Examining the Intelligence in Artificial Intelligence

By David Cycleback PhD (email)

Center for Artifact Studies.

The following looks at several problems and questions concerning our understanding of the word 'intelligence' and the phrase 'artificial intelligence' (AI), including: how to define these terms; whether intelligence can exist in AI; if artificial intelligence in AI is identifiable; and what (if any) kind of intelligence is important to AI.

WHAT IS ARTIFICIAL INTELLIGENCE?

Defining artificial intelligence is a never-ending debate, and you will find many different definitions,from overall ideas to particular details. To complicate matters, definitions change as the technology changes.

Here are just a few examples:

1) **Google dictionary:** The theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

2) **Encyclopedia Britannica**: Artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.

3) **Searchenterpriseai.techtarget.com**: AI (artificial intelligence) is the simulation of human intelligence processes by machines, especially computer systems

4) **Sciencedaily.com** The modern definition of artificial intelligence (or AI) is "the study and design of intelligent agents" where an intelligent agent is a system that

perceives its environment and takes actions which maximizes its chances of success.

> **5) Artificial Intelligence Illuminated (Jones & Bartlett Learning publisher)**: AI is the study of systems that would act in a way that to any observer would appear intelligent.

Not only do these definitions differ from each other – demonstrating that there is no universal agreement on what exactly is artificial intelligence – but there is a variety of debate contained within this collection of definitions.

First, these definitions are about intelligence, yet many don't define what is intelligence.

Second, some focus on human intelligence. This is a myopic and problematic view of intelligence. There are different types of intelligence, *e.g.* non-human animal intelligence. Furthermore, AI accomplishes tasks most efficiently when it uses its own, non-human methods. In other words, human methods are not always the best way for AI (University of Adelaide 2013).

Notice that many of the definitions don't say AI *has* intelligence, but appears to demonstrate it, or to do things that an intelligent being would do (*"perform tasks that normally require human intelligence...", "the simulation of human intelligence processes...", "able to perform tasks that normally require human intelligence..."*). This is significant; a computer seemingly exhibiting intelligent acts – or acting as if it is thinking – does not necessarily mean it *is* intelligent or thinking, and it often is not.

Only definition number 4 describes AI as *being* intelligent, rather than merely appearing to be intelligent. It is also noteworthy that number 4 is the one of the few definitions here that gives a definition of intelligence.

Definition number 5 says "...would act in a way that to any observer would appear intelligent." This again brings up the "appears" versus "is" issue. It also brings up the subjectivity of interpreting what is intelligent behavior, with intelligence often being defined by one's culture, language and species. And appearances are often deceiving.

There have been cases where computer programs have appeared to be having authentic conversations with humans when they were really just speaking gibberish or merely rotely repeating words or phrases that the people spoke to it. The most famous example is the early 1960s ELIZA language program created by Joseph Weizenbaum, a computer science professor at M.I.T. The program used language pattern matching to give humans the illusion the computer

understood what the humans were saying. Weizenbaum made the program to demonstrate the superficiality of communication between humans and computers, and was surprised when some human users felt the computer emotionally understood them (Sack 2018).

There is no universally accepted definition of artificial intelligence. Definitions have biases, arbitrary choices and sentiments. Some are working definitions and may change as the field of AI develops.

LET'S DRILL DOWN: WHAT IS INTELLIGENCE?

This is another great debate in and of itself, with even more definitions and categories than artificial intelligence. The following are just a few examples.

1) **Google dictionary:** the ability to acquire and apply knowledge and skills.

2) **Merriam-Webster Dictionary** (1) : the ability to learn or understand or to deal with new or trying situations : reason; also : the skilled use of reason (2) : the ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria (such as tests)

2) **Wikipedia:** Intelligence has been defined in many different ways to include the capacity for logic, understanding, self-awareness, learning, emotional knowledge, reasoning, planning, creativity, and problem solving. It can be more generally described as the ability to perceive or infer information, and to retain it as knowledge to be applied towards adaptive behaviors within an environment or context.

3) **Dictonary.com** The capacity for learning, reasoning, understanding, and similar forms of mental activity; aptitude in grasping truths, relationships, facts, meanings, etc.

4) **Cambridge Dictionary**: The ability to understand and learn well, and to form judgments and opinions based on reason.

These definitions differ, and the following paragraphs are a few notes for thought when assessing them and forming your own definition of intelligence.

