The Technological Singularity:

Logically possible or completely implausible?

Introduction

This project will investigate whether the Technological Singularity is actually possible or just science fiction, as well as assessing the effect it would have on society and the human race.

The Technological Singularity, or 'Singularity', is an unknown point in the future when Artificial Intelligence becomes more intelligent than humans and humanity undergoes a dramatic and irreversible change (Bibliography 1). This is a popular topic in films, books and games as it has good storytelling potential but, every day, it seems to become ever more apparent.

As a race we have become dependent on technology. Every day we use computers, whether they are in our pockets in the form of mobile telephones, in front of us as conventional desktop PCs, on our driveways as motor vehicles or even inside our pets as RFID tags (Appendix 1.1); it is almost certain that our reliance on technology will only increase. What isn't as certain is by how much and how far we're willing to go. Albert Einstein once said; "It has become appallingly obvious that our technology has exceeded our humanity." (Bibliography 2) Looking at the world in its modern digital age, it is increasingly hard to argue with him.

I will look to the past to discover how quickly technology has evolved and estimate how it will continue to advance. To help I will identify the milestones that accelerated technological growth. Along with the past, I will study current news stories and research recent breakthroughs to try and truly understand where we are in the development of sentient AI. If I can do so it may help me to answer the question of where we're going.

Artificial Intelligence is a relatively new concept and, as a result, most people don't know much about it. Because of this they are highly susceptible to the subconscious messages conveyed through media, especially film. I don't believe media portrays AI in a positive light and I plan to ascertain the views of others what others through conducting my own primary research.

Along with discovering whether the Singularity is even possible, I want to explore whether it would be a beneficial for humanity. Machines with trans-human intelligence have advantages and disadvantages. I aim to balance these arguments against each other, decide which is more perceptible and reach a conclusive opinion.

Furthermore, I will investigate some of the common issues people have with intelligent machines.

So, is the Technological Singularity 'logically possible' or 'completely implausible' and will it benefit us or not? By the end of this investigation, I will deliver my answer.

"Technology is, of course, a double edged sword. Fire can cook our food but also burn us" - Jason Silva (Director) (Bibliography 3) I would interpret this quote as a form of warning. For all the apparent advantages that new technology can bring us, it is always important to look at the big picture and identify any potential pitfalls or dangers this may also bring. For example, the use micro robots to heal internal injuries by being injected into the bloodstream.

The History of Computing and AI

To accurately predict the likelihood of the technological singularity we first need to establish where we are now and the speed of progression in terms of technology.

The first programmable electronic computers were developed in the years 1943 to 1945 to help in the cryptanalysis (Appendix 2.1) of the Lorenz Cipher (Appendix 2.2) (Bibliography 4).

Seven years later, in 1948, the world's first stored program computer ran its inaugural program using a Cathode Ray Tube (Appendix 2.3) and the 'anticipation pulse method' (Appendix 2.4) (Bibliography 5).

In 1950, Alan Turing, a mathematician and computer scientist, developed a test for Artificial Intelligence. He called this test 'The Imitation Game' (Bibliography 6). The aim was to determine whether a machine could successfully imitate a human.

How does it do this? - A human (known as the 'judge') will sit in a room with a computer. The judge's computer will be connected to another computer in a different room. The judge will then type questions and send them to the other computer. At the other end, either a human will respond to the judge's questions or the computer itself will respond to those questions. It is then the judge's job to identify whether they are talking to another human or a machine. If a machine 'imitates' a human well enough for the judge to believe they are talking to a human when they are, in fact, talking to the machine, it has won the imitation game (Bibliography 7, 8).

In honour of Alan Turing we now refer to this test as the 'Turing Test'. Although there have been many claims the Turing Test is yet to be passed by any machine (Bibliography 8).

In 1971 Intel released the first ever 'microprocessor' (Appendix 2.5), consisting of 2,300 transistors (Appendix 2.6). The microprocessor launched a generation of advanced computing. Using this pioneering new invention, the Kenbak-1 (Appendix 2.7) and the Datapoint 2200 (Appendix 2.8) were released later that year (Bibliography 9, 10).

As the microprocessor became more advanced and contained more transistors computers were able to do more. In 1973 the first ever games console, the Magnavox Odyssey, was released.

