PHIL/PSYCH 256
INTRODUCTION TO COGNITIVE SCIENCE
Week 7: Connections

PLEASE PUT AWAY ALL ELECTRONIC DEVICES

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Connectionism: Representation

Representation: simple units (like neurons) with activations (firing rates) and links to other nodes (excitatory and inhibitory)

Procedures: activation of a node is affected by the activation of all nodes to which it is linked and the strength (weight) of the link

Also known as:

ANN: artificial neural networks

PDP: parallel distributed processing

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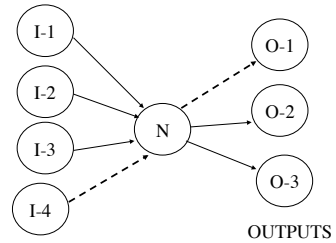
Connectionism: Representation



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Representation

- Local representation: each unit (neuron) stands for one concept, statement, or other representation.
- Distributed representation: many interacting units together needed to capture a concept or statement.
- Problem solving is constraint satisfaction.
  - Positive constraints: go together. Excite.
  - Negative constraints: don't go together. Inhibit.
- Limitations: hard to represent relations.

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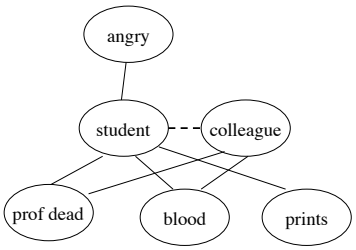
Example: Explanation



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Discussion Questions

- Is decision making a constraint satisfaction problem?
- Can you represent a decision you are facing as a connectionist network?

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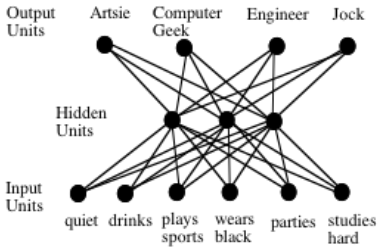
Distributed Representation



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Computational Power

- Problem solving as parallel constraint satisfaction.
  - Decision making and explanation.
- Learning by backpropagation (supervised) or by Hebbian (unsupervised).
- Integration of representation and learning.
- Limitations: sequential problem solving.

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Key Points

- Connectionism uses simple neuron-like representations and parallel processing.
- Constraint satisfaction problems can be modeled well by connectionist networks.

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Psychological Power

- Applications to language learning (past tenses), disambiguation.
- Applications to analogy, stereotypes.
- Applications to word recognition, reading, semantic cognition.
- Limitations: learning is slow; tendency to inflexibility; rules may be needed.

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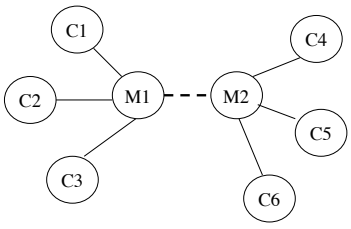
Disambiguation



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Language: Rules vs. connectionism

	Rules	Connectionism
Representations	Symbolic: if-then	Simple neurons, links
Processes	Serial inference	Parallel constraint satisfaction
Acquisition	Much innateness	Mostly learned

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Neurological Plausibility

- Pro: somewhat similar to brain networks
- Differences:
  - Brain has more neurons, connections
  - Chemical as well as electrical transmission
  - Brain is organized into areas (modules)
  - Need firing patterns, synchrony
  - Backpropagation is biologically implausible
    - Supervisor
    - Backward connections

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Discussion Question

- What computational approach gives a better account of language use and learning: rules or connectionism?

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Rumelhart

- Parallel algorithms can solve problems like the brain does: pattern matching, graceful degradation.
- Parallel constraint satisfaction.
- Learning algorithms, e.g. backpropagation.

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Key points

- Connectionism has many psychological applications, but also limitations.
- Connectionism is not as neurologically plausible as it at first seems.

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