

ASSIGNMENT NO. 2

Q.1 Discuss the Forward chaining and Backward chaining algorithms. Illustrate the working of forward chaining and backward chaining for the following problem.

→ "The law says that it is crime for an American to sell weapons to hostile nations. The country Nono, an enemy of America, has some missiles, and all of its missiles were sold to it by Colonel West; who is American."

Inference Engine

It is the component of the intelligent system in AI; which applies logical rules to the knowledge base to infer new information from known facts.

Forward Chaining:

It is also known as a forward deduction or forward reasoning method when using an inference engine. Forward chaining is a form of reasoning which starts with atomic sentences in the knowledge base and applies inference rules (Modus Ponens) in the forward direction to extract more

data until a goal is reached.

The forward chaining algo, starts from known facts, triggers all rules whose premises are satisfied, and add their conclusion to the known facts. This process repeats until problem is solved.

Backward Chaining:

Backward Chaining is also known as a backward deduction or backward reasoning method when using an inference engine. A backward chaining algorithm is a form of reasoning, which starts with the goal and works backward, chaining through rules to find known facts that support the goal.

Using the example given in question;

Prove: Colonel is a Criminal.

Step 1: Convert facts to FOL

1) American (x) \wedge weapon(y) \wedge hostile(z) \wedge sells(x, y, z) \rightarrow criminal(x)

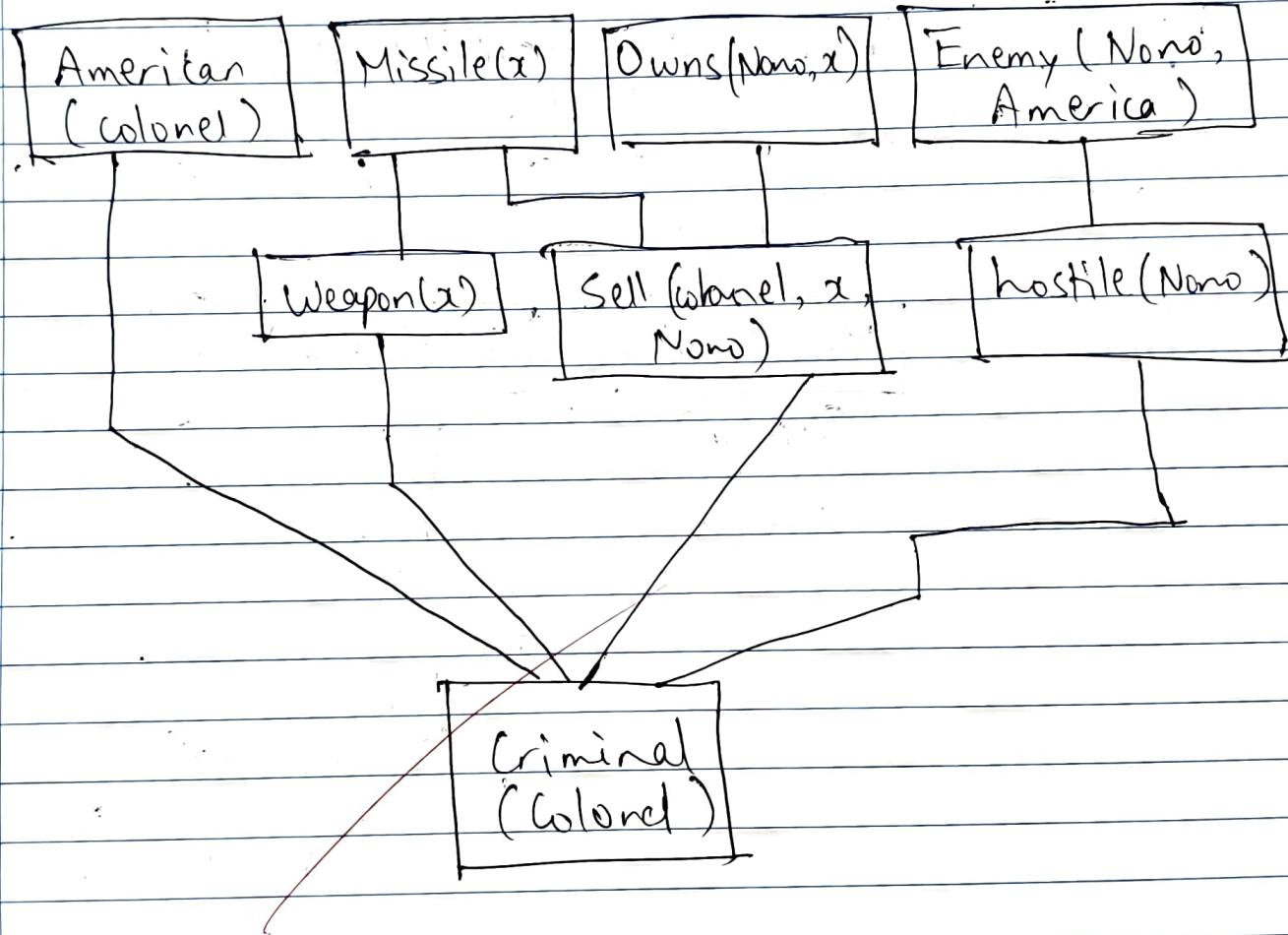
2) Enemy (None, America)

