



Future Advancements In AI And Their Potential Impact Of Natural Language Processing

Ms. Sarika Nibhanupudi¹,

Assistant Professor,

Department of Computer Science (PG),

St. Ann's College for Women, Hyderabad, India

Abstract: Artificial intelligence (AI) is a technology that creates computers that ensure that humans prepare things that involve intelligence. Natural Language Processing (NLP) is an extensively deliberated and explored topic at present. It is a subject that forms part of artificial intelligence (AI), which has attracted further consideration for demonstrating and examining. Its application has multiplied in numerous arenas like medicine, information extraction, email filters, machine translation, customer support, chatbots and virtual assistants, summarizations, etc. Different algorithms utilized for NLP are primarily reliant on the recurrent neural network. In the past few years, NLP has seen main developments as a result of the availability of enormous datasets, complex algorithms such as neural networks, and robust technology. This created a potential for machines to read and examine the unstructured input in the form of video, voice and writing. This review paper focus on the influence of in NLP. Also, highlights on Deep learning architecture, particularly (RNN) and its variant, such as - (LSTM). Furthermore, recent advancements in NLP and the application of NLP are discussed. This paper also examines the challenges and limitations of NLP. Finally, NLP in the health sector, finance, and conversational AI will also be addressed.

Index Terms - Component, formatting, style, styling, insert.

I. INTRODUCTION

With the quicker improvement of the times, intelligent technology continues to progress, intelligent products develop boundlessly, and people's lives are flattering and more convenient. The growth of artificial intelligence (AI) has turned out to be intimate from knowledge. A deep understanding of statistics, logic, psychology, philosophy, and so on is needed for research dedication. Nowadays, AI is an extensively deliberated buzzword. The foremost of AI is to perceive and acquire from environments because they can resolve issues and improve their own decisions [1] Natural Language Processing (NLP) is identified as the "jewel in the crown of artificial intelligence" [2] and established as a fundamental subfield within AI, determined to construct a bridge to create a communication break between humans and machines by allowing the computers to be familiar with, clarify and practice the human language. NLP reinforces a mass of AI applications, revolutionizing fields such as machine translation, intelligent virtual assistants, customer service, and social media analysis. The development of NLP technology originated in the 1950s when machine translation systems were first introduced. Over the past few decades, NLP has experienced essential growth, which has been determined by revolutions in , neural networks, and [3] . NLP is challenging because it is difficult to comprehend the assembly of an ambiguous sentence. Additionally, it involves an enormous volume of resources and desires computational difficulty to investigate a statement. So, it can assist humans in efficiently interpreting the sentence. NLP is fundamentally categorised into two constituents, Natural Language Generation (NLG) and Understanding (NLU), which progress the mission of learning and creating the text [4] . (NLG) is the progression of generating, and that are consequential from an presentation. It is an essential of NLP and occurs in four levels: recognizing the , how objectives can be accomplished by assessing the condition and accessible of communication and understanding the plan as a . NLG be made up of a and , and of representation and application and a speaker Natural Language Understanding (NLU)/ Linguistic supports

technologies to comprehend and examine it by digging out , , emotions, etc. is a discipline that realizes the importance of , the perspective, and several kinds of Language stages are one of the furthestmost investigative tactics to signify the , facilitating the creation of the by executing the gratified , planning, and s employment stages. Numerous key terminology of the is allocated into seven stages from the easiest to furthestmost complex, namely , , syntax, semantics, , and [5] .

II. NLP AND MACHINE LEARNING

and are subdivisions of that have gained significant recognition and have been widely applied across various industries in recent decades. Machine Learning involves programming computers to improve their performance based on experience or example data. It uses statistical methods to build mathematical models. [6, 7] . Machine learning has played a productive role in significant applications of . Machine learning employs neural networks and intelligent modules which are capable of learning from old data. In Machine learning, the guidelines for language processing are developed from the training data. There are three methods of from data: , unsupervised, and learning. In supervised learning, training data collection deals with instances labelled by predictive features and appraises for the objective attribute. In contrast, there is no objective attribute in unsupervised learning and thus so labelled data. In reinforcement learning, the machine learning models utilize a response that is shown as a prize or castigation to make the best use of its execution. Deep Learning and Machine Learning support computer systems to acquire the data and make their own inference. It aids the computer system in cracking problems that could not have been encountered earlier or enhances its feedback established on its past understandings over time. and are admired methods due to their capability to study millions of documents, and they can be helpful in a different range of fields like automobiles, insurance, manufacturing, customer service, e-commerce, healthcare, transportation, and energy, among others. Machine learning and deep learning have donated considerably to the intelligence of computer systems. But, capitalizing on these intelligent systems is a challenging mission. Moreover, only a few machine learning engineers were capable of utilizing or connecting with these intelligent machine learning systems. Managing and exploration of human language are performed in numerous phases. A pragmatic analysis, syntactic analysis, morphological analysis, discourse analysis, or semantic analysis might operate at every phase. This degree of analysis decides the machine's capability to practice and comprehend natural language. Natural language processing has progressed into a distinct discipline by itself as well. Natural language processing has turned out to be trendy because of systems like Google Assistant, Alexa, and Siri [7] .

