

## Assignment No: 2

Q.1 Discuss the forward and backward chaining algorithm. Illustrate the working of forward and backward chaining for following problem.



- Forward Chaining

→ For any type of inference there should be a path from start to goal. When based on the available data a decision is taken then the process is called as the forward chaining.

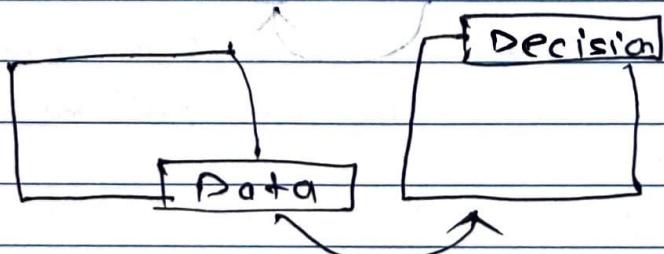
Forward chaining (or data-driven inference) works from an initial state, and by looking at the premises of the rules, performs the action, possibly updating the knowledge base or working memory.

This continues until no more rules can be applied or some loyale limit is met.

For example; "if it is raining then we will take umbrella".

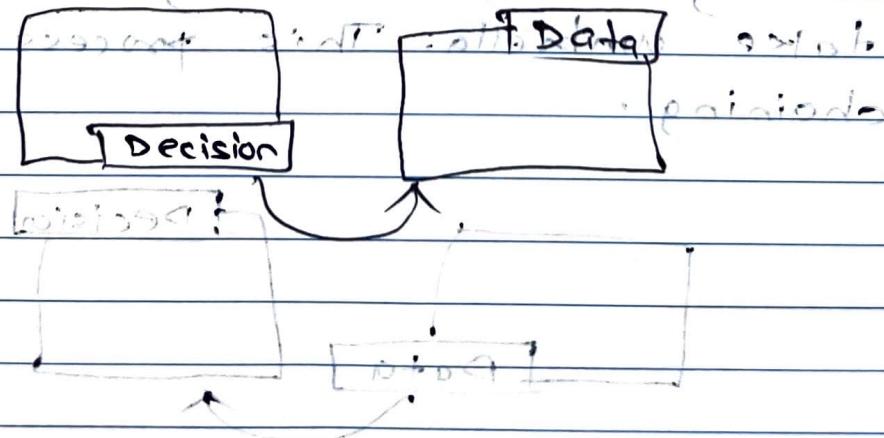
Here, "it is raining" is the data and "we will take umbrella" is a decision.

This means it was already known that it's raining ~~but~~ that's why it was decided to take umbrella. This process is forward chaining.



## Goal Formulation

- Backward Chaining: based on the source of the source
- ↳ If based on the decision the initial data needed is fetched, then it is called as backward chaining.
- Backward chaining or goal-driven inference works towards a final state, and by looking at the working memory to see if goal already there and if no such a step is not taken to establish goal and set up sub-goals for achieving premises of rules. This continues until some rule can be applied, applies to achieve goal like taking umbrella when going out.
- For e.g., If while going out one has taken umbrella then based on the decision it can be guessed that it is raining. Here, "taking umbrella" is a decision based on the data generated that "it is raining".
- This process is backward chaining and both several possible paths are shown with arrows between them to show which path is chosen.



• Illustration for given problem

- Given Problem :

The law says that it is a 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?

- 0 Village is not a nation
- Facts : 1) Nono is an enemy of America.
- 2) Colonel West is an American.

Rules : Selling weapons to hostile nation is a crime.

- 1) Selling weapons to hostile nation is a crime.
- 2) All of Nono's missiles were sold by Colonel West.

0. It is not logical to start with:

- Forward Chaining into known facts

- 1) Start with known facts

- 2) Apply rule 2 : Colonel West sold missiles to

Nono and Nono is a hostile nation

- 3) Apply rule 1 : Selling weapons to hostile nation is a crime for Americans.

