Psychology 617 (Spring 2004)

Neural Network Models in Psychology

Time: Tuesday and Thursday 8:30 - 10:18 am

Place: 250 TO (Townshend Hall)

Instructor: Jay Myung, 240B Lazenby, 2-1862, myung.1@osu.edu,
Office hours: Monday & Wednesday at 11- noon

Description

This is an introductory course on connectionist (neural network) models in psychology, with focus on the theoretical foundations of neural network modeling. The course is intended for the students who have no prior experience with connectionist modeling and will emphasize mathematical properties of various connectionist models. Topics to be covered include: perception, linear associator, backpropagation networks, Hopfield net, Kohonen's maps, Grossberg's ART, and oscillatory networks. Some examples of connectionist models in categorization, priming, visual perception, and language will be discussed.

Prerequisites

- Psychology 321 and 608; or graduate standing; or permission of instructor

Texts and Websites

1. (Required textbook) J. A. Anderson (1995). *An Introduction to Neural Networks*. MIT Press.

2. (Optional book): P. Quinlan (1991). *Connectionism and Psychology*. University of Chicago Press. Non-technical, introductory level, written fro cognitive psychologists.

3. (Optional book): S. Haykin (1999). *Neural Networks: A Comprehensive Foundation* (2nd edition). Prentice Hall. Technically rigorous, comprehensive theory, written for engineers.

4. (Optional book): J. Hertz, A. Krogh, & R. G. Palmer (1991). *Introduction to the Theory of Neural Computation*. Addison Wesley. Best theory book written by physicists.

5. (Optional book): C M Bishop. (1995). *Neural Networks for Pattern Recognition*. Oxford University Press. Written from the machine learning standpoint for computer scientists.

6. (Optional book): M. A. Arbib (1998, ed.). *The Handbook of Brain Theory and Neural Networks*. MIT Press.

7. (Optional book): P. S. Churchland & T. J. Sejnowski (1992). *The Computational Brain*. MIT Press. Computational neuroscience book.

8. (USC Courseweb): CS542: Neural Computation with Artificial Neural Networks.
(http://www-clmc.usc.edu/courses/CS542).
9. (On-line course in neural nets): Neural Nets by Kevin Gurney
(http://www.shef.ac.uk/psychology/gurney/notes/index.html)

Evaluation

Students will be evaluated based on one exam, five homework assignments, one class presentation, and class participation in discussion.

Homework (five)	50%
Midterm exam (Thu, May 20)	30%
Class paper presentation*	10%
Class participation of discussion	10%

To get an A or A-, your total percentage must be at least 80%.

(*: 30-min presentation of a summary of the paper in discussion)

Course Schedule

Week 1 (Mar 30, Apr 1):

Tue: Introduction: "Brain as a Computing Machine"

Example of neural network modeling: I J Myung, C Kim & W B Levy (1997). Context-dependent recognition in a self-organizing recurrent network. In M G Shafto & P Langley (eds.), *Proceedings of the 19th Annual Conference of the Cognitive Science Society*, pp. 530-535.

Thu: Single neuron computation, Chs. 1 & 2

Demonstration of neural network software

Take-home reading: P K Simpson (1990). History of artificial neural systems. In P K Simpson, *Artificial Neural Systems: Foundations, Paradigms, Applications, and Implementations*, pp. 137-145. Pergamon Press.

Take-home reading: M. A. Arbib (1987). Learning Networks. In M A Arbib, *Brains, Machines and Mathematics* (2nd edition), chap 5 (pp. 90-120). Springer-Verlag.

Week 2 (Apr 6, 8):

Tue: Linear associator network, Chs. 6, 7

Review of vector and matrix algebra

Take-home reading: N H Donegan, M A Gluck & R F Thompson (1989). Integrating behavioral and biological models of classical conditioning. In R D hawkins & G H Bower (eds.), *Computational Models of Learning in Simple Neural Systems*, chap. 5 (pp. 109-156).

Thu: Perceptron, Ch. 8

Take-home Reading: M Minsky & S. Papert (1969). *Perceptron*, pp. 1- 20. MIT Press.

Week 3 (Apr 13, 15):

Tue: **HW#1 due**

Backpropagation network, Ch. 9

Take-home Reading: T J Sejnowski & C R Rosenberg (1986). NETtalk: A parallel network that learns to read aloud. *Johns Hopkins University Electrical Engineering and Computer Science Technical Report* JHU/EECS-86/01.

Take-home Reading: F Crick (1989). The recent excitement about neural networks. *Nature, 337*, 129-132.

Thu: **Discussion Paper 1**: M A Gluck & G H Bower (1988). From conditioning to category learning: An adaptive network model. *Journal of Experimental Psychology: General, 117*, 227-247.

Week 4 (Apr 20, 22):

Tue: **HW#2 due**

Model evaluation and model selection in connectionist modeling

Take-home reading: I J Myung & M A Pitt (2003). Model fitting. In L Nadel (ed.), *Encyclopedia of Cognitive Science, Vol 3*, pp. 47-51.

Thu: **Discussion Paper 2**: J L Elman (1999). Finding structure in time. *Cognitive Science, 14*, 179-211.

Week 5 (Apr 27, 29):

Tue: **HW#3 due**

Reinforcement learning network, Ch. 9

Thu: **Discussion Paper 3**: M A Gluck, M Meeter & C E Myers (2003). Computational models of the hippocampal region: linking incremental learning and episodic memory. *Trends in Cognitive Sciences, 7*, 269-276.

Week 6 (May 4, 6):

Tue: Hopfield network, Ch. 12

Take-home Reading: J J Hopfield & D W Tank (1985). "Neural" computation of decisions in optimization problems. *Biological Cybernetics, 52*, 141-152.

Thu: **Discussion Paper 4**: A G Barto & R S Sutton (1981). Landmark learning: An illustration of associative search. *Biological Cybernetics, 42*, 1-8.

Week 7 (May 11, 13):

Tue: **HW#4 due**

Kohonen's feature maps, Ch. 14

Thu: Grossberg's ART network

Take-home Reading: G A Carpenter & S Grossberg (1992). A self-organizing neural network for supervised learning, recognition and prediction. *IEEE Communications Magazine, 30*, 000-000.

Week 8 (May 18, 20):

Tue: **Discussion Paper 5**: R. Miikkulainen (1997). Dyslexic and category-specific aphasic impairments in a self-organizing feature map models of the lexicon. *Brain and Language, 59*, 334-366.

Thu: **Midterm Exam** (May 20, Thu at 8:30 - 10:18)

Week 9 (May 25, 27):

Tue: **HW#5 due**

Neural oscillators and perception

Take-home Reading: W Singer et al (1997). Neuronal assemblies: Necessity, signature and detectability. *Trends in Cognitive Science, 1*, 252-260.

Thu: **Discussion Paper 6**: G Laurent & H Davidowitz (1994). Encoding of olfactory information with oscillating neural assemblies, *Science, 265*, 1872-1875.

Week 10 (Jun 1, 3):

Tue: Neural networks as statistical models

Discussion paper 7: B Cheng & D M Titterington (1994). Neural networks: A review from a statistical perspective. *Statistical Science, 9*, 2-54.

Thu: Neural networks as theories of mind

Discussion Paper 8: M McCloskey (1991). Networks and theories: The place of connectionism in cognitive science. *Psychological Science, 2*, 387-395.