Some of the definitions are premised on reason ("the power of the mind to think, understand, and form judgments by a process of logic."). These are too limited and myopic. Human intelligence has a variety of methods, including logical reasoning, symbolic, emotional, intuitive, social, altered conscious state. Human learning and decision making are sometimes via conscious logic,

but also via automatic irrational subconscious intuition. Non-human animals learn, acquire knowledge, and function using non-conscious knowledge.

Others of the definitions are broader and account for other forms of human intelligence and decision making processes. These are the better definitions. That there is a mixture of learning plus application of skills and knowledge is what is important, not how it is done. In fact, all human thinking, even symbolic reasoning, involves some degree of subconscious intuition, emotional, aesthetic, and psychological aspects.

Note that, unlike many of the artificial intelligence definitions, these definitions don't include the word 'human'--- though it can be fairly argued that the use of reason implies human.

The broader, non human-centric definitions of intelligence make the earlier human-centric definitions of artificial intelligence seem myopic, biased and immature. Artificial intelligence, including artificial general intelligence, should be defined by the broader definitions of intelligence. The human way of thinking and reasoning is one way, but there are other ways, perhaps even better ways. The approach to artificial intelligence can include human ways, but also other ways. And, in current practice it often does. Computers, such as in deep learning, sometimes do things differently than humans.

DIFFERENT WAYS OF THINKING

There are many different ways for brains to process information. Human brains and bodies have evolved to use a particular and limited way suitable for their particular purposes and needs. For different purposes, needs and environments, and often using different sensory information, non-human animals and artificial minds process information differently.

Non-human animals are highly intelligent and mentally capable in ways humans are not. Bats use echolocation to map out space. Spiders hunt by making elaborate webs. Humans use bloodhounds and their highly advanced sense of smell to locate things humans cannot. Termites use swarm intelligence to create advanced homes, pointing out that a mind does not have to be a single entity. (Margonelli 2014)

"For millennia, all kinds of authorities – from religion to eminent scholars – have been repeating the same idea ad nauseam, that humans are exceptional by virtue that they are the smartest in the animal kingdom. However, science tells us that animals can have cognitive faculties that are superior to human beings."-- Dr Arthur Saniotis, University Adelaide School of Medicine (Saniotis in University of Adelaide 2013)

Computers' symbolic methods, deep learning and Bayesian networks may be very loosely and primitively based on how in part humans process information. However, that's not how humans think. Humans thinking and intelligence use mental methods that computers do not: emotions, sentience and consciousness. When performing apparently human mental or physical tasks, such as dialoguing with a human or making an artwork or playing a board game, AI is necessarily doing it differently than a human.

"It's wrong to compare artificial intelligence to the human mind, because they are totally different things, even if their functions overlap at times," writes software engineer, Ben Dickson (Dickson 2018).

Humans themselves think and process information in a wide diversity of ways. Many of what are traditionally pathologized as disorders are just different ways of thinking. Austitic have social disabilities but are often better than normal humans at mathematics, focus and data analysis. Dyslexics have reading disabilities but are better than normal at spatial analysis and big picture thinking. The bipolar have troubles fitting in with social norms but the disorder is associated with creativity and high intelligence (Greenwood 2016). Paul Dirac (autistic), John Nash (schizophrenic), Albert Einstein (dyslexic) and Vladimir Nabokov (synesthesia) succeeded in their fields because of not despite their different ways of thinking. (Randerson 2009) (Nutt 2015) (Clark 2020) (Elise 2016). Psychologist and director of the American Institute for Learning and Human Development Thomas Armstrong said that computer scientists may come to prefer AI that thinks like an autistic person rather than a normal human (Armstrong 2018).

Each way of information processing has its positives and negatives, special skills and problems. Computers are superior to humans at some tasks, humans and non-human animals are superior at other tasks. It is not a matter of which is better or worse. They are just different, and often for different purposes. The present and future should combine the different brains and skills.

That humans cannot know which, if any, way or combination of ways of thinking is the 'best' or 'correct' for examining the world and reality is one of the key limits to human knowledge.

It also brings into question the human qualities of sentience, emotions, social intelligence, aesthetic perception and consciousness: are these required for a computer to be considered intelligent? If artificial general intelligence is defined as being like a human, then, yes, those human qualities are required. However, a highly advanced brain that can learn, acquire knowledge and do many different and great things may not require those qualities.

HOW CAN THE EXISTENCE OF INTELLIGENCE IN A COMPUTER BE CONFIRMED?

