

Cognitive Psychology

## Learning the English past tense

### Connectionism and Neural Networks

Lesson VII: Language  
module 34



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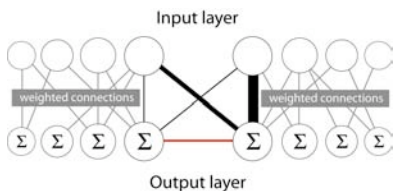
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Cognitive Psychology

### Connectionist models

#### Parallel distributed processing (PDP)

- Motivated by neural information processing
  - Huge # of "simple" information processing units
  - Information processing by activation flow between units and integration of activation within units
  - Units can be active (above threshold) or inactive



Input layer

Output layer

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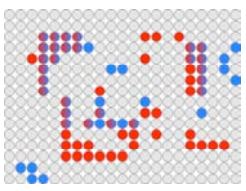
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Cognitive Psychology

### Distributed representation

- Representation of concepts
  - Unlike traditional semantic network models, one unit doesn't represent a concept by itself
  - Representations are distributed across many units (activation patterns within the network)
  - Allows for subtle, "sub-symbolic" interactions and fuzzy representations



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**Cognitive Psychology** Learning in connectionist models

- **Learning by statistical association**
  - Units that are active at similar times will tend to strengthen their connections between each other
  - Units that are not correlated in their activity will decrease their connections
- **Teaching**
  - In many models, a network of units will be given an input activation pattern and a target output pattern
  - Changes in connection weights depend on how different the current activation is from target value
  - Effects can be back-propagated (passed on) to other units

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**Cognitive Psychology** Learning of English past tense

- **Phenomenon**
  - Children first learn correct forms of past tense of irregular verbs
  - Later children overgeneralize the rule "-[e]d" and make mistakes for irregular verbs (taked, tooked)
  - At the end, past tense for irregular verbs will return to correct forms
- **Rumelhart & McClelland's (1986) model**
  - Connectionist network representing the phonological representations of present and past tense verbs as input and output "layers"
  - Training of the model with verbs at frequencies of normal occurrence of these verbs in language

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**Cognitive Psychology** Rumelhart & McClelland's (1986) connectionist model of past tense learning

Phonemes Present tense: t, p, ai, ^, sh

Hidden Units: (represented by circles)

Phonemes Past tense: ^, sh, t, ai, d

Input: "tie"      Output: "tied"

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Cognitive Psychology Learning of English past tense

- One problem with phonology

tease...tease d  
please...please d  
freeze...froze  
squeeze...squeeze d

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Cognitive Psychology Interesting aspects of the model

- Single route model
  - The model doesn't assume that there are separate processes for regular and irregular verbs
  - Traditional models assume that children have to memorize irregular forms and separately learn the general rules
- Model behavior
  - Shows qualitatively similar behavior as children's learning curves
  - Shows examples of overgeneralization in the middle of the learning process
  - Returns to almost perfect behavior after a large number of learning episodes

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