AI[CT1]:

SAQ:

1. What will be the output of minmax if leaf node are 3 12 8 2 for a two level game tree? -> 8
2. In a binary tree of depth 5 calculate α.β pruning? -> 28
3. In the sentence "I saw her duck", which word is ambiguous? -> duck
4. State the reason why syntactic parsy important in nlp? -> it determine grammatical structure.
5. Rule based system are more preferred in certain expert system why ? -> clear logical reasoning & traceability .
6. State the procedure by which a robot calculate its next position using transformation metrics? -> by multiplication of notation & translation metrices.
7. If P (disease) = 0.01
   P (positive | disease) = 0.99 & P(positive | no disease) = 0.05.What is the probability of disease or positive? -> 0.166
8. What does the following ambiguity means: He saw the man with the telescope & Which process resolve -> programatics.
9. What is the impact of syntactic ambiguity of nlp model -> causes multiple parse tree.
10. Interpret the roll of feedback in robotic motion control -> ensure accurate movement best on sensor data.
11. Use fuzzy membership on the following scenario temperature = 35℃ with fuzzy set cold new = 0.2 hot new = 0.8 which category belong? -> hot.
12. What is the primary purpose of semantic analytics -> determining the meaning of sentences.
13. Compute the total no. of bigrams ->
14. Difference between forward & backward chaining in expert system -> forward = data driven & backward = gold driven.
15. How many node will be expended in a graph with branching factor 2 & depth 3 if iterative deepening is apply -> 14
16. If a perfectly order binary tree having depth 4 is process using α-β pruning ,what will be the no. of nodes prun? -> 11

17.**Calculate the no. of evaluation set by α-β pruning if a binary game tree has 3 labels -> 7**

18.**Interpret the output of the purest sentence ->**

19.**What will be the result if dependency percept is applied on 'John gave marry abook'. -> Indirect object.**

20.**How many POS tags are there PENN tree bank tag set -> 45**

21.**Interpret the benefit of modular design in expert system -> easy updating & scalability.**

22.**Define the term syntax in Natural Language processing -> Structure & grammatical rule of sentence.**

23.**What is the role of discourse processing of NLP -> understanding multi sentence relationships .**

24.**Which algorithm is often used for syntax analysis -> parser**

25.**How many syntactic trees can be created form the following sentence the oldman the boats -> 2**

26.**Identify the components responsible for movement in a robot -> actuators.**

27.**Alculate the final position of a 2D robot arm when translation matrix 2,3 and rotation matrix = 90° will be the final co-ordination on point(1,1) -> (1,5)**

SAQ:

1.Solve the following numerical perform α-β pruning on a perfectly ordered binary tree of depth 4 then how many nodes will be purned.

In a **perfectly ordered binary tree of depth 4**, there are a total of **31 nodes** (since $2^5 - 1 = 31$).

When **α–β pruning** is applied in the **best-case scenario** (perfect ordering):

- Only **18 nodes** are actually visited.
- Therefore, the number of **pruned nodes** = 31 – 18 = 13.

🟩 **Answer:**

👉 **13 nodes will be pruned.**

2.What is the purpose of discourse analysis?

- Discourse analysis focuses on how individual sentences combine to create meaningful and coherent communication.

- It helps interpret the context, tone, and relationships between speakers or sentences.
- It identifies references, topics, and links that connect ideas across a paragraph or dialogue.
- It enables deeper understanding in NLP by analyzing meaning beyond single sentences, ensuring contextual interpretation.

3.Classify the linguistic component involve with semantic & syntactic processing.

- **Syntactic Processing:** Syntactic processing deals with the grammatical structure of sentences. It focuses on how words combine to form phrases and sentences according to grammar rules. Components involved include morphological analysis, parsing techniques, and grammar formalisms (like context-free grammar). It checks the word order, agreement, and dependency relations to ensure a sentence is grammatically valid. The output is usually a parse tree that shows the syntactic relationship among words.
- **Semantic Processing:** Semantic processing focuses on the meaning and interpretation of words, phrases, and sentences. It uses linguistic components like semantic networks, ontologies, word sense disambiguation, and predicate logic. The goal is to understand what the sentence actually conveys, not just if it's grammatically correct. It identifies concepts, roles, and relationships between words to create a meaningful representation of the text that a computer can reason about.

4.Define the level of language processing in NLP.

