National University
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CS 461: Artificial Intelligence

Assignment No. 4

Instructions:

1. Submit your assignment with **report** within due date and time. Late submission will result in deduction of marks.
2. Mention your names and roll numbers clearly on your document.
3. Name your zip or other folder/file, that you want to submit, according to the following format: **AI_A4_RollNo**
4. Try to solve each task of the assignment by your own in group of **maximum two persons**.
5. No excuse or resubmission is permissible.
6. For programming questions, you can use any language for implementation.

Question No. 1: [Sentence Validity]

Consider the following sentence:

$$[(\text{Food} \Rightarrow \text{Party}) \vee (\text{Drinks} \Rightarrow \text{Party})] \Rightarrow [(\text{Food} \wedge \text{Drinks}) \Rightarrow \text{Party}]$$

a) Determine, using enumeration, whether this sentence is valid, satisfiable (but not valid), or unsatisfiable.
b) Convert the left-hand and right-hand sides of the main implication into CNF, showing each step, and explain how the results confirm your answer to (a).
c) Prove your answer to (a) using resolution.

Question No. 2: [Sentence Validity]

Decide whether each of the following sentences is valid, unsatisfiable, or neither with some proof:

a) $\text{Smoke} \Rightarrow \text{Smoke}$

b) $\text{Smoke} \Rightarrow \text{Fire}$

c) $(\text{Smoke} \Rightarrow \text{Fire}) \Rightarrow (\neg \text{Smoke} \Rightarrow \neg \text{Fire})$

d) Smoke ∨ Fire ∨ ¬ Fire

e) ((Smoke ∧ Heat) ⇒ Fire) ⇔ ((Smoke ⇒ Fire) ∨ (Heat ⇒ Fire))

f) (Smoke ⇒ Fire) ⇒ ((Smoke ∧ Heat) ⇒ Fire)

g) Big ∨ Dumb ∨ (Big ⇒ Dumb)

Question No. 3: [Propositional Logic]

Consider a vocabulary with only four propositions, A, B, C, and D. How many models are there for the following sentences?

a) B ∨ C.

b) ¬ A ∨ ¬ B ∨ ¬ C ∨ ¬ D.

c) (A ⇒ B) ∧ A ∧ ¬ B ∧ C ∧ D.

Question No. 4: [Propositional Logic]

Consider the following scenario where the agent has progressed to the point shown in Figure given below,

1,4	2,4	3,4	4,4
1,3 **W!**	2,3	3,3	4,3
1,2 **A** **S** **OK**	2,2 **OK**	3,2	4,2
1,1 **V** **OK**	2,1 **B** **V** **OK**	3,1 **P!**	4,1

A = *Agent*
B = *Breeze*
G = *Glitter, Gold*
OK = *Safe square*
P = *Pit*
S = *Stench*
V = *Visited*
W = *Wumpus*

The agent has perceived nothing in [1,1], a breeze in [2,1], and a stench in [1,2], and is now concerned with the contents of [1,3], [2,2], and [3,1]. Your task is to construct the set of possible worlds and mark the worlds in which the KB is true and those in which each of the following sentences is true:

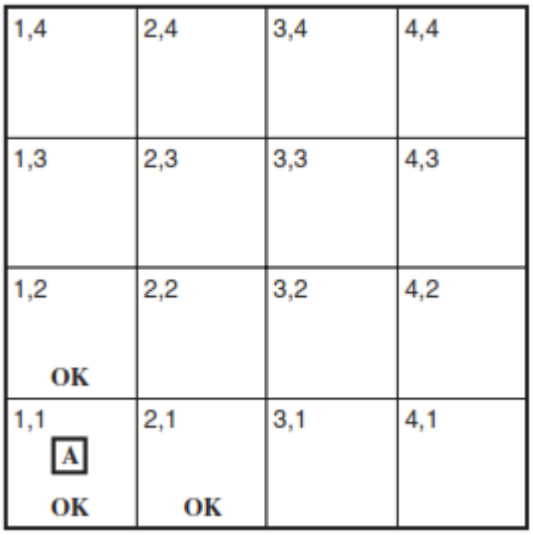
α_1 = "There is no pit in [2,2]."

α_2 = "There is a Wumpus in [1,3]."

Hence, show that $KB \models \alpha_1$ and $KB \models \alpha_2$.

Question No. 5: [Propositional Logic]

[Wumpus world]: Consider the following example where the knowledge base is:



R_1: $\neg P_{1,1}$.

R_2: $B_{1,1} \Leftrightarrow (P_{1,2} \vee P_{2,1})$.

R_3: $B_{2,1} \Leftrightarrow (P_{1,1} \vee P_{2,2} \vee P_{3,1})$.

R_4: $\neg B_{1,1}$.

R_5: $B_{2,1}$.

$P_{1,1}$= pit in [1,1] and $B_{1,1}$= Breeze in [1,1]

- Apply the inference rules and derive the proof step by step that ¬P1,2.
- Apply the resolution theorem and derive the proof step by step that ¬P1,2.