Research Essay

Artificial Intelligence in the Context of Healthcare Applications in the Built Environment: Utop-ai or Dystop-ai?

Tor Alexander Bruce*

Northumbria University Newcastle, UK

Abstract

Artificial Intelligence (AI) is a common term, born in the wake of cybernetics. Used in a discursive or practical, applied sense in engineering science, it is a vast and expanding research discipline or field. In the context of research creating digitally-based AI-informed systems in the built environment for mental healthcare, this paper seeks to understand what benefit AI is currently contributing or might bring to recent concepts, within a society seeking alternative options to conventional treatments and a world where the study of human cognition has entered ambitious new territory. This paper combines with ongoing empirical research linked to four architectural-based and product innovations in digital mental healthcare: These have formed and are forming studies engaging hundreds of participants. AI could have critical relevance as applied to each example. As an analytical research paper a question asked is: *To what purpose could AI apply to the recent concepts and is this required to support human progress*? This paper concludes that whether AI is included in or excluded from the human domain should never become a decision of the technology itself, but for humans to determine whether a state of equilibrium can be achieved for lives within a reality seemingly out of balance.

Keywords: Artificial intelligence, built environment, mental healthcare; HCI, digital interventions, Koyaanisqatsi.

We can only see a short distance ahead, but we can see plenty there that needs to be done

Alan Turing

Digital frontiers

Somewhere, someone on the planet is discussing, reading about, working on or experiencing Artificial Intelligence (AI) first hand. This is interesting to consider, because at no other junction in history, not so much as a century ago, has it become possible for such a reach to be permitted, in terms of who has access to information and communication technology and where they are situated. A vast portion of the world, it could be said, is attuned or tuning in and in future it may become impossible no matter where one lives, to not be, linked, in some way – something akin to Tron's[1] "grid" – a digital frontier. Information exchanging, communication-sharing and

*Correspondence author: Dr. Tor Alexander Bruce, PhD, MRes, Cert. Ed. AFHEA,Northumbria University Newcastle, UK.
E-mail: toralexanderbruce@gmail.com

[1]TRON is a 1982 American science fiction movie

technological tinkering has potential to bring people together, but also to drive people, as well as nations, apart.

Human beings in Ancient Greece are accredited the design of the oldest known example of an analogue computer, the Antikythera Mechanism, more than 2200 years ago, believed to calculate astronomical events at a time when positioning of stars and planets held vital significance for what took place on the ground or in the seas. This device was an early tool, an example of a technology some individuals at this historical juncture felt was required.

By the 19th century, Charles Babbage was credited with having first conceived an automatic digital computer (*Difference Engine, Difference Engine 2, Analytical Engine*); then, in the 20th century, Konrad Zuse developed the *Z1*, a mechanical calculator and the *Z2*, an electromechanical computer. This was followed by Alan Turing's *Colossus*, he being considered as the man who invented computer science - both John Von Nuemann and Turing formalized the architecture of modern-day computers as a universal machine.

Francois Gernelle invented the Micral N, as the world's first personal computer in 1973 and the first portable computer complete with carry case was the IBM 5100 in 1975. The first lap-top was the Epson HX-20 launched in Japan in 1981.

Artificial intelligence

As computers have become more sophisticated and the interest in them more expansive – together with a rise in global population since 1973 from an estimated 4 billion to 8 billion plus within 50 years - the ability of machines to perform and multi-task has somewhat developed. This is timely in certain cases, for example where dismantling beached ships in Bangladesh can lead to fatalities, computerised, mechanical arms can achieve this on their own – although albeit programmed and serviceable, by humans. Humanoid robots designed for working in warehouses are also intended for delivery, by the year 2025 (Kingston, 2023) with many more examples ~~are~~ being developed for work in logistics and other industries.

AI relates to the intelligence of machines or software and may also refer to the machines themselves. The acronym AI could be attributed to Jon McCarthy of Massachusetts Institute of Technology (MIT), as one of the founders of AI as a discipline who writes: '*It is 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 […] My own opinion is that the computers of 30 years ago were fast enough if only we knew how to program them […] There are two main lines of research. One is biological, based on the idea that since humans are intelligent, AI should study humans and imitate their psychology or physiology. The other is phenomenal, based on studying and formalizing common sense facts about the world and the problems that the world presents to the achievement of goals […] It is a race, but both racers seem to be walking'* (McCarthy, 2007: p.2-12).

