15-486/782:
Artificial Neural Networks

Fall 2006

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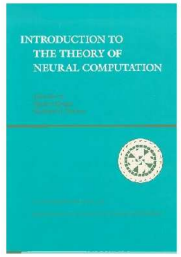
Course Info

Time: Mon/Wed 3:00 to 4:20

Place: WeH 5409 (but first two weeks in WeH 4623)

Credit: 12 units

Textbook: *Introduction to the Theory of Neural Computation,* by Hertz, Krogh, and Palmer.



Other readings will be made available online.

Web: /afs/cs/academic/class/15782-f06

Grading

For 15-486:

Homeworks, midterm, and final exam each contribute 33% of your course grade.

For 15-782:

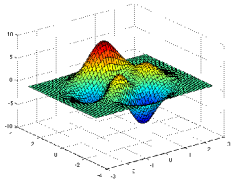
Homeworks, midterm, final exam, and project each contribute 25% of your course grade.

Cheating/Plagiarism

- If you have trouble understanding something, you can of course discuss the material with your classmates, as well as the TA and the instructor.
- But work you turn in with your name on it must have been done by you.
- If you use code or equations from someone else, and you disclose this, you may not get full credit, but you cannot be accused of cheating. Good advice throughout your career: always acknowledge your sources.

MATLAB

You need to learn MATLAB. It's fun!



Type "matlab" on Andrew to run it.
"peaks" will display this graph;
"help peaks" will tell you about it

Student Version of MATLAB: available for Windows/Linux/Mac for $99.
Purchase from mathworks.com or CMU bookstore.

Tutorials are available online:
see the class homepage.

Varieties of "Neural Network" Research

1) Neuronal Modeling
2) Computational Neuroscience
3) Connectionist (PDP) Models
4) Artificial Neural Networks (ANNs)

Some investigators work in more than one area.

Courses in all four areas are available at CMU or Pitt.

1: Neuronal Modeling

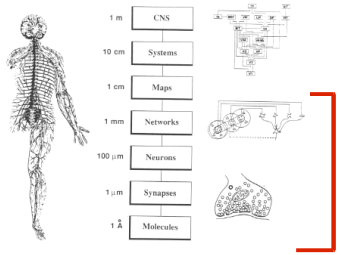
Understand the operation of single neurons or small neural circuits.

Detailed biophysical models of nerve cells (receptors, ion channels, membrane voltage), and collections of cells.

Journal of Computational Neuroscience

CNS conference; CoSyNe meeting

Comp. neuro. course at Pitt (Bard Ermentrout, Math Dept.)



Churchland & Sejnowski 1988

2: Computational Neuroscience

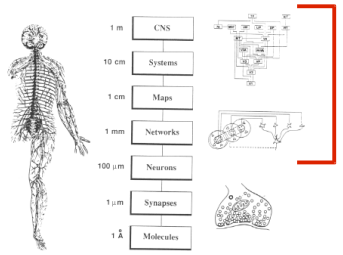
Modeling information processing in real brains.

The models refer to specific anatomical structures (e.g., hippocampus, cortex, cerebellum), but their operation may be abstract.

Many journals, including J. Neurosci; Network; Neural Computation, and Hippocampus.

CNS and CoSyNe meetings.

15-883: Computational Models of Neural Systems (Touretzky)



Churchland & Sejnowski 1988

3: Connectionist (PDP) Modeling

Parallel **D**istributed **P**rocessing

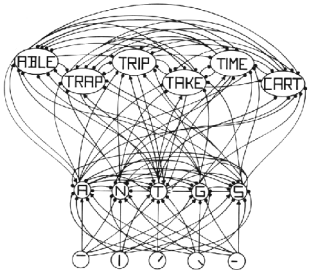
Model human cognition in a brain-like way:

Massively parallel constraint satisfaction.

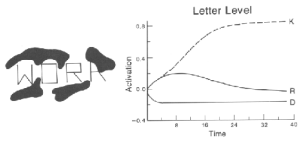
Distributed activity patterns instead of symbols.

