Proceedings of the Symposium for Virginia Tech Undergraduate Research in Computer Science

VTURCS 2023

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6:30pm-8:30pm

Commonwealth Ballroom

The Virginia Tech Undergraduate Research in Computer Science (VTURCS) program highlights the research and capstone projects of our undergraduate students during the past year. We are grateful for the support of Virginia Tech's Computer Science Resources Consortium (CSRC), a collection of companies that work with the Department of Computer Science to further our teaching and research mission.

R1: Enhancing Art Gallery Visitors' Experience through Audio Augmented Reality Technology

Authors: Abhraneil Dam, Yeaji Lee, Arsh Siddiqui

Advisor: Myounghoon Jeon

Audio Augmented Reality (AAR) applications are gaining traction, especially for entertainment purposes. To that extent, the current study explored its use and effectiveness in enhancing art gallery visitors' experiences. Four paintings were selected and sonified using the Jython algorithm to produce computer generated music (Basic AAR); the audio was then further enhanced with traditional music by a musician (Enhanced AAR). Twenty-six participants experienced each painting in Basic, Enhanced, and No AAR condition. Results show that AAR cues had a significant effect on participants' subjective feedback towards the paintings. Sentiment Analysis shows that participants mentioned significantly more positive words from Enhanced AAR than the others. Enhanced AAR also made participants express a sense of immersion, whereas Basic AAR made them concentrate more on forlorn aspects of the paintings. Findings from this study suggest ways to improve and customize AAR cues for different painting styles and indicate the need for multi-modal augmentations.

R2: Solar System Explorer in Virtual Environments

Authors: Priyanka Nair, Clara McDaniel

Advisor: Sang Won Lee

Virtual reality (VR) technologies have great potential in STEM education because they provide immersive learning experiences that one cannot have in the real world. However, interactivity using VR head-mounted displays is often a solitary experience, isolating learners from the social and learning context. In addition, many people are not able to use VR due to age, vision impairments, tendencies to motion sickness, sanitary concerns, and discomforts due to the headset messing up their hair or makeup. This makes it challenging for younger students to learn through collaborations with peers and instructors. The Solar System Explorer aims to address these issues. This study implements a socially connected VR system that is inclusive for immersive learning in STEM settings. This is possible by establishing a VR platform whose state is shared over mobile devices tracked with six degrees of freedom (6DOF). Learners thus do not have to wear head-worn devices; instead, they can view monoscopic VR on tablet screens. With this technology, Solar System Explorer in Virtual Environments is able to give students the experience of walking freely through the solar system. The concepts of moon phases, eclipses, and planet orbits should be understood by all as they are common occurrences that one may witness in their lifetime. Seeing these phenomena in real life and understanding the science behind them allows students to make connections and be more aware of the world around them. The experience provides three separate scenes to assist with the understanding of the solar system. Scene 1 is a proportionally accurate model to the real scale of the solar system, including the trails of the orbits. Scene 2 is an exaggerated model that makes each planet more visible, serving as a valuable tool for conceptual understanding. Finally, Scene 3 is a perspective from the surface of the Earth looking upwards at the orbit of the moon, allowing the user to experience the different phases of the moon in relation to the Sun. With these distinct scenes, a docent in either a school or museum setting can present information about the solar system to students that is supported visually by the 3D environment.

R3: Octave: An End-User Programming Environment for Analyzing Spatiotemporal Data

Author: Andy Luu

Advisor: Sang Won Lee

With sensing technology increasing in various industries, computational thinking and data analysis are more necessary than ever. For example, the construction industry, where investments in sensing technologies such as laser scanners, camera drones, global positioning systems (GPS), and radio frequency identification (RFID), to name a few, have opened the door to more data-driven analysis and decision-making. However, making sense of the raw data from sensors can be a challenging task for domain experts, especially without programming expertise. Therefore, there emerges a need to train the construction workforce to be equipped with computational thinking skills. Our approach to fostering computational thinking skills in the future construction workforce is our platform Octave. Octave stands for Observable Connections between Tables, Algorithms, and Visualization in an End User Programming environment. Octave currently allows users to see a temporal visualization of their data, a table of the raw data, and create an algorithmic state that users can specify. For example, users can create a spatial state that represents certain areas of a construction site, such as a crane's danger radius or a truck's dumping zone. Any two states can also be used to create a combination state to gather connections between the points between the two regions. A usability study was conducted in Octave with thirteen total Construction Management Students. The majority of the students found the site easy to use with simple terminology and believed that it would be beneficial in gathering connections from actual GPS data. Octave is currently being used by the CEM department to aid students in learning about data analysis, and we have hopes to expand its usage to construction sites in general.

R4: Broadband Data Kit: Automating Broadband Reporting In Underserved Areas

Authors: Roshni Saxena, Brooke Ritter, Rayhan Biju, Michael Peters

Advisors: Margaret Ellis and Shaddi Hasan

Access to broadband infrastructure has become an issue that the government has been working to fix, expanding this access to all people, especially the underserved and underrepresented. The Federal Communications Commission (FCC) will distribute more than $42B to these underserved areas, with the only condition being that the Internet Service Providers (ISPs) report their coverage once every six months. For a small ISP, filing a Broadband Data Collection (BDC) report can be a tedious and overwhelming task, and they will get fined if they don't complete the report. Our project seeks to create an automated process of creating this report, by creating software that takes in fiber and fabric files, which are location files, with other metric data, and generating a report. We created a web app solution to make this process easier such that small ISPs will be able to address this issue. The software takes in the data files, stores them in a database containing multiple endpoints on a backend server, and then the backend processes the data and creates a visualization of all of the coverage on a map. The map can be viewed by the ISPs to see their coverage and find any issues, such as a location that the ISP knows they cover, but the map doesn't show the location as covered. In the future, our team will create the software that generates the .csv reports. Our team will also look into creating user management and generating the option for the ISPs to send updates to the FCC. We will also meet with potential clients that would benefit from our web app. Moreover, the objectives of this project are to complete the BDC report preparation for small ISPs, automating the custom analysis pipeline to create a self-serve tool that small ISPs can use to map the coverage of their wired and wireless networks, and finally, to improve usability and performance of networking tools.

R5: Optimizing Mobile Web Apps via Safe Cross-Language Insourcing (SCLI)

Authors: Yonden Sawyers

Advisor: Eli Tilevich

An important part of the modern computing infrastructure are so-called web applications. In such applications, their client code runs in a web browser, while their server code runs in some remote server in the cloud. The client and the server communicate with each other via the available network, whose latency and reliability can greatly impact the user experience. Namely, users can experience a varying degree of delay or outright disconnection due to changing conditions. This research project explores a novel solution to this problem through sandboxing insourced route handlers to the client to allow for both local and remote execution of server-side resources in response to changing network conditions. Named “Safe Cross-Language Insourcing” (SCLI), this approach bridges a gap between server and client functionalities to reduce the overall delay experienced by the end user. Specifically, SCLI wraps fetch and HTTP libraries to obtain real-time telemetry on the performance of server-side resources. Based on the obtained telemetry, SCLI then insources functionalities from the server to the client as deemed most advantageous from the performance-improvement standpoint. The main advantage of our approach is its transparency for mobile application developers, as all profiling and transformations are taking place behind the scene. Hence, our approach can be seamlessly integrated into any project without incurring any extra developer effort. Applying our approach to several existing web applications showed its potential in reducing client response times, especially for limited networking conditions.

R6: Towards gaze-based prediction of the intent to interact in mixed reality

Authors: Sraavya Gudavalli, Anish Narkar

Advisor: Brendan David-John

Mixed reality (MR) is the next wave in computing following mainframes, PCs, and smartphones. It liberates us from screen-bound experiences by offering naturalistic interactions with data in our living spaces and with our friends. MR brings together real world and digital elements. In mixed reality, you interact with and manipulate both physical and virtual items and environments, using next-generation sensing and imaging technologies. MR allows you to see and experience the world around you while also interacting with virtual content using your own hands—all without ever removing your headset. Enabling natural gestures for input in future mixed-reality devices will rely on prediction models to create frictionless modes of human-computer interaction.

To make sure this happens accurately and smoothly, mixed-reality devices will depend on eye tracking and prediction of gesture inputs. Sensors that track the user's eyes and hands will be used to predict what object a user wants to select, and when they want to select it. Predicting interaction intent allows a system to create shortcuts for selection during complex tasks that are accurate and seamless for the user.

Prior works have collected eye-tracking data in VR to train models that predict when users would select an item with a VR controller. Extending interaction to mixed reality, which includes a mix of real and virtual objects, requires additional considerations based on how users eye and hand movements differ when selecting real and virtual objects.