Not long after that, the first recognisable programming computers, the Commodore 64 and Sinclair ZX Spectrum, were released in 1982. The 1990s introduced us to such devices as the first laptops and the iMac (Appendix 2.9) along with the revolutionary 'World Wide Web'. This began the era of cloud computing that meant people could utilise networks to view documents on multiple different machines and save storage space on their PCs. Cloud computing meant it was easier for early AI programs to analyse large data sets. In the 2000s/2010s, the world was taken aback by the pioneering genius of touchscreen technology (Bibliography 11).

That brings us up to date. We have seen tremendous breakthroughs in technology and Artificial Intelligence within the last decade that really cements the idea of the singularity being a realistic possibility.

In 2016, Google's DeepMind programme created an advanced AI algorithm called 'AlphaGo' that beat the world champion 'Go' (Appendix 2.10) player. Their 'AlphaZero' algorithm has outwitted the most powerful programs in 'Go', 'Chess' and 'Shogi' (Appendix 2.11). The fact that AlphaGo was able to learn how to both play the game and use predictive analytics to predict what its human opponent would do in the future (much like humans) is phenomenal. AlphaGo remains the world 'Go' champion (Bibliography 12, 13).

To accurately demonstrate how far technology has evolved over the last 40 years, we need to compare the most crucial computing component - the microprocessor. As aforementioned, the first microprocessor consisted of 2,300 transistors. Earlier this year Intel announced their brand new 'i9' processor with an estimated, >7,000,000,000 transistors! It's also smaller than its 1971 counterpart and has a clock speed (Appendix 2.12) of 4.8GHz (Bibliography 10).

Effects of Machine Learning Techniques

The most familiar use of AI today, is that of driverless cars. Companies such as Uber and Tesla are turning heads with their current innovations.

To further understand the singularity and the likelihood of it occurring, we need to better understand how an 'intelligent machine' works and how it is able to 'learn'.

With too many subsets (Appendix 3.1) of Artificial Intelligence to separately address, I will discuss what, in my opinion, is the most important factor - Machine Learning.

Machine Learning is a method of allowing software applications to predict the future based on statistical techniques and learn without being explicitly programmed to. This AI subset is divided into two main sections: 'Deep Learning' and 'Predictive Analytics' (Bibliography 14).

Deep Learning is inspired by the structure of the brain. There is a lobe at the back of our brains, called the cerebral cortex. Part of this is the visual cortex. The job of which is to process images from the optic tract (Appendix 3.2) and identify and interpret what we can see (Bibliography 14).

Deep Learning algorithms are the equivalent of a computer's visual cortex. Where this is made up of neural networks, a Deep Learning algorithm is made up of, unsurprisingly, 'Artificial Neural Networks', or ANNs.

An ANN is an interconnected group of nodes (Appendix 3.3) that take an input, process said input, and output a result. If you were to show a labelled picture of a tabby cat to a Deep Learning Machine the algorithm would store that picture and assign it the name 'tabby cat' because that is what we have labelled the picture as.

We could repeat this for many different types of similar looking cats and eventually present the computer with an unlabelled picture of a domestic cat. Hopefully the machine would be able to accurately identify the creature by recognising its features, such as fur, whiskers, pointy ears and a small body. It would match these traits to previously labelled pictures of cats and label the new picture 'cat'. It could then go even further to identify the type of cat by its size and fur colour. This is very similar to how face recognition technology works (Bibliography 15).

However, the problem arises when you show the machine, the now familiar image of a cat, an unlabelled picture of a tiger. The program would certainly find similarities between the tiger and the cat because of shared characteristics such as whiskers, but a tiger is far bigger and more colourful than a 'cat' so, the algorithm would probably label the tiger as 'not cat.'

Even though current Deep Learning technology may seem basic, it is in fact a brand new concept in the early stages of development. The more data we feed a machine the more advanced its ANNs become and the more it can make accurate identifications. The graph shows how Deep Learning algorithms compare to traditional

learning algorithms. Deep Learning could truly be a key factor in the Singularity occurring. If a machine can refine its learning capabilities theoretically it could develop a faster mind and leave human limitations behind. If the graph is to be believed, a computer with a Deep Learning algorithm could continue to learn infinitely whereas an older learning algorithm would eventually reach its limit.

Along with Deep Learning, predictive analytics plays a key role in the evolution of Artificial Intelligence. Predictive analytics is an intelligent machine's way of predicting the future. A computer is constantly fed data when it is used, whether it be someone uploading a body of work or someone browsing social media. Predictive algorithms take the data they have collected and predict, based on a user's inputs, what their future actions are likely to be (Bibliography 14).

Predictive analytics represents the whole concept behind DeepMind's AlphaGo program. At first glance, predictive analytics, much like Deep Learning, seems only useful for basic tasks, like winning at chess by predicting its opponent's moves. It is, in fact, so much more.