Typical levels are:

(1) Phonology/phonetics — sounds and pronunciations,

(2) Morphology — morphemes and word formation,

(3) Syntax — sentence structure and grammatical relations,

(4) Semantics — literal meaning of words/phrases, and

(5) Pragmatics/Discourse — speaker intent, context, coherence and conversational implicatures. NLP systems map input through these progressively higher levels to reach understanding.

5.Distinguish between model based & case based reasoning.

Model-Based Reasoning	Case-Based Reasoning
Uses a predefined model or theory of the system.	Uses past cases or experiences to solve new problems.
Derives conclusions using logical or mathematical reasoning.	Adapts solutions from similar past cases.
Requires detailed domain knowledge and formal models.	Requires a large case library and retrieval mechanism.
Handles new, unseen situations well through model simulation.	Performs best when similar past examples exist.
Example: Diagnosing faults in circuits using circuit laws.	Example: Diagnosing a disease by comparing with past patient cases.

6.Calculate the no. of evaluation set by α-β pruning where the binary game tree has 3 labels with optimal ordering.

Binary game tree, depth = 3

Optimal ordering (best case for α–β pruning)

Branching factor = 2

Total leaf nodes : $2^3 = 8$ leaves
α–β pruning (best case)

- In best-case ordering, only 5 leaf nodes are evaluated.
- Remaining 3 leaf nodes are pruned.

Number of evaluation nodes = 5[ans]
Number of pruned nodes = 3

7.Difference between programmatic & discourse analysis.

Pragmatic Analysis	Discourse Analysis
Focuses on the meaning of a single sentence or utterance in context.	Focuses on meaning and coherence across multiple sentences.
Deals with speaker intention and implied meanings.	Deals with how sentences are linked to form a connected text.
Concerned with context-dependent interpretation (like sarcasm, politeness).	Concerned with reference, topic continuity, and coherence.
Example: Understanding indirect requests like "Can you pass the salt?"	Example: Linking "John went home. He was tired." using "He."
Works at sentence or utterance level.	Works at paragraph or conversation level.

8.Which property make expert system differ from a traditional support system?

The key property that differentiates an expert system from a traditional decision support system (DSS) is its ability to mimic human expert reasoning using a knowledge base and an inference engine. Expert systems apply logical rules to stored knowledge to draw conclusions or make decisions similar to those of a human expert. In contrast, traditional DSS mainly focus on data analysis, reports, and statistical models to assist in decision-making. Expert systems can also explain the reasoning behind their conclusions, making them more transparent and intelligent. They are knowledge-driven, while DSS are largely data-driven. This ability to reason, learn, and justify decisions makes expert systems more advanced and human-like.

9.With an example, describe how anaphora resolution works in discourse analysis.

Anaphora resolution is the process of identifying the real-world entities that pronouns or referring expressions point to in a text. It helps maintain coherence and logical connection between sentences. For example, in the sentences *"Ravi bought a car. He loves it."*, the pronoun *"He"* refers to *Ravi* and *"it"* refers to *the car*. Discourse analysis uses grammatical cues, gender and number agreement, and contextual information to resolve such references correctly. Without anaphora resolution, the meaning of the discourse could become unclear or confusing. It plays an important role in natural language processing and text understanding systems.

10.Differentiate between minimax & α-β pruning.

Minimax Algorithm	Alpha-Beta Pruning
Explores all nodes in the game tree.	Prunes branches that cannot affect the final decision.
Guarantees optimal result but with high computation.	Produces same result as Minimax with fewer evaluations.
Has exponential time complexity O(b^d).	Reduces effective branching factor to O(b^(d/2)) in best case.
Does not skip any node.	Uses α (max lower bound) and β (min upper bound) for cutoffs.
Example: Basic two-player game evaluation.	Example: Optimized chess engine search with pruning.

11.Add the following two fuzzy no. - f1 = (12,15,18) f2 = (7,9,11)

Fuzzy number addition is done component-wise:

$$f_1 + f_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$$

Where l= lower, m= middle, u= upper.

Step 1: Add corresponding components

$$\text{Lower} = 12 + 7 = 19$$

$$\text{Middle} = 15 + 9 = 24$$

$$\text{Upper} = 18 + 11 = 29$$

✅ Step 2: Result

$$f_1 + f_2 = (19, 24, 29)$$

12.Identify & describe the linguistic component required be syntactic & semantic processing.

