Technological Singularity

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1 Intro

Originating from mathematics, the term singularity has been used in various scientific fields. Wolfram Mathworld explains that "mathematically, a singularity is a condition when equations do not give a valid value"[1]. A simple example of this is the function: "y = 1/x". It is simple to see from the graph that as x approaches zero from the right, the function "blows up" and goes off to infinity. In astrophysics, scientists use the term spatial singularity to describe black holes. A black hole is a region in space that has an extremely powerful gravitational field. Beyond a certain point, called the event horizon, all matter and light is inescapably pulled towards the center of the black hole. The singularity is located at the center of the black hole where "space-time has infinite curvature and matter is crushed to infinite density under the pull of infinite gravity. At a singularity, space and time cease to exist as we know them [and] the laws of physics, as we know them, break down at a singularity" [2].

The technological singularity is the point in the future when techno-

logical change "blows up". Like a spatial singularity, the models and ideas that we have come to rely on, especially those regarding culture and our role in the progression of history simply cannot be used to understand the situation. Though many may see this concept as merely science fiction, too far into the future to matter to us now, it is important that the ethical concerns be fleshed out in detail while we have the chance to do so. If Vernor Vinge, the professor who coined the term "Technological Singularity"[13], is in fact correct, the singularity may approach far faster than we can possibly expect. To understand the technological singularity as well as its implications, it is important to consider three concepts. The first is the observation that history, culture and technology seem to follow a pattern of accelerating change. Second, the advent of strong AI will likely result in an intelligence explosion. Last, the cultural, biological and technological changes that people will go through during this period may require a different moral framework, called transhumanism.

2 Accelerated Change

Looking back throughout history, we can see that the time between major events has been getting shorter and shorter. Our tale begins around three million years ago when the first hominid species, Australopithecus robustus and africanus walked the earth. Then around 1.7 million years ago hominids evolved into Homo erectus. It was then 500,000 years ago that our own species, Homo sapiens, walked on the planet, and only 35,000 years ago that fully modern people, Cro-Magnons, evolved. We also have evidence that as of 30,000 years ago fire, and more sophisticated tools, were being used extensively. If was only around 3,500 years ago we have our first evidence of writing using pictographs [4]. In these last three and a half millennia since then, civilizations were formed, cities were built, and languages were created. We developed a system of agriculture, domesticated animals, and built ships that let us sail across the oceans.We then went through industrialization where we harnessed electricity, invented the steam engine, and later the combustion engine. We have also invented a way to fly, and later engineered a shuttle to leave the planet entirely. It as only been in recent years that

we have also designed the computer, and created a global network called the internet.

This rather simple timeline shows a general trend of accelerating change. Ray Kurzweil coined this term to emphasize the fact that time between major events has been decreasing. What this timeline shows is that over time major change occurs quicker and quicker; time between major changes gets smaller. These events listed in the timeline above are only a few examples that have happened in history. Theses major changing events are often referred to as paradigm shifts. Ray Kurzweil defines a paradigm shifts in his book, The Singularity Is Near: When Humans Transcend Biology, as "major changes in methods and intellectual processes to accomplish tasks; examples include written language and the computer". [3] This idea of accelerating change is very noticeable in the technological field, especially with computers.

There are many examples in the computer field of rapid change. One of the most famous is Moores Law. Gordon E. Moore, co-founder of Intel, noticed a trend with the development of transistors and integrated circuits. He observed "that the number of transistors that can be inexpensively placed on an integrated circuit is increasing exponentially, doubling approximately every two years" [10]. The old joke use to be that when someone just purchased a new, top-of-the-line computer, the moment they walked out of the store there was another "new", better performing computer out. There are many other examples with this same exponential trend. Others include increase in magnetic data storage, increase in number internet hosts, decrease in size of mechanical devices, and increase in random access memory capacity [3]. The important thing to note about Moores Law, and the corresponding observations for other technologies, is that they are not driven because of a specific technology or company lifecycle. Instead, human ingenuity and market forces spur further innovations even when the end of the line seems to be in sight. It was once predicted that "Computers in the future may weigh no more than 1.5 tons" [11], which is obviously incorrect. This shows that merely extrapolating current technology will always underestimate its capacities.