3> Owns(Nono, x)
4> Missile(x)

5> $\forall x : \text{Missile}(x) \wedge \text{owns}(\text{Nono}, x) \rightarrow \text{sell}(\text{colonel}, x, \text{Nono})$
6> Missile(x) \rightarrow Weapon(x)

Proof by Forward Chaining :

Start with all known Facts



Therefore, it is proved that "Colonel is a criminal".

Proof by Backward Chaining

Start with goal

(Goal)

Criminal (Colonel)

$\theta = \{\text{Colonel}/x\}$

American (Colonel) | Weapon(y) | Sell (Colonel, y, z) | hostile(z)

{ }
 3

True

Missile(y)

{x/y}

True

Sell (Colonel, y, z)

Missile(y)

{ }
 3

True

hostile(z)

Owns (None, y)

{ }
 3

True

Enemy (z, America)

{ }
 3

True

Since, all the statements are proved true,
 using backward chaining, therefore
 "Colonel" is a criminal.

Q.2 Consider following example and prove using resolution "Curiosity killed cat".

→ D Everyone who loves all animals is loved by someone.

$$\begin{aligned} & \forall x \text{ people}(x) [\forall y \text{ Animal}(y) \rightarrow \text{loves}(x, y)] \\ \longrightarrow & \exists z \text{ people}(z) \wedge \text{loves}(z, z) \end{aligned}$$

$$\begin{array}{l} \text{2) FOL: } \forall x \left[\exists z \text{Animal}(z) \wedge \text{kills}(x,z) \right] \\ \longrightarrow \forall y \neg \text{loves}(y,x). \end{array}$$

3) $\forall x \text{ Animal}(x) \rightarrow \text{loves(jack, } x)$

↳ kill(jack, Tuna) ∨ kill(Curiosity, Tuna)

5) Cat (Tuna)

6) $\forall x \text{Cat}(x) \rightarrow \text{Animal}(x)$

To prove : kills (curiosity, tune)

~~By contradiction, \neg kills(wriosity, twg)~~

Step 1: Convert to CNF

$$\begin{aligned} & \rightarrow \forall x \text{ people}(x) \left[\left[\neg \exists y \neg \text{Animal}(y) \vee \text{loves}(x, y) \right] \vee \right. \\ & \quad \left. \left[\exists z \text{ loves}(z, x) \right] \right] \\ & \hookrightarrow \forall x \left[\left[\exists y \text{ Animal}(y) \wedge \neg \text{loves}(x, y) \right] \vee \right. \\ & \quad \left. \left[\exists z \text{ loves}(z, x) \right] \right] \end{aligned}$$

◦ Skolemization :-

$$\forall x [\text{Animal}(f(x)) \wedge \neg \text{loves}(x, f(x))] \vee \text{loves}(g(x), x)$$

Drop universal quantifiers :-

$$[\text{Animal}(f(x)) \wedge \neg \text{loves}(x, f(x))] \vee \text{loves}(g(x), x)$$

$$2) \neg \text{loves}(y, z) \vee \neg \text{Animal}(z) \vee \neg \text{kills}(z, z)$$

