



# ARTIFICIAL INTELLIGENCE

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NATURAL LANGUAGE PROCESSING

CHRISTIAN SY

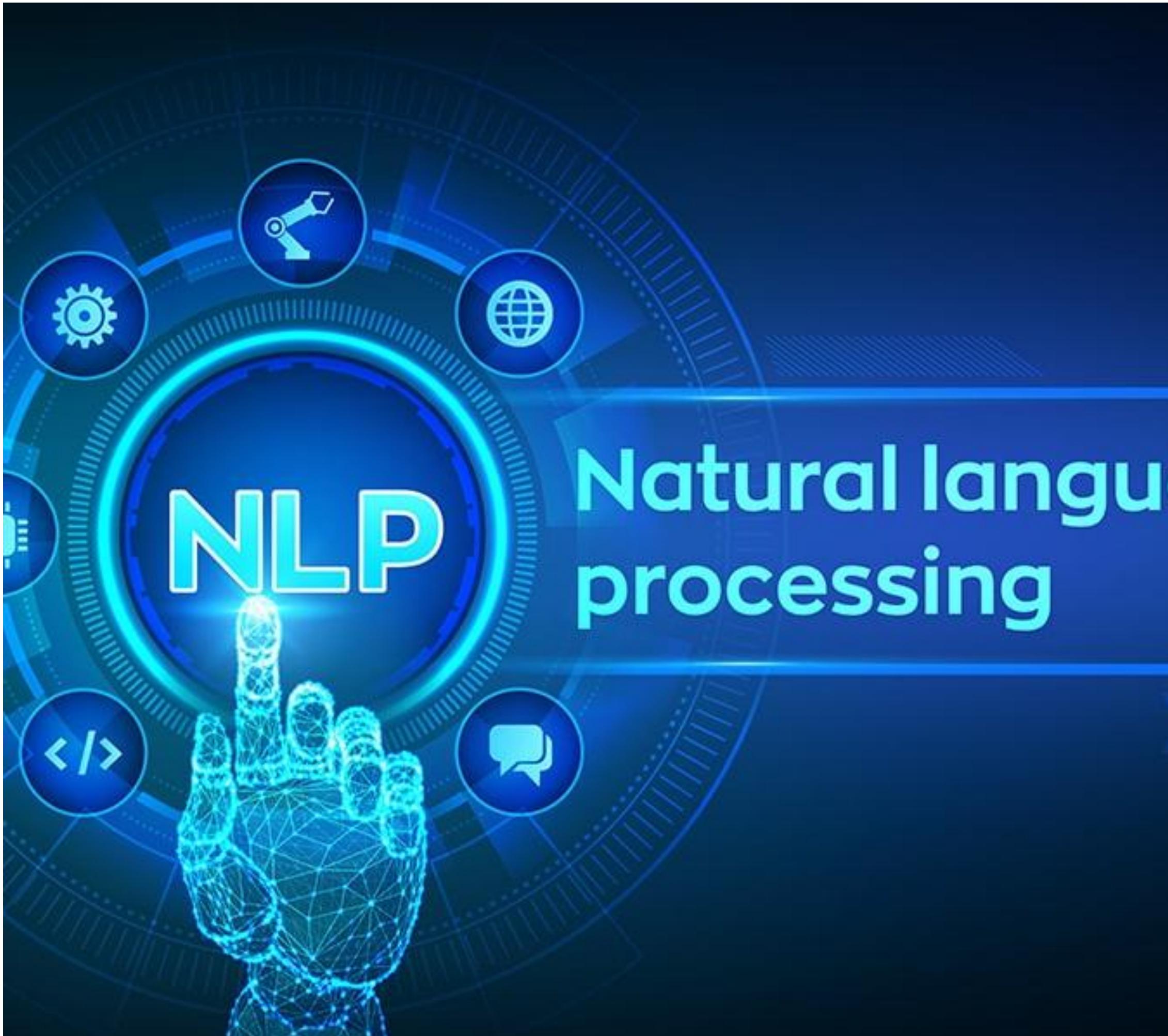
# SPECIFIC LEARNING OUTCOMES

By the end of this topic, students will be able to:

- 1 Define** the concept of Natural Language Processing (NLP) and **explain** its primary goals in computing and communication.
- 2 Differentiate** various NLP tasks across syntax, semantics, and pragmatics, and **identify** their roles in language understanding.
- 3 Apply** core NLP techniques such as Part-of-Speech (POS) tagging, parsing, and entity recognition using sample sentences.
- 4 Analyze** meaning and context in language through semantic tasks such as Word Sense Disambiguation and Sentiment Analysis.
- 5 Evaluate** real-world NLP applications in Philippine settings (e.g., tourism, education, government services) and **propose** relevant use cases or solutions.

# OUTLINE

1. WHAT IS NLP?
2. NLP GOALS
3. NLP APPLICATIONS
4. NLP TASKS
5. ROLE OF MACHINE
6. LEARNING IN NLP
7. CHALLENGES IN NLP



# NATURAL LANGUAGE PROCESSING

Think of NLP as a **translator** between humans and computers:

- ✓ Humans speak in sentences with meaning
- ✓ Computers understand only numbers and patterns
- ✓ NLP converts human language → machine understanding and back.

# NATURAL LANGUAGE PROCESSING

Natural Language Processing (NLP) is a field of Artificial Intelligence (AI) that focuses on enabling computers to understand, interpret, generate, and interact using human languages.

It bridges **human language** and **computer understanding** by combining:

- ✓ **Computational linguistics** → language rules & structure
- ✓ **Machine learning** → pattern recognition & learning from data
- ✓ **Deep learning** → advanced neural models for complex language tasks

**In simple terms:** NLP teaches machines how to read, write, listen, and speak like humans.

**Example:**

When you type “*Pizza near me*” into Google, it understands you want places selling pizza around your current location – not a pizza definition.

# NLP GOALS

The primary goals of NLP include:

- ✓ **Language Understanding**  
Extracting meaning and context from text or speech
- ✓ **Language Generation**  
Producing natural, fluent responses or text
- ✓ **Human–Computer Communication**  
Enabling intuitive interactions via chatbots, voice assistants, etc.
- ✓ **Knowledge Extraction**  
Deriving insights from large text data
- ✓ **Automation of Manual Language Tasks**  
Translation, summarization, editing, categorization, etc.

Goal	Example	Analogy
Understand language	Detecting positive/negative product reviews	Reading someone's facial expression
Generate language	ChatGPT writing responses	A person composing a reply
Enable communication	Siri responding to voice commands	Talking to a helpful assistant
Extract knowledge	Finding trends in customer feedback	A librarian scanning books for key info

# NLP APPLICATIONS

Application	Real-World Example
Machine translation	Google Translate, DeepL
Sentiment analysis	Brand monitoring, product reviews
Chatbots & Virtual Assistants	Siri, Alexa, ChatGPT
Speech recognition	Voice typing, call transcription
Text summarization	News summarizers, research tools
Information retrieval	Search engines like Google
OCR + Text extraction	Scanning and reading documents
Spam detection	Email filtering
Autocorrect & grammar checking	Grammarly, MS Word

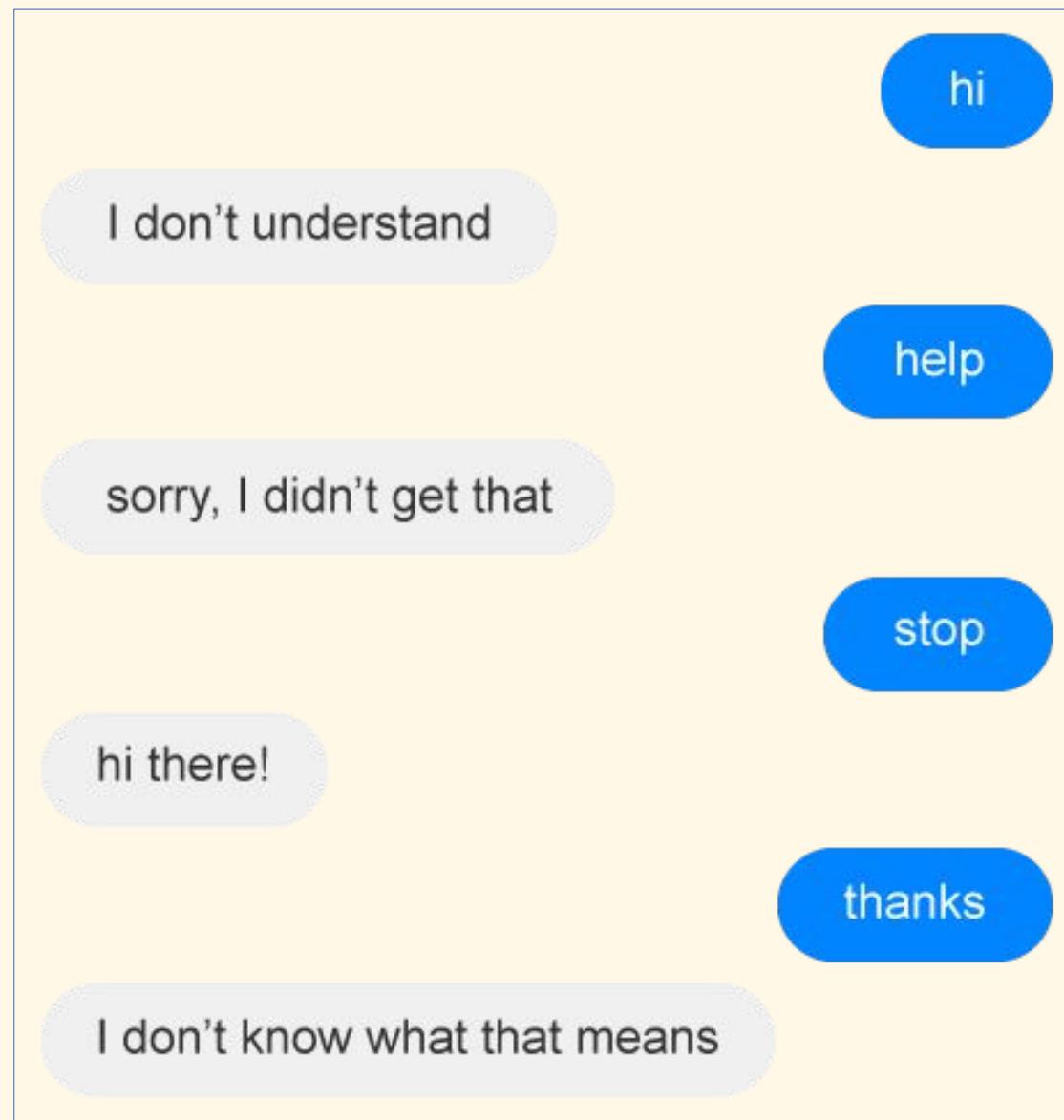
**NLP is everywhere – smartphones, banks, hospitals, education, business analytics, etc.**

