Ryan A Davis

CSE 488 – Computer Ethics

Dr. Yasha Karant

Computing Errors & the Consequences of Artificial Intelligence

The basic concepts outlined within this essay will cover the ethical issues relating to the various software and hardware flaws that cause financial and physical damage, as well as the potential consequences from artificial intelligence and the cybernetic augmentation of humans. At first glance, these issues appear to be quite different from one another, but upon further review it becomes apparent that they both share basic commonalities regarding fundamental flaws in the computing world. These issues are similar in that they both relate to the rapid progression in technology, and are at times unable to maintain essential ethical standards in order to both minimize computer system errors and prevent physical harm or financial loss.

The damage resulting from software errors, as well as cybernetic augmentation, is already staggering, and even more alarming considering the human dependency on technology is rapidly progressing. We will see, based on evidence, that great physical harm and financial loss at the hands of neglected software is becoming a global issue and effecting thousands, if not millions of people. If we, as computing professionals, do not adhere to the fundamental ethical standards that uphold the safety of human beings, we will witness the cause and suffering of more people. We will experience further financial loss if we don’t regulate basic software errors and impose strict human-machine regulations.

There are numerous cases of physical harm and even death as a result of basic arithmetic rounding, memory leaks, and various hardware malfunctions. Arithmetic Rounding, outlined in the IEEE floating point standard, is a computing protocol which guarantees that simple mathematical functions will yield correct results with infinite precision. Although this becomes more difficult within complex functions, they should be incredibly accurate to the last bit. Race conditions, is a system flaw in which an output is significantly dependent on the sequence of operations within the system itself, as a result of two separate signals "racing" each other to be the first to output. Race conditions are common in software, logic circuits, and electronic systems. A memory leak is a software problem which occurs when a computer program uses up memory but doesn't give it back to a computer's operating system. The most common example of this is when a programmed object is stored in system memory but isn't accessible by the code itself. In the majority of the cases researched, most problems were due to the basic flaws in the software design similar to these examples. In any case, there are no ethical justifications for those responsible for the physical harm or financial loss resulting from the negligence of basic computing protocol.

Of the numerous circumstances resulting in human harm as a result of basic software and hardware errors, the situations that involved the death of hundreds of people outshine the rest. On July 3rd, 1988, the USS Vincennes shot down a civilian airliner over the Strait of Hormuz during the Iran-Iraq war. The tragedy, resulting in the death of all 290 passengers and crew, was attributed to the failure of the tracking software used aboard the ship. The crew and captain aboard the US naval ship misread the cryptic and misleading output displayed by the software. Believing they were tracking an Iranian F-14 Tomcat fighter jet, they subsequently fired two surface-to-air missiles at the airliner, killing everyone on board. The United States government, although never fully admitting failure amongst their software and crew, paid nearly $62 million USD in compensation ($300,000 per victim).

This USS Vincennes case represents a key example in the sheer amount of damage that can be caused from a computing system error. Furthermore, the US government appeared to have directly used a situational ethical system to justify their actions. The USS Vincennes' captain claimed that he was just trying to protect his ship, and in light of the state of the software, he assessed that his decision was solely based on the tracking system having displayed the airliner's speed as that of an F-14 Tomcat. Despite these details, the software developer that the US government employed should have upheld higher quality control and testing standards, especially considering the types of sensitive situations the US navy (and other armed forces) encounter on a daily basis in which thousands of people's lives (possibly millions) are at stake. The developers themselves employed a utilitarianism ethical system, as they likely believed the software they created saved millions of lives, and any negative aspects (including death) are simply 'par for the course.'

Another example of a critical software error is the Pentium FDIV bug, in which an Intel microprocessor floating-point unit was claimed to meet IEEE standards, but actually didn't. It became known that certain floating-point division operations being calculated on the P5 processors generated false results. Upon review by Intel themselves, there were missing values in a data structure which were used for the division algorithm. The error was discovered by an outside party and made public in 1994. Even though the error was found to be rare and didn't produce any physical harm, Intel recalled the microprocessors soon after the discovery, and lost roughly $475 million dollars.