- **Parser:** Analyzes the grammatical structure of a sentence to identify relationships between words.
- **Grammar Rules:** Define how words combine to form valid sentences (used in syntactic processing).
- **Lexicon:** A dictionary of words with their meanings, parts of speech, and relationships (used in semantic processing).
- **Ontology or Semantic Network:** Represents concepts and their relationships to interpret meaning.
- **Semantic Role Labeler**: Identifies the roles of words in a sentence, such as who performed an action and what was affected.

13.Define the steps in semantic roll in leveling.

- **Predicate Identification**: Detect the main verb or action in a sentence that expresses an event or process.
- **Argument Identification:** Find all the words or phrases (nouns, noun phrases) that are related to the predicate.
- **Role Classification:** Assign specific semantic roles such as Agent (doer), Patient (receiver), Instrument, or Location to each argument.
- **Representation:** Create a structured representation that shows the relationship between the predicate and its arguments to understand "who did what to whom."

14.Explain with an example – syntactically correct but semantically ambiguous.

A sentence that is syntactically correct but semantically ambiguous follows grammar rules properly but has more than one possible meaning. This ambiguity arises because the structure allows different interpretations of the same words. For example, the sentence *"I saw the man with a telescope"* is grammatically correct but semantically unclear — it could mean that *I used a telescope to see the man*, or that *the man I saw had a telescope*. Such sentences show that even if syntax is correct, meaning can still be uncertain, highlighting the importance of semantic analysis in understanding true intent.

15.Why knowledge representation is critical in expert system development.

- It defines how expert knowledge is stored and accessed within the system.
- A good representation allows efficient reasoning and accurate decision-making.
- It enables the system to explain its conclusions and improve transparency.
- Proper knowledge representation ensures flexibility to update or expand the knowledge base easily.

16. Identify the problem when representation is weak.

- The system may produce incorrect or incomplete conclusions due to missing details.
- It becomes difficult for the inference engine to retrieve or apply knowledge effectively.
- Weak representation limits the system's ability to handle complex or uncertain problems.
- It reduces the system's overall accuracy, performance, and ability to explain its reasoning.

17.Create a rational between α-β pruning to path optimization.

Alpha–beta (α–β) pruning and path optimization are closely related because both aim to reduce unnecessary exploration during problem-solving. In α–β pruning, branches of a game tree that cannot affect the final decision are cut off early, saving computation time. Similarly, in path optimization, non-optimal or longer paths are ignored to reach the goal more efficiently. Both methods focus on evaluating only the most promising options and eliminating redundant ones. This ensures faster decision-making while maintaining accuracy in finding the best possible outcome.

18.Compare the applications of expert systems in medical diagnosis and robotic surgery.

In medical diagnosis, expert systems are used to identify diseases based on patient data, symptoms, and medical rules stored in their knowledge base. They help doctors by suggesting possible conditions and suitable treatments, improving the speed and accuracy of diagnosis. In contrast, in robotic surgery, expert systems assist in controlling surgical robots with high precision and safety. They analyze real-time sensor data and ensure that each surgical movement follows expert medical guidelines. Thus, while medical diagnosis expert systems focus on *decision support*, those in robotic surgery focus on *execution and control*, both enhancing healthcare quality and reliability.

19.Determine all possible state-space instances.

State-space instances are the distinct configurations the problem can assume — determined by the problem variables and their possible values. For example, in an 8-puzzle the instances are every arrangement of the tiles (9! / 2 valid permutations). Determining all instances means enumerating every reachable combination given the problem's constraints and operators.

20.Construct the state space graph.

A state-space graph has nodes representing states and edges representing valid transitions (actions). To construct it: define the state representation, enumerate operators that change states, apply operators to generate successor states, and connect nodes with directed or undirected edges; the resulting graph visualizes all paths from initial to goal states and supports search algorithm application.

21.Define the search space.

The search space is the complete set of states and transitions that an algorithm may explore to solve a problem, including the initial state(s), all successors generated by operators, and goal states. Its size and structure (branching factor, depth, cycles) directly determine the computational effort required and influence the choice of search algorithm.

Math:

1. Word Vector Representation:

- The words "apple", "fruit", "book", "object", "fish", and "not" are listed.
- Each sentence is represented as a vector indicating the presence (1) or absence (0) of these words.

