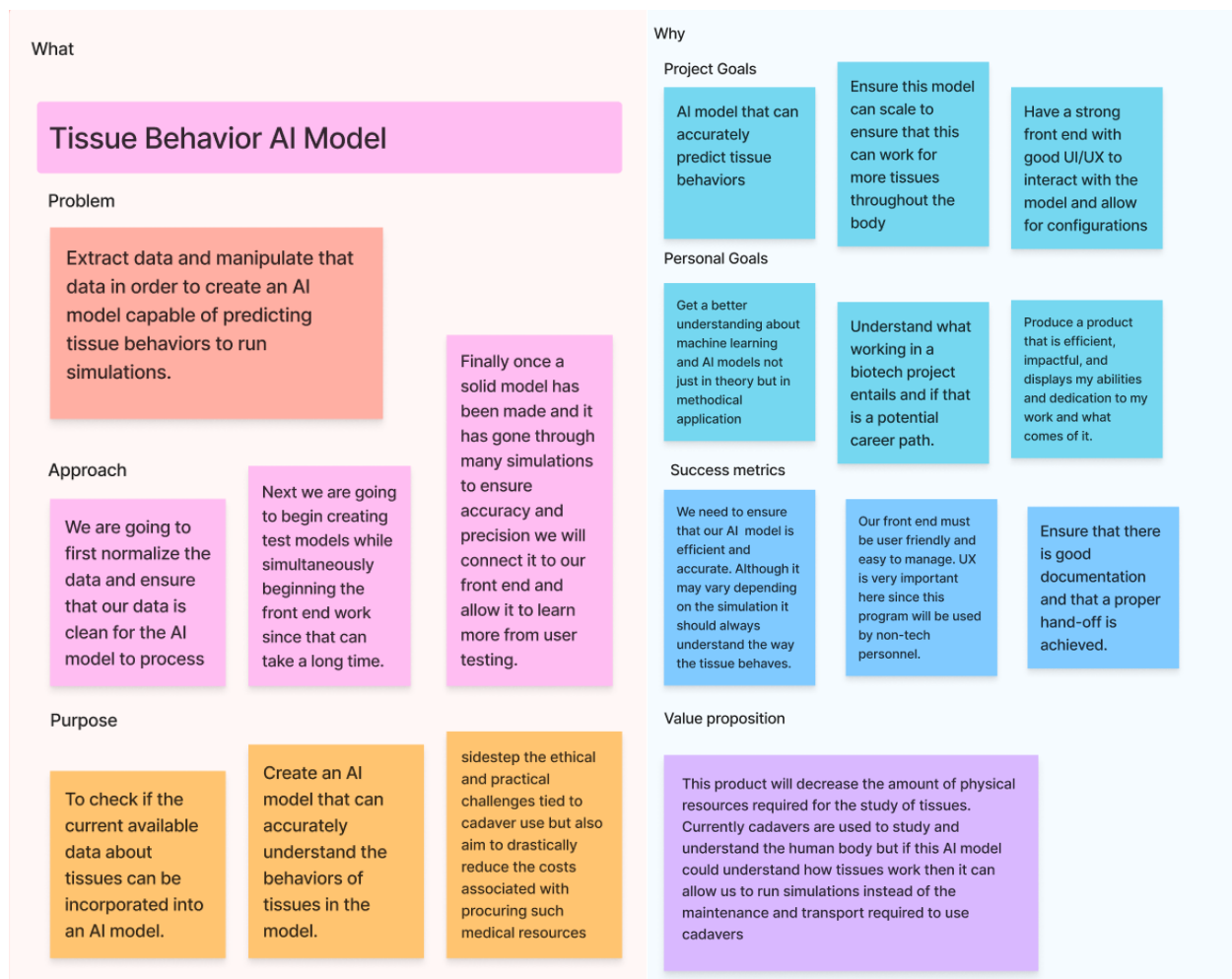1. Introduction

Our senior design project, in collaboration with our esteemed sponsors at Washington University, pursues a groundbreaking vision: to engineer an AI model capable of substantially enhancing our grasp on tissue behavior. Traditional methods have predominantly leaned on cadaver studies, which present multiple challenges. These encompass ethical concerns, restricted availability, and the inherent inability to authentically replicate the responses of living tissues.