$$3) \neg \text{Animal}(x) \vee \text{loves}(\text{jack}, x)$$

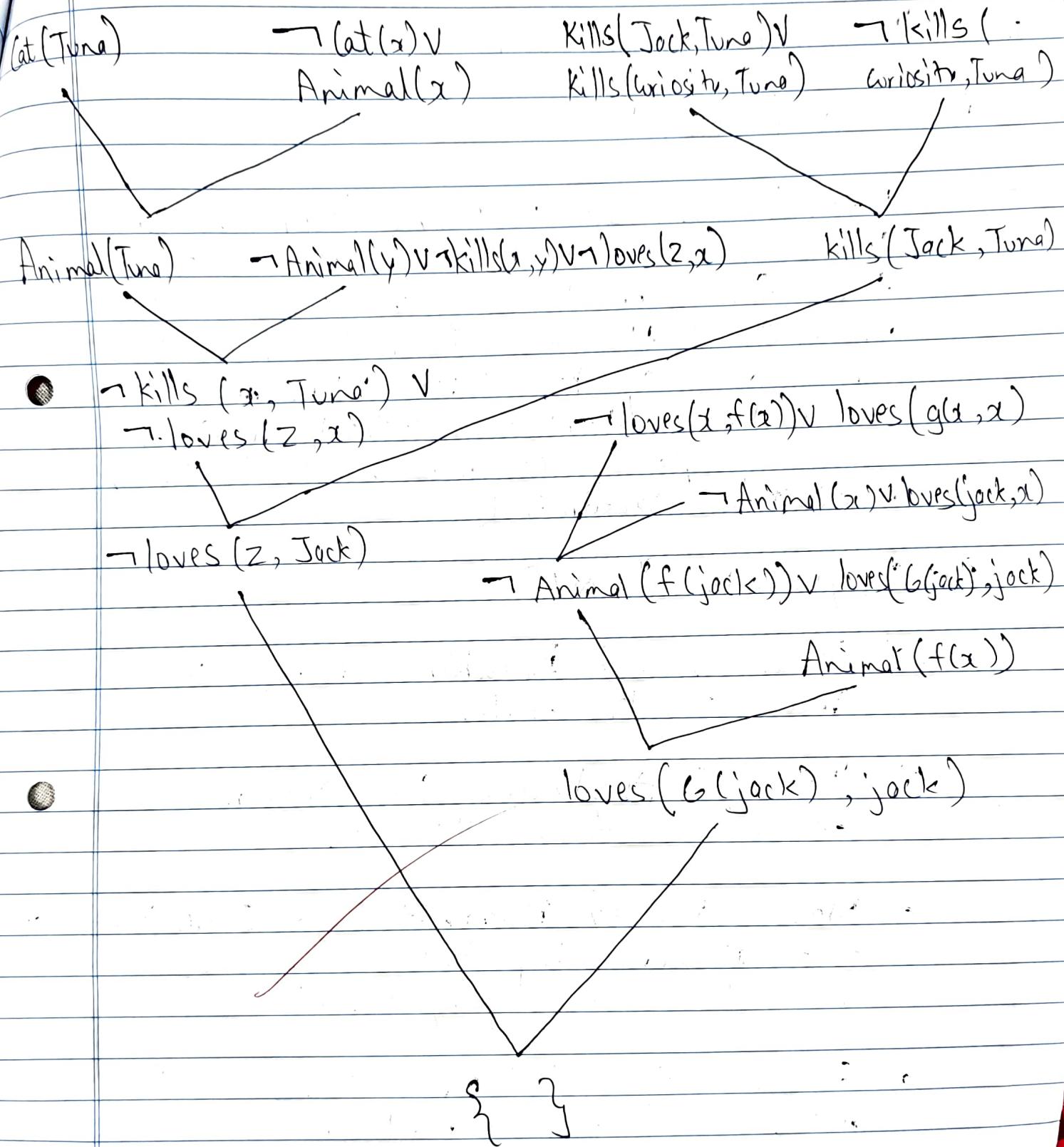
$$4) \text{kills}(\text{jack}, \text{Tuna}) \vee \text{kills}(\text{Curiosity}, \text{Tuna})$$

$$5) \text{cat}(\text{Tuna})$$

$$6) \neg \text{cat}(x) \vee \text{Animal}(x)$$

$$7) \neg \text{kills}(\text{Curiosity}, \text{Tuna})$$

Resolution graph :-



Q.3 Discuss in detail NLP.

1) What is NLP?

→ Natural language Processing (NLP) is a branch of AI within computer science that focuses on helping computers to understand the way that humans write and speak. With NLP, organizations can analyze text and extract information about people, places and events to better understand sentiments.

2) Components of NLP -

(a) Tokenization : Breaking down text into smaller units.

(b) Parsing : Analyzing the grammatical structure of sentences.

(c) Named Entity Recognition : Identifying and categorizing entities mentioned in text, such as people, places, etc.

(d) Semantic Analysis : Understanding the meaning of words within the given context.

(e) language generation: Creating human like text on given prompt/input.

3) Difficulties in NLP:

→ They arise due to complexities and ambiguity inherent in human language. Challenges include understanding context, dealing with slang, handling variations in syntax and grammar, resolving ambiguity, and accurately capturing nuances such as sarcasm or irony.

4) Steps involved in NLP:

- (a) Preprocessing
- (b) Tokenization
- (c) Parsing and Syntax analysis
- (d) Semantic analysis
- (e) Feature extraction
- (f) Model training
- (g) Evaluation and testing
- (h) Deployment

5) Role of NLP in AI:

NLP plays a crucial role by bridging gap

between human communication and machine understanding. It enables various apps and facilitates more effective human-computer interaction.

Q.4 What is Robotics? Discuss the role of AI in robotics. Brief up the application of robotics in health care and agriculture.

→ Robotics is a multi-disciplinary field that involves the design, construction, operation, and use of robots. Robots are programmable machines capable of carrying out tasks automatically often with varying degrees of human interaction.

Role of AI in Robotics:

The role of AI is significant, as it enables robots to perceive, learn, reason and act intelligently in dynamic environments.

Healthcare and Agriculture:

Following are some of the applications:
Surgery, Rehabilitation, Livestock Monitoring, Harvesting and Sorting.