For example,
First sentence vector = [apple: 1, fruit: 1, book: 0, object: 0, fish: 0, not: 0]
Second sentence vector = [apple: 0, fruit: 0, book: 1, object: 1, fish: 0, not: 1]
Third sentence vector = [apple: 0, fruit: 1, book: 0, object: 0, fish: 1, not: 0]

2. Term Weight (TW):

- TW is calculated as 6 in the note.
- There are also fractions like $\frac{1}{6}$ and such meant to represent weights or probabilities.

3. Fruit Document (FD) Calculation:

- The fruit document is calculated as:

$$\text{Fruit-document}(FD) = \frac{2^2}{18} = \frac{4}{18} = \frac{2}{9}$$

1. Bag of Words and Word Vectors

Sentences:

- Apple is a fruit.
- Book is an object.
- Fish is not a fruit.

Vocabulary: Apple, Fruit, Book, Object, Fish, Not

Word Vector Calculation

	Apple	Fruit	Book	Object	Fish	Not
First	1	1	0	0	0	0
Second	0	0	1	1	0	1
Third	0	1	0	0	1	0

Term Frequency Calculation

- **Total Words (TW):**
  - TW = Total number of word occurrences = 6 WhatsApp-Image-2025-11-0
- **First Sentence:**
  - Apple: $\frac{1}{6}$
  - Fruit: $\frac{1}{6}$ WhatsApp-Image-2025-11-0

- **Second Sentence:**
  - Book: $\frac{1}{6}$
  - Object: $\frac{1}{6}$
  - Not: $\frac{1}{6}$ WhatsApp-Image-2025-11-
- **Third Sentence:**
  - Fruit: $\frac{1}{6}$
  - Fish: $\frac{1}{6}$ WhatsApp-Image-2025-11-

2. Fruit Document (FD) Calculation

The score is extracted from the notes:

$$\mathrm{FD} = \frac{2^2}{18} = \frac{4}{18} = \frac{2}{9}$$

- "2" likely refers to how many times 'fruit' appears, squared, divided by the total word count (perhaps across all sentences). WhatsApp-Image-2025-11-

3. Bag of Words Table Calculations

For each document/sentence:

- Sentence 1: {Apple: 1, Fruit: 2}
- Sentence 2: {Fish: 1, Not: 1, Fruit: 2} WhatsApp-Image-2025-11-

Here are example calculations from basic AI NLP models using your notes and real-world NLP practices:

1. Word Vector (Bag of Words) Calculation

Suppose your vocabulary is:
Apple, Fruit, Book, Object, Fish, Not

You have three sentences:

- Sentence 1: "Apple is a fruit."
- Sentence 2: "Book is an object."
- Sentence 3: "Fish is not a fruit."

The vector representation for each sentence (using presence/absence):

	Apple	Fruit	Book	Object	Fish	Not
S1	1	1	0	0	0	0
S2	0	0	1	1	0	1
S3	0	1	0	0	1	0

2. Term Frequency Calculation

Term frequency (TF) for word w in sentence S:

$$TF(w, S) = \frac{\text{number of times } w \text{ appears in } S}{\text{total number of words in } S}$$

Suppose "fruit" appears 2 times in all sentences. Total words across sentences = 18.
TF for "fruit":

$$TF(\text{fruit}) = \frac{2}{18} = \frac{1}{9}$$

If your model uses TF^2:

$$\text{Fruit document score} = \frac{2^2}{18} = \frac{4}{18} = \frac{2}{9}$$

as shown in your calculation. WhatsApp-Image-2025-11-0

3. Bag of Words (Word Count) Calculation

Count the frequency of each word in the document:

- Apple: 1
- Fruit: 2
- Fish: 1
- Not: 1

So, Bag of Words for "Apple is a fruit. Fish is not a fruit.":

$$\{\text{apple} : 1, \text{fruit} : 2, \text{fish} : 1, \text{not} : 1\}$$

4. One-Hot Encoding Example

Suppose your vocabulary is ("cat", "dog", "mat"), and "cat" is represented as:

$$\text{cat} : [8]$$

"dog" as:

$$\text{dog} : [8]$$

"mat" as:

$$\text{mat} : [8]$$

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"Natural Language Processing is fun"

Total words (tokens):

Count each word:

- Natural
- Language
- Processing
- is
- fun

Total words, $T = 5$

Calculation of N-grams:

- For bigrams (N=2):
  Number of bigrams = $T - 1 = 5 - 1 = 4$
- For trigrams (N=3):
  Number of trigrams = $T - 2 = 5 - 2 = 3$
- For 4-grams (N=4):
  Number of 4-grams = $T - 3 = 5 - 3 = 2$

