CS263B Connectionist NLP **Syllabus** **Spring 09**

(Note: URLs here usually do *not* refer to the specific paper mentioned in this syllabus but rather to multiple related papers by author and/or co-authors.)

WEEK 1. COURSE OVERVIEW AND INTRO.

Overview of Symbolic NLP vs. Conn NLP and Intro. to ANNs

Anderson, J. A. (1995). *An Introduction to Neural Networks*. Bradford Book/MIT Press, Cambridge, MA. **[INN]** http://www.cog.brown.edu/~anderson/

Early Localist Connectionist Networks for NLP

Cottrell, G. W. and Small, S. L. (1983). A Connectionist Scheme for Modelling Word Sense Disambiguation. *Cognition and Brain Theory*, **1:** 189-120.
http://www1.elsevier.com/homepage/sal/ampersand/issue5/small.pdf

Waltz, D. and Pollack, J. (1985). Massively Parallel Parsing: A Strongly Interactive Model of Natural Language Interpretation. *Cognitive Science*, **9:** 51-74.
http://www.cs.brandeis.edu/~pollack/publications.html

WEEK 2. EARLY PDP NETWORKS FOR NLP

Feedforward PDP Networks for NLP

Rumelhart, D. E. and McClelland, J. L. (1986). On learning the past tenses of English verbs. In **[PDP, Vol. 1]** http://cognet.mit.edu/library/books/view?isbn=026268053X

McClelland, J. and Kawamoto, A. (1986). Mechanisms of Sentence Processing: Assigning Roles to Constituents in Sentences. In **[PDP, Vol. 2]**
http://psychology.stanford.edu/~jlm/

Critiques of Early PDP Networks

Fodor, J. A. and Pylyshyn, Z. W. (1988). Connectionism and cognitive architecture: A critical analysis. In S. Pinker and J. Mehler (eds.), *Connections and Symbols*. Bradford Book/MIT Press, Cambridge, MA. 3-71, **[C&S].** (Reprint of *Cognition*, Vol. 28, 1988).
http://www.isrl.uiuc.edu/~amag/langev/cited2/fodorpylysnnectionismandcalanalysis.html

Pinker, S. and Prince, A. (1988). On language and connectionism: Analysis of a parallel distributed processing model of language acquisition. 74-193. In **[C&S]**.
http://www.ecs.soton.ac.uk/~harnad/Papers/Py104/pinker.conn.html

Lachter, J. and Bever, T. (1988). The relation between linguistic structure and associative theories of language learning – A constructive critique of some connectionist models. 195-247. In **[C&S]** http://www.u.arizona.edu/~lachter/research.html

Localist vs. PDP Approaches

Feldman, J. A. (1989). Neural Representation of Conceptual Knowledge. In Nadel, Cooper, Culicover and Harnish (eds.). *Neural Connections, Mental Computation*. MIT Press. **[NCMC]** http://www.eecs.berkeley.edu/Faculty/Homepages/feldman.html

Smolensky, P. (1988). On the proper treatment of connectionism. *Behavioral and Brain Sciences*. Vol. 11, 1-23. (Open peer commentary: pp. 23-74)
http://www.cog.jhu.edu/faculty/smolensky/

WEEK 3. DISTRIBUTED CONNECTIONIST PRODUCTION SYSTEMS

Coarse Coded Systems

Touretzky, D. S. and G. E. Hinton (1988) A Distributed Connectionist Production System, *Cognitive Science* 12(3), 423-466. See also **[C&M]**
http://www.cs.toronto.edu/~hinton/chronological.html

Touretzky, D. S. (1990) BoltzCONS: Dynamic symbol structures in a connectionist network. *Artificial Intelligence*, Vol. 46, Nos. 1&2, pp. 5-46. Also in Hinton, G. (ed.) (1990). *Connectionist Symbol Processing*. MIT / Elsevier **[CSP]**.
http://www-2.cs.cmu.edu/~dst/

Tensor Product Systems

Dolan, C. P. and Smolensky, P. (1989), Tensor Product Production System, *Connection Science*, **1:** 53-68. http://www.cog.jhu.edu/faculty/smolensky/

Smolensky, P. (1990). Tensor Product Variable Binding and the Representation of Symbolic Structures in Connectionist Systems. *Artificial Intelligence* 46, 159-216. In **[CSP]**
http://www.cog.jhu.edu/faculty/smolensky/

Dolan, C. P. (1989). *Tensor Manipulation Networks: Connectionist and Symbolic Approaches to Comprehension, Learning, and Planning*. Ph.D. Dissertation. Computer Science Dept., UCLA.

