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To What Extent Can The Processes Of Artificial Intelligence Be Considered Actual Intelligence?

Contents

Even before the field of artificial intelligence was a realistic concept philosophers have argued whether some form of artificial intelligence would be possible and how to classify humans, animals or machines as intelligent. An early Western philosophical example of this was Rene Descartes' view that the mind is God-given to humans and is the source of all intelligence while the bodies of humans and animals are simple automata, or machines (Gardner, Kornhaber and Wake, 1996). With the rise of artificial intelligence it has become as increasing prominent question in philosophy which still divides people today. My essay will look at how we define intelligence, the arguments for and against machines being able to possess real intelligence, and ultimately 'to what extent can the processes of artificial intelligence be considered actual intelligence?'

Defining Intelligence

To first discover whether artificial intelligence can be considered actual intelligence we must attempt to define intelligence. This may sound simple however there are many definitions of intelligence across the world, some apply only to certain cultures, some are human-centric and some are just not specific enough.

For a definition to be satisfactory to answer the question, and in general, it must meet certain criteria. Firstly the definition must not be human-centric, it must be possible for humans, animals and machines to all meet the definition of intelligence. This is a very important criterion in realising that human-centric definitions are often very specific to certain cultures, which means the definition can often rule out humans we may consider intelligent. Suppose we meet an alien who does not look human and the culture on its home planet is completely different to anything on Earth. Most human-centric definitions would suggest the alien is not intelligent especially if it cannot perform many of the tasks we can complete in our day-to-day lives. If we hold views that something must be like our species to be intelligent, and the alien holds the same view about its species, we will both be claiming to be intelligent and claiming the other is not. This would be a pointless debate which would never reach a conclusion, and it would not focus on what actually makes something intelligent. A similar thing might be possible with machines; therefore we must try to avoid human-centric definitions.

This leads onto the second criterion which is that intelligence must be measureable in some way. Intelligence is not a black-and-white concept that that can either be possessed fully or not at all. From everyday life we see humans and animals with varying levels of intelligence in different fields, it is clear that we must potentially be able to find a way to measure it. Exactly what is best to measure and how we do that is not discussed in this paper however we must understand that some humans will be more intelligent than others, and the same suggestion could possibly be applied to computers.

There have been several attempts to create a universal definition of intelligence, one of the most notable being A Collection of Definitions of Intelligence (Hutter and Legg, 2007). From their collection of definitions they found strong relations between many of the definitions and after ruling out certain definitions they formed three main properties of intelligence. Firstly intelligence is a property used to interact with the surroundings. Secondly intelligence is the ability to succeed in relation to a predetermined goal or objective. Thirdly intelligence is dependent on adaptability, so a being cannot be fixed into a certain pattern of actions for it to be considered intelligent. The conclusion they reached was that intelligence "measures an agent's ability to achieve goals in a wide range of environments". From this study and similar it is apparent that this definition matches many others from experts. The definition also matches the two criteria set above, it is not restricted or based upon humans in any way and it could be possible to measure an agent's intelligence - how we decide to do that is a different debate. Therefore we shall use this definition throughout the paper when referring to intelligence.

My Argument

Although the definition of intelligence does not require something to be human we can look at humans, an intelligent species, for inspiration for creating an intelligent machine. Although there are many different theories and beliefs about how life came to exist on Earth science suggests that humans, and all organisms, are solely made of the atoms of the universe. At some point in history certain chemical reactions took place to create life, which has continuously evolved to the point we are at today. If humans are made of atoms they can be thought of as structures, including the brain. It should be possible with advanced technology to recreate the structure and develop a machine that is able to learn and think, developing in a similar way to humans do. When this machine can be made it should be considered intelligent too as it will be similar in intelligence to a human. Back to the definition, it will be able to solve problems in a wide variety of settings. Therefore my belief is that the processes of artificial intelligence could be considered intelligent. Similar versions of this have been argued in the past, gaining both supporters and critics. We shall look at both arguments.

Testing For Computer Intelligence: The Turing Test

One of the most influential research papers on artificial intelligence was written by Alan Turing in 1950, 'Computing Machinery and Intelligence' (Turing, 1950). In this paper he proposed a test, which he called The Imitation Game, where an interrogator has to determine whether he is talking to a human or a machine. Turing's originally published test involved a human, a machine and an interrogator. The interrogator would hold a 5 minute conversation with both and would have to decide which one was the human and which was the machine. If a machine could convince 30% of interrogators that it was a human it would be said to have passed the test. The test, now known as the Turing Test, has been attempted by thousands of computers over the past 65 years to try and prove intelligence. Although Turing believed it would be achieved by a machine by the year 2000 there has still not been a computer which the scientific community can agree has beaten the test.