If each racer is walking, they are currently gathering pace. Andresen suggests that if John McCarthy were to coin a new phrase for AI today he might use "*computational intelligence*" describing McCarthy's research involving elaboration tolerance, creativity by machines, free will

of machines, as well as improving ways of attempting situation calculus (Andresen, 2002: 0.84-85). Computers are unarguably becoming more intelligent, but at the start of this journey, human beings in their current form – not replaced by cyborg for now – are continuing to engage in the thinking. A question emerges whether it couldn't forever be a case that humans and machines would exist and progress together in a "Utopai". Or, where in a world some may regard as being politically void of morals and ethics, it could be assumed that future AI would only mirror this outlook. Here, in the hands of human, humanoid or any other variable construct, systems would seek a repeat of the trajectory humankind has set on course, towards an annihilation of anything that stands in the name of its own progress at a cost of whatever else; most certainly a Dysopai in terms of what could become manifest upon Earth's landscape by result. However, similar to nuclear energy and weighing its pros and cons, outcomes depend on whose hands the technology is in and how they envision its purpose. Threats also arising include privacy and security risks, displacement of jobs across different industries (in a growing population); power, e.g. via corporation or country; technology in the hands of those who use it from a military perspective – although any type of advancement including biological warfare could be equally considered a threat.

Biological and Phenomenal AI

In the past ten years AI has seen breakthroughs and these can be classified, from everyday smart household devices through to gadgets through to social media, an example being when a sentence is typed, appearing on a computer screen and an invisible force predicts the next word-choice the user may or may not require. It would seem there's no real AI- issue here, at a basic level where tools, similar to Antiktthera Mechanism, are harnessed to assist and support the endless quest of human progress. As examples, in the healthcare sector, AI has been applied in various ways including health service management, patient data and diagnostics and predictive medicine (Wen Loh et al., 2022). Two types of AI is commonly used in healthcare application: machine learning (ML), performing tasks in recognising relationships in data and Deep Learning (DL) containing an input, output and intermediate hidden layers (Mirza et al. 2019). Zhou et al. describe that in the past decade a rapid development of AI has been witnessed, including: self-learning and self-coding algorithms, recurrent neural networks (RNN) algorithms, reinforcement learning, pre-trained models and other deep learning algorithms. These researchers suggest that the artificial brain is the pathway to Artificial General Intelligence (AGI) – also known as Strong AI, whereby unlike traditional and machine-learning approaches which attempt to mimic biological brain function, building an electronic brain is more straightforward and could generate similar functionality (Zhou et al.).

Strong Artificial Intelligence

Strong AI, also known as artificial general intelligence or its acronym AGI, has an aim of imagining, prototyping and trialling intelligent machines, ones that can perform intelligent, human level tasks; displaying qualities such as being innovative or logical of its own accord, similar to a human. Zhang, Zhu and Su discuss third generation AI, where machines have ability to interpret (or the opposite). These authors discuss the formulation of human behaviour in a

context of maximising use of brain-like working mechanisms when developing AI - abstractly portrayed in Figure 1:

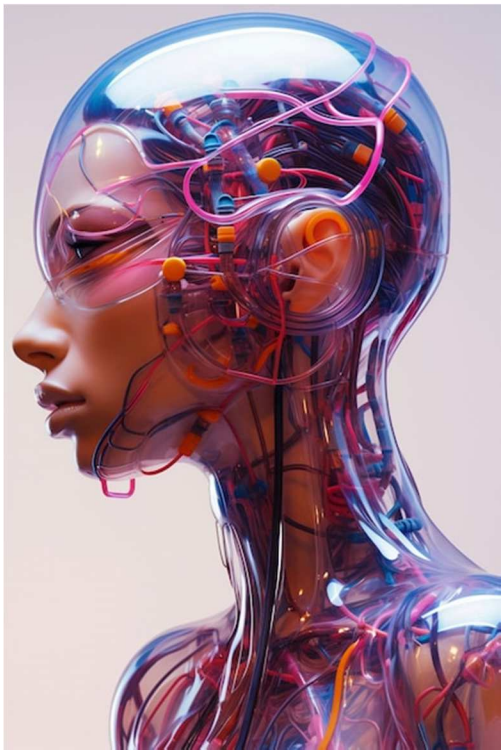

Figure 1: Abstract Human (Freepik)

This paper also describes a new stage in symbolic AI when, in 1997, an IBM-designed large-scale AI system called *Deep Blue* defeated a world chess champion (Zhang Zhu, Su, 2023). This was constructed of general-purpose supercomputer processors with chess-accelerator chips, the most advanced version searching up to 200 million moves per second. From these early wins for AI machine-learning, algorithms in more advanced systems were developed, performing tasks such as machine vision and recognition of speech patterns. IBM still ranks in the world's most advanced AI systems.