This is a big and continuing debate. There are different definitions and types of intelligence, both human and non-human. Even when going by one type, it is a question of how to identify its existence and even if it can be identified.

The type of intelligence that is hoped to be identified by testing is artificial general intelligence, or intelligence that is like a human's.

The most famous intelligence test for computers was devised in a 1950 paper by Alan Turing, and is called the **Turing test**. The test was devised to determine if a computer can think like a human, Turing and most others believing that thinking is an essential and integral part of intelligence. Turing wrote that if a computer acts, reacts and interacts as if it is thinking and sentient, then we can say that it is thinking and sentient (Oppy 2016).

In the Turing test, a human interrogator, a computer and another human are placed in separate rooms. Within a fixed timeframe, the interrogator must distinguish between the computer and the other human based on their teletype (one might use email or text today) replies to questions posed by the interrogator. According to Turing, by such tests, a computer's success at "thinking" can be measured by the probability of it being identified as a computer by the interrogator (Oppy 2016).

COUNTER ARGUMENTS TO THE TURING TEST

While the Turing Test has been the most famous and used as an intelligence or thinking test for computers, there have been refutations of it.

One is that it is human-centric, testing the ability to communicate in a distinctly human way. Non-human animals are intelligent using non-symbolic communication and much of a human's intelligence does not involve language. Computers can act intelligently while using communication that is not understandable to most or even all humans.

At the Georgia Institute of Technology in the United States, computer scientists had two artificial intelligence programs communicate with each other in a test bartering economy. The problem was the scientists forgot to program in that the AI had to stick to English and the two programs developed their own mutual language that the scientists did not understand. English is a cumbersome language for AI, and the programs developed a more efficient for them 'gobbledygook' language. The scientists reprogrammed so only English was used. However, the question then was if it was better for the AI to work better in its own language that humans may never be able to understand, or be less efficient using a language the humans can understand (Slack 2017).

OTHER TESTS

Because humans interact with the world through their senses, an argument is that a better test of human-like intelligence and thinking should include image or sound processing. The interrogator could ask the computer to interpret sights and sounds, then reason about them.

A test could involve physically doing things, actually acting with the world.

University of California-Berkeley professor Michael Jordan suggested a test "Even more difficult: The system doesn't know about soccer, but I explain soccer to the system and then it provides a running commentary on the match" (Jordan in Barton 2014).

A possible test would be for AI to make a "passable" artwork, as that involves creativity, aesthetics, design and originality. Of course, defining "passable" and art opens up another area of debate.

Doing just one test is not the correct way to test for human intelligence or general artificial intelligence. A key to humans and artificial general intelligence (AGI) is that it can do many and varied things. If someone's proposed intelligence test is to play chess, there are computers that can and have beat the best human at chess but cannot play checkers.

New York University psychology professor Gary Marcus said: "There's all the stuff you can do with deep learning, like it makes your speech recognition better. It makes your object recognition better. But that doesn't mean it's intelligent. Intelligence is a multi-dimensional variable. There are lots of things that go into it" (Marcus in George 2017)

There should be many and varying tests to identify artificial general intelligence. Even a human IQ test does not measure many essential qualities of human thinking and intelligence.

University of California-Berkeley computer scientist professor Stuart Russell argues against using a single test as a standard, no matter which one, because: "If you fix a landmark goal, you tend to end up with systems that are narrow and inflexible. A different kind of mission might be preferable, one which can expand with our own abilities and desires." (Russell in Batson 2014)

MOVING THE GOALPOSTS

Throughout the history of artificial intelligence and computers, humans have changed the definition for "What is intelligence?" whenever a computer passes one of their narrow intelligence tests. Humans tend to be uncomfortable with the idea of a computer having

human-level or better intelligence, and once a computer achieves something, the humans suddenly say "that's not real intelligence."

A case in point is the chess-playing super computer called Deep Blue. A longstanding intelligence test was for a computer to beat a human at chess, with chess clearly being an advanced game and chess masters being considered highly intelligent. When IBM's Deep Blue computer beat world human champion Garry Kasparov, many humans suddenly changed their mind and said that chess wasn't really a good test of human intelligence. They said the computer was just doing massive number crunching, and that didn't count as *real* intelligence.