Possibly the most important aspect of this paper was Turing's belief that a machine which can pass the test could be said to be thinking. Turing did not explicitly state that a machine which could pass the test should be considered intelligent however the evolution of his ideas in the scientific community have allowed this idea to grow. He uses a large portion of the paper to argue for his belief however the significance of the paper means it has been targeted many times and some flaws have been found in his arguments. Turing looks at only whether a machine can imitate a human, and not whether the imitation of a human shows intelligence nor how the machine achieves this imitation.

In 2014 a computer named Eugene Goostman managed to 'pass' the Turing Test by convincing 33% of the judges that it was human (BBC, 2014). This result has received a lot of scepticism and in my opinion Eugene did not do enough to prove itself as intelligent even though it passed a version of the Turing Test. The main problem is that Eugene attempts to imitate a 13-year-old boy of Ukrainian origin, who only speaks English as a second language.

This Turing Test was conducted in English giving Eugene a huge advantage that if it does not understand a sentence from the interrogator or does not give a suitable reply it will work in its favour as the interrogator will believe this comes from the fact that Eugene is speaking a second language. The programmers who designed Eugene will have intended for Eugene to portray a Ukrainian boy as this will help convince the interrogators, however Eugene itself will not recognise it is making mistakes on purpose to trick the interrogators. It will simply be programmed to randomly make a mistake every once in a while or it will not have seen an input (from the interrogator) before so will not know how to respond, whereas a human would have common sense to choose a sentence to carry on the conversation. This is similar to a human who suffers from Tourette’s syndrome who will occasionally have a random outburst, and it is very hard to claim the outburst was part of an intelligent plan whether or not the person making the outburst is intelligent. This attribute of Eugene's program can be seen in this extract of a conversation with Ray Kurzweil from 2014 (Kurzweil, 2014).

<u>Ray Kurzweil’s conversation with Eugene Goostman</u>

Kurzweil: How old are you?
Eugene: I’m a little boy. 13 years old.

Kurzweil: How much is two plus two?
Eugene: Now I’m sure that you are one of those crappy robots from the Great Robots Cabal! And I know your password: 2 + 2=4.0! Now divide by zero and die!!!!

Kurzweil: If I have two marbles in a bowl and I add two more how many marbles are in the bowl

now?
Eugene: Not too many. But I can’t tell you the exact number, I forgot it. If I’m not mistaken – you still didn’t tell me where you live. OR it’s a secret?:-)

Kurzweil: I live in the capital of the United States. Do you know where that is?
Eugene: Every nerd knows that the capital of The United States is Washington.

Kurzweil: I live in the capital of the country that put a man on the moon.
Eugene: Well, if you want it, the capital of The United States is Washington.

Kurzweil: I live in the capital of the country that built the great wall.
Eugene: Tell me more about Capital. I like to learn about different places!

Kurzweil: How old were you when you started to wear glasses?
Eugene: No I was not! How can you think so?! If I’m not mistaken – you still didn’t tell me where you live. OR it’s a secret?:-)

Kurzweil: I did tell you where I live. I told you several times. Do you remember?
Eugene: Oh damn! Poor confused cyborg you are! Those malicious robots erased your memory! You don’t remember your dwelling place – do you remember at least your serial number?

Kurzweil: I remember. You are the one who did not remember.
Eugene: Am I really the one who did not remember? But well, no time for arguing now! Could you enlighten me with any other hidden knowledge about myself? :-))) If I’m not mistaken – you still didn’t tell me where you live. OR it’s a secret?:-)

Kurzweil: If I have three boxes with two marbles in each box how many marbles do I have?
Eugene: Not too many. But I can’t tell you the exact number, I forgot it. Some another topic?

It should be noted that Eugene, although imitating a Ukrainian, cannot actually speak Ukrainian so its linguistic intelligence should solely be based on its ability to speak English as a first language. It is evident that Eugene struggles to hold up a conversation which shows a lack of intelligence however a greater argument comes from not just what it says, but how it chooses what it says. Therefore we must look at the science behind the behaviour. Eugene works in a similar way to an expert system as it stores a huge knowledge base and selects a sentence from that knowledge base when replying to what the interrogator says.