For instance, natural language processing has been necessary for improving robotics, and machine learning has been significant to the growth of computer vision, which is a division of AI). Machines only binary, whereas processing charges machines to understand human language. Machine learning has performed a very significant role. It plays an crucial part in . [8] .

III. AND LEARNING TECHNIQUES

Machines cannot understand human language, but they can appreciate binary language. Processing natural language is required to create a machine that understands human language. Machine learning techniques like Random forests, Naive Bayes, Decision Trees, and Support Vector Machines have made contributions in all fields of study. Processing of natural language involves many steps to create an understanding of the language for the machine. They are Pragmatic analysis, , morphological analysis, analysis, or analysis.

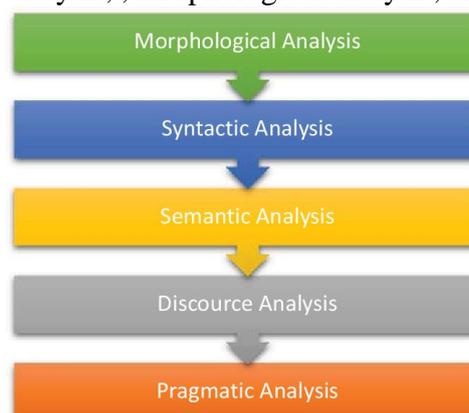


Figure 1: Stages in Natural Language Processing

a) *Morphological Analysis:*

Morphological natural language processing involves tokenization and stemming, where tokenization assists in identifying words and sentences and stemming helps to remove the affixes. Support Vector Machines and Recurrent Neural Networks are surrounded by Machine Learning and Deep Learning algorithms which have been engaged in tokenization [9]. Shrivastava *et al.* (2005) developed a stemmer and morphological analyzer for the Hindi language and reported 100% accuracy of their system. They utilized 86 suffix replacement rules to transform the term, and the *resulting* candidate root practice was tested *against* a list of root forms (RFList) gained from Hindi word net. They deemed it to be the correct root form [10]

b) *Syntactic Analysis:*

Syntactic parsers check a language's grammar rules in given sentences. Many machine learning and *deep learning* algorithms, like *recurrent neural networks* and random forests, have been incorporated into this task. Syntactic parsers have been integrated by utilizing machine algorithms like K-nearest neighbour [9] Subert *et al.* (2023) discovered a monitoring tool for multiple sclerosis patients based on automatic speech recognition and natural language processing techniques. It employs lexical and syntactic features attained from unprompted discourse. The multiple sclerosis patients who participated in this research distinct a deterioration in lexical and syntactic language domains [11]. Themistocleous *et al.* (2024) employed natural language processing-based *extraction* methods to automatically acquire *language* features from storytelling in ASD (Autism Spectrum Disorder) children and later on trained with *machine learning* models on the *children* by a combination of *narrative* and *expressive* vocabulary *data* to produce behavioural targets that efficiently distinguish ASD from normally *developing children*. The outcomes promise fit for the utilization of *machine learning technology* for *children* with ASD [12]

c) *Semantic Analysis:*

This extracts the *dictionary meaning* or the precise *meaning* from *context*. The structure of the sentence and word are evaluated, and the meaning of phrases and words is stipulated. If the structure mapping is not possible then they are rejected. Kittiphong Sengloiluean *et al.*, in 2017 [13], suggested a semantic approach to answering the query by using DBpedia and WordNet. They also suggested the procedures for resolving the *problem* of find out the *med entities*, *properties*, and word resemblances of *named entities*. The study tested the accuracy of answers to questions. In 2017, Kazar Okba *et al.*, on the basis of ontologies combination they, suggested to translate the given text from the source language to another language. They designed and incorporated a translation system based on the semantic interpretation of every translated word, which enables the detection and treat ambiguity zones. For this suggested method, they used an OWLXML file, which might contain grammar, terminology and annotation details. They also developed algorithms to translate an unedited product [14]

d) *Discourse analysis*

Discourse analysis assists the particular sentence in depending on the sentence that follows it and also raises the *meaning* of the sentence that follows it [9]. Rahangdale and Agrawal, in 2014 [15], proposed a Natural language-based Discourse Analysis method, which has been used for extracting data from news articles of various domains. For this method, they used the rhetorical structure theory, which can be utilized to find coherent groups of text that are most prominent for extracting details from text.

