COMP 5307 Knowledge Representation
Winter 2018 Assignment 4

Instructions:

1. **For your solution use the template file that was posted on the course news, and follow the instructions in it, and those here below.**

   In particular: (a) Include at the top of the first page: full name, student number, and email address. (b) Assignments have to be created with Latex, and submitted in pdf format. (c) Every problem solution MUST include the problem statement as found below in this assignment. The source file for this assignment is provided. (d) Latex has to be used as such, not as a simple text editor, such as Notepad. Latex is much more than that. In particular, formulas have to be written using Latex's mathematical features, and then compiled.

2. Assignments are individual; no group work allowed.

3. Submit by email to the instructor (bertossi@scs.carleton.ca), with "Assignment "Number", KR" in the subject. **Include your last name in the file name!** For example, in the subject: "Assig. 4 KR". The file name: "bertossi-4.pdf".

4. **Only a single pdf file will be accepted as submission. No tar or zip files (or anything like that), please.**

5. **Keep your Latex source files, you may be requested to show them. The same applies to the whole interaction with the automated reasoner as text files.**

6. Explain your solution very carefully, but still be succinct in your answers. No unnecessary verbose arguments, please. Go to the point.

   Make explicit all your assumptions.

7. **Not following the instructions above or the solution template file will make you lose points.**

1. (a) Determine if the Datalog$^{\pm}$ program, Π, below is: Weakly-acyclic, sticky, weakly-sticky. Show the associated graphs.

$$\begin{aligned} U(x) &\rightarrow \exists y\, R(x,y), \\ R(x,y) &\rightarrow P(y,x). \end{aligned}$$

Furthermore, compute the chase starting with the EDB $D = \{R(a,b), U(c)\}$. Assume here and below that the chase only enforces a rule when its body is true and the head is not. [4 points]

(b) Do the same for the programs, Π_1 and Π_2, below, and use representative EDBs to obtain their chases: [6 points]

$$
\begin{array}{rcl}
R(x,y) & \rightarrow & \exists z\ R(y,z), \\
R(x,y), R(y,z) & \rightarrow & S(x,y,z).
\end{array}
\qquad
\begin{array}{rcl}
R(x,y) & \rightarrow & \exists z\ R(y,z). \\
R(x,y), R(y,z) & \rightarrow & S(x,y,z). \\
S(x,y,z) & \rightarrow & P(x,z).
\end{array}
$$

(c) Do the same for the programs, Π_3 and Π_4, below, and use representative EDBs to obtain their chases: [6 points]

$$
\begin{array}{rl}
R(x,y) & \rightarrow \exists z\ R(y,z), \\
R(x,y), U(y), R(y,z) & \rightarrow R(x,z),
\end{array}
\qquad
\begin{array}{rl}
R(x,y) & \rightarrow \exists z\ R(y,z), \\
R(x,y), R(y,z) & \rightarrow R(x,z).
\end{array}
$$

2. You have three bottles of paint, blue (b), red (r) and white (w), and a brush B. You may run out of paints. You may wash the brush in order to use a different color. So, you have fluents with a last argument to accommodate situations: $\mathit{RunOutOf}(\cdot,\cdot)$, $\mathit{Clean}(\cdot,\cdot)$, $\mathit{Color}(\cdot,\cdot,\cdot)$ (the second argument is the color of the first), $\mathit{Closed}(\cdot,\cdot)$. You have actions $\mathit{open}(\cdot), \mathit{wash}(\cdot), \mathit{buy}(\cdot), \mathit{paint}(\cdot,\cdot)$ (painting the first argument with color as in second argument). **Using Reiter's situation calculus**:
(a) Give two positive effect axioms. (General for pairs predicate/action) [2 points]
(b) Give two negative effect axioms. (Idem) [2 points]
(c) Two action precondition axioms. [2 points]
(d) Give a successor state axiom for each of *Clean* and *Color* [6 points]
(e) Indicate three **other** classes of axioms that are part of the theory for reasoning about actions and change [6 points]
(f) Initially, the *wall* is blue, and you want to paint it red. The brush has white paint and you run out of red. What is a plan to reach your goal, in general? Indicate such a plan. Be as technical and precise. [2 points]
(d) How would you use an automated **theorem prover** to derive such a plan? (as the proof of a theorem) [4 points]
You may make minimal assumptions if something is missing, but you have to be explicit and explain them.

Deadline: April 11 at 23:55