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Graduate Submission

Boston, Chicago

Enterprise Scale Implementation of Large Language Models

Using LLMs to propel companies into competitive positions for future success

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1. Abstract

This work is representative of a consultation performed for Processi Enterprises that was solicited with the intent of positioning the company as a competitive actor in the high-tech, design and manufacturing industry in 2040. Stakeholder interviews were conducted that elicited pain points followed by research into the applicability of Large Language Models (LLMs) as a solution path. Furthermore, use cases were discussed that address the pain points by means of LLM implementation as well as discussion regarding the required oversight by the company and ethical considerations. Recommendations were then made to highlight specific implementations in the company that will drive positive change upon successful implementation.

2. Motivation

Industry 4.0 is currently making noteworthy progress in the implementation at the enterprise level in the manufacturing and design sector. The fourth industrial revolution places a strong emphasis on the integration of cutting-edge technologies, coupled with unprecedented levels of connectivity and digitalization [1]. A crucial component of this new phase in the industrial landscape is the transformation of system connectivity through the deep integration of technology, machinery, and human operators. This integration gives rise to cyber-physical systems (CPS) that operate at the intersection of the physical and virtual realms [2]. A key component of Industry 4.0, Big Data, stands foundational to Large Language Models. Figure 1 shows the convergence of LLMs at the center of the interaction between machines, humans, and knowledge. In order to strategically plan the future implementation of Industry 4.0 at Processi Enterprises, stakeholder interviews were conducted to identify the challenges and provide consultation on realizing Industry 4.0 goals. The following challenges were elicited for consultation: inefficiencies in realization of stakeholder intent, excessive time spent in intra-company communication, and the lack of students entering the workforce poised to readily adopt new technologies.

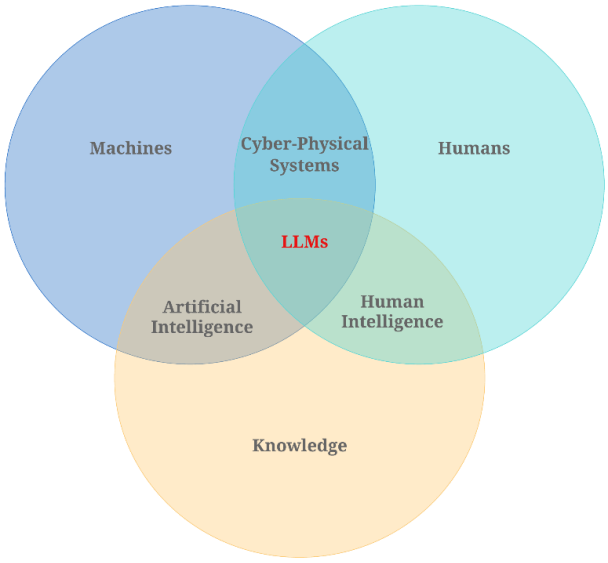

Figure 1: Venn Diagram Showing LLM Interaction with Machines, Humans, and Knowledge.

3. Background

OpenAI's ChatGPT is a sophisticated platform developed that integrates machine learning (ML) and Natural Language Processing (NLP) techniques to facilitate interactive conversations with machines [3]. This platform has popularized LLMs, leading to widespread adoption and fostering optimism for the technology [4]. By leveraging transformer-based neural networks, ChatGPT exhibits a deep understanding of intricate language structures, enabling it to generate contextually appropriate responses. Its architecture also incorporates Reinforcement Learning from Human Feedback (RLHF), which allows the model to continuously learn and enhance its performance based on user input [5]. This adaptive capability renders ChatGPT highly versatile for deployment across various industries.

Transformer-based language models have emerged as valuable contributors within innovation teams, bringing their expertise to bear on ideation and problem-solving tasks [6]. LLMs have been shown useful in providing approximate knowledge on a large breadth of information. In educational settings, AI has proven instrumental in elevating learning outcomes, productivity, and overall engagement by facilitating personalized learning paths and providing individualized assistance [7].

Moreover, ChatGPT has demonstrated its utility in managerial contexts by facilitating the sharing, organization, and retrieval of institutional knowledge. Its ability to provide decision-making assistance at the strategic level has the potential to revolutionize management practices [8]. From referencing age old management theories and providing specific decision-making advisements to the creation of novel content, ChatGPT has shown promise across a polarity of tasks. For example, in the realm of creativity, Human-ChatGPT collaboration has yielded notable benefits, particularly in areas such as entrepreneurial content generation. From crafting persuasive

elevator and crowdfunding pitches to generating engaging social media content, ChatGPT stands poised to revolutionize entrepreneurial endeavors [9].

