CIS 730 Artificial Intelligence
CIS 530 Introduction to Artificial Intelligence
Fall 2018

Homework 6 of 10: Problem Set
Knowledge Representation and Reasoning, Part I:
Ontology Reasoning, Classical and Robust Planning

Assigned: Thu 18 Oct 2018
Due: Thu 25 Oct 2018 (before midnight)

The purpose of this assignment is to exercise your knowledge of ontologies and classical partial-order planning. You will continue to work with using ontological and fact-based knowledge about a simple domain and reasoning with it using Protégé-OWL.

This homework assignment is worth a total of 100%.
Each problem is worth 25% for CIS 730 students and 34% for CIS 530 students.

Refer to the following tutorials:

https://protegewiki.stanford.edu/wiki/Pr4_UG_ex_Pizza
https://protegewiki.stanford.edu/wiki/Protege4Pizzas10Minutes
http://bit.ly/protege-owl-tutorial-manchester-1_3 (Chapter 4, p. 13 – 75)

and to:
http://bit.ly/protege-owl-tutorial-manchester
http://bit.ly/pizza-ontology-1_5
http://stardog.com – Stardog, containing the *Pellet* reasoner (latest version: 5.0.4, 03 Oct 2017)
https://github.com/stardog-union - Git repository for Stardog (for documentation only)
http://protegewiki.stanford.edu/wiki/DLQueryTab - description logic queries
http://www.w3.org/TR/owl2-manchester-syntax/ - OWL2 syntax (latest version: 11 Dec 2012)

1. **(530/730) Using Pellet to answer queries with the Pizza Ontology.** Download and install Stardog Community 5.0.4 on your operating system from the above URL. Follow the instructions in the Pizza Ontology tutorial that you used in MP5-3. Use Pellet to answer the following queries:

   a) Get all pizzas from Italy (via the `hasCountryOfOrigin` property)
   b) Get all pizzas with a meat topping (via the `hasTopping` property)

   Turn in `ps6-1.zip`, an archive containing a text file `ps6-1.txt` of your queries and screen shots of their entry into the Pellet GUI and the displayed results.

2. **(530/730) Formulating your own queries.** Use Pellet to answer the following queries:

   a) Get all pizzas that are **not** American or spicy
   b) Get all pizzas that are vegetarian (per Lecture 23)

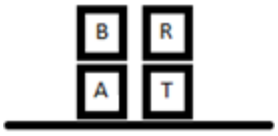
   Turn in `ps6-2.zip`, an archive containing a text file `ps6-2.txt` of your queries and screen shots of their entry into the Pellet GUI and the displayed results.

3. **(730) Developing a simple domain ontology for currencies.** Define an ontology for currency conversion that includes: USD (American dollar), JPY (Japanese yen), EUR (Euro), BTC (Bitcoin), ETH (Ethereum). Look up current conversion rates on https://coinmarketcap.com/converter/. Use a Pellet query to demonstrate a conversion chain of length 4.

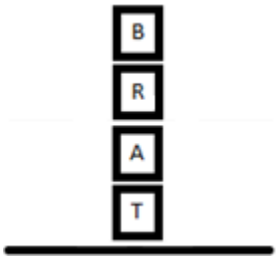
   Turn in `ps6-3.zip`, an archive containing a text file `ps6-3.txt` of your queries and screen shots of their entry into the Pellet GUI and the displayed results.

4. **(530/730) Blocks World Planning in STRIPS.** As a new intern for Burns Industries, you are asked to help prototype a partial-order planner for its Springfield power plant. Trace through the behavior of STRIPS on the following Sussman Anomaly-type problem:

   Initial state:



   Final goal state:



   Specify:

   a) The STRIPS specification of the operator `Move(x, y, z)` with predicates `On(x, y)` and `Clear(x)`, and constants `B`, `R`, `A`, `T`, and `TABLE`. This is a generalization over the operators `Stack` and `Unstack`, or `Move-to-Table`, and the predicate `On-Table`.
   b) Show an example of a threat that must be resolved by reordering of operators.
   c) Illustrate the resulting partial-order plan. You may use abbreviations to limit the amount of redundancy and branch factor (fan-out and fan-in) as long as you clearly indicate what the successor states are.
   d) Discuss any of the four forms of robust planning we covered in class and how it might benefit your planning agent.

   Turn in `ps6-4.pdf`, a PDF file of your solution with text of the STRIPS trace and an illustration of the solution (a partial-order plan).

Class Participation (required)

Post to the PS6 discussion thread your *muddiest point* (most unclear point) regarding any topic since the start of R&N 3e Section III.

Term Project Interim Reports

Submit a short interim report as specified in class by Fri 09 Nov 2018, and attend office hours this week and next (by a week before fall break) to give a brief update.

Coming Up Next

Machine Problem 7 (due Fri 03 Nov 2017) – Reasoning and Learning Part I: Clausal Form Concluded; Intro to Probabilistic Reasoning (Hugin), Probabilistic Reasoning (Inference and Causality); The Waikato Environment for Knowledge Analysis (WEKA). You will finish the CNF conversion function from MP5 and start to work with Hugin, TETRAD, and WEKA.

Problem Set 8 (due Wed 08 Nov 2017) – Reasoning and Learning, Part II: Probabilistic Reasoning (Inference and Causality), Version Spaces, and Decision Trees; The Waikato Environment for Knowledge Analysis (WEKA). You will solve some Bayesian network reasoning and learning tasks and a few classification problems to simulate the behavior of supervised inductive learning algorithms, and continue working with classification models in WEKA.

Machine Problem 9 (due Wed 16 Nov 2017) – Perception and Understanding, Part I: Artificial Neural Networks (ANNs) and Genetic and Evolutionary Computation (GEC). You will apply ANN and GEC to a pattern recognition or obstacle avoidance task for a simple mobile robot.

Problem Set 10 (due Wed 29 Nov 2017) – Perception and Understanding, Part II: Natural Language Processing (NLP), and Vision. You will solve problems and answer some discussion questions about perception and understanding. (This will include some practice final exam questions.)