NATURAL LANGUAGE PROCESSING

Natural Language Processing (NLP) is a field of Artificial Intelligence that focuses on enabling computers to understand, interpret, and generate human language. The goal is for machines to process text or speech in a way that captures the meaning and context, so they can respond or take action appropriately.

Evolution of NLP

Word Embedding	• Focused on converting words into numerical representations (vectors) so that computers could process them mathematically. • Achieved using linear algebraic transformations, enabling models to capture some meaning and similarity between words.
Deep Learning Era	• Neural Networks began to be applied for text-based analysis. • While effective, they struggled with long sentences because all input had to be processed at once, making it difficult to capture long-range dependencies.
Recurrent Neural Networks (RNNs)	• Introduced to handle sequences by feeding the output of one step back into the network for the next step.Allowed the model to "remember" previous context when processing new words. • However, for long sentences, this became computationally expensive and prone to issues like the **vanishing gradient problem**.

Evolution of NLP

Word2Vec	- Provided dense, context-aware vector representations for words by analyzing their usage in large corpora. - Helped capture semantic relationships ("king" - "man" + "woman" ≈ "queen"). - Often combined with RNNs to enhance context understanding.
Attention Mechanisms	- Enabled models to focus on the most relevant words in a sentence or paragraph rather than processing all tokens equally. - Made it feasible to analyze much larger texts efficiently. - Eventually became a core component of Transformer architectures.
BERT	- Bidirectional Encoder Representations from Transformers. - Reads sentences both forward and backward, creating contextual embeddings for every word. - Strong at tasks like sentiment analysis, question answering, and named entity recognition.
GPT Series	**Generative Pre-trained Transformers** trained with billions of parameters. - Specialized in text generation, conversation, and creative writing by predicting the next word in context. - GPT-3 and beyond enabled advanced applications such as coding assistance, content creation, and reasoning.