

# NATURAL LANGUAGE PROCESSING



## NLP

ITAI 2373 – Mod 01



# AI latest News



# Today's Class

## Today's Class

- Course Overview and Expectations

- Definition and Scope of NLP

- Brief History of NLP

- Key Applications and Industry Use Cases

- Introduction to the NLP Pipeline

- Overview of NLP Tools and Libraries

# To Succeed in This Course

- **Read the Syllabus** (At least):
  - Missed Assignment /Make up Policy
  - Academic Integrity
  - Attendance Procedures
  - Faculty Statement about Student Success
  - Copy and Save the Course Calendar
- Turn in assignments on time
- Check Canvas/HCC email **EVERYDAY**
- Practice with real datasets - Don't just copy code, understand it
- Summer term = Accelerated pace - 2x speed, stay current or fall behind
- Build your NLP portfolio for day 1 - Document every project for career advancement



# Course Learning Objectives



By the end of this course, you will be able to:

- - Summarize the evolution and industrial impact of NLP/NLU
- - Apply classic ML methods to build text analytics pipelines
- - Analyze linguistic features to extract structured knowledge
- - Evaluate effectiveness and ethical implications of NLP systems
- - Design and create functional NLP applications (chatbots, QA systems)
- - Work with both text and speech modalities

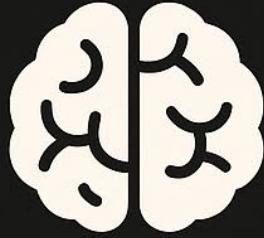


# NLP Definition according to AI

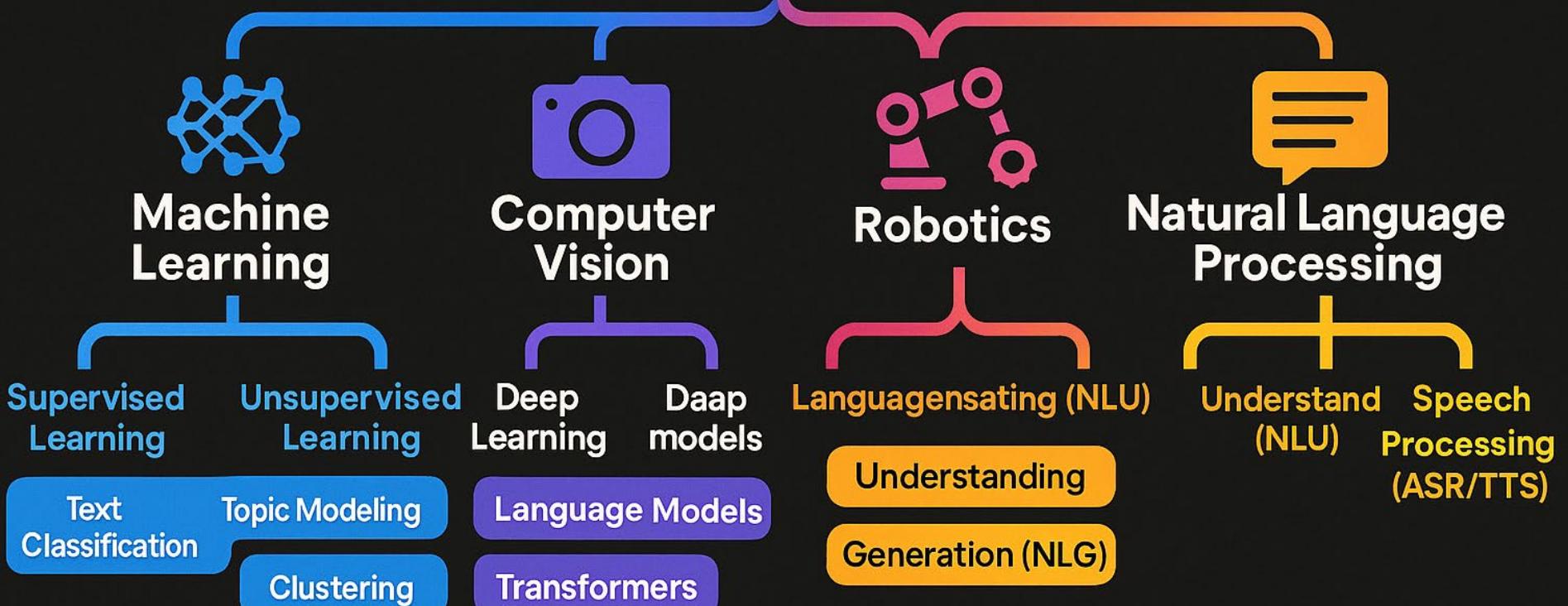
- NLP, or Natural Language Processing, is the techy art of teaching computers to understand human blabber—y'know, the chaotic mess of words, slang, and emojis we spew daily. It's like giving a robot a PhD in deciphering your drunk texts or your grandma's passive-aggressive emails. The goal? Make machines less "beep boop, error 404" and more "yo, I totally get your vibe." Think of it as a linguistic wingman for AI, helping it navigate the wild jungle of human chit-chat without faceplanting into a sarcasm trap. 😊



