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CAN ARTIFICIAL INTELLIGENCE STILL BE CONSIDERED A NONCONVENTIONAL TECHNOLOGY IN 2023?

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Abstract: This scientific paper seeks to explore the evolution of Artificial Intelligence (AI) in the context of contemporary businesses. With the rapid advancement of technology, businesses have increasingly embraced AI as an essential tool for enhancing innovation and operational efficiency. Over the past years, there has been a notable shift in how AI is applied and utilized within business environments. This transformation can be attributed to various factors, including advancements in machine learning algorithms, increased computational power, and the availability of extensive datasets. This scientific paper delves into the significant impact that AI has had on modern business practices given that, today, AI has become an integral component of contemporary businesses, fundamentally altering the way organizations operate and make decisions. This study adopts a literature review methodology on the development of AI technologies, tracing their progression from traditional rule-based systems to contemporary deep learning approaches. By examining key milestones and breakthroughs in AI research, this paper offers a chronological framework to facilitate an understanding of AI's evolutionary path. Furthermore, the paper explores the adoption and integration of AI technologies in modern businesses, highlighting how AI has been leveraged to streamline operations, enhance decision-making processes, and drive innovation.

Keywords: artificial intelligence, business environment, innovation, machine learning

1 INTRODUCTION

The transformative power of technology has always had a significant impact on the business environment, offering opportunities for increased efficiency, innovation, and competitiveness. Artificial Intelligence is no exception, offering a framework in which organizations can exploit vast amounts of data to drive decision-making, automate complex and routine processes, personalize customer experiences, and foster new and disruptive business models. This technological paradigm shift enables companies to not only streamline their operations but also to explore new frontiers in product and service offerings, tailor their approaches to customer engagement, enhance predictive analytics, and stay ahead in a rapidly evolving digital landscape. Artificial Intelligence integration into various business aspects marks a crucial step towards a more agile, informed, and innovative corporate world.

However, it also presents challenges, including the need for new skills and navigating ethical and regulatory issues. As Artificial Intelligence becomes more integrated into daily business operations, there is a growing demand for a workforce proficient in AI and data analytics, necessitating significant investment in education and training. Ethically, the rise of AI raises concerns about privacy, bias in decision-making, and the potential for job displacement. Companies must approach these issues with a focus on responsible AI use, ensuring transparency, fairness, and accountability in their AI systems. Additionally, the regulatory landscape for AI is still evolving, requiring businesses to stay informed and compliant with diverse and sometimes rapidly changing regulations. Balancing the immense potential of AI with these considerations is crucial for sustainable and ethical growth in the digital era.

2 ARTIFICIAL INTELLIGENCE OVER THE YEARS

Introduced in 1956 at a conference at Dartmouth University, the term "Artificial Intelligence" (AI) pertains to the capability of computers to undertake tasks typically done by humans. This concept signifies a groundbreaking shift in technology, highlighting the evolution of machines that can mimic human actions and thought processes. AI encompasses a variety of functionalities, including problem-solving, learning, planning, and understanding language, and it is not just about replicating human actions but also involves the machines' ability to adapt, improve, and make decisions based on new information, much like a human would. (Zhang & Lu, 2021)

The evolution of Artificial Intelligence (AI) from 1956 to the present day has been a journey marked by significant milestones, technological advancements, and shifting perspectives on the capabilities and future of AI, as described in Figure 1.

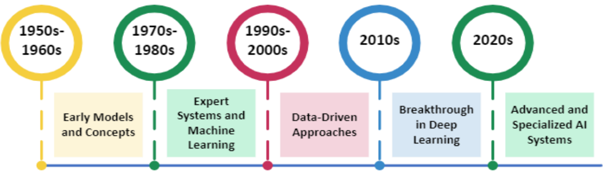

Figure 1. Artificial Intelligence: stages of evolution

1950s - 1960s: The Beginnings of AI, marked by the appearance of the early Artificial Intelligence models and concepts, such as the Logic Theorist.

