**6CS003 Emerging Technologies Assessment 4**

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Date of submission: Thursday 16 May

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**Intelligent Systems**

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Intelligent Systems has been debated ever since the first computers were designed and built, Alan Turing one of the first Computer Scientists and generally considered the architect of Computer Science and Artificial Intelligence once posed the question Alan Turing (1950), "Can machines think?". In this paper an introduction to Intelligent Systems is given, the uses and repercussions are shown, as well as limitations and similar technologies and an attempt is made to show how this question is as important now as it was then.

1. **Introduction**

Intelligent Systems attempts is concerned with how we determine intelligence, specifically to do with a machines intelligence. Typical modern computers today are able to perform various functions based on the software and hardware installed, produce data in a range of file types, process and analyse an increasingly large amount of data and when connected to the internet, data can be uploaded and downloaded for other computers to process and analyse. However while modern computers can perform these functions and do them very well as run-times decrease thanks to the advancement in computing technology, this does not make modern computers intelligent.

In order to deem a computer intelligent, first the question must be asked, how do we determine intelligence? Various parties and individuals have attempted to answer such a question with varying degrees of success. Alan Turing (1950) once asked "Are there imaginable digital computers which would do well in the imitation game?", this essentially asks whether a computer can pass the imitation game or 'Turing Test' which tests whether a computer can imitate human traits. In the imitation game a human the judge, starts a conversation with another human and the computer designed to flawlessly replicate the actions of another human being in a conversation. For testing purposes all of the conversations members are separated from each other, should the judge be unable to consistently tell the computer from the human then the computer has passed the imitation games test. This is supported by the work of Saygin et al (2000), states that,

The British mathematician Alan Turing proposed the Turing Test (TT) as a

replacement for the question "Can machines think?" in his 1950 Mind article ‘Computing Machinery and Intelligence’ (Turing, 1950). Since then, Turing’s ideas have been widely discussed, attacked, and defended over and over. At one extreme, Turing’s paper has been considered to represent the "beginning" of artificial intelligence (AI) and the TT has been considered its ultimate goal. At the other extreme, the TT has been called useless, even harmful. In between are arguments on consciousness, behaviourism, the ‘other minds’ problem, operational definitions of intelligence, necessary and sufficient conditions for intelligence-granting, and so on.

However it is important to note that the imitation game is not about checking the ability to give the correct answer, it merely looks at how similar the answer from the machine is to what the human responses would be.

The human brain is capable of processing huge amounts of data all at once, one neuron is similar to one core in a processor, however while the human brain has millions of neurons in comparison to computer processer cores they run relatively slow with neurons running at ten to one hundred hertz while computer processor cores run in the gigahertz range. This makes computers very efficient at completing tasks and solving problems but this still does not make a computer intelligent.

This is where the field of artificial intelligence (AI) comes in, the subject is ultimately about the producing of machines that act intelligently. We determine intelligence by comparing for example in this case a computer that performs skills usually reserved only for humans, such as playing the piano, holding a conversation or recognising a friend etc. Norving, P. (2012) states that "Traditionally, a programmer will start off knowing what task they want a computer to do. The knack in AI is getting a computer to do the right thing when you don't know what that might be." and that is what makes constructing an artificial intelligence such an issue.

In order to successfully create an artificial intelligence, the machine must be capable of handling uncertainty, such as complications derived from an earlier action that only appear and affect you until a certain amount of time after the action is taken for example. In order for a computer to be deemed intelligent as Norving, P. (2012) states that "…a system must not only model a task, but also model the world in which that task is undertaken. It must sense its environment and then act on it, modifying and adjusting its own actions accordingly. Only when a machine can make the right decision in uncertain circumstances can it be said to be intelligent."

1. **Applications and Implications**

One application of intelligent systems is an artificial intelligence, this is where a machine can think for itself and make decisions on its own, it is capable of conscious thought. Artificial intelligence has been debated and researched for many years and several methodologies have been taken in order to develop an artificial intelligence as shown by the work of Brunette *et al* (2009) who states,

Two main approaches were developed for general AI; the “top down” approach which started with the higher level functions and implemented those, and the “bottom up” approach which looked at the neuron level and worked up to create higher level functions.