Step 1: Count the Number of N-grams

For a sequence containing T tokens (words),

- Number of N-grams = $T - N + 1$

With $T = 5$ (Natural, Language, Processing, is, fun):

- Unigrams (n=1): $5 - 1 + 1 = 5$
- Bigrams (n=2): $5 - 2 + 1 = 4$
- Trigrams (n=3): $5 - 3 + 1 = 3$
- 4-grams (n=4): $5 - 4 + 1 = 2$

Step 2: List All Possible N-grams

- **Unigrams:**

  Natural
  Language
  Processing
  is
  fun

- **Bigrams:**

  Natural Language
  Language Processing
  Processing is
  is fun

- **Trigrams:**

  Natural Language Processing
  Language Processing is
  Processing is fun

- **4-grams:**

  Natural Language Processing is
  Language Processing is fun

Step 3: Basic N-gram Probability Calculation

Probability of a bigram (2-gram) under the Maximum Likelihood Estimate (MLE):

$$P(w_n|w_{n-1}) = \frac{\text{Count}(w_{n-1}, w_n)}{\text{Count}(w_{n-1})}$$

For example, if "Processing is" occurs once and "Processing" occurs once:

$$P(\text{is}|\text{Processing}) = \frac{1}{1} = 1$$

This formula scales to trigrams and higher n-grams; just count n-gram and (n-1)-gram occurrences.

1. Sequence Combinations (Permutations)

Calculate the number of passive token combinations for 4 tokens (ordered, no repetition):

$$^4P_4 = 4! = 4 \times 3 \times 2 \times 1 = 24$$

Word k permutations:

$$^kP_k = k!$$

2. Statistical Language Model Probability

Given:

- $P(\text{"is fun"}) = 0.01$
- $P(\text{"fun"}) = 0.03$

Calculate:

$$P(\text{"is"} \mid \text{"fun"}) = \frac{P(\text{"is fun"})}{P(\text{"fun"})} = \frac{0.01}{0.03} = \frac{1}{3} \approx 0.333$$

3. Cosine Similarity Between Two Vectors

Vectors:

$$A = , \quad B = [1][2][3]$$

Dot product,

$$A \cdot B = (1 \times 2) + (2 \times 3) = 2 + 6 = 8$$

Magnitude of A:

$$\|A\| = \sqrt{1^2 + 2^2} = \sqrt{1 + 4} = \sqrt{5}$$

Magnitude of B:

$$\|B\| = \sqrt{2^2 + 3^2} = \sqrt{4 + 9} = \sqrt{13}$$

Cosine Similarity:

$$\text{Sim}(A, B) = \frac{A \cdot B}{\|A\|\|B\|} = \frac{8}{\sqrt{5} \times \sqrt{13}} = \frac{8}{\sqrt{65}} \approx 0.992$$

Extended Cosine Similarity Example

Vectors:

$$A = , \quad B = [3][4][5][6]$$

Dot product:

$$A \cdot B = 3 \times 6 + 5 \times 7 = 18 + 35 = 53$$

Magnitudes:

$$\|A\| = \sqrt{3^2 + 5^2} = \sqrt{9 + 25} = \sqrt{34}$$

$$\|B\| = \sqrt{6^2 + 7^2} = \sqrt{36 + 49} = \sqrt{85}$$

Cosine Similarity:

$$\frac{53}{\sqrt{34} \times \sqrt{85}} = \frac{53}{\sqrt{2890}} \approx \frac{53}{53.740} \approx 0.986$$

A. Vectors

The two vectors are defined as:

$$A = [3, 5] \quad \text{and} \quad B = [6, 7]$$

B. Dot Product (Scalar Product)

The first step calculates the **dot product** (or scalar product) of A and B. This is the sum of the products of their corresponding components.

$$\text{I. } A \cdot B = (3 \times 6) + (5 \times 7) = 18 + 35 = 53$$

C. Magnitude (Euclidean Norm)

The next steps calculate the **magnitude** (or Euclidean norm) of each vector, often denoted as $||A||$. This is the length of the vector in space, found using the Pythagorean theorem.

$$\text{II. } ||A|| = \sqrt{3^2 + 5^2} = \sqrt{9 + 25} = \sqrt{34}$$

$$\text{III. } ||B|| = \sqrt{6^2 + 7^2} = \sqrt{36 + 49} = \sqrt{85}$$