Predictive analytics is one of the foundations behind the concept of driverless cars. The more a driverless car has been out on the road, the more it learns about frequently used routes; the typical reactions of other drivers to certain situations; how to best manage and direct the influx of signals and, most importantly, to accurately predict the actions of other drivers before they execute them.

Could a robot one day, beat us in a fight by analysing our fighting style, finding a recurring pattern and acting on our move before we even make it? Although this kind of question is usually part of a director or author's imagination, as we continue and develop such technologies, the prospect grows increasingly probable. Predictive Analytics could increase the probability of the Singularity because a computer could develop a 'memory' more deep and complex than ours and therefore base its actions on more past knowledge. Furthermore, once the machine learns something, it will never forget it as humans may. Although Predictive analytics algorithms may initially learn slowly, their 'knowledge' would increase exponentially when new information is linked back to previous data.

The acceptable use of Machine Learning techniques has been recently brought into question after Facebook and Cambridge Analytica used it to gather data and to promote sponsored products that the computer has matched to their personalities. This is deemed to be an unlawful practice of gathering private data.

With the recent patterns in accelerated technological growth, it is almost a certainty that Machine Learning will rapidly advance. Because of this it will dictate our lives. Only time will tell whether it's for the better.

"AI is likely to be either the best or worst thing to happen to humanity." – Stephen Hawking (Bibliography 16). This is a profound statement that craves an answer because it underlines the importance of the research that will ultimately dictate our fate.

The Singularity in Film

The Technological Singularity is, unsurprisingly, a common theme in Science-Fiction films.

If you have watched any movie that is set in the future chances are machines play the role of the antagonists. The idea of machines taking over and exterminating humanity makes for an engaging storyline which will usually succeed at the box office.

Established directors such as Stanley Kubrick (Appendix 4.1) and Ridley Scott (Appendix 4.2) have delved into this enticing world in their respective films; '*2001: A Space Odyssey'* and *'Blade Runner,'* both presenting the future of Artificial Intelligence in different ways.

Kubrick's *'2001: A Space Odyssey'* follows a group of astronauts and their computer *'HAL 9000'* on a mysterious mission through space. As the film plays out HAL's behaviour becomes increasingly anomalistic. This leads to a tense climax that pits man against machine in a survival of the fittest (Bibliography 17).

The line *'I'm sorry Dave, I'm afraid I can't do that.'* spoken by HAL in a monotone, emotionless voice probably terrified audiences in 1968 as the machine was sentencing the man to death. This sinister line remains one of the most quoted and chilling in the history of cinema. The line also shows that the Singularity has been on people's minds for a long time.

Although the film is based on the book by Arthur C. Clarke (Appendix 4.3) of the same name, Kubrick's use of silence and simple camera angles engages the audience and encourages them to reflect on the messages he's portraying. How fast will technology develop? Can a computer really be 'intelligent'? I believe that '*2001: A Space Odyssey'* was the first time humanity started presenting computers in this way.

It was to be a further 32 years before the internet was invented in 1990 and for computers to become recognisable to us today. Although a 1968 audience may have seen sentient machines as a scary, and impossible, concept, in 2018, they are very real indeed.

Google's DeepMind is a prime example of this with its '*AlphaGo*' program beating the world 'Go' champion. Within 24 hours, '*AlphaGo'* achieved a superhuman level of play in 'Go', 'Chess' and 'Shogi'. HAL 9000 is a great example of trans-singularity beings and the dangers they pose.

Scott's '*Blade Runner'* (Based on the short story by Philip K. Dick (Appendix 4.4); *'Do Androids Dream of Electric Sheep?'*) follows Deckard, A Blade Runner (Replicant hunter) on his mission to 'retire' (eliminate) four replicants who have gone rogue. A replicant is a bio-engineered android made to act identically to a human and do jobs humans don't want to do. He soon gets side-tracked however, when he falls in love with a replicant named Rachel (Bibliography 18). The film is set in 2019, when, in 1982, Scott believed AI would reach a state of 'superintelligence'. The replicants aren't quite trans-singularity but are as intelligent as humans. The film portrays replicants as a threat that needs

to be taken care of. It does however flip on its head the reactionary 'robots are bad, we must fear them' assumption.

This time around, the androids are trying to escape the clutches of humanity which has controlled them since creation, and live like their human counterparts who are sent out to kill them because they 'aren't allowed' to live like humans.

