National University of Singapore
School of Computing
CS3243: Foundations of Artificial Intelligence
Tutorial 6

Readings: AIMA Chapter 7 & 8

1. The *WalkSAT* algorithm is a local search algorithm used to determine whether a proposition is entailed by a KB (whether the resulting KB is satisfiable). It is similar to simulated annealing in that it uses randomness and allows steps that generate more conflicts to be taken with some probability. The algorithm is shown below.

> **function** WALKSAT(*clauses*, p, *max-flips*) **returns** a satisfying model or *failure*
> **inputs**: *clauses*, a set of clauses in propositional logic
> p, the probability of choosing to do a "random walk" move, typically around 0.5
> *max-flips*, number of flips allowed before giving up
>
> *model* ← a random assignment of *true*/*false* to the symbols in *clauses*
> **for** $i = 1$ **to** *max-flips* **do**
> **if** *model* satisfies *clauses* **then return** *model*
> *clause* ← a randomly selected clause from *clauses* that is false in *model*
> **with probability** p flip the value in *model* of a randomly selected symbol from *clause*
> **else** flip whichever symbol in *clause* maximizes the number of satisfied clauses
> **return** *failure*

   On the other hand, `DPLL` is a deterministic model checking algorithm. It uses pure symbols and unit clauses as the basis for heuristics that attempt to converge to a solution quicker than the standard `TT-Entails`.

   (a) How you would modify the WalkSAT algorithm to use the heuristics of pure symbols and unit clauses.

   (b) How would such a modification affect the performance of the resulting algorithm? How does it impact time complexity?

2. (Question 8.2 from AIMA) Consider a knowledge base containing just two sentences: $P(a)$ and $P(b)$. Does this knowledge base entail $\forall x \;\; P(x)$? Explain your answer in terms of models.

3. (Question 8.3 from AIMA) Is the sentence $\exists x, y \; x = y$ valid? Explain.

4. (Wumpus World) Represent the following English sentences in first-order logic:

   (a) Anyone who meets the wumpus is killed by it.

   (b) Anything that glitters is gold.

   (c) Not every square contains a pit.

5. (Modified Question 8.6 from AIMA) Represent the following sentences in first-order logic, using a consistent vocabulary that you must define:

   (a) Some students took French in Spring 2001.

   (b) Every student who takes French passes it.

   (c) Only one student took Greek in Spring 2001.

   (d) The best score in Greek is always higher than the best score in French.

   (e) Everyone who buys a policy is smart.

   (f) No person buys an expensive policy.

   (g) There is an agent who sells policies only to those people who are not insured.

   (h) There is a barber who shaves all men in town who do not shave himself.

6. (Modified Question 8.7 from AIMA) Represent the sentence "All Germans speak the same languages" in predicate calculus. Use $Speaks(x, l)$ to specify that a person x speaks language l and $isGerman(x)$ to specify that a person x is a German.