International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 22 No. 1(s) (2026)



ijerst.editor@gmail.com

editor@ijerst.com

www.ijerst.com
© 2026 IJERST. All Rights Reserved
Peer Reviewed, Referred & Indexed Journal

Research Paper

Natural Language Processing- An intermediator between human and machines

Name of Author

Miss. Changede Ashwini Ashok.

Assistant Professor, (HOD) Department of Computer Science,
Rajarshi Shahu Mahavidyalaya, Deolali Pravara
Email id: ashwinichangede2012@gmail.com

Abstract:

In the 1950, NLP invented when researchers first experimented with machine translation. In 1954 Georgetown-IBM experiment that automatically translates 60 Russian sentences into English. With applications development like document classification, spam filtering, and basic chatbots NLP technologies gained fame in the 1990s and early 2000s. However, the crossroads came in the 2010s with the growth of deep learning models which uses neural network architecture to analyze data sequences, making it possible to analyze larger blocks of text. NLP used by organizations to encode sentiments suppressed in support tickets, emails, customer feedback, and social media posts.

Both in theoretical development and practical applications Natural Language Processing (NLP) has been in presence for more than fifty years and has made significant contributions to the field of human-computer interaction (HCI).

As the day passes, digital devices become affordable and accessible, the demand for interfaces that are effective, robust, modest, and user-friendly—regardless of users' expertise levels or physical limitations—continues to grow. Since natural language enables easy and efficient communication between humans, its potential in human-computer interaction is substantial. Whether spoken or written, natural language can complement other interface modalities, such as graphical elements like windows, icons, menus, and pointing devices. In certain situations—particularly for users with disabilities—natural language may even serve as the primary or only viable mode of interaction. (Natural Language

Processing: A Human-Computer Interaction Perspective).

This paper includes the concept of NLP, definition, steps involved in natural language processing, examples, tools useful for natural language processing, benefits of NLP, challenges and limitations, futures scope of NLP as intermediator between human and computers.

Keywords:

Natural Language Processing (NLP), Artificial Intelligence, Deep Learning, Human–Computer Interaction (HCI), Text Processing, Sentiment Analysis, Named Entity Recognition (NER), Language Models, Transformer Models

Introduction:

Natural Language Processing (NLP) provides an essential platform for communication between human (natural language) and computer understanding language as machine code It is a branch of artificial intelligence, computer science, and linguistics that enables machines to read, interpret, and produce human language. NLP helps computers and digital devices to understand recognize and generate text and speech by combining computational linguistics, the rule-based modelling of human language together with statistical modelling, machine learning and deep learning. (www1). The advent of computational linguistics marked a turning point, as researchers began to incorporate statistical methods and algorithms to analyses and generate language more effectively. In the 1980s and 1990s, the development of machine learning techniques further propelled the field, allowing systems to learn from large datasets rather than relying solely on predefined rules (A Study on Natural Language Processing: Bridging the Gap Between Human Communication and Machine Understanding, February 2025). With the advent of BERT, GPT, RoBERTa, and T5 and the increasing popularity of large language models, human-machine communication has become deeper and richer. Consequently, these advancements made it possible for NLP applications to scale across languages, domains, and use cases, giving rise to numerous applications in health, finance, customer service, and education. Another exciting aspect is the marriage between NLP and other AI fields like computer vision and knowledge (Natural Language Processing (NLP):Transforming Human-Machine Communication)graphs, which push the boundaries for what multimodal AI can accomplish.

Definition:

Natural language processing (NLP) is the processing of natural language information by a computer. NLP is a subfield of computer science and is closely associated with artificial intelligence. NLP is also related to information retrieval, knowledge representation, computational linguistics, and linguistics more broadly (enw).

The steps involved in Natural Language Processing Works: (2026)

1. Input in the form of text and speech:

- **Text acquisition (Receiving voice input):** The system takes written language like sentences or documents.
- **Speech Recognition (Receiving voice input):** When the input is audio, it is first converted into text

2. Pre-processing

The text is cleaned and prepared. It can include:

- **Removing punctuation marks or noise:** Text normalization is done by removing unwanted characters or symbols from text.
- **Tokenization:** splitting sentences into smaller words so they can be processed easily.
- **Case folding (Changing the case):** Converting all words into the same case for uniform processing.
- **Eliminating frequent words:** Removing **common words** like is, the, and to focus on meaningful terms.
- **Reduce computational power: Reducing words to base form as c**onverting words like coming to come.

3. Language Analysis:

The system focuses on structure and semantics:

- **Detection of correct grammar:** Classifying nouns, verbs, and other parts of speech in a sentence is done.
- **Finding the relationships among words:** Discovering how words are connecting to each other in a sentence.
- **Perspective understanding:** Defining the actual meaning of a word based on neighboring text.

