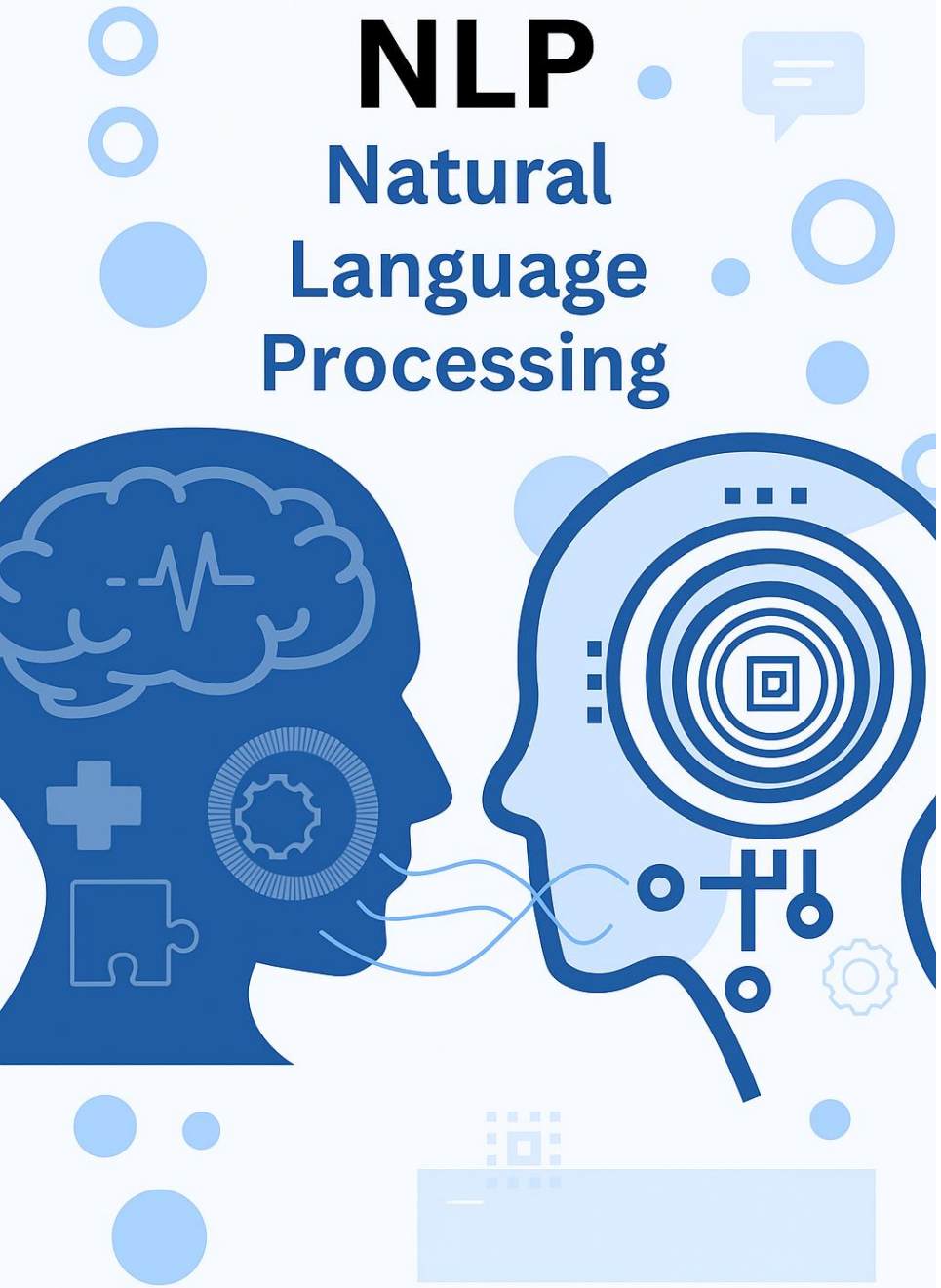

NATURAL LANGUAGE PROCESSING (NLP)