Deep Learning

Deep Learning, as a form of machine learning, is a machine learning technique programming computers to learn by example, in a similar way to humans. The word deep refers to the number of hidden layers in the systems neural network, where conventionally these might contain only a few. In machine learning a person will manually identify features and a classifier to arrange images, whereas with deep learning, both the extraction of features as well as the next steps are automatic. Table 1 shows the relational elements:

Table 1: AI, ML, DL

Artificial Intelligence A technique enabling computers to mimic human behaviour
Machine Learning A subset of AI using statistical models and algorithms, permitting machines to improve with experiences
Deep Learning A subset of Machine Learning where multi-layer neural networks are manifest

Deep Learning has potential to boost the capability of, for example, robots, where they become able to process complex data and recognise patterns. Mouha talks about the sheer world of diversity encountered in real-world settings, where robots face challenges as they attempt a shift from the lab (Mouha, 2021), whereas other scholars describe AI, ML and DL in their review as having revolutionized the field of advanced robotics where current technologies are being used in the design and development of "cobots", as collaborative robots that function alongside human beings and have potential to adapt to changing tasks and environments (Soori, Arezoo, Dastres, 2023).

Human annihilation, upgraded human or seeking balance

A study that set out to clarify what probability exists for high level machine intellect, risks and the speed of development, highlights a one in two chance of high-level machine intelligence by 2040-50, rising to nine in ten by 2075 – (Muller, Bostrom, 2016). Further research involving one of the same authors was designed to provoke serious philosophical discussion, concluding that the main issue a human population will actually face is an AI that can cause significant damage, if badly used (Muller, Cannon, 2021).

Technology in its pro-state can be defined as the recognition by any life form of developing something assistive to their or its being. A spider forms its web; a sea-creature mimics its surroundings via change in colour; a tree communicates via its root system; a human-initiated friction between stick and stone generates fire. Abstractly, in a future blended with the current now and its past, an awareness exists where people no longer conceptualise of such epochs, all being one force of continuum, repeating until the Sun engulfs tiny planet Earth. Inbetween, choices exist where nations can embrace whatever technology they choose, for example, to rise exploratively through space,or to raze its billions of years of nature-born evolution to the ground. The choice, as humans have now become what their ego could describe as God, is their own.

In the end, at the very point where all will become a hopeless yet worthwhile task of survival against even greater inhospitable climates than humanity is facing now, it won't matter. What

could be supportive, is the observing of a global pause, where the pathway opted for in a current light permits future generations to experience nothing less than Utopic. But as this would seem only to exist in science fiction, not in fact, there are ethical considerations surrounding what could lead to an advancement or a demise. Whether humanity as a race, as a species, adopt and adapt AI toward a purpose of good versus whatever else, will determine its prolonged or abruptly cut short, recognisable status. Here, tools held in the right or wrong hands will determine whether those with power act reasonably, or as monsters, or Gods. As Tegmark asserts: '*We're the guardians of the future of life now as we shape the age of AI*' (Tegmark, 2017: p.335). This AI business is obviously, on some reaches of the scale, serious stuff.

Conscious, Artificial

In the movie Star Wars, a droid named C-3PO, a part-cobot by modern terms, accompanies a human, Luke Skywalker and his comrades. C-3PO, unlike his buddy R2-D2 who communicates via analogue sounds, is voiced by an English Actor and is very well articulated. In the movie, C-3PO was a golden shell with a human playing the role inside, as an actor. By contrast, no trace of human exists inside a true to life AI robot, where its entire circuitry is formed by engineered parts. A project that began in Switzerland in 2005 called Blue Brain, set out with goals to identify brain anatomy and function, using biological reconstructions of a mammalian brain (Sharma et al. 2014).