- **Detecting names and places:** Spotting objects like person, locations, names, or dates.

- **Detection of sentiment:** Identifying emotion behind the text positive, negative or neutral.

4. Text Representation and Embedding Techniques

This step translates text into numerical vectors.

- **Text representation:** By using statistical features or vector representations text is converted into numbers so machines can process it.

- **Traditional representations:** Word counts and importance scores these prior methods are used to represent text.

- **Word embedding:** By capturing similarity and meaning recent methods represent words as dense vectors.

- **Contextual embedding:** Advanced models generate word senses based on the surrounding sentence.

5. Model Training

Once text is converted into numbers, machine learning models analyse patterns to perform natural language processing tasks.

- **Model training:** By converting text into vectors, algorithms learn patterns from data to perform tasks like classification or translation.

- **Traditional machine learning:** Earlier NLP systems depend on statistical algorithms to learn from manually prepared features.

- **Deep learning approaches:** Modern NLP practices neural networks that spontaneously learn language structure from large data.

- **Pre-trained models:** Large language models trained on massive datasets can be reused and fine-tuned for tasks.

6. Output Generation

The system produces outcome such as:

- Text reply

- Voice reply

- Paraphrase

- Summary

- Prediction

The NLP process explained by following simple example:

“Sham is happy with the new car.”

An NLP system can work on above statement and gives outcome as follows:

 Detect- Sham as a person
 Identify -Car as an object
 Recognize- Sentiment as positive
 Understand- Topic as product review

Natural language processing tools (htt)

You can select from several natural language processing tools and services available to help you start using NLP today. Three popular options include the following:

- Google Cloud NLP API
- IBM Watson
- Amazon Comprehend

Benefits behind using Natural Language Processing (www2):

Natural language processing (NLP) plays a central role in many modern technologies. Conversational agents like Amazon Alexa and Apple Siri rely on NLP to interpret spoken user queries and deliver relevant responses. More advanced systems, such as GPT-3, extend these capabilities by generating sophisticated text on a wide range of topics and enabling chatbots to sustain coherent, context-aware conversations.

Beyond virtual assistants and chatbots, major technology companies also leverage NLP in other applications. Google uses NLP to refine search engine results by better understanding user intent, while Facebook applies NLP techniques to identify and filter hate speech and other harmful content on its platform.

The process of classifying the emotional intent of text is categorized under sentiment analysis. Usually, the input given to a sentiment classification model is text, and the output is the probability that the sentiment expressed is positive, negative, or neutral.

The branch of sentiment analysis Toxicity classification where the aim is not just to classify aggressive intent but also to categorize threats, insults, obscenities, and hatred towards certain identities.

To extract entities in a piece of text into predefined categories such as personal names, organizations, locations, and quantities is considered under Named entity recognition.

Binary classification problem in NLP, where the purpose is to classify emails as either spam or not known as Spam detection.

Grammatical error correction technique is useful for to correct the grammatical rules within text.

Topic modeling is being used commercially to help lawyers find evidence in legal documents.

Natural language generation (NLG), also known as text generation, focuses on producing text that closely reflects human writing. These systems can be adapted to create content in multiple styles and formats, including tweets, blog posts, and even programming code.

The methods used for text generation have evolved over time. Early models relied on probabilistic approaches such as Markov processes. Later, neural network architectures like LSTMs improved the ability to capture long-range dependencies in text. More recently, transformer-based models — including BERT, GPT-2, and LaMDA — have further enhanced the fluency, coherence, and contextual accuracy of generated content.

Today, NLG is widely used in applications such as autocomplete features and chatbots, where generating relevant, natural-sounding responses is crucial.

Summarization is the task of shortening text to highlight the most relevant information.

Question answering deals with answering questions posed by humans in a natural language**.**

Challenges and Limitation of NLP:

1. Ambiguity in Language

In human language a single word or sentence can have several meanings depending on context, therefore making perfect clarification difficult for NLP systems.

Types of ambiguity:

- **Lexical ambiguity** – A word has multiple meanings.
  Example: “Bank” can mean a financial institution or the side of a river.
- **Syntactic ambiguity** – A sentence can be structured in multiple ways.
  Example: “I saw the man with a telescope.” (Who has the telescope?)

- **Semantic ambiguity** – The meaning depends heavily on context.

2. Sarcasm Detection Difficulty

Sarcasm means a talker wants to say something but means the opposite. Detecting sarcasm is extremely difficult because it requires:

- Understanding tone and emotion
- Recognizing cultural and social context
- Identifying contradictions between literal and intended meaning

Example:
"Great! Another Monday morning traffic jam."
The word "Great" appears positive, but the intended meaning is negative.