Large Language Models have been trained on a massive amount of text that spans across most languages. It is little surprise that these tools have quickly become the state of the art for language translation. ChatGPT, in particular, was found to perform higher on benchmark datasets than any other commercially available model [10]. From human language and use cases to the synthesis and dissemination of machine language, or code, LLMs have shown much promise. Specifically, ChatGPT has been shown useful as a code debugging tool and even allows those with limited programming experience to produce working code. When compared against other state of the art commercially available debuggers, ChatGPT was found to perform just as well, or better, than its competitors with a much higher ease of use [11].

ChatGPT and other LLMs hold enormous potential for future use cases and have been shown successful in a variety of use cases. It is the author's belief that Processi Enterprises will benefit from several implementations of LLMs that are elicited below. These implementations will propel this company forward towards a position as a competitive and high-tech global design and manufacturing enterprise in the year 2040 as well as advance the parallel implementation of Industry 4.0.

4. Proposed Implementation

4.1 Inter – Company Interaction

Although gathering requirements from stakeholder interactions is an integral part of the design and manufacturing process, miscommunications between stakeholders and the enterprise's interpretation can occur. This happens regardless of the competence of the individual responsible for gathering stakeholder requirements. Because of the inherent entropic nature of communication between technical experts and non-technical clients, LLM (Large Language Models) have a unique ability to solve or at least mitigate the issues associated with communicative intent. However, due to the inconsistent nature of these LLMs, currently there is still a necessity to have humans scrutinize the output.

Collection of data of this type leads directly into data-driven solutions like LLMs. When a domain expert makes decisions on stakeholder intentions, there is a probabilistic nature in the expert's output as they must make assumptions about stakeholder intentions. Similarly, LLMs have outputs that are probabilistic as well; however, as an enterprise continues to collect data over stakeholders, LLMs can be fine-tuned to make more accurate assessments of what stakeholder's needs, ultimately leading to better solutions. Enterprises of the future landscape that wish to position themselves to deliver market-ready solutions must embrace these new tools in order to mitigate the loss of communicative intent. This will be especially important in enterprise level operations that span across many cultures, languages, and internal practices.

4.2 Intra-Company Communication

As shown in figure 2, there is a clear distinction between inter-company communication and intra-company communication. This differential exists also in the implementation and considerations of LLM implementations. New employees are often required to undergo onboarding activities that introduce trainees to project specific information, company or domain specific terminology, and enterprise specific software and documentation. LLMs can continue to evolve further as they interact with the current occupant of a role [5]. Oftentimes, companies undergo lengthy time or monetary heavy processes to be able to get new hires up to speed on the position-centric institutional knowledge. The questions, lessons, and general knowledge learned and associated with that role can be used to supplement the new hires via the use of LLMs [7].

LLMs have been shown to act as a knowledge repository when fine-tuned on company documents; hence, it is sensible that the quickest response to questions that span from the domain specific knowledge to general operational questions could be answered readily and accurately by LLMs. Even now we are seeing new tools that have recently entered the marketplace that aid in intra-company communication such as automated assistants that read and compose emails or summarize large documents and extract information therewithin.

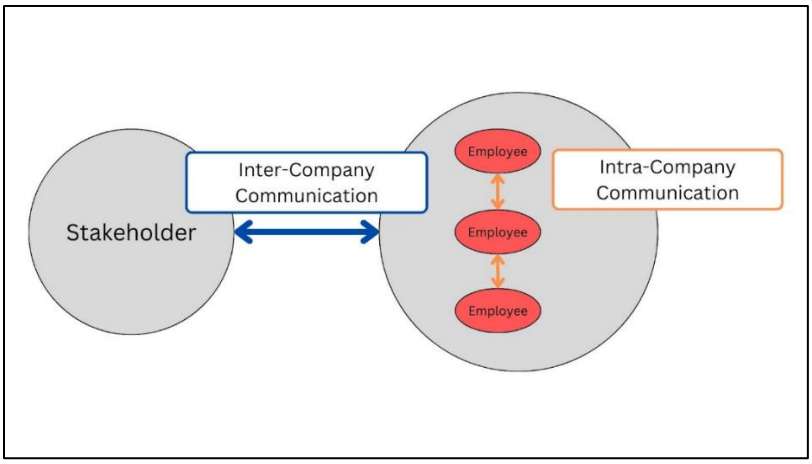

Figure 2: Differentiation between inter/intra company communication.

4.3 Undergraduate Curriculum Changes

ChatGPT is currently a contentious topic within higher education. We have already begun to see some institutions take swift action to ban the usage of this tool in academic settings []. It is not the goal of this paper to discuss the ethical concerns that such a tool raises in an academic setting; however, there is an incentive to continue to let students gain familiarity with such tools. It is hard to argue that such LLMs do not have a positive impact on worker productivity considering the widespread adoption ChatGPT has experienced. In January 2023, ChatGPT reached over 100 million users. This monumental feat made ChatGPT the fastest growing consumer application to date [12]. Given that a significant part of the duty of higher education is to equip students for the job market, it appears unreasonable to prohibit the use of these tools in educational environments.

