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Artificial Intelligence as a Continuum: The Three Levels of Artificial Intelligence Towards a Basic Understanding of Key Terms

Background:
The FMRAC Working Group on Artificial Intelligence and the Practice of Medicine used the following working definition of artificial intelligence (AI) for its Fall 2019 national and international survey of medical and other professional regulatory bodies:

"A machine's ability to mimic the cognitive functions of the human mind." – Source: Duke-Margolis Center for Health Policy

At its January 2020 meeting, the Working Group received a report on feedback from the aforementioned survey which included various definitions of AI that had been adopted or were being considered for use by respondent organizations – please refer to Appendix 1. While bodies such as the World Medical Association have provided definitions of both artificial and augmented intelligence, neither Health Canada nor the International Medical Device Regulatory Forum (IMDRF) have officially adopted terms to date.

Current Situation:

As part of its mandate, the FMRAC Working Group on AI and the Practice of Medicine aims to achieve a common understanding of artificial intelligence as a foundation for its work and its communications with others. To this end, it is proposed that the following definitions and descriptions of three levels of AI, also known as the continuum of AI, be adopted by the Working Group for working purposes at this time.

The Three Levels of AI[i] [adapted from source]:

The continuum of human-machine intelligence generally varies by degree of control and decision-making:

i. Assisted Intelligence
Machines are basically repeating or improving the tasks that humans are already doing … so machines are doing the action, but humans have the control and decision.

Considered the most basic level of AI, **assisted intelligence** is primarily used as a means of automating simple processes mundane tasks. Requiring constant human input and intervention, assisted intelligence only works with clearly defined inputs and outputs. The main goal of assisted intelligence is improving things people and organizations are already doing — so, while the AI can alert a human about a situation, it leaves the final decision in the hands of end users. The exception would be those cases in which a predetermined action has been clearly defined.

ii. Augmented Intelligence

Machines that enable humans to do more (and different) things than they are currently capable of doing … so machines are doing the action but there's collaborative human-machine decision-making. Augmented intelligence enhances human intelligence.

This cognitive technology is designed to enhance, rather than replace, human intelligence. This "second-tier" AI is often what people consider when discussing the overall concept in general, with machine learning capabilities layered over existing systems to augment human capabilities. Augmented intelligence allows organizations and people to do things they couldn't otherwise do by supporting human decisions, not by simulating independent intelligence. Among the models included under this umbrella are machine learning, natural language processing, complex image recognition aiding differential diagnosis and neural networks.

The main difference between assisted and augmented intelligence is that augmented intelligence can combine existing data and information to suggest new solutions rather than simply identifying patterns and applying predetermined solutions. Thanks to deep learning capabilities and continuous training, augmented intelligence machines are able to make better and faster decisions than humans, which can be especially helpful in time-sensitive applications.

iii. ***Autonomous Intelligence***

Machines that fully accomplish tasks on their own without human intervention … so machines are making both the actions and decisions.

The most advanced form of AI is autonomous intelligence, in which processes are automated to generate the intelligence that allows machines, bots and systems to act on their own, *independent of human intervention*. Autonomous intelligence does not currently exist in health care.

Appendix 1

Definitions of Artificial Intelligence or Other

Canadian Medical Protective Association: "The capacity of a machine or computer to mimic intelligent human thought processes and learn new information."

General Medical Council definition/comment: "Machine learning is the practice of using algorithms to analyse data, learn from that data and make a determination or prediction using new data. Humans create these algorithms, but these algorithms have the ability to analyse datasets on a scale that wouldn't be practicable for humans. Whilst 'machine learning' has been around for over 60 years, the hype about applying this in a healthcare context is a result of the increasing availability of 'big data' or large datasets to feed machine learning technologies, enabling them to generate increasingly accurate outputs that can be used for more effective prediction, diagnosis and treatment."

Medical Council of New Zealand's proposed definition of AI: Computer systems that perform tasks normally requiring human intelligence. These computational methods include but are not limited to machine image recognition, natural language processing and machine learning.

World Medical Association
Artificial intelligence consists of a host of computational methods used to produce systems that perform tasks which exhibit intelligent behavior that is indistinguishable from human behavior. *Augmented intelligence* (AI) is a conceptualization of artificial intelligence that focuses on artificial intelligence's assistive role, emphasizing that its design enhances human intelligence rather than replaces it.

FMRAC Working Group working definition of AI (from the Duke-Margolis Center for Health Policy), "A machine's ability to mimic the cognitive functions of the human mind."
For machine learning (also known as data-based AI). "The ability to learn without being explicitly programmed."

CADTH: AI is a branch of computer science concerned with the development of systems that can perform tasks that would usually require human intelligence, such as problem-solving, reasoning, and recognition.[ii]

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[i] https://fedtechmagazine.com/article/2020/01/assisted-intelligence-vs-augmented-intelligence-and-autonomous-intelligence-perfcon

[ii] An Overview of Clinical Applications of Artificial Intelligence. Canadian Association for Drugs and Technology in Health. **October 2018.** https://www.cadth.ca/dv/ieht/overview-clinical-applications-artificial-intelligence

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