The Logic Theorist, or, as they called it, “The thinking Machine” was developed by Al Newell and Herbert Simon in 1956 and was based on several fundamental principles that reflect its approach to simulating human thought processes in problem-solving. The key principles that reflect its approach to simulating human thought processes in problem-solving were:

- Symbol Processing in Memory: It views thinking as the process of handling symbols within short-term and long-term memories. These symbols are abstract and amodal, meaning they are not directly tied to sensory inputs.
- Information Carriage in Symbols: Symbols are regarded as carriers of information. They represent things and events in the world, but their primary function is to influence other information processes, thereby guiding behavior. As Newell and Simon stated, symbols serve as information by altering the actions of information processes.
- Hierarchical Knowledge Representation: In the Logic Theorist, knowledge is represented hierarchically. This is evident in how logic expressions are structured with elements and sub-elements. Similarly, the processes it employs are also hierarchical, setting sub-goals that trigger new processes.
- Use of Heuristics in Problem Solving: The system tackles complex problems using heuristics. These heuristics are relatively efficient but do not always guarantee a solution. They provide a method to approach problem-solving more effectively than brute-force methods.
- Backward Working from Theorem to Axiom: The Logic Theorist operates by working backwards from the theorem that needs to be proved. It employs heuristics to make valid inferences, retracing steps until it reaches an axiom. (Gugerty, 2006)

1970s - 1980s: The appearance of Expert Systems and Machine Learning, such as SHRDLU, MYCIN or the emergence and development of neural network models.

SHRDLU, developed by Terry Winograd in the late 1960s, is an early and influential program in the field of artificial intelligence, particularly in natural language understanding. Its main characteristics were:

- Language Understanding: SHRDLU demonstrated a form of true language understanding to a certain extent, as it was capable of interpreting commands given in natural language and executing actions in a simulated environment to show that it understood these commands.
- Specific Command Interpretation: The system could understand and act upon specific words such as "pick-up", "big", "box", that were defined at a fundamental level within the program's architecture.
- Knowledge Representation: Knowledge in SHRDLU was hand-coded in a procedural form. This means that the information the system used to interpret and respond to commands was explicitly programmed into its procedures.
- Action in Simulated Environment: When given commands, SHRDLU could carry out actions in a "real world" setting, which in this case was a simulated block world. This environment consisted of simple objects like blocks, pyramids, and boxes that the system could manipulate.

Innovative at its time, SHRDLU was one of the first AI systems to effectively demonstrate the integration of natural language processing with a dynamic understanding of a represented world. It was an early example of creating an interactive environment where language had a direct impact on the actions of an AI system. (Ho & Wang, 2019)

MYCIN, developed in the early 1970s, was a groundbreaking program in the field of artificial intelligence, specifically in medical decision support systems. It was designed as a LISP program to offer advice on therapy selection for patients with infections. The system comprised a Consultation System for generating advice, an Explanation System for detailing the reasoning process, and a Knowledge Acquisition System for experts to update the knowledge base.

MYCIN acted as an intermediary between medical experts and nonexperts: the experts provided general medical knowledge, while nonexperts (physicians) input patient-specific data, then, MYCIN used the general medical knowledge to assess specific patients and provide therapeutic advice, effectively becoming the decision-maker. The system included two internal explanation mechanisms - the "General Question-Answerer" and the "Reasoning Status Checker" - to provide explanations for its judgments and advice. Decisions were based on domain-specific knowledge in the form of rules ("Static Knowledge"), which the Rule Interpreter used alongside specific patient data to generate conclusions and advice. MYCIN also maintained a record of its operations and decisions, which could be accessed for clarification or justification of its conclusions.

The major limitations of the system included the fact that it required physicians to initiate the interactive session, which they often did not do for tasks they felt capable of handling themselves, the complex control structure and representation scheme of MYCIN were seen as potentially unnecessary for certain medical inference tasks and the fact that MYCIN required more computing power and memory than was typically available in hospital environments at the time, limiting its practical deployment.