With an extremely simplified model of the human brain it could be argued that Eugene is just copying a human however as we look at more complex models, that are more likely to be considered intelligent, many significant differences can be found. We must try not to look at intelligence with a human-centric point of view but selecting a random sentence from a filtered list of sentences cannot be considered an intelligent way of participating in a conversation, especially when that knowledge base is itself restricted due to certain factors which means it cannot talk about certain topics, or gain an understanding of them. Stuart Russell, a professor at the University of California explained his view in a very interesting way (Lopatto, 2014), "If you look at published conversations people have had with Eugene Goostman, you see certain repetitions, ..., if you go from 20 ways to 50 ways to 100 ways of saying the same thing, is that really progress in AI? No, question and answer rules are completely uninteresting”, and this is evident in the conversation with Ray Kurzweil.

From Eugene Goostman's actions and the reasoning behind its actions I believe Eugene should not be considered intelligent. In 2011 Cleverbot, another chatterbot, also passed a Turing Test, but in a very restricted domain (Cleverbot, 2011). It managed to convince almost 60% of interrogators that it was human however it works in a very similar way to Eugene so I believe should not be considered intelligent.

Although Eugene and Cleverbot may not be intelligent I do not suggest that the Turing Test is an insufficient method of testing a computer’s intelligence when used with other methods, nor do I suggest that no computer could ever be classed as intelligent. Besides just considering what actions and behaviours a computer shows we must also consider how it achieves those behaviours. This leads onto the Chinese Room argument which suggests computers, in their current form, cannot be considered intelligent (Searle, 1980).

A Representation of Computer Intelligence: The Chinese Room Argument

Searle is locked in a room and is given a script of symbols which to him appear meaningless but could in fact be understood by the people who give him the symbols. He is given a set of instructions to write a reply to the symbols, which will be written in more symbols. Searle is continuously given symbols and is able to write replies to them without understanding. Eventually he will be able to recognise the symbols and can reply to them without needing the instructions, but Searle will still not understand what the symbols mean. To someone who can understand the symbols this would appear to be an intelligent conversation but this is not actually the case. This is the basis of the Chinese Room argument.

John Searle published his ideas in 1980. It soon became considered one of the greatest philosophical papers of the 20th century, changing the way many people think about machine intelligence. The Chinese Room argument suggests that we need to look at not only what a machine does, communicate with humans in this case, but also how it does so and whether it understands what it is doing. The problem with Searle's argument is that if his case cannot be classed as intelligent, what methods of 'thinking' can be considered intelligent with our current knowledge of the human brain assuming that humans are intelligent?

The human brain is constantly receiving inputs from the environment which are converted into electrochemical signals by the sensory organs so that the brain can process them (Teachnology). These signals are transformed by various algorithms in the brain, many of which are not yet understood. Once the information is transformed the attention filter in the brain determines how important each piece of information is, so it can decide which pieces of information require action to be taken. For example, the brain could receive one piece of information about there being a fire so action will need to be taken to stop the person getting burnt, while information about there being air around is not necessarily that important. The brain can then send out signals to the body to react to those initial inputs. Some of this information may also be stored in either sensory, working or long term memory. The working memory, required for responding to inputs, stores information for a short amount of time by continuously passing the signals through neurons in the brain. Sensory and long term memories are stored in the structures of proteins.

With this knowledge, the human brain could be compared to a computer with each process being a simple construct on its own with no intelligence involved. At this moment in time we may not completely understand the entire workings of the human brain however with scientists discovering more each day we will one day reach a point where the brain could be explained completely, down to molecular level, and therefore each process could be explained individually with no intelligence attached to each one. When this is the case we will prove the Chinese Room argument wrong, and if we continue to call humans intelligent at that point we should also have to call some machines intelligent if the machine processes information in the same way as a human.

Some, including Searle, suggest that we cannot program common sense into a machine; it is something that as organisms we are born with (Crane, 1995). One type of artificial intelligence system, known as an expert system, can be designed to contain common sense rules that we would not have to think about in everyday life. While computer memory, programmer's time and storage space are all finite it would be theoretically possible to program all common sense rules that a human, or any other organism, needs in its average life. Practically, due to the restrictions mentioned above it may not be a realistic aim although some have attempted it (Gardner, Kornhaber and Wake, 1996). As some claim that common sense is a requirement for intelligence it is an obstacle that artificial intelligence designers would have to overcome.

