

THE IMPACT OF NATURAL LANGUAGE PROCESSING ON LANGUAGE LEARNING AND TEACHING

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Abstract: *With the increasing affordability and widespread availability of technology, language learning has become significantly more accessible to the general public. Various educational software and e-learning platforms have played a key role in this transformation. Notably, applications like Duolingo, Grammarly, and Mondly have successfully demonstrated the viability of language learning apps as a business model. Moreover, recent advancements in Natural Language Processing (NLP) software hold the potential to enhance the effectiveness of these teaching methods, possibly supplementing or even replacing traditional face-to-face instruction. This study aims to track the evolution of e-learning in the language learning industry and examine possible ways in which Natural Language Processing will impact this domain.*

Keywords: *Natural Language Processing; ChatGPT; Language Learning, Chatbots; Deep Learning*

1. INTRODUCTION

The field of natural language processing (NLP) has undergone significant development in parallel with advancements in information technology and computer science. Since the 1950s, researchers have been striving to bridge the gap between humans and machines, leading to the emergence of computational linguistics as a scientific discipline. Over the years, the evolution of NLP has been driven by the pursuit of creating language software that can understand and generate human-like text.

Initially, early language software relied on predefined rules and workflows to process and generate text. However, the introduction of statistical methods and later machine learning techniques revolutionized the field, enabling rapid progress in NLP. Today, the quality of computer-generated text has reached a level where it is becoming increasingly difficult to distinguish it from human-written text. These advancements in NLP have already made a significant impact on various domains, particularly in the realm of language learning and improvement. Applications like Duolingo, Grammarly, and Mondly have leveraged NLP techniques to enhance foreign language learning, aiding learners in their quest for linguistic proficiency. However, recent breakthroughs in NLP, exemplified by models such as ChatGPT, and the substantial investments in the field, indicate that we are on the cusp of

even greater developments. The growing interest in NLP has the potential to usher in a new era of natural language understanding and generation.

While the advancements in educational technology and NLP are undoubtedly promising, it is crucial to approach their implementation with careful consideration. It is essential to acknowledge that the business aspects of the field can present challenges of their own. Mere technological progress does not guarantee revolutionary changes without the thoughtful and responsible application of these advancements.

Looking ahead, the future of NLP holds great potential for further advancements, offering new possibilities and opportunities. However, it is paramount to ensure that these developments are implemented in a manner that aligns with ethical considerations and promotes responsible use.

This paper explores the historical development of NLP, its current state, and the potential implications for the future. By examining the advancements made thus far and acknowledging the challenges and ethical considerations associated with the field, we can gain a comprehensive understanding of the significance and potential impact of NLP in the broader context of language processing and communication.

2. EARLY LANGUAGE MODELS

Man's attempt to bridge the gap between

himself and machines has been witnessed from the beginning years in the history of computer science.

One of the most important moments in the history of natural language processing was the Georgetown IBM experiment conducted in 1954. This experiment was a collaborative effort between Georgetown University and IBM. It aimed to demonstrate the potential of automated machine translation. The experiment used a rule-based approach to translate 60 sentences from English into Russian (Hutchings, 2004). The program was rule-based instead of being statistics-based or employing a deep learning approach as commonly used in today's NLP models. These 60 sentences contained limited vocabulary and had simple grammatical structures. The experiment was conducted on the IBM 701 computer, a large processing machine for the time.

The method of translation was significantly simpler than modern methods used by translation machines, such as Google or DeepL. The program was based on a sequential workflow: English sentences were input into the machine, then analyzed and interpreted in a manner similar to how parsing methods are being used nowadays, by attributing numerical data to individual words and phonemes so as to make them intelligible to the machine. Afterwards, linguistic rules are applied, and the sentences are converted into Russian. Although substantial post-editing was required by bilingual experts on the machine-generated translations, this experiment showcased the possibility of machine translation for the first time. Furthermore, despite its limitations, the Georgetown-IBM experiment provided the foundation on which future research and advancements in the field of machine translation and natural language processing were built. It marked the beginning of interest in human-computer relations and language translation through the use of computation.

This workflow-based approach is what we nowadays call 'rule-based NLP'. This system relies on predefined sets of grammatical criteria, which are crafted by domain experts such as linguists. These rules are based on formal grammars of the chosen languages and have to be inputted manually into the program. On the one hand, this approach allows for a high level of control and transparency within the language model, as well as not requiring large amounts of training data to function. On the other hand, the rule-based NLP model can be rigid and require manual updates to the code, and creating such a model can be cumbersome as it requires large

levels of human labor (Deng, 2018).

The late 80s saw the rise of NLP models based on statistical frameworks. By using statistical techniques to learn patterns and relationships between words and linguistic data, models can be trained to learn the rules of a language without the need for fixed procedures being manually inputted into the machine. This is the method most commonly used nowadays in NLP models, such as ChatGPT. While allowing for greater levels of flexibility and adaptability, this kind of approach requires large amounts of labeled training data and, of course, greater processing power to facilitate the machine learning process.