Fregnac describes a recent trend toward industrialization of brain exploration and the prowess of AI algorithms, revealing that future facilities will be developed with a purpose of building brain models (Fregnac, 2021). Further authors suggest that AI researchers and neuroscientists need to align in a multidisciplinary way to achieve biologically constrained AI with human-like capabilities (Jorgen Hole, Ahmad, 2021). What emerges from this is insight that these developments are unfolding and gathering momentum towards something real – researchers being active here and not stood still.

An already artificial reality?

As a labelled *human*, I am sat today at a workstation consisting three HP screens, one being a laptop, my fingers attached to and tapping away at a keyboard. I ate air-fried chicken yesterday evening, its meat being mechanically pulped in a factory and purchased via a cashier-less Asda-supermarket checkout. I voice-Whatsapped a message and then face-timed a friend who was receiving a Deliveroo via a young man powered through the city streets via an electric E-wheel or unicycle. Her kids were upstairs, one fishing for sharks in a Holo-lens virtual reality and the other flicking through Spotify with Netflix playing in the background. After speaking, I commanded the lights in the room to dim and after viewing UFC-highlights via an iPhone, I slept.

In recent months, as an interdisciplinary researcher in the fields of HCI and Life Sciences, I have considered concepts perhaps already in the making: a solar-powered, talking net, with ability to monitor suicidal behaviour on bridges and keep people calm until the authorities arrive; a

gauntlet-type attachment to my left forearm, so anything I require as hands-free, including heating hot water, can be mounted, rather than hand-held and where this is driven completely via voice activation. Such innovations could preserve human life in the first instance and act as convenience tools in the latter. Robot-friends for the lonely; AI support in arid regions to let hikers know of available water sources. Concepts will continue as long as there are thinkers and this may be how to view AI, as an extension of a human-requirement to continue to innovate. How far it reaches is up to the creator, but how about if, taken too far, human beings no longer have any requirement to think for themselves? Is this the next intended evolutionary state the species is destined towards of its own making, ego journeying to an unretractable extreme?

AI replacing human in mental healthcare

A comprehensive literature search of reviews and articles published between 2017-22 highlight a disrupting of mental healthcare via applications and computational psychiatry, yet the use of AI up until now has been comparatively (compared to, e.g. oncology and radiology) modest and remains at a preliminary stage, hampered by lack of large, high quality heterogeneous data sets. Because mental health challenges can be influenced by socio-environmental and biological determinants, non-exclusively, both diagnoses and treatments are largely reliant on a clinician-patient relationship. However, despite challenges, AI stands to benefit mental healthcare, through such applications as pattern-recognition techniques; streamlining clinical workflow(Jin et al. 2020) with Figure 2 showing potential applications.

Other studies describe challenges linked to a technology-distant state of clinical practice, modelling and implementation being largely disconnected (Koutsouleris, 2022) - an earlier review discussing both the promise and pitfalls of AI in mental healthcare (Graham et al., 2019). The World Health Organization (WHO) suggests the leveraging of digital transformations to reimagine future health systems, as part of an innovation agenda to improve patient pathways and care delivery. The term digital health expands the e-Health concept and includes the growing role of mobile devices, telehealth, big data and AI (WHO, 2022; 2023). Researchers describe AI having been used for decades in mental healthcare, where AI Mental Health Apps (MHapps) and chatbots offer a place to access tools and a discussion forum but should not be regarded as a clinical replacement for a therapist (Gamble, 2020).

