

## Introduction to Natural Language Processing

Artificial Intelligence has integrated in our lives, and its technology has grown quickly in the past few years. Natural Language Processing (NLP) is a branch of Artificial Intelligence (AI) in which a computer simulates language comprehension similar to that of a human. This simulation is accomplished by the use of a combination of rules-based approaches, statistical-based approaches, and usually incorporates Deep Learning models taken from the Machine Learning (ML) branch of AI. Thus, ML and NLP are separated entities within AI, NLP utilizes ML models to produce computer AI. Herein, a basic overview of NLP.

As noted previously, AI has been incorporated in our lives, and NLP is available in many of our normal day activities. From simple spam detection to Personal Assistants, such as Apple™ Siri, Google™ Assistant, and Amazon™ Alexa. Thus, it can be seen that NLP in general has two domains, that of speech/text understanding and speech/text generation. Starting with speech recognition, vocal language is converted to text. Once as text, the language input is processed into sentence and/or word tokenization, parts of speech (parts of speech tagging), named entity recognition (NER) to which statistical methods can be drawn. Prediction analysis with ML models assists in sentiment analysis, and recognition of language meaning. As such, this is considered Natural Language Understanding (NLU) by which computers take in input of speech or text and are able to comprehend the input [1]. NLU is a branch of NLP. Google and spam detection are prime examples of NLU in the world. Utilizing ML pipelines, machine translations and response generation, applications such as Chat GPT and chatbots are a possibility. Producing language response or output via text or speech is Natural Language Generation (NLG) [2], which is the other subdivision of NLP. Thus, the text generated by Chat GPT or the voice response of electronic personal assistant (such as Alexa and Siri) are modern world applications and examples of NLG.

As noted, NLP has three approaches by which the end product is obtained. First is the rules-based approach of NLP. Language by its nature has certain rules by which form the syntax and structure of the language. Converting these rules into code provides a foundation in which computers could fundamentally understand or comprehend language. Rules-based approaches is considered the first element of NLP, and in part may be the foundation upon which NLP extended. As noted in Class, ELIZA is one of the first implementation of rules-based approach to simulate a Rogerian psychotherapist. [3] Rules-based approaches powers many of the spelling and grammar checker seen in word-processing applications, as well as some language translation applications.

The next biggest step of NLP was with Statistical based approaches. Utilizing mathematical distributions and statistical methods, NLP is given the ability to predict meaning, words and sentiment. Humans do similarly without the mathematical detail. For instance, if someone shows expressions of sadness and communicate this with words, one can infer or guess the next words that the person might state or at least determine that they might be in a depressed state. Statistical Based approaches provide a means for computer to have this ability

to infer and makes logical suggestions. This methodology is seen in auto-completion technology as seen in some websites and word processing applications. Similarly, this technology is utilized (at least in part) in sentiment detection bots that have been proposed and utilized by some companies and theorized academically [4] .

Finally, the last approach in NLP is ML Deep Learning Techniques. One of the fundamental tools in ML is the concept of the neural net, which in essence is an encoded simulated human neuron. These neurons take in data (input), and weighs these inputs. After reaching a certain threshold the neuron is activated, thus simulating a neuron. Coupled with Gradient Descent and other linear algebra models, an approximation based on a trained made. Once the neuron is coupled with other neurons (also call perceptron) a connection of inputs and weights are created. Utilizing the concept of back-propagation in which the weights are adjusted to be closer to a pretrained model. Together the network of neurons and backpropagation are the basis of convoluted neural networks (CNN) which had limitations. Due to these limitation, Recurrent Neural Networks were conceived to take in multiple inputs and make multiple inference, which leads to the concept of Deep Learning. [5] With the foundation of Deep Neural Networks and Deep Learning, provides a means for computer cognition that is utilized in Chat GPT as well as the predictive aspect of spam detection.

In conclusion, NLP has three fundamental approaches that are used in modern technology and applications. These include Rules-based, Statistical-based, and ML/Deep Learning - approaches. NLP will play a major role in the development of technologies that will interact and hopefully aid humanity. As a side note, my interest in this field was introduced in a ML course, and I found the project in that class was interesting as I had never been exposed to NLP. In many ways, NLP crosses many disciplines, one of which was medicine—to which I too share a multi-disciplined background. There are many interests (chat-bot generation, text completion, and language translation) which are outside of my profession, but I believe that this could be utilized in a humanitarian project. With the basic NLP fundamentals, it is my belief that this technology can be utilized in a utilitarian way to better humanity.

## Works Cited

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