Background Reading for AI2 Module 1, Task 2

Chris Mellish,
Division of Informatics

October 1999

This document lists some sources of background reading on the material covered in the lectures of Module 1, Task 2. Unfortunately there is no single textbook that covers all this material. The examinable content of Module 1, Task 2, consists of the material covered in the lectures, tutorials and assigned work. In general, many of the sources listed below go into more detail than is needed to follow the examinable material, but they may provide useful clarification and alternative descriptions in some cases.

Luger and Stubblefield (LS) also contain a lot of useful material. I have referenced the 2nd edition here but the 3rd is currently on sale.

10 Search Spaces

The general nature of search problems, and a number of toy and real examples, is described in Russell and Norvig CH 3 and 4. Sparseness and fan-in/out are discussed in Stefik p149 and p199. Methods for dealing with cycles are described in Russell and Norvig. Russell and Norvig discuss local maxima and plateaux in connection with hill-climbing search. LS 36-40.

11 Search Algorithms

Search criteria are described well in Stefik pp153-156. Russell and Norvig deal with uninformed search strategies in section 3.5 and also compare their time and space complexities. They deal with informed search strategies in Chapter 4. A number of search strategies are also covered in the AI1 Planning and Search module. Some real-world search problems are described in Russell and Norvig CH3 and 4. LS Ch3, Ch 4.

12 Facts, Rules and the Propositional Calculus

The representation of simple facts and rules, as well as the search involved in backwards deduction, are covered in the AI1 Knowledge Representation and Inference module. Rus-

sell and Norvig describe logics in general, and propositional logic in particular, in Ch 7. Lemmon, chapters 1 and 2, is another good introduction to propositional logic. LS Sec 2.1, 5.4.

13 Establishing Validity/Theorem Proving

Russell and Norvig Ch 7 explains rules of inference for propositional logic in a general way. Section 6.5 shows this being used to reason about a small world. Bundy is a survey of the automation of (deductive) inference, from its beginnings to the present day. LS Ch 11.

14 Theorem Proving Search Spaces

Formulation 1 in the lectures is that used in Mendelson. The example problem and an approach to it using truth tables, resolution and Wang's algorithm are described in Raphael p116 onwards. LS Sec 11.2

15 Establishing Satisfiability

Gent and Walsh (1999) is a thorough survey of approaches to solving SAT and the description of DP is derived from there. The figures for the performance of DP are from Jeroslow and Wang, which reports an investigation into the effectiveness of different heustistics. LS Sec 2.3

16 Satisfiability by Guessing

The location of hard SAT problems is discussed in Mitchell et al, and some of the graphs in the lecture are from there. The connections between phase transitions in SAT and phenomena in Physics are described in Kirkpatrick and Selman. GSAT was first presented in Selman et al. Russell and Norvig present GSAT briefly in the context of an exercise. The pictures showing the behaviour of GSAT are taken from Gent and Walsh (1993).

17 Iterative Improvement and Stochastic Search

Russell and Norvig discuss iterative improvement algorithms. They discuss a non-stochastic version of hillclimbing, which is different from our stochastic version, though it has similar problems. Tuson surveys different approaches to stochastic search and proposes a methodology for using these to solve AI problems. LS Sec 4.1, 4.3.

THE REFERENCES

- Bundy, A., "A Survey of Automated Deduction", Informatics Research Report 1, University of Edinburgh, 1999.
- Gent, I. and Walsh, T., "An Empirical Analysis of Search in GSAT", *Journal of Artificial Intelligence Research*, Vol 1, pp23-57, 1993.
- Gent, I. and Walsh, T., "The Search for Satisfaction", technical report, Dept of Computer Science, University of Strathclyde, 1999 (available via http://dream.dai.ed.ac.uk/group/tw/
- Jeroslow, R. and Wang, J., "Solving Propositional Satisfiability Problems", *Annals of Mathematics and Artificial Intelligence* Vol 1, pp167-187, 1990.
- Kirkpatrick, S. and Selman, B., "Critical Behaviour in the Satisfiability of Random Boolean Expressions", *Science* 264:1297-1301, 1994.
- Lemmon, E. J., *Beginning Logic*, Thomas Nelson, 1972.
- Mendelson, E., *Introduction to Mathematical Logic*, Van Nostrand Reinhold, 1964.
- Mitchell, D., Selman, B. and Levesque, H., "Hard and Easy Distributions of SAT Problems", *Proceedings of AAAI-92*, pp459-465, 1992.
- Raphael, B., *The Thinking Computer*, W.H. Freeman, 1976.
- Russell, S. and Norvig, P., *Artificial Intelligence: A Modern Approach*, Prentice Hall, 1995.
- Selman, B., Levesque, H. and Mitchell, D., "A New Method for Solving Hard Satisfiability Problems", *Proceedings of AAAI-92*, pp440-446, 1992.
- Stefik, M., *Introduction to Knowledge Systems*, Morgan Kaufmann, 1995.
- Tuson, A., "No Optimisation without Representation: A Knowledge Based Systems View of Evolutionary/Neighbourhood Search Optimisation", draft PhD thesis, University of Edinburgh.