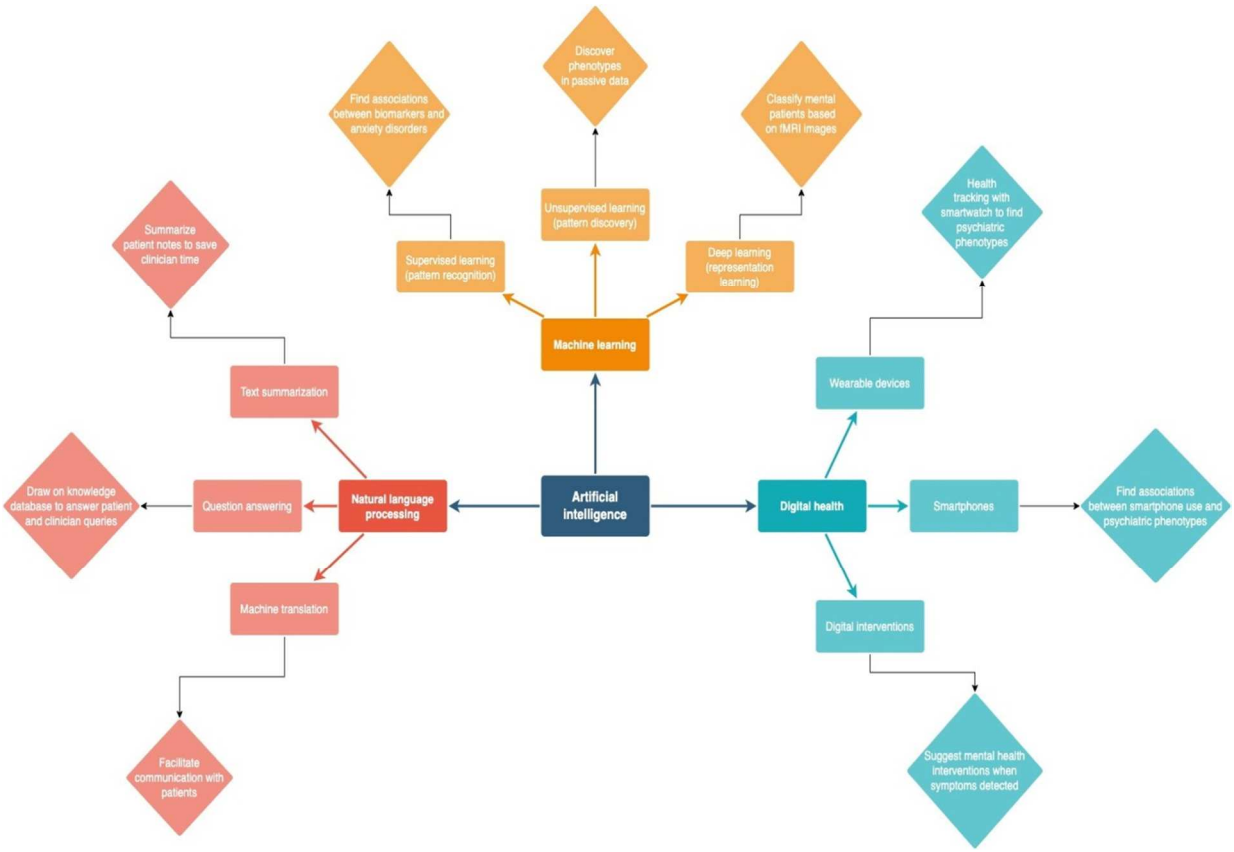

Figure 2: AI technologies and their potential applications in mental healthcare (Accessible via: Jin et al.)

Achieving a general AI

Artificial General AI (AGI), as pre-described, refers to a type of AI possessing human-like cognitive abilities, including a capacity to understand, learn, apply knowledge, communicate, plan and perform tasks without being specifically programmed to do so. This could lead to machines that can act with human-like versatility. However, according to some researchers, if AI is to ever achieve general AI it would need to shift from the '*Flatland*' of a 2D reality '*to a tera-dimensional space that represents the million billion synapses between the neurons in the cortex of the human brain*' (Barthomelew, 2020).

Similarly, Spivack et al. describe how failure of AI tools such as chatbots powered by large language models in addressing complex knowledge tasks, is because they do not and cannot perform any actual cognition (Spivack et al., 2024). This all ties into real world application and user-needs, to support a rise of AI from minority to a majority status, in such a regard as to be positioned higher than humans.

Application of AI to recent concepts

Since 2018 I have become involved in the design and driving of proof-of-concept innovations, each at varying stages of being trialled and implemented as additions to real-world clinical practice, or as support tools. Whether these could adopt AI is straightforward to answer, because they could. In addition, as a response to whether this might then advance human understanding of people themselves, as part of the therapeutic intervention procedure, as users of these systems or products, the answer remains affirmative. Specifically, each innovation I have worked on links to supporting people who have faced levels of human trauma to make sense of their situation, using interactive devices to achieve this. What has also become apparent through the design stages, is that by involving the built environment purposely, this supports a human requirement to make sense of where they have been, where they are and where they want to go. In total, these concepts include a digital therapeutic intervention located in an Extended Reality (XR) setting: The Timeline – Figure 3. Also: The Intuitive Jacket, The WISE Room and The Reflection Chair – Figures 4, 5, 6. I am also constructing a funding proposal of approximately £650k linked to the application of a range of multi-media technology in a context of reducing bridge-related suicide, currently based in the UK.