# Where NLP Fits in AI



# ARTIFICIAL INTELLIGENCE



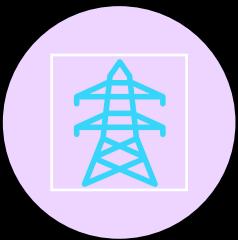
# Why is NLP Important?



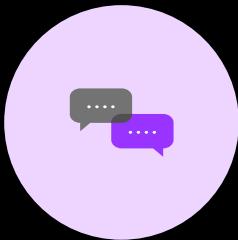
Explosive growth of unstructured text data  
(80% of enterprise data)



Enables human-computer interaction through natural language



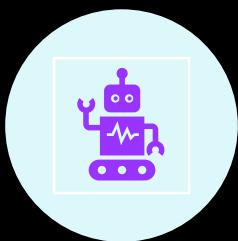
Powers essential technologies: Search engines, virtual assistants, translation



Critical for accessibility (speech-to-text, text-to-speech)



Drives business insights: Customer sentiment, market intelligence



Foundation for modern AI applications and robotics

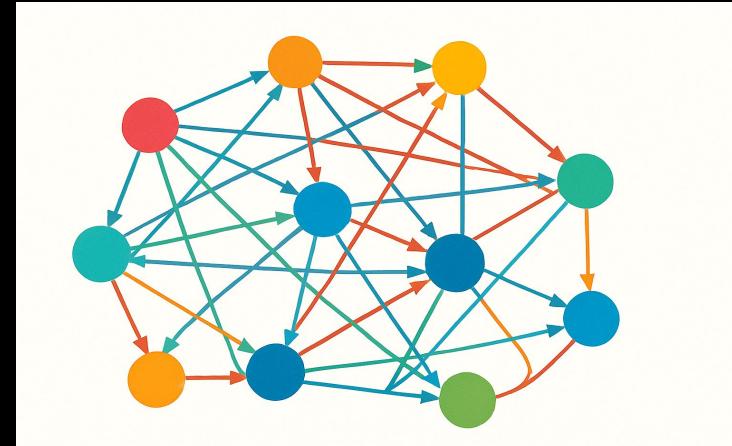
# Challenges in NLP



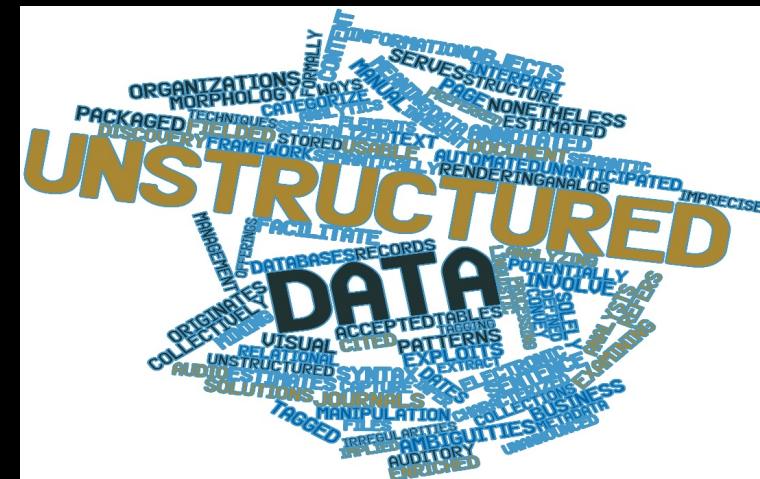
Lack of precision



Meaning that is based on context



Many complex dependencies

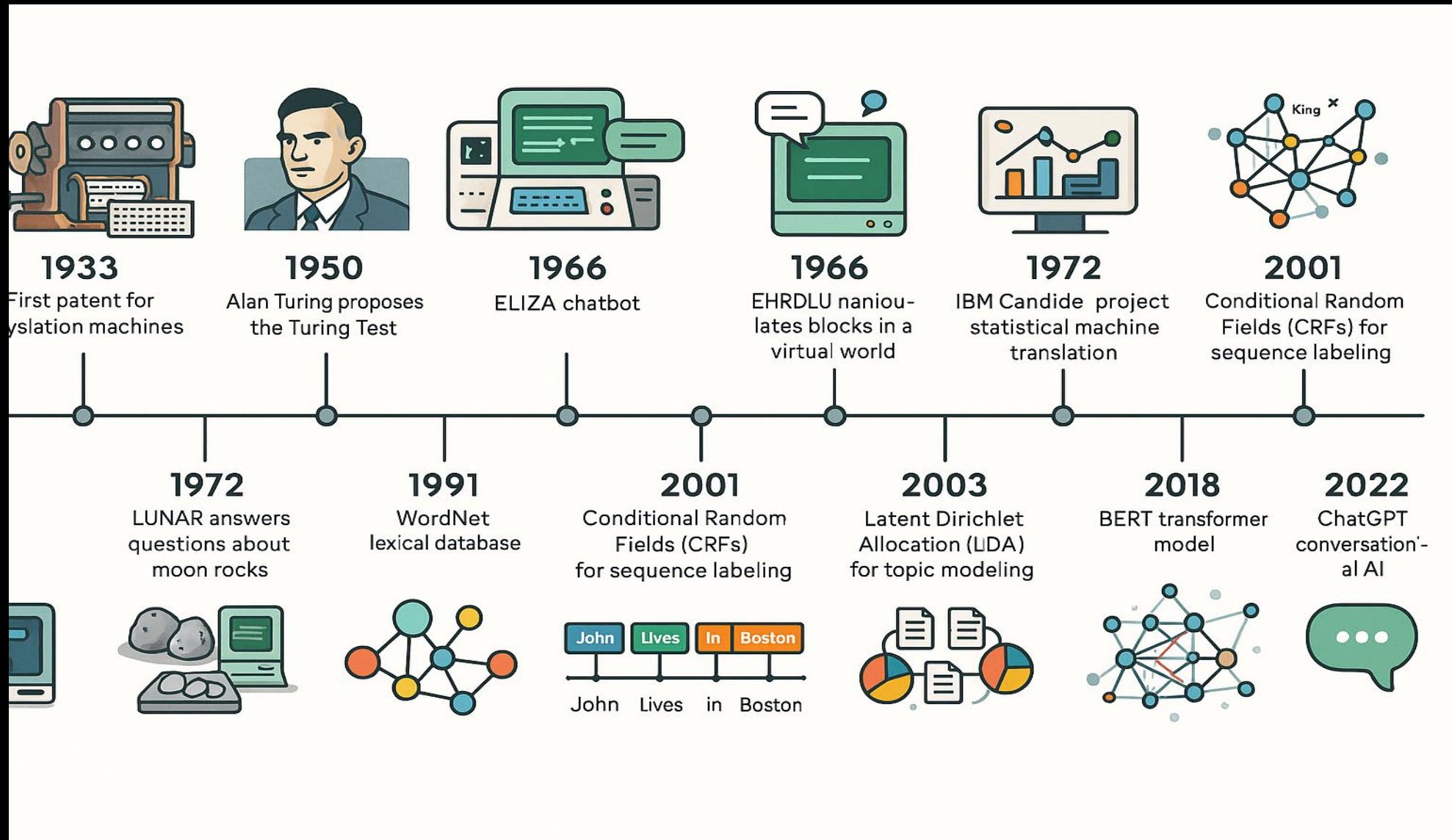


Lack of structure

# Recent NLP Breakthroughs (2020-2025)

- ChatGPT Launch (Nov 2022) – Democratized conversational AI
- GPT-4 & Multimodal Models (2023) - Text, image, and code integration
- Claude, Gemini, & Competition (2023-2024) - Rapid AI assistant evolution