WEEK 4. SIMPLE RECURRENT NETWORKS (SRNs) & MORE PDP ISSUES

SRNs

Elman, J. L. (1990) Finding Structure in Time. *Cognitive Science*, 14(2), 179-211.
http://crl.ucsd.edu/~elman/

St. John, M. and McClelland, J. (1990). Learning and Applying Contextual Constraints in Sentence Comprehension. *Artificial Intelligence*, vol. 46, 217-257. Also in **[CSP]**
http://psychology.stanford.edu/~jlm/

St. John, M. & McClelland, J. (1992). Parallel Constraint Satisfaction as a Comprehension Model. In R. Reilly and N. Sharkey (eds.) (1992). *Connectionist Approaches to Natural Language Processing*. Lawrence Erlbaum Assoc. **[CANLP]**

Distrib. Reps., Modularity & Computational Power of PDP Networks

van Gelder, T. (1992), Defining 'Distributed Representation', *Connection Science*, **4:** 171-191. http://www.arts.unimelb.edu.au/~tgelder/Publications.html

Hadley, R. F. (2003), A defence of functional modularity, *Connection Science*, **15**: 95-116. http://www.cs.sfu.ca/~hadley/

Hadley, R. F. (2000), Cognition and the computational power of connectionist networks, *Connection Science*, **12:** 95-110. http://www.cs.sfu.ca/~hadley/

Marcus, G. (1998). Rethinking Eliminative Connectionism. *Cognitive Psychology*, Vol. 37, pp. 243-282. http://www.psych.nyu.edu/gary/marcus_pubs.html

Catastrophic Forgetting and Knowledge Transfer

Ans, B. and Rousset, S. (2000), Neural networks with a self-refreshing memory: knowledge transfer in sequential learning tasks without catastrophic forgetting, *Connection Science*, **12:** 1-19.

Ans, B., Rousset, S., French, R. M. Musca, S. (2004), Self-refreshing memory in artificial neural networks: learning temporal sequences without catastrophic forgetting. *Connection Science*, **16:** 71-99. http://www.u-bourgogne.fr/LEAD/people/rfrench.html

More on Biological Neurons

Wiskott, ., Rasch, M. J. and Kempermann, G. (2004), What is the functional role of adult neurogenesis in the hippocampus? *Cognitive Science Eprint Archive (CogPrints)* 4012. http://cogprints.org/4012/

Fields, R. D. (2005), Making Memories Stick, *Scientific American*, **292:** 75-81. http://neuroscience.nih.gov/Lab.asp?Org_ID=274

Rule Extraction from ANNs

Andrews, R., Diederich, J., Tickle, A. B. (1995), Survey and critique of techniques for extracting rules from trained artificial neural networks, *Knowledge-Based Systems*, **8:** 373-389. http://www.aus.edu/engr/cmp/people/Dr.%20Joachim%20Diederich.php

WEEK 5. LOCALIST/STRUCTURED ANNS AND DYNAMIC BINDINGS

Signatures for Dynamic Bindings, Disambiguation, Planning, and Memory

Lange, T. E. and Dyer, M. G. (1989) High-level Inferencing in a Connectionist Network. *Connection Science*, 1(2) 181-217.
http://www.informatik.uni-trier.de/~ley/db/indices/a-tree/l/Lange:Trent_E=.html

Lange, T. and Wharton, C. (1995). A Structured Connectionist Approach to Inferencing and Retrieval. In R. Sun and L. A. Bookman (eds.), Computational Architectures Integrating Neural and Symbolic Processes. Kluwer, MA. pp. 69-115. **[CAIN&SP]**

Sun, R. (1992). On Variable Binding in Connectionist Networks. *Connection Science*, vol. 4, no. 2. http://www.cogsci.rpi.edu/~rsun/

Sun, R. (1995). A Two-Level Hybrid Architecture for Structuring Knowledge for Commonsense Reasoning. In **[CAIN&SP]**. http://www.cogsci.rpi.edu/~rsun/

Phase Synchrony for Dynamic Bindings, Reasoning, and Retrieval

Bower, B. (1998). All Fired Up. *Science News*, Vol. 153, Feb. 21.
http://findarticles.com/p/articles/mi_m1200/is_n8_v153/ai_20396428

