The 'technologcial singularity'

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Abstract— The purpose of this report is to discuss the concept of a technological singularity. In this paper we look at the three schools of thought as to what a technological singularity would be, the benefits, risks and social implications for a technological singularity. How it may be achieved, and what advances in technology indicate we are on the path to a technological singularity. Technology is going to continue its advance, producing technologies with super-human capabilities. There are tremendous benefits to a technological singularity, but there's also very dangerous risks, and profound social implications. We need to be prepared to avail of the benefits while avoiding the risks.

Keywords—technological singularity, artificial intelligence, transhumanism, post-biology

I. INTRODUCTION

Once only in the domain of science fiction the concept of machines becoming more intelligent than humans, is now something many scientists predict will occur in the not so distant future.

At this point where machines achieve human-level intelligence, they will begin to design and rapidly produce ever-increasing levels of intelligence producing a super-intelligent machine vastly superior to humans. This point where machines exceed human intelligence has become known as the technological singularity.

While the word singularity was used by Irving John Good in 1965 [1] and before that by John Von Neumann [2, p. 59], the term technological singularity was really popularised by computer scientist and science fiction writer Vernor Vinge in 1993 [3].

II. THE THREE SCHOOLS OF THOUGHT

A technological singularity may mean different things to different people, some perceive it as a threat to the future of humanity, others as delivering unlimited benefits to humanity, and some see it as inevitable so we have to manage it to avoid the risks and avail of the benefits.

Elibezer Yudkowsky [4] [5] divides technological singularity into three schools of thought, the accelerating school, the event horizon and intelligence explosion.

A. Accelerating

Technology will continue its upward trajectory accelerating and delivering new technologies. In the accelerating technological singularity school of thought, technological advances not in the traditional linear fashion, but in an exponential manner, enhancing and extending human life. It's an optimistic vision where we make ourselves smarter by merging with technology. Innovations in biotechnology will enable us to reprogram our own biology and evolve beyond Darwinian evolution. This scenario is often called post-human or trans-human. Many of the futurist evangelists such as Ray Kurzweil [6] and John Smart [7] are advocates of this theory.

B. Event Horizon

The potential for technological developments with singularity are inconceivable to humans, you have to possess an equivalent level of intelligence to understand what a super-intelligent technology could deliver. This unpredictable scenario is Vinge's view of technological singularity.

This is analogous to a singularity in physics, which was where the term was adopted from, in that a singularity exists in black holes where things are so dense that the laws of physics as we understand them no longer apply [8], and all bets are off.

C. Information Explosion

A super intelligent technology, able to design, simulate, test and replicate itself, improving with each iteration, would lead to an intelligence explosion [9] [10], this view is supported by I.J. Good [1] and Yudkowsky [4]. Since this vision for a technological singularity, is so rapid and uncontrollable by humans, it is often a storyline in science fiction creating a dystopian future.

While the Event Horizon and Intelligence Explosion schools are somewhat negative outlooks, either we don't know what could happen, and it is out of our control, the accelerating school often sees only the good aspects of technological singularity

III. HOW CAN A TECHNOLOGCIAL SINGULARITY BE ACHIEVED

Koch [11] outlines two pathways which could deliver a true Artificial Intelligence(AI), if we persist with improving our AI technology we will deliver an Artificial General Intelligence (AGI). An alternative way is to emulate the neural activity of an organic brain or nervous system, this is called the Integrated Information Theory (IIT). The IIT theory is proposed as an avenue that produce sentient machines.

Could a super-intelligence can be achieved by an Internet singularity, Flake [12] argues that with increasing scope of the internet, more people with access to the internet, more and more devices and systems integrated into it, with this increasing knowledgebase and computational power, it could possess an intelligence level exceeding that of any human. With increased levels of interconnectivity and complexity, Vinge suggests the internet could just wake up, becoming alive.