- Real-time Translation Devices - Earbuds, smart glasses, wearables
- AI Code Generation - GitHub Copilot, Code Llama transforming programming
- Voice Cloning & Synthesis - Ethical concerns and detection challenges
- Regulatory Responses - EU AI Act, US Executive Orders on AI

# Brief History of NLP





# NLP, NLU & NLG Relationship

Automatic speech  
recognition

Text-to- speech

**Natural Language Understanding**  
The ability of computer to understand human text and speech

**Natural Language processing**  
The Overall term for how computers understand, interpret and use human language

**Natural Language generation**  
The ability of computers to generate human text and speech

# Modalities in NLP

## Text

- Written language: emails, documents, social media
- Structured and unstructured formats

## Speech

- Spoken language: conversations, commands
- Requires audio processing and transcription

## Multimodal

- Combination of text, speech, and visual elements
- Future of human-AI interaction



# NLP Tools & Libraries Overview"



## NLTK (Natural Language Toolkit)

- **Best for:** Learning, prototyping, academic research
- **Strengths:** Comprehensive, well-documented, educational
- **Use cases:** Text preprocessing, sentiment analysis, basic parsing



## SpaCy

- **Best for:** Production applications, real-world projects
- **Strengths:** Fast, accurate, pre-trained models
- **Use cases:** NER, dependency parsing, large-scale processing



## Hugging Face Transformers

- **Best for:** State-of-the-art pre-trained models
- **Strengths:** Easy access to BERT, GPT, T5, etc.
- **Use cases:** Advanced text generation, classification, Q&A

# NLP Application Categories

## What Problems NLP Solves

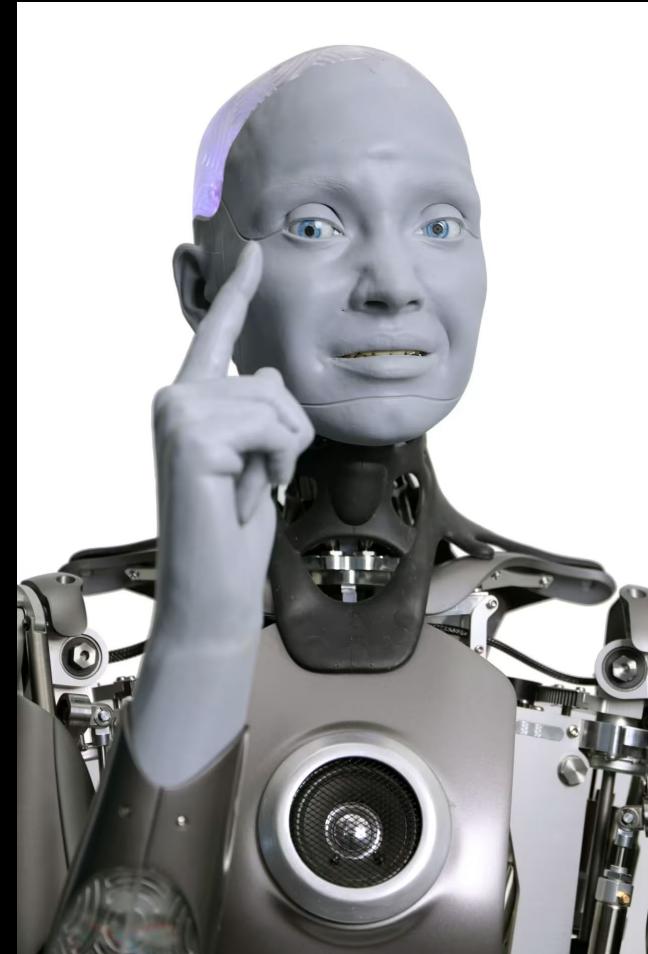
-  **Communication & Translation**
  - Breaking language barriers → Real-time translation
  - Converting between modalities → Speech↔Text, Text↔Audio
  - Making content accessible → Screen readers, transcription
-  **Understanding & Analysis**
  - Extracting insights from text → What are customers saying?
  - Organizing information → Automatically sort emails, documents
  - Finding patterns → Detect trends in social media, reviews