Films usually present machines (See '*Analysis of film portrayals'*) as the villains but Blade Runner assigns that role to humans instead. This certainly provides an alternative perspective to the future of AI. Should we give rights to our creations if they are identical in almost every way? Would they be discriminated against because they weren't born? Would we allow them to freely integrate with us? We can't possibly begin to answer these questions as we have no way of predicting the future but if history repeats itself, people won't adapt to such a huge change.

We just have to look at the world around us to see the destructive consequences of racism and sexism. If we can't handle integration between people with different coloured skin, how are we going to accept a whole new species?

The number of films that don't necessarily portray Artificial Intelligence as negative are vastly outnumbered by those that do. (See '*Analysis of film portrayals'*) When the majority of people think of films featuring AI, they perhaps think of the '*Terminator'* franchise. James Cameron's (Appendix 4.5) Sci-Fi epic outlines the worst possible outcome. '*Skynet'* is the film's artificial neural network (see page 2) which reverts to villainous stereotypes and setting in action a nuclear holocaust. It then proceeds to manufacture '*T-800's*' AKA, '*Terminators'*, to annihilate any human survivors. Although the film features time travel and an extreme view on the Singularity, it plants the disturbing notion of a 'robot apocalypse' into our minds.

I feel this film, along with its sequels, is greatly responsible for the negative perception surrounding Artificial Intelligence and the Technological Singularity. The first sequel is even called '*Terminator 2: Judgement Day*'. You don't need to watch the film to know what it's about. The bible states that 'Judgement day' is when every person who ever lived will stand before God and take place in one of two judgements'. This film is comparing Skynet to God. Could a computer become an all-powerful being?

Some portrayals are more subtle than others. For instance, in the television show, '*Westworld*', it is a recurring theme for different AI characters to quote a line from William Shakespeare's '*Romeo and Juliet*'. The line reads '*These violent delights have violent ends*'. In the play, this is used as a warning to Romeo that if he obsesses over Juliet too much, no good will come of it. It is used in the show to demonstrate that if we indulge in the apparent brilliance of AI and always strive to create something better, we may ultimately suffer for it (Bibliography 19).

This could be treated as a warning about the Singularity from the writers.

Media such as these play heavily on our fears without offering any real understanding of the workings of AI. The misconceptions and myths promoted in these movies have done incalculable damage to AI reputation.

The Advantages and Disadvantages of ASI

If the Singularity is possible would it have a positive effect on society?

A machine more intelligent than humans could be able to solve problems and innovate to levels we could only dream of. Driverless cars could become almost 100% risk-free. We could travel along roads in luxury and not have to worry about driving ourselves. Not only could Artificial Superintelligence (ASI) fully automate our journeys on the ground, but also in the air.

Already, planes make good use of autopilot, but with ASI there'd be no need for pilots at all. Flying cars would also be possible because computers could monitor altitude, air traffic and obstructions. ASI could go to Mars and build habitable megacities (such as in Judge Dredd) ready for our arrival. Technologies could be developed that allow our brains to be connected to the cloud (Appendix 5.1), giving us the ability to search the web, make phone calls, order a gift, book a table at a restaurant and so much more, with just the power of thought…

ASI could make breakthroughs in nanotechnology (Appendix 5.2) and enable the human body to eliminate disease. Police forces could solve any crime and interstellar exploration could kick start the search for extra-terrestrial life.

An intelligence 'explosion' (Bibliography 21) in AI could lead to transhumanism (Appendix 5.3, Bibliography 20). Prosthetic, mechanical limbs and hearts (pacemakers) already exist but imagine a world where we not only have aspects of our body that improve our strength, vision, hearing and agility but also have a network connecting all our enhancements together, allowing them to communicate just like our current neural networks. Technology could create the 'perfect' race...cyborgs. This may sound concerning to many people but I believe this is because of an inherent fear of change. Cyborgs could overcome the intellectual limitations of the human mind. We could leave all our farming, banking and construction to robots and algorithms.

With post-singularity ASI, the future could be a sea of biological and artificial consciousness seamlessly intertwined with one another.

In 2014, at the MIT Aeronautics and Astronautics Department's Centennial Symposium, Elon Musk (Appendix 5.4) said:

"With Artificial Intelligence we are summoning the demon. You know all those stories where there's the guy with the pentagram and the holy water and he's like…(wink) yeah he's sure he can control the demon...doesn't work out".