# NLP APPLICATIONS

Application	Example in daily life	Why it matters
Machine translation	Google Translate	Breaks language barriers
Virtual assistants	Siri, Alexa	Hands-free help
Spam filtering	Gmail filtering junk mail	Protects users from threats
Sentiment analysis	Social media analytics	Businesses understand customers
Chatbots	Bank customer support	24/7 service
Autocomplete & autocorrect	Smartphone keyboard	Easier communication
Search engines	Google search queries	Faster info access
Document summarization	Tools that shorten long articles	Saves time

NLP used for **Filipino and Bicolano language translation** in local tourism/education apps.

# CHATBOTS



AA What kind of nlp application is chatgpt?

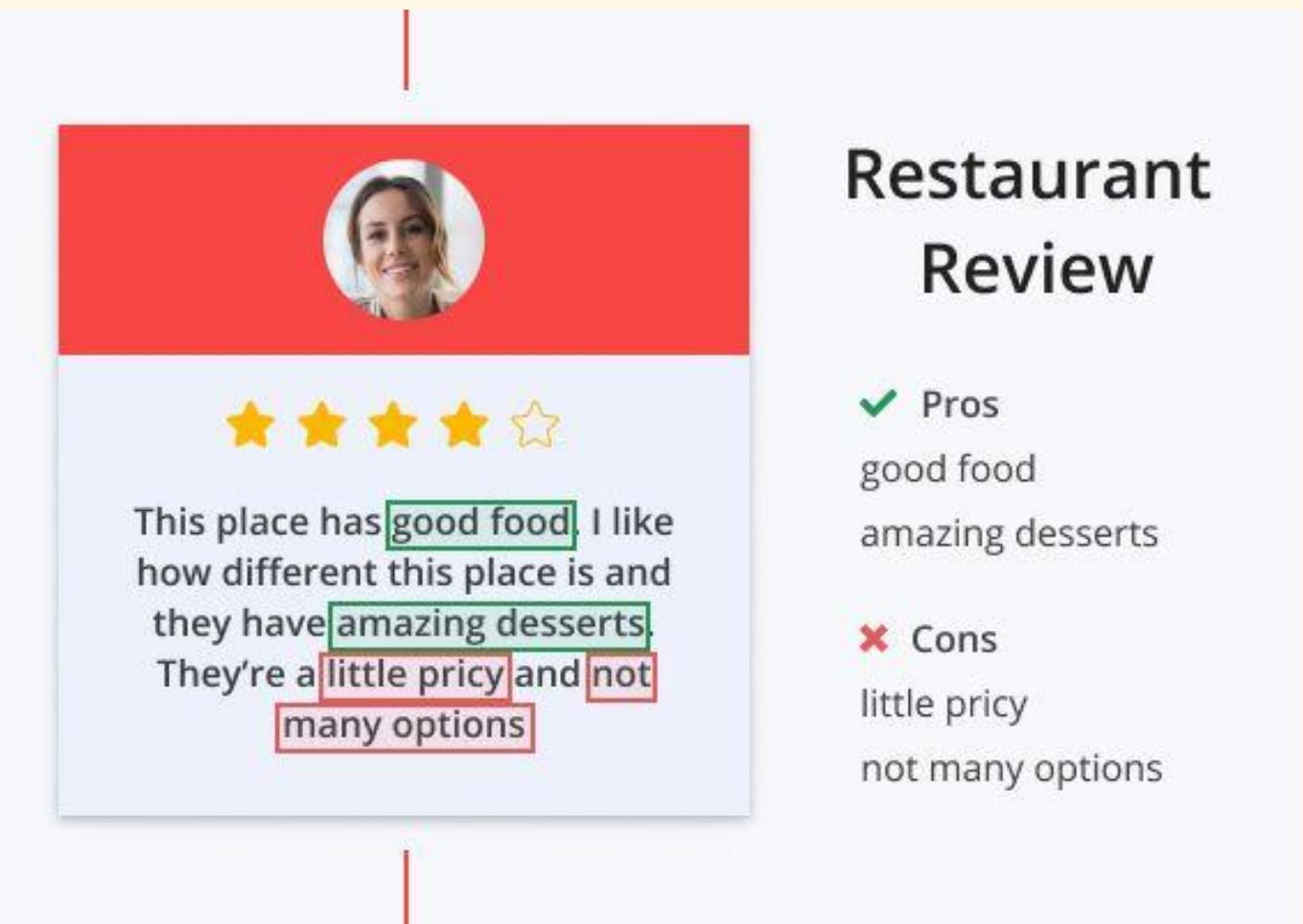
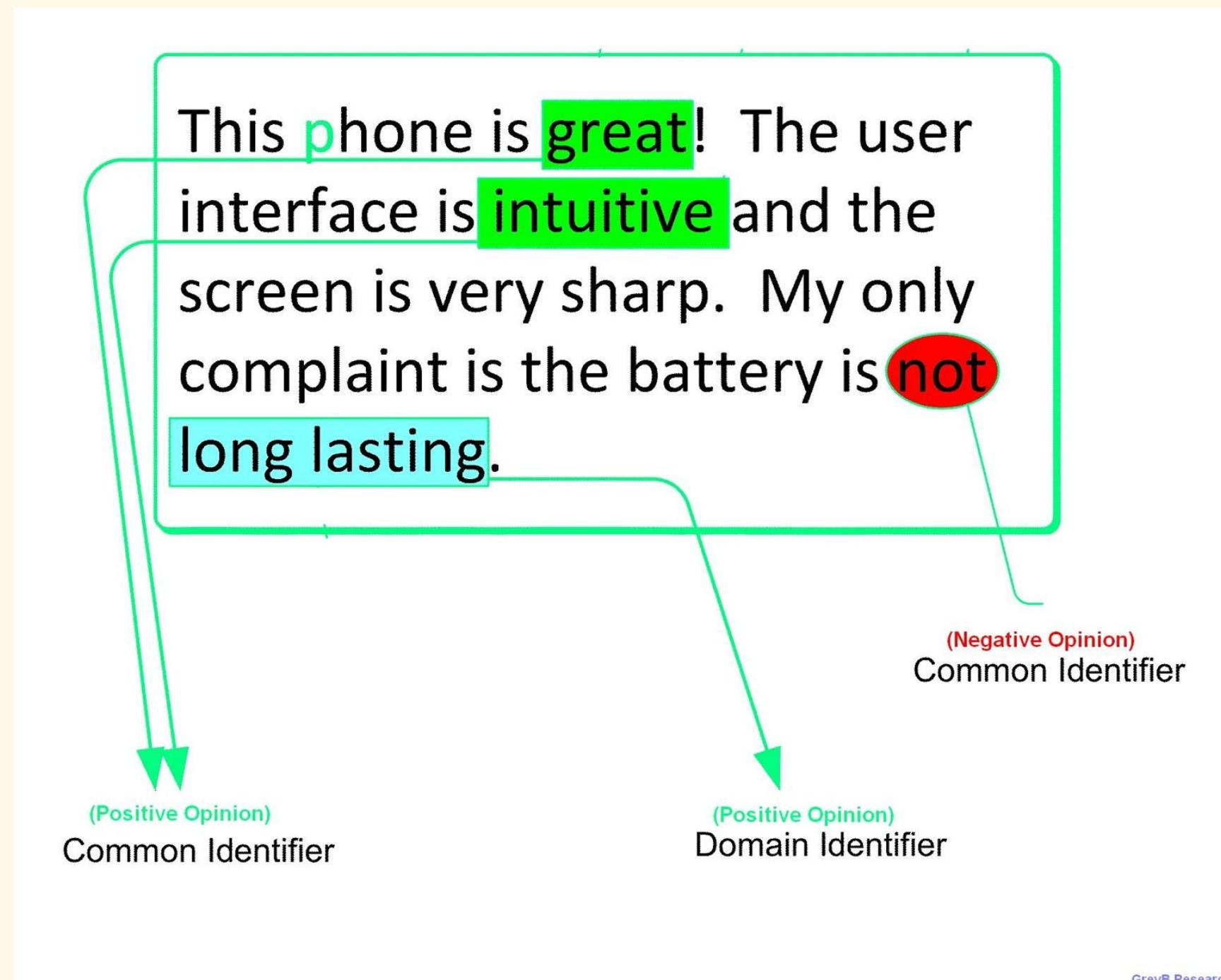
ChatGPT is a Natural Language Processing (NLP) application that is designed to generate human-like responses to user queries or prompts in natural language. ChatGPT is a large pre-trained language model that uses deep learning algorithms to analyze and understand the context and meaning of text-based inputs, and generate coherent, contextually appropriate responses. ChatGPT can be used for a variety of applications, such as chatbots, language translation, content generation, and more.

