Thesis Project Portfolio

From Coursework to Industry: Improving UVA's Full Stack Web Development Offerings

(Technical Report)

Neuralink and BCIs: Addressing Policy Gaps and Societal Concerns

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2025

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Technical Project Abstract

Modern web development practices and frameworks are critical for preparing computer science students for industry, yet the current UVA curriculum lacks emphasis on these technologies. To address this gap, I propose the implementation of a new full stack web development course that integrates modern tools, frameworks, and practices used in industry. This proposal will build on insights from analyzing and comparing UVA's existing courses in this realm to an external program I participated in that focused on modern web development. The proposed course would combine hands-on experience with popular frameworks like React, Node.js, and Docker, and cover important topics such as RESTful APIs, CI/CD pipelines, and scalable deployment practices. Methodologies in this course would primarily include hands-on project-based learning, working in teams with other developers, and case-studies which look at real-world best practices in action. Anticipated outcomes include a higher degree of student readiness for industry roles which require modern web development skills, as well as a more relevant curriculum which aligns with industry standards. Future work will involve creating course material, getting approval to run the course, piloting the course, and gathering feedback from students and professionals to refine it over time.

STS Project Abstract

In this paper, I investigate the regulatory and ethical challenges posed by Neuralink's Link device and similar brain-computer interface (BCI) technologies, focusing on whether existing policy frameworks align with core societal values. Neuralink, founded by Elon Musk, is pioneering neural interfaces with bold therapeutic promises such as restoring motor function for paraplegics. However, there have been setbacks, such as the malfunction of its first human

implant, that raise serious concerns about corporate transparency, ethics, and regulatory oversight.

I use a policy analysis framework to evaluate current regulations, including HIPAA, the GDPR, and FDA guidelines, identifying how they succeed or fall short in protecting autonomy, privacy, equity, and safety for BCI users. My findings show that HIPAA offers limited protections outside of traditional healthcare contexts, and the GDPR struggles with issues like outdated static consent frameworks and re-identification from anonymized neural data. FDA processes, although suited for assessing safety and efficacy, fall short in incorporating ethical and value-laden concerns which are inherently tied to BCI technologies.

To address these gaps, I propose reforms such as explicitly classifying neural data, introducing dynamic and ongoing consent frameworks, differentiating between therapeutic and enhancement applications, and requiring more transparency from private companies like Neuralink. I also propose the use of ethical advisory boards within regulatory bodies to assess the broader societal impacts of emerging technologies. By aligning regulations and procedures with societal values such as therapeutic prioritization, equity, privacy, and transparency, policymakers can foster innovation while also protecting individuals from harm. Ultimately, I provide a foundational roadmap for ensuring that the transformative potential of BCIs is harnessed responsibly.

Connection Between Technical and STS Projects

While these two projects focus on fairly different subjects—web development education and BCI regulation—both have some shared themes, such as aligning technological progress with the values and needs of society. My technical report proposes a modernized UVA computer science curriculum through the introduction of a hands-on, full-stack development course that

better prepares students for real software engineering roles. Similarly, my research paper on Neuralink examines how BCI technology is developing faster than policy frameworks, calling for modernized regulations that reflect societal values and give people the protections they need when using these technologies.

Additionally, both projects have to do with bridging gaps. In my technical report, this involves bridging the gap between theory and practice in computer science education, as I argue that universities must prepare students not only with foundational concepts but also with the practical skills demanded by real jobs. In my research paper, this involves bridging the gaps in policies that result from technological innovation moving at such a fast pace, as I argue that policymakers must design policies that can evolve alongside these technologies to protect society and cater to their values.

Finally, both papers argue against inaction and complacency. Without project-based learning of modern technologies and evolving curriculum, students have been graduating unprepared for their career demands. Similarly, without proactive and evolving regulations, companies like Neuralink may exploit neural data or use their technologies for dangerous purposes. In both cases, adapting to changing standards and technologies is crucial, and failure to do so can have both individual and societal consequences.