Vic Grout utilized this idea, in his novel Conscious [13], whereby with increased network complexity, similar to a brain, a point is reached where IT develops sentience, with catastrophic results.

IV. Advances in technology indicate that we are on a path to technologcial singularity

Technological developments in different fields indicate the that we could arrive at a technological singularity. Developments in quantum computing, biotechnology, genetics, in nanotechnology all point to a future with technological singularity. Neuromorphic chips and neural networks, could further revolutionize information science [14]. Emulating other organic systems such as the Octopuses multi-brain configuration, could also inspire further developments in AI [15].

Moore's law [16] where the number of transistors on a microchip double every two years has proved remarkably accurate and continues to do so, this ever increasing processing power, and shrinking of hardware, has fueled technological development over the last half century. Moore's law facilitates the strange deflationary nature of technology, where more functionality and capacity costs less as time goes by.

We attribute "intelligence" to machines, doing everyday tasks now for us, from google and Siri answering questions for us, to GPS and guidance systems and to airplane autopilot. While "Intelligence is in the eye of the observer" [17, p. 954], they just sophisticated algorithms in deterministic situations, and not true intelligence.

A test, which will indicate when we have a super intelligence technology at our disposal, is when people thrust super-intelligent machines with their lives, e.g. when people accept machines can perform medical procedures on them without human intervention, and accept fully autonomous vehicles on the road.

A. Chess Computers

From the early days of computers, chess programs were developed, early versions while able to play were unsophisticated, and inferior to many club players. With better algorithms with input from expert chess players, the programs improved over time.

A milestone was in 1995 when IBM's Deep Blue beat the world chess champion Garry Kasparov [11] [18] [19]. In many ways this was a brute force method, dependent on processing power and speed at searching knowledgebases developed with the expertise of grandmasters.

A major sea-change was the development of AlphaZero backed by Google. In 2017 AlphaZero was given the rules of the game, and proceeded to learn how to play chess in a few hours through machine learning, it was not only beat the best human chess grandmasters, but the best computers programmed by Chess grandmasters [20]. Variants of the AlphaZero program also achieved similar success with other cerebral board games such as Go and Shogi. [21]

With AlphaZero AI has crossed a Rubicon, not only is the best chess player not a human, but the best chess playing computer now has learned to play chess without human expertise [22, p. 3].

With such advances in AI and machine learning, it is easy to imagine a self-improving evolutionary software lifecycle. Much of the technology could be assembled, to create a hardware creation lifecycle, with computers designing,

Fig. 1. Faith No Moore. Source Intel press reports, The Economist. [25]
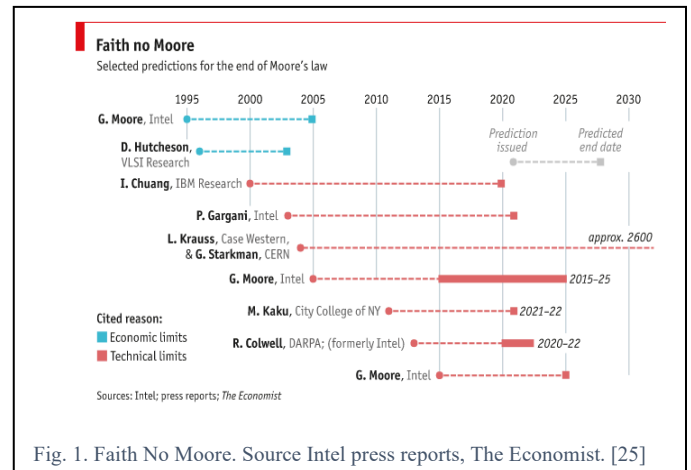
simulating, and producing on 3D printers, physical hardware [23, p. 6].

V. Obstacles to a technologcial singularity

The demise of Moore's law has long been predicted, even by Moore himself (see Fig. 1), there is, an argument that potential to increase the circuit density on a microchip and processing speed is limited by the laws of physics [24], there is some evidence of this is that the increase in high end processors has plateaued since the mid-2000's [25]. With Moore's law ending and reduced increases to processing speed, the advance towards a technological singularity maybe curtailed.

