User-Tailored Privacy by Design

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The Path to my Research

In my freshman year of high school, a few friends and I came up with a rather interesting idea. We imagined a computer program with access to various controls, whether they be to a game or any other interaction. The system would begin by randomly “pressing buttons”, and the user would tell it whether it was doing well or badly, and it would somehow adjust it behavior accordingly. Based on these vague parameters, I programmed a system that mapped semi-random inputs to several button outputs through mathematical transformations. Though this system wasn’t very scientific, and the idea was somewhat underdeveloped, the program was able to “play” Tetris for a few moments before losing. I was proud of what I had created, but I knew it could be improved. Through my pursuits to improve it, I discovered the vast field of machine learning, a subfield of artificial intelligence interested in “teaching” computers to do things.

Later that same year, my Spanish teacher, who also taught AP Computer Science, told me about my school’s Science Research Program. In this program, sophomore students narrow down a field of interest, and spend three years developing a full research study with a mentor. I had spoken with this teacher about my interest in computer science, and we both recognized this program as an opportunity for me to

explore and expand my computer science understanding. At that point, I had been programming for more than three years, but I now realize how crucial my research has been in bringing my programming ability to the next level. I contacted the people in charge of the program's organization, and began my preliminary work over the summer preceding sophomore year.

Over the summer, I began to research a broad field of interest: Artificial Intelligence (AI). At the time, I had limited knowledge about the field, but was fully aware of my passion to know more about it, and to use it to make progress in my field. I found academic and general articles regarding recent revolutions in AI, and procured a basic understanding of the mathematics involved in it. The process of learning about such a vast and mysterious field on my own was powerfully enlightening, and brought back feelings of teaching myself to code. I believe that these deeply enriching opportunities to improve myself through self-motivation and discipline shaped my intellectual curiosity, and nurtured my sense of scientific understanding.

From its very beginning, sophomore year was more than I could ever have hoped for in terms of scientific discovery. My science research class provided a nurturing yet rigorous space to learn more about my topic. My workload was comprised of finding new research and articles related to artificial intelligence, and narrowing down my field of interest. Before long, I decided I wanted to apply artificial intelligence to user interfaces. In other words, I wanted intelligent programs to make changes to the

interactions users have with systems, to make them easier, safer and more rewarding to use. I also dove deeper into the mathematics of machine learning. I began teaching myself about calculus, the study of change, and linear algebra, the study of linear equations. These topics are some of the most important foundational components to machine learning algorithms. With a large amount of time and effort, the complicated, magical concepts of machine learning began to sink into my intuition. Mathematical understanding transformed this mystifying field into a concrete set of tools with which to make real change.

Later in my sophomore year, I began speaking with my future mentor, Bart Knijnenburg, a professor at Clemson University. I had been interested in his research, which looked into adaptive privacy in online systems like Facebook, for some time. My first contacts with him were extremely interesting, shedding light on the true breadth of knowledge belonging to a person with years of experience in my field. My discussions with him showed his research to be very similar to my interests, as they related to using adaptations to make applications safer and easier to use. He also exposed me to research that he and others in the field had done, showing me the progress that had been made, and the countless mysteries yet to be uncovered.

After many discussions with Dr. Knijnenburg, he agreed to be my mentor. He and I began formulating a concept for adaptive privacy on Facebook, inspired heavily by previous work he had done. It involved several different ways of creating and showing

privacy adaptations. Over the summer before junior year, he and I developed these ideas, and began to imagine an online interaction, similar to Facebook, where we could test these adaptations. According the the specifications we developed, I designed various adapted mockups of such a system. Over a few months, I created numerous mockups, and showed them to my mentor for critique. This design process was my first truly collaborative research experience, and it was extremely enlightening.

Upon the finishing of the mockups, I was tasked with the development of an actual research application. This basically involved creating an entire website that simulated Facebook, including our proposed adaptations. Even at the time of this assignment, I had been programming for a long time. However, I had only elementary experience with web development, so it was very much a learning experience for me. Since my junior year, a collaborator (a PhD student from Clemson) and I have been programming this dynamic system, and I feel that it has given me valuable experience, and has solidified my desire to pursue programming in the future.

My experience with research has opened up countless life changing opportunities. For example, my mentor invited me to a User-Tailored Privacy by Design summit he was organizing in late 2017. I had the amazing experience of flying down to South Carolina and meeting the very students and researchers who wrote the research I had learned so much from. I was able to speak with them about my research and ideas on a deep level, and felt respected as a peer among a group of people whom I

deeply revered. This opportunity was a monumental boost for my passion about computer science and human-computer interaction.

