Evaluating the Use of AI in Recent and Well-known Products

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Abstract:

This report explores the uses of Artificial Intelligence (AI) in recent products, specifically the use of Natural Language Processing (NPL) for the use in the in multiple major businesses and companies. The purpose of this research is to further understand and introduce the concept of NPL and its uses in everyday technologies that may be taken for granted. The methods that are proposed to aid in the implementation of NPL in search engines are the state-of-the-art NLP models such as Hidden Markov Model (HMM), Support Vector Machines (SVM) and Naïve Bayes Classifiers. The report will also introduce and elaborate on the principles of NLP that are implemented for said search engine as well as display concepts and results achieved in real-world applications. Lastly, the report will conclude with why the methods proposed has aided in the successful implementation of AI in search engines, with the use of NPL and its principles.

Introduction:

The current state of AI in recent products, specifically Natural Language Processing (NLP) is used in a multitude of products such as ChatGPT, search engines, language translation services, healthcare and clinical text analysis and many more. The example of NPL applied in these products encompass speech identification, linguistic comprehension, data retrieval, query resolution, dialogue exchanges and lexical analysis.

As Deng Li and Yang Liu explains [1], NPL is the study which investigates how the natural human language is processed with the help of computers, which can in turn aid performing a multitude of useful task. NPL is the discipline that is the combination of computational linguistics, computing science, cognitive science and artificial intelligence.

This report aims is to evaluate the use of AI in recent well-known products such as the multiple principles and methods used that has led to the advancement of NLP and its implementation in current products. The hypothesis that is introduced in this report is that the integration of NLP into diverse products has significantly advanced the capabilities of AI-driven technologies and has led to the success of multiple tools and services that are essential is this technological era.

The motivation in the exploration of this concept is to bring the methodologies and principles used in NPL to light employed by these products, and to further understand them. This report will provide a cohesive and comprehensive understanding of the importance NPL and its methods, which plays a major role in the advancement of AI field.

Method:

Support Vector Machines (SVM)

A method that has been introduced in the implementation of NPL is the concept of Support Vector Machines (SVM) which is a learning method used in AI to classify objects. As explained in "Natural language processing: an introduction" [2], SVM is a discriminative approach of learning in which inputs by a user (agent) such as words are classed into different categories such as parts of a speech according to a feature set. These inputs are then transformed mathematically using a function which enables the separation of the data points (inputs) provided from the different categories, this function is called the 'kernel function'. The below graph shows the visualization of the 'kernel function' implemented [2].