The long-term goal of this work will be to design a user study on interaction in MR and observe behavior while playing a virtual 3x3 sliding puzzle game and a physical 3x3 puzzle. Data will be collected from participants using the Magic Leap 2 and track how they solve the puzzle and labeling data when they interact with real and virtual objects.

The scope of this project will be to provide additional insights into behavior during AR interaction and build a corpus of data to enable training of gaze-based prediction models in MR.

R7: Enhancing Brain Flow Visualization with Automated 3D Data Processing: A Study on fMRI Data from Mice with Tumors

Authors: James de Chutkowski, Daniel Park, Hun Liang

Advisor: Nicholas Polys

Our team of computer science students collaborated with researchers at Fralin Biomedical Research Institute (FBRI) to improve and automate data fusion and visualization of brain tumor data. We focused on the challenge of optimizing and automating the processing of 3D volumetric and vector field data sets from fMRI scans. It is crucial to maintain performance, preserve data quality and resolution, and provide a usable platform for biomedical scientists. In this poster, we present our innovative pipeline approach to enhancing flow visualization of brain tumors through open source 3D data processing and Web-based High-Performance tools. Our team has successfully designed, documented, and benchmarked new techniques for the production of X3D Web3D visualizations using Python and Paraview automation. This streamlined approach not only enhances brain flow visualization in the context of tumor research but also provides a reproducible and transparent framework for future studies with both human and mouse scans.

The proposed approach to the end-user productivity involves three main steps: 1) Data processing and registration with Python, which includes handling missing or incomplete data, and manipulating data to correct improperly registered data; 2) ParaView pipelining to generate X3D data and visualizations, which involves constructing a visualization pipeline, recording the process into a Python script, customizing rendering properties, and exporting data to images and to the X3D format for Web-based visualization; and 3) Publishing to the Web and process automation using Jupyter Notebook, which includes uploading X3D data to a Web server, automating data processing, visualization, and publishing steps in a Jupyter Notebook, and sharing the notebook with collaborators for reproducibility and transparency.

R8: Hidden Figures

Authors: Michael Atkins, Caylie Baughman, Kalina Kazmierczak, Matt Lorenzo, Xandra McCoy, Aniruthan Ramadoss, Yiting Wen

Advisors: Godmar Back, Kirk Cameron, and Margaret Ellis

The Hidden Figures project is a new project within BURGS that aims to aggregate data on individuals who contribute to the computing industry, particularly in the area of High Performance Computing (HPC). Our mission is to highlight underrepresented people and showcase their contributions to the field. We hope we can inspire future generations of diverse individuals to pursue careers in computing.

The project is split into a backend and frontend. The backend is an extension of the Computer Systems Genome (CSG) database. Alembic, a database migration tool in Python, was used to create SQL Tables and SQLAlchemy, a python ORM and SQL wrapper, was used to set up relationships in the tables. Endpoints were created to perform queries on the database table, complete with filtering by rows and columns, through the CSG API. After the database was established, a spreadsheet was used to store contributor and contribution information carefully selected from a variety of sources such as academic publications, online databases, and historical archives. The CSG python library and pandas were used to automate data insertion from the spreadsheet into the database.

The frontend's goal is to leverage the backend to create visualizations that show connections between contributors and their contributions. A timeline was created to visualize the women who have contributed to HPC and their specific contributions. We chose 20 influential women and utilized the Timeline.js tool developed by Knight Lab to generate the timeline visualization. A network visualization was also developed to showcase the connections between different contributions in computing, demonstrating how they relate to one another. The React library D3 was used to develop a network graph which shows how certain innovations influenced each other. The network also connects the hidden figures to their innovation.

Our future goals are to expand our project by collecting more data on hidden figures in the HPC community and gathering more concrete information about each individual. We plan to create more visualizations and improve the format to make it more visually appealing. Additionally, we aim to explore the potential for making connections between our HPC history data and the current CSG database of architecture and supercomputer benchmark data, in order to gain deeper insights into the evolution of HPC technology over time.

R9: J-WAVE - Java Web Application for Vulnerability Education

Authors: Michael Alexander Kyer

Advisor: Stephen Edwards

Over the years of software development in the variety of languages that exist, thousands of vulnerabilities have been identified. Many of these vulnerabilities have been exploited for malicious purposes. Oftentimes, they are present due to developer errors such as: the inclusion of libraries with known vulnerabilities, taking shortcuts which skips the implementation of important security measures, or other poor programming practices that lead to gaps in the system's overall defense. Prevalent vulnerabilities will vary on a language by language basis, but some languages are more popular than others. Java, one of the more popular languages, was created to be portable. Thus, it can be run on any operating system and produce the same results. Therefore, a vulnerability that exists within Java can be exploited on any Java-capable machine. Java is also a very common language for educational purposes. Educational institutions worldwide are teaching their students how to program in Java, so there is an early opportunity for students to learn about these vulnerabilities. This raises the question: Is it possible to create a tool that simultaneously detects and educates developers on Java-specific vulnerabilities?

To solve this problem, we introduce J-WAVE, a Java Web Application for Vulnerability Education. J-WAVE is a web service that allows for the submission of a collection of .java and .class files, and it will utilize a variety of static application security testing (SAST) tools to scan that code for vulnerabilities. Each of the SAST tools used is open source and has been identified by the National Institute of Standards and Technology (NIST) as a source code security analyzer. The list of tools used in our application includes: PMD, FindSecurityBugs, Semgrep, and Yasca. Utilizing these tools, J-WAVE aims to identify the pros and cons of each tool, as well as provide the ability to scan Java programs for any vulnerabilities present. Ultimately, achieving these goals will allow for J-WAVE to be utilized effectively in the classroom. It will allow educators to reactively change their curriculums to better teach students about trending vulnerabilities. Even more importantly, it will proactively educate students by showing them their vulnerabilities and giving the tools necessary to correct them.

R10: CSGenome GPUs and Client API

Authors: Michael Atkins, Todd Cochran, Brendan Doney, Xandra McCoy, Aniruthan Ramadoss, Yiting Wen

Advisors: Godmar Back, Kirk Cameron, and Margaret Ellis

In recent years, accelerators have become increasingly popular in HPC to increase performance. Prior to 2011, accelerators did not see use in the TOP500 list, a ranking of the world's currently most powerful supercomputers and their specifications. However, in the most recent publication, 180 of the 500 systems made use of accelerators, with the current top system making use of over eight million accelerator cores. As accelerators continue to gain traction and see increased usage in HPC systems, it is important that we add this area of hardware to our CSG database to model the hardware breakdown of these systems.

Currently, there is no existing database that records this information in a standardized format. The TOP500 list records one accelerator explicitly and multiple accelerators in a non-standard format but does not record hardware information for multi-accelerator systems. Therefore, we aimed to standardize and add this data to the Computer Systems Genome (CSG) database. We architected a schema in which a computer system may have an accelerator configuration consisting of one or more accelerators. Accelerators are one of three categories: graphics cards, coprocessors, and interconnected GPUs. An accelerator configuration can be linked to one or more systems and is represented as a total accelerator core count and a set of accelerators. We supplement each accelerator with an individual count, if available. The hardware information for each accelerator was scraped from TechPowerUp, cleaned, and then added to the corresponding table.

The methodology employed to clean, insert, and maintain the collected GPU data revolved around the group's Client API. This Client API is a Python binding to the CSG project's existing REST API for both internal and external use via its PyPI package called csgapi. The primary motivation for creating the Client API was to facilitate the data transfer of not only GPU data to the CSG database, but also the biannual TOP500 data. Jupyter notebooks on the CSG website now use this python package to fetch computer systems information to create visualizations and analyses. The Client API is capable of filtering, sorting, and performing range queries for all of the CSG tables, with built-in pagination for efficiency. It also forwards verbose error messages to promote ease of use. As the CSG project evolves, this Client API will prove to be a valuable asset for the maintainability and usability of our data, while the GPU data supplements essential information for our database.

R11: Crowdsourcing the Computer Systems Genome Database

Authors: Sophya Hargenrater, Michael Atkins, Justin Turkiewicz, Brian Mamani Balderrama, Tai Nunez, Bhavya Patel, Collin Dunphy, Alina Bhatti, Sofia Kazmierczak, Rio Young, Sarah Huang, Ryan Gniadek

Advisors: Godmar Back, Kirk Cameron, and Margaret Ellis

The Computer Systems Genome project at Virginia Tech has an overall mission of consolidating computer systems information into a centralized database, cataloging the lineage of that information, and making that information publicly accessible via an Application Programming Interface and website. The database has grown to include over 15,000 systems, 4,000 processors, and 3,000 memory entries. This large scale has motivated the group to introduce a crowdsourcing feature such that outside collaborators can submit corrections and additions to the database.