The Intel developers of the P5 microprocessors obviously ethically justified their actions by the utilization of situational ethics. They simply produced an error by neglecting a particular part of the data structure. Intel didn't appear to have any ill intent, nor did they want to recall the processors and lose nearly half a billion dollars, so egoism or utilitarianism would not justify their actions. Regardless, Intel shouldn't have claimed to meet IEEE standards if they were not actually adhering to them. This claim violates both the ACM Code of Ethics and IEEE standards, as they were not trustworthy in their claim, nor did they maintain the highest quality in a low-level process.

Another incident occurred in the medical industry, where software is becoming more prominent for a multitude of daily medical processes. The Therac-25 system, a radiation therapy machine developed by the Atomic Energy of Canada Limited, was developed in 1985 and subjected to scrutiny after patients were given massive overdoses of radiation. At approximately 100 times the standard dose, the obvious flaw in software design was apparent. Citing a multitude of errors, including never having the Therac-25 independently tested, the overall reason for the software design errors was sheer neglect from AECL.

The developers of the Therac-25 system did not properly test for risks on its machines, a direct violation of both the ACM and IEEE Code of Ethics. By not having the system properly inspected and reviewed by an outside party, this left the quality control directly in the hands of the apparently overconfident developers at the AECL. This directly led to the software standards not being confirmed by other sources, and the poor software design went unnoticed due to the fact that the programmers themselves were responsible for testing and debugging the system. Perhaps situational ethics could be applied here, as this case occurred in the mid 1980s, well before proper system protocol was common and ethical standards were put into place to maintain computing standards. However, we do know that they neglected the system and the testing process, so egoism, and furthermore their desire to profit with as little work as possible, was a likely justification of their actions.

The evolution in computing systems has brought forth the application of Artificial Intelligence and Robotics. Artificial Intelligence is the study and design of intelligent agents, one that perceives its own surroundings and acts on its own, usually to optimize its chances of success. Robotics is the actual physical design, construction, and application of a computing system applied to a moving Robot. First used in manufacturing, Robots have rapidly evolved into complex machines that are used for a variety of purposes, including defusing bombs and assisting in medical procedures.

To display a machine's ability to showcase intelligence, the Turing test is used. The test, which engages a human judge in a conversation with both another human and a machine designed to perform like a person, checks whether the judge can tell the difference between the machine and the other human. The strengths of the test are its simplicity, along with its ability to maintain a broad amount of subjects the judge can engage in with the machine. Even though the test is considered the initial standard for measuring a machine's artificial intelligence, the test's weakness lies in how it limits the scale of what the test can prove. The Turing test only shows that a machine is behaving like a human, not whether it actually behaves intelligently. Other critiques some have voiced are that the test only measures synthetic intelligence - not real 'organic' intelligence, but rather the external behavior of the machine. In an attempt to argue that external behavior can't be used to show if a machine is "thinking" or just simulating the thought process, John Searle presented the Chinese Room experiment. The experiment's intent was to show that the Turing test didn't properly indicate that the 'intelligent machine' had a conscious mind or the means to understand. However, the Chinese Room experiment also had its share of negative critics, namely, that the experiment suffered from logical errors and the misinterpretation of the main premise of the experiment itself.

In light of its developments, there are both advantages and disadvantages in the utilization of Artificial Intelligence. Some of the common applications for AI are its prominence in space exploration, with its ability to survive in harsh planetary environments and complete important tasks for global space programs such as NASA. However, not all of the applications of AI are positive. Looking into the future, if robots replaced humans in particular job industries, how could we be sure they would make correct decisions? There is more to modeling human behavior than just intelligence. Furthermore, what will happen to society when unemployment hits a new low as a result of the lower and middle level jobs being taken over by artificially intelligent robots? The resulting depression and ensuing death would not fit into any code of ethics. Therefore, although the developers of AI use Utilitarianism to justify artificial intelligence and its utilization in robotics, we cannot justify how it would negatively affect human society.

Much like AI, Cybernetic organisms are also drawing social controversy. They were once considered science fiction, and are now becoming a reality in today's society. Being used for therapeutic purposes and human augmentation, human 'hybrids' have multiple implementations. Technology has paved the way for doctors to repair and regrow damaged body parts, including spinal cord injuries - which would have otherwise left someone permanently paralyzed for life. Thus far, technology has provided for a variety of positive therapeutic uses, but we have to wonder what this will lead to in the future. Despite this fear, utilitarianism justifies a developer's motives for creating such technology, especially for therapeutic uses, as it helps an enormous amount of people with likely low casualties.

