Bioinformatics Approach for the Discovery of Novel Endocrine Interactions in Humans and an Analysis of Sex Based Differences
(Technical Topic)

The Aftermath of The Snowden Leaks and Its Impact on Big Data: A Look at How Stakeholder Perspectives Influence a Technology's Application
(STS Topic)

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Introduction

Advancements in technology have allowed for a better understanding of the human condition. Diseases previously thought fatal and debilitating have been completely effectively treated by the use of vaccines and modern medicine. Conditions such as heart arrhythmia can in some cases be treated with pacemakers that correct disturbances in electrical conduction. These biomedical technologies have slowly grown to serve precise and microscopic purposes, to the point that some might consider these approaches invasive.

This presents the challenge of balancing precision and invasiveness. Should a gene that greatly increases the chance of brain cancer be removed from the human genome? Is it worth it to invade the genetic code of humans that has taken millions of years to evolve into what it is today, and completely eliminate the chances of a fatal disease from developing? While these questions might not be what scientists ask themselves when they conduct their research, they are still important ideas leaders in scientific fields consider when introducing new technologies to society. After all, if these practices are rejected by the general public, there will be no application of the technology.

In order to explore this relationship between novel technologies and societal acceptance, I will explore what social constructs affect emergent technologies like genetic engineering, and then extend this knowledge to determine if the work conducted in my technical research will be at risk of public rejection.

Technical Topic: Bioinformatics Approach for the Discovery of Novel Endocrine Interactions in Humans and an Analysis of Sex Based Differences

For my technical topic, my group and I will design a software package for inferring and interactions between organs based on gene expression data. We will apply this analysis to compare inter-organ communication in human males and females. The foundation of this work is based on previous work by Seldin et al. These investigators created an analysis framework for using gene-to-gene correlations to identify inter-organ communication pathways of the endocrine system (Seldin et al., 2018). Our group hopes to expand on their work by creating a user-friendly R software package that scientists can freely download and apply to their data to identify correlations and differences in gene expression data.

Signaling between tissues is what dictates everything in the body. Expression of a gene in one organ can lead to a response in another. Understanding cross-organ communication pathways could allow scientists to predict, treat, and even prevent diseases.

However, constructing inter-organ communication models requires more than collecting and compiling expression data from samples. In order to cultivate significant findings, this data needs to be analyzed using statistical methods, and compared to relevant examples in literature and also *in vivo*. Correlations calculated from such analyses are powerful tools for exploring the relationship between gene expression and organ function.

Furthermore, performing these steps needs to be precise, and capable of immediate repetition. Chances of achieving statistical significance increases the more an experiment is run, further cementing the necessity for a fast and reproducible method. Performing these tasks on a computer, using programs, is the best solution to this. However, the scientists that need the analyses for their research may not be experts in computer programming, and thereby be incapable of performing these analyses on their own. A user-friendly, openly distributed program would best resolve this, but it would have to be developed by individuals who understand the data and are also familiar with programming languages. Such a task is what my team members and I hope to accomplish in our Capstone project.

Our research is separated into three phases. In the first phase, we acquire human gene expression data, and then process and format it to visualize the gene expression profiles. This first phase is accomplished using the R programming language, as well as some UNIX commands. Phase two involves designing a user-friendly R software package that is capable of comparing data formatted like that in Phase 1. Software development for this package will involve writing scripts that automatically perform correlation analyses, as well as writing the documentation for these scripts. Documentation for software includes guidance for each file of code, and also a vignette, which is a step-by-step depiction of the package and how it is used. User-friendly design of the package is paramount for distribution, since we hope to publish our work to the greater scientific community. Phase 3 of our project applies our work from Phase 2 and compares the endocrine signaling differences between the human males and females. We hope to discover novel differences in cross-organ signaling based on sex, and expand this knowledge to compare disease pathologies in both sexes.

STS Topic: The Aftermath of The Snowden Leaks and Its Impact on Big Data: A Look at How Stakeholder Perspectives Influence a Technology's Application

Technology has an incredible impact on society. Technological advances are what has allowed humanity to evolve into what it is today. So much importance and power is given to the technology, making it seem like humanity is the one who exists to serve it. However, this is not the case; technology's purpose is to resolve issues and serve a function humans could not physically achieve. Technology is the one who serves humanity, and thereby society has control over technology. Moreover, society dictates what technologies should be implemented, and what technologies should be prohibited. It might seem like a simple relationship, but in reality, there are many components that are involved in this decision.