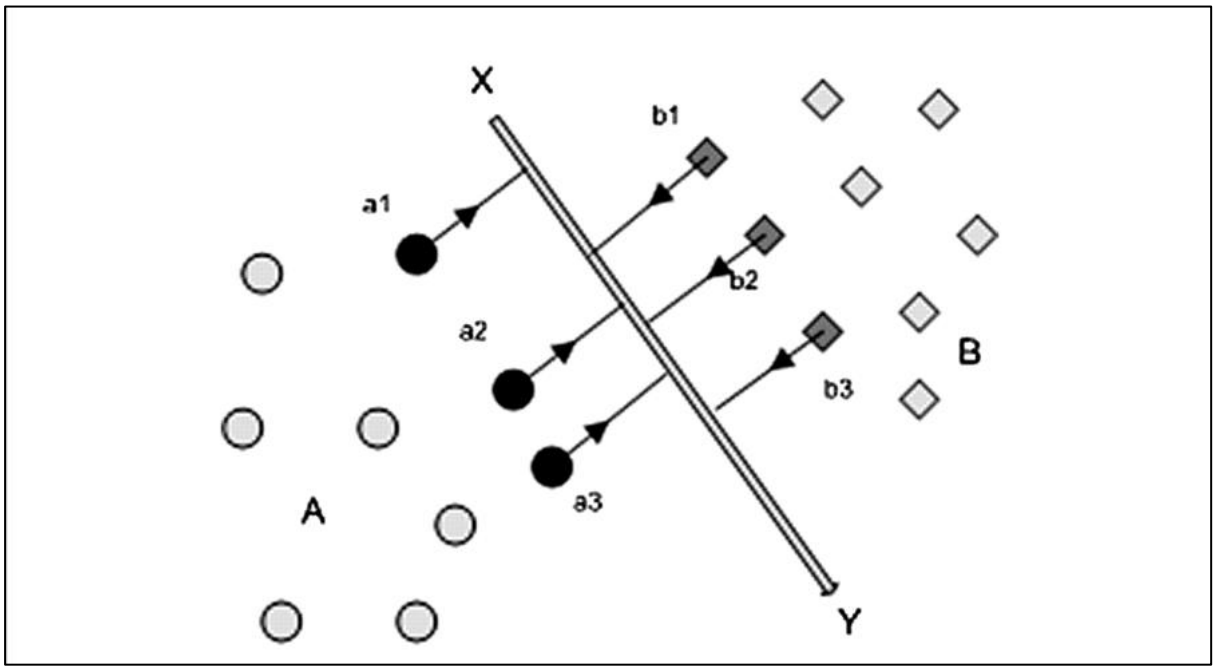

Figure 1: A simple 2-D case illustrated with data points.

From the above figure, it is shown that a separation via a straight line (X-Y plot) is used to part these data provided by category A (circles) and B (diamonds). The algorithm (SVM) then figures out the X-Y plot by picking the closest data points (support vectors) from each of the categories such as a1, a2, a3 and b1, b2, b3 and positions the line so that it can create a line that has the widest gap between the categories. This process then chooses a subset of training data

(support vectors) which are the most ideal to split the categories. The most common kind of 'kernel function' used is called a Gaussian, which is the cornerstone of statistics called 'normal distribution'. The examples in which this concept is generally used in are recognition and classification such as image classification, text and document classification and medical diagnosis.

Hidden Markov Models (HMM)

HMM is another state-of-the-art model in NLP, which is a system in which a variable, with different probabilities, switches between states that will then give different symbols for each time it switches, the set of viable states could be large, however they are finite and known [2]. The outputs can be described however the system's internals such as the state-switch and output probabilities are hidden. Below is a diagram which shows the visualization on the implementation of HMM [2].