Conducting authentic scientific research has made me feel closer to the mathematics I have learned along the way, and more in-tune with the scientific methodologies I have applied. It has revealed to me that mathematics is a profound, concise and elegant framework with which to describe the innumerable beautiful, terrible and otherwise enigmatic phenomena of the natural world. It has also shown me that science is not the nebulous pursuit of knowledge for its own sake, but is rather a unique perspective, in which understanding is a goal with an unknown but certainly present path leading to it. Conducting research with these new ideas in mind has totally reshaped my view of the world, and has convinced me that I would like to pursue programming and the discovery of new understanding.

My Project

The goal of my research is to find out the effects of showing different people various privacy suggestions in a Facebook-like system. In theory, this understanding could provide tools that allow users who want different amounts of privacy to achieve it conveniently. To adapt to users, however, one needs a model of the users. We picked “Privacy Profiles”, a previously established user model. Privacy Profiles basically categorize users of a social network based on the privacy features they use and are aware of. For example, people who often block people may be categorized as “Privacy

Maximizers". Based on this model, we designed three ways of creating adaptations, and three ways of showing them. When generating suggestions, we can use "optimization", which helps the user with things they already do, "solidification", which helps them with features inside of their profile (ones which they "should" be using), or "self-actualization", which suggests things they might not do themselves.These are called "Adaptation Methods". These adaptations can then be shown in various ways, called "Introduction Methods": "automation" implements changes without asking the user first (with an "undo" button), "highlighting" makes features more visible or prominent, and "suggestion" shows a Privacy Dinosaur (Based on of a similar dinosaur on Facebook) to give personalized suggestions.

The purpose of these various methods is to test the effects of very different adaptations being shown to different people in different ways. We hypothesized that the different adaptation methods will vary in terms of how dangerous people feel the methods are. For example, optimization might be less dangerous than self-actualization. However, we also suspected that more dangerous adaptations would be perceived as more novel. Similarly, the more bothersome an introduction method is, the safer it may be. For this reason, we also hypothesized that different combinations of methods would work well. People may like optimizations to be automated, but not self-actualizations. Finally, we proposed that users with different privacy profiles would prefer different methods, and different features would work best with different adaptations.

As I discussed before, a dynamic website has been in development for some time that implements these ideas. However, due to time constraints, we designed a study based on the mockups alone. My collaborator interviewed 20 people at Clemson University, showing them various paper mockups of different features and adaptations. He asked them their opinions of the mockups and of the different adaptations, in addition to whether they used and were aware of the different features. Even these simple questions led to some rather interesting results.

The first result of interest arises upon comparing usage and awareness of features to preferred introduction method. People generally preferred an unadapted version in cases where they knew about a feature, but didn't use it. Interestingly, this implies that people who don't use a feature don't want help using it. In other words, adaptation may be a tool for optimizing a system, rather than expanding the user's horizons. Automation was preferred for features the user knew about and used. This further implies that users see adaptation as a means of easing burden. Highlighting and suggestion behaved similarly by this metric, without any immediately intriguing observations.

It is also interesting to look at the preferred introduction methods for different features. It seems that for "benign" features such as putting photos in an album, users preferred either automation or suggestion. This can be interpreted as meaning that more informed users like the burden to be eased with automation, and less

knowledgeable users appreciate personalized help. Conversely, for a feature like deletion of a post, we observe a tendency towards suggestion and an unadapted version. This may mean that, in potentially dangerous or socially awkward transactions, more informed users prefer to be in control, and less informed users want personalized help to provide a safety net. It also appears that more uncommonly used features work well with highlighting, but the lack of specific data makes this a conjecture.

Despite the limited sample size and the preliminary nature of this study, it provided monumental information to be used in designing a more conclusive study. The mechanism for finding participants was relatively unbiased, and the data regarding usage and awareness appears to be approximately representative of the population. For these reasons, many safe yet profound judgements can now be made in the design of the dynamic study. Even in isolation, these results certainly pave the way towards adaptation on social networks.

Takeaways and Advice for Young Researchers

This research process has been one of the best things I have experienced in my entire life. It opened up countless doors in my pursuit of scientific understanding, and gave me the experience and work ethic required to truly fulfill my dreams of discovery and creation. I encourage high school students to undertake scientific and mathematical pursuits using any opportunities available to them. I know from experience that it is impossible to truly understand science and math without exploring them in practice.

High schoolers who have a passion for discovery and profound understanding of our world have no better path than scientific research. It is an experience that I will always be grateful for, and I am excited to take the path it has set me on.