REPORT 1

Use of Large Language Models to Improve Accuracy and Relevance of Responses in Virtual Assistants and Chatbots

[ANONYMIZED REPORT – NO IDENTIFYING INFORMATION]

Abstract

Chatbots and virtual assistants powered by Large Language Models (LLMs) have improved human–machine interaction by providing more accurate and relevant responses. Studies highlight the importance of prompt design and fine-tuning techniques for the effective performance of these tools. However, the implementation of LLMs raises ethical issues such as transparency and privacy. Speculative design proves crucial for anticipating and mitigating risks, promoting responsible technological development. By imagining future scenarios, this approach demonstrates that it can help maximize the benefits of virtual assistants while ensuring inclusivity, empathy, and respect for user privacy.

1. Introduction

Virtual assistants and chatbots have achieved significant popularity across a wide range of applications [Wei et al. 2024; Ding et al. 2023]. Although they have existed for a long time, these tools have recently gained renewed relevance through integration with Large Language Models (LLMs), which are artificial intelligence (AI) applications capable of enabling more sophisticated forms of communication when associated with natural language prompts.

Recent studies have demonstrated the effectiveness of implementing LLMs in virtual assistants and chatbots, yielding promising results. For example, Wei et al. (2024) explore the efficiency and advantages of using LLMs in chatbot construction, showing that prompt design factors can guide chatbots to communicate naturally and collect data reliably. In experiments with different prompt designs, chatbots were able to cover 79% of targeted information slots, demonstrating that prompt

structure and conversational topics significantly influence conversational flow and data collection performance.

Ding et al. (2023) conducted a study using the UltraChat dataset, applying fine-tuning as an effective practice for implementing chat-based language models such as ChatGPT. Aiming to push open-source models to a higher level, the authors investigated interactions between humans and AI assistants, obtaining results that demonstrated the superiority of the dataset and the strong performance of the UltraLM model compared to other models.

However, the implementation of LLMs in virtual assistants and chatbots raises ethical and social issues that must be considered. Piñeiro-Martín et al. (2023) proposed a study that, while demonstrating the advantages of LLM-integrated virtual assistants, also explored ethical challenges associated with this integration, particularly because these systems are increasingly used in public services.

Speculative design offers a valuable perspective for exploring the future of LLM-enhanced virtual assistants and chatbots. By imagining hypothetical scenarios, it becomes possible to identify opportunities to maximize the benefits of this technology while mitigating ethical and social risks. When adopted within an ethical and responsible framework, these systems can serve as powerful tools for good, promoting inclusion, empathy, and privacy protection.

Finally, speculative design provides a valuable and complementary approach to research and development involving LLMs in virtual assistants and chatbots. By anticipating possible futures and exploring the social and ethical implications of these technologies, speculative design helps ensure that technical progress is accompanied by careful consideration of human and societal impacts, contributing to the responsible and innovative development of more accurate and relevant virtual assistants.

The remainder of this article is structured as follows: Section 2 presents the theoretical foundation; Section 3 contextualizes the speculative design methodology and presents the tools used in the study; Section 4 explores the mapping of the current

state of the topic; Section 5 explores the speculation of possible futures; Section 6 explores the projection of a desirable future; and finally, Section 7 presents the conclusion.

2. Theoretical Foundation

2.1. Artificial Intelligence

According to Russell and Norvig (2004), artificial intelligence is a field of computer science focused on creating systems capable of performing tasks inspired by human intelligence. AI has been driven by advances in algorithms, improvements in hardware, and the availability of large volumes of data.

According to the authors, such complex tasks include:

- **Data analysis:** extraction of valuable insights from large datasets, supporting strategic decision-making across various sectors;
- **Problem solving:** addressing complex challenges in innovative and efficient ways, optimizing processes and increasing productivity;
- **Task automation:** performing repetitive and tedious tasks with precision and scalability, freeing human time for more creative and strategic activities;
- **Pattern recognition:** identifying patterns and anomalies in data, enabling highly reliable predictions and prevention;
- **Content generation:** producing text, images, videos, and other content formats creatively and originally, opening new possibilities for communication and marketing.

2.2. Large Language Models (LLMs)

Within the AI domain, LLMs stand out for their ability to process and generate natural language in a human-like manner [Yang et al. 2023]. Trained on vast datasets of text and code, these models demonstrate impressive capabilities, such as:

- **Natural language understanding:** interpreting nuances of human language, including context, intent, and implicit meaning;
- **Fluent text generation:** producing high-quality text in various styles and formats, such as articles, poems, scripts, and even code;
- **Language translation:** translating texts between languages with accuracy and fluency, breaking linguistic barriers and facilitating global communication;
- **Answering complex questions:** providing complete and informative responses to open-ended, complex, or ambiguous questions;
- **Creative content creation:** generating creative formats such as poems, scripts, musical pieces, and emails, exploring language in innovative ways.

2.3. Virtual Assistants and Chatbots

Virtual assistants and chatbots represent the practical application of AI in human–machine interaction, revolutionizing how people communicate with technology [Suta et al. 2020]. Through user-friendly interfaces and natural conversations, these systems offer several benefits, including:

- **24/7 customer support:** providing uninterrupted customer service, answering questions, resolving issues, and offering relevant information;
- **Task automation:** automating repetitive and frequent tasks such as scheduling appointments, booking flights, and making purchases;
- **Personalized user experience:** delivering personalized and individualized experiences by adapting to user needs and preferences;
- **Feedback collection:** continuously gathering user feedback to iteratively improve services and products;
- **Increased productivity:** helping users complete tasks more efficiently and effectively, optimizing time and resources.

