

EVOLUTION OF ARTIFICIAL INTELLIGENCE TECHNOLOGY IN MODERN COMPUTING: AN ANALYSIS OF RECENT RESEARCH

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Abstract

This research explores the evolution of artificial intelligence (AI) technology in the context of modern computing, focusing on analysing a range of recent research. AI has undergone significant development, with key advances in machine learning, deep learning, and natural language processing that have increased its analytical and computational capacity. The review notes how AI has been widely adopted in various industries, including healthcare, automotive, finance, and manufacturing, bringing significant improvements in productivity and decision-making. However, the research also highlighted emerging challenges, such as ethical issues, data privacy, and algorithmic biases, that need serious attention. In conclusion, while AI in modern computing shows promising progress, continuous research and innovation are needed to overcome these challenges to realise AI's full potential.

Keywords: Technology Evolution, Artificial Intelligence, Modern Computing.

Introduction

In recent decades, artificial intelligence (AI) has undergone rapid development, affecting various aspects of human life. The concept of AI, which initially existed only in the realm of scientific imagination, has now become an integral part of modern computing.

Modern computing is an ever-advancing development of information and communication technologies, bringing significant changes in the way data is generated, processed and analysed. It encompasses various technologies such as cloud computing, quantum computing, and artificial intelligence (AI), all of which have enhanced the ability of computing systems to handle large and complex volumes of data with high efficiency. (Ismail, 2021). Modern computing allows us to run more powerful and sophisticated applications, from deep big data analytics to real-time personalisation of services, as well as supporting innovation across a wide range of industry sectors such as health, finance, manufacturing and transportation. At its core, modern computing has become the backbone of today's digital age, enabling pervasive digital transformation and connecting devices and systems in an intellectual and unified network. (Igulu & Saturday, 2023).

AI has a wide range of applications, from facial recognition, natural language processing, to autonomous cars. The development of AI technology is fuelled by advances in computing, the availability of large amounts of data, and the development of machine learning algorithms. (Monteiro et al., 2021)..

As AI technology evolves, much research has gone into developing and improving algorithms and enhancing the capabilities of computers to handle increasingly complex tasks. Recent research in this field has shown that AI can not only improve efficiency and productivity in various industrial sectors, but can also open up new opportunities that were previously unimaginable. However, behind these advancements, there are various challenges and issues that need to be addressed (Jia, 2024). One of the main challenges is how to ensure that the development and application of AI is done ethically and responsibly. In addition, the integration of AI into modern computing systems often faces competitive, technical, and regulatory barriers. Questions of reliability, transparency, and security of AI systems are also a major focus in the research community and industry. (Rufai et al., 2023)..

The need to understand how the evolution of AI technology occurs in the context of modern computing drives the importance of this research. An analysis of the latest discoveries, research methods, and applications of AI will provide deep insights into the direction in which the technology is evolving and how to optimise its use. This research also aims to identify the latest trends in AI research and how they affect key areas, such as healthcare, finance, and transport. (Siddiqui & Haroon, 2022).

Considering this background, this research will make an important contribution in understanding the evolution of artificial intelligence technology in modern computing, as well as analyse the current research to achieve more significant progress in the future.

Research Methods

The study in this research uses the literature method. The literature research method is a systematic and comprehensive approach to collecting, evaluating and analysing existing information from various written sources, such as books, scientific journals, articles and other publications, in order to gain an in-depth understanding of a particular topic. Literature research involves steps that include identifying relevant sources, assessing their quality and credibility, and synthesising the information to identify trends, gaps and key findings in the field of study. This method is useful for building theoretical frameworks, developing hypotheses, and providing context for empirical studies, thus providing a strong foundation for further research as well as a contribution to the existing body of knowledge. (JUNAIDI, 2021); (Abdussamad, 2022); (Wekke, 2020).

Results and Discussion

AI Evolution from an Algorithmic Aspect

Artificial Intelligence (AI) is a branch of computer science that focuses on developing systems or machines that can perform tasks that typically require human intelligence. This includes capabilities such as learning, reasoning, problem-solving, perception, and natural language understanding. (Lang, 2021). AI technology utilises algorithms and techniques such as machine learning, neural networks, and natural language processing to analyse data and make informed and adaptive decisions. AI has been applied in various domains, from speech and image recognition, recommendation systems, chatbots, to autonomous vehicles and virtual assistants, with the main goal of improving efficiency, accuracy, and innovation in various industrial sectors and daily life. (Shafik, 2023).