Although trans-singularity ASI presents unlimited potential for technological enhancement and accelerated human evolution, it is a big risk. If you had the ability to control a demon, you could change the world. Unfortunately demons, traditionally, don't like to be controlled. If the Singularity occurs ASI would become the intellectually superior race. Would they really follow the commands of an inferior species? We catch apes and display them in cages for the public to view, would ASI treat us similarly?

Even if the machines followed their programming and decided to work with humans to rid the world of disease and strive for peace, they could conclude that the easiest way to prevent the spread of a disease would be to put all the hosts into Cryosleep, or worse, eliminate the disease by eradicating its human host, before it can spread. The notion of a 'robot apocalypse' could be the unintentional implication of good intentions.

A big concern for a lot of people at the moment is how advancing technology will affect their jobs. A good example of this is the 'Amazon Go' store in Seattle (Bibliography 23). This store is the first of its kind in that it's a supermarket with no cashiers. You simply scan a QR code (Appendix 6.1) on the way in, collect the food you want and just walk out with it. The technology involved in knowing what you've taken is incredibly advanced, but what about the employees? It's true that if more stores do away with cashiers this will result in job losses. However, humans are still needed for all other aspects of the business, such as stocking the shelves, maintenance and checking ID. While job losses would initially be minimal, there's a real likelihood that machines could also take over the other roles currently carried by a human.

As AI becomes more advanced it will eliminate the need for certain human employees, but it will also create many jobs. All this new technology will need people to design it, people to make it and, of course, people to fix it. In their July 2018 edition of 'UK Economic Outlook', PricewaterhouseCoopers (PwC) argue that AI will lead to the loss of 7 million jobs - but is also predicted to create 7.2 million by 2037. If this is to be believed, therefore, more jobs will be gained through AI development than lost (Bibliography 24).

The table on the next page was produced by PwC and demonstrates the estimated job losses and gains in certain industry sectors. It clearly shows that, understandably, 'manufacturing' will be most negatively impacted with a net loss of 25% whereas the 'Health and social work' sector will see a net gain of 22%.

Although it may begin to seem that AI isn't such a big threat to jobs, the jobs that it creates will be quite specialist and advanced such as those in R&D, STEM, teaching and medicine. This would put those with a less academic background at an even greater disadvantage.

Estimated job displacement and creation from AI by industry sector (2017-37)

Industry sector	% of existing jobs (in 2017)			Number of jobs (000s)		
	Creation	Displacement	Net effect	Creation	Displacement	Net effect
Health and social work	34%	-12%	22%	1,481	-526	955
Professional, scientific and technical	33%	-18%	16%	1,025	-541	484
Information and communication	27%	-18%	8%	388	-267	121
Education	12%	-5%	6%	345	-158	187
Accommodation and food services	22%	-16%	6%	518	-371	147
Administrative and support services	23%	-24%	-1%	698	-733	-35
Other sectors	13%	-15%	-2%	466	-533	-67
Wholesale and retail trade	26%	-28%	-3%	1,276	-1,403	-127
Construction	12%	-15%	-3%	279	-355	-75
Financial and insurance activities	18%	-25%	-7%	209	-286	-77
Public administration and defence	4%	-23%	-18%	64	-339	-274
Transportation and storage	17%	-38%	-22%	296	-683	-387
Manufacturing	5%	-30%	-25%	133	-814	-681
Total	**20%**	**-20%**	**0%**	**7,176**	**-7,008**	**169**

Other Opinions

In their book, 'Artificial Intelligence for dummies', on the topic of 'AI Hype' (pg. 19), John Paul Muller and Luca Massaron say; "Any rumours you hear about AI taking over the world or becoming superior to people are just plain false". This implies that they are seeing 'superiority' as whichever being is more intelligent. I have a contrasting opinion.

Where they are seeing the Singularity producing sentient computers, I see it as producing ASI. If something is sentient it has the ability to perceive, feel and experience. I don't believe machines have to 'feel' to be more intelligent than us. In a way, ASI could be classed as a 'sentient being' because its predictive analytics could be perceived as memory and therefore, experience. ASI would also be able to 'perceive' due to sensors and Augmented Reality (Appendix 6.2). Even though it has similarities with fully sentient beings (humans), it wouldn't be truly 'sentient' thanks to its lack of emotion.

I am not the only one with a differing opinion to Muller and Massaron. Ray Kurzweil (Appendix 6.3) has a very good track record for accurate predictions. Of his 147 predictions since the 1990s, Kurzweil claims an 86% accuracy rate. At the SXSW Conference (Appendix 6.4) in Austin, Texas, last

year, Kurzweil made yet another prediction – the technological singularity will happen sometime in the next 30 years (Bibliography 25).