The Computer Systems Genome team hopes to utilize this feature to generate large amounts of diverse data. A fully fledged authentication system was needed to facilitate this feature and verify the identity of any users to ensure that their contributions are trustworthy.

Implementation of the crowdsourcing and authentication features introduced new complexity to our application. This necessitated an evolution from a monolithic, single database application to a multi-database application. To achieve this, we added an authentication SQLite database to hold the structured authentication information via a User table, Access Token table and Reset Token table. We paired this with a new API to allow us to create user management pages on our website. Users can view their profile, manage their tokens, and reset their password all from the website. Admin-level users can manage permissions of other users and view any user in the database.

With an authorized account, users then have the ability to suggest edits and make contributions to our database. The user can view their individual submissions, each stored in a crowdsourcing mongo database, in their profile where they can modify and add comments to any of their contributions. The user’s submissions would be in a pending stage, until the admin, who has a higher clearance level, will be able to either approve or reject the user’s submissions. In the circumstance that the admin approves their submission, our database will be updated; however, if it is rejected, the admin has the option to comment and converse with the user regarding their submission.

In conclusion, the Computer Systems Genome project at Virginia Tech has successfully transitioned from a monolithic, single database application to a multi-database system, streamlining the process for users to contribute valuable information. The implementation of

crowdsourcing and authentication features has the potential to expand the size and reliability of the database in addition to creating a richer, more interactive user experience on our website.

R12: A Qualitative Study on the Technical Interview Experience from the Interviewee Perspective

Author: Teresa Thomas

Advisor: Sang Won Lee

Technical interviews often involve writing code on a whiteboard or remote editor and thinking aloud in response to an interviewer's programming problem. Our study is a qualitative interview study, currently conducted with students close to graduation or for those who are recently employed out of school. The technical interview process is an often stressful one for many interviewees. We seek to understand the concerns and thoughts behind the technical interview from the interviewee perspective to see the potential in how to improve the technical interview process.

R13: Sounds of Learning: Developing a User-Friendly Web Audio Instrument for Educational Coding Environments

Authors: Joshua Cheng

Advisor: Sang Won Lee

This project was designed to be created for use in the "TechGirls Camp" program, aiming to empower young women from diverse background to explore careers in STEM. Leveraging the power of the Tone.js Web Audio framework, this project provides a flexible, easy-to-use, and engaging instrument that serves as a foundation for students to develop their own user interfaces (UIs) and experiment with sound manipulation. Students will be encouraged to apply their creativity and problem-solving skills to develop unique UIs that connect to the instrument, thereby fostering an engaging and interactive learning experience.

R14: Integrating Rust into the CS3214 Curriculum - Customizable Shell

Authors: Kieran Siek, Jack Williamson

Advisor: Godmar Back

In the last decade, Rust has emerged as a viable alternative to traditional systems programming languages such as C. Unlike C, Rust provides memory safety, which precludes programmers from making mistakes and creating vulnerabilities normally associated with explicit memory management. At the same time, the Rust runtime system eschews the use of a tracing garbage collector, relying on compiler-guided immediate but safe reclamation of objects instead. Beyond the memory safety, Rust also incorporates a number of features found in modern languages, such as type inference, generics, and traits. Computer systems education has so far relied on C as the teaching language of choice because of its ubiquity and heritage. However, as more and more systems development shifts to Rust, it is necessary to consider what the use of Rust in computer systems education could look like.

This research project presents a Rust re-implementation of the first project of CS3214 Computer Systems - a job control shell. Traditionally, students implement a working shell that supports job control, pipes, I/O redirection, process group management, and terminal access control. The students are given starter code containing a shell syntax lexer/parser, signal handling utilities, job control data structures, as well as a comprehensive shell testing suite. This project implements both the complete shell and testing suite entirely in safe Rust. As part of the re-implementation, a safe wrapper was written around raw C bindings to platform APIs. The wrapper, as well as fixes and improvements to third-party dependencies used in the project were shared (and some merged) with the upstream open-source community.

R15: Context-Aware Sit-Stand Intervention for Promoting Healthy Behaviors of Knowledge Workers

Authors: Joseph Bae, Donghan Hu

Advisors: Sang Won Lee and Sol Lim

With the onset of Covid-19 and the shift to work from home, ergonomics has become an increasingly pressing topic across the workforce. Although sit-stand desks are popular among workers, it has been observed that many fail to take advantage of their newly acquired desks and reap the benefits of being able to sit or stand while working. Sit-stand desks have been proven to be effective in promoting healthy behaviors by encouraging users to alternate postures between sitting and standing. Therefore, it has been recognized that some intervention is necessary to make users intentionally use the features that come with their sit-stand desks. This intervention can take the form of either free or forced intervention. Free intervention allows users to decide when and how they will use their standing desk to change postures. However, this approach has flaws, such as the potential for lack of self-motivation, lack of awareness, and limited suitability of standing for certain job tasks and situations. In short, free intervention may result in the user not using the desk's features at all. Thus, forced intervention appears to be the best solution as the user would change their posture consistently throughout their workflow by adjusting the desk's height at set time intervals. However, there are problems with this approach as forced intervention could disrupt the workflow due to a lack of context, causing the desk to change height whenever it is programmed to do so. Our solution to these problems is to create a machine learning model that will nudge the user to adjust their posture based on the context they are in, compelling users to change posture while minimizing workflow disruption. Split into three phases, the goal of phase one was to develop a distance sensor unit and a screen-tracking application that would collect corresponding data in a user study. The next two phases will analyze the collected data and train a machine learning model to determine when the user is most willing to switch their posture according to the context they are in.

R16: BURGS: Computing Performance in Machine Learning

Authors: Vineet Marri, Kathryn Nei, Kavya Polina, Kevin Xiong, Alex Lin

Advisors: Dimitrios Nikolopoulos and Margaret Ellis

With the continual rise of resource intensive machine learning models, the need for improving said models' performance also continues to increase. Previous research has addressed this topic by focusing on the effects of multithreading on the performance of training a model. This project aims to evaluate the impact of multithreading with PyTorch and OpenMP on the inference efficiency of NLP models like GPT-2 and BERT. Additionally, we are interested in explicitly comparing CPU vs GPU performance in regards to inferencing as well. Our findings thus far indicate that with OpenMP, using a thread count equal to half the number of physical cores was enough to yield optimal results, contradicting what is recommended in Intel's guide on maximizing CPU performance for PyTorch. Generally using too few threads results in not enough cores being utilized and too many threads causes excessive overhead. However, it seems that the amount of tasks available while running inference testing for the PyTorch models in question does not require the thread count to be equivalent to the total number of cores in the machine and instead only needs about half the amount. Usually cores can have multiple threads to allow programs to execute instructions on a different thread while waiting for the other to finish up. However, a core utilizing all its threads causes them to compete with each other for shared resources, leading to negligible performance benefits. On the other hand, intraop multithreading with Pytorch followed a similar pattern to that of OpenMP, however performance did degrade when we tried to use too many threads. Next, PyTorch's interop thread count function seemed to have little to no effect on the run time of the model. We believe this is because interop threading is used for interoperation with other libraries that use threads. GPT-2 and BERT both don't utilize other libraries that they interop with, thus, interop thread count would not matter. Finally, utilization of the GPU by using Pytorch's CUDA function significantly increased the performance of the model. We believe that this is the case because ML models use matrix operations in order to conduct inference tasks. GPUs have more arithmetic logic units; thus, they are more optimized for these specific tasks that can parallelize those processes better than CPUs.

R17: Automated Resume Parsing, Resume vs. Online Profile

Authors: Sahar Farzanehpour

Advisor: Chris Brown

Companies use various methods to gather job applications for software developers depending on their specific requirements. This research aims to compare two such methods: applying through online profiles and submitting applications based on uploaded resumes. Numerous websites like LinkedIn, Indeed, Handshake, etc., serve as job boards for companies to post job openings, but the application process is usually completed on the company's website. Through a survey, we aim to obtain participants' opinions on online profiles and whether they think resumes can be replaced by online profiles. Based on the survey results, most participants prefer online profiles over resumes, but companies' requirements force them to use and upload resumes. Some participants mentioned that they specifically don’t like uploading resumes because of parsing challenges. Further, additional survey results show candidates distrust automated resume parsers and find they lack procedural justice in decision making in the job application process. Therefore, the question arises of whether to solve resume parser issues or improve the functionality of online profiles. To answer this question, we also need to seek companies' opinions on online profiles and understand why they still prefer resumes. Ultimately, our goal is to streamline the job search process and make it more efficient.

