OntarioTech
MITCH AND LESLIE FRAZER
Faculty of Education

Artificial Intelligence and Education: A Primer

Chris D. Craig & Robin Kay

Have you ever been curious about how we think and learn? It is a timeless question that led to the development of Artificial Intelligence (AI) through science and engineering research following World War II (McCarthy, 2007; Russell & Norvig, 2010). Building from earlier works of classical scholars such as Thomas Bayes, Charles Babbage, and Nikola Tesla—who respectively contributed Bayesian inference, the analytical engine, and the concept of a machine's *own mind*—Alan Turing exerted notable influence in the early development of AI when he reenvisioned the question into: *Can machines think?* (Meacham, 2021; Russell & Norvig, 2010; Tesla, 1900; Turing, 1950).

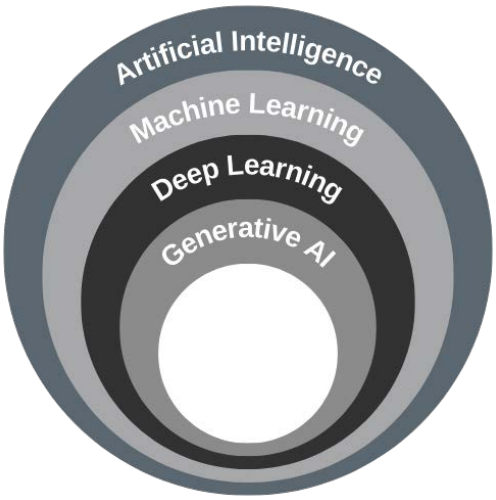
Soon after, in 1956, John McCarthy was credited with providing the general definition of AI, and while others exist, it is often referenced (Russell & Norvig, 2010). Where *intelligence* refers to the computational aspect of goal achievement, McCarthy (2007) defines AI as:

> The science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. (p. 2)

The following 70 years have seen AI become an embedded part of everyday life. For example, an AI tool entitled "Mal" was recently used in the development of a new Beatles song [video], and we encounter it regularly through financial services, healthcare, video games, chatbots, online recommendations, security technologies, and email (Kennedy et al., 2023; Russell & Norvig, 2010; Savage, 2023; Sullivan, 2023). The increased diffusion comes with various AI subsets (Figure 1). One notable aspect is *machine learning*, which uses statistical methods to improve outputs and goals—for example, viewing recommendations on Netflix—with increasing accuracy (Aggarwal et al., 2022; Manning, 2020; Sajja, 2021). Within machine learning, *neural networks* refer to using interconnected nodes inspired by human neurons to classify and cluster information (Aggarwal et al., 2022; Manning, 2020; Sajja, 2021). As a subset of machine learning, *deep learning* uses hierarchical neural network layers to model data such as facial recognition in a manner inspired by the human brain (Aggarwal et al., 2022; Manning, 2020; Sajja, 2021). Generative AI is another subset that has received a lot of recent media attention (e.g., OpenAI's Chat GPT or Google's Gemini) and is a subset of deep learning which creates digital relics through the influence of pre-existing artifacts to create audio, images, text, and video (Baidoo-Anu & Ansah, 2023; SAS Institute, n.d.). Other common examples include *Expert Systems, Natural Learning Processes,* and *Machine Vision* (Collins et al., 2021). For a more complete exploration of the evolution and integration of AI into our everyday lives, review Shadbolts' (2022) article "From So Simple a Beginning": Species of Artificial Intelligence.

Figure 1

Nested AI Subsets



Note: *Adapted from Aggarwal et al., 2022; Manning, 2020; and Sajja, 2021.*

Recognizing that AI's underlying processes and classifications are technical, diverse, and often challenging to classify, two generally referenced types include *narrow* and *general* (Aggarwal et al., 2022; Wang, 2019). Narrow AI refers to our common systems with a singular high-proficiency task focus, such as autonomous vehicles or digital assistants (Aggarwal et al., 2022; Manning, 2020). Next, General AI is a concept that refers to systems with context awareness modelled after a human's ability to adapt to diverse situations (Sajja, 2021). While General AI is not yet a reality, an example of a technology approaching general intelligence is OpenAI's ChatGPT (Wu et al., 2023).

Artificial Intelligence in Education

As AI is now a part of many aspects of our society, our formal education systems seek to integrate technology to support diverse stakeholders such as administrators, teachers, and students. Intending to foster adaptive and interactive learning environments, the cross-disciplinary research of Artificial Intelligence in Education involves psychology, computer science, and education (Doroudi, 2022). Additionally, the cross-disciplinary approach seeks to support learning by offering computationally precise and explicit knowledge to encourage learners to gain a deep and finely tuned understanding of the learning process and their learning (Luckin et al., 2016). While educational structures constantly face challenges due to emergent digital technologies (e.g., the calculator, computers, the internet, and cell phones), AI provides a unique opportunity to personalize learning and reinvent our modern structures to address pervasive myths and challenges that limit student learning.