The evolution of artificial intelligence (AI) from the aspect of algorithms started from simple basic concepts to become more complex and sophisticated over time. In the early era of AI, around the 1950s and 1960s, the main focus was on algorithms based on logic and clear formal rules, known as rule-based systems. (Balasubramaniam & Balasubramaniam, 2023).. These algorithms work by following a set of human-defined rules to reach the solution of a problem. Examples are the inference engines in early computer programmes such as Logic Theorist and General Problem Solver, which were designed to solve various mathematical logic problems. (Nwaneri & Ugo, 2023)..

In the 1980s and 1990s, attention turned to methods that allow computers to learn from data, namely machine learning. Algorithms such as linear regression and decision trees began to be applied for data analysis and prediction. One of the significant leaps in this type of algorithm was the development of artificial neural networks, which were inspired by the structure and function of the human brain. Neural networks allow computers to recognise patterns in data through a training process that mimics the way humans learn. At the end of this period, we also see the emergence of statistical-based learning techniques such as Support Vector Machines (SVM) and Ensembles that provide stronger performance on various predictive tasks. (Nourani, 2021).

In the 2000s, advances in computing technology and the availability of abundant data triggered rapid developments in deep learning, a sub-field of machine learning that focuses on the use of highly complex deep neural networks. Deep learning algorithms, such as Convolutional Neural Networks (CNN) for image recognition and Recurrent Neural Networks (RNN) for sequence data processing, took AI to new heights in terms of accuracy and capability. (Kapoor et al., 2023). They require large computing power and extensive datasets, yet manage to achieve outstanding results in various

applications such as image and speech recognition, and natural language understanding. (Lauterbach, 2021).

As we enter the 2010s to the present day, AI continues to evolve with increasingly sophisticated algorithm innovations, including reinforcement learning and its combination with probabilistic-based models. Reinforcement learning algorithms allow AI systems to learn through interaction with their environment by trial and error, similar to the way living organisms learn naturally. One famous example is the Deep Q-Networks (DQN) algorithm developed by DeepMind and used to win complex video games. In addition, recent approaches such as Generative Adversarial Networks (GANs) have opened up new opportunities in the field of content generation with the ability to generate realistic synthetic data. (Jin, 2023). Continuing to innovate, AI from the algorithmic aspect is now playing an important role in supporting other technological advancements and paving the way towards wider and more adaptive applications in the future. (Jaiswal & Jaiswal, 2020).

In recent years, AI has continued to show tremendous development with the emergence of large generative models, such as GPT (Generative Pre-trained Transformer) which has brought advancements in natural language processing. This model was introduced by OpenAI and is based on the transformer architecture introduced by Vaswani et al. in 2017. This algorithm enables amazingly natural text understanding and production, enabling applications such as chatbots, automatic writers, and more advanced language translation systems. The ability of transformers to work with sequential data has brought significant improvements in the ability of models to handle context and maintain coherence in long texts. (Mishra, 2020).

In addition, AI is increasingly being made more accessible and applicable on an industrial scale through optimisation techniques and model pruning, so that they can run more efficiently on resource-constrained devices such as smartphones and IoT devices. (Gong, 2023). Techniques such as transfer learning have also helped accelerate the adoption of AI in various industrial domains, allowing large pre-trained models to be applied to specific tasks with little customisation. These steps ensure that the sophistication of AI is not only limited to large-scale computing infrastructure but also to more practical and everyday applications (Khan et al., 2024).

AI has also started to adopt more interdisciplinary approaches, including integration with the fields of robotics, cybersecurity, and ethics. Recent algorithms combine deep learning with adaptive control in robotics, creating more autonomous and responsive systems. In the field of cybersecurity, AI algorithms are used to detect and respond to threats in real-time, improving data and network security (Zhu et al., 2022). Ethically, the discussion around "accountable AI" is particularly relevant, where there are efforts to make algorithms more transparent, steerable, and avoid bias so that their use remains fair and beneficial to society at large. (Sharma & Vanshika, 2022)..

In conclusion, the evolution of AI algorithms has progressed from simple rule-based approaches to the complexity of artificial neural networks and deep learning, as well as the application of generative models and transformers. Each of these stages of development has opened new doors to the wider application and efficiency of AI, enabling various industries to optimise their processes and open up new opportunities. Looking ahead, with more interdisciplinary incorporation and improved techniques and infrastructure, AI is expected to become more integrated and essential in our daily lives, bringing us closer to an era of smarter and autonomous technology.

AI Evolution from an Implementation Aspect

In the early stages of AI evolution, algorithm implementation was generally done through rule-based systems. These systems work by relying on a set of human-defined rules to make decisions. For example, expert systems are designed to mimic human reasoning by following certain pre-programmed rules. Although they have limitations in terms of flexibility and adaptability, these systems are able to solve specific problems such as disease diagnosis or technical problem solving in a particular domain. (Situ, 2020).

