Assignment 2: Logic and Planning

Due: 10:00pm, Sunday 6 October 2013. Email solution to `poole@cs.ubc.ca`

This can be done in groups of size 1, 2 or 3. Working alone is not recommended. A group of size n can choose any $n+1$ questions from questions 1-5. All members of the group need to be able to explain the group's answer. Please look at all of the questions, as the exam will assume that you have thought about all of the questions. Everyone should do question 6. Please post questions to the Connect web site.

Question 1

Consider the knowledge base (where $\{a, b, c, d, e, f, g, h\}$ is the set of all atoms):

$a \leftarrow b \wedge g.$ $\quad$ $b \leftarrow c \wedge e.$
$b \leftarrow d \wedge c.$ $\quad$ $c.$
$d \leftarrow f.$ $\quad$ $f.$
$g \leftarrow h.$

(a) Give a model of the knowledge base.

(b) Give an interpretation that is not a model of the knowledge base.

(c) Give all atoms that are logical consequences of the knowledge base.

(d) Give all atoms that are not logical consequences of the knowledge base.

(e) Consider the clauses:

$smoke \leftarrow fire.$ $\quad$ $alarm \leftarrow tampering.$
$alarm \leftarrow fire.$ $\quad$ $leaving \leftarrow alarm \wedge acl.$
$report \leftarrow leaving \wedge lcr.$

Suppose that *fire*, *tampering*, *acl* and *lcr* are assumable.

(i) What are the minimal explanations for (set of assumables that imply) *leaving*?

(ii) What are the minimal explanations for *leaving* $\wedge$ *smoke*?

Question 2

Consider the domain of house plumbing represented in Figure 1. In this figure, $p1$, $p2$ and $p3$ are water pipes. $p1$ is the pipe coming in from the main water supply. $t1$, $t2$ and $t3$ are taps and $d1$, $d2$ and $d3$ are drainage pipes. The other labels should be obvious.

Suppose we have the following atoms:

- *pressurised_*p_i, is true if pipe p_i has mains pressure in it. $p1$ is always pressurized. Other pipes are pressurized if they are connected to a pressurized pipe through an open tap.
- *on_*t_i is true if tap t_i is on.
- *off_*t_i is true if tap t_i is off.
- *wet_b* is true if b is wet.
- *flow_c* is true if water is flowing through component c.
- *plugged_c* is true if component c has the plug in.
- *unplugged_c* is true if component c doesn't have the plug in.

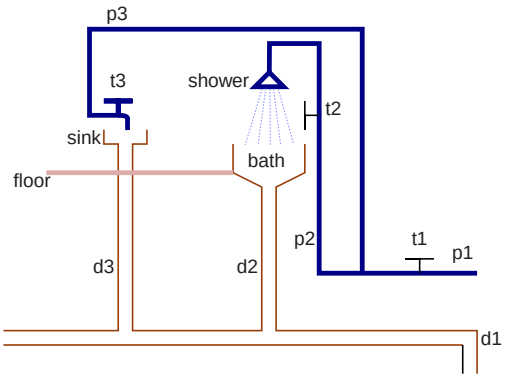

Figure 1: The Plumbing Domain

Assume the taps and plugs have been in the same positions for one hour; you don't need to consider the dynamics of turning on taps and inserting and removing plugs.

The file `http://www.cs.ubc.ca/~poole/cs502/2013/as2/plumbing.ailog` contains a AILog axiomatization for how water can flow down drain $d1$ if taps $t1$ and $t2$ are on and the bath is unplugged.

(a) Finish the axiomatization for the sink in the same manner as the axiomatization for the bath.

(b) What information would you expect the user to be able to provide that the plumber can't? Change the axiomatization so that questions about this information are asked of the user.

(c) Axiomatize how the floor is wet if the sink overflows or the bath overflows. They overflow if the plug is in and water is flowing in. You may invent new atoms as long as you give their intended interpretation.

(d) Suppose a hot water system is installed to the left of tap $t1$. This has another tap in the pipe leading into it, and supplies hot water to the shower and the sink (there are seperate hot and cold water taps for each). Add this to your axiomatization. Give the denotation for all atoms you invent.

(e) We might like to know why the floor is wet or why there is water in a drain. Add assumables to your representation so that the system can explain such observations.

You need to hand in a complete listing of your program, including the intended interpretation for all symbols used and a trace of the AILog session to show it runs.

Question 3

We can treat a sequence of topics taught in a course as a plan. Topics have preconditions and achieve learning goals. Given a set of learning goals, a planner should be able to produce a sequence of topics that achieves the learning goals. This could be used to produce a custom textbook or a custom online course that adjusts to the interests of students or instructors.

In this question you are to prepare a handout for a tutorial that uses this domain to explain representations for actions and how planners work. It should be at most 2 pages (plus one optional page of diagrams if the diagrams don't fit into the two pages). You can assume that the students have access to the textbook, so you don't need to explain what is in the text. Your description must include concrete examples.

Question 4

Give a possible exam question (perhaps with sub-parts) that would be good to test students about propositional reasoning. It should be worth 10 marks, and take students approximately 10 minutes to complete in an exam setting. It must be clear what the question is asking for and must be self-contained. Give a solution.

Question 5

On the wiki `http://wiki.ubc.ca/Course:CPSC:Artificial_Intelligence` create pedagogical or real-world examples that use useful for students to learn about logic or planning. Please add references for real-world examples. You will need to login with your CWL to edit. This is intended to be an open-ended creative question. This is a cooperative question, as anyone can edit other people's questions. It is possible to gain credit by improving other's contributions. Please help to build a useful resource.

It can be worth multiple questions in this part; please justify any claim of how many questions your contribution is worth. It is even possible to do the whole assignment just by creating useful resources.

Question 6

For each question in this assignment, say how long you spent on it. Was this reasonable? What did you learn?