CPSC 522 — Spring 2013
Assignment 2

Due: 12:30 p.m., Wednesday 6 February 2013.

Please ask questions on Connect. Feel free to discuss this with your classmates, but what you hand in must be your own work.

Question 1

Consider the language with constant symbols a and b, predicate symbols p, q and r, and the knowledge base *KB* that consists of the clauses:

$p(X) \leftarrow q(X).$
$p(Y) \leftarrow r(Y).$
$q(a).$
$r(b).$

Suppose there are three individuals ✂, ☎ and ✈.

(a) How many interpretations are there where $D = \{✂, ☎, ✈\}$?

(b) Give a model of *KB*. You must specify ϕ and π.

(c) Give an interpretation with the same domain that isn't a model of *KB*. You must specify ϕ and π.

(d) Give three atoms that are logical consequences of the knowledge base.

(e) Give three atoms that are not logical consequences of the knowledge base.

(f) How many models of *KB* are there where $D = \{✂, ☎, ✈\}$?

Question 2

For this question you should use AILog (see `http://artint.info/code/ailog/ailog_man.html`).

Suppose we have the following relations about movies:

- *rating*(P, M, R) that is true if person P gives rating R to movie M
- *director*(M, P) that is true if person P is a director of movies M.
- *year*(M, Y) that is true if movie M was made in year Y.
- *name*(P, F, L) is true if F is the first name and L is the last name of person P. (Note that strings are specified using single quotes.)

(a) axiomatize a relation *likes_movie_by*(P, D) that is true if a person P rated a movie directed by person D with a rating greater than 2. [Optional for those who know the database query language SQL: think about how this view/relation can be defined in SQL.]

(b) axiomatize the relation *namesake_of_director*(P) that is true if person P has the same name as a different person who directed a movie they saw.

(c) axiomatize the relation *likes_latter_movie*(P, D) that is true if person P likes a later movie by director D more than they liked an earlier movie by the same director.

(d) show how these relations can be defined using the individual-property-value representation, and give a solution to one of the above questions using this representation.

Test that this works in AILog. Show how you have tested it using a database that covers the cases required to test the definitions.

Question 3

For this question you should use AILog (see `http://artint.info/code/ailog/ailog_man.html`).

Consider the house plumbing domain represented in the diagram of Figure 1.

In this example, constants $p1$, $p2$ and $p3$ denote cold water pipes. $p1$ is the pipe coming in from the main water supply. Constants $p4$ and $p5$ represent hot water pipes (coming out from the hot water system). Constants $t1$, $t2$ $t3$, $t4$ and $t5$ denote taps and $d1$, $d2$ and $d3$ denote drainage pipes. The constants *shower* denotes a shower, *bath* denotes a bath, *sink* denotes a sink, *hws* denotes a hot water system, and *floor* denotes the floor. Figure 1 is intended to give the denotation for the constant symbols.

Suppose we have as predicate symbols:

- *pressurised*, where *pressurised*(P) is true if pipe P has mains pressure in it. $p1$ is always pressurised. Other pipes are pressurised if they are connected to a pressurised pipe through an open tap.

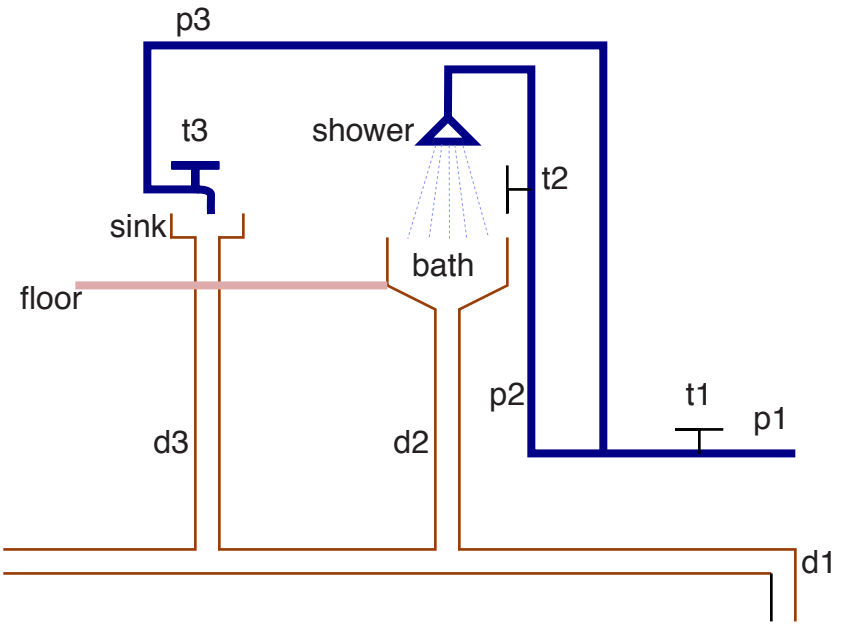

Figure 1: A Plumbing Domain

- *on*, where $on(T)$ is true if tap T is on.
- *off*, where $off(T)$ is true if tap T is off.
- *wet*, where $wet(B)$ is true if B is wet.
- *flow*, where $flow(P)$ is true if water is flowing through P.
- *plugged*, where $plugged(S)$ is true if S is either a sink or a bath and has the plug in.
- *unplugged*, where $unplugged(S)$ is true if S is either a sink or a bath and doesn't have the plug in.

Assume that 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://cs.ubc.ca/~poole/cs522/2013/as2/plumbing.ailog`contains an AILog axiomatization for how water can flow down drain $d1$ if taps $t1$ and $t2$ are on and the bath is unplugged.

(a) Write general rules (using logical variables) about how plumbing works in a way so that a plumber will be able to specify what is connected to what and the rule base can derive the effect of turning on taps, putting in plugs.

This should work for the sink as well as for the bath.

(b) Suppose there is a hot water system 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). The shower is warm of there is both hot and cold water running into it. Add this to your axiomatization. Give the denotation for all constants and predicate symbols you invent. Test it in AILog. (What is the temperature of the shower when both taps are on? Is it hot and cold and warm? Is this reasonable?)

(c) What information do you expect for a plumber to know and what do you expect a homeowner to know? Make the predicates that the homeowner will know *askable*.

What are limitations of the askable mechanism in AILog? (Hint: think about how askable may be related to conditioning.)

(d) Suppose you want to use the same rules to be used to determine how to set the taps and the plug to have a desired effect such as making the floor wet or filling the bath. (We are designing the position of the taps to have some desired effects.) Make some predicate *assumable* to enable this reasoning. Explain how to interpret the output of AILog as a design.

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 4

How long did the assignment take? What did you learn? Was it reasonable? What suggestions do you have to improve the assignment?