Models are fairly abstract.

Cog Sci./Psych journals
PDP models course



McClelland & Rumelhart 1981



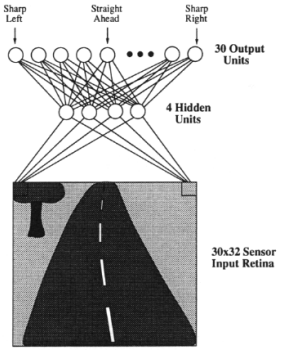
4: Artificial Neural Nets

Simple, abstract, "neuron-like" computing elements; local computation.

Pattern recognition, adaptive control, time series prediction.

This is where the money gets made.

Neural Computation; Neural Networks.
NIPS conference.
15-782 (this course).



Pomerleau 1993: ALVINN

It Began With McCulloch & Pitts

W. S. McCulloch and W. Pitts (1943) Logical calculus of the ideas immanent in nervous activity. Philosophy of Science 10(1), 18-24.

Warren McCulloch

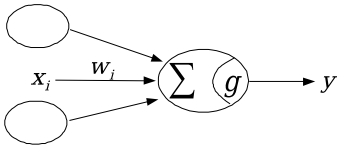
Walter Pitts

Revolutionary idea: think of neural tissue as circuitry performing mathematical computations.

The McCulloch-Pitts Neuron

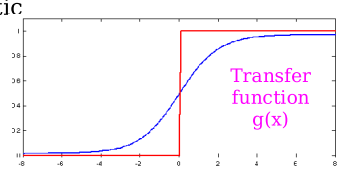
- Linear weighted sum of inputs:

$$netact = \sum_i w_i x_i = \vec{w} \cdot \vec{x}$$



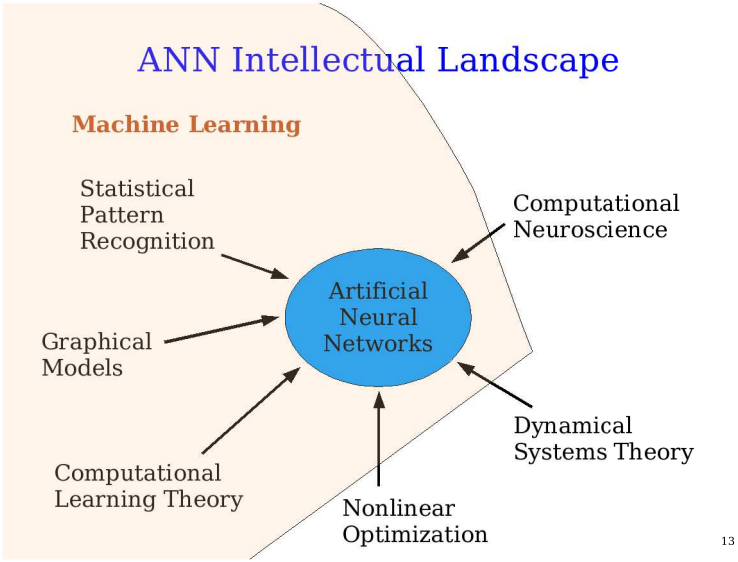
- Nonlinear, possibly stochastic transfer function:

$$y = g(netact)$$



- Learning rule:

$$\Delta w_i = \ldots$$



Organization of this Course

- Survey of neural net architectures: perceptrons, backprop nets, Kohonen, Hopfield, Boltzmann, etc.
- Sample applications: robot control, speech recognition, connectionist symbol processing.
- Hands-on experience: MATLAB demos and programming assignments.
- Biological basis of neural nets.
- Midterm and final exams. Project for 15-782.

What You Should Do Today

- Hand in your student survey questionnaire.
- Read chapter 1 of HK&P (Hertz, Krogh, & Palmer).
- Start learning MATLAB.
  - Type “demo” for a list of demos, and scroll down to the “Graphics” section. Play around a bit.
- Get started on Wednesday's reading.