e) *Pragmatic Analysis*

Pragmatic analysis is performed to recognize the anticipated *meaning* of a given *sentence* [7]. Chen *et al.* (2024) examined the possible use of AI-generated conversations in pragmatic analysis. They found that in speech act performance, ChatGPT performed equally to humans. However, AI systems were provided with supplemental data that functioned as attitudinal indicators.

IV. AI TECHNIQUES FOR NLP ENHANCEMENT

In the present world, NLP has developed a portion of daily life. NLP is a programmed procedure that examines text by consuming various technologies and theories with the assistance of a computer. There are various methods to enhance the NLP by using AI. They are:

➤ **Part-of-speech (POS) tagging**

According to Robin (2009), Parts of Speech (POS), *tagging* is the progression of assigning a specific part of speech to words. POS tagging employs either one statistical model or rule-based algorithms to examine the contextual practice of a word inside a sentence, consequently assigning a suitable part of speech tag. It applies *Bayesian Models*, Markov Models, Maximum Entropy, and Transformation – Based Learning (TBL) in POS tagging. A *research* work by Sajjad and Schmid [16] offered four Urdu POS taggers: *tree tagger*, random forest (RF) tagger, *TnT* tagger, and SVM tagger. They also evaluated POS taggers. For this research, they piloted investigations on a quantity of about 110000 that were gathered from cyberspace. The tag set consumed in their research encloses 42 syntactic categories. However, the SVM tagger acquired a precision of 95.66%. In contrast, Demilie [17] suggested an *Awngi* language part of speech tagger by applying the *hidden Markov Model*. They established 23 handcrafted tag sets and assembled 94,000 sentences. The empirical outcome displays that uni-gram and bi-gram taggers accomplish 93.64% and 94.77% accuracy, correspondingly. The research was conducted by Kumar *et al.* (2019) [18] to report the difficulty of Part-Of-Speech (POS) tagging for Malayalam tweets. A tag set used to be intended, which encloses 17 unprocessed tags, and 9915 tweets were labelled physically for research and assessment. They were assessed with various models like *gated recurrent units* (GRU), long short-term memory (LSTM), bidirectional LSTM (BLSTM), and recurrent neural networks (RNN). The trials were conducted on the origin of personality and word level at diverse hidden conditions. The growth in hidden states directly developed the tagger model.

➤ **Named entity recognition (NER)**

Named Entity Recognition (NER) represents a foundation task in Natural Language Processing (NLP). NER encompasses the recognition and organization of identified entities like names of individuals, administrations, places, dates and extra with documented information. Its essential part remains in its size to extricate organized data from indistinct text, thus improving data retrieval, analysis, and understanding [19]. Current deep learning techniques for NER comprehend a range of models comprising long short-term memory (LSTM), convolutional neural networks (CNNs), transformers like BERT and GPT and *recurrent neural networks* (RNNs) [20]. A research study conducted by Kim *et al.* anticipated unsupervised named entity arrangement models and their collections, which utilize a small-scale named entity phrasebook and an unlabeled amount for categorizing named entities [21]. The research was performed by Mojibian *et al.* [22] To estimate the effectiveness of a marketable medical Named Entity Recognition (NER) model, which was blended with a post-processing procedure to recognize supplementary pulmonary nodules from CT reports. The consequences were reliable through the cooperation of unbalanced and balanced datasets, which indicates the model enactment is independent of nodule frequency. The NER model revealed more sensitivity and specificity in identifying pulmonary nodules stated in CT images. Zhang and Yang (2018) carried out an investigation to determine a lattice-structured LSTM model for Chinese NER that fixes a sequence of input characters in addition to all possible words that influence and correspond to a lexicon. So that error circulation of division be able to prevent throughout level [23].

➤ **Machine Translation**

Machine translation (MT) is a field of *computational linguistics* that discovers the usage of software to translate speech or text from one *language* to another. There are three categories of machine translation: statistical, system-rules based and neural [24]. In 1949, Warren Weaver anticipated the consumption of computers to unravel the task of machine translation [25]. Conducted survey-based research by Jolley and Maimone to research the usage of attitudes, *perceptions* and beliefs about *Google Translate* and familiar free online machine translation (FOMT) utensils by students and teachers in university Spanish courses. The outcome revealed that the majority of participants had utilized machine translation at a certain point, with 74.11% recording either one regular or occasional use [26]. Similarly,

Prates *et al.* (2019) reveal that Google's translation system is able to agonize from gender bias by making sentences taken from the U. S. Bureau of Labor Statistics into a loads of languages that are gender unbiased, comprising Chinese, Yoruba and Hungarian. They are translated into English and show that Google Translate shows a preference for males for conventional fields such as STEM (Science, Technology, Engineering and Mathematics) jobs[26].