MYCIN was a pioneering Artificial Intelligence system in medical decision-making, especially notable for its rule-based approach, explanation capabilities, and focus on infectious diseases. However, its practical application was hindered by technological limitations and the reluctance of medical professionals to rely on computerized advice for clinical decision-making. (Shortliffe, 1977)

1990s – 2000s: The evolution of data-driven approaches, marked by IBM's Deep Blue or the Support Vector Machines (SVMs).

Deep Blue, the chess machine developed by IBM, is famous for defeating the then-reigning World Chess Champion, Garry Kasparov, in 1997. Deep Blue was capable of playing chess at a level that surpassed the best human players, as evidenced by its victory over Kasparov, it could analyze millions of chess positions per second, allowing it to evaluate numerous potential moves and strategies rapidly. The system was designed to understand complex chess strategies, utilizing a deep knowledge of chess games and tactics.

Figure 2. IBM’s Deep Blue computer (chess-chivalry.com)

Deep Blue combined a single-chip chess search engine with a massively parallel system, integrating hardware and software components for efficient chess analysis, the system used 480 single-chip chess search engines, capable of searching 2 to 2.5 million chess positions per second each.

Deep Blue was a massively parallel system, consisting of a 30-node IBM RS/6000 SP computer, enhancing its computational power. The chess chips had a complex evaluation function, that included over 8000 features, allowing it to evaluate chess positions with great sophistication. It utilized a database of games played by chess grandmasters, aiding its strategic planning and decision-making and, depending on the complexity of the chess position, Deep Blue's system speed varied, averaging around 100-200 million positions per second, with a peak at 330 million positions per second.

The system was organized into layers, with a master processor handling top-level analysis and distributing tasks to worker processors and new software tools were developed for match preparation, including evaluation tuning and visualization tools.

In terms of limitations and challenges, Deep Blue was highly specialized for chess, with its capabilities and design tailored specifically for this game, and, while its hardware evaluation function was powerful, it was not easily modifiable, which posed challenges in adding new features or adjusting existing ones.

Deep Blue's victory over Kasparov marked another significant milestone in the field of Artificial Intelligence, demonstrating the potential of computers in complex decision-making and strategic planning tasks. Its development involved overcoming several technical challenges and represented the culmination of years of research in computer chess. (Campbell & Hoane & Hsu, 2002)

Support Vector Machines (SVMs) are a class of powerful and versatile machine learning algorithms used for classification, regression, and other learning tasks. Their main characteristics are:

- ➢ Learning by Example: SVMs are designed to learn from examples. They are trained using a set of data where each example is labeled as belonging to one of two categories. For instance, in recognizing fraudulent credit card activities, SVMs would learn from examples of both fraudulent and nonfraudulent transactions.
- ➢ Application in Diverse Fields: Originally designed for tasks like recognizing handwritten digits, SVMs have been successfully applied in various fields, including biomedicine, like classifying gene expression profiles in cancer research.
- ➢ Separating Hyperplane: The core idea of an SVM is to find a separating hyperplane in the data space. In a two-dimensional case (like the simplified gene expression example), this hyperplane is a line dividing a plane in two parts where each class lays on either side.
- ➢ Maximum-Margin Hyperplane: SVMs aim to find the hyperplane that has the maximum margin, i.e., the maximum distance between the data points of both classes. This concept ensures that the model is not only separating the two classes but also doing so with the widest possible margin, which helps in generalization to new data.
- ➢ Soft Margin: In real-world data, perfect separation is often not possible. The soft margin concept allows some misclassifications in the training data to achieve a more robust model that generalizes better on unseen data. This is particularly useful in cases where the data is not perfectly separable or has some overlap.
- ➢ Kernel Function: SVMs can perform linear classification with the linear kernel but can also handle non-linear data by using a kernel function. This function transforms the data into a higher-dimensional space where a linear separation is possible.
- ➢ Predictive Ability: Once trained, SVMs can predict the class of new, unseen data, such as determining whether a new patient’s gene expression profile corresponds to a particular type of leukemia.