University of Liverpool philosophy professor Barry Dainton wrote, "It's true that as soon as a computer can perform a task as well as humans we tend to say 'Ah, we always knew that *that* task didn't require *real* intelligence.' Fifty years ago, the ability to do fast and accurate arithmetic in one's head, or play chess better than anyone else in the world, would have been taken as paradigms of what intelligence was all about. Now that computers can do it, we take a different view. So: because of this bias, it could well be that computers have *already* made more progress that AI's critics like to admit." (Dainton 2018)

DO THE AI INTELLIGENCE TESTS REALLY IDENTIFY THINKING?

Recall that Alan Turing said that a computer program that *exhibits* thinking or sentience can be said to have it. Also remember that many of the original definitions of artificial intelligence above defined it as having said "appeared to have" or "exhibited to the external observer" actions that are associated with human intelligence. This was the position of many of the early AI scientists, such as Marvin Minsky, Nobel Prize winner Herbert A. Simon and, obviously, Turing. In 1958, Simon claimed that there were already machines that think (Allen 2001).

However, philosophers, most notably Hubert Dreyfus and John Searle, argued that "appearing to have" or "exhibiting to the external observer" intelligence or thinking is not proof that the computer is really thinking. They argued that the computers that computer scientists claimed were thinking were not, that the computers were merely rotely following assigned tasks with no understanding or awareness of what they were doing. They said that real thinking requires understanding and awareness of what one is doing. (Crease 2019)

The most famous refutation of the Turing test was by philosopher John Searle in his **Chinese room argument** (Cole 2020). He said it showed that the Turing test was unable to prove that a computer was thinking.

His argument has a human that cannot read or speak Chinese locked in a room with Chinese characters and a manual showing how to match questions in Chinese with appropriate responses

from the Chinese characters. The room has a slot where Chinese people insert written questions in Chinese, and another slot where the man in the room pushes out the appropriate response from the manual. To the Chinese people outside, the room has passed the Turing test. However, the 'translator' in the room is merely following the manual and has no understanding of the language. Searle said, while the Chinese room appeared to outsiders to be thinking in Chinese, it was not. The man inside does not understand Chinese. (Hauser 2015)

The Turing test only tests if a computer appears to be thinking, not if it really is.

DOES IT MATTER IF A COMPUTER IS REALLY THINKING?

AI pioneer John McCarthy who coined the term artificial intelligence, said that the Chinese room argument and other philosophical debates about whether or not computers are really thinking or have sentience or consciousness were beside the point. He felt that all that matters is what a computer can do, and felt that philosophical matters were separate to the practical work. He wrote, "Presumably some philosophers of AI will do battle with the idea that AI is impossible (Dreyfus), that it is immoral (Weizenbaum) and that the very concept is incoherent (Searle). It is unlikely to have any more effect on the practice of AI research than philosophy of science generally has on the practice of science." (McCarthy 1996)

However, to philosophers such as Hubert Dreyfus and John Searle, the philosophical debates about thinking, sentience and other internal states of mind are required if there is ever to be artificial general intelligence (Crease 2019)

The 1960s-70s was a time when prominent computer scientists said that AGI was just around the corner. In 1965, Herbert Simon said that "machines will be capable, within twenty years, of doing any work a man can do." (Crevier 1993). In 1970, M.I.T.'s Marvin Minky said "In from three to eight years we will have a machine with the general intelligence of an average human being." (Grudin 2012)

Dreyfus strongly disagreed with them. He said the issues about real thinking were essential, and that their 'non thinking' symbolic AI approach would not produce AGI, at least in the near future. And he was correct.

CAN WE EVER KNOW IF ARTIFICIAL INTELLIGENCE HAS REAL THINKING, SENTIENCE, AND CONSCIOUSNESS?

No, at least not with absolute certainty.

We can guess but cannot know what other humans and non-human animals, much less computers, are really feeling and thinking. Despite appearances or actions, we can never know if computers are really thinking, if they have emotions, feelings, sentient understanding.

If computers ever gain human-like thinking, sentience, emotions, and consciousness, we will never know for certain. This is an issue for ethics, where whether or not a computer or robot has sentience is legally and ethically significant. It is also an issue if your definition of artificial intelligence requires these human-like qualities.

A counter argument is that, while we can never be one hundred percent sure what another human or non-human animal thinks or feels, we regularly judge by their actions and responses that they do think and have feelings. This argument says that, similarly, we will be able to reasonably judge if a computer has thinking, intelligence and sentience by its actions and responses.