Shastri, L. and Ajjanagadde, V. (1993). From simple associations to systematic reasoning: a connectionist representation of rules, variables and dynamic binding using temporal synchrony. *Behavioral and Brain Sciences*, vol. 16, 417-451.
http://www.icsi.berkeley.edu/~shastri/bib4html.html

Shastri, L. (1999). Advances in SHRUTI – A Neurally Motivated Model of Relational Knowledge Representation and Rapid Inference Using Temporal Synchrony. *Applied Intelligence* 11, 79-108. http://www.icsi.berkeley.edu/~shastri/bib4html.html

Relative Position Encoding for Dynamic Bindings & Syllogistic Reasoning

Barnden, J. (1995). Complex Symbol-Processing in Conposit, A Transiently Localist Connectionist Architecture. In **[CAIN&SP]**
http://www.cs.bham.ac.uk/~jab/index.html#SELECTEDPUBS

Spiking Neurons and Chaotic Bindings

Sougne, J. P. (2001), Binding and multiple instantiation in a distributed network of spiking neurons, *Connection Science*, **13:** 99-126.
http://www.fapse.ulg.ac.be/web/myspace.php?id=u014144&lng=en&idser=UDI&q=publications

Raffone, A. and van Leeuwen, C. (2001), Activation and coherence in memory processes: revisiting the Parallel Distributed Processing approach to retrieval, *Connection Science*, **13:** 349-382.
http://pdl.brain.riken.go.jp/publications/published/Raffone__van_Leeuwen_Conn_Sci_2001.pdf

WEEK 6. MORE RECURRENT ANNs AND SOMs FOR NLP & Q/A

Story Understanding and Learning with SRNs and SOMs

Miikkulainen, R. and Dyer, M. G. (1991). Natural Language Processing with Modular PDP Networks and Distributed Lexicon. *Cognitive Science*, **15:** 343-399. http://www.cs.ucla.edu/~dyer/Papers/CogSci91Risto.pdf

Miikkulainen, R. (1993). *Subsymbolic Natural Language Processing: An Integrated Model of Scripts, Lexicon, and Memory*. MIT Press, Cambridge, MA. (see also UCLA CS Dept. Ph.D. Dissertation, 1990). http://nn.cs.utexas.edu/pub-list.php

WEEK 7. RECURSIVELY FORMED DISTRIBUTED REPRESENTATIONS

Recursive Autoassociative Memories (RAAMs)

Pollack, J. (1990). Recursive Distributed Representations. *Artificial Intelligence*, vol. 46, 77-105. Also in **[CSP]** http://www.cs.brandeis.edu/~pollack/publications.html

Chalmers, D. J. (1990). Syntactic Transformation on distributed representations. *Connection Science*, **2:** 53-62. http://consc.net/chalmers/

Chrisman, L. (1991). Learning Recursive Distributed Representations for Holistic Computation. *Connection Science*, **3:** 345-366. http://chrisman.org/Lonnie/publications.htm

Sentence & Story Processing

Lee, G., Flowers, M. and Dyer, M. G. (1992). Learning Distributed Representations of Conceptual Knowledge and their Application to Script-based Story Processing. In N. Sharkey (ed.) *Connectionist Natural Language Processing*. Intellect, Oxford, England. pp. 215-247. **[CNLP]** http://nlp.postech.ac.kr/~gblee/

Miikkulainen, R. (1995). Subsymbolic Parsing of Embedded Structures. In **[CAIN&SP]**. http://nn.cs.utexas.edu/pub-list.php

Dyer, M. G. and Lee, G. (1995). Goal/Plan Analysis via Distributed Semantic Representations in a Connectionist System. *Applied Intelligence*, Vol. 5, No.2. http://nlp.postech.ac.kr/~gblee/

E-RAAMS, L-RAAMs, B-RAAMs

Sperduti, A. (1994), Labelling Recursive Auto-associative Memory, *Connection Science*, Vol. 6, No. 4. http://www.math.unipd.it/~sperduti/interest.htm

Adamson, M. J., and Damper, R. I. (1999), B-RAAM: A Connectionist Model which Develops Holistic Internal Representations of Symbolic Structures, *Connection Science*, Vol. 11, No. 1. http://eprints.ecs.soton.ac.uk/380/

Niklasson, L. and Linaker, F. (2000), Distributed representations for extended syntactic transformation, *Connection Science*, **12:** 299-314