Over time, developments in data processing and storage allowed machine learning implementations to become more dominant. Machine learning algorithms no longer rely on rigid rules but on data to "learn" and make predictions or decisions. (Duymaz & Şahin, 2023). This model training includes algorithms such as linear regression, decision trees, and K-nearest neighbors (KNN) that utilise large datasets to "train" the system. The result is a system that is more flexible and capable of continuously improving its performance through learning from new data without direct human intervention. (Lang, 2021).

Further developments brought us to the era of deep learning, which uses multi-layer artificial neural networks architecture to model complex data. The implementation of deep learning enables more complex pattern recognition and strengthens the feature representation capabilities of unstructured data such as text, images, and audio. Algorithms such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) are becoming popular in image and natural language processing. Tools such as TensorFlow and PyTorch make it easier to implement deep learning, making it more accessible to the scientific community and industry. (Wang, 2022).

The latest stage in the evolution of AI is the introduction of transformer models such as GPT (Generative Pre-trained Transformer) and BERT (Bidirectional Encoder Representations from Transformers). These implementations have revolutionised natural language processing capabilities and produced more humanised and coherent text. (Zhou, 2024). The transformer models utilise self-attention mechanisms that enable them to retain context better in long texts and produce higher quality output. In addition, techniques such as transfer learning and fine-tuning allow large models that

have been trained on general data to be applied to specific tasks with minimal effort, accelerating adoption in various areas of industry and research. (Aliyu et al., 2023).

Throughout this evolution, AI has grown from a very specific and limited system to a more versatile and powerful technology, ready to take on complex challenges in various domains.

Use of AI in Big Data

In the Big Data ecosystem that includes large data volumes, variety of formats, and rapid data growth rates, AI plays an important role. AI technology enables faster data processing and analysis by utilising machine learning and deep learning algorithms that are capable of handling large amounts of data at high speeds. This involves sorting, grouping, and analysing data to identify patterns and trends that conventional methods may not be able to detect. As such, organisations can make faster and more informed decisions based on insights gained in real-time (Tang et al., 2020).

AI enriches predictive analytics capabilities in Big Data by providing more accurate models to predict future outcomes. AI models, especially those based on machine learning, can study historical data and detect complex relationships between variables. This gives organisations an edge in areas such as marketing, where AI can be used to predict customer behaviour, or in risk management to forecast potential financial or operational threats. By increasing predictive accuracy, AI helps organisations reduce uncertainty and strengthen business strategies. (Badawy, 2023).

AI plays a role in enhancing service personalisation by providing sharper segmentation analysis. In an increasingly personalised world, AI enables companies to customise products and services to individual preferences based on large and complex user data. Recommendation algorithms such as those used by streaming and e-commerce platforms are examples of how AI utilises Big Data to provide relevant content and products to consumers. This not only improves customer experience but also drives increased sales and brand loyalty. (Shana et al., 2022).

Aside from the analytical benefits, AI also plays a critical role in maintaining data security. With the ability to detect anomalies in large data streams, AI can automatically identify suspicious activity or unusual patterns that may indicate security threats such as data breaches or cyberattacks. Machine learning and clustering analysis technologies are used to recognise deviations from the norm and provide early warning to system managers or security teams. Thus, AI helps maintain the integrity of the Big Data ecosystem and protect sensitive information from potential threats.

Conclusion

The evolution of artificial intelligence (AI) technology in modern computing based on recent research, there are several key points that stand out. Firstly, AI has undergone rapid development since its birth, with advances in machine learning, deep

learning, and natural language processing. These technologies not only expand computational capacity but also enhance analytical capabilities in handling and processing large amounts of data. Modern AI algorithms are capable of performing tasks that were once only handled by humans, such as speech and image recognition, with ever-increasing levels of accuracy. Recent research has focused on improving the efficiency of AI models, making computing more energy-efficient and more accessible across devices.

Moreover, the evolution of AI is shaping various industries with accelerated adoption in sectors such as healthcare, automotive, finance, and manufacturing. The implementation of AI in modern computing brings fundamental changes to productivity and decision-making processes. However, research also notes the accompanying challenges, such as ethical issues, data privacy, and algorithmic biases that need to be overcome to realise the full potential of AI. The future of AI in modern computing looks promising, with research continuing to create smarter, more reliable and secure systems, in line with evolving societal and regulatory needs.