Regenerate response

|

ChatGPT Feb 13 Version. Free Research Preview. Our goal is to make AI systems more natural and safe to interact with. Your feedback will help us improve.

# SENTIMENT ANALYSIS



# LANGUAGE TRANSLATORS



Haaretz הארץ? אולי הפעם הוא יצליח?

היום: בתבינויו שוב וניסה לה העביר את דוח טרכטנברג במשילה [www.haaretz.co.il](http://www.haaretz.co.il)

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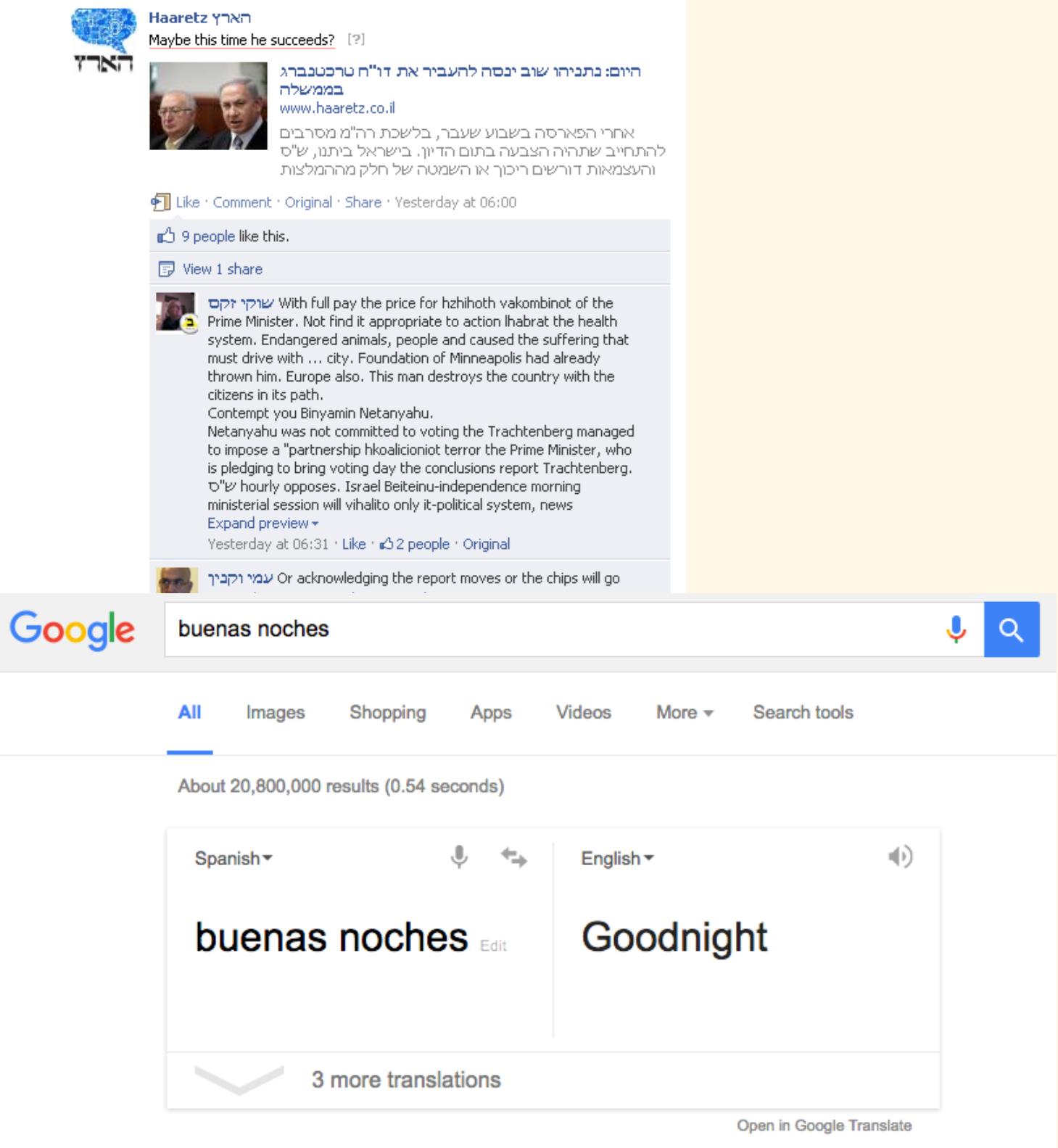
שוקי זקס עם שלם משלמים את מחיר הוצאות והקמפייניות של ראש הממשלה, שלא מצא לנכון להציג להרשות מושכת הבריאות. סיכון חיים אנשים ולאחרים גרם לסלול, תוהה לගרש את החיצוי הזה מהעיר. מאה"ב כבר זורקו אותו. פאוורפה גם. האיש הזה חורש בשקדנות את המדינה וככליה את אורה. בו לך בנימין נתניהו. נתניהו נהרתו: לא מתחייב להצבעה על טרכטנברג [www.ynet.co.il](http://www.ynet.co.il). השותפות הקואליציונית הצליחה להטיל מושה על ראש הממשלה, שכבב אינו מתחייב להביא להצבעה הרם את מסקנות דוח טרכטנברג. ש"ס לפיענוחת. ישראלי בוענו ומפלגת העצמאות יקימו בדורקן ישבת שרים וויליטו ריק בה - המשחתת הפליטית, חדשות

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עמי וקברן או שחדות' יעבר או שביבי יעביר  
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Dalya Gumin שיפסיקו להציגו ותחלו לבצע  
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Yuval Gilor מנאס כבר לך הביתה  
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Haaretz הארץ? Maybe this time he succeeds? [?]

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שוקי זקס With full pay the price for hzihioth vakombinot of the Prime Minister. Not find it appropriate to action Ihabrat the health system. Endangered animals, people and caused the suffering that must drive with ... city. Foundation of Minneapolis had already thrown him. Europe also. This man destroys the country with the citizens in its path. Contempt you Binyamin Netanyahu. Netanyahu was not committed to voting the Trachtenberg managed to impose a "partnership hkoalicioniot terror the Prime Minister, who is pledging to bring voting day the conclusions report Trachtenberg. ש"ס hourly opposes. Israel Beiteinu-independence morning ministerial session will vhalito only it-political system, news

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Or acknowledging the report moves or the chips will go

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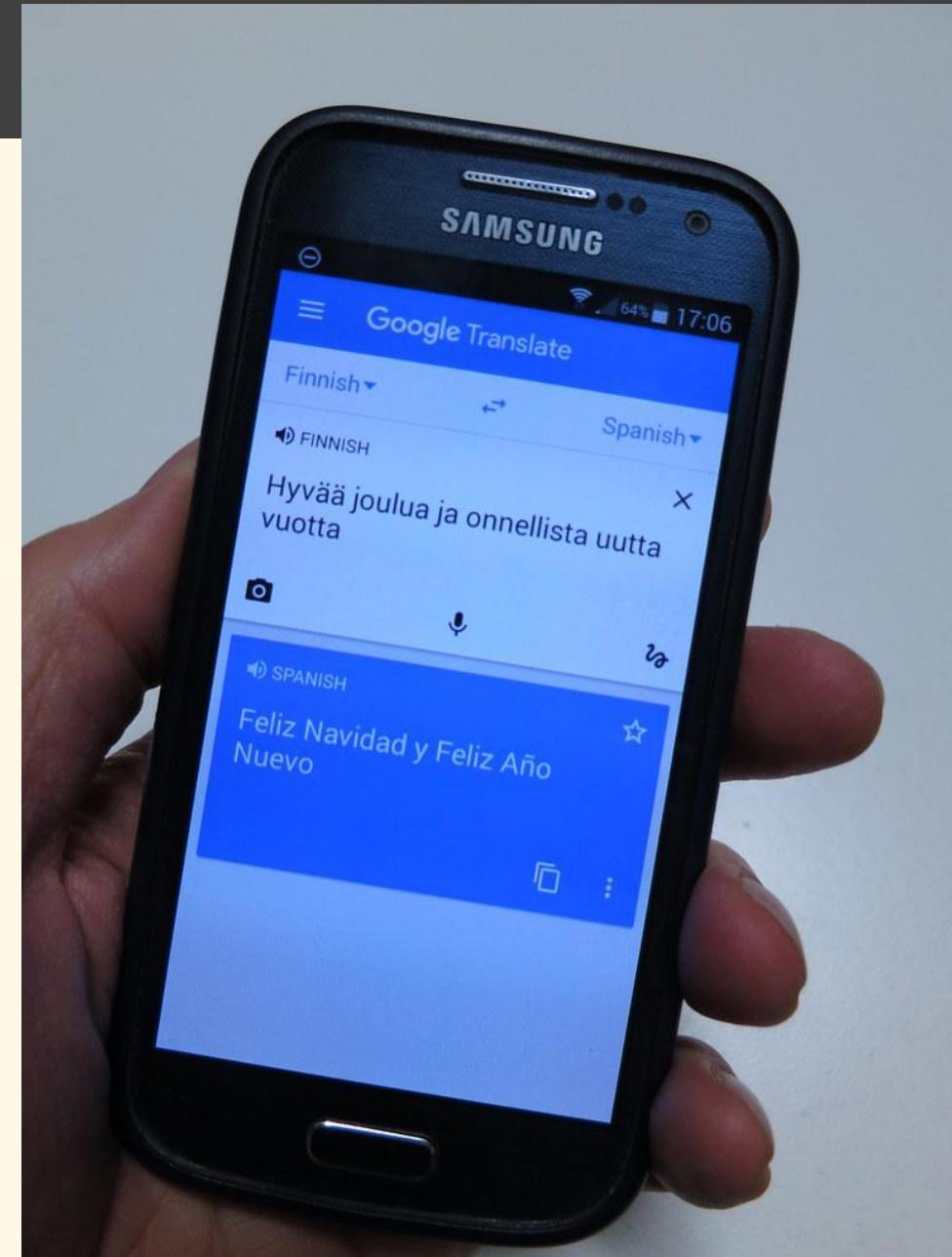
About 20,800,000 results (0.54 seconds)

