CSE175 Introduction to Artificial Intelligence — Homework set #3
Fall semester 2024 — Miguel Á. Carreira-Perpiñán

This set covers chapter 7 of the AIMA textbook (4th ed.). References (figures, etc.) are to the AIMA textbook. In all exercises, *explain your answers.* **Total possible points: 100.**

Exercise 1 (40 points). Consider a knowledge base KB consisting of the following sentences in propositional logic:

$$p \qquad \neg g \qquad \neg m \Rightarrow g \qquad r \Leftrightarrow \neg m \qquad q \Leftrightarrow (p \wedge m)$$

and the sentences $\alpha = q$, $\beta = q \wedge r$. Prove (or disprove) KB $\models \alpha$ and KB $\models \beta$:

1. (10 points) By writing out explicitly the truth table.
2. (10 points) By using inference rules (such as modus ponens, and elimination, etc.) and standard logic equivalences (see AIMA section 7.5.1).
3. (20 points) By transforming the KB into CNF (conjunctive normal form) and then applying resolution (see AIMA section 7.5.2).

If you are careful (in how to apply the rules, or in the order in which to process clauses), the proofs can be quite short.

Exercise 2 (60 points). Consider the following world and agent:

- We have discrete locations $1, 2, 3 \ldots$ and times $0, 1, 2 \ldots$.
- The agent can only be in one location at any given time.
- The agent can only take one of two actions at any time: either move (always to the next location, i.e., from i to $i + 1$), or grab (but grabbing can only be done once during the game). Executing the grab action results in the agent catching the gold only if it is at a location that contains gold.
- At the start of the game, the agent is at location 1, and there is gold in exactly one location.
- If at some time t the agent is at a location containing the gold, it perceives it, as a symbol $gold^t$. Otherwise, it does not perceive it: $\neg gold^t$.
- The goal is for the agent to catch the gold.

Design a propositional logic system that could be used to model this:

1. (10 points) Create the relevant symbols and explain their meaning.
2. (20 points) List relevant axioms and explain their meaning.
3. (5 points) List relevant sentences that encode the start of the game.
4. (5 points) Formulate an assertion α to indicate success (which we would use, together with the knowledge base KB composed of your axioms and sentences above, to formulate a plan, by calling Ask(KB,α)).

Apply to the particular case where the gold is at location 3. Running SATplan on your KB with a suitable goal would produce a plan (sequence of actions) that achieves the goal, if such a plan exists (and assuming you correctly formulated your KB), but this would involve many symbols and sentences and it would be too complicated. Instead, just play out two scenarios where the agent acts in two ways:

5. (10 points) Give, for times 0 to 4, the truth values of all symbols (including the percepts) for a successful agent behavior (the agent takes a sequence of actions that lead to getting the gold). You must obtain the values by applying your axioms to your initial state formulation (not by guessing what the values should be). Tabulate them like this (where 0 and 1 stand for false and true, respectively):

t	p^t	q^t	r^t	...
0	1	1	0	...
1	1	0	1	...
2	0	0	0	...
3	1	0	1	...

6. (10 points) Repeat but for an unsuccessful agent behavior (the agent takes a sequence of actions that lead to not getting the gold).

Hint: read carefully AIMA chapter 7, in particular sections 7.4.3, 7.7.1 and 7.7.4.