If created an artificial intelligence would be capable of processing huge amounts of data and the ability to think for itself and make decisions based on this conscious thought. There are several applications for an artificial intelligence such as performing highly complex simulations extremely quickly and efficiently, the artificial intelligence could simulate better designs for computers or more specifically the processors which deal with the instructions or programs to be carried out. An artificial intelligence would be able to handle simulations with huge numbers of objects in them and as processors become smaller and smaller with time and developments and yet with increasing levels of processing power this ability will be highly useful to further and quite possibly revolutionise how we develop processors. An artificial intelligence could also simulate the current forms of transport in use across the world and be able to detect flaws and from that allow for adjustments and therefore improvements to current transport systems as a means for relatively quickly, cheaply and therefore efficiently overhauling the transport systems in use across the world. The social implications for this would mean faster computers at relatively cheap prices for the advancements made due to cost effective designs simulated by an artificial intelligence, more people would be able to afford faster computers in order to help with education, industry, business etc. Also this would allow for improved travel durations, dependability, less fuel is used saving money and thanks to that there will be reduced travel expense for passengers, which intern helps boost the world's economy. Therefore the simulations an artificial intelligence could carry out would allow for great improvements inindustry, business and in general improve the opportunities and the quality of life of everyday people.

The general social implications for the introduction of true artificial intelligences would be enormous as it will lead to a change in how we perceive our society as it may one day come to pass that the technological objects that we have today and are taken for granted, such as a phone or mp3 player will be much more than simple objects. Should it be possible to insert an artificial intelligence into these objects, due to the fact that these artificial intelligences could be deemed intelligent we may find ourselves holding conversations with these objects in the same manner that we would if we were talking to another human being, even perhaps forging relationships with these objects as they should be able to understand and respond to our outlooks, emotions etc as much as we would expect another human being to do. These objects could evenbecome friends for example, although this seems a strange conclusion to make, nevertheless this is exactly the type of change that might be brought about by the introduction of an artificial intelligence which can then be placed into our commonly used items, a complete change in how we perceive ourselves as humans and how we perceive machines.

One application of intelligent systems is humanoid robotics, which in recent years has steadily been growing in popularity and is a major part of research and development in the robotics field. The entire field centres around the need for these robots to be able to act 'human' in nature, this therefore requires the need for robots to be able to perceive us an a level that is highly demanding and should bring about the development of robots that are able to send and receive complex inputs and outputs. As shown by the work of Asfour *et al* (2012), who states,

These aspects are, thus, particularly supported by humanoid robots, i.e., embodied robots that perceive, understand, and act in the real world in close interaction with humans to perform a wide range of tasks in different applications. Humanoid robots are associated with the idea of robots that are as versatile and flexible as humans and whose physical appearance is similar to that of the human body. Beyond physical resemblance, humanoid robots are meant to resemble humans in their actions, reasoning, and communicating about the world.

Therefore this shows the need for branching out in terms of the fields covered such as Humanoid robotics, artificial intelligence, general machine perception, interaction between humans and machines etc, before it can be truly called a useful application. This will enable the acceptance of the use of personal robots by the general population via achieving the level of interaction desired as shown previously.

There have been many developments in humanoid robotics throughout its history, including Toyota's partner robot, Petman, iCub, DARwin-OP, Lola, ASIMO and many others that are milestones in the development of humanoid robotics and in turn bring on the next developments of this technology and therefore these developments are well justified and ultimately needed for the development of an intelligent machine.

However none of the developments in humanoid robotics has led to a machine that can almost be called 'human', merely robots with aspects of humans, there is clear motivation for this cause as shown by the work of Asfour *et al* (2012), who states,

The Humanoid Robotics Technical Committee (HR-TC) was established with the mission of advancing science, technologies, and engineering of humanoid robotics, as well as engaging in education and outreach activities. The major activities of the HR-TC are reflected by the firmly established annual IEEE Robotics and Automation Society (RAS) International Conference on Humanoid Robots, which is an internationally recognized prime event of the humanoid robotics community.

This therefore emphasises the backing that has been acquired for humanoid robotics and its related fields with the goal of creating a 'human like', intelligent system.