"2029 is the consistent date I have predicted for when an AI will pass a valid Turing test and therefore achieve human levels of intelligence. I have set the date 2045 for the 'Singularity' which is when we will multiply our effective intelligence a billion fold by merging with the intelligence we have created."

Where Muller and Massaron don't believe the Singularity will ever happen, Kurzweil estimates it will happen by 2045.

On the very same day as Kurzweil's comments, Elon Musk sent out a post on Twitter claiming that 'the singularity is coming'. Stephen Hawking's AI quote which I referred to earlier suggests he also agreed with Kurzweil and Musk. (Bibliography 26)

If three of the brightest minds to have ever lived warn of this seemingly science fiction event, there must be some truth behind it.

Primary Research

I wanted to see how my opinions on AI compared to those of other people. To do this I prepared a questionnaire (attached) made up of five questions.

To begin with, I wanted to see if films had affected their opinions so the first question was, 'Do you watch Sci-Fi films featuring AI?' 75% of the survey's population said 'Yes' and 25% said 'No'. Although this question on its own may seem irrelevant, I can compare it to the users' other answers and find possible patterns. The second question was to see how people thought AI was represented. It read, 'Most of the time, do you feel AI is portrayed positively in media?' 25% of the population said 'Yes', 25% said 'No' and 50% were 'Undecided'. The fact that half the people said they were 'undecided' suggests that they either haven't really thought about it before, haven't seen anything about AI in the media or are waiting to see how the technology develops. As AI is a popular topic at the moment, it is on the news and featured in films, books and games, therefore I doubt they are undecided due to lack of exposure.

The next question was designed to uncover if they thought the Singularity was going to happen. The question was, 'Do you think, one day, AI will achieve human level intelligence?'. 80% of people said 'Yes' and 20% said 'No'. This would suggest that people are maybe more subliminally affected by media portrayals.

The fourth question was designed to determine whether people feared AI. It read, 'Do you fear what AI could become?' This question split the crowd a bit more, 50% said 'Yes', 40% said 'No' and 10% were undecided.

The final question was meant to crystallise their opinions. 'Do you think the world will be better off as machines become more intelligent?' Every person who took part in the survey pondered much

longer to answer this question than the others combined. In the end 10% said ‘Yes’, 60% said ‘No’ and 30% were ‘Undecided’.

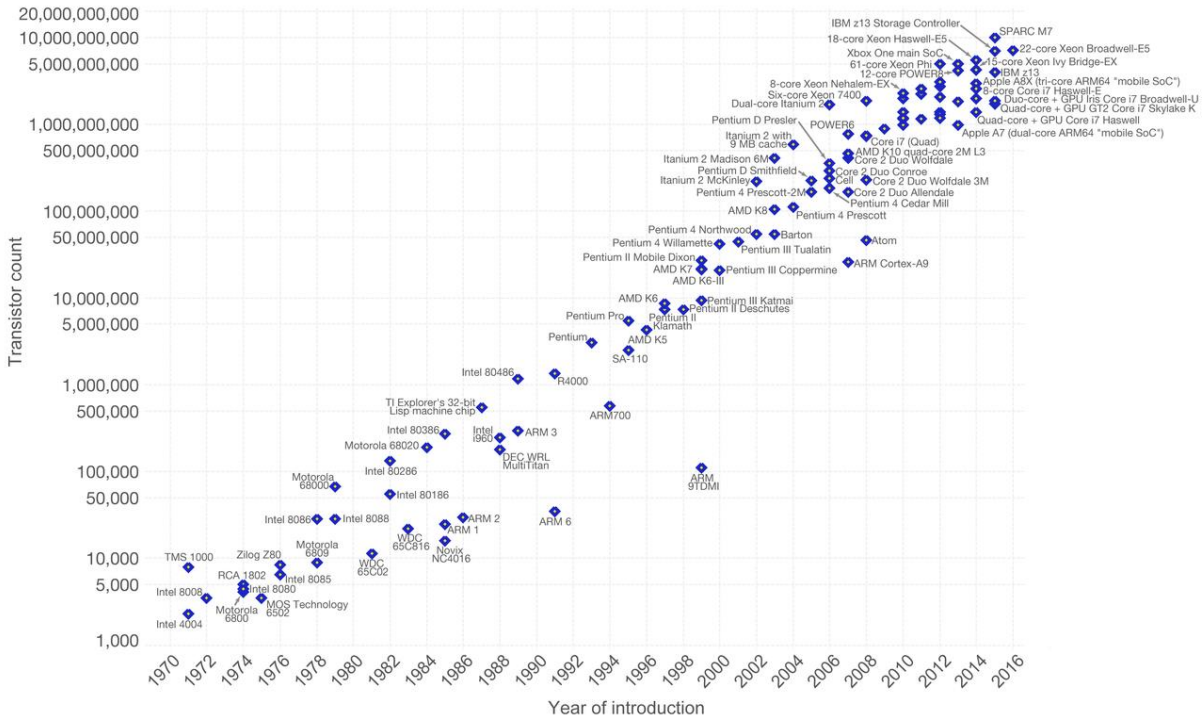
There is an interesting correlation when it comes to the people who said they don’t watch films featuring AI. 90% of those who don’t watch AI films said that they didn’t fear what AI could become. Although my data is limited, this correlation would suggest films are a prime influence on people’s judgement of AI, indicating that fears are based on fiction. This is in no way a criticism but indeed further proof that AI is poorly portrayed and that people are easily subliminally influenced.