Merging the pioneering strides of medical research with the transformative power of AI, our project aspires to transcend the limitations traditionally associated with cadaver-dependent methods. By simulating tissue behavior through AI, we not only sidestep the ethical and practical challenges tied to cadaver use but also aim to drastically reduce the costs associated with procuring such medical resources. Such an innovative approach could potentially revolutionize various facets of medical science, spanning from advanced research to specialized training and precise treatment planning, while also offering a more cost-effective and scalable solution.

Embarking on this ambitious venture, I perceived my involvement as much more than a conventional role. The intricate task of emulating tissue dynamics and decoding its intricacies not only resonated with my academic aspirations but also provided me with a profound immersion into the biotechnological realm. This invaluable insight fortified my capacity to assess and appreciate the prospective trajectory of a career within biotech. Such revelation, combined with unwavering dedication, impelled me to ensure that my involvement was not merely transactional but transformative. From the nascent brainstorming sessions to intricate data assessments, the

grandeur of our project's potential consistently ignited my zeal to innovate, strategize, and effectually contribute. Our continuous interactions with specialists at Washington University further enriched this journey, bringing academic depth and real-world relevance, molding a project that is as promising as it is pivotal.

What

Tissue Behavior AI Model

Problem

Extract data and manipulate that data in order to create an AI model capable of predicting tissue behaviors to run simulations.

Finally once a solid model has been made and it has gone through many simulations to ensure accuracy and precision we will connect it to our front end and allow it to learn more from user testing.

Approach

We are going to first normalize the data and ensure that our data is clean for the AI model to process

Next we are going to begin creating test models while simultaneously beginning the front end work since that can take a long time.

Purpose

To check if the current available data about tissues can be incorporated into an AI model.

Create an AI model that can accurately understand the behaviors of tissues in the model.

sidestep the ethical and practical challenges tied to cadaver use but also aim to drastically reduce the costs associated with procuring such medical resources

Why

Project Goals

AI model that can accurately predict tissue behaviors

Ensure this model can scale to ensure that this can work for more tissues throughout the body

Have a strong front end with good UI/UX to interact with the model and allow for configurations

Personal Goals

Get a better understanding about machine learning and AI models not just in theory but in methodical application

Understand what working in a biotech project entails and if that is a potential career path.

Produce a product that is efficient, impactful, and displays my abilities and dedication to my work and what comes of it.

Success metrics

We need to ensure that our AI model is efficient and accurate. Although it may vary depending on the simulation it should always understand the way the tissue behaves.

Our front end must be user friendly and easy to manage. UX is very important here since this program will be used by non-tech personnel.

Ensure that there is good documentation and that a proper hand-off is achieved.

Value proposition

This product will decrease the amount of physical resources required for the study of tissues. Currently cadavers are used to study and understand the human body but if this AI model could understand how tissues work then it can allow us to run simulations instead of the maintenance and transport required to use cadavers

2. Preliminary Data Analysis

Upon receiving the initial mock dataset, provided to us as a precursor to the official dataset from Washington University, I immediately took personal initiative:

• Personalized Exploration: I dedicated myself to a meticulous study of each column of data. This process allowed me to form preliminary hypotheses concerning tissue characteristics, even if the data was subject to change.

• Self-driven Statistical Mastery: Recognizing the nuances within, I furthered my statistical capabilities, employing tools such as standard deviation to interpret potential data trends.

• Data Visualization Skills: Fully aware of the importance of visual interpretation, I sharpened my aptitude in producing meaningful graphs from the data.

Handling the mock dataset was an exercise in precision and foresight. Given that this was a stand-in until we received the primary dataset from our partners at Washington University, it was crucial to approach it with the perspective that while the data might differ, the structures and some underlying patterns might remain similar. This understanding was essential, especially when dealing with a dataset enriched with both numerical values and categorical elements, such as different injury classifications like 'slash' and 'bludgeon'.

Being partnered with a large institution like Washington University presented its own set of challenges. Due to the nature of bureaucratic processes in expansive organizations, there were inevitable delays in

accessing the main data set. However, this mock data provided an invaluable opportunity to lay the groundwork for our future endeavors. I ventured into researching the integration potential of such datasets, particularly with platforms like PyTorch and NumPy, ensuring that when the actual dataset arrives, the transition would be seamless.