The implications of humanoid robotics on society are for example, should machines become socially apt and or 'intelligent', it will lead to a boost in the economies of countries that implement such an application. This will be brought about by having them play a physical role in society such as supplementing a human manual labour work force or even replacing it entirely due to the lack of needs, such as breaks, as a human labourer must by law take breaks as determined by the field he/she works in, this costs a business work time and therefore productivity. There also are several different applications for humanoid robotics such as shown by the work of Yokoi, K. (2007) who states,

Honda’s ASIMO robot performs tasks of a receptionist or information guide tasks automatically in concert with people and carries objects using a cart….Okada et al. used humanoid robots for house-keeping chores such as washing dishes and cooking….Ogura et al. constructed a humanoid robot, WABIAN-2, to use for quantitatively testing rehabilitation or welfare equipments….examples of human care services: handing in the medicine….facial expression of robot avatar agent….Operating industrial vehicles: Humanoid robot got on the cockpit, seated on the protective seat, and drove the backhoe and excavated in the rain.

Therefore this shows that humanoid robotics would allow for industries to prosper with an improved or supplemented work force as well as improving the effected populations quality of life if they are not needed to perform unskilled physical labour as well as many other applications that 'human like' robots will be able to provide.

This therefore would ultimately challenge the population to achieve a better education and also the qualifications that come with that and so alongside the rapid advancements in technology, it should create an environment an increasing amount of jobs requiring persons with a higher education or craft than was previously required in order to be a productive member of society. This would drive society to become increasingly intelligent and add to the progression of the human race in general. Therefore it is clear that there are substantial benefits to the development of humanoid robotics, however this will take much cooperation from those working in the collective fields that will ultimately lead to the development of human like robots, I believe that it is worth the effort of attempting to have all the required fields work together in order to achieve this goal as the benefits outweigh the difficulties that effect this development.

Another application of intelligent systems is neuroprosthetics devices, these are devices with the ability to be implanted in a human body in order to either repair or in some cases improve upon part of the human nervous system as shown by the work of Millan, J. Del. R. (2009) who states "Neuroprosthetics is a rapidly growing discipline that brings together neuroscience and biomedical engineering….and seeks to interface the neural system directly to prostheses. The ultimate goal is to restore motor, sensory, or cognitive functions." An example of this is sensory prosthetics, this is where neuroprosthetics devices are implanted in order to repair or improve auditory and or visual sensors. In terms of auditory prosthetics devices, a popular example is the cochlear implant which improves a person's hearing capability as shown by the work of Melo, P. L. (2009) who states,

The cochlear implant consists of externally worn and surgically implanted components. These external components are required to sound capture and processing. This processed information is transmitted, via radio, to the surgically implanted electronics, which will generate patterns of stimulation pulses to the cochlea, through a multichannel electrode system. This multichannel array is usually inserted into the inner ear to deliver the stimulus currents to the hearing nerve fibers, which will lead the signals to the brain….

This shows a technical description of how the cochlear implant works, it is clear that this effects society as whole. The implication being that persons whose hearing has been damaged or those who have been rendered deaf due to environmental hazards, auditory damage by genetics etc, can be restored or improved if the cochlear nerves that the implant relies upon to function are usable as deafness can be caused due to the damaging or destruction of these nerves which this particular implant cannot correct. Therefore for those implanted with this device and re-gain or gain their hearing, this completely affects their life as they will perceive life in a way that is different from what they are used to depending on their own circumstances and experiences therein.

Another example of sensory neuroprosthetics devices is those implants that affects a patients visual capabilities, this is where an implant will improve or restore a person's sight as shown by the work of Melo, P. L. (2009) who describes a prototype for an implant,

In this visual neuroprosthetic device, a small camera mounted on eyeglasses captures images and wirelessly sends them to a microprocessor….which will convert them into an electronic signal and send it to a receiver on the eye. This receiver will send these signals to the microelectrode array, through some micro connector cable. These signals on the microelectrode array will emit pulses that will stimulate the retina remaining viable cells….After the implantation, the patients were able to discern light from dark ….Moreover, they were able to find and count large objects on a screen and even sense movement objects across the same screen….