R18: Revisiting the Instructional Memory Allocator: Replicating the Hoard

Author: Sam Lightfoot

Advisor: Godmar Back

A key component of the Computer Science curriculum at Virginia Tech is CS3214: Computer Systems, in which a major project, p3, is implementing a memory allocator. The tests used today to benchmark that allocator lack realistically sized, multithreaded benchmarks and does not distinguish between allocated memory and physically accessed memory; these characteristics give rise to an allocator that does not have multithreaded capability and is in general not scalable. The goal of this project is to redesign the p3 by replicating a modern allocator, and to benchmark the replication using a test suite that evaluates size- and thread-scalability.

Today's memory allocators are thread-scalable and are designed to be atop a virtual memory system that distinguishes between allocated (virtual) memory and the underlying physical memory. One such memory allocator proposed by Emery Berger et al. at ASPLOS-IX in 2000 is the Hoard. At its core is the superblock, an aligned block of memory that houses and manages allocable blocks of the same size. Superblocks are organized by the size of their blocks into size classes, which are grouped into thread-mappable entities called heaps. Using only the publication from 2000, which describes, with some omissions, the general algorithms used to allocate and free memory, we were able to replicate the Hoard using C. We call this allocator samalloc, a stable allocator based on the original Hoard.

The Mimalloc benchmark suite fulfills the second requirement for revamping p3. It combines published benchmarks that target both general and edge cases for multithreaded allocation, making it the perfect suite to evaluate students' allocators.

Using the Mimalloc benchmarks to compare samalloc with other modern allocators, we found samalloc is generally slower but touches less physical memory than the others. More work needs to be done to restructure p3, but we did produce a stable allocator using only Emery Berger et al.'s 2000 publication as reference.

R19: Moving the eBPF Verifier and JIT Out of the Kernel

Author: Adam Oswald

Advisor: Dan Williams

eBPF (Extended Berkeley Packet Filtering) is deemed as a “kernel superpower” that aims to provide kernel developers a way to write safe kernel code that can extend kernel functionality in a similar fashion to kernel modules. eBPF programs are statically verified and compiled through an in-kernel verifier to check for termination and memory safety. However, this guarantee of safe kernel programs is not always true. The verifier and JIT has historically shown to have vulnerabilities and bugs such as memory leaks, use-after-frees, and deadlock/hangs. In addition, verification proves to be a concern in resource-constrained embedded systems where processing speed and memory limits may prove verification to be impossible within the constraints of these devices. We describe a design that allows for offloading verification to a remote virtual machine that accepts an eBPF program, verifies, compiles, and signs the native precompiled executable. This signed precompiled executable can be distributed among these resource-constrained devices, allowing them to check the signature and load an eBPF program without needing the verifier and JIT on the embedded device.

R20: Optimizing ORM Performance for CSGenome

Author: John Zhao

Advisors: Godmar Back, Kirk Cameron, and Margaret Ellis

The overall mission of the CS Genome project is to catalog the lineage of computer systems information and make that information publicly accessible via an Application Programming Interface (API) and website. For the API section, the CS Genome project mainly uses Flask to control the endpoints and the SQLAlchemy Object Relational Mapper (ORM) to control the database using Python code. During testing each different endpoint listed in the API docs of CSGenome, the loading time appears to take extremely long for some endpoints. After investigating the generated SQL code, the original program would take the loading technique that only loads the items needed for this query and treat each relationship as a separate SQL call, generating enormous SQL queries.

Based on the documentation of SQLAlchemy, it follows that there are multiple loading techniques for the relationships. By applying the "Chained-loading" technique (add the "joinedload(relationships.items()[index][0]).subqueryload(relationships.items()[index][1])" as the option during the pagination process, in the retrieving data benchmark test, most performances of endpoints got improved. Time will improve more if the total number of data increases. The number of SQL queries will also decrease while keeping the data retrieved the same.

R21: KiData: Simple Data Visualization Tool for Future Data Scientists

Authors: Andrew Ahn, Gurkirat Singh, Heechan Lim, Jack Homer, John Golden, Josh Yang, Lin Yang, Sahith Kancharla, Sasha Holt, Siliang Zhang, Timothy Kelley, Zhuoqun Wang, Raseen Nirjhar

Advisor: Sally Hamouda

Data and Visualizations provide us with insights, analysis, and conclusions, that are easy to understand logically. Through visualizations, one can easily interpret the logic behind a graph and can answer various questions which he cannot use just numbers. The current school curriculum does not adequately prepare students to understand, analyze, interpret, or produce more complex data visualizations. Thus, it also does not prepare them early for a possible career in data science. Elementary school kids are enthusiastic and try to find the logic behind everything they see. So, by making use of data and visualizations, we can make them learn and understand the educational material efficiently. This project helps elementary school children to learn and understand data through visualizations.

Building on this aim, our project was to develop an easily accessible web-based tool that has lessons with an interactive question-answer section. The website has 12 lessons in total, divide on the basis of grade levels: 1st-2nd grade, 3rd-4th grade, and 5th-6th grade. While studying lessons, one can scroll down after reading and practice the questions based on the visualizations. The website also has the potential to include games based on data and visualization.

The lessons are implemented using React.js and Java with spring framework. The website can potentially add new lessons, with a minimum requirement to store the lessons in a markdown folder. The website has a navigation bar that has different tabs: Home, Lessons, Games, About, and Contact. We have also included a feedback form that can be filled out by the users to give any kind of feedback to the support team. Currently, the website is in the testing stage. Future surveys for teachers and elementary school students will be added to the system to better enhance the features provided.

R22: Understanding the Motivations and Participatory Culture Behind Viewing Reaction Videos

Author: Rodney Okyere

Advisor: Sang Won Lee

Have you ever stumbled upon a video with a title like "REACTING TO..." or "Funny reactions of..." while browsing platforms such as YouTube or TikTok? These videos are called "reaction videos," where creators or "reactors" share their reactions to other video clips. With over-exaggerated facial expressions and verbal commentary, reaction videos cover a vast range of content, including video games, movie trailers, anime episodes, and music videos. Genre-dedicated channels for these videos have amassed hundreds of thousands of subscribers and millions of views per video, creating a community-like atmosphere for viewers to identify with creators. Despite their popularity, few studies have explored the motivation behind viewers' engagement with reaction videos. Our research aims to address this gap by examining why viewers are drawn to this genre of videos. The insights gained from our study will facilitate the development of a platform that enhances engagement between creators and viewers on a larger scale.

R23: Implementing PTY support to the American Fuzzy Loop (AFL) Fuzzer

Author: Tanvi Allada

Advisor: Godmar Back

Fuzzing has become a crucial aspect of software engineering for detecting vulnerabilities in applications that handle untrusted user input. In a feedback loop, a controlling program generates input for these programs and observes their behavior. The fuzzer monitors whether the target program crashes, hangs, or misbehaves in any other way, and which part of the code is being executed. Based on this feedback, the fuzzer mutates the input to increase the chances of exposing latent vulnerabilities and exploring new paths. Fuzzing is widely used in cybersecurity applications, both offensively and defensively.

This research project aims to explore the concept of fuzzing and its relevance in the CS 3214 Computer Systems curriculum by identifying software vulnerabilities and systemic failures in the Customizable Shell (cush) project that cannot be detected through gdb and unit testing. To achieve this, we used the American Fuzzy Lop (AFL) fuzzer, a gray-box fuzzer that measures code coverage during compile time and directs the generation of new inputs based on the coverage metric.

When using the AFL to fuzz programs, they run in the same environment as the fuzzer, which can be risky when testing cush. The input provided could lead to harmful output on the local machine, making it an unsafe way to find bugs. To solve this, we created a sandboxing mechanism that separates the program from the local environment. This security measure ensures that any unwanted behavior stays within the sandbox. We achieved this by using a docker container that contains all the necessary project files and libraries for secure testing within the sandbox.

Another problem uncovered was the inability to fuzz programs requiring a terminal. We introduced a new PTY mode that allows AFL to have a controlling terminal during fuzzing, enabling it to detect bugs that cause the executable to crash or hang. With the implementation of the new PTY mode, our fuzzer is now able to detect and resolve issues in programs that require a terminal, enhancing its capabilities and overall performance.

Overall, implementing PTY mode helped us find both crashes and hangs within the cush project. Some of the input provided included echo statements, advanced piping commands, and control signal handling. In the future, we plan on expanding this mode to test other shells such

bash, korn, and c shell. We also plan on fuzzing current CS 3214 students cush implementations to help them write stronger and more secure code.

R24: Introducing Rust into the CS3214 Curriculum: Personal Server

Authors: Jack Williamson, Kieran Siek

Advisor: Godmar Back

Over the past few years, Rust has emerged as a promising alternative to traditional systems programming languages, such as C, by providing memory safety and modern language features. As the landscape of systems development evolves, it is important to explore the potential role of Rust in computer systems education. This study investigates the feasibility of incorporating Rust into the CS3214 curriculum through porting its personal server project (p4) and examining the implications for learning objectives and outcomes.

