Neural learning

PSY 200

Greg Francis

Lecture 08

A problem with virtual reality.

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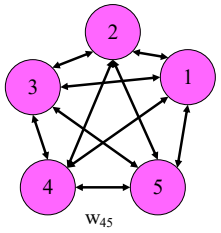
Networks

- As we saw last time, a network of neurons can have very complicated behavior
- The behavior depends on the *connections* between cells
- How do those connections get established?



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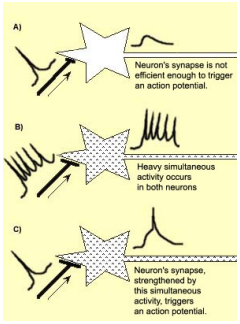
Hebb's rule

- If two neurons are active simultaneously, then they strengthen the connection between them
- Signals from the *environment* change the properties of the network



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A "simple" model

- A cell's activation is *on* or *off* (one or zero)
- Cell connections (weights) are reciprocal
- Cells update activations one at a time
- Cell activations are calculated with the rule

$$a_i = \begin{cases} 1 \text{ if } \sum w_{ij} a_j > 0 \\ 0 \text{ if } \sum w_{ij} a_j \le 0 \end{cases}$$

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Simplified learning

- Initially, all connections are zero
  - $w_{ij} = 0$
- Hebb's rule
  - cells that are simultaneously active develop *positive* weights (excitation)
  - an active cell develops *negative* weights with inactive cells (inhibition)
- Demonstration

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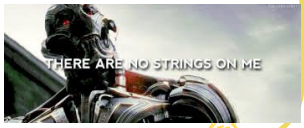
Self-organization

- A network of this type does not need an intelligence to set the connection weights
- The network self-organizes in response to stimulation
- It can *remember* things it has previously experienced
- It can interpret new information on the basis of things it has previously learned



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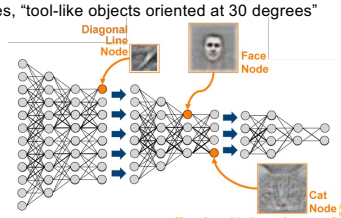
Deep learning

- Google used one version of a neural network to analyze 10 million YouTube stills
  - 1000 computers (16,000 cpu's) over 3 days
- The network self-organized to identify common patterns
  - Cats, faces, "tool-like objects oriented at 30 degrees"



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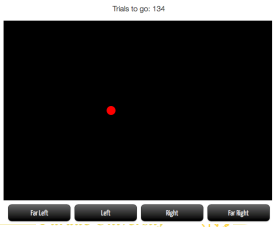
Learning

- This may *not* be the same type of learning you do when you study for school
  - but it is important just the same
- Consider implicit learning
  - A long sequence of trials, where you press a key to indicate the appearance of a dot at a corresponding location



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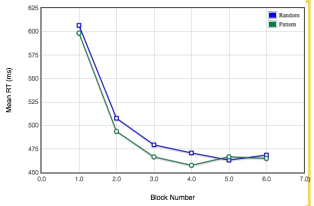
Implicit Learning

Class data (~80 in each group)

Global data (~13,000 in each group)

- We are interested in how fast you respond to the dot
- Two groups of subjects:
  - Random: each sequence is random
  - Pattern: each sequence is the same (but so long that people typically do not notice)
- Subjects in the pattern condition are faster (they have partly learned the sequence, and generate faster responses to expected locations)



- More generally, networks in your brain can learn information about your environment without you being aware that something is being learned

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Learning

- Lots of learning happens that you do not notice
- Consider the length of your arm
  - to catch and throw objects your brain must know exactly your arm's length
  - but the length of your arm changes as you age!
    - » And depends on unknown environmental factors

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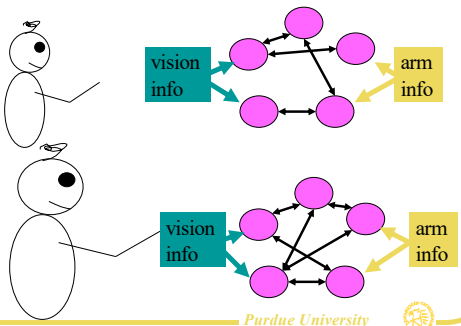
Hand-eye coordination



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Coordination and learning

- We do not know the exact nature of the network involved in this coordination
  - but we know it continually modifies part of itself to match up with the current situation
- This is actually a good design feature, because the brain cannot know in advance every detail of the eye-hand system

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Virtual reality

- Using computer graphics to convince the body it is someplace other than it really is
- Useful for
  - architects, designers
  - surgeons, pilots
  - entertainment

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Cameras

- Enhance visual perception
- Night vision for helicopter pilots

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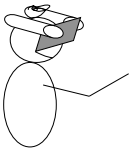
Cameras

- Enhance visual perception
  - MRI overlaid on actual image of brain for surgeon
    - » highlight tumor
  - Avoid other brain regions
    - » faster



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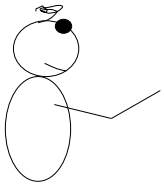
Problem

- The network coordinating eye-hand systems, adjusts itself
- Extended use of the computer cameras makes the user adapt so his eyes are where the cameras are!



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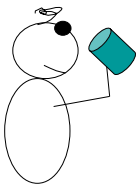
Problem

- After taking the cameras off, it takes some time to adapt back
- Eye-hand coordination is off
- Could be a problem for surgeons and pilots!



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Other adaptations

- Inverted prisms
- Fortunately, the adaptations return to normal pretty quickly
- Kind of like the feeling you get after roller-skating

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Conclusions

- Learning in neural networks
  - changing connections
  - relatively simple rules
- Much of our perceptual and motor behavior is based upon this type of continuous learning
- It's not clear if more cognitive learning is similar

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Next time

- Review for Exam 1
- Then
- Neural networks for visual perception
  - brightness
  - color
  - form
- *Why we see color afterimages.*

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