3. Speculative Design Methodology

This study applied the speculative design methodology, an approach that allows the exploration of different futures—both negative and positive—through narrative and imaginative provocations. Several tools were used to support the execution of the process, aiming to achieve a better understanding of possible scenarios over the next five years.

The tools used in the study and their contributions are listed below:

- **Future scenario generator:** used to envision possible futures within a five-year horizon; three scenarios were created;
- **Problem comprehension card:** used after scenario generation to identify potential problems associated with the envisioned scenarios;
- **Tarot cards:** after consolidating information from previous tools, tarot cards were used to explore and enrich a newly constructed scenario;
- **Peer conversations:** conducted to refine the scenario and incorporate different perspectives.

4. Mapping the Current State of the Topic

The use of LLMs represents a significant advancement in the field of virtual assistants and chatbots. By improving response accuracy and relevance, these technologies have the potential to transform how users interact with automated systems, offering more satisfying and efficient experiences. Ongoing research and the development of new techniques will ensure that these models continue to evolve and better meet societal needs.

4.1. Mapping the Topic

Recent studies demonstrate the effectiveness of implementing LLMs in virtual assistant and chatbot applications. Selected results are summarized below.

Wei et al. (2024) explored the efficiency and advantages of using LLMs in chatbot construction:

- **Objective:** to explore which prompt design factors help guide chatbots to communicate naturally and collect data reliably;
- **Method:** four prompt designs with different structures were formulated, involving 48 online participants who interacted with chatbots guided by different prompt designs; conversational flows and user perceptions were evaluated;
- **Results:** chatbots covered 79% of targeted information slots, and both prompt designs and conversation topics significantly influenced conversational flow and data collection performance.

Ding et al. (2023) conducted a study using the UltraChat dataset and applied fine-tuning to implement chat-based language models:

- **Objective:** to push open-source models further by capturing a wide range of human–AI assistant interactions;
- **Method:** a large-scale, diverse instructional conversation dataset (UltraChat) with 1.5 million high-quality multi-turn dialogues was used; a LLaMA-based model was fine-tuned to create UltraLM;
- **Results:** statistical analysis showed UltraChat's superiority across several key metrics, and UltraLM consistently outperformed other open-source models.

Piñeiro-Martín et al. (2023) demonstrated that LLM-integrated virtual assistants bring significant advantages while introducing ethical challenges:

- **Objective:** to analyze the current regulatory framework for AI-based virtual assistants in Europe and examine ethical issues;
- **Findings:** the study argues for ethical principles prioritizing transparency, fairness, and harm prevention;
- **Results:** the article provides guidelines for ethical use, including data privacy, bias mitigation, and user control.

4.2. Current Scenario Context

To understand the current scenario in which LLMs improve response accuracy and relevance, it is necessary to consider interactions between people, technologies, and the environment.

- **People:**
    - End users who expect accurate and relevant responses;
    - Developers and researchers who design and improve LLMs;
    - Companies and organizations that implement virtual assistants to optimize processes.
- **Technologies:**
    - LLMs as the core technology;
    - Computational infrastructure such as cloud platforms and data centers;
    - Communication networks enabling real-time interaction.
- **Nature:**
    - Environmental impact due to high energy consumption in model training.

4.2.1. Role of Each Actor

- End users: demand accurate and relevant responses;
- Developers and researchers: design and improve LLMs;
- Companies and organizations: deploy and use the technology;
- Computational infrastructure: supports training and operation;
- Communication networks: enable real-time interaction;
- Nature: impacted by energy consumption.

4.3. Trends, Signals, and Evidence

- **Trend 1:** Increased adoption of LLMs by companies
    - Signals: market reports show growing AI investment;
    - Evidence: Gartner (2023) reports that over 70% of companies plan to implement AI by 2025.

- **Trend 2:** Continuous improvement in LLM capacity and efficiency
    - Signals: technological advances and efficiency gains;
    - Evidence: AI research publications on transformer architectures.

5. Speculation of Possible Futures

5.1. Five-Year Projection

Trends were projected into a five-year future scenario with widespread adoption by companies and end users, aiming for increased efficiency in interactions with LLM-based tools.

5.2. Future Scenario Mapping

If no intervention occurs:

- LLM-based assistants become ubiquitous in daily life, business, public services, and education;
- Users become highly dependent on virtual assistants;
- Assistants achieve high precision, natural interactions, and integration with IoT, AR, and VR technologies.

6. Projection of a Desirable Future

6.1. Designing an IT Solution

A proposed integrated AI management platform includes:

- Transparent and ethical AI algorithms;
- Robust data privacy management;
- Energy sustainability modules.

6.2. Expected Operation

- Transparency and explainability;
- Strong privacy protection;
- Energy optimization;

- Continuous auditing.

6.3. Reconfigured Future Scenario

- Increased trust and ethical adoption;
- Reduced environmental impact;
- Greater equity and digital inclusion.

6.4. Additional Actions

- Development of privacy and sustainability technologies;
- Creation of AI and environmental regulations;
- Institutional changes, including ethics committees and education programs.

7. Conclusion

The evolution of chatbots and virtual assistants driven by LLMs represents a major advancement in human–machine interaction. While offering increased accuracy and relevance, these technologies also raise ethical and social challenges. Speculative design emerges as a vital approach for anticipating risks and promoting responsible innovation. By integrating technological progress with ethical considerations, virtual assistants can contribute positively to society while respecting privacy, inclusion, and sustainability.

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