3. Low-Resource Languages

Many NLP systems are trained primarily on high-resource languages such as English, Chinese, or Spanish. However, thousands of languages worldwide lack:

- Large digital text corpora
- Annotated datasets
- Linguistic research resources

4. Bias in AI Models

NLP models learn from large datasets collected from the internet. If the training data contains biased language or stereotypes, the model may reproduce or even amplify these biases.

Types of bias include:

- Gender bias
- Racial bias
- Cultural bias
- Political bias

5. Data Privacy Concerns

NLP systems often process sensitive information, including:

- Emails
- Medical records
- Customer feedback
- Personal messages

If data is not properly secured, it may lead to:

- Unauthorized access
- Identity theft
- Data misuse

6. Computational Cost of Large Models

Modern NLP models, especially transformer-based architectures, require enormous computational resources.

Training large models often involves:

- High-performance GPUs or TPUs
- Massive datasets
- Significant electricity consumption

This leads to:

- High financial costs
- Environmental impact due to energy usage
- Limited accessibility for smaller organizations and researchers

Future Scope of NLP as an Intermediator Between Human and Machine:

- **Improved multilingual support** to reduce language barriers using models like BERT.
- **Multimodal AI integration**, combining text, speech, and images for richer interaction.
- **Personalized AI assistants** that understand user preferences and provide proactive support.
- **Applications in healthcare and education**, including intelligent tutoring and clinical data analysis.
- **Ethical and responsible AI development**, focusing on fairness, transparency, and privacy.
- **Real-time translation and robotics integration**, enabling seamless global communication and smarter environments.

Overall, NLP will continue evolving as a powerful bridge between humans and machines, making communication more intelligent, accessible, and human-like.

Conclusion:

Natural Language Processing (NLP) has evolved significantly from the early machine translation experiments of the 1950s to today's advanced transformer-based models. For example, the 1954 Georgetown–IBM experiment conducted by Georgetown University and IBM is considered a major milestone in machine translation. This experiment demonstrated that computers could automatically translate languages, strengthening confidence in the field.

Over time, NLP progressed from rule-based systems to data-driven machine learning approaches, and later to deep learning methods. The introduction of transformer architectures brought a major breakthrough in language understanding. Modern models such as BERT and GPT-3 have significantly improved contextual understanding, semantic interpretation, and text generation capabilities.

NLP plays a crucial role as a bridge between humans and machines. With the help of computational linguistics, statistical modeling, and neural networks,

computers can now meaningfully understand, analyze, and generate human language. Applications such as Sentiment Analysis, Named Entity Recognition, machine translation, question-answering systems, text summarization, and conversational agents have transformed industries including healthcare, finance, education, and customer service.

Despite these advancements, NLP still faces several challenges, including linguistic ambiguity, difficulty in detecting sarcasm, bias in artificial intelligence systems, privacy concerns, limited support for low-resource languages, and the high computational cost of large models. Addressing these issues requires continuous research, ethical AI practices, the development of inclusive and diverse datasets, and sustainable computational strategies.

The future of NLP is promising. Improvements in multilingual systems, multimodal AI integration, personalized digital assistants, real-time translation, and responsible AI development will further strengthen the connection between humans and intelligent systems. Ultimately, NLP technology will become more accessible, intuitive, and human-centered—enabling more natural and seamless communication between humans and machines.

Bibliography

www.ibm.com. [Online] https://www.ibm.com/think/topics/natural-language-processing.

en.wikipedia.org. [Online] https://en.wikipedia.org/wiki/Natural_language_processing.

2026. *geeksforgeeks.org.* [Online] 24 Feb, 2026. https://www.geeksforgeeks.org/nlp/introduction-to-natural-language-processing-nlp/.

https://www.coursera.org/in/articles/natural-language-processing. [Online] https://https://www.coursera.org/in/articles/natural-language-processing/in/articles/natural-language-processing.

www.deeplearning.ai. [Online] https://www.deeplearning.ai/resources/natural-language-processing/.

google.com. [Online] https://www.google.com/search?client=firefox-b-d&q=natural+language+processing+itermidiator+between+computer+and+human.

A Study on Natural Language Processing: Bridging the Gap Between Human Communication and Machine Understanding. **Asharaf, Zartashya. February 2025.** s.l. : https://www.researchgate.net/publication/3

88953488_A_Study_on_Natural_Language_Processing_Bridging_the_Gap_Between_Human_Communication_and_Machine_Understanding, February 2025.

Natural Language Processing (NLP):Transforming Human-Machine Communication. **Kumar, Anish.** Vol. International Journal for Multidisciplinary Research (IJFMR). E-ISSN: 2582-2160 .

Natural Language Processing: A Human-Computer Interaction Perspective. **Manaris, Bill.** Vols. volume-47.

https://www.google.com/