We evaluated Rust's unique features, including its ownership model, lifetimes, and the use of Result and Option enums, and assessed their impact on code safety, robustness, and error handling. By implementing the personal server project in Rust, we compared its performance and effectiveness against the existing C implementation.

Our findings reveal that the Rust version not only passed all test cases but also reduced lines of code and mitigated common student errors. Additionally, the use of Rust crates led to the optimization of the C implementation, demonstrating some advantages that Rust brings to systems programming. However, Rust exhibited higher latency metrics compared to the C implementation, suggesting potential areas for optimization and improvement.

Integrating Rust into the CS3214 curriculum could enable a shift in focus from safety and security concerns to new learning objectives, such as asynchronous I/O and concurrent programming. This alignment with industry trends could help students gain a more comprehensive understanding of Rust's strengths and areas for improvement, fostering a well-rounded learning experience.

In conclusion, our study highlights the potential benefits and challenges of using Rust in the CS3214 curriculum and its possible impact on computer systems education. By considering Rust as a teaching language and addressing its limitations, we can work towards equipping students with the skills required to excel in the rapidly evolving world of systems programming.

R25: Development and Deployment of the PCS 3.0 CMS

Author: John Golden

Advisor: Godmar Back

The proper introduction of competitive elements into any field can help foster rapid growth and critical thinking skills. Virginia Tech is an active participant in the ICPC, the International Collegiate Programming Contest, where teams of three work to solve real-world problems in a competitive manner. Virginia Tech's dedicated ICPC Programming Team maintains an online contest and judging website dubbed the Programming Contest System (PCS) that emulates these competitive environments by hosting mock contests. This web application is also used for the Virginia Tech Highschool Programming Contest, an outreach effort designed for students interested in competitive programming. This independent study project is designed to be a follow up to a group effort of refining the application in spring 2022 and aims to update the system to be in accordance with modern counterparts of its current software. Since the system was principally designed in 2016, its judge and webserver are reliant on Python 2 (and a sleuth of packages designed for Python 2) alongside Docker images that use outdated versions of Ubuntu. These systems are to be updated to Python 3 and Ubuntu 22 respectively, so future development efforts can fix issues without significant software-related barriers. Stable portions of the spring 2022 changes, such as an updated sidebar, revision to forms, and styling changes, are set to be integrated with PCS 3.0 to turn it into a comprehensively refreshed system. Updated university IT policies have also made it necessary to migrate the system from its old cloud provider to an AWS instance. By the end of this project, a working instance of the main PCS website and the VTHS Contest should be running on an AWS instance.

R26: SmarTrail: An App to Understand Long-distance Hiking Experience

Authors: Isaiah Hipolito, Ansuman Nayak, Jonathan West

Advisor: Scott McCrickard

Hiking is an ever present, ever popular activity around the world, which often entails people trying to escape technology and the hustle and bustle of everyday life. However, in the modern era technology is more portable than ever, and long distance hikers often use their smartphones and other devices for a variety of purposes as they travel. This project was developed to learn more about how long distance hikers, such as those through hiking the Appalachian Trail, use technology to enhance their experience or make necessary connections to the outside world. This was primarily done through weekly surveys set to rotate through sets of questions evaluating the user and their use of technology, among other pieces of information which may correlate with usage habits. Given the lack of consistent internet connection, the app was designed to store data in a local database which syncs when a network connection becomes available. Additional features were provided to both incentivize use of the app and to give insight into users' own technology usage habits, which informs their responses to certain questions. These include tracking of hiking progress between survey responses and app usage statistics. Hikers may not realize how little or how much they use their smartphone on the trail until being directly provided with the information. The app was shared with hikers at a Trail Days event, and will be used to collect data on through hikers of the Appalachian Trail.

C1: Lucky's Music Box

Authors: Karen Tran, Will Phan, Devin Hux, Tam Vu

Advisor: Sang Won Lee

Lucky’s Music Box is a web application artifact that combines computers, cats, and music. The web application has three features: a curated Spotify playlist generator, a piano keyboard with cat meows, and an area to “meet Lucky’s friends, which lists cats available for adoption around the user’s location. The curated Spotify playlist generates a playlist based on the user’s current weather conditions. To further personalize each playlist to the user, the user’s top artist or preferred artist, the user’s top song, and the seed genres associated with the current weather condition also play a part in crafting a unique playlist for each user. The piano keyboard with cat meows combines the love for music and cats. The piano has 13 “keys” controlled through the keys on a computer’s keyboard. The meows are recorded from real cats and featured in the “meet Lucky’s friends” area. Lucky’s music box was developed to explore the theme of computer music but also to encourage cat and music lovers to have fun.

C2: Samplify: Overcoming Music Creative Block with a Consolidated Crate Digging and Sampling Experience

Authors: Jenna Pearson, Kevin Chandran, Brian Kim, Joshua Cheng

Advisor: Sang Won Lee

"Samplify" is an innovative web application made for sample-based music producers that combines the YouTube and music worlds to deliver a productive, user-friendly, and engaging experience. Samplify reduces the need for traditional crate digging by using YouTube API to access curated genre-specific playlists, saving producers time and effort while preserving the genuine feel of finding unusual and obscure samples. With customizable filters such as origin, Samplify empowers users to explore a vast range of musical styles and overcome creative blocks.

Samplify incorporates a "Chopify" tool, transforming the sampled audio into playable pads, inspired by the iconic Akai MPC. This feature encourages musicians to manipulate and re-contextualize the samples, fostering creativity and promoting the evolution of new compositions. Through the integration of YouTube, music, and cutting-edge technology, Samplify revolutionizes the sampling process, streamlining the workflow for producers while honoring the culture and art of crate digging.

C3: Accursed Din: Music Visualization Platformer

Authors: Natalie Hirakawa, Ai Le, Chris Wormald

Advisor: Sang Won Lee

Accursed Din is a music-based puzzle platformer game where players are tasked to get through a haunted mansion. By avoiding ghosts and using companions corresponding to different instrumental tracks, players interact with the environment to solve puzzles and complete levels. Accursed Din's main concept is "music made physical," which is accomplished in two main ways. First through the way the music's waveform informs the environment via gameplay elements like the companions, enemies, and platform, and secondly, via spatialization of the wave through visual elements.

C4: Unifying the Approval Process of College of Engineering Travel Forms

Authors: Daniel Vasquez, Jenny Leidig, Mark Hamilton, Josh Hicks

Advisor: Rich Charles

The goal of our project was to create a web application to centralize submitting travel reimbursement requests for students and faculty in the College of Engineering in order for travel approvers to keep track of requests and reduce the amount of time to process requests. In the College of Engineering at Virginia Tech there are 13 different departments. Each department is individually responsible for handling how both approval and reimbursement information is collected and input into CR-SNAP, the university's application for actually handling the approval of forms. There are two main issues with how the current system operates: First, each department has a different form for collecting required information from students and faculty. Second, these forms range from paper forms to Google forms, resulting in an inability to easily keep track of already submitted forms. To solve these issues, our approach began by contacting our project sponsor, Brad Martens, to gain contact information for the travel form approvers in each department. We contacted each approver to obtain a copy of both the approval and reimbursements forms that they currently use for the approval process. We then consolidated required information from all of the forms to create a unified form containing the information that satisfies the needs of any given department. Once this form had been completed and deemed satisfactory by our sponsor and the departments, we turned our attention to digitizing the form and creating a web application to address the concern of managing submitted forms. To address the concerns previously identified, we designed a dashboard for approvers to manage and keep track of submitted requests. Additionally, we created a form submission for users to submit all required travel information, both for approvals and reimbursements. Now, all communication for submission and approval can be conducted within a single space, rather than having to do things by hand or through a third party. Our application is built with a React front end, Python Flask backend, and MongoDB as the database.

C5: Songwood: Harmonia

Authors: Shayla Carter, Kathryn Nei, Nick Rabak, Ravi Parikh

Advisor: Sang Won Lee

Songwood: Harmonia is a metroidvania-platformer focused on rhythm and sound, inspired by games like Hollow Knight and Hi-Fi Rush. In this game you play as a mouse who has just returned to his home forest, but quickly discovers that the music he remembers is gone. The player must gradually explore the map, battling enemies to restore the forest's music and unearthing cairns that reveal the overarching story of the forest's song. Songwood has three main gameplay mechanics. First is the "music beat," a visual-audio indicator that helps the player stay in-time with the background music's rhythm. The game rewards the player for staying on-beat; attacking enemies to the beat blends the player's violin song with the environment's backing track and rewards the player by filling their music meter. This "music meter" stores music; when half-full, the player can use their stored music to heal themselves, and when full, the player can perform a burst attack that damages all enemies on-screen. Third is the "rhythm door," featuring Guitar Hero-style rhythm games that must be completed to gain access to new areas. We elected to develop Songwood in Unity 2D due to Unity's wide range of built-in features, sizable developer community, and variety of pre-made assets. Our development process began with ideation, as we gradually refined our initial brainstorming into a set of core mechanics for our game. We then implemented these mechanics in-game, tweaking our ideas as we went. From there, we designed level collision, designing each level section in a way that would highlight one or more of our game mechanics and adjusting to account for issues found during playtesting. Finally, we added visual polish and set dressing to clean up the scene and create a stronger atmosphere that fit the theme of our game. This all comes together to create an immersive and fun player experience.