### AI in Mental Health Use Cases with Real-Life Examples

-  Apple's Health and Mindfulness App
-  Woebot Health's AI-Driven Mental Health Support
-  Wysa's AI-Powered Cognitive Behavioral Therapy
-  IBM Watson's EVA Mitigating Psychological Stress

# Core Application of NLP (2of2)

-  Content Generation
  - Creating new text → Summaries, articles, responses
  - Answering questions → Customer support, search engines
  - Assisting writing → Grammar checking, style suggestions
-  Interactive Systems
  - Conversational interfaces → Chatbots, virtual assistants
  - Command understanding → Voice control for devices/robots
  - Context-aware responses → Maintaining conversation flow
-  Safety & Moderation
  - Spam Detection - Email and message filtering
  - Content Moderation - Keeping platforms safe
  - Fraud Detection - Analyzing communication patterns



# NLP in AI/Robotics Systems Integration

## Interaction

- **Voice commands** → Robot control and navigation
- **Dialogue systems** → Natural conversation with robots
- **Multimodal understanding** → Combining speech, gesture, and context

## AI System Architecture:

- **Intent Recognition** → Understanding user goals from natural language
- **Knowledge Extraction** → Building knowledge bases from text
- **Real-time Processing** → Low-latency response requirements

## Industry Applications:

- **Healthcare Robots** → Processing patient conversations and medical records
- **Manufacturing** → Natural language interfaces for industrial automation
- **Autonomous Vehicles** → Voice commands and passenger interaction

# NLP Applications in Everyday Life

## 🎙 AI Recording & Transcription Devices:

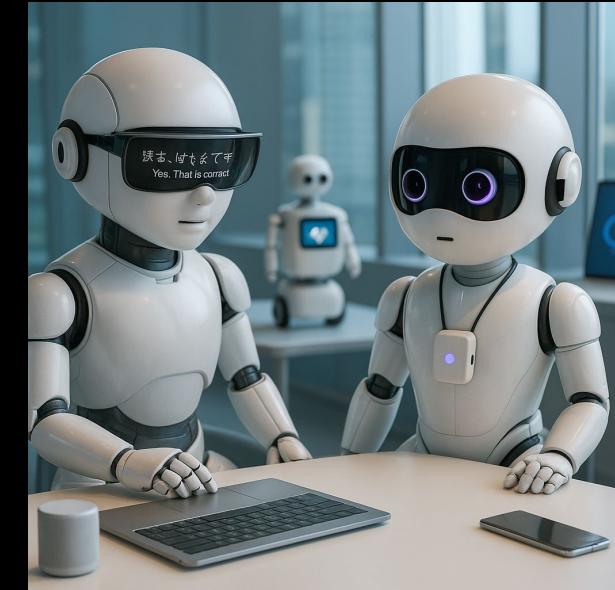
- Plaud NotePin - wearable AI meeting recorder
- Otter.ai Meeting Owl - 360° conference recorder