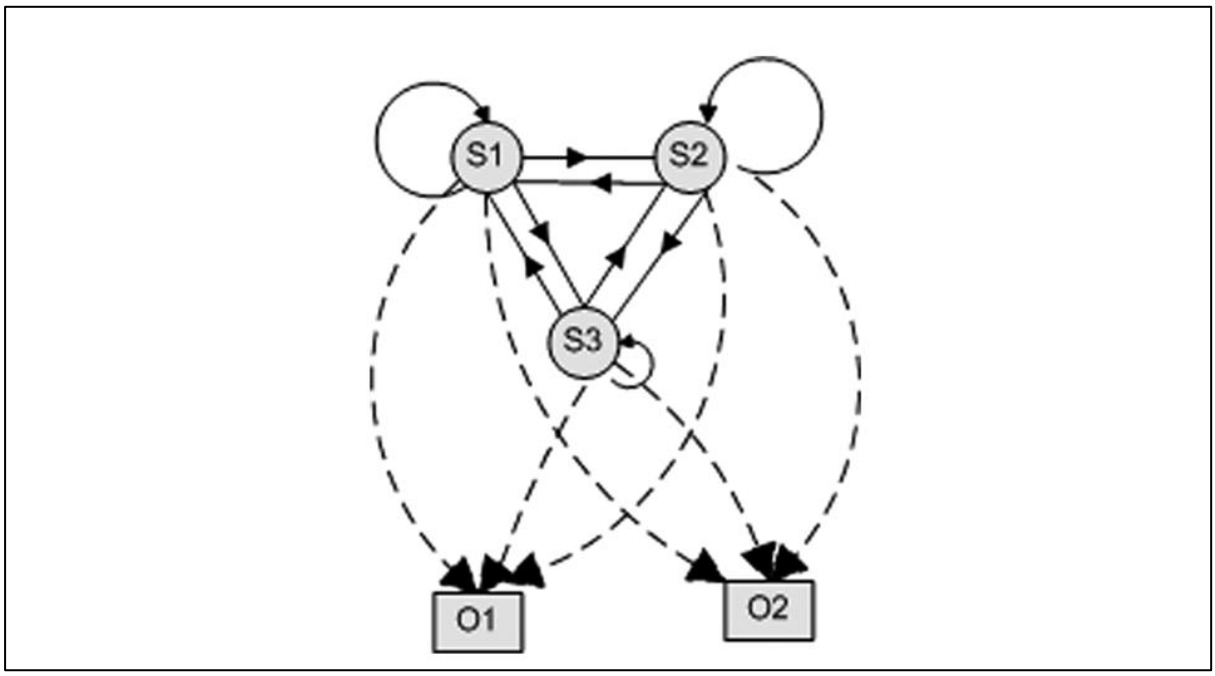

Figure 2: A simple illustration on HMM

From the diagram provided demonstrates the temporal nature of HMM, circles denoted as S1, S2 and S3 are the states and the boxes denoted O1 and O2 are the output values. The solid lines which are used to connect the states indicates the switches between the different states, with each line having a switching probability that is hidden. The direction of said solid arrows shows

the switch's direction and there are cases in which a state switch back to itself. The dashed lines connecting a state to an output value is 'output probability' which indicates the chance of generating a specified output from a state. When a switch or output probability is zero, it will not be shown. The total switch and output probabilities leaving a state always adds up to 1.

As mentioned in the 'Natural language processing: State of the art, current trends and challenges' article [3], HMM is widespread use in speech recognition, which an output sequence is paired with a sequence of individual phonemes. This is implemented in various fields such as bioinformatics problems in which it aids in task such as multiple sequence alignment.

Results and Discussions:

From the above method implementation of NPL, it has been shown that has helped in the advancement of Neural Network and vice versa. The 'Natural language processing: State of the art, current trends and challenges' [3] article states that earlier machine learning techniques such as Naïve Bayes, Hidden Markov Model (HMM), Support Vector Machines (SVM) and many more were primarily used for NPL, however during the end of 2010 neural networks transformed NLP by learning a multitude of features, which is particularly useful in word embedding and representing words as vectors. Neural networks are also used in information retrieval, text summarization, classification, translation, sentiment analysis and speech recognition. Moreover, it also can predict unseen states and scenarios where hidden states are anticipated, unlike HMM, which predicts hidden states.

As such, it has resulted in the development of other models such Bi-directional Encoder Representations from Transformers (BERT). As elaborated by Ravichandiran [4], multiple NLP models such as BERT, GPT and T5 are based on a transformer architecture, known as one of the most popular state-of-the-art deep learning architectures that is frequently used for NPL. The article "Natural language processing: State of the art, current trends and challenges" [3] also states that older language models analyse text (input) in one direction which is often used for predicting the next word in a sentence. In contrast, BERT comprehends text (input) in both directions at once, which in turn enhances the understanding of a language.

From the above statements presented, it can be assumed that the relationship NLP and neural networks have is a symbiotic relationship. This can be attributed to the fact that NPL has contributed to the advancement of neural networks, particularly in the field of language processing. Conversely, due to the rise of neutral network, it has also has greatly influenced the progress of NPL. This is because neural networks have allowed NPL models to further delve deeper into understanding linguistics nuances, context and semantics which thus enhancing the capabilities of language-based algorithms, leading to the development of more advanced NPL models. As a result, this would suggest that this symbiotic relationship has helped in the greater advancement of AI across the board to achieve accuracy, efficiency and adaptability, thus revolutionizing language-driven technologies.

However, there are also some limitations of NPL models that could be said. As explained in the “Natural language processing: an introduction” article, some NPL models such as BERT has a limitation in handling large text sequences [3]. This is due to its token limit of 512 token (units of a piece of text) per input sequence, which makes BERT unable to analyse text over said limit in a single pass. As such, it could lead to difficulty in preserving the context or coherence of a large text, as it must be split into smaller chucks to fit the 512 token limit to be passed. Therefore, it could be suggested that with this limitation, it will lead to a less user-friendly experience as well as leading to a less accurate result (output) due to the input limitation presented.

Conclusion:

In conclusion, it could be said that with these methodologies and concepts stated in this report not only aids in a single niche in AI, but it also helps in the growth of other AI principles. As shown in this report, the symbiotic relationship between NPL and neural networks has aided in the advancement of both principles as NLP models leverage neural networks in improving performance in understanding context, semantics and nuances within a text and vice versa. Further research can also be done on the symbiotic relationships that NPL and neural networks have with other methodologies to further the support these claims, and thus impacting well-known products.