- 4) Conclusion : Colonel West committed a crime

by selling missiles to Nono's part

Conclusion : [Forward]  $\leftrightarrow$  [Elimination] rule 6

- Backward Chaining is used and works well
- 1) Start with the goal: Colonel West committed a crime.
- 2) Check if there's rule that concludes Colonel West committed a crime. Rule 1 applies.
- 3) Check if the condition for Rule 1 is satisfied.
- 4) If Table proves Colonel West sold weapons to Nono, check if there's a rule or fact supporting this. Rule 2 applies.
- 5) Check if the condition for Rule 2 is satisfied.
- 6) Conclusion: Colonel West committed crime by selling missiles to Nono.

Q.2 Consider following examples and prove using Resolution

- Everyone who loves all animals is loved by someone
- Anyone who kills a cat is loved by no one
- Jack loves all animals
- Either Jack or Curiosity killed the cat, who is named Tuna
- Did Curiosity kill the cat?

Step 1: Negate the statement to be proved

What kills (Curiosity, Tuna)

Step 2: Converting given statement to FOL

$$a) \forall x [\forall y \text{Animal}(y) \Rightarrow \text{Loves}(x, y)] \Rightarrow \exists y \text{Loves}(x, y)$$

- b)  $\forall n [\exists z \text{ Animal}(z) \wedge \text{kills}(n, z)] \Rightarrow \forall y \sim \text{Loves}(y, n)$
- c)  $\forall n \text{ Animal}(n) \Rightarrow \text{Loves}(\text{Jack}, n)$
- d)  $\text{kills}(\text{Curiosity}, \text{Tuna}) \wedge \neg \text{kills}(\text{Curiosity}, \text{Tuna})$
- e)  $\text{Cat}(\text{Tuna})$
- f)  $\neg \text{kills}(\text{Curiosity}, \text{Tuna})$

~~Step 3: Converting FOLs to CNF~~

~~Conjunctive normal form~~

~~Disjunctive~~

~~Normal form~~

~~Conjunction~~

a)  $\text{Animal}(F(n)) \vee \text{Loves}(g(n), n)$

$\sim \text{Loves}(n, F(n)) \vee \text{Loves}(g(n), n)$

~~(Cnf) animal~~

~~(Cnf) loves~~

b)  $\neg \text{Loves}(y, n) \vee \neg \text{Animal}(z) \vee \neg \text{kills}(n, z)$