This relationship is best explored by utilizing the Social Construction of Technology (SCOT) theory. Scholars use this framework to identify the importance of structural concepts to gain an understanding of the social shaping of technology (Klein & Kleinman, 2002). They use four core concepts that comprise this framework. The first concept is interpretative flexibility, the idea that technological artifacts have unique meanings and applications for a variety of groups (Bijker & Hughes, 1984). An example of this is an automobile; some individuals' livelihoods revolve around driving all the time, whereas others see driving as a leisurely activity. All groups seek different applications and experiences from their automobiles; someone who drives a bus for a living will have a different appreciation for automotive technology than someone who races Formula 1. This group-by-group investment is the second component of SCOT; relevant social groups are the embodiment of the unique meanings and applications (Klein & Kleinman, 2002). When inventing a new technology, relevant social groups need to be considered, both in their expectations and possible reactions, since they will be the consumers that dictate a technology's fate. However, since technology can be adapted and improved, any issues that arise with the technology can be fixed. This idea of multiple attempts at designing a technology is what the third concept of SCOT is based on. There will be conflicts between the different interpretations of a technology, so continuously adjusting the design until all conflicts subside is the only way for the technology to be fully welcomed (Klein & Kleinman, 2002). This concept is known as closure and stabilization (Klein & Kleinman, 2002). The fourth and final concept is the wider context. Wider context includes all the other sociocultural and political milieu in which development takes place (Klein & Kleinman, 2002). This can include things like the backgrounds of individuals groups, the relationship between sets of groups, the rules that dictate how groups respond.

Society as a whole often reacts negatively when a new technology challenges the established morality. The previously existing morals that were ingrained and upheld by the public now face the challenge of a tool that hopes to improve the quality of life by pushing the boundaries of a social construct. The objective of this thesis is to explore the relationship between society and genetic engineering, an ethically challenging technology, and observe which groups and ideas directly influence its public acceptance or rejection.

Three groups can easily be identified. The general, uneducated public; scientists and those with the training to understand the methodology behind genetic engineering; and finally, health care providers. Each of these groups are biased in different ways, yet they all somehow influence the probability of widespread application of genetic engineering. Novel technologies, like genetic engineering, are foreign to uninformed individuals, and often scary or formidable. Likewise, these individuals developed their understanding of ethics from their own personal experiences. Understanding how to introduce new technologies, and framing them as the best solution to a problem, is the greatest challenge when dealing with the general public.

Scientists and those familiar with the field will take less convincing to accept genetic engineering. This group has experience with topics and ideas such as genetically editing animals. Their views and biases already lean towards accepting technologies, since it’s what their life revolves around. However, science is a self-correcting discipline. Those involved in the scientific community might challenge the efficiency of genetic engineering, and question why other practices were not chosen. This group is just as likely to reject a technological advancement, but because they are aware of the possibilities that exist.

The last relevant group are the health care providers. If genetic engineering was to be adopted as a general practice, some entity would be responsible for providing the service.

Whether it’s under private or public health care, performing genetic engineering would cost money. Would individuals be willing to give up their income to fund a service they might not even use? Or how would these health care companies advertise such a service? A comparable example to genetic engineering is abortion. Abortion is highly controversial all over the world, and countries that have legally approved abortion have special clinics for it. Abortion also acts as a great example of how othr social groups accept or reject ethically challenging procedures. Comparing genetic engineering and abortion could provide insight as to how society accepts medical practices.

Conclusion

In exploring the social constructs that affect technologies, a greater understanding of public approval metrics will be garnered that will elucidate the likelihood of inter-organ mapping being widely accepted by the public. Research will have to be conducted to further understand the relevant social groups of this novel technology, and if there exist any possible alternative strategies that might mitigate public outrage. Conducting this research will not only increase the chances of public approval, it will also fuel the scientific exploration of alternative strategies not originally imagined by the authors.

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