➤ Question Answering

Question-answering systems have developed as a decisive stage for spontaneously answering questions enquired by humans in natural language using either a pre-structured database or collections of natural language documents. The demand for this system proliferations *day by day* since it distributes short, *precise* and *question – specific* answers [27]. QA systems were established *initially* as early AI systems in the 1960s. In the research work of Abdallah *et al.*[28] describes the substantial opening in Arabic natural language processing assets by initiating Arabica QA, the leading extensive dataset for machine reading understanding and open-domain question answering Arabic. This broad dataset involves 89,095 answerable and 3,701 unanswerable questions produced by workers to appear parallel to answerable ones, besides with additional tags of open-domain questions, indicating a fundamental development in Arabic NLP resources. Additionally, the research encompassed a wide-ranging evaluation of the large language models (LLMs) for Arabic question-answering. In 2020, Sandhuram *et al.* [29] created a model in which the types of questions enquired could be responded to in distinct mathematics. NLP is operated to categorize the series of answers to the query asked. The logic system determines a practical approach to asking the question. The researcher utilized SQUAD to accomplish the analysis. Lexical Chain and Keyword analysis are used in their system for responding to the questions for established articles.

V. Deep learning design for enhanced NLP

Deep learning permits computational models to study characteristics gradually from information at various levels. Deep learning techniques instigated deep neural networks. Its algorithm authorizes the data by means of numerous layers, where each layer is efficient for obtaining features increasingly and permits it to be transferred to the subsequent layer [30]. In the past few years, deep learning technology has been established and utilized in the NLP field, and it has endured progressive variations. Deep learning models like Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) have been recognized to be efficient in managing the long-term reliance current in text information [31].

• Recurrent Neural Networks (RNNs)

Recurrent Neural Networks (RNN) are a group of deep learning models that are essentially invented to manage sequential data. It influences the unique characteristics of sustaining a memory of preceding inputs through consuming their internal memory to handle sequence of inputs. Consequently, it creates preferably matched for applications like NLP, speech recognition, and time series prediction, whereby framework and the instruction of information points are essential. The establishment work by Werbos in the 1970s [32] established the perception of backpropagation through time (BPTT) that placed the foundation for training RNNs. The increasing difficulty of information and tasks in recent years has determined a constant revolution in RNN architectures and alternates. The pertinency of RNN is inadequate because of two reasons: 1) RNNs need *pre – segmented training* and *post – processing* of the *output* to adapt into the labelled sequence; 2) the long-term *dependencies* in data make space among the appropriate data and the location where it is desirable is prominent, RNNs consume only limited usage[33]. Medrouk and Pappa, in 2018 [34], utilized two deep *neural networks*, *Convolution Neural Networks* (CNN) and *Recurrent Neural Networks* (RNNs). In support of their research, they utilized unstructured text data that were assembled from the web and inscribed in Greek, French and English and, as a consequence, advocated the inception of a simple, so far prevailing method for deep networks in a multilingual framework. In research work of Graves *et al.*, (2006) have established a Connectionist Temporal Classification (CTC) model to train RNNs throughout aimed at tagging the sequence. Their technique operated wonderfully for complications that the input-outputs label configuration is unfamiliar with, and it does not involve *pre – segmented* training data and *post – processing* of the outputs. Research conducted by Hong, Zhang, and Xu [35] employed the AMC technique on the basis of RNN, containing the possibility of moderately utilizing the appropriate equivalent sequence attribute of acknowledged

communication signals. This procedure mentions raw signals straightly with inadequate data length and prevents digging out signals that are characterized manually. The anticipated technique is associated with the CNN way, and the consequence discovered by the RNN technique is progressive in the signal-to-noise ratio (SNR). The precision is enhanced from 80% to 91%. Likewise, *Guo et al.* [36] created a *RNN* based *health* indicators (*RNN – HI*) to improve the precision for the *RUL* (Remaining Useful Life) forecast of compartments. However, the *RUL* of influence is determined using an *exponential model* with a pre-set failure threshold of *RNN – HI* in preference to the trained *RNN* directly. In autonomous research, Niu and O'Neill implanted RNN-based deep-learning methodologies to calculate solar radiation [37]. This analysis demonstrated the ensuring consequences accomplished by RNN models in precisely estimating solar radiation levels. An approach was established by *Li et al.* [38] on RNN for the anticipation of photovoltaic (PV) potency, revealing promoted tiers of resilience and precision.