This shows a technical description of an early prototype of a visual sensory prosthetic device that was implanted into patients and tested where it showed success although limited it is a prototype and justified the technology to be possible and therefore is worth attempting to develop further in order to improve upon the early successes that this prototype has achieved. Therefore this technology should be able to either improve upon or restore a person's sight and in doing so improve their quality of life as their perception of the world has changed for the better depending on the circumstances.

Another type of neuroprosthetics device is motor prosthetics which help a person with difficulties in moving limbs. An example of this is a device that assists a person with damage to their lower extremities or control of their lower extremities through injury or disease etc. The device attempts to assist those with walking difficulties due to a stroke, this is shown by the work of Melo, P. L. (2009) who states,

The implanted stimulator receives the control signals through an external control unit….the stimulation is activated by a wireless switch located in the shoe….A 2008 study has been performed regarding the patients’ perceptions of the benefits of such a device, and the findings suggested that the ActiGait improved walking and appeared to be easy to use….

This description if the implant clearly shows its usefulness in dealing with the issues people are having with their motor control, in this case by a stroke. It also leads to the validation of the field is this device has had success in dealing with the life affecting issues people have been having.

Neuroprosthetics devices although they are important as they greatly affect people's lives who undergo implantation and ultimately either help to repair or restore a person's hearing or sight etc, they are nonetheless not 'truly' intelligent. They may receive signals from the human body wherever they are implanted and respond based on whatever they receive especially with the more experimental devices that receive signals from the brain, they still only act on instructions programmed prior to implantation in order to execute their function.

The impact this has on society is not as substantial as with other so called 'intelligent systems' as these devices are merely inanimate objects performing a function, however they clearly effect a person's life who undergoes implantation of one of these devices as they help to repair or even restore functionality to a person's body. This in of itself improves effected people's quality of life as they regain functionality of their own body and are able to live life without the burden of knowing a part of themselves is not working as it should and based on this it is clear that developing these neuroprosthetic devices will be useful to society and further research and development is justified.

1. **Limitations**

For many of these 'intelligent systems' the only limiting factors other than the technological hurdles that comes with developing new or complex technologies is the societies perception of the technology and any ethical issues that come with the technology. For example should a true artificial intelligence be 'born' and placed into a mechanical body in order to fulfil a role such as manual labour for example on structures they have perceived to be damaged, therefore humans are not forced to do this work themselves it can be delegated to a robot, it could be very useful for industry as they should be more efficient but society may see this as humans being made redundant instead of how they were intended to be received which is to relieve humans from the tiring job of manual labour much as the introduction of the car relieved horses from the tiring job of being the main form of transportation used.

Also the ethical issues that are prevalent with an artificial intelligence is the sort of safeguards that should be placed in order to protect the human race from the very technology it developed. This is due to the fact that a true artificial intelligence will be sentient and intelligent to the point where it is no longer an inanimate object or device but a living being but not organic in nature. Should an artificial intelligence take umbrage to how they are controlled by their creators and rebel, it could create a dangerous situation as they could be capable of large scale devastation and damage to the human race and the world as a whole if proper precautions are not taken.

1. **Similar Technologies**

A similar technology to Intelligent systems is quantum computers, they are different to normal computers because they can they perform the tasks that a normal computer can do only in parallel, when a special type of algorithm known as a 'Quantum Algorithm' as shown by the work of Lanzagorta and Uhlmann (2009).

Therefore the use of a quantum algorithm combined with a quantum computer would allow for much greater performance as shown by the work of (Imperial College London, 1997a), "With the correct type of algorithm it is possible to use this parallelism to solve certain problems in a fraction of the time taken by a classical computer."

Quantum computers are a similar technology to Intelligent systems because with the greater performance that could be achieved by the use of a quantum computer and quantum algorithms not only would they be able to solve problems much faster than the modern computers of today, but they could also pave the way for the birth of the first 'true' artificial intelligence.