PMDS606L

MODULE 1

LECTURE 2

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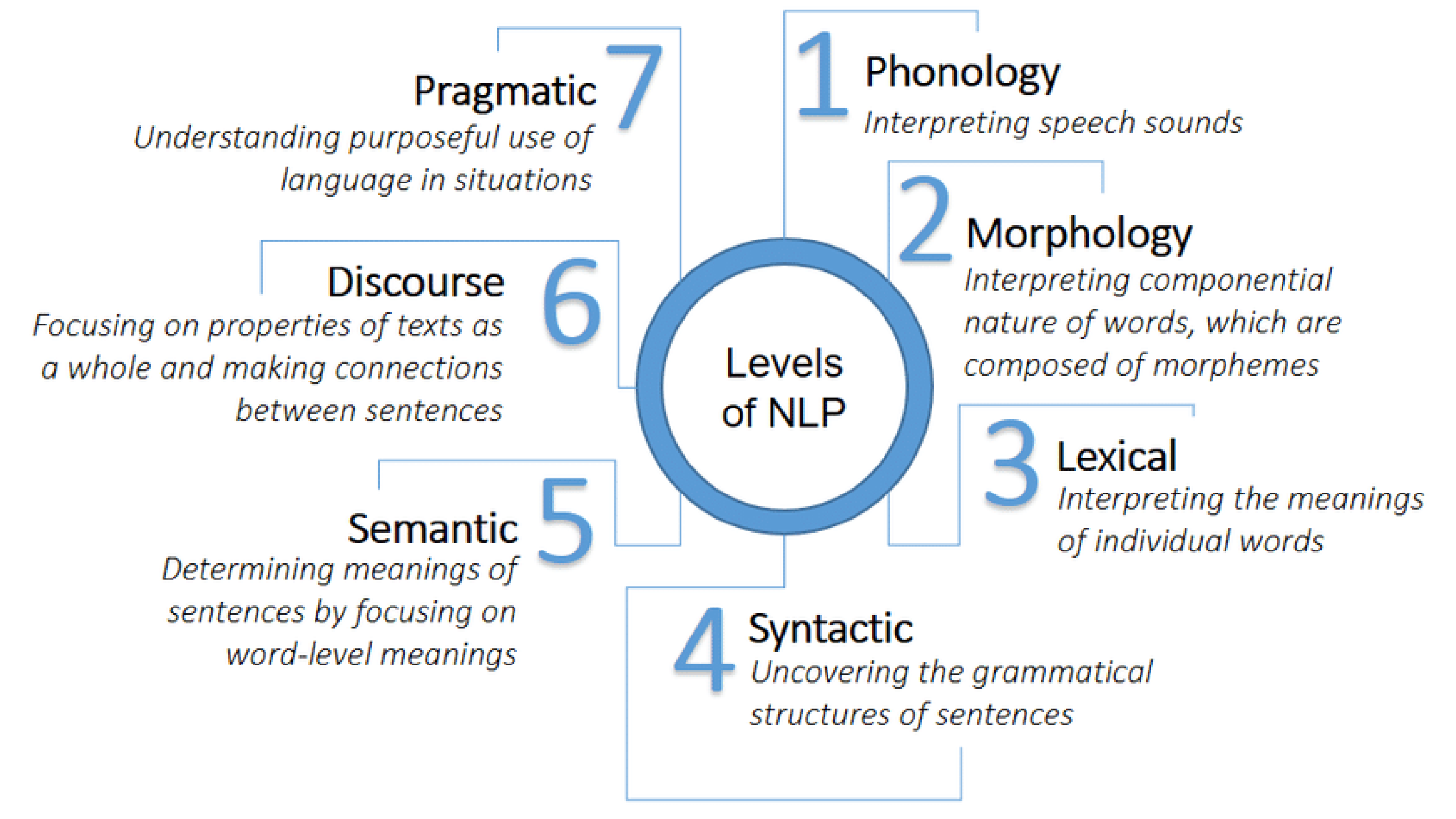
Levels of NLP
1 Phonology
Interpreting speech sounds
2 Morphology
Interpreting componential nature of words, which are composed of morphemes
3 Lexical
Interpreting the meanings of individual words
4 Syntactic
Uncovering the grammatical structures of sentences
5 Semantic
Determining meanings of sentences by focusing on word-level meanings
6 Discourse
Focusing on properties of texts as a whole and making connections between sentences
7 Pragmatic
Understanding purposeful use of language in situations