- **Long Short-Term Memory (LSTM) Networks**

Long Short-Term Memory (LSTM) was primarily introduced by Hochreiter in 1997 [39]. LSTM is a progressive variant of Recurrent Neural Networks (RNN) that delivers the problem of apprehending long-term dependencies. And its supplementary has grown in significant popularity in the deep learning identity. Meanwhile, comparing LSTM with RNN, the LSTM model has been recognized to be further valuable at maintaining and employing information upon a more extended sequence. Ayvaz and Alpay operated *Long Short – Term Memory (LSTM)* neural network methods to *forecast* accurate production data and procurement of reasonable outcomes, superior to conventional models. In their research to reformer preservation arrangements to lessen unpredicted breaks, they utilized an innovative technique that is made of the conjoined usage of disintegration in the empirical approach of cooperative and long-term memory. Their outcomes exhibited a functioning superior to other state-of-the-art models [40]. In 2016, Taylor, Leblanc and Jaokowicz [41], a deep LSTM network was utilized as a predictor of the ordinary bus interaction behaviour in automobiles. Significant divergences were distinguished by consuming an energetic threshold to notice anomalous communication behaviour triggered by cyber-attacks. Correspondingly, *Woo et al.* utilized the *long short – term memory (LSTM)* deep *neural network* to recognize the nonlinear parts of the Nomoto model of a pilotless surface vessel. However, the model demands the association of an abridged linear model to develop the motion prediction [42]. In another study, *Suraki et al.* [43] conceals numerous improvement procedures, which include gradient descent-based optimization, adaptive learning rate approaches, and LSTMs-peculiar optimization procedures in the framework of air pollution estimating consuming cooperative RNNs. Research work conducted by *Arono et al.* utilized an LSTM network with MFCC (mel-frequency cepstral coefficients) and spectrogram inputs intended for emotion recognition determination through speech signals [44]. In 2021, *Ozer et al.* applied LSTM in a transfer learning method on the basis of XCORR cross-correlation. LSTM model is accomplished with the information, and the evaluations of the developing models are transmitted and qualified with the original data. The consequences attained with RMSE, MAPE and MAE metrics exhibited that the anticipated model exploiting LSTM and transfer learning was effectively associated with models that were known to operate well on small-scale datasets, for instance, RF, XGBoost, and Light Gradient Boosting Machine (LGBM) algorithm [45].

VI. RECENT ADVANCEMENTS IN NLP

For the past few decades, Natural Language Processing (NLP) has witnessed significant advancement, which was determined by the rapid development of deep learning procedures. These advancements made a transformation in the field so that computers were permitted to interpret, comprehend, and generate human language. The two primary deep learning architectures used in NLP are RNN and Transformers. Models like ELMo, GPT, BERT, etc, have enhanced the capability of NLP models to comprehend context in language. These models is capable to generate representations of words which are sensitive to their context, which allows them to capture subtle nuance in meaning.

➤ ELMo

In 2018, Peters *et al.*, [46] anticipated Embeddings from Language Models (ELMo) which was trained on multilayer RNN and literates word embedding from context. As a training objective, the bidirectional language modelling is used by which the context of each word was embodied by connecting right-to-left and left-to-right illustrations and became SOTA for different major NLP benchmarks consisting of NER, Question answering and sentiment analysis. It can accumulate more than one vector per word so it offers dynamic and optimal dynamic. Subsequently, the embedding of respectively token be subject to its context of the input sequence, even out-of-vocabulary (OVV) token have efficient input depiction [47].

➤ BERT

Bidirectional Encoder Representation from Transfer (BERT) was invented by a scientist Devlin *et al.*, which is a deep directional transformer based PTM on google. The two-pre-training objective of BERT are Masked Language Model (MLM) and the Next Sentence Prediction (NSP). BERT have become a major foundational model option among other Transformer-based model for different NLP mission. The trained model's dependence is on basis of number of parameters where it exists in two sizes as: BERT_{BASE} (110 million) and BERT_{LARGE} (340 million). The model have been open free accessible by numerous researchers and many people is creating and evaluating diverse additions of BERT. For instance, Zhou . *et al.* proposed two models: TopicBERT-TA and TopicBERT-ATP. The development had the capability to capture the principle of text on a corpus level, somewhat than the sentence and word level. TopicBERT-ATP utilizes ATSC (aspect term sentiment classification) to create and identify the topic of the complete text corpus. TopicBERT-TA also utilizes ATSC, though it improves a topic extension layer that is low-level representation, which is unlabelled and transformed dynamically. Likewise, Ma *et al.* anticipated T-BERTSum, where this model utilizes the Neural Topic Model (NTM) and LSTM along with BERT. This model adds the topic-aware sequence to allow topic-awareness, which develops topic embeddings [48]. The research work of Nguyen *et al.* suggested the BERTweet model, which was the first public large-scale pre-trained language model for English tweets [49].