Spanish ▾ English ▾

buenas noches Edit Goodnight

3 more translations

Open in Google Translate



# INFORMATION EXTRACTION

New York Times Co. named Russell T. Lewis, 45, president and general manager of its flagship New York Times newspaper, responsible for all business-side activities. He was executive vice president and deputy general manager in September who in September was named president and CEO.

Person	Company
Russell T. Lewis	New York Times newspaper
Russell T. Lewis	New York Times newspaper
Lance R. Primis	New York Times Co.

## Information Extraction

Subject: **curriculum meeting**

Date: January 15, 2012

To: Dan Jurafsky

Event: Curriculum mtg

Date: Jan-16-2012

Start: 10:00am

End: 11:30am

Where: Gates 159

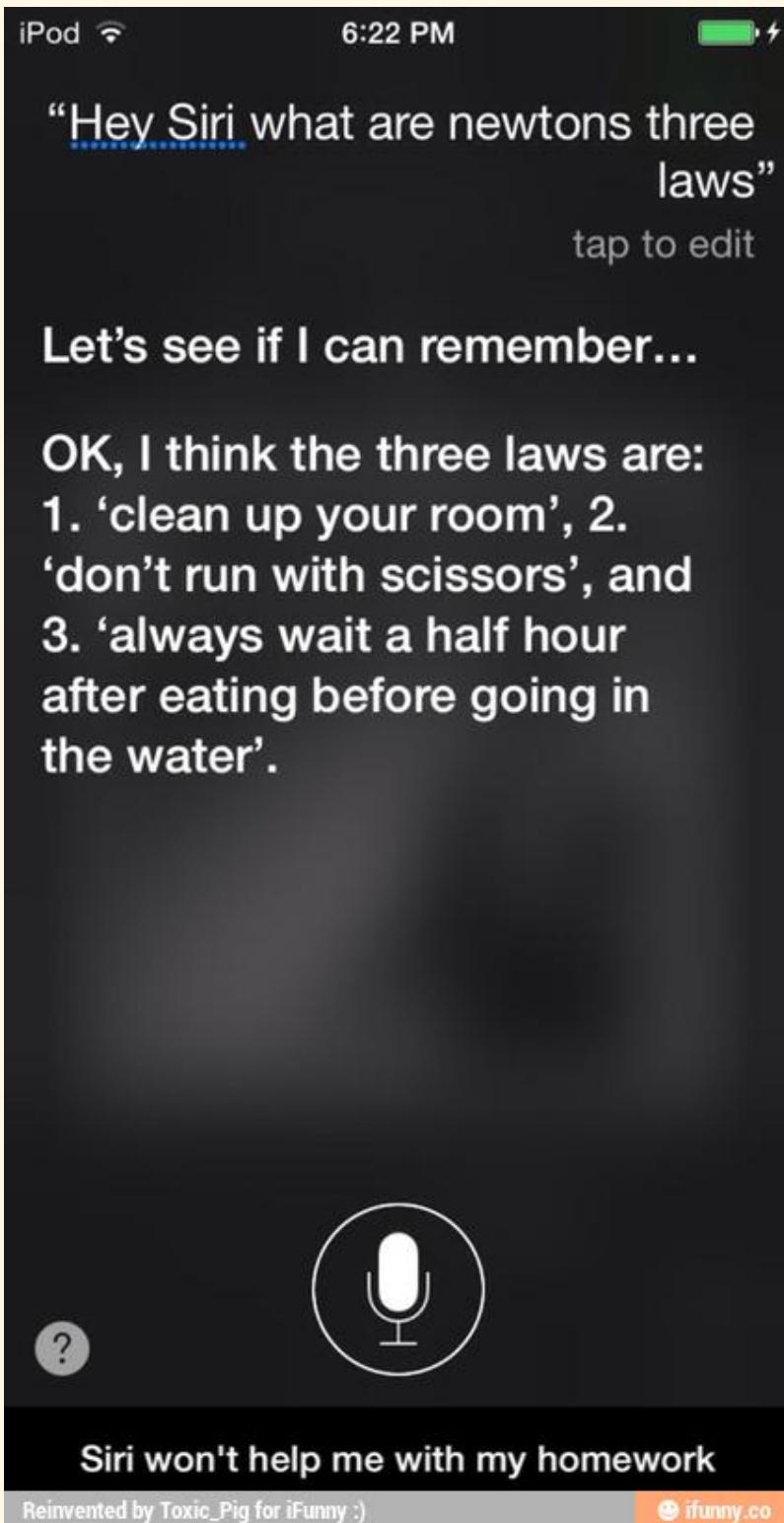
Hi Dan, we've now scheduled the curriculum meeting.

It will be in Gates 159 tomorrow from 10:00-11:30.

-Chris

Create new Calendar entry

# VIRTUAL ASSISTANTS



# NLP TASKS

## SYNTAX

- POS tagging
- Parsing
- Morphological analysis

## SEMANTICS

- Named entity recognition
- Word sense disambiguation
- Sentiment analysis

## PRAGMATICS

- Dialogue management
- Speech recognition
- Text summarization
- Natural language generation

# SYNTAX-LEVEL TASKS

- (Deals with grammar and sentence structure — *how language is organized*)
- Syntax tasks help machines detect correct/incorrect grammar and sentence flow.

Task	What it Does	Example	Real-World Use
<b>Part-of-Speech (POS) Tagging</b>	Labels words as noun, verb, etc.	run → verb or noun?	Grammar checkers (Grammarly)
<b>Parsing</b>	Builds grammatical structure of a sentence	“The dog chased the cat” → subject/verb/object tree	Machine translation accuracy
<b>Morphological Analysis</b>	Breaks words into roots + affixes	“Unbelievable” → un + believe + able	Search engines understanding variations of words

# POS TAGGING

**POS tagging is a process of assigning a POS or lexical class marker to each word in a sentence (and all sentences in a corpus).**

Word	POS Tag	Explanation
Adobo	NOUN	Food name
is	VERB	Linking verb
a	DET	Article
popular	ADJ	Describes “dish”
dish	NOUN	Noun
in	PREP	Location preposition
the	DET	Article
Philippines	PROPN	Country

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dish	NOUN	Noun
in	PREP – preposition	Location preposition
the	DET – determiner	Article
Philippines	PROPN – proper noun	Country

# PARSING

**Parsing analyzes how words are structured in a sentence, based on grammar rules → It tells who is doing what, to whom, when, where, etc.**

Parsing is like **building a family tree** of a sentence:

- Who are the parents? (phrases)
- Who are the children? (words)

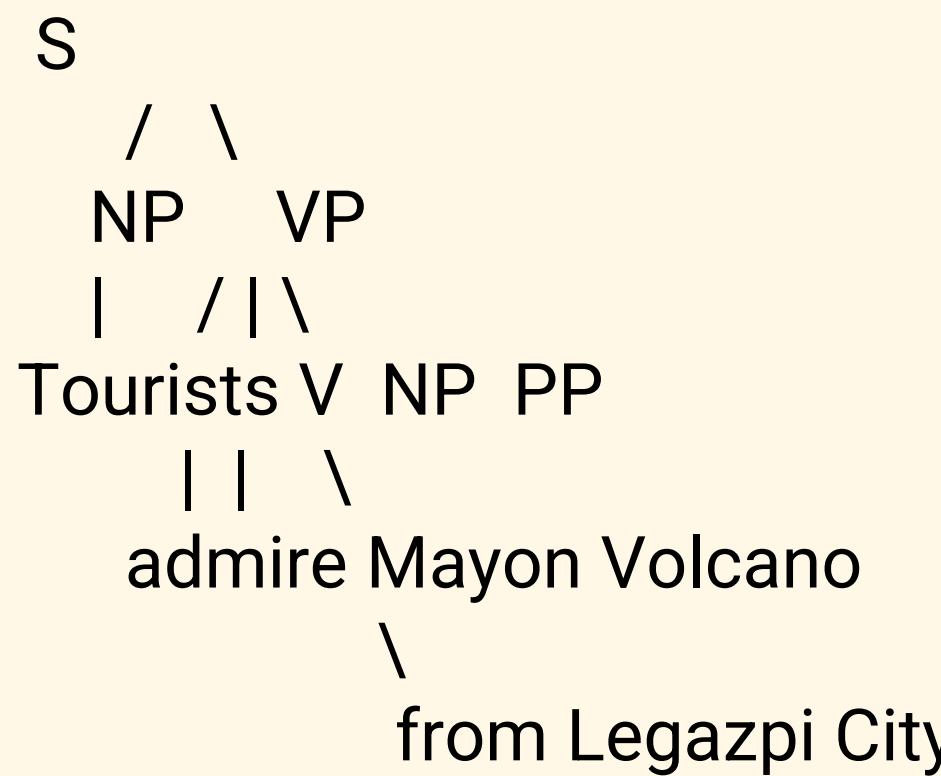
Or like a **blueprint of a house** showing how rooms are connected.