~~(Cnf) not loves~~

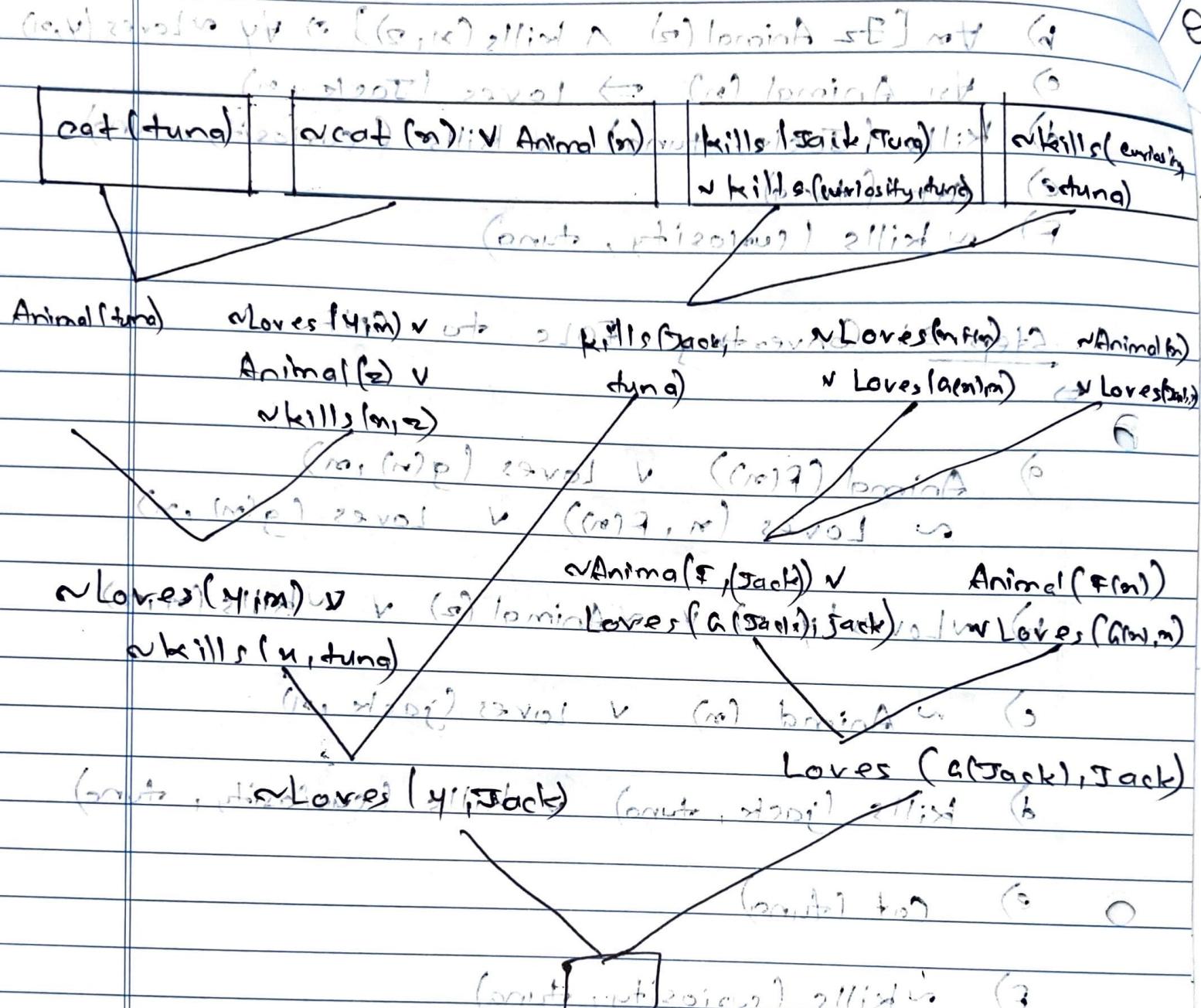
c)  $\neg \text{Animal}(n) \vee \text{Loves}(\text{Jack}, n)$

d)  $\text{kills}(\text{Jack}, \text{Tuna}) \wedge \neg \text{kills}(\text{Curiosity}, \text{Tuna})$

e)  $\text{Cat}(\text{Tuna})$

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

Step 4: Proof by resolution



motherless and David : P gets.

Q.3 Discuss in detail NLP elaborating on the following points:

- 1) What is NLP? Explain its area of applications.  
⇒ As the name suggests, Natural Language Processing involves machines or robots to understand and process the language that human speaks, and infer knowledge from the speech input.  
- It also involves the active participation from machine in the form of dialog i.e. NLP aims at the text or verbal output from the machine or robot.  
- The input and output of an NLP system can be speech and written text respectively.

2) Components of NLP: (i.e., Explain)

- ⇒ Mainly there are two components of NLP:

- a) Natural Language Understanding (NLU)  
⇒ In this part of the process, the speech input gets transformed into the useful representation in order to analyze various aspects of the language.
- As the natural language is very rich in forms and structures, it is also very ambiguous. There can be different forms of ambiguities like lexical ambiguity, which is a very basic i.e. word level ambiguity.

## b). Natural Language Generation (NLG) :-

- ⇒ In order to generate the output text, the intermediate representation requires to be converted back to the 'natural language format'. Hence in this process there are multiple sub-processes involved in generating the text.
  - They are as follows:-
    - i) Text planning
    - ii) Sentence planning
    - iii) Text Realization

3)

## Difficulties in NLG :-

- ⇒
  - a) Ambiguity : Natural language is inherently ambiguous, with words and phrases often having multiple meanings depending on context.
  - b) Variability : Language usages vary greatly across different regions, dialects, and social groups, making it challenging to create generalized models.
  - c) Lack of context : Understanding the context in which words and phrases are used is crucial for accurate interpretation.