Figure 3: The Timeline

Figure 4: The Intuitive Jacket

Figure 5: The WISE Room

Figure 6: The Reflection Chair

Questions that have arisen when considering implementing or attaching machine learning or robots capable of performing with almost human-ability in support of these concepts is this: Do these systems require AI to support what has so far been a human task of sense making in a human-constructed reality? Or will we, by adding an artificial layer, reduce a human task to none at all, similar to generative AI where the task is hurried along with less human involvement?

The ramifications of additional layers are already evident via the sheer level of resources required to permit this additional layer to function: energy consumption, producing hardware, storage of data, emissions, algorithmic bias – where we could ask whether we are mining so deep the ground will be removed from beneath us? However, parallel to one argument is a reality that AI also has the potential to contribute to environmental sustainability optimization, climate modelling, renewable energy, management of resources. The impact of AI and weighing pros and cons is a complex issue.

Conclusion

This analytical paper was constructed by a curious individual who senses they are stood at a very vivid intersection upon humanity's timeline. Here, human beings who have achieved a population of eight billion and rising, are seeking to adapt to their surroundings and, with varying descriptions of technologies from the seemingly most basic through to advanced, acknowledge their place, bringing as much or as little comfort to their lives as intended. They are vying for positions of stability in ways that see them not only engaged in a survival of the fittest and being adaptable, but at a point where geographical positioning on the planet is key, especially where war and hostility is rife. Some appear to achieve a great deal in living and leading a flourishing life with very little, while others require a lot – with levels of consumption of resources evident through this comparison.

Perhaps a question as to whether AI is good or bad for a global community, supportive or not to its people and environment, might lead to Utop-ai or Dystop-ai – should never become one that's answerable through technology because it exists. By powering down all systems, humanity could seek to identify whether a reality containing the so many additional layers it has accomplished, will be worthy for long term prospects or only to profit infatuations in the immediate. These are gargantuan questions and possibly have no human-level resolve as a species experiencing its current evolutionary form of intellect.

To end, the word *balance* may be of value and, seemingly without head-brain thinking, another arrives prominently, as though through senses; as gifted by the Hopi Indians: *Koyaanisqatsi*[2]. But who could ever imagine that an unconventionally educated tribal people, even with their rich culture and instilled spiritual beliefs, transcended to such a point of predictive learning and emotionally astute Human Intelligence (HI), surviving by themselves for thousands of years, without any support of AI whatsoever? If we are only moving closer to a world out of order, as they observed, should we be asking AI for the answer and mining in this direction, or journeying deeper into ourselves?

Received April 8, 2024; Accepted May 18, 2024

References

Andresen, S.L.(2002) John McCarthy: father of AI. IEEE Intelligent Systems, Volume 17, Issue 5. Online: https://ieeexplore.ieee.org/document/1039837/authors#authors

Bartholomew, Bradley, Y. (2020) Why AI Will Never Surpass Human Intelligence. Journal of Consciousness Exploration and Research, Volume 11, Issue 3, pp.281-290. https://www.jcer.com/index.php/jcj/article/view/879/883

Fregnac, Yves (2021) How Blue is the Sky? History, Teaching and Public Awareness. Online: https://www.eneuro.org/content/eneuro/8/2/ENEURO.0130-21.2021.full.pdf

[2]According to Hopi Dictionary: HopiikwaLavaytutuveni, the prefix koyaanis means "corrupted" or "chaotic", and the word qatsi means "life" or "existence", literally translating Koyaanisqatsi as "chaotic life"

Gamble, Alyson (2020) Artificial intelligence and mobile apps for mental healthcare: a social informatics perspective. Aslib Journal of Information Management. Online: https://www.emerald.com/insight/content/doi/10.1108/AJIM-11-2019-0316/full/html

Jin, Kevin, W., Qiwei, Li, Xie, Yang, Xiao, Guanghua (2023) Artificial intelligence in mental healthcare: an overview and future perspectives. The British Journal of Radiology. Online: https://www.birpublications.org/doi/epub/10.1259/bjr.20230213

Jorgen Hole, Kjell, Ahmad, Subutai (2021) A thousand brains: toward biologically constrained AI. SN Applied Sciences. Online: https://link.springer.com/article/10.1007/s42452-021-04715-0