Some experts doubt that true intelligence is achievable by a machine, as Steven Pinker says "Sheer processing power is not a pixie dust that magically solves all your problems" [26], Microsoft's Paul Allen, refers to an intelligence break, which ultimately limits the power of AI [27].

VI. Consequences of a technologcial singularity

A. Benefits

An ultra-intelligence could solve problems we have been unable to solve, discover vaccines, find cures for diseases. Make discoveries which would benefit humanity, predict potential natural disasters, do dangerous jobs previously done by humans, improve our quality of life with extended leisure time [28]. Those who support the acceleration school of thought on a technological singularity, see it as, providing life extending technology to humans, humans evolving beyond evolution!

B. Risks

Significant figures in science and technology, such as Stephen Hawking [29], Bill Gates and Elon Musk [30], have highlighted the existential dangers to humans from advanced AI, even technological singularity pioneer Vernor Vinge thinks it is a distinct possibility [31].

Badly programmed AI in a technological singularity could lead to catastrophe [32, p. 7]. A super intelligence could produce more dangerous weapons which it or humans could use.

With machines superior to us [33], would we even be needed in the future? [34] A malevolent super intelligence could consider humanity a threat, perhaps its only potential threat and actively seek to destroy us [14].

Without a set of ethics, or human oversight, a super-intelligence could engage in activities threatening humans and human interests [35]. Machines would need an ethical framework, a set of rules, a more nuanced version of Asimov's laws of robotics [37], which would protect humans, with moral grey areas, such as no-win situations requiring human mediation [36].

C. Social Implications

A technological singularity would have profound implications for society, for business it would be a major paradigm shift, a robotic labour force is something which would deliver endless productivity, where would humans fit into this new world? There is an argument that just like after the industrial revolution and with automation, other jobs became available, however a technological singularity would affect nearly every sector of employment. Smith [38], suggests people get a robot, which works for them and they reap the financial return from its efforts, another idea is for everyone to be provided with basic living income.

One uncomfortable consideration is what if technological singularity advances prolong life indefinitely? Would this be available to the eight billion or so on the planet? How would society look like if people kept on living, and people kept on producing babies either via the traditional way, or with the benefits of genetic tailoring by the super-intelligence, to ensure physical health and enhanced mental ability of future generations, would the planet not become overcrowded. In the film Logan's Run [39] a dramatic solution to overpopulation is to not let anyone live over the age of 30! Surely a super-intelligence would decide that to protect resources and avoid an ever increasing population

VII. Can a technologcial singularity be avoided

Technology is going to continue developing, it would be impossible to stop or pause, since someone somewhere, some country, scientist, company or organisation, would proceed and develop the technology for personal, economic, political or military gain. Whether or not a technological singularity is inevitable, either way we are going to reach a point of having a super-intelligence at our disposal. It is naïve to expect that we can have a big red off button [22] in case technological singularity goes wrong, instead we have to control it throughout its creation, ensuring any technology produced reflects our human ethics and values and can't become a risk to humanity.

Conclusion

Ever improving technology is evidence that a technological singularity, a point at which, machines achieve a level of intelligence equivalent to that of a human, and begin to exceed it, will be achieved.

While it may not be the human-technological utopia or post-human machine controlled dystopian world as some fear [31], we will have a machine superintelligence and

technologies, cyclically evolving and improving, which can be a powerful resource for humanity. It does pose many challenges to us, and profound implications for society.

However, I still think that point is many decades away and not as early as 2045 [40] as some have predicted.

In this paper, I don't examine in depth how you would measure and attribute intelligence to a device or system, and evaluate it in comparison to a human, also I didn't elaborate on a possible code of ethics for all machine creations, food for thought for another time.

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