ETHICS OF REVERSE ENGINEERING OF THE BRAIN AT ALLEN INSTITUTE FOR BRAIN SCIENCES

Erin Yingling (eny4@pitt.edu)

INTRODUCTION: ENGINEERING ETHICS

The Code of the Standard Engineer

As the problem solvers of the people, engineers' designs and projects tend to have very strong impacts on the lives of many. Because of this fact, it is imperative that all engineers know, understand, and uphold the values of very strict ethical codes. The standard code, for example, that applies to engineers of all disciplines is provided by the National Society of Professional Engineers. This "Code of Ethics for Engineers" gives a very basic but thorough layout of the general morals for engineers to live and work by. The "Fundamental Canons" for example, demand attention to public welfare, competence in an engineer's chosen area of performance, truthfulness, loyalty, and honor. As the Preamble of the code states, “Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity” [1].

The Addition of Bioengineering Ethics

Although the field of biomedical engineering, (or bioengineering), differs in many ways from the more typical disciplines, biomedical engineers are in no way exempt from the ethical code. Rather, they must abide to arguably stricter moral and ethical demands. Bioengineers work in a profession that “combines expertise and responsibilities in engineering, science, technology, and medicine” [2]. Due to this adoption and incorporation of strategies and processes bioengineers utilize from different areas of study, bioengineering ethical code must also adopt and incorporate the various ethical values specific to these areas. For example, the Biomedical Engineering Society Code of Ethics includes a section on “Biomedical Engineering Health Care Obligations” that pertain specifically to protecting rights of patients, like doctor-patient confidentiality, as well as consideration of the effect of work on the availability and cost of health care.

In addition to these medical-based ethical issues, there are also biology-based debates over the admissible level to which bioengineering technologies intervene in nature, concerns over levels of environmental and biosocial impacts, and the extent to which biomimesis, “the imitation of biology in creating devices”, should be limited [3]. These nature-related issues are extremely common topics in the ethical discussions of bioengineering, with most focusing on whether different processes’ and designs’ effects on the natural world are too invasive or interruptive. These problems, though, create more discussion than just the typical question of whether or not a technology should be used on ethical basis. They also bring up questions of whether engineers should participate in philosophical dialogue surrounding these issues due to their first hand experiences and knowledge, rather than sitting back and serving the purely technical role of facilitator [3].

These ethical issues as well as almost any others are impossible to answer in a in a manner based simply on generalizations. Even in very specific situations, there are never clear-cut answers. For the sake of discussing the aspects of and possible solutions to those issues previously mentioned, I will apply them to a specific bioengineering effort being conducted by the Allen Institute of Brain Technology; the study and reverse engineering of the human brain.

A BIOENGINEERING EFFORT

What is “Reverse Engineering”?

“Reverse engineering” in itself is a term typically used for describing a process relating to computer programming in which software is analyzed, most times for the purposes of learning the specific functions of its parts. Only in recent scientific history has it been used to define more biologically focused endeavors, most specifically those relating to the function of the brain. Like with reverse engineering of computer software, the first step of brain analysis consists of “dissecting” into component parts to discover individual and systematic functions; which depending on the technique and focus of the specific laboratory, could consist of anything from a collection of data to examine specific functionality to an actual, literal dissection. Regardless of any difference in strategy, the data and knowledge collected from this dissection is then used to accomplish the second fundamental step of reverse engineering, which is described as a “(re)construction of the original system into duplicates” which in the case of brain study, are typically created in the
form of computer models [4]. The main focus of most neuroscientists and engineers working on “solving” the processes and actions of the brain is tracking specific circuits of neurons to discover which regions and structures correspond to certain functions.

Why Reverse Engineer the Brain?

Some people may question why so much time, money, and research is put into attempting to try to decode the workings of the organs responsible for human thought, but in reality there is a very wide range of reasons, many of which have effects on the lives of almost everyone. These reasons range from general human curiosity and urge to discover more about the biology behind higher brain functioning, to the more practical attempts to discover the causes behind common mental illnesses and brain disorders such as Multiple Sclerosis, Alzheimer’s disease, depression, migraine, and memory and eating disorders, so that effective care and treatments can be developed [5]. In fact, through data retrieved through these more in-depth studies of the brain so far, it was found that common depression drugs like Prozac and Zoloft had no effect on at least two brain areas where chemical imbalance was present. One scientist likened these common oversights and ineffectiveness of drugs for depression and schizophrenia to an attempt to “fix a car by pouring oil over the top and hoping some gets into the motor” [6].