C6: Musical Journey

Authors: Caitlin Tran, Andrea Rodis, Anish Dhondi, Rohith Mahesh

Advisor: Sang Won Lee

The motivation for this project was to create an interactive experience for players who enjoy music and puzzles. Our project strives to help players learn to identify the notes on a music staff as well as enhance their ability to reconstruct a song by ear. Inspired by the classic Super Mario Bros. video game, we have created a 2D-platformer on Godot. The user plays as a traveler writing songs along their journey. The player must traverse through each level to get to their piano, collecting notes and facing enemies along the way. At the end of each level, the player must order their collected notes to match the song that's been stuck in the traveler's head throughout that level. It's up to the player to help the traveler avoid hitting any sour notes!

C7: Virginia CS Source Job Board

Authors: Andy Luu, Nitish Gorentala, Jacob Mandelbaum, Christian Workman, Arnav Kalaria

Advisor: Rich Charles

As more students enter and graduate from the Computer Science program, Virginia Tech needs a website to provide career opportunities to these students. To provide students with these opportunities, our goal was to develop new functionality, as well as overhaul the front-end design by incorporating the React framework for the Virginia Tech Resume and Job Board website. Our team utilized Agile Methodologies throughout the project with development for the project broken up into five two week sprints. We also held weekly Stand-Up meetings with our Professor, who is also one of our stakeholders, for incremental progress updates and feedback and kept track of progress through Trello and a Burn-down Chart. Throughout the semester, our team worked on four major deliverables. The first deliverable was to convert the existing HTML templates into a modern framework for enhanced maintainability and performance, while maintaining the existing functionality that the site already offered. The second deliverable was to develop basic statistical reporting functionality for employers to see traffic on job listings. The third deliverable was to develop notification functionality to inform students of newly available jobs that match their interests and skills. The fourth deliverable was to make the search process more reactive with filters so students, companies, and admins can search for and interact with information on the site. Our group hopes that one of our main stakeholders, students, will be able to use a modern user interface to view all job postings and use search queries to filter jobs based on their preferences. Additionally, our group hopes that the website is simple for administrators and employers to make changes to the site since they are also major stakeholders in this project. Lastly, our group hopes that this website will be easy to maintain and modify in the future after it has been fully implemented, so we ensured that the website's repository contains documentation on the major software that was used to develop the site, as well as industry coding practices.

C8: Pomodoro Playlist

Authors: Sonali Kaushal, Sparsh Gupta, Swetha Vijayakumar, Hadeel Ameen

Advisor: Sang Won Lee

Are you one of those people who have a tough time staying focused during work sessions? Do you find yourself getting sidetracked with distractions that hinder your productivity and leave you feeling unproductive? If this sounds like you, then you're in luck because the Pomodoro technique may be just what you need to revolutionize the way you work. Developed by Francesco Cirillo, the Pomodoro technique is a time management strategy that involves breaking work sessions into shorter, focused intervals, followed by brief breaks. With the pomodoro timer, you can structure your day for maximum efficiency and productivity. But what if you could take your Pomodoro sessions to the next level?

Enter "Pomodoro Playlist," the music-based Pomodoro timer that's taking the productivity world by storm. With "Pomodoro Playlist," you can customize your work and break durations, choose from a carefully curated music selection, and even personalize your break time with YouTube videos of your choice. The application's music selection is designed to help users maintain concentration and productivity during work sessions. Choose from genres like jazz, classical, epic gaming, chillstep, instrumental pop, and instrumental K-pop to create the perfect ambiance for your workday. With "Pomodoro Playlist," you can say goodbye to distractions from irrelevant or repetitive music and hello to a focused and motivated mindset.

One of the coolest features of "Pomodoro Playlist" is its focus on personalized break music. Recharge your energy levels with your favorite songs, motivational videos, or even a podcast. With "Pomodoro Playlist," your breaks will be a time to rejuvenate and re-energize, leaving you feeling refreshed and ready to tackle your tasks. But that's not all. "Pomodoro Playlist" also includes a task tracking feature to help you stay organized and achieve your goals. Add tasks and track their durations to effectively manage your time and achieve your targets. Best of all, "Pomodoro Playlist" offers all its customization features for free. Unlike other music-based Pomodoro timer apps that require a subscription, "Pomodoro Playlist" is accessible to everyone, making it the perfect productivity tool for individuals looking to improve their focus, motivation, and productivity.

Ready to take your productivity game to the next level? Try 'Pomodoro Playlist' today and revolutionize your workday! With its music-based pomodoro timer, task tracking feature, and personalized break music options, "Pomodoro Playlist" is the way to work. Try it today and experience the benefits of increased focus and motivation!

C9: Creating a Web-based Dorm Reservation System for Alamein International University

Authors: Rebecca Whitten, Tedy Huang, Youssef Bedair, Khaled Bahaaeldin, Omar El-Hamrawy

Advisor: Mohammed Seyam

Alamein International University (AIU) is a young, tech-focused university located in New Alamein City, Matrouh Governate, Egypt. The current process for students to stay in university-provided housing is tedious, complicated, and entirely paper-based. This results in many students avoiding university housing when otherwise they might use it. As part of a study abroad collaboration between Virginia Tech and AIU, we have created UniRoom, a simple and efficient online system for any student at Alamein International University to book housing for short- and long-term stays. UniRoom is a web application built using NodeJS with a MySQL relational database storing the user, room, and booking information.

C10: ManageCamp

Authors: Rey Sanchez, Leon Nguyen, Jackson Burkey, Michael Guyer, Zac Comer

Advisor: Mohammed Seyam

The camping management application, ManageCamp, is a comprehensive solution for individuals seeking to enjoy outdoor recreational activities in the post-COVID era. With ManageCamp, users can find campsites across the United States, connect with other campers, and plan events together. The application features a user-friendly interface that enables seamless communication and socialization among users. Users can create a profile, set preferences, and discover new campsites based on their interests. The application also includes a chat feature that facilitates instant messaging, enabling users to exchange tips, share experiences, and coordinate events. Users are also able to add their own reviews, update information about existing campsites, trails, etc., and make itineraries. One of the key aspects of the app is socialization. ManageCamp allows users to meet new people through activity planning and community events. Additionally, the app provides a single location where information on campsites, attractions, and other outdoor activities are brought together, providing an easy way to plan outdoor trips.

ManageCamp was designed to largely serve suburban communities as the majority of residents in these areas have access to cars. Generally, these suburban communities do not have immediate access to places for camping, hiking, fishing, etc. Regardless, the app allows for a user of any community to plan a vacation or trip to any outdoor attractions no matter the level of camping experience.

C11: Time! To Cook: Accessible Recipe Database for Home Use

Authors: Udom An, Langdon Liebeler, Saron Worku, Patrick Riley

Advisor: Rich Charles

Time! To Cook is an easy-to-use recipe organizer that allows users to keep track of their cooking recipes. The goal is to provide a convenient and efficient way for users to store and retrieve recipes, saving time and effort in meal planning and preparation. Via a web interface accessible on both computers and tablets, the user's recipes will be searchable and filterable on the local network. When preparing meals, the user can filter down by meal type, main protein, and energy level of the recipes, saving time during the often tedious process of selecting a meal. Not only can it save time, but also reduce food waste, by showing recipes that can maximize the usage of leftover proteins. Additionally, the application is accessible to those with poor eyesight or requiring quick glances while cooking, with adjustable text sizes on displayed recipes. Time! To Cook was developed using an agile approach to project development, using biweekly sprints and sprint rituals to ensure accountability and distribute work. Work was dissected into individual tasks and assigned at the beginning of four sprints. This was used in conjunction with pair programming to increase collaboration and efficiency. As a cost effective and privacy measure, the application is hosted on the user's local network via a Raspberry Pi. Time! To Cook is a valuable tool for home cooks and anyone interested in streamlining their meal planning and preparation process.

