CS47100 Assignment 2

Due date: Sunday October 16, 2022 (11:59pm)

This assignment will involve written and programming exercises.

Part 1: Written Assignment (40 pts)

Propositional Logic (15 Pts)

1. (5 pts) Translate the following English sentences to Propositional Logic.

   Proposition symbols: Chris is happy (H), Chris laughs (L), Chris wins the game (W), Chris gets the reward (R).

   (a) Chris is happy if he wins the game.

   (b) If Chris wins the game then he is happy, and vice versa.

   (c) Chris laughs is equivalent to he is happy.

   (d) Chris can not be happy unless he wins the game.

   (e) Chris either gets the reward or wins the game if he is happy.

2. (10 pts) Decide whether each of the following sentence is valid, statisfiable or unsatisfiable. Valid means the sentence is true for all symbol truth-value assignments; satisfiable means for at least one symbol truth-value assignment the sentence is true; unsatisfiable means there is no symbol truth-value assignment for which the sentence is true. Here (S)nowing, (C)old, (F)ever are proposition symbols, which take values of either true or false. Explain your answers using truth tables.

   (a) $S \Rightarrow S$

   (b) $S \Rightarrow C$

   (c) $(S \land C) \lor (\neg F)$

   (d) $(S \Rightarrow C) \Rightarrow (\neg S \Rightarrow \neg C)$

   (e) $((S \land C) \Rightarrow F) \Leftrightarrow ((S \Rightarrow F) \lor (C \Rightarrow F))$

First Order Logic (25 pts)

3 (11 pts) Inference via resolution.

Consider a logic puzzle described by the following sentences:

(1) The only foods in this supermarket that I do not recommended you to buy are unhealthy for the liver.

(2) Green foods are all delicious.

(3) No organic foods are unhealthy for the liver.

(4) I do not recommend you to buy any foods that are not green.

(5) All the organic foods in this supermarket are delicious.

As an example, sentence (1) can be translated into first-order logic as follows:

$$\forall x \neg Recommend(x) \Rightarrow \neg HealthyForLiver(x)$$

(a) Convert sentences (2)–(5) into first order logic. Besides the predicates used in the translation of sentence (1), you can also use the additional predicates $GreenFood(x), Delicious(x), OrganicFood(x)$.

(b) Convert sentences (1)–(4), but not (5), into conjunctive normal form.

(c) Prove sentence (5) based on sentences (1)–(4) using resolution.

4 (14 pts) Inference via backward chaining.

(a) Write logical representations for the following sentences, suitable for use with Generalized Modus Ponens:

i. Lions, tigers, and leopards are carnivores
ii. An offspring of an lion is an lion.
iii. Simba is an lion.
iv. Simba is Sarabi's offspring.
v. Simba is Kion's parent.
vi. Parent and Offspring are inverse relations.
vii. Each carnivore has some parent.

(b) Prove that Kion is a lion using backward-chaining algorithm. Draw the proof tree generated by the algorithm.

(c) Given the query $\exists a\ Carnivore(a)$, how many solutions for a can you find using your sentences?

(d) Can you prove that Sarabi is a lion? If yes, please show your proof. If no, can you add an additional sentence to the knowledge base to make it true without directly claiming "Sarabi is a lion"? Show both the sentence that you'd like to add to the knowledge base and your proof given the new knowledge base.

Submission

Upload your answers to the **written** assignments as a pdf format file in Gradescope:

- For your pdf file, use the naming convention `username_hw#.pdf`. For example, your TA with username *mmostafi* would name his pdf file for HW2 as `mmostafi_hw2.pdf`.
- To make grading easier, please start a new page in your pdf file for each subquestion. Hint: use a `\newpage` command in LaTeX after every question ends. For example, use a `\newpage` command after each of part (a)-(b) of Question 1.
- If you want to apply extension days, please specify how many extension days you want to use in this assignment in the first line of your submission pdf. Please note that once used, the extension days cannot be changed.
- After uploading to gradescope, mark each page to identify which question is answered on the page. (Gradescope will facilitate this.)
- Follow the above convention and instruction for future assignments as well.

Part 2: Programming Assignment (60 pts)

For the programming assignments we will use the Pacman project designed for the course CS188 at UC Berkeley: `https://inst.eecs.berkeley.edu/~cs188/fa20/project2/`

Please remember that solutions to any assignment should be your own. Using other people's solutions, within or outside Purdue goes against the course academic honesty policy. The TAs will be using code similarity measures to detect plagiarism cases when grading the assignment.

In this assignment, you will design agents for the classic multi-agent version of Pacman, including ghosts. Along the way, you will implement both minimax search and alpha-beta Pruning, and try your hand at evaluation function design.

The code base has not changed much from the previous assignment, but please start with a fresh installation, rather than intermingling files from HW1.

TODO:

1. Complete Project 2: Questions 1 (Reflex Agent), Question 2 (Minimax), Question 3 (Alpha Beta Pruning) and Question 5 (Evaluation function) described on the Berkeley site. Submit your modified versions of multiAgents.py for grading. We will multiply your original score returned by `autograder.py` (20 pts in total) by 3.

Submission

Please upload the following files: `multiAgents.py` to Gradescope.