## Why is Parsing Important?

- ✓ Improves **translation accuracy**
- ✓ Helps chatbots understand **intent**
- ✓ Supports **search** (“Hotels in Legazpi near LCC Mall”)
- ✓ Needed for **voice assistants** in PH settings

# PARSING

E.g. Tourists admire Mayon Volcano from Legazpi City.



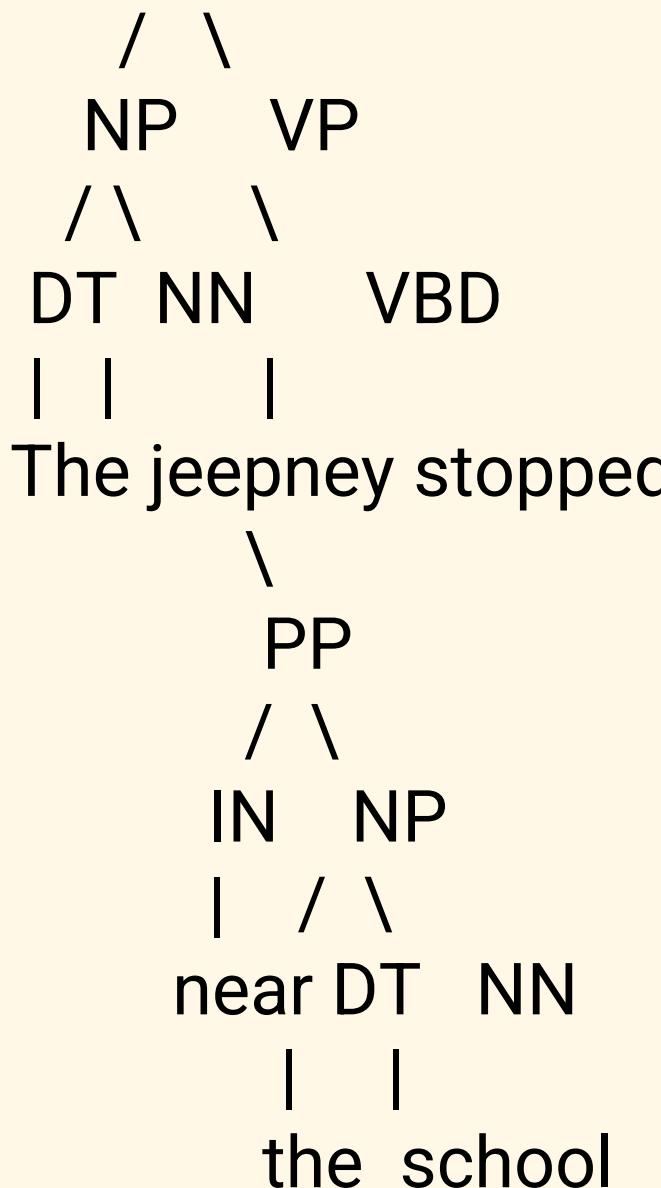
Component	Phrase	Explanation
<b>NP (Subject)</b>	<i>Tourists</i>	Noun Phrase
<b>VP</b>	<i>admire Mayon Volcano</i> <i>from Legazpi City</i>	Verb + Object + Prepositional Phrase
<b>Direct Object (NP)</b>	<i>Mayon Volcano</i>	What tourists admire
<b>PP</b>	<i>from Legazpi City</i>	Location phrase modifying the verb <b>admire</b>

- Shows who is doing the admiring, and from where.

# PARSING

E.g. The jeepney stopped near the school.

S



Word	POS Tag	Meaning
The	DT	Determiner
jeepney	NN	Singular common noun
stopped	VBD	Verb, past tense
near	IN	Preposition
the	DT	Determiner
school	NN	Noun, singular

- Parsing identifies “near the school” as modifying the action, not the jeepney.

# MORPHOLOGICAL ANALYSIS

- ✓ Identifying the inflectional and derivational elements of a word. (Morphemes = smallest units of meaning)
- ✓ Morphological analysis helps computers understand how word structure changes meaning, especially important in education, government systems, and tourism apps in the Philippines.

Morphological Analysis breaks a word into:

- **Root / Base word**
- **Prefixes** (added before the root)
- **Suffixes** (added after the root)
- **Inflections** (changing tense, number, etc.)

# MORPHOLOGICAL ANALYSIS

## Philippine Tourism Context

Word: **Reopening**

Sentence: *The museum is reopening in Vigan City.*

Part	Element	Meaning
Prefix	<b>re-</b>	again
Root	<b>open</b>	allow access
Suffix	<b>-ing</b>	action continuing

- Morphological meaning: *open again* (due to reopening after closure)

# MORPHOLOGICAL ANALYSIS

## Disaster Response Context

Word: **Evacuation**

Sentence: *Evacuation centers in Albay are ready.*

Part

Root

Suffix

Element

**evacuate**

**-ion**

Meaning

move people to safety

action or process

- Morphological meaning: Becomes a **noun** referring to the process.

# MORPHOLOGICAL ANALYSIS

## Education Context

Word: **Unenrolled**

Sentence: *Some students are still unenrolled.*

Part	Element	Meaning
Prefix	un-	not
Root	enroll	register for classes
Suffix	-ed	past form

- Morphological meaning: Negation applied to a past action.

# SEMANTIC-LEVEL TASKS

- (Deals with meaning, context, and relationships between words)
- These tasks allow computers to understand human communication, not just read text.

Task	What it Does	Example	Real-World Use
<b>Named Entity Recognition (NER)</b>	Detects names, places, organizations, dates	“Meet Ana in Manila on Nov 20”	Extracting info from medical/legal documents
<b>Word Sense Disambiguation (WSD)</b>	Figures out correct meaning of words	“Bank” → riverbank or money bank?	Search engines understanding intent
<b>Sentiment Analysis</b>	Identifies emotions/opinions	“I love this phone!” → Positive	Market analysis, product reviews

# SEMANTIC TASKS

Identifies and classifies **named entities** in text into predefined categories like:

- Person (PER)
- Location (LOC)
- Organization (ORG)
- Dates, Events, Products, etc.

Example: President Marcos visited Legazpi City with the Bicol University officials.