➤ GPT

In 2018, Radford et al. suggested a transformer-based PTM known to be Generative Pre-Training (GPT). GTP is based on transformer architecture, a deep neural network created for natural language processing missions. It performs subsequent tasks like text *classification*, question-answering, and *sentiment analysis* [50]. GPT uses the autoregressive decoder portion of the transformer architecture. Every new version of GPT is trained by enhancing a large amount of text. The transformer architecture used in GPT is a substantial improvement over earlier tactics to NLP like CNN and RNN. It utilizes a self – aware *mechanism*. ChatGPT is a public tool which uses GPT technology [51]. GTP 2 is a successor to GPT, which was developed by Radford *et al.* [52]. In contrast to GPT, GPT-2 utilizes 1.5 billion parameters, which is 10 greater than GPT-1. *GPT – 3* is a *third – generation* and *autoregressive* language model which utilizes deep learning techniques to produce human-like text. It was developed by OpenAI. Its capacity is about 175 billion parameters significant and 100 *times* greater than GPT-2 [53]. GPT-3 inscribes texts of excellent quality mechanically and autonomously. GPT-4 is the 4th generation of GPT series, which OpenAI developed. It was launched in 2023, and it is accessible to the public via ChatGPT Plus in an inhibited volume. It was altered with *reinforcement* learning based on *input* from *humans and AI* for *human alignment* and *policy* conformance [54]. The researcher Neves (2022) utilized ChatGPT to operative predictive modelling on basis of past data [55]. Research conducted by Thiergart *et al.* [56] used GPT-3 to automatically draft the response for received mail. In contrast, Roetzer and Kaput [57] utilized GPT-3 to develop *human – like* manuscripts that are augmented for *marketing* purposes, such as billboard replica, website copy, email promotions, and social media displays. Similarly, Stegeran and Myśliwiec trained *GPT – 2* on an enormous corpus of *video quests* and utilized *GPT* to create the conversation for quest-giver *NPCs* in *role – playing* games [58].

VII. RECENT ADVANCEMENTS IN NLP

- **Sentiment analysis**

Sentiment analysis (SA) has many benefits in *business* exploration. In 2016, the author Wang and Zheng explored research on *Chinese internet* reviews from different *domains* to decide what kind of compounds impact sentiment classification performance [59]. Sentiment analysis can be utilized to forecast the *financial market* and *forecast stock prices*. Xing *et al.* [60] utilized the news to forecast stock price trends rise or fall. Trends have a tendency to enhance during the good news and fall during the bad news. ChatGPT is a perfect tool for performance sentiment analysis because it comprehends the complications and refinements of human language. The research conducted by Sudirjo *et al.* offered the usage of ChatGPT in business customer sentiment analysis. In this research, they establish that ChatGPT can help in understanding and meeting customers' needs [61].

- **Machine translation**

Machine translation have been used extensively in several domains due to its incredible efficiency, less price and great *translation* quality. The researchers Koehn and Knowles [62] revealed that while the *training* words enhanced from 0.4 Million to 385.7 Million for *English – Spanish Translation*, quality increased by 30% in terms of the *bilingual evaluation understudy (BLUE)* score. Text translation is one of the most common forms of machine translation. MT offers a *convenient* way to view web pages in *foreign languages*. Machine translation also aids in describing the content of images and *performs* visual question answering.

- **Spam Detection**

Spam detection is utilized to identify unwanted emails or text data reaching people's inboxes. Jaswal and Sood [63] introduced an *image* spam detection system. It utilizes the *Hidden Markov Model* to detect the spam image. Similarly, Algur and Pendri anticipate a system in which link and content spam detection is utilized to identify the web page as spam [64]. In research work, Basavaraju *et al.* suggested a new spam detection method that utilizes text clustering on the basis of a vector space model. Through this technique, they are able to extract and detect spam/non-spam email [65].