References

- Abdussamad, Z. (2022). *Qualitative Research Methods Book*. Query date: 2024-05-25 20:59:55. <https://doi.org/10.31219/osf.io/juwxn>
- Aliyu, A., Ogbuju, E., Kolajo, T., Olalekan, I., & Oladipo, F. (2023). Government regulatory policies on telehealth data protection using artificial intelligence and blockchain technology. *Artificial Intelligence and Blockchain Technology in Modern Telehealth Systems*, Query date: 2024-12-06 21:12:34, 409-439. https://doi.org/10.1049/pbhe061e_ch14
- Badawy, M. (2023). Integrating Artificial Intelligence and Big Data into Smart Healthcare Systems: A Comprehensive Review of Current Practices and Future Directions. *Artificial Intelligence Evolution*, Query date: 2024-12-06 21:12:34, 133-153. <https://doi.org/10.37256/aie.4220232980>
- Balasubramaniam, A., & Balasubramaniam, S. (2023). Artificial intelligence and blockchain technology for efficient electronic medical record management. *Artificial Intelligence and Blockchain Technology in Modern Telehealth Systems*, Query date: 2024-12-06 21:12:34, 95-117. https://doi.org/10.1049/pbhe061e_ch4
- Duymaz, Y. K., & Şahin, Ş. (2023). From Ancient Mythology to Modern Technology: The Historical Evolution of Artificial Intelligence. *European Journal of Therapeutics*, 29(4), 964-965. <https://doi.org/10.58600/eurjther1895>
- Gong, Z. (2023). Evaluation of the Application of Artificial Intelligence Technology in Computers. *2023 2nd International Conference on Data Analytics, Computing and Artificial Intelligence (ICDACAI)*, Query date: 2024-12-06 21:12:34, 114-118. <https://doi.org/10.1109/icdacai59742.2023.00027>
- Igulu, K. T., & Saturday, N. R. (2023). An overview of artificial intelligence and blockchain technology in telehealth systems. *Artificial Intelligence and Blockchain Technology in Modern Telehealth Systems*, Query date: 2024-12-06 21:12:34, 1-43. https://doi.org/10.1049/pbhe061e_ch1

- Ismail, B. M. (2021). A Modern Vision for the Applications of Artificial Intelligence and Emerging Technology in Museums and Cultural Heritage. *International Journal of Artificial Intelligence and Emerging Technology*, 4(2), 56-72. <https://doi.org/10.21608/ijaiet.2021.256804>
- Jaiswal, S., & Jaiswal, T. (2020). Remarkable Skeleton Based Human Action Recognition. *Artificial Intelligence Evolution*, Query date: 2024-12-06 21:12:34, 108-121. <https://doi.org/10.37256/aie.122020562>
- Jia, Y. (2024). Analysis of the Impact of Artificial Intelligence on Electricity Consumption. *2024 3rd International Conference on Artificial Intelligence, Internet of Things and Cloud Computing Technology (AIoTC)*, Query date: 2024-12-06 21:12:34, 57-60. <https://doi.org/10.1109/aiotc63215.2024.10748289>
- Jin, Y. (2023). Evolution of Neural Development. *Natural Computing Series*, Query date: 2024-12-06 21:12:34, 129-181. https://doi.org/10.1007/978-981-99-1854-6_5
- JUNAIDI, J. (2021). ANNOTATED QUALITATIVE RESEARCH METHODOLOGY JOHN W. CRESWELL. Query date: 2024-05-25 20:59:55. <https://doi.org/10.31237/osf.io/6kt5q>
- Kapoor, J., Kaur, I., & Kaur, G. (2023). Artificial Intelligence Technology-Embedded Learning: Rethinking Pedagogy for Digital Age. *2023 2nd International Conference on Applied Artificial Intelligence and Computing (ICAIC)*, Query date: 2024-12-06 21:12:34, 87-93. <https://doi.org/10.1109/icaaic56838.2023.10140614>
- Khan, M. S., Alshahrani, M. Y., Wahab, S., Gupta, G., & Kesharwani, P. (2024). Evolution of artificial intelligence as a modern technology in advanced cancer therapy. *Journal of Drug Delivery Science and Technology*, 98(Query date: 2024-12-06 21:12:34), 105892-105892. <https://doi.org/10.1016/j.jddst.2024.105892>
- Lang, V. (2021). Artificial Intelligence. *Digital Fluency*, Query date: 2024-12-06 21:12:34, 165-244. https://doi.org/10.1007/978-1-4842-6774-5_4
- Lauterbach, A. (2021). Cognitive Computing: Quo Vadis? *Artificial Intelligence and Computing Logic*, Query date: 2024-12-06 21:12:34, 29-50. <https://doi.org/10.1201/9781003180487-2>
- Mishra, A. (2020). Distributed Artificial Intelligence. *Distributed Artificial Intelligence*, Query date: 2024-12-06 21:12:34, 1-18. <https://doi.org/10.1201/9781003038467-1>
- Monteiro, A. C. B., França, R. P., Arthur, R., & Iano, Y. (2021). An Overview of Medical Internet of Things, Artificial Intelligence, and Cloud Computing Employed in Health Care from a Modern Panorama. *Internet of Things*, Query date: 2024-12-06 21:12:34, 3-23. https://doi.org/10.1007/978-3-030-75220-0_1
- Nourani, C. F. (2021). *Artificial Intelligence and Computing Logic*. Apple Academic Press. <https://doi.org/10.1201/9781003180487>
- Nwaneri, S. C., & Ugo, H. C. (2023). Artificial intelligence and blockchain-assisted projects and synergies for telehealth systems. *Artificial Intelligence and Blockchain Technology in Modern Telehealth Systems*, Query date: 2024-12-06 21:12:34, 155-175. https://doi.org/10.1049/pbheo61e_ch6
- Rufai, M. A., Aliyu, A., Ochepe, F. O., & Oladipo, F. O. (2023). Application of artificial intelligence and blockchain technology in telehealth systems: Innovation, technology, challenges, and prospects. *Artificial Intelligence and Blockchain Technology in Modern Telehealth Systems*, Query date: 2024-12-06 21:12:34, 471-495. https://doi.org/10.1049/pbheo61e_ch16