Moreover, it is shown by Cambria and White [5] that NLP systems have been increasingly moved away from a heavy dependency on word-based techniques. Instead, NPL will start to consistently adopt semantic understanding which leads to the transition from Syntactics Curve to the Semantics Curve. In Figure 3 also by Cambria and White, it shows the gradually improvement in NLP research throughout the years.

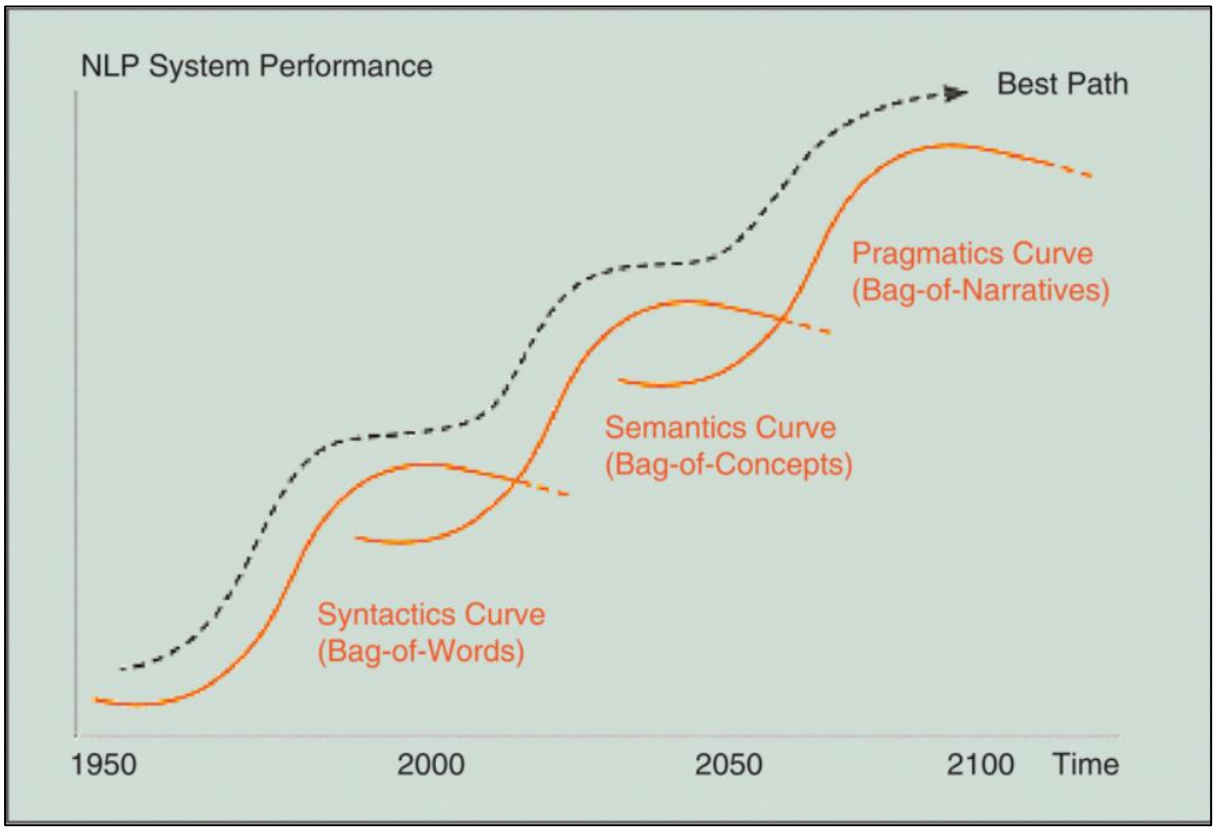

Figure 3: Envisioned evolution of NLP research through three different eras or curves

From this report, it could be implied that a benefit to these advancements in NPL and neural network in AI has led to creation and improvement of major products that are being widely used such as ChatGPT and search engines due to the advancements made in language understanding and processing through NPL, thus making a multitude of task easier. However, as mentioned in this report, there are still some limitations to these methodologies such as the text limit available for text processing and recognition by principles such as BERT. Therefore, future areas that could be explored is improving the scalability and efficiency of these techniques for real-time applications.

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