The next progression in human-machine evolution is augmentation. Humans are already augmenting their bodies, enhancing their external features through plastic surgery, and taking human growth hormones to attain gargantuan muscle mass and/or other means. It is only a matter of time before people start installing artificial muscles or tendons for military or athletic purposes - to create the ultimate 'super soldier' or 'mega athlete" - which increases the chances of success or profit. If this were to occur and become common practice, it would be unethical according to the ACM Code of Ethics and other ethical systems. Considering the complexity of cybernetic organisms, there are many negative consequences that could arise when it comes to the well-beings of society and the augmented humans themselves. The augmented human could suffer severe health complications from an enhanced body part malfunctioning or not being fully compatible with a human's organic system. This is a direct violation of many ethical systems. When it comes to the creation of a super-human, the ethical system turns to egoism, as it is simply a human or military organization looking for an 'edge' that will improve their chances of attaining their goals, or to attain more profit.

We should assume many people oppose my views as they relate to the ethical points I've raised towards the negative aspects of computing errors and cybernetic organisms. One could argue that the exponential progression in computing technology has brought us great benefits in society. Although this may be true in some cases, there can be no denying that some of these errors could have been avoided had the developers taken more time to ensure the systems functionality and reliability. In the cases involving death, they were due to errors that could have easily been fixed. The same positive comments can be said for the growth of cybernetic organisms benefitting many humans with physical ailments, and although this may be true, it is happening at such a rapid rate that it will become increasingly difficult to moderate its progress. Simply put, preventable mistakes are being made that are harming thousands, if not millions of people, based on the fact that technology is quickly evolving with minimal quality control or ethical standards to maintain the well-being of the human race.

The legal consequences for any individual human committing acts that lead to death or colossal financial loss result in lengthy jail sentences, or perhaps the death penalty. Yet, the organizations mentioned in this essay never suffer these criminal consequences, rather, it is accepted as standard that things will go wrong and people may die as a result of computing errors or complications from human-machine augmentation.

A civil case could potentially be brought to the organizations whose computing system produced an error which resulted in death or financial, with the outcome being that the accused must pay a vast sum of money to the injured party or their family. Considering this fact, it is unethical for these organizations to produce computing systems or machines that produce errors that yield potentially catastrophic results. Technology is moving at such a fast pace that it is becoming nearly impossible to regulate. As computing professionals, we must stress the importance of maintaining vital ethical standards more than ever, to ensure the safety of human beings above all else. If not, further death and financial loss will occur, and perhaps occur on a global scale that could potentially cripple the global economy and its human population.

Works Cited

ACM Council. "ACM Code of Ethics and Professional Conduct— Association for Computing Machinery." Association for Computing Machinery. ACM, 16 Oct. 1992. Web. 05 Feb. 2012. http://www.acm.org/about/code-of-ethics

IEEE. "IEEE - IEEE Code of Ethics." IEEE - The World's Largest Professional Association for the Advancement of Technology. IEEE, 1 Feb. 2010. Web. 05 Feb. 2012. http://www.ieee.org/about/corporate/governance/p7-8.html

Koebler, Jason. "Artificial Intelligence Pioneer: We Can Build Robots With Morals." *US News*. U.S.News & World Report, 16 Mar. 2012. Web. 19 Mar. 2012. http://www.usnews.com/news/articles/2012/03/16/artificial-intelligence-pioneer-we-can-build-robots-with-morals

Dershowitz, Nachum. "Software Horror Stories." Software Horror Stories. 11 Nov. 2003. Web. 11 Mar. 2012. http://www.cs.tau.ac.il/~nachumd/horror.html

Knapp, Alex. "Is Ethical Human Genetic Enhancement Possible?" *Forbes*. Forbes Magazine, 15 Sept. 2011. Web. 19 Mar. 2012. http://www.forbes.com/sites/alexknapp/2011/09/15/is-ethical-human-genetic-enhancement-possible