- Shafik, W. (2023). Artificial intelligence and Blockchain technology enabling cybersecurity in telehealth systems. *Artificial Intelligence and Blockchain Technology in Modern Telehealth Systems*, Query date: 2024-12-06 21:12:34, 285-326. https://doi.org/10.1049/pbhe061e_ch11
- Shana, J., Jayadurga, N. P., R, P. K., & R, P. (2022). JUXTAPOSITION BETWEEN TWO CONVOLUTIONAL NEURAL NETWORKS FOR MUSIC GENRE CLASSIFICATION. *YMER Digital*, 21(7), 1090-1096. <https://doi.org/10.37896/ymer21.07/89>
- Sharma, I. & Vanshika. (2022). Evolution of Neuromorphic Computing with Machine Learning and Artificial Intelligence. 2022 *IEEE 3rd Global Conference for Advancement in Technology (GCAT)*, Query date: 2024-12-06 21:12:34, 1-6. <https://doi.org/10.1109/gcat55367.2022.9971889>
- Siddiqui, Z. A., & Haroon, M. (2022). Application of artificial intelligence and machine learning in blockchain technology. *Artificial Intelligence and Machine Learning for EDGE Computing*, Query date: 2024-12-06 21:12:34, 169-185. <https://doi.org/10.1016/b978-0-12-824054-0.00001-0>
- Situ, H. (2020). Evolutionary Stable Strategies in Games with Fuzzy Payoffs. *Artificial Intelligence Evolution*, Query date: 2024-12-06 21:12:34, 63-71. <https://doi.org/10.37256/aie.122020420>
- Tang, Y., Lin, Y., Huang, X., Yao, M., Huang, Z., & Zou, X. (2020). Grand Challenges of Machine-Vision Technology in Civil Structural Health Monitoring. *Artificial Intelligence Evolution*, Query date: 2024-12-06 21:12:34, 8-16. <https://doi.org/10.37256/aie.112020250>
- Wang, S. (2022). The Influence of the Sustainable Evolution of Artificial Intelligence Technology (AIT) on the Blossom of the Intelligent Technology Industry (IT). 2022 *International Conference on Artificial Intelligence in Everything (AIE)*, Query date: 2024-12-06 21:12:34, 271-275. <https://doi.org/10.1109/aie57029.2022.00058>
- Wekke, I. S. (2020). *Qualitative Research Design*. Query date: 2024-05-25 20:59:55. <https://doi.org/10.31219/osf.io/4q8pz>
- Zhou, S. (2024). Future Development of Information Management Systems Based on Big Data Technology, Artificial Intelligence Technology and Cloud Computing. *Proceedings of the 1st International Conference on Engineering Management, Information Technology and Intelligence*, Query date: 2024-12-06 21:12:34, 742-746. <https://doi.org/10.5220/0012972100004508>
- Zhu, R., Feng, Z., & Chen, Q. (2022). Evolution of International Security Specifications for Artificial Intelligence. 2022 *International Conference on Information System, Computing and Educational Technology (ICISCET)*, Query date: 2024-12-06 21:12:34, 217-222. <https://doi.org/10.1109/iciscet56785.2022.00060>