SVMs are a popular choice in machine learning due to their effectiveness in both linear and non-linear classification, robustness, and ability to handle high-dimensional data. They are especially valued in domains where precision is crucial, such as in biomedical applications. (Noble, 2006)

2010s: Breakthroughs in Deep Learning: With the emergence of models such as IBM Watson, OpenAI's Generative Pre-Trained Transformer (GPT) series or Google's BERT, AI began to exceed human performance in specific tasks like image and speech recognition.

IBM Watson represents a significant advancement in the field of cognitive computing, particularly in its application to life sciences research. Its main characteristics and capabilities are as follows:

- Data Integration and Analysis: Watson excels at integrating and analyzing large volumes of data from hundreds of sources in various formats. This is crucial in life sciences where research often involves diverse datasets.
- Understanding Different Data Types: It can process and understand different types of data, from structured data like lab values in databases to unstructured data like the text of scientific publications.
- Industry-Specific Knowledge: Watson is trained to comprehend technical and scientific content, including specialized terminology used in life sciences.
- Advanced Cognitive Capabilities: It utilizes advanced reasoning, predictive modeling, and machine learning techniques to facilitate and accelerate research.
- Specialized Knowledge Base: For life sciences, Watson includes a vast repository of medical literature, patents, genomics data, and chemical and pharmacological information.
- Novel Connection Identification: Watson is capable of making novel connections within millions of pages of text, a feature that can lead to breakthrough discoveries in drug development and other areas of life sciences.

Its applications and impact include:

- Drug Target Identification and Repurposing: In pilot studies, Watson has shown potential in accelerating the identification of novel drug candidates and drug targets by effectively utilizing big data.
- Enhancing Research Novelty and Speed: The cognitive computing abilities of Watson infuse novelty and add speed to the research process in life sciences, an area that demands rapid innovation.
- Adverse Event Detection and Coding: Watson is being explored for its potential to improve the accuracy and speed of identifying and coding adverse drug events from textual data like case reports and published articles.
- Predictive Text Analytics: Its capabilities in predictive text analytics are being tested for extracting known relationships and hypothesizing novel relationships in scientific data.

IBM Watson's cognitive computing technology, especially in its application to life sciences research, represents a significant leap in handling and making sense of large and complex datasets. Its ability to integrate, analyze, and derive insights from diverse data types holds promise for accelerating innovation and discovery in various fields. (Chen & Argentinis & Weber, 2016)

Generative Pre-Trained Transformers (GPTs): Natural language generation (NLG), which involves computer programs generating human-like language, encompasses techniques like machine translation, text summarization, and paraphrasing. The transformer model, introduced in 2017 by Vaswani et al., represents the cutting-edge neural network architecture for NLG and NLP, surpassing previous models like RNN and LSTM. Its advantages include overcoming the vanishing gradient problem and enabling parallel training. As transformer models and training data scale up in size, they excel in capturing longer sequences, leading to enhanced language understanding and generation capabilities. Despite being a relatively recent innovation in NLP and NLG, the transformer technique has found applications across various domains. In the medical field, experts are utilizing transformer models to create structured patient information, thereby enhancing medical datasets. Additionally, content creators are employing GPT models to brainstorm and generate creative ideas. Nevertheless, a recent analysis indicates that the use of transformers in engineering design tasks remains largely untapped, presenting significant potential for future exploration.

The Generative Pre-Trained Transformer (GPT) refers to a series of pre-trained language models developed by OpenAI, which have become the most known type of transformers for natural language generation (NLG) tasks. These pre-trained language models (PLMs) are trained on extensive datasets containing a vast array of text, equipping them with the capability to handle a variety of specific language-related tasks efficiently.