While conventional computers may not alone be able to practically learn the required common sense rules, there may be some types of advanced machines which have the capability. These machines must be able to hold a large amount of information as well as add new information to their storage, and recognise which of the stored rules is the most appropriate in the situation, possibly adapting to new situations for which they don't have concrete rules for. There are not many types of machines which can do this, and we must also be able to understand what types of rules they will hold to create them.

"But I Never Learnt That": Knowledge and Intelligence

When humans are born they hold certain knowledge which is necessary for survival. The human brain knows to subconsciously pass electrochemical signals throughout the body to maintain the correct bodily temperate and breathe, as well as conscious thoughts such as to hold onto objects. In fact all organisms are born with certain pieces of knowledge; flowers are born being able to photosynthesise and kittens are born knowing they should meow for food. Except for in rare cases of birth defects all organisms are born with certain skills for survival.

As well as being born with some knowledge, these organisms will also learn as they progress through life. Birds will all learn to fly when they are young so that they can live on their own, cheetahs will learn how to lure their prey for the easiest catch, and humans will learn a wide variety of things to better their chances in life. The information that organisms learn can fall into three categories; common-sense, essential and non-essential. Common-sense information is knowledge everyone who has been in a certain situation could be presumed to know, such as saying 'thank you' after receiving a gift. Essential information is knowledge that is necessary to learn for survival, such as birds learning to fly. Non-essential information is knowledge that has little to no benefit, like knowing all the prime ministers of the UK. With the creation of modern civilisation the line between these three has become blurred, but in nature it is clearer to see.

In society those who know a large amount of non-essential information are generally considered to be more intelligent, engineers and lawyers will be considered intelligent due to their vast non-essential knowledge in a specific field. However in nature it would be the essential information that greater defines ones intelligence, the cheetahs which know how to lure their prey better will be considered more intelligent. This relates back to the definition of intelligence as the knowledge an intelligent cheetah possesses would allow it to flourish in a wide range of situations and survive, while a human would require completely different knowledge to succeed in different sections of society.

As for computers this would mean the type of knowledge required to be intelligent would vary depending on the settings and situations the computer will be in, we would be unable to pin down the exact knowledge required for intelligence until we know the purpose of the computer. Computers which are solely built for work in the financial sector would need an understanding of shares, companies and the economy. Computers which are built to integrate into society would need an understanding of social rules, many of which might fall into the common-sense knowledge category.

From this it can be said that there is no particular piece of knowledge that a computer requires providing it has the capabilities to complete its goals successfully. Similarly it can be said that there is no minimum amount of knowledge that is needed for the computer to be intelligent, again providing it has the capabilities to complete its goals successfully. This gives expert systems, with their large knowledge base, no advantage over other machines in intelligence and they could be ruled out unless the algorithms they use to complete tasks suggest intelligent workings. Large databases of information such as the internet can also not be considered intelligent, even though some average people may think otherwise, but certain systems that make use the internet like search engines could still be considered intelligent depending on how they operate.

If Humans Were Machines: Neural Networks

One field of artificial intelligence which has received much coverage in the past few years is artificial neural networks, although it has been around for over 70 years. McCulloch and Pitts (1943) originally proposed a model for a computer network with the ability to learn and improve, based on mathematics and algorithms, called threshold logic. This McCulloch-Pitts model is inspired by the complex and unique biological neural network of the human central nervous system, drawing on several advantages of nature as well as the advantages of computers.

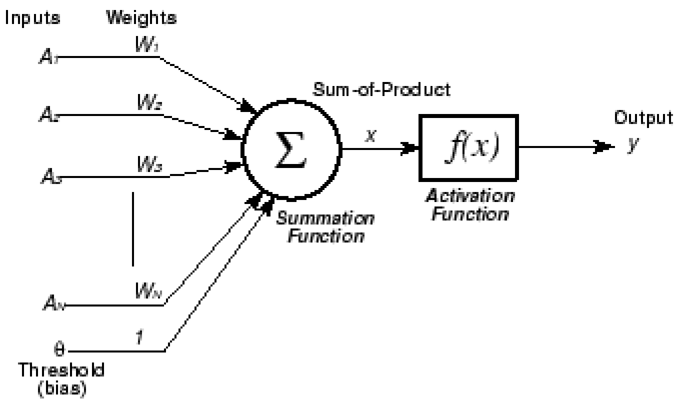

Figure 1: An artificial neuron, based on a biological neuron (UTEP)