C12: Beat Defense

Authors: Ross Shaffer, Joseph Bae, Stephanie Grover, Ethan Homoroc

Advisor: Sang Won Lee

“Beat Defense” is a tower defense game that combines the elements of music and tower defense game mechanics. The game challenges players to protect their home by playing 4 different instruments in time with the music to defeat an array of monsters that spawn based on the rhythm of the songs playing in the background. The game is designed to be accessible to players of all levels of musical experience, as well as for 2 players at the same time. “Beat Defense” provides players with an interactive and engaging game playing experience that is heavily influenced by the structure of the songs. At the end of each level, players receive a percentage score based on the accuracy of their performance. “Beat Defense” offers players a unique and exciting experience that combines the elements of tower defense and rhythm games.

C13: GYD: Graph Your Data

Authors: Jinit Shah, Shalini Dubey, Moemen Moustafa, Ahmed Shokr, Youssef Tarek

Advisor: Mohammed Seyam

Analyzing large amounts of text data can be a time-consuming and labor-intensive process, especially when dealing with numerous entities, relationships, and keywords. This project presents a web-based tool that addresses this problem by automating the process of analyzing text data and visualizing it as a knowledge graph using advanced machine learning and natural language processing models. The tool also includes features for text summarization and question answering to enhance its usability.

Using state-of-the-art machine learning and natural language processing algorithms, the tool generates a knowledge graph that summarizes the most significant entities, relationships, and keywords in the text data. The graph is presented in an interactive format, allowing users to explore and navigate the data and gain deeper insights into its structure and meaning.
The text summarization feature generates a concise summary of the text data, while the question answering feature enables users to ask specific questions about the text data and receive relevant answers based on the context of the data.

This tool has potential use cases for students, researchers, data analysts, and business owners. It is a valuable resource for summarizing and visualizing large amounts of text data in an intuitive and interactive manner.

In conclusion, this web-based tool represents a significant contribution to the field of natural language processing and machine learning by automating the process of analyzing and visualizing text data. The results obtained from this tool are promising, and its ease of use makes it an excellent tool for both novice and experienced users.

C14: Parasocial

Authors: Rio Young, Madeleine Houser, Jamie Sloop, Benjamin Altermatt

Advisor: Sang Won Lee

YouTube has become a medium through which people have come to form communities and interact with each other in new and ingenious ways. It is the embodiment of the phrase “internet killed television”. The platform has allowed people to express themselves, and a couple genres that have blown up in particular have been video game playthroughs and vlogging. Posting videos about video games or games in general is not a new concept on YouTube, but the communities that have formed around the idea are what have brought it to where it is today. Many YouTubers that play video games have huge followings of fans and viewers. And due to this fact, many end up creating other kinds of content to become more personal and interactive with their fans. The game our group is presenting aims to show how far fans may go to get to know YouTubers they admire. It is an interactive, story game where the player will act as a manager for a YouTuber that is starting up a new vlogging channel to become more personal with their viewers. The game is intended to replicate YouTube’s user interface to give a sense of immersion for the player. Interaction is done by performing various actions such as uploading videos, responding to comments, and watching videos. Progress happens through going through each week, of which there are currently eight weeks in the game, and during each week, the player can perform several of the actions listed above. Different options for each action are also available for players to choose from. Players may choose to watch certain videos on their recommended page, choose from several different comments to respond to, and choose which video they would like to upload to the channel. To give the sense of the player choosing their own story and way to play, each action they perform may affect the story in a different way. Their choices may end up giving them different video or comment options the next week. This allows players to feel more immersed in the game, as their actions will have a noticeable effect on the outcome of the game.

C15: DISC: "DISC-over a World of High-Quality Music and Musical Communities with Your Ultimate Daily Music Companion!"

Authors: Bisrat Zerihun, Elmer Villalobos, Philip Froehlich, Rodney Okyere

Advisor: Sang Won Lee

Our team was tasked with creating an artifact that fell under the themes of YouTube as an Expressive Medium, Computer Music, or Programming as a Creative Practice. Given our shared interest in music curation, we decided to focus on creating a virtual music recommender that would not only align with the theme of Computer Music but also enable music lovers to discover new ways of finding and enjoying music while fostering a community around their shared passion. So meet "Disc".

Discovery, or "Disc." for short is a web app that offers a new "song of the day" every day, along with a curated collection of information about the song and artist. Our team of expert music curators carefully selects each track to ensure that it's high-quality and worth listening to. We believe that every song has the power to inspire and connect people, and that's why we're committed to bringing you the best music every day.

But Disc. is more than just a music discovery platform - it's a place where you can build and discover communities of music lovers just like you. Our app makes it easy to connect with others, share your thoughts, and discover new music together. Whether you're a die-hard fan of a particular artist or just love discovering new music, you'll find a community of like-minded people who share your passion.

Inspired by popular apps BeReal and Kiwi, we wanted to combine the best of both worlds - the excitement of discovering something new every day and the joy of sharing it with others. With Disc., you can exchange thoughts with other music lovers, share your own "song of the day" for others to discover, and interact with the app by leaving emoji reactions and writing reviews.

Disc. aims to connect people through the power of music. We know that discovering new music is more fun when you can share it with others, and that's why we've built a community of music lovers where you can share your thoughts on each song and connect with others who share your musical taste. Our app is not just about discovering new music, but also about discovering communities and building connections.

In summary, Disc. is an innovative web app that aims to help you discover fresh music that matches your taste alongside a community of music lovers. Whether you're looking for a new favorite artist or want to connect with others who share your passion for music, Disc. is the

perfect platform for you. So why wait? Join Disc. today and embark on a musical journey like never before!Disc. is a web app that offers a new "song of the day" every day, along with a curated collection of information about the song and artist. Our team of expert music curators carefully selects each track to ensure that it's high-quality and worth listening to. We believe that every song has the power to inspire and connect people, and that's why we're committed to bringing you the best music every day.

C16: Inquizit

Authors: William Meyn, Jason Tran, Yuqin Feng , Logan Shapiro

Advisor: Mohammed Seyam

Inquizit is a media platform meant to foster collaboration in research. Whether someone is creating a survey, answering a survey, commenting on uploaded research, or connecting in organizations, everyone can find a way to collaborate. Our goal is to make it easy for new researchers and curious individuals to collect and use research data while still providing advanced tools for experienced researchers. We provide tools to let users create widely customizable surveys that can be tagged and searched for to more easily create engagement in their data gathering. Inquizit provides a wide range of answer types for surveyors to gather information efficiently. Surveys can be shared to individuals by link, allowing for both signed-in users and non-users to answer surveys. Surveys and research can be tagged so that they show up in searches and recommendations. A user's preferences are calculated using the surveys they answer and the research they view. Search results and recommendations are also made using these parameters. Users can cite public surveys, allowing them to build off previous research to make new discoveries. Collected data from these surveys are conveyed to the cited survey as well. Users can generate visualizations on their gathered response data, including metadata such as answer delay and answer changes. More finalized research, such as a pdf of a report, can be uploaded to a user's profile. Organizations can be set up to group users and allow them to showcase the research of members and create sub-organizations that fit within them. All of these features serve to make research more collective.

C17: Purchasing Application for The College of Engineering

Authors: Caylie Baughman, Brian Mamani Balderrama, Grant Huie, Lena Bolz

Advisor: Rich Charles

Our capstone team was tasked with creating a purchasing application for the College of Engineering, with the mission of simplifying and standardizing the process between the engineering departments. Before we began this project, the purchasing process for students and faculty had been done on paper and with physical copies of documents. This process was very cumbersome for everyone, especially when dealing with multiple documents and many sources of form submission, as the departments did not have a standardized form or process. We were presented with the opportunity to develop an application, from the bottom up, for a fully functional purchasing request database and website. With the web app that we have built, students and faculty now have a convenient, central location for handling purchase requests for all of the College of Engineering departments. The process begins with the user logging into our website using CAS which provides a layer of security. Then, the user can create purchase requests. Once they submit their request, it is routed through a multi step approval process within the requestor's department. Approvers (such as the PI and Business Managers) log in using the same CAS method and have options to approve, return, or edit a user’s request during their stage in the approval process. Now, the College of Engineering has a significantly simplified and standardized website for the purchasing process between engineering departments, making it more efficient and convenient for students and faculty.