## 💬 Conversational AI

- ChatGPT, Claude, Gemini for writing & coding

## 🌐 Multimodal Translation

- Real-time speech translation earbuds
- Ray-Ban Meta Smart Glasses



# NLP Applications in Everyday Life

## Smart Environments

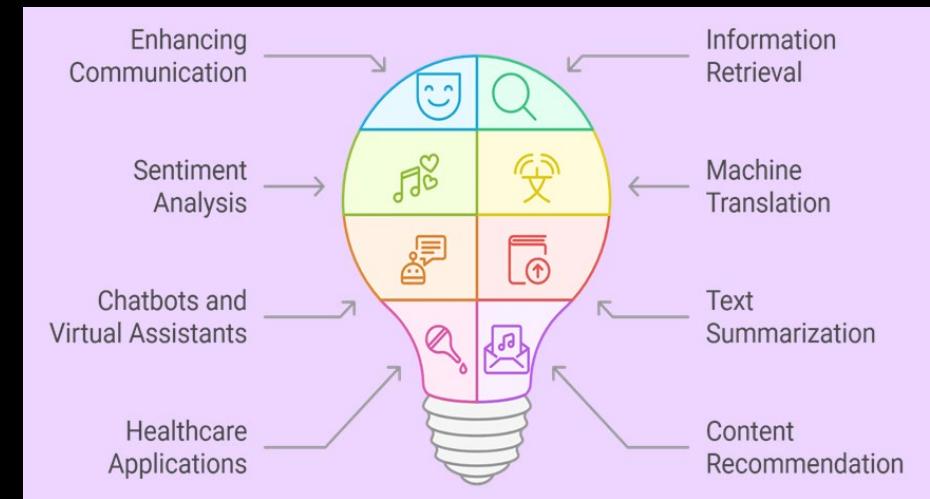
- Voice-controlled homes and robots
- Natural language vehicle interfaces