Moreover, an in-depth dive into literature reviews and active participation in community forums provided me with a vantage point into the experiences of others who might have wrestled with similar data challenges. This engagement aimed to assimilate best practices in data handling while also discerning potential pitfalls to avoid.

This proactive phase, grounded on the mock dataset, not only fortified my grasp of the data's potential intricacies but also set the stage for a more informed and efficient approach once the primary data from Washington University became accessible. Throughout this preparatory journey, my guiding principle remained unwavering: to ensure that every piece of data, whether mock or real, was judiciously employed to refine our comprehension of tissue dynamics.

3. AI Technologies Researched

Armed with a deeper understanding of the dataset from the initial phase, I recognized the impending need to align our project with the right technological tools. Data visualization has already unveiled intricate patterns and relationships within our data, providing us with unique insights. It was now time to translate these insights into actionable decisions.

Technologies:

- NumPy Proficiency: Recognizing its potential, I deep-dived into NumPy, making me the team's go-to for numerical operations.

- PyTorch Mastery: While familiarizing myself was an option, I chose to master PyTorch, taking on advanced courses and challenges.

In the realm of computational tools, both NumPy and PyTorch emerged as strong contenders. However, rather than diving headfirst into them, I embarked on a meticulous research journey. My goal was clear: to determine which platform would most complement our dataset and the patterns I'd uncovered.

NumPy's reputation for efficient numerical computations was well-known. Its capabilities in handling intricate data structures made it a potential asset. But it was crucial to understand how it could cater to our specific dataset. Drawing from the data visualizations, I weighed the strengths of NumPy against the dataset's characteristics, assessing how its functionalities could amplify our analytical capabilities.

Meanwhile, PyTorch's prowess in the AI domain was equally compelling. Its flexibility, combined with a vast array of neural network capabilities, offered a promising avenue for data modeling. I examined how the patterns revealed in our data visualizations might be modeled within the PyTorch framework, considering the potential advantages and limitations.

This research-driven approach was far from a solo endeavor. Engaging with literature reviews, community forums, and seeking insights from peers and experts provided a holistic perspective. The feedback loops from these interactions further enriched our decision-making process.

By merging the insights from data visualization with the potential of these technologies, I aimed to steer our project not just towards a

technological choice but an informed strategy. The visualization laid the groundwork, and my research sought to ensure our technological path was in harmony with our data-driven insights.

Python Proficiency and API Integration:

• Deepening Python Skills: PyTorch and NumPy are Python libraries. Thus, any backend language chosen would need to have a robust Python interface. Given this, I prioritized refreshing and deepening my knowledge of Python, ensuring that I'm well-prepared for any complexities that might arise during integration.

• API for Model Interaction: API development is more than just setting up endpoints. It's about ensuring that the data flows seamlessly, processes efficiently, and delivers the intended results. With my central role in API, I focused on designing an architecture that would allow for smooth interaction between our frontend and the AI models. This would mean devising endpoints that can efficiently handle model inferences, accommodate potentially large payloads, and return results in a format that's intuitive for the frontend.

• Interfacing with PyTorch and NumPy: Venturing deeper into Python also brought with it the understanding of how PyTorch and NumPy

function at their core. This understanding is pivotal as when the AI model is finally ready, the API should be capable of not just calling the model but also ensuring that data preprocessing, model inference, and post-processing are all streamlined.

Balancing between the academic demands and project intricacies, another dimension surfaced that was indispensable to the successful continuation of our project: backend interfacing with the AI model. Since my primary role revolves around API development and ensuring smooth integration with our prospective models, it was imperative to delve into the mechanics of Python – the natural choice for PyTorch and NumPy.

The road ahead is undoubtedly filled with intricate challenges. However, with the foundation laid during the mock data phase, coupled with my enhanced Python capabilities and clear vision for API development, I am optimistic about our project's ability to efficiently integrate, process, and deliver. Through continual learning and relentless determination, I'm poised to ensure that our backend is not just functional but exemplary in its efficiency and reliability.

4. Front-end Development and Technologies

The essence of our project, beyond its computational complexity, rested on how effectively we could translate our findings to end-users. As I delved deeper into the project, it became increasingly apparent that the user interface would play a pivotal role in the project's success. A meticulously

crafted UI/UX would not only make our findings accessible but would ensure that users could seamlessly interact with our system.