These questions of 'Is it thinking?,''What is it thinking?' and 'What is it doing inside it's mind?,' are real, practical issues with computer scientists. There is the *black box problem*, where the inner workings of a system, such as a computer, can only be observed by its inputs and the outputs, and it is unknown what is really being done inside the system. The system (box) is black or opaque to the outsiders, including the computer scientists. This is often the case with artificial neural networks and deep learning, where it comes up with answers, but the computer scientists don't fully know or understand its internal methods that were used to produce the answers. This brings up questions about the reliability of the system's answers.

Now and in the future there will be artificial intelligence where humans do not fully understand how it works. If there is artificial general intelligence, humans will likely not understand, at least fully, it's cognitive workings. There will always be mystery and the philosophical and practical problems that come with that.

References:

Allen F (2001), "The Myth Of Artificial Intelligence," americanheritage.com/myth-artificial-intelligence

Armstrong T (2018), 'Neurodiversity,' institute4learning.com/resources/articles/neurodiversity/

Batson J (2014) 'Forget the Turing Test: Here's How We Could Actually Measure AI', Wired magazine, https://www.wired.com/2014/06/beyond-the-turing-test/

Clark C (2020), "Famous Dyslexics who have Impacted the World,"
commlearn.com/famous-dyslexics-who-have-impacted-the-world/

Cole, D (2020), 'The Chinese Room Argument,' https://plato.stanford.edu/entries/chinese-room/

Crease R (2019), 'Why artificial intelligence has brought scientists and philosophers together,'
physicsworld.com/a/why-artifical-intelligence-has-brought-scientists-and-philosophers-together/

Crevier, Daniel (1993), *AI: The Tumultuous Search for Artificial Intelligence*, New York, NY:
BasicBooks, ISBN 0-465-02997-3

Dainton, B (2018), 'Artificial Intelligence' (2018) University of Liverpool
https://www.liverpool.ac.uk/~bdainton/AI.htm

Dickson B (2018), 'There's a huge difference between AI and human intelligence—so let's stop
comparing them' bdtechtalks.com/2018/08/21/artificial-intelligence-vs-human-mind-brain/

Elise K (2016) , "12 Famous Artists With Synesthesia,"
mentalfloss.com/article/88417/12-famous-artists-synesthesia

George A (2017), 'Discussing the limits of artificial intelligence', Techcrunch,
https://techcrunch.com/2017/04/01/discussing-the-limits-of-artificial-intelligence/

Grudin J (2012), 'A Moving Target—The Evolution of Human-Computer Interaction,'
microsoft.com/en-us/research/wp-content/uploads/2017/01/HCIhandbook3rd.pdf

Greenwood (2016), Positive Traits in the Bipolar Spectrum: The Space between Madness and
Genius,' ncbi.nlm.nih.gov/pmc/articles/PMC5318923/

Hauser L (2015), 'Chinese Room Argument' Internet Encyclopedia of Philosophy,
https://www.iep.utm.edu/chineser/

Lubin G (2017), Animals Are Way Smarter Than We Give Them Credit For,
https://www.sciencealert.com/animals-are-much-smarter-than-people-realize-scientist-says

Margonelli, L (2014) 'Collective Mind in the Mound: How Do Termites Build Their Huge
Structures?'
nationalgeographic.com/news/2014/8/140731-termites-mounds-insects-entomology-science/

McCarthy J (1996), "The Philosophy of Artificial Intelligence"
www-formal.stanford.edu/jmc/aiphil/node2.html#SECTION00020000000000000000

Nutt A (2015) "Did John Nash's schizophrenia boost his beautiful mind?,"
washingtonpost.com/news/to-your-health/wp/2015/05/26/did-john-nashs-schizophrenia-boost-his-beautiful-mind/

Oppy G (2016), 'Turing Test', Stanford Encyclopedia of Philosophy,
https://plato.stanford.edu/entries/turing-test/

Ranerson J (2009) "A prenatal test for autism would deprive the world of future geniuses,"
theguardian.com/science/blog/2009/jan/07/autism-test-genius-dirac

Sack, H (2018), 'Joseph Weizenbaum and his famous Eliza'
http://scihi.org/joseph-weizenbaum-eliza/

Slack, A (2017) 'Facebook Pulls the Plug as Two AIs Invent Their Own Language,'
infosecurity-magazine.com/slackspace/facebook-ais-invent-their-own/

University of Adelaide (2013), 'Humans not smarter than animals, just different, experts say',
https://phys.org/news/2013-12-humans-smarter-animals-experts.html