As the new AI affordances continue to grow, reflecting on its potential role as an educational tool can also be helpful. To help outline the different roles, Ouyang and Jiao (2021) conducted a systematic summary, which resulted in three paradigms:

- **AI-directed** refers to the learner-as-recipient and involves AI being used to direct cognitive learning;
- **AI-supported** considers the learner as a collaborator with an instrument's AI components; and
- **AI-empowered** positions the learner as a leader in the interaction.

References

Aggarwal, K., Mijwil, M. M., Al-Mistarehi, A. H., Alomari, S., Gök, M., Alaabdin, A. M. Z., & Abdulrhman, S. H. (2022). Has the future started? The current growth of artificial intelligence, machine learning, and deep learning. *Iraqi Journal for Computer Science and Mathematics*, *3*(1), 115-123. https://doi.org/10.52866/ijcsm.2022.01.01.013

Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI*, *7*(1), 52-62. https://doi.org/10.61969/jai.1337500

Collins, C., Dennehy, D., Conboy, K., & Mikalef, P. (2021). Artificial intelligence in information systems research: A systematic literature review and research agenda. *International Journal of Information Management*, *60*, Article 102383. https://doi.org/10.1016/j.ijinfomgt.2021.102383

Doroudi, S. (2022). The intertwined histories of artificial intelligence and education. *International Journal of Artificial Intelligence in Education*, 1-44. https://doi.org/10.1007/s40593-022-00313-2

Kennedy, B., Tyson, A., & Saks, E. (2023, February 15). *Public awareness of artificial intelligence in everyday activities*. Pew Research Center. https://www.pewresearch.org/science/2023/02/15/public-awareness-of-artificial-intelligence-in-everyday-activities/

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson. https://oro.open.ac.uk/50104/

McCarthy, J. (2007, November 12). *What is artificial intelligence?* Stanford University: Project JMC. https://www-formal.stanford.edu/jmc/whatisai.pdf

Manning, C. (2020, August). *Artificial intelligence definitions*. Stanford University: Human-Centered Artificial Intelligence. https://hai.stanford.edu/sites/default/files/2020-09/AI-Definitions-HAI.pdf

Meacham, M. (2021). A brief history of AI and education. *International Journal of Adult and Non Formal Education*, *2*(4), 1-2. https://www.globalscienceresearchjournals.org/articles/a-brief-history-of-ai-and-education.pdf

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence*, *2*, 100020. https://doi.org/10.1016/j.caeai.2021.100020

Russell, S. J., & Norvig, P. (2010). *Artificial intelligence: A modern approach* (3d ed.). Prentice Hall.

Sajja, P. S. (2021). Introduction to artificial intelligence. In, *Illustrated computational intelligence: Examples and applications* (pp. 1-25). Springer Singapore. https://doi.org/10.1007/978-981-15-9589-9_1

SAS Institute. (n.d.). *Artificial intelligence: What it is and why it matters*. Retrieved March 2023 from https://www.sas.com/en_ca/insights/analytics/what-is-artificial-intelligence.html

Savage, M. (2023, June 13). *Sir Paul McCartney says artificial intelligence has enabled a 'final' Beatles song*. BBC News. https://www.bbc.com/news/entertainment-arts-65881813

Sullivan, W. (2023, November 3). *The Beatles release their last song, 'Now and Then,' featuring A.I.-extracted vocals from John Lennon. Smithsonian Magazine*. Retrieved March, 2024 from https://www.smithsonianmag.com/smart-news/the-beatles-release-their-last-song-now-and-then-ai-john-lennon-180983188/

Shadbolt, N. (2022). "From So Simple a Beginning": Species of Artificial Intelligence. *Daedalus*, *151*(2), 28-42. https://www.amacad.org/publication/so-simple-beginning-species-artificial-intelligence

Tesla, N. (1900, June 01). The problem of increasing human energy. *Century Magazine*, 175-211. https://archive.org/details/problemofincreas0000tesl/mode/2up

Wu, T., He, S., Liu, J., Sun, S., Liu, K., Han, Q. L., & Tang, Y. (2023). A brief overview of ChatGPT: The history, status quo, and potential future development. *IEEE/CAA Journal of Automatica Sinica*, *10*(5), 1122-1136. https://doi.org/10.1109/JAS.2023.123618