- React Expertise: I personally undertook advanced React courses, ensuring our project had the latest UI advancements.

- Bootstrap Innovations: My endeavors in Bootstrap ensured that our interface was cutting-edge and user-centric.

- API Integration Mastery: I delved deep into creating robust API linkages, ensuring backend and frontend harmony.

Recognizing the importance of this, I embarked on a journey to determine the most suitable dynamic front-end technologies for our project. My approach was two-pronged: understanding the technical strengths of each option and evaluating how they align with the unique requirements of our project.

React quickly emerged as a strong contender. Not just a popular choice, React's component-based architecture and its ability to create dynamic user interfaces made it a potential fit. I dived into advanced React courses, not just to understand its capabilities, but to evaluate its potential synergy with our project's objectives. Could React offer the responsiveness, scalability, and dynamic rendering our project demanded? These were the questions I sought answers to.

Alongside React, Bootstrap presented itself as a formidable option. Its responsive grid system and a rich library of components meant that we could potentially create an interface that was both visually appealing and adaptable to various devices. As I delved into Bootstrap's offerings, I was constantly evaluating: Does it align with our vision of a user-centric design? Can it adapt to the evolving requirements of our project?

But front-end technologies are only half the equation. The seamless interplay between frontend and backend is crucial. I began researching API integration techniques, understanding the intricacies of ensuring that our front-end technology could harmoniously communicate with our data-intensive backend. The goal is seamless data flow and real-time updates for users.

Throughout this research phase, my focus remained unwavering: to identify and recommend a technology stack that would not only elevate our project's interface but ensure that it was best positioned to meet the demands of our ambitious endeavor. The decision would be pivotal, and I was committed to ensuring it was both informed and visionary.
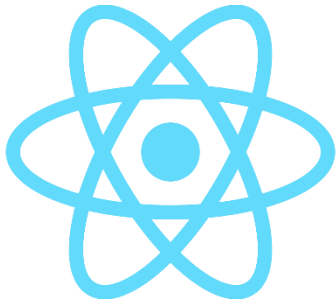
5. Time Management

While juggling multiple academic and project commitments, efficient time management became more than just a skill—it transformed into an imperative discipline. And I was determined to hone this discipline to ensure every commitment received its due diligence.

• Non-overlapping Schedule: I meticulously orchestrated my calendar, ensuring that project meetings were productive and unhindered.

• Priority Mapping: My day-to-day tasks were ranked, ensuring that urgencies were addressed efficiently.

• Initiated Weekly Check-ins: Recognizing the value of regular touchpoints, I introduced weekly team check-ins, which became brainstorming goldmines.

Every entry on my calendar, every scheduled discussion carried a strategic intent. Each meeting, each deadline was carefully positioned to ensure the flow of the project was not only unhindered but also optimized. By fine-tuning my calendar, I ensured that overlapping commitments, which could have been potential roadblocks, were systematically avoided.

But navigating through a plethora of tasks was not solely about avoidance; it was more about strategic prioritization. Recognizing the gravity of our project, I implemented a system to rank my daily tasks. This system ensured that urgent matters were promptly attended to, while also making certain that other critical tasks didn't fall by the wayside.

Yet, efficient time management wasn't just an individual endeavor. Recognizing the collective strength of the team, I proposed and instituted weekly check-ins. These sessions became more than mere meetings. They transformed into collaborative platforms where ideas were exchanged, help was offered kindly, and progress was keenly monitored.

To provide clarity on my time allocation, I analyzed my workload across all my courses. The result is a pie chart, succinctly illustrating how I effectively distributed my attention and efforts among three project-based classes, ensuring that this project received the dedication it warranted without compromising on my academic responsibilities.