Kingston, Jennifer, A. (2023) Humanoid robots are coming to a warehouse near you. Axios. Online: https://www.axios.com/2023/03/29/robots-workers-humanoid-warehouse-amazon

Koutsouleris, Nikolaos, Hauser, Tobias, U., Skvortsova, Vasilisa (2022) From promise to practice: towards the realisation of AI-informed mental health care. Online: https://www.thelancet.com/action/showPdf?pii=S2589-7500%2822%2900153-4

Lee, J. G., Jun, S., Cho, Y. W., Lee, H., Kim, G. B., Seo, J. B., & Kim, N. (2017). Deep learning in medical imaging: general overview. *Korean journal of radiology*, *18*(4), 570-584. Online: DOI: https://doi.org/10.3348/kjr.2017.18.4.570

Mirza, B.; Wang, W.; Wang, J.; Choi, H.; Chung, N.C.; Ping, P. (2019) Machine Learning and Integrative Analysis of Biomedical Big Data. *Genes*, *10*, 87. https://doi.org/10.3390/genes10020087

McCarthy, J. (2007) What Is Artificial Intelligence. Online: https://www-formal.stanford.edu/jmc/whatisai.pdf

Mouha, A. Radouan (2021) Deep Learning for Robotics. Journal of Data Analysis and Information Processing, Volume 9, Number 2. Online: https://www.scirp.org/journal/paperinformation.aspx?paperid=108571

Muller, Vincent, C., Bostrom, Nick (2014) Future Progress in Artificial Intelligence: A Survey of Expert Opinion. Online: https://philpapers.org/archive/MLLFPI.pdf?utm_source=baytoday.ca&utm_campaign=baytoday.ca&utm_medium=referral

Muller, Vincent, C., Cannon, Michael (2021) Existential risk from AI and orthogonality: Can we have it both ways? Ratio. Volume 35, Issue 1. Online: https://onlinelibrary.wiley.com/doi/10.1111/rati.12320

Sharma, Swati, Payal, Nitisha, Kaushik, Ankur, Goes, Nitin (2014) Blue Brain Technology: A Subway to Artificial Intelligence. IEEE Xplore. Online: https://ieeexplore.ieee.org/abstract/document/6821571

Soori, Mohsen, Arezoo, Behrooz, Dastres, Roza (2023) Artificial intelligence, machine learning and deep learning in advanced robotics, a review. Cognitive Robotics, Volume 3. Online: https://www.sciencedirect.com/science/article/pii/S2667241323000113

Spivack, Nova, Douglas, Sam, Crames, Michelle, Connors, Tim (2024) Cognition is All You Need – The Next Layer of AI Above Large Language Models (Pre-Publication Position Paper). https://arxiv.org/ftp/arxiv/papers/2403/2403.02164.pdf

Tegmark, Max (2017) Life 3.0. Being human in the age of Artificial Intelligence. Penguin, Random House, UK

Wen Loh, H.,O. Chui Ping, Seoni, S.DattaBarua, P. Molinari, F., U Rajendra, A. (2022)Application of explainable artificial intelligence for healthcare: A systematic review of the last decade (2011–2022), Computer Methods and Programs in Biomedicine,Volume 226. Online: https://www.sciencedirect.com/science/article/pii/S0169260722005429#bib0011

World Health Organization (2022) Regional digital health action plan for the WHO European Region 2023-2030. Online: https://iris.who.int/bitstream/handle/10665/360950/72wd05e-DigitalHealth-220529.pdf?sequence=2

World Health Organization (2023) The ongoing journey to commitment and transformation. Digital health in the WHO European Region 2023. Online: https://cdn.who.int/media/docs/librariesprovider2/data-and-evidence/english-ddh-260823_7amcet.pdf?sfvrsn=4c674522_2&download=true

Zhang, Bo, Zhu, Jun, Su, Hang (2023) Toward the third generation artificial intelligence. Science China. Information Sciences, Volume 66. Online: http://scis.scichina.com/en/2023/121101.pdf

Zhou Shao, Ruoyan Zhao, Sha Yuan, Ming Ding, Yongli Wang (2022)Tracing the evolution of AI in the past decade and forecasting the emerging trends,Expert Systems with Applications,Volume 209. Online: https://www.sciencedirect.com/science/article/pii/S0957417422013732