

CIS 730 Artificial Intelligence
CIS 530 Principles of Artificial Intelligence
Fall 2013

Homework 5 of 8: Problem Set

Knowledge Representation and Reasoning, Part II:
More FOL, Analogy, Case-Based Reasoning, Probability Intro
Assigned: Thu 24 Oct 2013
Due: Thu 31 Oct 2013 (before midnight)

This problem set will help you exercise the problem-solving techniques covered in the first half of the course by reworking a missed exam problem. It will also make use of the development skills you have learned from looking at examples of conversion of first-order logic (FOL) sentences to clausal form (*aka conjunctive normal form* or CNF). Finally, it will apply your understanding about analogical and case based reasoning from reading about it, and get you prepared to use *Bayesian Network tools in Java* as we cover it early next month.

Douglas Hofstadter's Stanford Presidential Lecture in the Humanities and Arts
<http://prelectur.stanford.edu/lecturers/hofstadter/analogy.html> – transcript
<http://www.youtube.com/watch?v=n8m7IFQ3njc> – recording

John Sowa's article on analogy:
<http://www.jfsowa.com/pubs/analog.htm>

Download *Hugin Lite* from the *Hugin* web site:
http://www.hugin.com/Products_Services/Products/Demo/Lite/

Refer to the *Bayesian Network Tools in Java (BNJ)* web site:
<http://bnj.sourceforge.net>
and the screenshots and AVI movies for *BNJ v3.0a*:
<http://www.kddresearch.org/Groups/Probabilistic-Reasoning/BNJ/Screenshots/v3/>

1. **(530/730) Hour Exam 1 Take-Home Component. (20% for CIS 530, 10% for CIS 730)**
Rework **one problem** for full credit. This can be a problem (among 4 for CIS 530 and 5 for CIS 730) that you did not complete, in which case the score will be added to your total exam score. If you are in CIS 530 and this problem is the fifth one you are completing, your score will replace your lowest score on any other problem. Turn in your solution as *PS5-1.pdf*.
2. **(530/730) Implicitization of Universals and Operators, Distributive Law, and Renaming Variables Apart (40%).** Extend your parser code by adding code to perform the "UDOR" part of the "INSEUDOR" procedure for conversion to clausal form. Print the resulting intermediate version of expressions given as standard input. Turn in `mp5_2`, a revised version of your scanner/parser code or spec.
3. **(530/730) Analogical Reasoning and Knowledge Representation. (30%)** Read the lecture by Hofstadter (you may also watch the video recording) and discuss how analogy can help in accessing both declarative and procedural knowledge. Give an original example of your own based on the ones given in Hofstadter's lecture and Sowa's paper. Turn in your solution as *PS5-3.pdf*.

4. **(730) Case-Based Reasoning and Mental Lexicons. (10%)** Discuss the compositionality of lexical items in case-based reasoning (CBR) and analogy (based on the section “The Mental Lexicon: A Vast Storehouse of Triggerable Analogies” in the Hofstadter lecture. Give an original example of your own. Is there a difference between the analogical version of this and the CBR version? Turn in your solution as *PS5-4.pdf*.
5. **(530/730) Preparing to use BNJ. (10%)** Download *Bayesian Network Tools in Java (BNJ)* v3 from the web site above and run through the Lauritzen-Spiegelhalter algorithm on: the *Burglary* example. Take a full set of screen shots for this as was collected for the new v3 stills on the *Asia* network. These should replace the top right image on the page (<http://bit.ly/RSpE3m>) and augment the *Asia* example with a new section.

Turn in both the Bayesian networks and a PDF file *PS5-5.pdf* explaining the meaning of each chance node and the conditional probability tables (CPTs).

Class participation (required). Post a response to the following questions to the KSOL message board for PS5 by Wed 30 Oct 2013 (you may cross-post to CIS530-L or CIS730-L and follow up there):

What other reasoning processes or patterns have you observed in children (or, what processes of reasoning or behaviors do you recall from your own childhood) that are distinguishable from “adult ways” of learning to reason? What do you think this shows about the way babies and small children learn about causality? Do you agree or disagree with Gopnik’s interpretation of the reasoning process in the videos she showed in her talk? Discuss.

Coming Up Next

Machine Problem 6 (due ~~Wed 06~~ Fri 08 Nov 2013) – Knowledge Representation and Reasoning, Part III: More Clausal Form, Rule-Based Expert Systems, and Intro to Probabilistic Reasoning (Hugin)

Problem Set 7 (due Fri 15 Nov 2013): Reasoning and Learning, Part I: Probabilistic Reasoning (Inference and Causality), Version Spaces, and Decision Trees; The Waikato Environment for Knowledge Analysis (WEKA), Artificial Neural Networks (ANNs)

Machine Problem 8 (due Fri 21 Nov 2013) – Reasoning and Learning Part II: Genetic Algorithms (GAs), Natural Language Processing (NLP), and Vision