Generative Pre-trained Transformers (GPTs) are a type of autoregressive language model designed to predict the next word in a sequence based on all previous words. GPT-2 follows a dual-phase training approach: initially, it undergoes pre-training on a vast text dataset gathered from millions of web pages. This general training is then fine-tuned for specific natural language processing (NLP) tasks using a tailored dataset relevant to the particular task. This fine-tuning involves adjusting the model's weights through gradient updates on a large task-specific dataset, adapting the pre-trained model for the intended application. However, acquiring a sufficiently large and relevant dataset for this phase can be challenging. (Zhu & Luo, 2022)

2020s: Advanced and Specialized AI Systems, such as GPT-3 or AlphaFold.

GPT-3, launched in 2020, represents an advancement over GPT-2, trained on an even more diverse and extensive dataset containing 400 billion tokens and boasting up to 175 billion parameters. A significant feature of GPT-3 is its capability for 'few-shot learning', where it can learn from a few examples of a given NLP or NLG task without the need for further gradient updates. This makes GPT-3 more versatile and efficient in adapting to various language tasks compared to GPT-2. (Zhu & Luo, 2022)

AlphaFold, utilizing advanced AI and deep learning, has significantly advanced the prediction of protein 3D structures, approaching experimental resolution. This breakthrough has revolutionized studies in function, evolution, disease, and other areas requiring protein structures. The vast and rapidly growing database of accurate protein structures is enhancing research, particularly in understanding signaling pathways, and identifying critical points like cancer driver mutations.

➢ Role in Medication Development: AlphaFold's most significant impact is expected in accelerating and improving the creation of new medications. It enables better understanding of how signals reach genomic targets and influence gene expression, thereby assisting in predicting pathways for drug development.

➢ AlphaFold and Protein Databank: AlphaFold's success is partly due to the Protein Databank, which provided a vast array of experimentally determined structures for training. However, AlphaFold does not fundamentally deepen our understanding of the protein folding mechanism.

➢ AlphaFold's Limitations: While transformative, AlphaFold has limitations: it doesn't solve the theoretical protein folding problem but rather improves practical predictions by incorporating evolutionary information. It also struggles with understanding allosteric mechanisms, crucial for cellular regulation and increasingly targeted in drug development due to their specificity and lower toxicity.

➢ AI in Protein-Protein Interactions and Drug Discovery: Beyond structure prediction, AI methods like AlphaFold are being applied to protein-protein interactions (PPIs), including human-microbiome PPIs. This has implications for understanding diseases and developing drugs. AI is reshaping drug discovery, aiding in drug repurposing, and identifying drug target combinations, thus providing specific hypotheses for experimentation.

AlphaFold represents a major leap in biological research, offering new avenues for understanding protein structures and interactions, and significantly impacting drug discovery and development. (Nussinov & Zhang & Liu & Jang, 2022)

3 CHALLENGES AND OPPORTUNITIES

As is every revolutionary topic in its first years, Artificial Intelligence is also surrounded by myths, misconceptions, or fake information. When people talk about AI, confusion, forecasts, and storytelling are usually just around the corner. This situation is similar to having three experts in a room discussing AI and ending up with four different definitions for the term. Such a broad range of interpretations and predictions leads to diverse and often extreme views. On one end of the spectrum, some harbor fears that AI will manifest in malevolent robots, intent on human destruction, a scenario fueled by popular culture and Hollywood blockbusters. On the other end, there are those who believe that AI's capabilities will never surpass those of a highly advanced smartphone.

