-valued activation. Each connection has a modifiable real- valued weight. Some of the nodes are called input nodes, some output nodes, the rest hidden nodes.

Connectionist AI and Symbolic AI

- Different architectures make different assumptions about the content they will process and about the types of problems they will solve.
- Connectionism applied very successfully to classification problems and low-level processing. Strengths include integrity in face of uncertain and incorrect data, and a natural gradation in match.

Connectionist AI and Symbolic AI

- But they require large amounts of training data and the knowledge in the final net which is usually opaque.
- Symbolic systems have largely complementary strengths/weaknesses.
- Human-like cognition probably requires both.

Connectionist

- Search : parallel relaxation
- Knowledge Representation: very large number of real-valued connection strengths. Structure often stored as distributed patterns of activation.
- Learning : Back-propagation, Boltzmann machines, reinforcement learning, unsupervised learning

Symbolic

- Search: state space traversal.
- Knowledge Representation: Predicate logic, semantic networks, frames, scripts.
- Learning: Macro-operators, version spaces, explanation-based learning, discovery.

End of Unit - 13