Unless specific rules are implemented to restrict the availability of AI, it is difficult to envision a future where the industry doesn't continue to exploit these LLMs for enhanced productivity.

Given the established premise that LLMs generally enhance productivity, it follows logically that higher education institutions will experience the impetus to respond to industry's expectations by incorporating LLM-related skills into their curricula. Moreover, an outright ban on this tool does not appear to be the optimal course of action. Instead, it is imperative to reassess our perspectives and explore avenues for improved integration of LLMs into pedagogical approaches and the education of future graduates.

5. Considerations

5.1 Ethical concerns related to LLM implementation in Inter-Company communication

When companies interact with each other, the use of advanced language models brings certain risks that necessitate careful monitoring by institutions to ensure its effective integration as a widely adopted business practice. For instance, considering the current level of accuracy of these models, human operators must retain accountability for the output within their areas of expertise. It is crucial to establish a system of checks and balances that prevents erroneous outputs from a confused language model from hindering business success or task completion. In this envisioned collaboration between humans and language models, the human operator may be able to accomplish tasks more efficiently, leading to a situation where the operator assumes additional responsibilities that may not be adequately verified by the human author. Additionally, because LLMs are subject to the intent of the training dataset these models may sometimes hold internal bias that must be recognized and circumvented by the human operator. In industries with extensive safety protocols in place, such as high-tech manufacturing, the human operator must always remain in the loop to ensure safety of humans as well as sensitive company information and company intellectual property [13].

5.2 Ethical concerns relating to LLM implementation in Intra-Company communication

The interaction and communication among employees within large-scale organizational structures play a pivotal role in driving company success and maintaining output quality [14]. While the integration of LLMs offers significant potential for automating certain tasks, there are ethical concerns associated with their implementation. One such concern is rooted in the fundamental human need for interpersonal connections and social interaction. When LLMs are utilized as both encoders and decoders in communication channels, there is a risk of restricting the natural socializing among employees. This limitation has the potential to diminish the overall work environment and undermine the efficiency gains achieved through LLM utilization. However, the author maintains the belief that the tasks targeted for automation do not primarily constitute the core elements of interpersonal interactions, and alternative measures can be implemented to foster collaboration, shared goals, and motivation among employees.

5.3 Ethical concerns relating to LLM implementation relating to LLM implementation in undergraduate curriculum changes.

In educational settings, large language models (LLMs) offer significant promise in enhancing students' learning experiences and improving the efficiency of educators. Nevertheless, it is important to exercise caution to ensure that students utilize these tools appropriately. Relying excessively on LLMs as a crutch rather than as a tool may result in reduced self-reliance among students, stifling their inclination to explore new problem-solving approaches or tasks [15]. Additionally, care must be taken such that learning outcomes are successfully evaluated in a way that accurately shows the aptitude of the student for the content and still allow the use of these tools in their learning pathway.

Graduate education faces unique concerns surrounding authorship in scientific literature. Two prominent schools of thought exist on this issue with the primary being that ChatGPT cannot hold authorship or be cited on academic work due to the lack of traceability in its information retrieval. However, LLMs do not have the ability to answer novel research questions or perform experiments with the primary implementation being text generation. The answer for this ethical dilemma is outside the scope of this work; however, the question could be distilled to two constituent parts: in academia, is it more important to retain authority over one's work or is it more important to more efficiently produce and disseminate knowledge?

6. Conclusion / Recommendations

In conclusion, a competitive enterprise in the year 2040 will be the enterprises that readily adopt new tools and technologies. Framed in this work is the proposed implementation of LLMs on the enterprise scale. Use cases, ethical considerations, and limitations have been discussed. It is our belief, as consultants, that Processi Enterprises will benefit from the following recommendations:

- Expose LLMs to stakeholder input to better understand communication intent and provide proper synthesis.
- Utilize LLMs for intra-company communication to increase worker productivity and quality of output as well as serve as hosts of position-centric institutional knowledge.
- Advocate for the use of LLMs in undergraduate learning experiences, as well as worker training, to tailor learning experiences as well as poise the students for efficient future use of these tools in the inevitably adopting workplace.

By effectively implementing the aforementioned recommendations, Processi Enterprises will solidify its position in navigating the uncharted territory of the year 2040. Furthermore, as the capabilities of large language models (LLMs) continue to grow exponentially, Processi Enterprises will have established a robust understanding of domain knowledge and relevant considerations for leveraging these evolving technologies, anticipating unparalleled capabilities.

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