Legend (current project-based courses):

Blue: COP4934

Red: COP4331C

Yellow: COP4503C
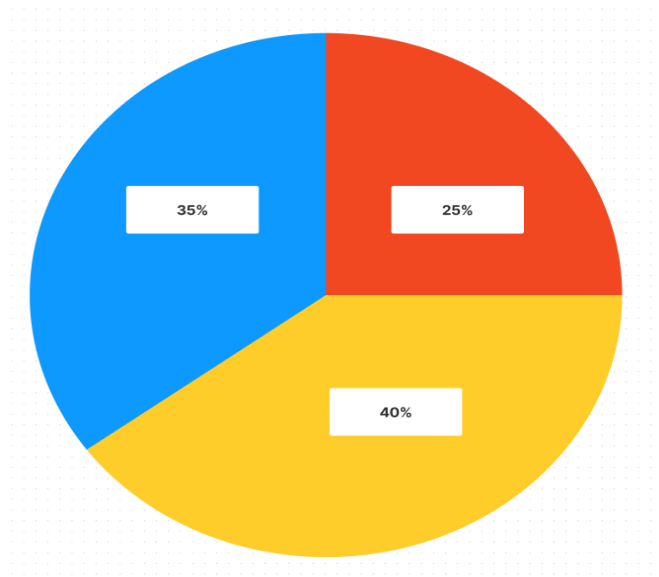
Balancing this project alongside my rigorous academic courses undeniably presented a significant challenge. Admittedly, my initial aptitude for schedule planning left room for improvement. Yet, the pressing demands of the project, combined with my academic obligations, prompted a critical adaptation.

I methodically honed my time management techniques. Tasks were systematically allocated, priorities clarified, and a proactive stance became my new norm. This transition from a casual planner to a more structured organizer was replete with learning curves, yet immensely rewarding.

While my current management approach may not claim perfection, it's evident that significant strides have been made. This progress is tangible not just in my ability to juggle multiple commitments but also in the quality and depth of my contributions. As I continue to shoulder my responsibilities in the project, my commitment to refining this skill remains unwavering. I view

every day as an opportunity to further improve, ensuring that with each task and challenge, I inch closer to mastering the art of efficient and effective time management.

6. Conclusion and Future Plans

Navigating through this project has been an intricate weave of challenges, insights, and growth opportunities. My involvement has been deeply rooted in determination and unwavering commitment:

• Focused AI Development: As we are on the threshold of the project's next phase, I'm earnestly preparing for intensive coding and algorithmic development. A clear and actionable roadmap is already set, reflecting my drive to transform our collective vision into palpable reality.

• Integration Strategy: Armed with a solid understanding of both API and frontend dynamics, I'm poised to be at the forefront of ensuring our AI model and user interface engage seamlessly.

• Feedback Mechanism: Recognizing the transformative potential of a user-centric approach, I've firmly established the foundations for an anticipatory feedback system.

Moreover, our partnership with our sponsors at Washington University, the custodians of the invaluable tissue data, has been instrumental. Our teams have been in continual communication, ensuring that the collaboration remains synergistic, transparent, and aligned with the project's overarching objectives. This rapport has not only facilitated data acquisition and validation but has also enriched our perspective, bringing academic rigor and industry relevance to our endeavor.

One of our impending endeavors is to connect with the previous developers who initiated this project. Gaining deeper insights into their foundational work and exploring the potential of integrating new ideas by leveraging their expertise will be invaluable. This synergy aims to bridge historical knowledge with fresh perspectives, ensuring that the project's continuity and innovation go hand in hand.

While the journey thus far has been steeped in challenges and learnings, I view it as the preparatory phase of an even more engaging narrative that lies ahead. As we pivot to the imminent developmental phase, my focus intensifies on mastering coding nuances and refining our algorithms. The strategy I've drafted is not merely an indicative blueprint but a tangible testament to my dedication to seeing our shared vision come to life.

The forthcoming integration phase, vital in amalgamating the robustness of our AI model with the fluidity of our user interface, demands precision and expertise. Here, my commitment is unwavering - to harness my knowledge to ensure this integration is a paragon of efficiency and efficacy.

Furthermore, as we transition closer to realizing our product, the salience of staying attuned to user feedback becomes paramount. I've proactively laid the groundwork to gather insights right from the nascent stages. This strategy is not solely about iterative product enhancement; it's

about ensuring our offering evolves harmoniously with user expectations and needs.

In summation, the milestones achieved thus far serve as foundational pillars. Yet, the journey ahead beckons with promises of innovation and excellence. And with the continued support and insights from our sponsors at Washington University, the previous developers, and our dedicated team's prowess, I remain resolutely committed to navigating this voyage with foresight, strategy, and unwavering dedication.