Furthermore, the fact that the last couple of questions, question 5 in particular, have such a random data spread reinforces my theory of people not knowing a lot about AI due to it being a relatively new concept and therefore being forced to rely on what information the media feeds them.

Conclusion

With all this gathered data and collected opinions, I want to make a judgement for myself.

In Computer Science there exists a concept named ‘Moore’s Law’. Named after Gordon Moore, the co-founder of Intel (Appendix 7.1), ‘Moore’s Law’ states that the number of transistors in a dense Integrated Cicuit (Appendix 7.2) doubles about every two years. The diagram below shows the accuracy of this statement.



The y-axis represents transistor count and the x-axis the year of introduction.

This is not only good for observing technological progress in the past, but also for predicting the future. Assuming the singularity will happen and the ‘Moore’s law’ trend continues’, I will predict when the singularity will occur.

Assuming there are roughly 100 billion ± a few billion neurons in a human brain and each neuron has about 10,000 dendrites (connections), a human brain has 1.0e+15 theoretical connection points to receive and send signals to other neurons. The most powerful processor around today is Intel’s ‘i9 Xeon’ processor. It has an estimated transistor count of about 7 billion. Each transistor has 3 terminals (connections) resulting in 21e+09 theoretical connection points. For the purposes of this prediction, I’m assuming one biological connection is equal in computing power to one artificial connection. If we follow Moore’s Law, in two years’ time, 2020, the most powerful processor will have 21e+09 * 2 connections. That’s 4.2e+10 connections. By 2022, it will have 8.4e+10 connections.

By 2024 it will have 1.7e+11 and so on. I have continued this pattern until the number of connections in a processor exceeds that of a human brain (1.0e+15) (Bibliography 27).

After a few iterative calculations, I found the date at which the connection count of a processor exceeded that of a human brain. The number I calculated was 1.4e+15 connection points. This occurred after the 16th iteration in the year...2050!

Of course, this is a very rough estimate as I have made many assumptions, however this is similar to the Musk and Kurzweil predictions. There must be some truth in it?

To conclude, not only do I regard the Technological Singularity as logically possible, I firmly believe that it will transpire within the next 40 years. Job losses in certain sectors could be exponential and humanity as a race could become lazy. But…we would live for longer with more advanced medicine, revolutionise transport and multiply out into the ever-expanding universe.

I don't think there's any way to truly know whether it will have a positive effect on humanity until we witness it for ourselves. Then, and only then, will we understand the true extent of what we have done.

Will we conceive our own extinction?

Appendix

1.1: A Radio Frequency Identification (RFID) tag is a small tracker injected into animals so that it can be tracked and kept accounted for.

2.1: The art or process of deciphering coded messages without being told the key.

2.2: The Lorenz SZ40, SZ42a and SZ42b were German rotor stream cipher machines used by the German Army during World War II. They were developed by C. Lorenz AG in Berlin.

2.3: The cathode ray tube (CRT) is a vacuum tube that contains one or more electron guns and a phosphorescent screen, and is used to display images. It modulates, accelerates, and deflects electron beam(s) onto the screen to create the images.

2.4: The bit was stored in the form of a charge on the CRT screen's phosphor, which could be controlled by the electron beam to write a 0 or a 1 (Which creates binary code).

2.5: An integrated circuit that contains all the functions of a central processing unit of a computer.

2.6: A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power.