The root of these strong and polarized opinions can often be traced back to the influence of Hollywood. Movies have popularized the notion of a world governed by an AI-driven simulation, asking the audience whether they choose the bliss of ignorance or the harsh reality. "The Terminator" series, with its iconic phrase "Hasta la vista, baby!", has embedded the image of ruthless AI-powered robots in the public consciousness. These cinematic portrayals, while compelling and entertaining, contribute significantly to the misconceptions surrounding AI. They play a key role in shaping public perception, often overshadowing the more nuanced and realistic advancements and applications of AI in various fields. (Kaplan & Haenlein, 2019)

Numerous discussions about the current legal regulation of Artificial Intelligence (AI) highlight the challenges and potential of AI as an autonomous legal entity. The evolving nature of AI legislation is a central theme, with different countries adopting various approaches to AI regulation. The concept of AI as an autonomous legal entity raises significant issues concerning accountability, rights, and responsibilities. The need for comprehensive, adaptable legal frameworks is emphasized to manage AI's rapid advancements and its integration into diverse sectors. (Atabekov & Yastrebov, 2018)

The rise of Artificial Intelligence, propelled by technological advancements, has sparked widespread debate, particularly regarding its integration into daily life and the ensuing legal and ethical issues. Challenges such as data privacy and AI bias have been prominent, leading to significant legal responses like the European Data Protection Directive and its successor, the GDPR, which imposed stricter personal data protection rules. These changes reflect an evolving legal landscape, grappling with the implications of AI, big data, and increased automation. This dynamic environment, with potential new regulations like the Artificial Intelligence Act, poses uncertainties and opportunities for future EU legislation, especially in how it intersects with existing frameworks like GDPR. (Güneş Peschke & Peschke, 2022)

On the other hand, for modern organizations Artificial Intelligence comes with opportunities, focusing on its transformative potential in modern organizations. AI offers enhanced efficiency through automation, leading to cost savings and optimized operations. It supports advanced data analytics, enabling more informed decision-making and predictive insights. AI-driven innovation can lead to new products and services, while improving existing offerings. Additionally, AI enhances customer engagement and personalization, creating tailored experiences, can streamline supply chain management and foster competitive advantages in the marketplace.

Despite current challenges, AI holds the potential to revolutionize workforce structure, job design, knowledge management, and decision-making processes. These advancements are expected to profoundly impact organizations and societies in ways that are not yet fully comprehended or realized. (Hind & Davenport & Pachidi, 2020)

4 CONCLUSIONS

AI has evolved from its inception in the 1950s, with each era bringing new developments, from the early Logic Theorist to the recent breakthroughs in deep learning and specialized systems like GPT-3 and AlphaFold. This evolution has seen AI transition from basic problem-solving and language understanding in the early years to sophisticated decision-making, predictive analytics, and complex data integration in recent times.

The widespread integration of AI into various business sectors and its influence on societal functions demonstrate its transition from a new concept to a fundamental component in many industries. AI's role in enhancing efficiency, decision-making, customer experience, and innovation indicates its established position in the corporate world. Ethical and regulatory challenges, including data privacy, bias, and workforce impacts, highlight its deep integration in all the structures of modern society.

Despite the fact that today it is widespread, AI continues to face challenges, including myths and misconceptions fueled by popular culture, as well as evolving legal and ethical considerations. The need for adaptable legal frameworks and responsible AI use underscores the ongoing nature of AI's integration into society, reflecting both its established role and the areas still in development.

The historical journey of AI, from a groundbreaking technology to its current universal presence, suggests that AI has become more conventional in many respects. Its applications across various industries, the need for AI-proficient workforce, and the focus on responsible AI integration are indicators of its mainstream acceptance.

In light of these observations, it can be argued that AI, in 2023, extends across the line between being a nonconventional and a conventional technology. While its rapid evolution, deep integration into various sectors, and widespread acceptance signify a shift towards conventionalization, the ongoing challenges, ethical concerns, and continuous development of groundbreaking AI models like GPT-3 and AlphaFold suggest that it retains elements of a nonconventional technology.

AI's status as a nonconventional technology in 2023 may not be as clear-cut as it once was, as it's more of a transitional phase where AI is both well-established in certain domains and still pioneering in others. The dynamism of AI's evolution, its expanding applications, and the ongoing debates about its role in society and business all contribute to a nuanced view where AI is seen as both conventional in some respects and still nonconventional in its capacity for innovation and transformation.

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