The Georgetown IBM experiment paved the way for more research in the domain of machine linguistics after proving the feasibility of using computer programs in translation. The doors opened for human-computer conversations. One of the earliest computer programs developed to simulate conversation and demonstrate natural language processing methods was called ELIZA. It was created at MIT in the mid-60s by Joseph Weizenbaum, and it attempted to simulate actual conversational abilities, emulating a psychotherapist in text-based interactions. While rudimentary by today's standards and not actually able to fully interpret the input, this program used pattern matching and substitution rules to rephrase the user input in the form of questions, creating the illusion of conversation.

The next significant milestone in the domain of natural language processing came in the early 70s when Terry Winograd developed the SHRDLU model. The SHRDLU model was also a developed rule-based NLP approach, and its aim was to understand both simple and ambiguous commands given to it. The program had a graphical interface displaying a three-dimensional world with various shapes in it. The users were able to interact with this block world through the use of natural language. SHRDLU could interpret user commands, answer questions about the position of the various shapes in the three-dimensional world, and the program was also able to move these shapes around based on text commands. While limited in scope, only being able to understand commands specifically given about the block world it displayed, the SHRDLU model showed the feasibility of interactions between computers and human language (Ontanon, 2018).

The launch of IBM's product Watson was another significant milestone in the history of natural language processing. Based on both structured and unstructured machine learning, this

application showed how language models and software could be used not only to interpret simple and ambiguous language in specific domains but in general as well. Watson participated in the game show Jeopardy! in 2011, showcasing a level of language understanding and reasoning that surpassed any previous NLP model up to that date (Ferrucci *et al.*, 2018).

As previously mentioned, Watson was based on machine learning and was designed to process and analyze large amounts of both structured and unstructured data. This set it apart from previous NLP models. While SHRDLU and ELIZA functioned in more specialized domains, such as interpreting spatial positioning of shapes in a three-dimensional world and simulating the conversation abilities of a Rogerian psychologist, IBM's program was capable of demonstrating linguistic ability when questioned on a broad variety of topics. The development of Watson aimed to perfect previous developments in question answering techniques, allowing the program to engage in real-time conversation with humans.

3. MODERN APPROACHES TO NLP

A 2017 paper called "Attention is All You Need", revolutionized the field of natural language processing by introducing the concept of Transformers, a type of neural network architecture which has since mostly replaced recurrent neural networks and NLP models (Vaswani *et al.* 2017). By using Transformers, a model no longer interprets the input as a unidirectional sequence of tokens. It is able to redirect its own attention from one part of the input to another and make decisions on how to interpret the text as a whole based on the context provided within itself. Simply said, an NLP model using Transformers can learn about the context of the input text while reading it.

Due to major improvements in the processing power of computers and the availability of larger data sets, which have come as a result of the internet becoming more accessible, all deep learning models, including NLP models that use deep learning, have been given the opportunity to make use of user-generated text in its natural form to learn about speech patterns and how to reproduce them seamlessly.

In the context of language learning, NLP models have already been used in various applications. Duolingo, one of the most popular foreign language learning apps (Blanco, 2022), has made use of NLP algorithms to analyze learners'

written and spoken responses to exercises and offer instant feedback and corrections in vocabulary, grammar, sentence structure, and even pronunciation. Duolingo also uses NLP for level assessment, being able to provide a series of exercises to learners in the very beginning parts of their learning journey and offer personalized content based on their apparent level of proficiency as determined by the model.

Another relevant use of NLP in language learning applications is employed by Mondly. While in a similar fashion to Duolingo, this app incorporates NLP techniques for correcting user mistakes (in grammar, vocabulary, register, spelling etc.), it also includes a chatbot designed to simulate conversation and offer interactive exercises to second language learners. This, of course, allows for a more natural approach to language learning, more similar to in-class speaking or writing exercises or actual text conversation with other speakers, than to the right or wrong framework typically seen in other e-learning platforms. The major advantage of chatbots compared to real interaction with human speakers is that it mitigates the effects that a classroom setting can have on individual students' confidence levels. As mentioned in their paper titled "How Technology Affects Instruction for English Learners," (Altavita, 2020) it provides real-time feedback in a semi-private environment, which can shield language learners from scrutiny, allowing them to practice their English without fear that they'll be mocked or bullied by native speakers. Of course, it is not only native speakers that can induce a feeling of inadequacy in learners, but people in general. Nevertheless, while still having the advantage of instant feedback that real-time communication has, chatbots could supplement reproductive skills involved in language learning in a more controlled and comfortable environment.

While it is clear how beginner learners can benefit from the use of NLP in their language learning problems, it is important to keep in mind the fact that even proficient or native speakers can be aided by such technologies (Tenen, 2016). Another immensely popular online platform known as Grammarly offers not only feedback on vocabulary, grammar, or spelling errors but also suggestions on how a user can adapt their writing style to make their text more appropriate for the context they are writing. Grammarly can offer suggestions to users on the ways in which they should adapt their texts to make them more formal or more appropriate stylistically.