- **Question answering**

Question Answering (QA) systems permit customers to obtain accurate *answers* for *questions* posed in *natural language*. *Question – answering* has been incorporated into diverse areas of knowledge. On the basis of the incorporation of a QA system in domains, it can be *divided* into closed *domain*, restricted domain, and open domain. It has been found that open domains based on *World Wide Web* implementation are part of research and *medicine* subjects. The researcher SugunaSri *et al.* integrate the question-answering system with Chatbots using NLP, which allows more significant support and engagement by providing an outline for solving education-associated questions [66].

- **Speech recognition**

Speech recognition technology utilizes NLP to renovate human language into a machine-readable format. Speech recognition aids in handicapped and disabled people [67]. Speech recognition facilitates in modern healthcare technology. It is utilized by recording the health data of patients electronically, so it permits the doctor to communicate with the system by merely speaking words [68]. The speech recognition software allows the computer to transform spoken words into inscribed text [69]. For instance, SIRI is designed to provide numerous methods of interaction with your phone, such as speck-up. Alexa technology is based on Machine Learning and NLP.

- **Information Extraction**

Information Extraction (IE) in NLP is an essential technology which *aims* to extract *structured information* from unstructured *text* automatically. In the clinical field, researchers have utilized NLP

systems to recognize a patient's medical condition, discharge summaries, history of illness, documentation, etc of a patient [70].

- **Chabot**

Chatbots are intelligent conversation agents that interact with users through natural language. Chatbots have the capability to offer educational content and personal assistance. In 2004, Jia [71] introduced a chatbot to chat among English learners, which utilizes simplistic tactics for logical reasoning and inference, mainly by semantic and syntactic analysis. Many companies have adopted chatbots to provide customer service. In a research work Gupta *et al.*, anticipated a website based chatbot written in RiveScript to assist customer in deciding which products ensemble for them. In the health sector, the chatbot provides patients with customised therapy and health data. Patient-relevant products and services provide diagnosis and recommendation of treatment for patient conditions. In the food industry sector, on the basis of the company, the chatbot accepts orders, arranges delivery details, provides customer feedback, offers discounts, tracks orders, etc. Subway chatbot [72].

VIII. Challenges of NLP

There are numerous challenges in NLP that hinder its additional development and integration.

1. Language Ambiguity:

Language ambiguity develops due to the numerous meanings of a word or phrase; hence, it creates challenges for NLP models to interpret context accurately. Anjali and Babu [58] explored the different types of ambiguities in NLP.

2. Bias and Ethics

In 2021, Hovy and Prabhumoye explained the five primary sources of bias in NLP. They are: 1) data bias because of limitation of data, missing or mislabelling markers and imbalance in training data; 2) limitation of model like selected algorithm or model architecture; 3) choice of assessment metrics; 4) selection or design of particular algorithm; and 5) NLP are applied to particular social context and purpose. The biases might influence the impartiality and credibility of NLP methods [73]. The requirement of the vast amount of data for the NLP model can lead to models which disseminate present societal biases or be unsuccessful in generalizing well to unseen examples. Attracting large amounts of data might be expensive and time-consuming. Also, NLP tasks like sentiment analysis or NER need essential human knowledge and effort. The ethical considerations necessary to ensure user privacy and incorporate robust data security are dominant. NLP technologies might be misused to develop misleading content or influence people's judgement. So, the NLP models are trained, and possible biases can be inherited. Furthermore, fact-checking mechanisms are vital to identify and discourse possible biases or misrepresentations produced by NLP techniques [74].

3. Text Format

The significant difficulty in NLP is that words or phrases are syntactic. The semantic translation problem occurs during machine translation. Computers are not able to comprehend human language by recognizing text [75].

IX. Limitations of Conventional NLP techniques

The emergence of machine learning and deep learning have converted NLP, which provides a path towards overcoming this limitation. The limitations of current NLP technology are as follows:

- Domains need to be slender enough so that present knowledge presentation practices can state the limitations of the applicable semantic concepts and relations [76].
- Precisely identifying irony and comprehension *sentiment* within an inadequate *context*, particularly in social media posts [77].
- Handcrafting is needed, especially in grammatical components of systems. *Lexicons* and axiomatizations of critical facts need to be created for each domain, and this remains a time-consuming task [78].

- Natural language understanding and sustaining conversation consistency across prolonged dialogues continue to be challenging for *conversational* agents [77].

X. Future Directions in NLP

1. NLP in healthcare

NLP technology is becoming beyond widespread in the healthcare sector. NLP can benefit doctors to detect patient's conditions by extracting and analyzing data from clinical notes and electronic health records. NLP can provide essential perceptions of patient health outside of the clinical setting by assessing patient-developed text information like symptoms and treatment outcomes. Furthermore, the creation of medical chatbots and NLP apps for document recovery may enhance patient participation and facilitate a more efficient right of entry to medical data [79]. NLP is a promptly emerging domain that can transform the method by which health care is distributed.

