Module 1: Critical Thinking

Brady Chin

Colorado State University Global

CSC515-1: Principles of Machine Learning

Dr. Dong Nguyen

March 23rd, 2025

Critical Thinking

NLP (Natural Language Processing) is changing the ways we communicate with machines by allowing AI to better understand, generate, and respond to text. With the continued development of NLP comes its reach into industry applications spanning from healthcare and finance to education and media. These developments also pose a larger set of questions in relation to context. This essay will address the future of NLP, its implications to other fields of AI, related ethical and social issues, and the machine learning methods that are enabling these advancements.

Future Applications

As natural language processing (NLP) advances, the deployment of these applications will continue to increase and improve, changing how humans interact with machines. One of the wide areas of development is real-time multi-lingual interaction which will be an area greatly enhanced by higher quality NLP models, allowing for greater and more accurate translation capabilities and eliminating language barriers (Ghatifernado, 2024 July 23). In medicine, for instance, AI medical assistants will be able to scan patient records, read the diagnostic reports, and suggest preliminary prognosis based on extensive knowledge bases of medical knowledge. Similar functions are anticipated in the legal field with AI legal secretaries that will parse through lengthy legal documents and provide insights and suggestions for professionals and magistrates. NLP effects on learning will also be a factor as computerized tutoring systems could provide different learning pathways, modifying instruction based on specifications provided by students and at their pace. There will also finally be an opportunity for more advanced NLP driven automating in the client servicing as well as writing content development, where AI systems will be able to create emails and client reports, for example.

Other Fields

NLP advancements extend beyond text and language based models; they are also highly beneficial in other sectors of AI, especially robotics, autonomous systems, and decision-making AI. In robotics, the enhanced NLP capabilities are opening new opportunities for humanoid robots to interact in a more fluid and natural way, making them more human-friendly and practical in applications such as elder care, customer services, and educational outreach (Reddy, S., 2023, October 26). In autonomous systems (such as autonomous vehicles and drones), NLP can also improve situations awareness by allowing AI to interpret and act upon voiced or text instructions in conjunction with various sensor data. NLP also enhance the functionality of reinforcement learning for AI agents through textual descriptions to aid in decisions in complex environments and increase understanding of tasks. Another area of focus and potential growth is multimodal AI, which combines NLP with computer vision and simultaneous speech recognition, allowing AI to interpret and act on multifaceted inputs. The added NLP function has enhanced precious applications of AI, such as security, virtual assistants, augmented reality, etc.

Ethical and Social Problems with NLP

Despite the immense opportunities ahead, technologies such as advanced NLP also come with ethical and social risks that must be properly managed in order not to make matters worse. One critical area of concern relates to misinformation that can be exacerbated by AI-driven text generator behavioral gradients. For instance, powerful language models like GPT-4 could produce fake news articles, impersonate the identities of existing individuals, or create misleading posts on social media, blurring the line for distinguishing reproducible artifacts of human origin against those created by artificial intelligence (Omdena, 2024, May 16). Another critical area of concern is the potential for bias in language models. NLP systems learned from biased datasets have the potential to include and promulgate stereotypical and discriminating interaction patterns, leading to unjust biases in hiring, law enforcement, and financial decision-

making. Alongside these concerns comes the increasing risk of privacy as AI models continue to improve in their contextual information analysis and the potential to extract personal information from user information and conversations. Surveillance risk fundamentally changes when governments and corporations use NLP for mass surveillance and monitoring people on a large scale while having to manage data integrity and individual rights. Addressing these concerns will involve an urgent requirement for AI to develop more transparently, shift towards data mitigation strategies for reasonable bias and discrimination outcomes, and acknowledging the need for appropriate regulation of AI towards human interaction for clarity.

Machine Learning Techniques

The advancement in NLP has predominantly been attributed to developments in deep learning methods, particularly transformer models such as BERT, GPT, and T5. Through self-attention, the models can effectively process huge amounts of text fast and detect sophisticated patterns in language. Furthermore, transfer learning has transformed NLP to the extent that researchers are able to fine-tune pre-trained model output for a specific task with much smaller amounts of data and computation required to achieve the same level of performance on an NLP task. Future, retrieval-augmented generation (RAG) has been introduced as one possible method to improve the factual accuracy of NLP models by allowing them to refer to outside knowledge instead of only on pre-trained model memory. Neurosymbolic AI combines rule-based reasoning and deep learning and can improve reasoning and interpretability in NLP. Additionally, breakthroughs toward making it more efficient such as LoRA (Low-Rank Adaptation) and distilled models allow sophisticated NLP applications to be run on low-end devices, reducing computation requirements and increasing accessibility (Noble, J., 2025, January 28). As the research continues to move forward, the focus will be on constructing and creating more robust, explainable, and energy-efficient NLP models that can generate innovation with tolerable risk.

Conclusion

The evolution of NLP (Natural Language Processing) is influencing the future of human-computer interaction and allowing for more complex AI applications in various industries. As NLP enables innovations in robotics, autonomous systems, and AI decision-making, it poses considerable challenges concerning ethics. These challenges include misinformation, bias, and privacy issues. By employing innovative machine learning methods and developing them responsibly, NLP will continue to improve but still maintain awareness of its potential risks. As the field grows, the balance between innovation and ethical responsibility will be important in determining the future of AI-enabled communication.

Ghatifernado Inc, (2024, July 23) *NLP for Multilingual Communication: Breaking Language Barriers.* Medium. https://medium.com/@ghatifernado.inc/nlp-for-multilingual-communication-breaking-language-barriers-6d0aac46c22b

Noble, J., (2025, January 28) *What is LoRA (low-rank adaption)?* IBM. https://www.ibm.com/think/topics/lora

Omdena, (2024, May 16) *Combating the Infodemic: How NLP is Revolutionizing the Fight Against Fake News and Misinformation.* https://www.omdena.com/blog/fighting-misinformation

Reddy, S., (2023, October 26) *NLP in Robotics: Enhancing Human-Robot Interaction.* Pranathi. https://www.pranathiss.com/blog/nlp-human-robot-interaction/