Department of Electrical and Computer Engineering

CSE 440: Artificial Intelligence

Assignment 02

Total Marks: 45

Instructor: Dr. Mohammad Mahmudul Alam	Semester: Fall 2025
Due date: December 13th, 2025	Section: 02

Instructions:

1. Submit a single PDF file containing your answers in consecutive order.
2. Keep your responses concise and relevant - only answer what is asked.
3. This is an open-book assignment; however, copying another student's work is strictly prohibited and will not be tolerated.
4. PDFs will be reviewed to determine whether the answers were generated using AI tools (e.g., ChatGPT, DeepSeek).

Question 1 (10 Marks):

In the following Wumpus world, V means visited, S means stench, and B means breeze. The numbers adjacent to V, S, and B indicate the coordinate position of the grid cell in (col, row) format.

V13 S13 B13	?		
V12 ¬S12 ¬B12	V22 S22 B22		
V11 ¬S11 ¬B11	V21 ¬S21 ¬B21	V31 ¬S31 B31	

In each visited cell, the observed information regarding V, S, and B is True. Prove that the Wumpus is in square (2,3). Hint: Apply inference rules to prove W23 is true.

Question 2 (10 Marks):

Consider the following propositional symbols & Knowledge Base (KB):

Propositional Symbols & Meaning:

A: The alarm is ringing.	F: The fire department is notified.
B: There is a fire.	G: There is an emergency.
C: There is smoke.	H: The sprinklers are turned on.
D: The heat sensor is triggered.	I: People evacuate the building.
E: The security system is activated.	J: The fire is extinguished.

KB:

1. $B \Rightarrow C$ (If there is a fire, then there is smoke.)
2. $B \Rightarrow D$ (If there is a fire, then the heat sensor is triggered.)
3. $G \Rightarrow H$ (If there is an emergency, the sprinklers are turned on.)
4. $A \Rightarrow E$ (If the alarm rings, then the security system is activated.)
5. $G \Rightarrow I$ (If there is an emergency, then people evacuate the building.)
6. $(A \wedge F) \Rightarrow G$ (If the alarm rings and the fire department is notified, then there is an emergency.)
7. $(C \wedge D) \Rightarrow A$ (If there is smoke and the heat sensor is triggered, then the alarm rings.)
8. $E \Rightarrow F$ (If the security system is activated, then the fire department is notified.)

9. (H ∧ F) ⇒ J (If the sprinklers are on and the fire department is notified, then the fire is extinguished.)
10. B (There is a fire.)

Query:

Prove J (The fire is extinguished) using:

- Forward Chaining (5 Marks)
- Backward Chaining (5 Marks)

On each line, write the name of the rule and the sentence number where the rule is applied.

Question 3 (5 Marks):

Translate the following sentence to First-Order Logic (FOL).

1. Every student in the university takes at least one course.
2. If a person studies hard, then they will pass the exam.
3. There exists a professor who teaches all students.
4. All students are friendly.
5. Every book in the library is written by some author.

Use the following predicates if necessary:

`Student(x)`	`Person(x)`	`Professor(x)`
`Teaches(x, y)`	`Author(y)`	`InLibrary(x)`
`StudiesHard(x)`	`Friendly(x)`	`Pet(x)`
`PassesExam(x)`	`Course(y)`	`Book(x)`
`WrittenBy(x, y)`	`Parent(x, y)`	`Takes(x, y)`

Note that `Teaches`, `WrittenBy`, `Parent`, and `Takes` are one-way relationships, i.e., Teaches(x, y) means x teaches y, not the other way around.

Question 4 (10 Marks):

Consider the following knowledge base (KB) in First-Order Logic (FOL):

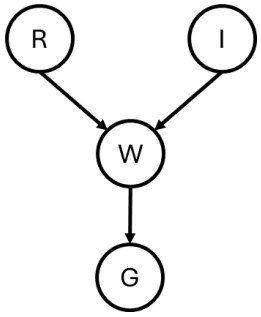
KB:	Meaning:
1. (∀x) bird(x) ⇒ hasWings(x)	"All birds have wings."
2. (∀x) (bird(x) ∧ hasWings(x)) ⇒ canFly(x)	"If x is a bird and has wings, then x can fly."
3. bird(Tweety)	"Tweety is a bird."

Prove that "Tweety" has the ability to fly using forward chaining (i.e., canFly(Tweety)). For each newly inferred sentence, show the Most General Unifier (MGU), i.e., (substitution list, θ).

Question 5 (10 Marks):

A Bayesian network is used to model a simplified smart farming system with the following binary variables: rain (R), proper irrigation (I), wet soil (W), and plant growth (G). The directed acyclic graph (DAG) and conditional probability table (CPT) of the network are given below:

DAG



CPT

P(R=true) = 0.2

P(I=true) = 0.6

R	I	P(W=true | R, I)
True	True	0.99
True	False	0.90
False	True	0.80
False	False	0.10

W	P(G=true | W)
True	0.95
False	0.20

A. Evaluate the overall joint probability of the Bayesian network. (2)

B. Evaluate the joint probability of wet soil and plant growth. (5)

C. Determine the independence of the following scenarios. (3)

a) Is R independent of G given W?

b) Are R and I independent?

c) Are R and I independent given W?