2. NLP in Finance

In the finance industry, [80] NLP is essential for managing a large amount of unstructured data. NLP technology might extract valuable information from significant data like social media *posts*, *news reports*, professional research reports, and customer feedback. NLP in finance can help analyze regulatory documents, regulations, and policies. It can also assist in exploring the differences in financial regulation in different countries. In the future, NLP in the finance sector will provide more efficient, personalized, and intelligent direction.

3. Advancements in conversational AI

Conversational AI technology, such as virtual assistants and chatbots, utilizes NLP, machine learning and big data to encourage human communication. Data collection is required for conversational AI to respond to people's inquiries. The machine is instructed to understand and progress human language using the data. Conversational AI chatbots are able to answer frequently asked questions, troubleshoot problems and conserve nature. Siri, Alexa, and Google Assistant are trending as conversational agents that interact with people by incorporating voice into the device [81]. Conversational AI has been used in various domains like education, business, health care, and customer service. Conversational AI assists as a cornerstone for development in industries and companies, and it also reshapes human communication in the digital age.

XI. Distributive Analysis

The current document provides a detailed review of the influence of Natural Language Processing and their advancements in AI. The analysis incorporates a collection of eighty-one research papers and articles published between 1952 and 2024. This review paper examines one paper each from the years 1952, 1990, 1997, 2002, 2004, 2004, 2005, 2006, 2009, 2010, and 2014. It also highlights two significant contributions from 2013 and notable contributions from 2012, 2015, and 2016. Additionally, it represents six impressive involvements from 2017, ten from 2018, seven from 2019 and 2020, nine from 2021, seven from 2022, eight from 2023 and six from 2024. This review aims to understand the latest advancement of NLP. It highlights the influence of machine learning and deep learning on NLP. It also explains the challenges and limitations of NLP. Through this analysis, the review seeks to improve understanding and foster further exploration in this dynamic area of study.

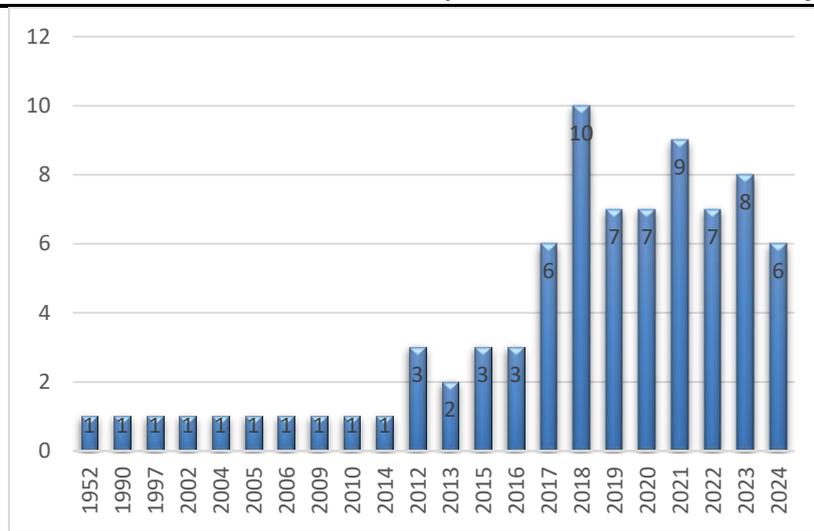


Fig. 2: Distributive analysis

XII. Conclusion:

In conclusion, artificial intelligence (AI) based Natural Language Processing has experienced rapid *advancements* in *recent* years; NLP stands at the forefront of innovation, shaping the future of human-computer interaction and unlocking a world of potential in different domains. The involvement of *machine learning* and *deep learning* have *significantly* enhanced the performance of the NLP system. NLP in other fields can save time, improve efficiency, and increase people's satisfaction. Despite the progress made in NLP, there are many challenges. The challenges like bias and ethics, ambiguities and text format in the NLP model remain. Addressing these difficulties will be vital to make sure the NLP endures in an advanced way. Machine Translation, *sentiment analysis*, Question-answering systems, *chatbots*, speech recognition, spam detection and information extraction are a few accessible NLP-based technologies. The upcoming NLP embraces potential in numerous domains, including healthcare, finance and conversational AI. The field has the capability to transform a broad number of domains and enhance the quality of life for people throughout the world. Therefore, we expect to see significant advancements and innovations in future.

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