In addition to the typical biological related purposes for reverse-engineering the brain, there are many initiatives for those concerned with computer sciences and programming technologies. The standard goal for computer-related brain study is simply to find ways to create more efficient and capable operating systems. The brain is commonly looked at as the “ultimate processing machine”, so it is thought that if computers could be made to work in similar ways as a brain, they would become ideal in computing power and user-interface [5]. There are also plausible ideas for improvements to “artificial intelligence” systems that make them easier to use and better at comprehending requests than current technologies. Some other ideas for brain-based technology can tend to stray into the realm of fantasy and scientific fiction. One optimistic researcher and creator of the ultra-sophisticated electron beam microscopes used for some of the current deeper brain studies, David Adler, believes that with increased understanding of higher brain functions, “brain-editing tools” will become possible, and memories may be able to be manufactured and sold in lieu of the products and trips that are currently needed to create memorable experiences [7]. While the majority of these ideas are quite real possibilities for the future, they require much more data about the brain than is currently needed, highlighting the importance of continued progress in reverse engineering techniques, data collection, and model building.

The Allen Institute: A Different Approach to Reverse Engineering

The specific group contributing to the effort for reverse engineering of the brain I plan to discuss is “The Allen Institute”, a foundation sponsored by Microsoft cofounder Paul Allen. After witnessing his mother’s descent into Alzheimer’s disease, Allen decided he wanted to create a research institute with a focus on discovering the functions of different parts of the brain, and in the process, find causes of and solutions to mental illnesses. Instead of funding one of the existing 10,000 labs worldwide pursuing distinct questions about the brain, Allen gathered several hundred scientists, engineers and technicians to work together. Rather than continuing the tradition of competing laboratories, this program was made with a new goal in mind; to synthesize all knowledge of the brain gathered by reverse engineering techniques into a comprehensive theory [8].

The specific area of the brain being focused upon at the Allen Institute is the visual neocortex. The many scientists utilize numerous techniques, some being common strategies previously utilized in brain study while others have been recently created by the expansive team at the institute, in attempts to map the effect of stimuli, mostly visual in type, on the neuron circuits of the neocortex. With this data, they plan to capture fundamental aspects of higher function such as perception, cognition, awareness, and decision-making processes and translate the basic mechanics to the human brain, which is believed to have the same general structure, just with 1000 times the size and complexity.

An advantage to the processes of the Allen Institute as compared to most laboratories lies in both the fact that there are many people creating multiple solutions to each problem, and in condition of the close proximity of the “Mindscope” research laboratories to the modelling facilities [6]. This closeness allows the computer model developers to work closely with the scientists, enabling quick analysis of experimental data and feedback. Through these cohesive strategies of reverse engineering, The Allen Institute hopes to revolutionize knowledge of the brain and create a “scientific big bang” in the field of neuroscience [8].

This effort truly is an amazing feat, and it has been described by fellow neurobiologists as “an institution renowned for its pioneering approaches in large-scale neuroscience” due to its efforts to accelerate the understanding of the human brain through both its focus on collectivity as well as its vow of releasing records and discoveries as public information [9]. However, although the Allen Institute is seemingly a dream team for those solely
interested in the furthering of neuroscience, it too deals with many situations that require ethical analysis, and as discoveries progress, it will without a doubt experience more.

**ETHICAL DILEMMAS RELATING TO THE WORK OF THE ALLEN INSTITUTE**

The Standard Engineering Concerns

Based on the very unique ways the Allen Institute has gone about studying, and in effect, changing the field of neuroscience, it has the possibility of conflicting with several different aspects of the NSPE Code of Ethics.

For example, the second “Rule of Practice” of the code mandates that “Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved” [1]. This is obviously a very important rule, but it can leave many questions as to the extent of experience required to be “qualified”. The scientists, engineers, and all others part of the team at Allen Institute are required to have excellent credentials in their specific fields, but as a whole, the majority of neuroscience is highly unknown. In addition, the vast amount of knowledge in the different technologies and procedures required causes for a need for the different team members to have very specialized knowledge. This could mean that while one person could have a very detailed knowledge of one part of a process, like the inner workings of a machine used for imaging the brain, they may have less in a related component, such as the interpretation of the data given. In essence, the use of the strategy of large-scale teamwork that Allen Institute is known for, the separate members must have trust in others’ abilities, which could in theory lead to a violation of ethics.