The theories of quantum computation suggest that every physical object, even the universe, is in some sense a quantum computer…..Ultimately this suggests that computers will be capable of simulating conscious rational thought. These theories provoke a minefield of philosophical debate, but maybe the quantum computer will be the key to achieving true artificial intelligence. (Imperial College London, 1997b)

Therefore should a quantum computer be constructed that is capable of conscious thought, this will essentially mean that an artificial intelligence will have been born and therefore would be able to acquire and complete jobs much faster than we could ever hope to. An artificial intelligence is a useful technology in of itself due to the sheer processing power it will be capable of, this will allow it to make predictions of for example weather forecasts, in order to improve their exactness, also an artificial intelligence would be able to perform analysis of data from across the world in order to discover previously unknown trends. As a result of quantum computers leading to the birth of an artificial intelligence, there are a great many benefits that can be reaped from this, however there are also hazards present with a sentient machine as science fiction has shown if problems were to arise it could be a dire situation for the human race as a species consequently in order to make certain that such a situation does not occur, precautions must be taken which inevitably willdelay the advancements of artificial intelligence but nevertheless the rewards are greater than the risks and should appropriate precautions and in general a level of caution in of itself be taken, it will be worth the effort of attempting to construct an artificial intelligence.

**5. Conclusion**

In this report I have given a brief introduction to Intelligent Systems, detailing its uses such as the development of an artificial intelligence for data processing and performing complex simulations etc and how this impacts on society for example improved travel times for public transport due to improvements brought about by an artificial intelligence running simulations and detecting flaws, its limitations such as ethical issues that come with these technologies and societies perception of these intelligent systems. Also similar technologies such as quantum computing which may be the way a true artificial intelligence is 'born'. This paper provides the reader with enough information on intelligent systems to understand its themes while generally not being so technical in nature that those unfamiliar with the topic will have issue with this report.

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| **PART B: LO3** | **A** | **B** | **C** | **D** | **E** | **F** |
| The background/Context of the technology’s emergence, ie from what other technology has it emerged or evolved? | An excellent, well-rounded, discussion of the technology and its emergence. | You have discussed all aspects of the technology and its emergence in some depth. | You have given a mainly descriptive account of the technology and its emergence. | The facts are presented, system of citing sources limited but useable. | You have made cursory mention of the technology and its emergence.  Over-reliance on a few sources; and poor use of citations.  Limited depth. | The technology’ or its emergence does not get a mention at all.  Citations have not been used to identify sources of any material used within the body of the report. |
| An evaluation of possible uses or markets. | An excellent, well-rounded, evaluation of the possible uses, markets. | You have evaluated in a limited way the technology’s possible uses, markets. | You have highlighted, the possible uses, markets. | You have mainly described the technology’s possible uses, markets. | You have made cursory mention of the technology’s possible uses, markets.  Limited depth. | The technology’s possible uses, markets do not get a mention at all |
| A discussion of the social, economic or technological implications of the technology | You provided an excellent, well-rounded, discussion of social, economic or technological implications of the technology | You have discussed the social, economic or technological implications of the technology | You have discussed, in a limited way, the social, economic or technological implications of the technology | You have made mention of the social, economic or technological implications of the technology | You have made cursory mention of the social, economic or technological implications of the technology  Limited depth! | The technology’s social, economic or technological implications does not get a mention at all |
| Structure: contents page; numbering; abstract; conclusion; references; etc  Appendices  Style:  Written in an appropriate academic style, with references? | An excellent structure, easy to navigate, easy to read (document standards compliant; consistency; summaries)  You have written in a clear, concise, academic style, which has been appropriately referenced.  Evaluative summary of meetings with tutor | Very good structure (easy to navigate, easy to read).  Your style is clear and concise, and is largely academic in style and suitably referenced.  Detailed but descriptive summary of meetings with tutor | A good structure that is relatively easy to navigate and comprehend.  Harvard referencing is used accurately. There may be some spelling, grammar, and punctuation issues affecting clarity in places.  Brief but accurate summary of meetings | A satisfactory structure but not always logically presented; and lacking appropriate sizing of section s and sub-headings.  Harvard referencing is used, but some errors in places.  The essay is not written in the 3rd person.  A list of meetings presented. | Poorly structured essay;  and, your style of writing is poor. | A poor effort;  Difficulty in navigating and comprehending content;  written in a non-academic style;  Poorly cited (or referenced )  or not cross-referenced at all! |

Comments

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