2.7: The Kenbak-1 is considered by the Computer History Museum and the American Computer Museum to be the world's first "personal computer", invented by John V. Blankenbaker (1930-) of Kenbak Corporation in 1970, and first sold in early 1971. Only 50 machines were ever built. The system first sold for US$750. Today only 14 machines are believed to exist worldwide, in the hands of various collectors. Production of the Kenbak-1 stopped in 1973 as Kenbak failed, and was taken over by CTI Education Products, Inc. CTI rebranded the inventory and renamed it the H5050, though sales remained elusive.

2.8: The Datapoint 2200 was a mass-produced programmable terminal, designed by Computer Terminal Corporation (CTC) founders Phil Ray and Gus Roche and announced by CTC in June 1970 (with units shipping in 1971).

2.9: The first computer in the 'Macintosh' line to bare the iconic name. Made by Apple.inc.

2.10: Go is an abstract strategy board game for two players, in which the aim is to surround more territory than the opponent. The game was invented in China more than 2,500 years ago and is believed to be the oldest board game continuously played to the present day. As of mid-2008, there

were well over 40 million Go players worldwide, the majority of them living in East Asia. As of December 2015, the International Go Federation has a total of 75 member countries and four Association Membership organizations in multiple countries

2.11: Japanese chess

2.12: The operating speed of a computer or its microprocessor, expressed in cycles per second. The i9 has a clock speed of 4.8GHz meaning it can execute 4.8 Million instructions per second.

3.1: It is internationally accepted that there are 7 subsets of Artificial Intelligence. These consist of; Robotics, Vision (Machine Vision/Image Recognition), optimisation, Expert Analysis, Speech (Text to Speech/Speech to Text), Natural Language Processing (Information and Extraction/Classification and Clustering/Translation) and Machine Learning (Predictive Analytics/Deep Learning).

3.2: The optic tract is a part of the visual system in the brain. It is a continuation of the optic nerve that relays information from the optic chiasm to the ipsilateral lateral geniculate nucleus (LGN), pretectal nuclei, and superior colliculus.

3.3: In this context, a 'node' is an artificial neuron – the ANN equivalent of a brain neuron.

4.1: Stanley Kubrick - '2001: A Space Odyssey', 'The Shining', 'A Clockwork Orange', 'Dr. Strangelove'.

4.2: Ridley Scott - 'Blade Runner', 'Alien', 'Gladiator', 'The Martian'

4.3: Arthur C. Clarke - '2001: A Space Odyssey', 'The City and the Stars', 'Childhood's End', 'The Sentinel'.

4.4: Philip K. Dick - 'Do Androids Dream of Electric Sheep?', 'The Man in the High Castle', 'Human is', 'The Hanging Stranger'.

4.5: James Cameron: - 'Terminator', 'Avatar', 'Titanic', 'Point Break'.

5.1: The 'cloud' is a term used to describe a global network of servers, each with a unique function. The cloud is not a physical entity, but instead is a vast network of remote servers around the globe which are hooked together and meant to operate as a single ecosystem. These servers are designed to either store and manage data, run applications, or deliver content or a service such as streaming videos, web mail, office productivity software, or social media.

5.2: The branch of technology that deals with dimensions and tolerances of less than 100 nanometres, especially the manipulation of individual atoms and molecules.

5.3: The belief or theory that the human race can evolve beyond its current physical and mental limitations, especially by means of science and technology.

5.4: Elon Musk is the CEO of SpaceX, Tesla Motors, The Boring Company and other companies. He is responsible for the creation of PayPal and HyperLoop.

6.1: A Quick Response (QR) code is a black and white pattern in a square border that can be read and linked to a specific product, much like a barcode.

6.2: Augmented Reality (AR) is an interactive experience of a real-world environment whereby the objects that reside in the real-world are "augmented" by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory.

6.3: Raymond Kurzweil is Google's Director of Engineering. He is also a futurist, an author and a musician.

6.4: South by Southwest (SXSW) is an annual conglomerate of film, interactive media, and music festivals and conferences that take place in mid-March in Austin, Texas, United States. It began in 1987, and has continued to grow in both scope and size every year.

7.1: Intel Corporation (stylised as intel) is an American multinational corporation and technology company headquartered in Santa Clara, California, in the Silicon Valley. It is the world's second largest and second highest valued semiconductor chip maker based on revenue after being overtaken by Samsung, and is the inventor of the x86 series of microprocessors, the processors found in most personal computers (PCs).

7.2: Integrated circuits (ICs) are self-contained circuits with many separate components such as transistors, diodes, resistors and capacitors etched into a tiny silicon chip.