4. THE PROBLEM OF IMPLEMENTATION

While the present paper has mostly dealt with the technological developments of NLP models so far, it is important to remember that the implementation of new technological discoveries plays an equally important role in their adoption and influence. As famously described by Nassim Nicholas Taleb in his book “Antifragile,” the quest for developing complex technologies may also blind people on how best to apply existing technologies and technological developments to current problems. In the 13th chapter of his book, he discusses the paradoxical reality of wheeled suitcase being a somewhat modern invention despite the fact that both wheels and the suitcase itself have existed for thousands of years. In this context, technological development itself was not the issue preventing the adoption of wheeled suitcases, but rather the lack of creativity in the implementation of already existing tools.

Furthermore, keeping on the same topic of wheels and their use in simplifying the daily lives of human beings, Taleb references the commonly known fact that Mesoamerican people had not invented the wheel and only began using it after it was brought to them by European colonizers. He points out the fact that, in reality, the American people did discover the wheel, but it was only used for children's toys without the idea of adapting it to simplify labor ever emerging. So, while the concept itself was understood and applied in one context, failure to see how it might be useful when used in a different environment was the issue.

It has been observed that the field of language studies has suffered from a similar phenomenon. The author of the paper titled “Blunt Instrumentalism: on tools and methods” (Tenen, 2016), details an instance in which he, alongside another developer, created a so-called collaborative translation platform which failed to take off with the public. This failure was not due to its technical limitations but because of something he termed “advocacy.” In his own words,

yet we fail to consider the difficulty of implementing that vision into practice. We build a tool but not the community around it. The classroom environment resisted change, and for good reason. Upon reflection, we saw that language teaching was grounded in proven, if sometimes imperfect, practices. Our platform development should have considered the strength of that tradition and not just its weaknesses. (Tenen, 2016:87).

5. ETHICAL CONCERNS AND CHALLENGES

Despite major advancements in the field of natural language processing, applications such as ChatGPT still face issues and limitations when it comes to simulating real-world or accurate speech. In this next section, we will examine the most common issues cited in the debate surrounding natural language processing programs.

From a stylistic standpoint, modern applications like ChatGPT can simulate the appearance of proper speech. However, it is important to recognize that these pieces of software lack actual understanding or the ability to reason. The output they provide is based on statistical models and analysis of speech patterns, rather than formal logic or problem-solving methods.

A second issue commonly found in NLP models is the rudimentary approach they take in considering the context of a conversation when providing answers. The models often struggle to fully grasp the nuances and context of a conversation, leading to potentially inaccurate or inappropriate responses.

A third issue, not limited to NLP models but prevalent in machine learning models in general, is the tendency to produce biased output based on the training data provided. While using larger and more diverse training datasets for deep learning models can help mitigate some of the bias, it's important to acknowledge that biases can never be completely eliminated.

The fourth problem commonly encountered in NLP models is the occasional generation of inappropriate or offensive content. This issue arises due to such content appearing in the training materials provided to the program. Efforts are being made to address and filter out such content, but eliminating it entirely remains a challenge.

It is crucial to recognize and address these limitations and issues in natural language processing models to ensure responsible and ethical use of the technology. Continued research and development are needed to overcome these challenges and improve the performance and reliability of NLP applications.

While other ethical issues surrounding natural language processing, such as its impact on literature originality or academic integrity, are important to consider, they are beyond the scope of this discussion on language learning.

When designing language learning courses that incorporate NLP models, the aforementioned limitations should be taken into account. Assuming

these models are used in a narrower context, different from the broad applications seen in chat-based models like ChatGPT, unstructured learning can be employed to a lesser extent in the model's training phase. The concern regarding the inability to reason or lack of actual understanding becomes less prominent when considering that language learning methodology typically focuses on lessons centered around specific topics. In such cases, there would be no need for a language model to respond to user input regardless of the conversation's topic.

Moreover, this approach would not necessarily exclude unstructured learning entirely, as current NLP models constantly adapt through user input and feedback. Similar programs could learn from and adapt to the common mistakes made by second language learners during their interactions.

6. CONCLUSIONS

In conclusion, the field of natural language processing has been developing alongside information technology itself since the 1950s. People have continuously strived to bridge the gap between humans and machines, leading to the emergence of computational linguistics as an independent field of scientific study. Initially, language software relied on pre-written rules and workflows, but the introduction of statistical methods and later machine learning brought about rapid advancements in the field. Today, computer-generated text is nearly indistinguishable from text written by humans. These advancements have already enhanced foreign language learning and language improvement through applications like Duolingo, Grammarly, and Mondly.

However, the recent interest in NLP, spurred by models like ChatGPT, and significant investments in the field suggest that even more developments lie ahead. While advancements in educational technology are generally positive, it's crucial to acknowledge that the business aspect also brings its own challenges. Mere technological advancement does not guarantee revolutionary changes without proper implementation.

The future holds great potential for further developments in natural language processing, but it's essential to take implementation into consideration so as to ensure the positive impact of these advancements.

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