Q) Steps involved in NLP. (Answer) (P)

→ To accomplish the primary task of NLP we have to undergo a Lexical analysis first and then a syntactic analysis.

### Syntactic Analysis

→ After the primary, Semantic Analysis follows.

→ Then Pragmatic analysis follows.

Q) What is the process of Discourse integration?

→ Pragmatic analysis is the process of discourse integration.

Q) Lexical Analysis is the first step.

→ Lexicon is the words and phrases in language. Lexicon analysis deals with the recognition and identification of structure of the sentences. Lexical analysis is divided into morphological and grammatical analysis.

Q) Syntactic Analysis is the second step.

→ In syntactic analysis the sentences are parsed as noun, verbs, adjective and other parts of sentences.

Q) Semantic Analysis is the third step.

→ In this phase, the actual meaning of the sentence is extracted from the structure and the words used.

4) Discourse Integration

⇒ The meaning of discourse with respect to NLP is nothing, but the context of the sentence or a word.

5) Pragmatic Analysis

⇒ Pragmatic deals with meaning of the sentences in various situations. In this, the sentences are interpreted to verify the correctness of the meaning in a given context.

6) Role of NLP in Applications

⇒ i) Language translation

a) Language translation

⇒ NLP powers machine translation system that can translate text between different languages, breaking down language barriers and facilitating languages on a global scale.

b) Information retrieval

⇒ NLP techniques are used to extract relevant information from large volumes of text, enabling systems to search, index and organize textual data effectively.

⇒ To extract features of sentences such as:

- basic about who has what info

## 1. Applications of NLP

In our daily life we use NLP in many ways.

- 1) **Voice Assistants** like Siri, Google Assistant etc.
- 2) **Chatbots** like Facebook messenger, WhatsApp etc.
- 3) **Autocomplete tools** like Google search.
- 4) **Language translation** like Google Translate.
- 5) **Sentiment analysis** in todays A.I.
- 6) **Text extraction** from columns.
- 7) **Content moderation** like YouTube.

Applications of NLP in PA are as follows:

1. **Text processing** in PA is done by NLP.

2. **Text generation** in PA is done by NLP.

3. **Text mining** in PA is done by NLP.

4. **Text classification** in PA is done by NLP.

5. **Text summarization** in PA is done by NLP.

6. **Text clustering** in PA is done by NLP.

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11. **Text clustering** in PA is done by NLP.

Q.4 What is robotics? Discuss the role of AI in robotics. Brief the applications of robotics in healthcare and agriculture.

- ⇒ Robotics is a multidisciplinary field that involves the design, construction, operation and use of robots.
- A robot is a machine that is capable of carrying out tasks automatically, typically with some degree of autonomy.

Roles of AI in Robotics :-

- 1) Perception
- ⇒ AI algorithm enables robot to perceive and interpret this environment using sensors such as camera, lidar, radar, etc.
- 2) Planning and Decision making
- ⇒ AI algorithms empower robots to plan and execute tasks autonomously by analyzing sensor data, generating trajectories, and making decision in real-time.
- 3) Learning and Adaptation
- ⇒ AI techniques such as machine learning and reinforcement learning enables robots to learn from experience and improve their performance over time.

- Application of Robotics :-

1) Healthcare

⇒ When we talk about human lives and health, any technologies that can give more efficient, helpful and faster analysis to hand out a proper treatment plan in time are tremendously valuable.

- Artificial intelligence and its subdivision ML is taking over the world right now.
- One of the best ml of healthcare application is a bot system that makes the treatment period much easier.
- There is huge application of ml in healthcare algorithms in the fields of oncology, pathology and Rare diseases.

2) Agriculture

- ⇒ Robotics is transforming agriculture with the development of autonomous vehicles such as drones and robotics tractor.
- These vehicles can perform tasks such as planting, spraying pesticides and harvesting crops with precision and efficiency, reducing labor costs and increasing productivity.

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