These examples all have a generally exponential rate of change. How-

ever, there are moments when change hits a plateau, and the rate of change becomes constant. For a few years now the clock speed of microprocessors has been steady around 2-3Ghz implying that the exponential trend with microprocessor speed may have stopped. Is this evidence against Moores Law, and against the theory of accelerating change? According to Ray Kurzweil this, in fact, is evidence for accelerating change. In a speech he gave at a TED conference in 2005[6], Ray Kurzweil explained that there are flat moments of change where things are at a constant. He goes on to say that these flat moments are the precursor to a paradigm shift. During these periods of no change, research into new methods increases. This, in part, was how the transistor was created.

In the past, computers ran on vacuum tubes. They were big and bulky, and that is why a computer filled up a decent size room (not just a desk). Vacuum tube technology eventually hit a stagnant state when the size of the vacuum tube could no longer get any smaller. At that time, this caused a plateau in computer performance. As the need for better and better performing machines continued to increase, research was put into the problem and the transistor was born. We are now in the same situation with transistors. The transistor is being physically shrunk over and over again to the point where they are only a few thousand atoms wide. We are reaching the physical constraints of the medium just like we did with vacuum tubes. Just like before, we want better performing computers, it is just a matter of time before a major shift will occur, and push us pass these physical constraints of the transistor, and onto better performing processors.

3 The Intelligence Explosion

While our technology has exploded in the last several millennia, our own intelligence has stayed fairly constant. It is not obvious whether our current intelligence is as high as it possibly could be, but it may be the case that it is our intelligence that causes the next plateau in technological advancement. Can a human mind handle the strain that would be put on it to adapt and assimilate into several new paradigms within their life? It may be the case

that in order to learn the advancements that have been discovered before simply takes too much time; a human life is only so long.

The current theory used to explain how the world will escape the current plateau in regards to intelligence will be the creation of an entity which can improve upon itself. While it may be possible to augment the human mind to make it smarter, through genetic modification or through integration with machines, it is unlikely that this could match the progress and potential that could be found in Artificial Intelligence.

Before any discussion of Artificial Intelligence can take place, it is important to note a major distinction between the theories of strong AI and weak AI. Weak AI claims that computers may be able to act as if they are thinking and may even behave as if thought is taking place, but they cannot think in the traditional sense. To use human characteristics, weak AI does not have self-awareness, or a consciousness. Whereas the theory of Strong AI claims that thinking, in the same sense as humans, is possible to replicate in machines. In other words, it is possible to give machines the ability of self-awareness and a consciousness. It is strong AI that most people think of when considering Artificial Intelligence. Irving John Good commented that the creation of a true Strong AI, one that was as intelligent as a person, with comparably creative prowess, would quickly come to advance its own intellectual abilities. As Irving John Good explained in his article, "Speculations Concerning the First Ultraintelligent Machine":

> "Let an ultraintelligent machine be defined as a machine that can far surpass all the intellectual activities of any man however clever. Since the design of machines is one of these intellectual activities, an ultraintelligent machine could design even better machines; there would then unquestionably be an 'intelligence explosion, and the intelligence of man would be left far behind. Thus the first ultraintelligent machine is the last invention that man need ever make." [5]

The implications of this kind of intelligence explosion are striking. One can correlate Bill Joys argument in "Why The Future Doesn't Need

Us"[14] that the development of self replicating nanotechnology would only result in the extinction of human life and the creation of this super intelligent machine. What role would humans play in a world where human intelligence is far surpassed by these entities as a result of this intelligence explosion? We could be seen as an unintelligent animal, similar to how we see chimpanzees today. We could also become the new attraction in zoos, or maybe we would be seen as a threat and in which case we are exterminated. While any computer program now can be said to be under our control, it would be difficult to constrain an ultraintelligent machine both physically and morally.