Another issue related to the processes at Allen Institute lies in the possible violation of the ninth Professional Obligation of the NSPE code. This obligation mandates that engineers “give credit for engineering work to those to whom credit is due” [1]. This, as most of the codes, is a seemingly simple rule to follow; however, the Allen Institute’s unique way of operating could once again play a factor in increasing the complexity. As with the issue of qualification, a team of hundreds working together on various interlinking processes creates ethical debate. How much input on a particular project would warrant “credit” for that project? Would those who did the majority of the work and research on a particular project be recognized more, and if so, how would that be done without discrediting the others? For most engineering projects, the recognition would be spread between a small group of contributors at the most, but with a massive team of contributors like that of Allen Institute, the process becomes more difficult.

The Enhancement Panic

In addition to the conflicts of the Allen Institute’s distinctive strategies with the general engineering code come the difficulties due to the bioengineering aspects of the particular work, specifically those dealing with our manipulation of the natural world. The majority of these particular issues deals heavily with the possibilities of future developments that may result from work by Allen Institute as well as other groups at reverse engineering the brain.

The “Brain Revolution” that spurred many of the projects currently active in neuroscience began only a little over a decade ago, and with it came quite a bit of panic and controversial. As the author of an article discussing the ethical results of the new focus on the studies of the brain at that time pointed out, even early on it had widespread societal effects; from lawyers submitting brain scans in an attempt to prove clients’ innocence, to high school kids taking Ritalin and other drugs to improve their attention and gain advantages on schoolwork [10]. The biggest issue brought up, however, was that of the possibility that someday scientists would discover ways to edit, or enhance the human brain. Though this kind of technology is still far from being developed, there is a very definite possibility it will come available someday. There are arguments for and against these kinds of enhancements, and most opinions depend on particular uses. Many people, for example, would agree with the technology being used to treat people with mental illnesses so that their brains can function at normal levels. The problem, though, as Monique Frize pointed out in her Synthesis Lectures on Biomedical Engineering Ethics, is that we don’t really know for sure “What is normal?” [11]. Normality of brain function, as with most aspects of human life, is an immeasurable quality. Also, public disapproval of possible enhancements is typically based on brain enhancements being thought of in the way steroids are used in sports; as a means of cheating. However in the same article it is pointed out that “literacy and numeracy are profound and far-reaching cognitive enhancements”, but today we consider them to be “normal” capacities [11]. By this argument, it seems that direct manipulation of the brain could simply be considered one of the next evolutionary steps for human beings.

My Own Ethical Struggle

Never have I been asked to consult on an ethically-charged engineering issue, but based on my past experiences with ethical dilemmas and my confidence in my own moral codes, I believe I have the ability to find a viable solution. For
example, if I were in a situation where I had to determine whether or not a specific technological development was safe for release into the public, I would utilize several resources. First I would look into the technology and weigh every positive and negative outcome, creating a sort of ethical pros and cons list so that I can completely understand the situation. In addition to my pros and cons, I would explain the situation and consult my peers as well as trusted friends and family members like my parents. With these steps taken, I would take any and all advice into consideration, but ultimately I would base my final decision off of my own research. The best case scenario would be that I could find a way to make the technology less dangerous or controversial in some way.

CONCLUSION: THE VARIABILITY OF ETHICAL INTERPRETATIONS

The main problem of dealing with a discussion or debate over ethics is the realization that there is never an entirely “right” or “wrong” point of view. While people can push their opinions on how neuroscience-related brain enhancements are either a great medical advancement or a potentially horrible new illegal drug in the way of Ritalin or performance-enhancing steroids, there is no way to make a definitive decision on that now given the fact that we are not yet aware of all the risks or benefits to society. Likewise, the issues of competency and credit that pertain to the team-style organization of Allen Institute must be examined with an open mind. While the official codes of ethics are valuable and must always be respected, we must also give some consideration to the fact that groundbreaking new processes such as those taking place in the work of Allen Institute as well as in the field of neuroscience as a whole sometimes call for changes in rules. If it can be assessed that these things are changing human life and engineering for the better, then why shouldn’t a code of ethics adapt with it?

References


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