Entity

President Marcos

Legazpi City

Bicol University

Category

Person

Location

Organization

# WORD SENSE DISAMBIGUATION

## DETERMINING THE CORRECT MEANING OF A WORD BASED ON ITS CONTEXT

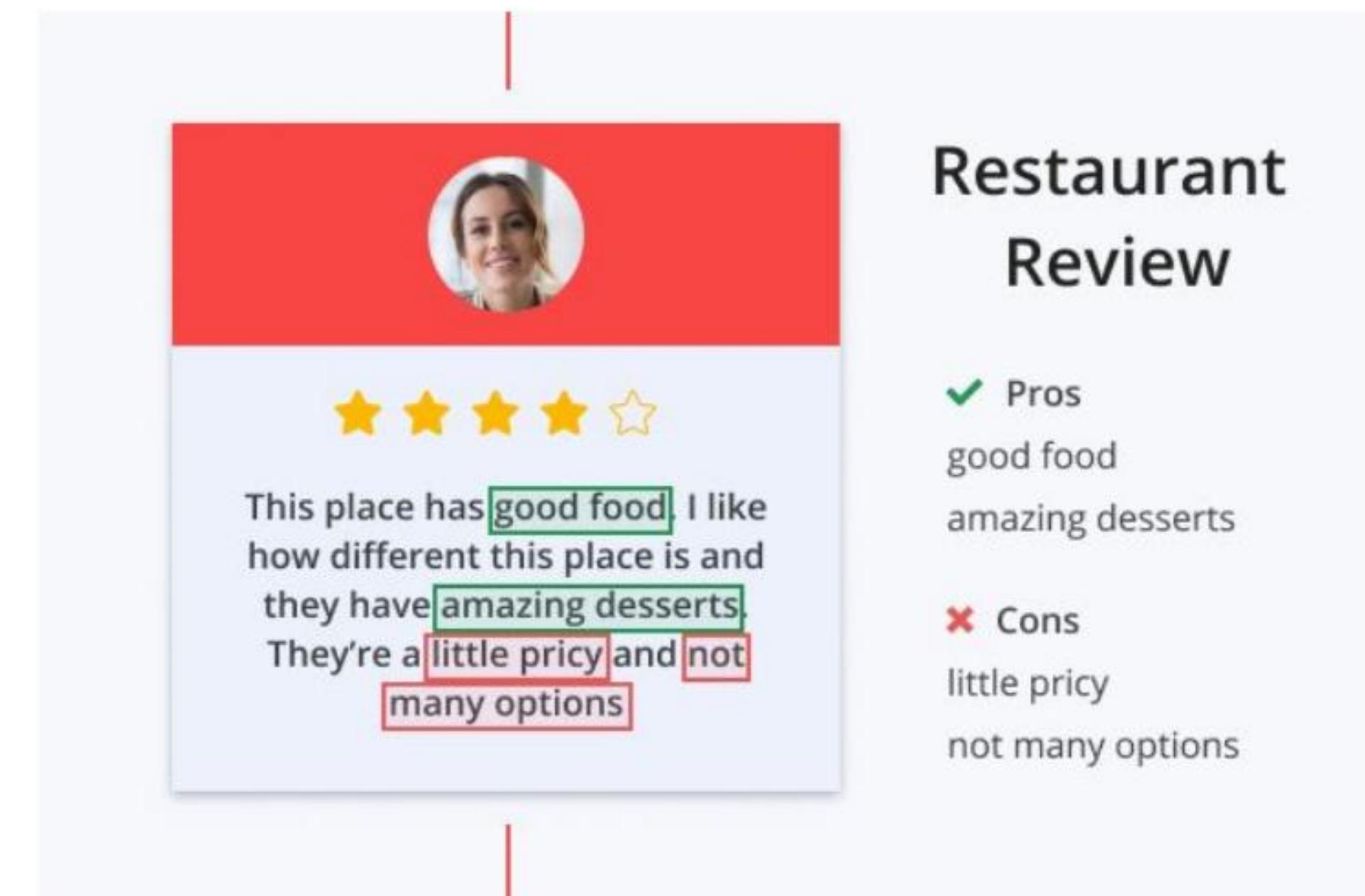
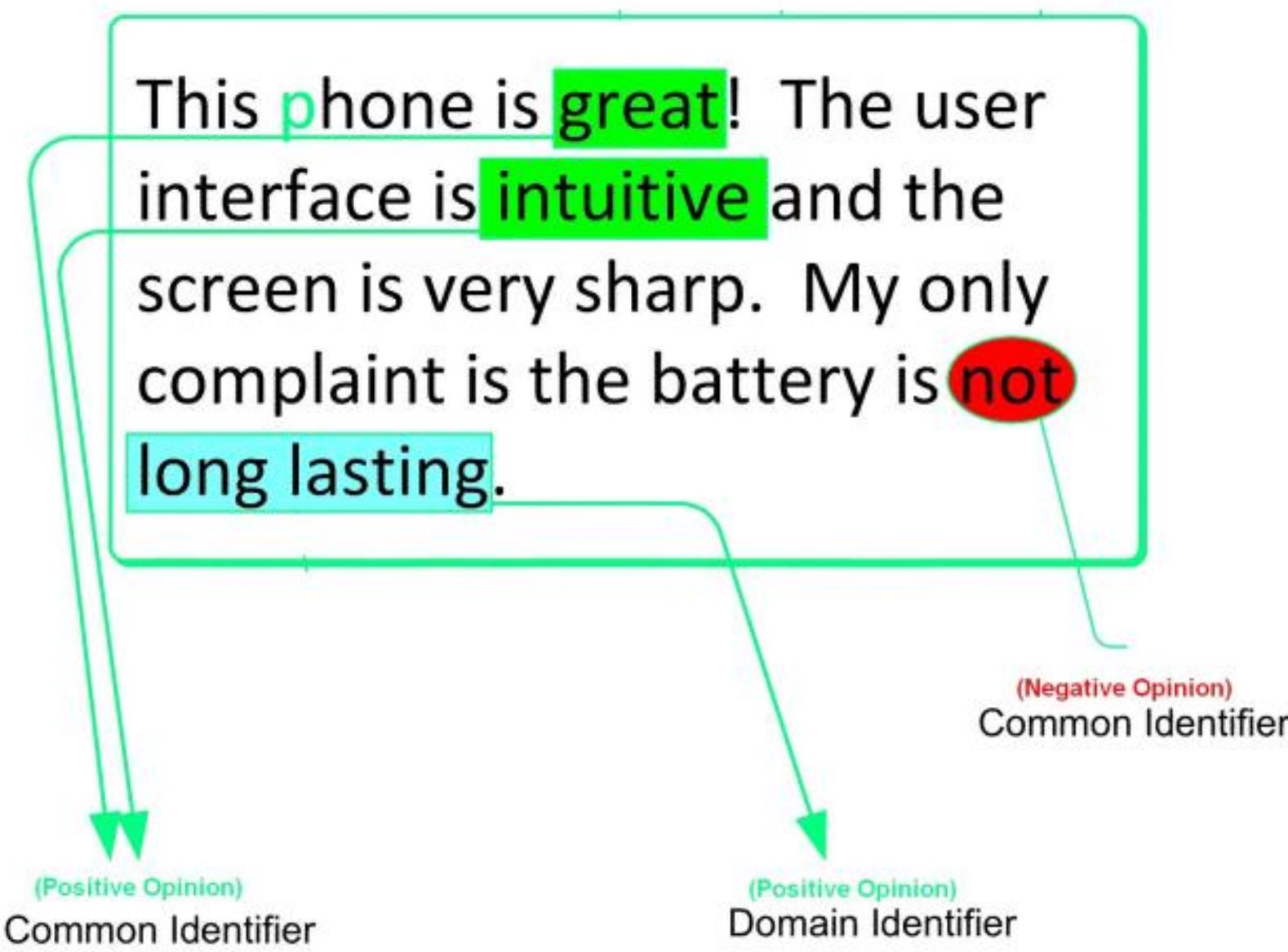
Many English (and Filipino) words are **polysemous** (multiple meanings).

The **bank** can guarantee **deposits** will eventually cover future tuition costs because it invests in adjustable-rate **mortgage** securities.

bank <sup>1</sup>	Gloss:	a financial institution that accepts <b>deposits</b> and channels the money into lending activities
	Examples:	“he cashed a check at the bank”, “that bank holds the <b>mortgage</b> on my home”
bank <sup>2</sup>	Gloss:	sloping land (especially the slope beside a body of water)
	Examples:	“they pulled the canoe up on the bank”, “he sat on the bank of the river and watched the currents”

# SENTIMENT ANALYSIS

DETERMINING THE SENTIMENT OR EMOTION EXPRESSED IN A PIECE OF TEXT.



# PRAGMATICS + ADVANCED CONTEXT TASKS

- **(Understands social intent, conversation flow, and behavior)**
- **These tasks make human-computer interaction smooth, helpful, and natural.**

Task	What it Does	Example	Real-World Use
Pragmatics	Interprets implied meaning, politeness, sarcasm	"Nice job!" (mad tone) = criticism	Customer service chatbots
Dialogue Management	Maintains conversational flow and context	Responding correctly after multiple turns in chat	Voice assistants (Siri, Google Assistant)
Speech Recognition	Converts voice → text	"Call Mom" becomes command	Virtual assistants, transcription
Text Summarization	Condenses long text into key info	Summary of 5-page article	News summaries, legal & medical reports
Natural Language Generation (NLG)	Machine writes language like a human	ChatGPT responses	Report automation, chatbots, content génération

# PRAGMATICS

Understands intended meaning beyond literal words — context, culture, tone, social norms.

## Example

Student: “Sir, ang init.”

Teacher: “Sige, I’ll turn on the aircon.”

Meaning: Student is **indirectly requesting** to adjust temperature.

“Pwede po bang pa-extend ng deadline?”

→ Polite request, not a question about possibility.

# DIALOGUE MANAGEMENT

Controls the **flow of conversation** in chatbots and voice systems:

- ✓ Maintains context
- ✓ Manages turns in conversation
- ✓ Chooses correct response

## Example

User: “*Where is Mayon Volcano?*”

Bot: “*It’s in Albay, Bicol.*”

User: “*How do I get there?*”

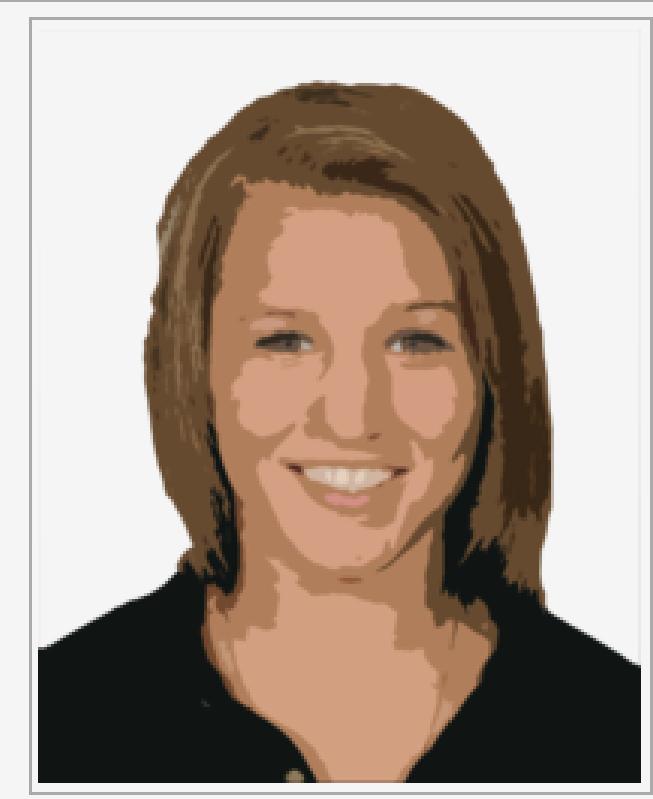
Bot still knows “**there**” = **Mayon Volcano**

# DIALOGUE SYSTEMS

Building systems that can engage in natural language conversations with humans, such as chatbots or virtual assistants

**Gift shop**

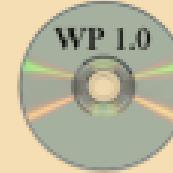
Items such as caps, t-shirts, sweatshirts and other miscellanea such as buttons and mouse pads have been designed. In addition, merchandise for almost all of the projects is available.