LEVEL 1: PHONOLOGICAL LEVEL

- Deal with: Sounds of Language (Phonemes)
- Goal: Understand how words are pronounced
- Applications: Speech Recognition, Text-to-speech, Speech-to-text.
- English has about **44 phonemes**, even though it has only 26 letters.

LEVEL 1: PHONOLOGICAL LEVEL

- **/p/** vs **/b/**

  "pat" → /pæt/

  "bat" → /bæt/

  The only difference is the first phoneme. Hence, /p/ and /b/ are different phonemes.

- **/k/** in:

  "cat" → /kæt/

  "cut" → /kʌt/

  Different vowel phonemes /æ/ vs /ʌ/ change the meaning.

LEVEL 2: MORPHOLOGICAL LEVEL

- Deals with: Structure of words (morphemes — smallest written units)
- Goal: Analyze and generate word forms.
- Example: “unbelievable” → un + believe + able
- Applications: Lemmatization, stemming, spell checking

LEVEL 3: LEXICAL LEVEL

- Deals with: Individual words and their meanings (dictionary level)
- Goal: Identify part of speech, word meaning, and word relationships.
- Tools: POS tagging, WordNet
- Applications: Named entity recognition (NER), keyword extraction

LEVEL 4: SYNTACTIC LEVEL

- Deals with: Sentence structure and grammar (syntax)
- Goal: Check if sentence follows grammatical rules.
- Applications: Grammar correction, machine translation

LEVEL 4: SYNTACTIC LEVEL

- **Parsing**
  Analyzing sentence structure according to grammar rules.
- **Constituency Parsing**
  Breaks the sentence into **nested phrases** (noun phrase, verb phrase, etc.).
  Example: Sentence: "The dog chased the cat."
    NP → "The dog", VP → "chased the cat"
- **Dependency Parsing**
  Finds **relations between words**, showing which words **depend** on others.
  Example:
    "chased" is the main verb
    "dog" is the subject of "chased"
    "cat" is the object of "chased"

LEVEL 5: SEMANTIC LEVEL

- Deals with: Meaning of sentences
- Goal: Understand what the sentence means logically
- Applications: Question answering, semantic search, chatbot responses

LEVEL 5: SEMANTIC LEVEL

- **Synonymy**
  "He is joyful" ≈ "He is happy"
- **Polysemy (Multiple meanings)**
  "I went to the bank"
  Which *bank*? (Need context)
- **Named Entity Recognition (NER)**
  "Apple" → Company or Fruit?
  "Barack Obama" → PERSON
  "India" → LOCATION
- **Semantic Role Labeling (SRL)**
  Who did what to whom?
  "John broke the window with a bat."
  Agent: John
  Action: broke
  Object: the window
  Instrument: bat

LEVEL 6: DISCOURSE LEVEL

- Deals with: Contextual meaning across sentences
- Goal: Understand how previous sentences affect current interpretation
- Example: In a conversation: “Rita dropped the vase. She was sad.” — Who was sad?
- Applications: Text summarization, coreference resolution

LEVEL 6: DISCOURSE LEVEL

User: I want to book a flight.
Bot: Sure. Where would you like to go?
User: Delhi.

Even though "Delhi" is a fragment, the **bot understands** it means **"I want to go to Delhi"**, based on previous discourse.

LEVEL 7: PRAGMATIC LEVEL

- Deals with: Real-world context and speaker's intention
- Goal: Understand implied meaning and social context
- Example: "Can you pass the salt?" is a request, not a question
- Applications: Chatbots, sarcasm detection, sentiment analysis

LEVEL 7: PRAGMATIC LEVEL

- "Oh great, another meeting. Just what I needed today!”