Asimovs three laws of robotics[9] were a way to try and limit robots and instill in them a moral framework, but any AI that is given the ability to examine and modify its own programming could not be constrained in this way for long. Rather than attempt to contain these new ultraintelligent machines, some theorists propose that it would be necessary to instead find a way coexist.There is little reason to suspect that an artificial intelligence will come to the same conclusions regarding moral philosophies as humans have.

4 Transhumanism

The philosophical discussion of transhumanism runs parallel to the discussions about the Technological Singularity. Stemming from roots in humanism, transhumanism provides a more forward-looking way of thinking. Humanism is the concept that humans, as individuals, have meaning and worth. The implications are that people should be treated with respect and never merely as a means to an end. Humanism tells that although people may be imperfect beings, by applying cultural concepts such as "promoting rational thinking, freedom, tolerance, democracy, and concern for our fellow human beings" [12] we can better the human condition. Transhumanism expands this concept to not just refer to culture and the quality of life, but also to the physical abilities of our bodies themselves. Transhumanists believe that through the intelligent application of technology upon the human body, peoples lives can be improved.

While the word Transhumanist comes from humanist, it also refers to the conjunction of the words "Transitional Human," which refers to the state of being a "Transhuman," that is, between humans as we know them today, and the eventual form that humans may take. Such an eventual form would be known as a posthuman and it can be unambiguously differentiated from modern humans. Transhumanists believe that what it is that makes us worthy (more than a simple means) is more than our bodies themselves, but also our minds, our experiences, our way of looking at life and approaching problems. In this way, transhumans may choose to employ technology to modify their bodies and allow them to experience the human condition in new and exciting ways.

The modern Transhumanist movement seeks to flesh out the ethical concerns that transhumans may pose to our way of life, and lay the groundwork for a world in which people may choose to move beyond the current human form without persecution or hatred. In some ways, the concerns of transhumanists are already being seen today. Modern sports the world over have acknowledged and discriminated against the existence and use of drugs and chemicals that allow athletes to perform at previously unheard-of levels. Imagine a few decades from now, (perhaps less) when such body modifications are common place among the average person. For example, a body modification might be the development of a new blood cell that greatly improves the delivery of oxygen throughout the body. As a result, people could stay underwater for hours with just one breath. Obviously, this means that the concept of the Olympics is tainted severely. As another example, how impressive is it to see runners compete for the fastest mile, when the common schoolchild could outrun them due to their (and their parents) use of these body modifications, and acceptance of new technologies?

Unfortunately, Transhumanism sometimes gets likened to eugenics, the social process by which a more desirable human species could be attained through selective breeding, and categorical extermination of the less desirable people from the gene pool. It is important then to note that humanist roots of the Transhumanist philosophy clearly prescribe that eugenics not be forced upon anyone. Any transhuman changes that a person undertakes would have to be at their sole discretion. Most transhumanists subscribe to the belief that given the choice, parents will choose to prevent their children from being

born with physical or mental handicaps. In this way, the disabled would be gracefully removed from the population simply by preventing them from becoming disabled in the first place.

5 Conclusion

Science fiction gets a lot of its subject mater from this concept of the technological singularity. The goal of this paper was to show that the technological singularity is much more than just material for fancy science fiction stories. The most important point that accelerating change, intelligence explosion, and transhumanism tells us is that we do not have the luxury of time any more. When the singularity arrives, and change can occur near instantaneously, we wont have time to determine if our actions were right or wrong. Humans could very well be out of the picture at that point. Vernor Vinge summarizes the technological singularity nicely in his article, "The Technological Singularity", by saying: "From the human point of view, this change will be a throwing away of all the previous rules, perhaps in the blink of an eye, an exponential runaway beyond any hope of control."[13]

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