Hi. I'm your automated online assistant. How may I help you?

 Ask

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# SPEECH RECOGNITION

Converts **spoken language** → **text**.

## **Example (Filipino-accented English)**

User speaks: “Directions to Daraga Church”

System outputs: “Directions to Daraga Church”

Challenges include:

- ✓ Code-switching (Eng + Filipino)
- ✓ Regional accents (Bicolano, Cebuano, etc.)

# TEXT SUMMARIZATION

Produces a shorter version of a document while keeping the main ideas.

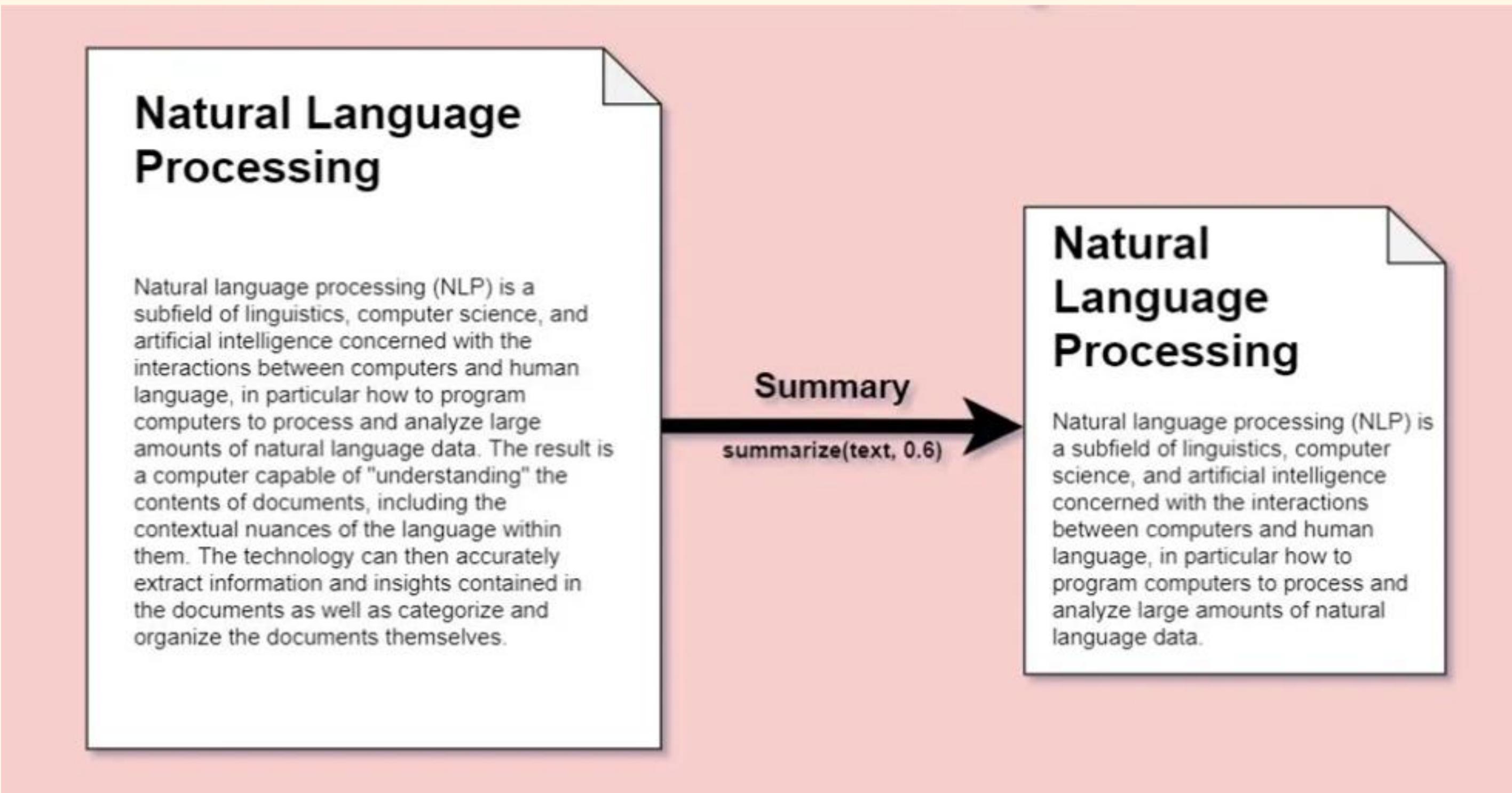
Input: 10-paragraph news about **Mayon Volcano alert level**

Output: 3-sentence summary with:

- Current alert level
- Evacuation status
- Affected communities

# TEXT SUMMARIZATION

Automatically generating a summary of a text that captures the most important information.



# NATURAL LANGUAGE GENERATION (NLG)

Generates human-like language from data.

Input data:

“Mayon alert level: 3. Evacuation: 1,200 families.”

NLG System Output:

“Alert Level 3 is raised over Mayon Volcano,  
prompting the evacuation of 1,200 families.”

# NATURAL LANGUAGE GENERATION

**Using computer algorithms to automatically generate natural language text, such as news articles or product descriptions**

AA

What will be the weather today?



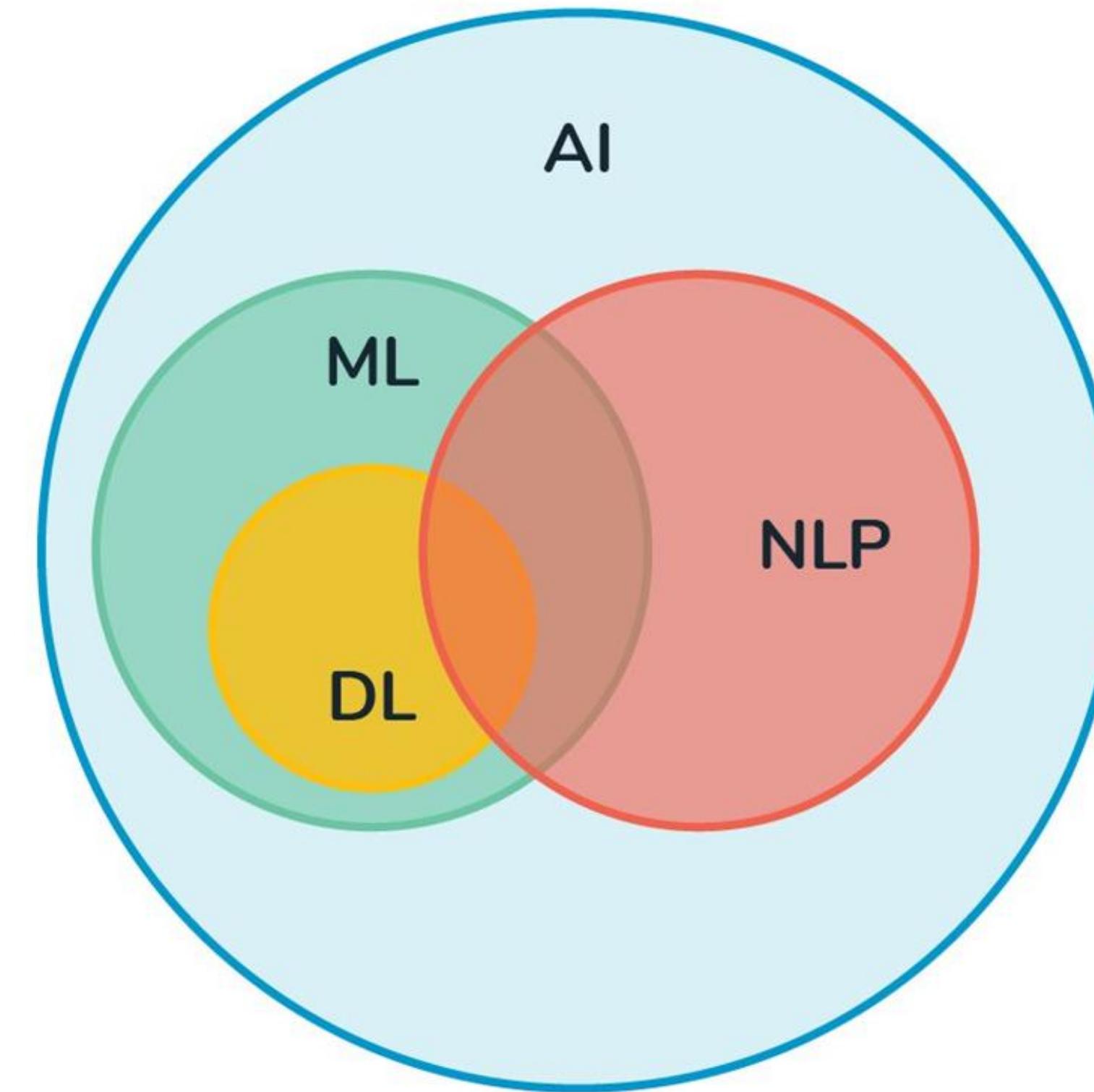
I'm sorry, as an AI language model, I don't have real-time access to weather information.  
Please check your local weather forecast or a trusted weather website or app for up-to-date information on the weather in your area.