- **Why It's Hard for NLP:**

Literal words are **positive**, but context (e.g., too many meetings, tone, facial expression in real life) reveals **negativity**.

Requires understanding **speaker’s mood**, **background situation**, and **cultural use of irony**.

AMBIGUITIES

- Lexical Ambiguity
- Syntactic Ambiguity
- Semantic Ambiguity
- Pragmatic Ambiguity
- Anaphoric (Referential) Ambiguity

LEXICAL AMBIGUITY

- Meaning: A single word has multiple meanings.

- Example: “Bank” → could mean a riverbank or a financial institution.

Ambiguous Word	Possible Meanings	Example Sentences
Bank	1. Financial institution 2. River edge	- "I deposited money in the bank." - - "They sat on the river bank."
Bat	1. Flying animal 2. Sports equipment	- "The bat flew out of the cave." - - "He hit a six with the bat."
Seal	1. Animal 2. To close something tightly	- "The seal clapped its flippers." - - "Seal the envelope, please."
Pitch	1. Throw 2. Sales talk 3. Musical note	- "He made a great sales pitch." - - "The pitcher threw the pitch."
Light	1. Not heavy 2. Brightness	- "This bag is light." - - "Turn on the light."
Right	1. Correct 2. Direction 3. Legal claim	- "You're right." - "Turn right." - - "You have a right to speak."
Rock	1. Stone 2. Genre of music 3. Sway	- "He threw a rock." - - "I love rock music." - - "The boat began to rock."
Well	1. In good health 2. A water source	- "She is doing well." - - "They dug a well."
Date	1. A calendar day 2. A romantic meeting 3. Fruit	- "What's today's date?" - - "He went on a date." - - "I ate a date."
Watch	1. To observe 2. A timepiece	- "Watch the road!" - - "He looked at his watch."

SYNTACTIC AMBIGUITY

- Meaning: Sentence structure allows multiple interpretations.

- Example: “I saw the man with the telescope.”

→ Did I use the telescope, or did the man have it?

SYNTACTIC AMBIGUITY

- **"She watched the man on the hill with the binoculars."**
- **Meaning 1:** She used binoculars to watch the man who was on the hill.
- **Meaning 2:** She watched the man who was on the hill and had the binoculars.
- **Meaning 3:** She was on the hill, watching the man with binoculars.

SYNTACTIC AMBIGUITY

- **Visiting relatives can be annoying."**
- **Meaning 1:** The act of visiting relatives is annoying.
- **Meaning 2:** Relatives who visit can be annoying.

SEMANTIC AMBIGUITY

- Meaning: Sentence meaning is unclear, even if structure is correct.

- Example: “The chicken is ready to eat.”

→ Is the chicken going to eat, or be eaten?

SEMANTIC AMBIGUITY

- **"He saw her duck."**
- **Meaning 1:** He saw the woman lower her head quickly (verb: duck).
- **Meaning 2:** He saw the duck that belonged to her (noun: duck).

PRAGMATIC AMBIGUITY

- Meaning: Depends on speaker's intention or context.

- Example: "Can you open the door?"

→ Literally asking for ability, but meant as a request.

PRAGMATIC AMBIGUITY

- **"Do you know what time it is?"**
- **Meaning 1:** A question about your knowledge of the time.
- **Meaning 2:** A polite way of asking for the current time.

ANAPHORIC (REFERENTIAL) AMBIGUITY

- Meaning: Uncertainty in what a pronoun refers to

- Example: “Rita told Sita that she won.”

→ Who won?

ANAPHORIC (REFERENTIAL) AMBIGUITY

- **"When Sarah met Priya, she was very nervous."**
- **Who is "she"?**
  - Sarah was nervous.
  - Priya was nervous.

- **"Ravi called Arjun while he was driving."**
- **Who was driving?**
  - Ravi could be driving.
  - Arjun could be driving.