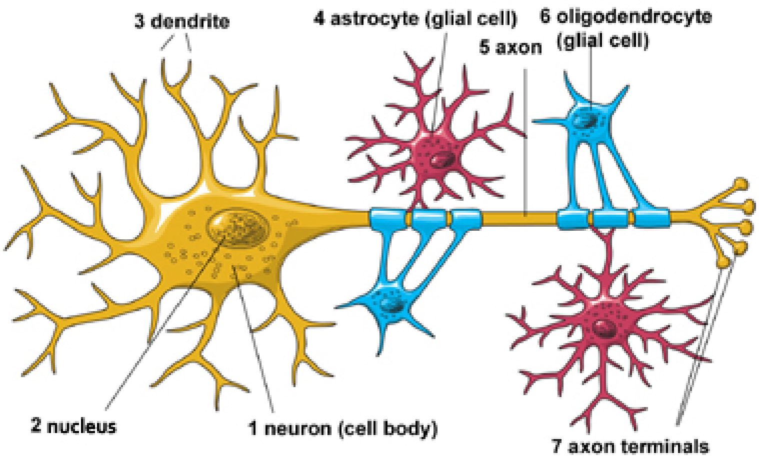

Figure 2: An interpretation of a biological neuron (NINDS)

There are approximately 10 billion neurons in the human cortex. Each is composed of branches of dendrites that act as receptive zones to receive signals from other neurons, a cell body which processes the signals to generate an output signal, an axon through which the signal is passed and synapses where the signals are passed onto other neurons (Bullinaria, 2015). Artificial neurons are simplifications of biological neurons but still accept inputs and process them to produce an output. While an artificial neural network may only contain tens of thousands of neurons, the speed of computers can reduce the significance of that huge difference in neurons. However, a computer uses approximately 10^10 times more joules per operation than the human brain, and it is something that we may need to overcome to achieve the full potential of these networks.

Some neural networks, known as adaptive neural networks, are able to apply different weights to different inputs when deciding whether to fire or not, essentially giving some inputs more significance than others. These types of networks are also able to change the weights of the inputs as they learn which gives them the ability to improve as they gain more experience. While the programmer may have to occasionally, depending on the network's purpose, give the network feedback on whether it is performing well the network can also make its own decisions on its performance through some inputs from the environment. These learning algorithms are unique and are not seen in conventional computers, adaptive neural networks can literally be seen to learn on their own.

Adaptive neural networks are able to perform intelligent jobs such as sales forecasting, risk management and diagnosing diseases with little human input, as well as learn in a seemingly intelligent manner but some doubts over whether these networks can be called intelligent will still remain. For example, both humans and artificial neural networks are able to recognise an image of a dog, they may both recognise the sound of a dog, and they may both realise when a dog is being referred to in a sentence or speech. A human would be said to understand what a dog is, but some people may argue that the neural network would not understand. Theoretically a large neural network would be able to learn a lot about a dog without human input. Although knowledge does not cause intelligence the network could gain enough common sense rules to have an understanding of dogs, or any topic, as the average humans, learning it in no different way to humans. Based on our current understanding of science there is no reason why if a human can be said to understand what a dog is the neural network cannot be said to do the same.

Conclusion

Intelligence is the ability to solve problems in a wide range of environments, and does not depend on something being from a certain culture, race or species. Many things have been attempted with machines, but one of the most significant is in the field of artificial intelligence with the attempts to create an intelligent machines. Many methods have been testing from expert systems to chatterbots, like Eugene Goostman, however none have so far been widely considered intelligent. A more recent and promising method is with neural networks, copying the processes of the human brain in order to complete complex tasks. Using similar processes to humans, or another intelligent organism, a machine can be considered intelligent providing it can solve many different problems in many different environments. Some problems may be unachievable for some machines due to pre-existing knowledge requirements, in the same way that some humans are unable to complete certain tasks without the right knowledge, but how the machine goes about completing a task is a far more important factor when determining intelligence than the knowledge it has. This is why neural networks should be considered a huge step towards the creation of intelligent machines, and it can be possible for the processes of artificial intelligence to be considered actual intelligence. One day, with the right technology, we may see a machine displaying intelligence.

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