## Healthcare Applications

- Clinical documentation (Nuance DAX)
- Patient conversation analysis

## Digital Safety & Moderation

- Content filtering and fraud detection



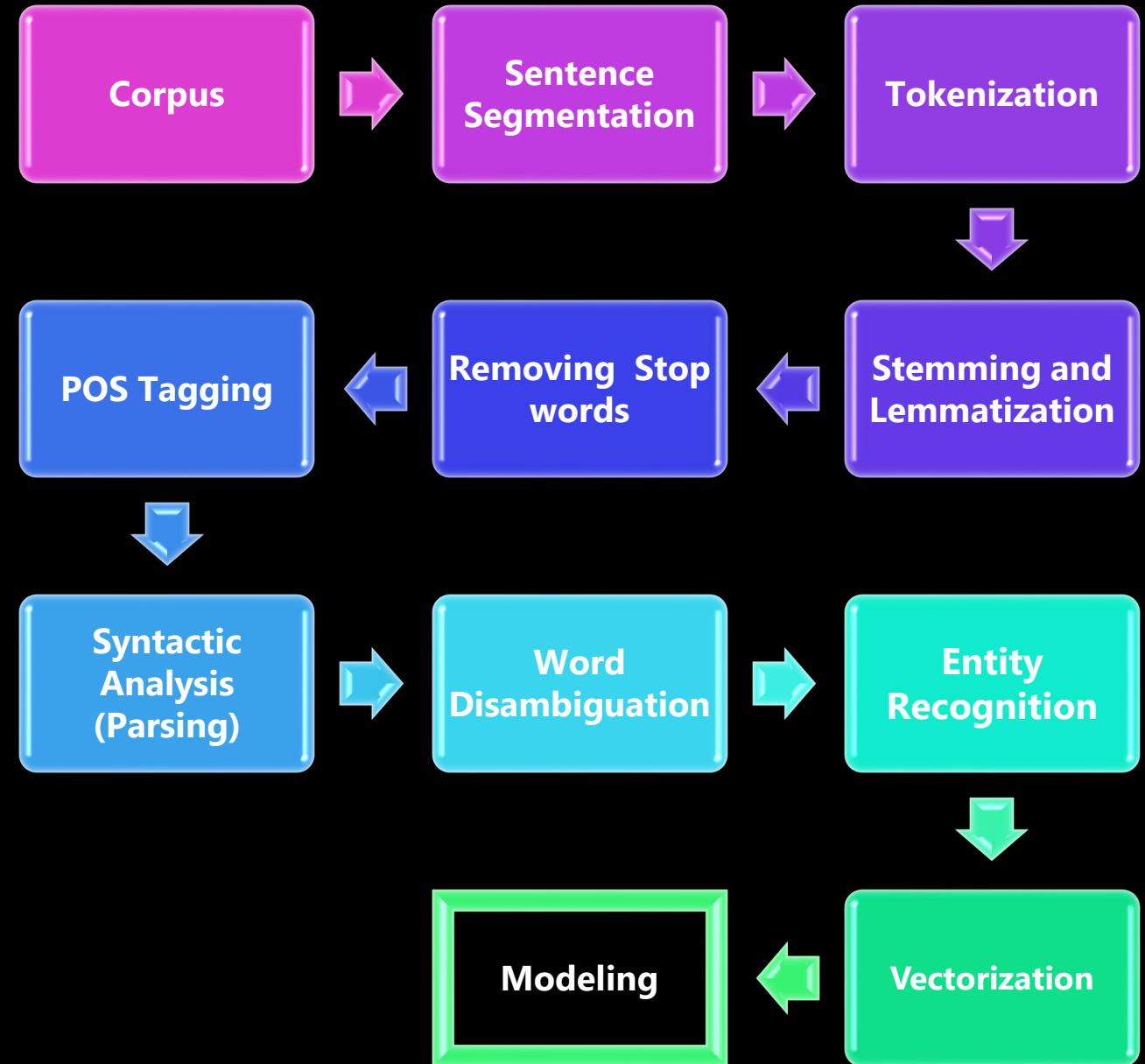


# NLP Pipeline

**Pipeline Flexibility:** Not every project needs every step. **Modern approaches** often skip traditional steps:

- **Traditional:** Full preprocessing → Feature engineering → Classical ML
- **Modern:** Minimal preprocessing → Pre-trained models → Fine-tuning
- **Hybrid:** Combine both approaches based on data size and requirements

**Your Choice Depends On:** Data size, computational resources, accuracy requirements, interpretability needs



# Key Takeaways

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- NLP bridges human communication and computer understanding through text, speech, and multimodal processing
- The field combines linguistics, computer science, and machine learning to solve real-world problems
- Core applications include search, translation, virtual assistants, sentiment analysis, and conversational AI
- The NLP pipeline transforms raw text through preprocessing, analysis, and modeling stages
- Modern tools like NLTK and SpaCy make NLP accessible for building practical applications
- Next steps: Prepare for module 02

# Your Learning Journey - What's Ahead



## Foundation Building (Modules 1-4):

- **Text preprocessing** → Clean messy real-world data
- **Text representation** → Convert words to numbers computers understand
- **Linguistic analysis** → POS tagging, parsing, semantic roles



## Core Applications (Modules 5-10):

- **Sentiment analysis** → What do customers really think?
- **Text classification** → Automatically organize documents
- **Named entity recognition** → Find people, places, organizations
- **Topic modeling** → Discover hidden themes in large text collections



## Advanced Systems (Modules 11-16):

- **Language models** → Understanding how modern AI generates text
- **Conversational AI** → Build your own chatbot or virtual assistant
- **Real-world deployment** → Take your NLP system from laptop to production
-  **Your Capstone Project:** Design and build a complete NLP application that solves a real problem