COMP9444: Neural Networks Course Introduction

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Course Introduction

Assumed knowledge: COMP9024 Data Structures and Algorithms *or* COMP2011 Data Organization

Topics chosen from: Network architectures: perceptrons, Hopfield and Kohonen nets, ART models, back-propagation trained feed-forward networks, recurrent nets, weightless nets. Computational complexity analysis of training neural network architectures. Probabilistic analysis of generalisation capabilities of feed-forward networks. Hardware based neural nets. Introduction to fuzzy logic, neurotrained nets; designing successful applications of neural networks; tensor product networks; and recent developments in neural networks. The assessment will include assignments related to using neural nets.

Lecturer-in-charge: Dr W.H. Wilson
Lecturer: Dr A. Hoffmann

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Other COMP courses

Lecture Plan

Lectures: Thursday 6-9pm; room: Civil Engineering 101
Schedule: (the order and content shown below may vary - this is an indication only). Lecture notes for each week will be available when a link appears in the column, below, labelled **Notes**.

Week	Date	Lecturer	Topic	Notes	Assignment Out
1	29 Jul	Achim	Introduction and brain physiology	-	
2	5 Aug	Achim	Perceptrons	-	
3	12 Aug	Achim	Multi-layer perceptrons	-	Backprop
4	19 Aug	Achim	Support vector machines 1	-	
5	26 Aug	Achim	Support vector machines 2	-	?
6	2 Sep	Achim	Committee machines 1	-	
7	9 Sep	Achim	Committee machines 2	-	
8	16 Sep	Bill	Recurrent networks 1	-	
9	23 Sep	Bill	Recurrent networks 2/Boltzmann machine	-	Recurrent networks
Break	30 Sep	-	-	-	
10	7 Oct	Bill	Tensor product networks	-	
11	14 Oct	Bill	Self-organising systems	-	Kohonen nets
12	21 Oct	Bill	Simulated annealing	-	
13	28 Oct	Bill	Neurodynamics - Hopfield nets	-	
14	4 Nov	Both	Revision	-	

Lecture Notes

You are advised not to print these until shortly before the appropriate lecture, as they may be updated between now and the lecture.

- Brain Physiology (week 1/2)
- Intro to Perceptrons (week 2/3)
- Intro to Support Vector Machines (Reading material is chapter 6 in textbook.)
- Intro to Learning Theory (These notes are selected from slides for the textbook by Tom Mitchell: Machine Learning,

McGraw-Hill 1997). As a consequence, the page numbers are not consecutive. The notes compliment the material in your textbook.
- Committee Machines (ps format) (Reading material is chapter 7 in textbook.)
- Committee Machines (cont'd) (ps format) (Reading material is chapter 7 in textbook.)
- Computational Limitations of Neural Network Architectures (pdf format)
- Do we need symbols for designing complex AI systems? (pdf format)

Lectures for weeks 7-13 (see table above for details) - again, these may not be up to date until shortly before the relevant lecture.

Updated:
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Not Yet Updated:

- Temporal Processing: Recurrent Nets 1 and 2 [pdf]
- Tensor Product Networks [pdf]
- Simulated Annealing / Boltzmann Machine [pdf]
- Self-organising systems 1 [pdf]
- Neurodynamics - Hopfield Nets [pdf]

Assessment

The assessment for this course will consist of:

- 3 hour final exam (70%)
- 4 programming assignments worth 30% in total.
  However, this component of your assessment will be based on your *best 3* assignment marks.
  It *is* acceptable to hand in only 3 assignments.
  Planned assignment due dates are weeks 6, 8, 11, and 14.
  Achim Hoffmann will be away from weeks 4 to 9, and unfortunately he may not be able to mark the first assignment until his return.

The best 3 assignment marks will be added together and scaled to give a class mark out of 100. The exam will also be marked out of 100. The class mark and final exam mark will be combined using the harmonic mean formula, weighting the exam as 70% (0.7) and the class mark as 30% (0.3):

```
final mark = class * exam/(class*0.7 + exam*0.3)
```

The effect of this formula is that uneven performances are penalised: getting 100% (30/30) for the assignments and 30% (21/70) for the exam would allow a pass if the marks were simply added together, but under the harmonic mean formula, it results in a final mark of 38%.

In fact, if you get 100% (30/30) for the assignments, you will need a mark of at least 41% to obtain a pass in this course. Details of the assignments are below.

Late submission of assignments: Assignments submitted late are subject to the following penalty: the maximum mark obtainable reduces by 10% per day late, up to a maximum of 50%. Thus if the assignment is marked out of 10, and students A and B hand in assignments worth 9 and 7, both two days late, then the maximum mark obtainable is 8, so A gets min(9, 8) = 8 and B gets min(7,8) = 7. Assignments handed in over a month late, or after (if) a solution has been released, will normally receive no marks.

Sample Exam Questions

- Questions on material (to be) taught by Bill Wilson
- (Space for Achim Hoffmann's Questions)

Text Book

Haykin, S. Neural Networks: a comprehensive foundation, 2nd edition. Prentice-Hall, 1999

Recommended Reference Books

On the role of neural networks and connectionism as framework for developing AI systems:

Hoffmann, A.G. Paradigms of Artificial Intelligence - A methodological and computational analysis, Springer-Verlag, 1998.

Journals and Conferences

Here are the names of some of the more prominent Neural Network journals and conferences (work in progress):

- J: Neural Networks
- J: IEEE Transactions on Neural Networks
- J: Neural Computation
- J: Connection Science
- C: NIPS (Neural Information Processing Systems)
- C: ICONIP (International Conference On Neural Information Processing
- C: for conferences organized by the International Neural Network Society, see here, under Announcements.

Some material on neural networks appears in more general journals and conferences. Places to look for the cognitive science end of NNs include:

- J: Behavioral and Brain Sciences
- J: Artificial Intelligence
- J: Cognitive Science

Software Availability

- Haykin's Matlab code
- Other Matlab code
- C code for Tensor Product Net operations (simplified version of STAR-1 system)
- tlearn user manual (about 40 pages) and Unix manual for tlearn (7 pages);
- tlearn home page from which you can download Mac and Windows versions, as well as source code for a Unix version (but see next dot-point);
- tlearn (not xtlearn) is available for pc.i86.linux machines, at `~cs9444/bin/tlearn`. The interface is via command-line arguments. `:-(`
- xtlearn is available for pc.i86.solaris machines, if you can find one, at `~cs9444/bin/xtlearn`. Note that the interface is a bit different from the Mac interface, on which the documentation is based. The Mac version has a built-in text editor, whereas in the Unix (X-windows) version, you need to use your own favorite text editor to create the `.cf`, `.data`, `.teach`, etc. files.

PLAGIARISM WARNING

Copying in assignments is unacceptable. Assignments will be checked. The penalties for copying range from receiving no marks for the assignment to receiving a mark of 00 FL for the course. Allowing someone to copy your work counts as plagiarism.

Assignments

Links to the assignment specification documents will appear below when each assignment is ready (or almost ready).

1. Assignment 1 (in ps) - on Multi-Layer Perceptron - due on 2 September 2004 in the class. (Here in pdf.)
2. Assignment 2
3. Assignment 3
4. Assignment 4

Testing your Program: Testing is an important part creating a correct program. Here are some tips on testing.

Dictionary

- The Machine Learning Dictionary for COMP9414

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