⟳ Regenerate response

  
A small blue arrow pointing upwards and to the right, indicating where to click to send the message.

# MACHINE LEARNING + NLP



- Artificial intelligence
- Machine learning
- Language Processing
- Deep learning

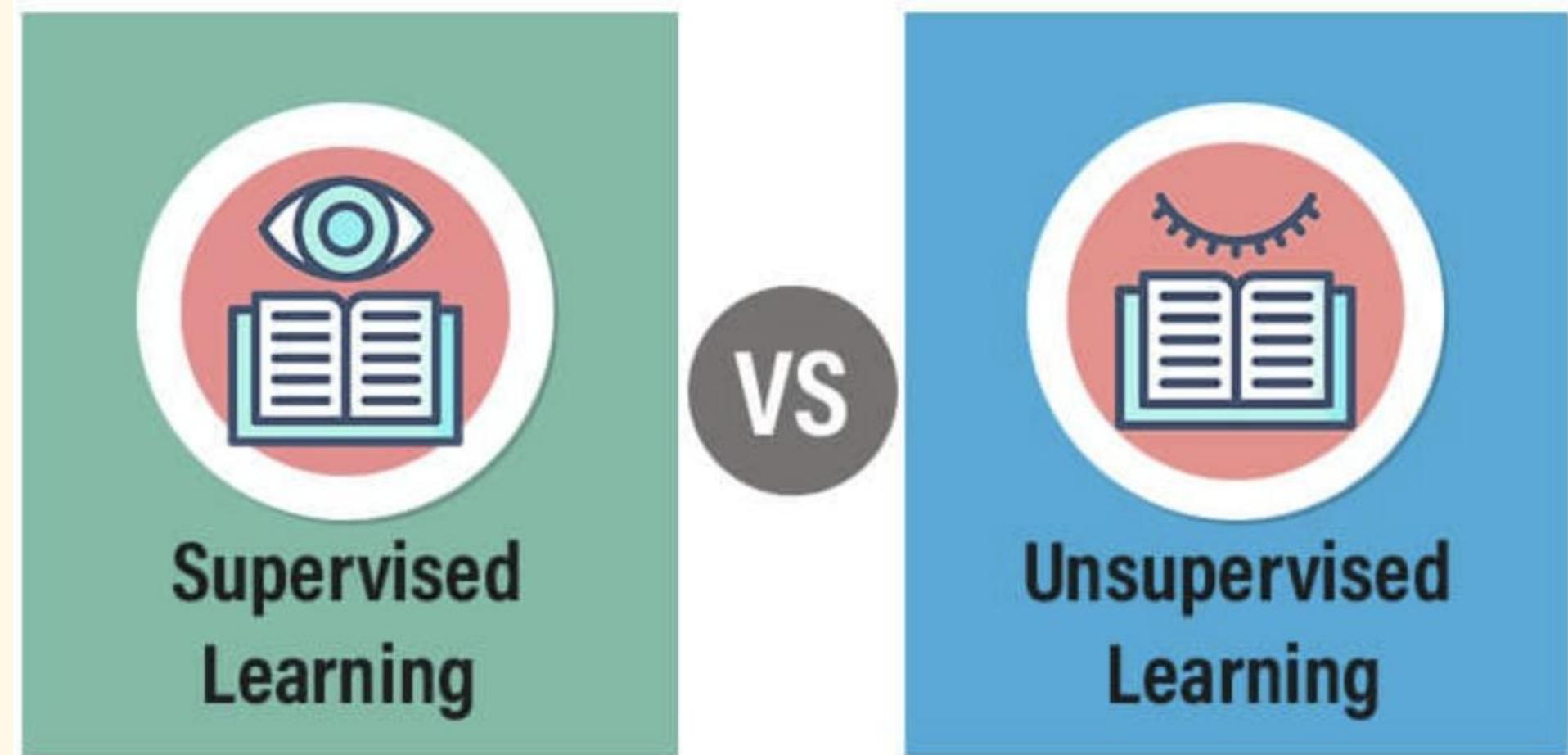
# MACHINE LEARNING IN NLP

## Supervised learning

- sentiment analysis, named entity recognition, and machine translation

## Unsupervised learning

- text summarization, topic modeling, and word embedding



# CHALLENGES IN NLP

- Data quality
  - domains with limited data
- Ambiguity
  - e.g. sarcasm, irony, and figurative language can be difficult for machines to understand.

# CHALLENGES IN NLP

- Domain-specific language
  - different jargons and terminologies for different domains
- Lack of interpretability
  - difficult to interpret NLP models

# CHALLENGES IN NLP

- Ethics and bias

- NLP applications can perpetuate biases in the data used in training can them, leading to unfair and discriminatory outcomes

- e.g. NLP system might be more likely to deny a loan application to a person of a certain race or gender, even if they are otherwise qualified.

- Privacy

- NLP technology relies on vast amounts of data, which can be used to track people's behavior and preferences

# NATURAL LANGUAGE PROCESSING

NLP has contributed significantly to technological advancements in various domains, but there are still challenges that need to be addressed. Addressing these challenges will require a concerted effort from researchers, developers, and policymakers to ensure that NLP applications are accurate, ethical, and beneficial to society.

# REFERENCES

- Prakash M Nadkarni, Lucila Ohno-Machado, Wendy W.Chapman, Natural language processing: an introduction, Journal of the American Medical Informatics Association, Volume 18, Issue 5, September 2011, Pages 544–551, <https://doi.org/10.1136/amiajnl-2011-000464>
- Jurafsky, D., & Martin, J. H. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition.
- <https://chat.openai.com/chat>

# PRE-ASSESSMENT - PART A: EVERYDAY TECH OBSERVATION

Answer based on your experiences with apps or devices you already use.

1. Name **one app** that you think uses NLP.

Example choices: Facebook, Gmail, Siri, Chikka, Google Maps, BPO chatbots.

*Explain what the app understands or processes in language.*

2. When you say “**Call Mama**” to a phone assistant, what do you expect it to do?

*Explain in one sentence how the system interprets your words.*

3. When you type a message and your phone **autocorrects or suggests words**, what kind of language skill do you think is happening?  
(Describe in your own words)

# PRE-ASSESSMENT - PART B: MEANING AND AMBIGUITY

Give 2 possible meanings for each sentence (your interpretation only).

"The bank is closed."

Meaning 1: \_\_\_\_\_

Meaning 2: \_\_\_\_\_

"Please open the window."

Meaning 1: \_\_\_\_\_

Meaning 2: \_\_\_\_\_

*(Literal vs. implied meanings encouraged)*

## PRE-ASSESSMENT - PART C: ENTITY RECOGNITION (INTUITION-BASED)

Circle words that are **specific names** (even if unsure).

*President Marcos visited Legazpi City after the eruption of Mayon Volcano.*

# PRE-ASSESSMENT - PART D: REAL USE CASE MATCHING

Match the scenario to the technology you think is responsible.

## Scenario

1. Google automatically completes your sentence
2. Shopee filters reviews by “Positive” or “Negative”
3. Waze listens when you say “Navigate to BUCS!”
4. Gmail detects a date and suggests adding it to your calendar

## Think: Which NLP ability is used?

- A. Speech Understanding
- B. Emotion/Sentiment Understanding
- C. Suggesting the next word
- D. Understanding meaning and intention

# PRE-ASSESSMENT - PART E: SHORT PRACTICAL RESPONSE

If you were to build a chatbot for BUCS students,  
what is one question it should understand and respond to?

Question: \_\_\_\_\_

Expected Response: \_\_\_\_\_

This tells you:

- who thinks of *language as input*
- who considers *actionable responses*

# POST-ASSESSMENT - PART A: APPLICATION

- Perform **POS Tagging** on the sentence:  
The jeepney stopped near the school.  
(Example format: The/DT jeepney/\_ ...)
- Draw or describe the **Parsing tree structure** for the same sentence.
- Provide one example for **Word Sense Disambiguation**, showing at least **two different meanings** of the same word in two sentences.

# POST-ASSESSMENT - PART B: HIGHER-ORDER THINKING

Write your answer in 2–3 sentences each.

1. Why is Machine Learning important for NLP?
2. Give one Philippine-based real-world application for either:
  - Speech Recognition
  - Text Summarization
  - Dialogue Management

- Explain why NLP is useful in that scenario.

## POST-ASSESSMENT - PART C: SEMANTIC ANALYSIS

Identify the sentiment of this statement:

“The BRT system in Cebu will reduce traffic, but construction is causing delays.”

- A) Positive
- B) Negative
- C) Mixed

Explain briefly: \_\_\_\_\_

# POST-ASSESSMENT - PART C: SEMANTIC ANALYSIS

**Do Named Entity Recognition (NER) on this:**

- President Marcos met mayors in Albay during the Mayon response operations.
- List at least 3 named entities and label them.

## POST-ASSESSMENT - PART C: SEMANTIC ANALYSIS

Provide an example of a real-world situation where pragmatics enables chatbots to produce more polite or context-aware responses.

# THANK YOU!

ANY QUESTIONS?