WEEK 8. MORE NEURAL ARCHITECTURES

Hebbian Competitive Networks (CALM/ART-Related)

Hadley, R. F., Rotaru-Varga, A., Arnold, D. V. and Cardei, V. C. (2001), Syntactic systematicity arising from semantic predictions in Hebbian-competitive network, *Connection Science*, **13:** 73-94 http://www.cs.sfu.ca/~hadley/

Phaf, R. H., den Dulk, P., Tijseeling, A. and Lebert, E. (2001), Novelty-dependent learning and topological mapping, *Connection Science*, **13:** 293-321. http://www.tijsseling.com/academic/download/calmmap.pdf

Cascade Correlation Networks

Shultz, t. R. and Rivest, F. (2001), Knowledge-based cascade-correlation: using knowledge to speed learning, *Connection Science*, **13:** 43-73. http://www-etud.iro.umontreal.ca/~rivestfr/wordpress/publications/

Propagation Filters and Parallel Distributed Semantic Networks

Sumida, R. A. and Dyer, M. G. (1992). Propagation Filters in PDS Networks for Sequencing and Ambiguity Resolution. In Moody, J. e., Hanson, S. J., Lippmann, R. P. (eds.) *Advances in Neural Information Processing Systems 4*, pp. 233-240. Morgan Kaufmann Publ. **[NIPS-4]** http://www.cs.ucla.edu/~dyer/Publications.html

Sumida, R. A. (1997). *Parallel Distributed Semantic Networks for Natural Language Processing*. Ph.D. Dissertation, Computer Science Dept., UCLA.

BackProp w/ Error from Self-Organizing Maps (SOMs)

Weijters, A., van den Bosch, A. and van den Herik, H. J. (1997), Behavioural Aspects of Combining Backpropagation Learning and Self-organizing Maps, *Connection Science*, **9**: 235-251. http://is.tm.tue.nl/staff/aweijters/

Neural Blackboard Architecture

van der Velde, F. and de Kamps, M. (2006). Neural blackboard achitectures of combinatorial structures in cognition. *Behavioral and Brain Sciences*. Vol. 29, pp 1-72. http://atknoll1.informatik.tu-muenchen.de:8080/tum6/publications/documents/Documents/1149257077.42/BBS2902lowres.pdf

WEEK 9. GROUNDING LANGUAGE ACQUISITION IN PERCEPTION/MOTION AND PROJECT & FAVORITE-PAPER PRESENTATIONS

Regier, T. (1992). *The Acquisition of Lexical Semantics for Spatial Terms: A Connectionist Model of Perceptual Categorization.* UC Berkeley CS Ph.D. TR-92-062.
http://ccp.uchicago.edu/~tpregier/projects.html

Nenov, V. I. and Dyer, M. G. (1993). Perceptually Grounded Language Learning: Part 1 -- A Neural Network Architecture for Robust Sequence Association. *Connection Science*, **5:** 115-138.

Nenov, V. I. and Dyer, M. G. (1994). Perceptually Grounded Language Learning: Part 2 -- DETE: A Neural/Procedural Model. *Connection Science*, **6:** 3-41.

WEEK 10. PROJECT & FAVORITE-PAPER PRESENTATIONS

Students give 15 min. oral presentations on project & Favorite Paper

COURSE GRADE:

15%: Class Participation, Favorite Paper Review, Project Presentation
85%: Term Project/Paper

Class Participation = attend lectures

Favorite Paper Review -- written 2-page summary/review of a "favorite" paper NOT covered in syllabus. This review is emailed to instructor (as MS Word or pdf file) and summarizes key content of favorite paper with reasons why is your favorite paper.

Project Presentation – approx. 10 min. oral presentation to class on your project (example I/O, architecture, issues, current status)

Term Project/Paper – maximum: 10 single-spaced pages + appendix (no limit on appendix length). Term paper covers (not necessarily in this order):

- general I/O of system;
- examples of specific I/O
- architecture
- methodology, approach, claims, goals
- issues/problems/how addressed
- training data (if any)
- performance and evaluation
- status: what works/doesn't
- if team of two, then also who did what

Appendix should contain:

- selected main code (documented)
- selected edited execution traces
- implementation details (programming language, software packages…)
- anything else you want to include

Email term-project/paper as MS Word or pdf file (with separate appendix containing: main (documented) code, selected execution traces, etc.)

If project is done by team of 2 then include a section in that paper describing who contributed what parts (of paper, coding, debugging).