C18: Fit to Draw: Bringing Arts and Fitness Together

Authors: Priyanka Nair , Zachary Gaydos, Roshni Saxena, Gary Grutzik

Advisor: Scott McCrickard

With the prevalence of smartphone addiction in our society, people spend less time exercising, going outside, and interacting with others; However, physical activities provide valuable health benefits, including preventing heart disease and boosting mental health. Our capstone project theme this semester was “designing outdoor games". We incorporated social and artistic aspects into the outdoor exercise-related game to enhance user experience. Our application is a game called “Fit to Draw.” Inspired by the popular game “Pictionary", “Fit to Draw” requires players to draw shapes and objects from a bird’s-eye view by looking at a map on their phone and having the location feature trace their steps. To start the game, players join a room with up to 5 other players, and the host of the room adjusts game settings such as the number of hints and drawing time. At the start of a round, players pick a word from a short set of random words drawn from a word bank. After they’ve chosen their word, each player must draw a picture of the word using the map and a set of colors provided. Players stop drawing when they submit or when they run out of time. Afterward, players are needed to display each other's drawings and must guess the word by typing it into the chat box. The faster a player guesses the word correctly, the more points they will earn. The drawer will also earn points if their word is guessed correctly. Random letters of the word will be revealed over time as hints if the player cannot guess the word quickly. At the end of the round, players are shown the scores with how many points they won. We designed our game to appeal to everyone, regardless of age or demographic. Initial testing of this game has shown a high rating for player satisfaction and a potential for people to exercise, interact with others, and have fun.

C19: HemeAI: Automated CBC & Peripheral Blood Smear

Authors: Amrita Ballurkar, Bhargav Iyer, Ritvik Prabhu

Advisor: Hoda Eldardiry

This project discusses an approach to automate the process of complete blood counts (CBCs) and peripheral blood smears. CBCs and peripheral blood smears are critical lab tests that doctors rely on to provide crucial information about the cellular components of blood. The process of manually reviewing cells after an abnormal CBC can lead to human error and long wait times for results. We propose using YOLO, a computer vision model, to classify the blood cells and identify abnormal cells within a blood sample. The approach adopted was to first use YOLO to perform a CBC by counting and classifying each cell. If there are abnormalities in the ratios between the cells, we will once again use YOLO to identify and count specific white blood cells and abnormal red blood cells, and diagnose from five diseases: anemia, thrombocytopenia, basophilia, eosinophilia, and leukemia. The first YOLO model, which was used for the preliminary analysis, yielded an F1 score of 0.85, while the second model, which was used to diagnose the disease, yielded an F1 score of 0.75.

C20: FitEx Farmers Market : An Innovative Way of Encouraging Personal and Group Fitness

Authors: Taylor Flieg, Grace Reback, Aidan Sprague, Peiyao Tao

Advisor: Scott McCrickard

FitEx Farmers Market is a mobile exercise game (exergame) built on the core elements of FitEx, which is an evidence-based, statewide walking program founded on the principles of group dynamics, goal setting, self-monitoring, and multi-tier feedback. While FitEx Farmers Market does not directly use the exact methods and structure of the FitEx system, it was the inspiration for the development of this project and fueled many of the design decisions. The game is centered on the popular theme of managing a farm, growing crops, and selling produce. Contrary to other games in this genre, progress in these tasks is directly related to the number of steps taken each day. The goal of the application is to promote people accomplishing an adequate amount of physical exercises through various motivation techniques such as personal achievement, cooperation, and goal setting. From the game entertainment side, users complete daily and weekly challenges to level up and unlock new crops and farm plots. From the social interaction side, users join together to complete large group challenges for greater rewards. The target audience, which was derived from a user survey and drove much of the UI and feature design, is young adults (18 to 24 years old); however, the game can be enjoyed by people of all ages. The application was developed in a two-month timeframe using the Unity game engine to allow for native compilation and smooth execution on both iOS and Android devices. The Google Fit API was used in conjunction with a node.js web server to access and update user step counts frequently, making requests every 5 seconds. Google Firebase was used as a means for user authentication and data storage. The app is currently under evaluation by student play testers who will spend a week playing the game and completing a self-guided diary study each day. The results will provide valuable feedback on the social impact and cooperative motivation of the group system, and will assist in fine-tuning the gameplay parameters such as step requirements, level progression, and challenge rewards to create a fun, impactful exergame experience. Future work could include incorporating native health apps (e.g., Apple Health) to allow for faster and more accurate step acquisition, as the current method (Google Fit API) can be a hindrance to users.

C21: Accomplish

Authors: Elliot Jimeno, Will Ayres, Juan Jovel, Sami Marzougui

Advisor: Mohammed Seyam

Accomplish is a dynamic mobile application designed to allow users to join circles and complete daily challenges. The app provides a fun, interactive, and competitive environment in which users are able to push each other to achieve their goals. With Accomplish, users can create or join circles and engage in daily challenges, such as fitness or productivity goals. Circle members are able to see each other's progress by posting a photo of themselves completing the challenge, which helps motivate and encourage the rest of the circle. Accomplish is not just about individual achievement, it is also about the sense of community and collaboration that comes with being part of a circle. The app encourages users to keep their challenge completion streak alive, hold each other accountable, and ultimately build a sense of camaraderie. By allowing users to create their own circles and challenges, Accomplish is able to provide a diverse set of circles that cater to different interests, hobbies, and goals. For example, a user who is interested in learning a new language can create a circle and challenge others to practice the language every day. Similarly, a user who is passionate about fitness can create a circle and challenge others to complete a fitness challenge every day.

C22: WenDiGo

Authors: Braden Huebsch, Duke Hill, Jacob Conklin, Joey Tomei

Advisor: Dr. Mohammed Seyam

WenDiGo is an application designed to provide a platform that public parks and facilities can adopt to allow queuing and reservations for their respective locations. The system is also intended to provide users with information regarding how busy these parks and facilities are at given times, so they know if they would be able to get a spot if they went at a given time. One of the big issues with trying to get outside in a place like Blacksburg is that there are only so many places to go, and they are often full when you most want to go - WenDiGo aims to solve this and make life easier for both the common resident and for the parks themselves. Aside from the main features of reservations and activity information, WenDiGo also helps users find new locations they may have not previously visited, all in accordance with the specifications they are searching for. In addition to all of this, when users are viewing how busy a park or facility is, they can see if there are any groups open to having new people join them in whatever activity they are doing. So, WenDiGo not only saves time for users, helps public facilities organize park activity, and allows users to discover new exciting locations and activities around them, it also encourages people to make new friends, promoting both getting outside and being social at the same time.

C23: Scavenger Hike

Authors: Adrian Shirazi, Zaineb Almarzooq, Jared Cesen, Nikolas Greenfield

Advisor: Mohammed Seyam

Many children are bundles of energy, and the outdoors is the perfect place for them to release it. In the modern world, however, it is becoming increasingly difficult to get them to explore the Great Outdoors. We decided to tackle that problem by creating a game which encourages children to get active while simultaneously learning what Mother Nature can offer. Our game aims to engage children with the outdoors. Scavenger Hike is a mobile application which brings people of all ages together to embark on a scavenger hunt. Participants of the same hunt will compete against each other to find special trail features. Once found, participants will snap a photo of the feature, and will move on to the next item to capture. Once all features have been found, the hunt is complete, and their score will be listed on a scoreboard for all participants to see. This introduces a competitive aspect to the game that is perfect for any group of young students. Users are able to create their own scavenger hunt by dedicating a time and place, and several of their own trail features they want their participants to look for. Users will have their own customizable avatar; the more scavenger hunts the user goes on, the more items they unlock to customize their avatar with. Scavenger Hike is a mobile application built with React Native. It utilizes several APIs such as Google Maps API and Google Places API.

C24: TourTech

Authors: Naylle Pando, Katie Spring, Sameer Kewalramani, Kaylin Pham

Advisor: Scott McCrickard

TourTech is an interactive, GPS-based application that is intended for new and prospective students who have had little to no experience with Virginia Tech's campus. Using Human Computer Interaction principles and the course's theme of Designing Outdoor Games, we wanted to provide an experience for our targeted audience to provide themselves with a self-guided tour with the campus themed storyline. In addition to the related storyline, our team provides users with several pieces of information about the Campus that promotes activity while educating the potential students.

The game begins with news breaking out that the hokie bird has gone missing right before a Virginia Tech football game. A student is then given the first clue in which displays that the first location of interest is at Burruss Hall. The player must walk to the first clue which is shown by a GPS map that displays both the user and clue's location. Once getting the first clue, the user is given instructions on game play in which they must walk towards the floating maroon icon and tap on it to learn more about the location. After learning about the location, the user will receive the next clue in the form of a multiple choice question; this will provide the next location of interest. Following these steps, students are intended to learn about the several Virginia Tech buildings and resources.

We utilized Unity and Unity Mapbox to create this app to fit onto an Android Phone. In addition, several students have tested this app to mimic a prospective student's experience.

C25: Campus Courts

Authors: Mathew Carter, Peyton Dexter, Parker Harnack, Rishi Murudkar, Abir Rahaman

Advisor: Mohammed Seyam

Campus Courts is an application created to facilitate pickup basketball in the Blacksburg community. Pickup basketball is a fun and strenuous pastime for many college students and community members where groups that may or may not know each other play a game of basketball at public courts or facilities. The sport is great for staying in shape and connecting with new friends, but there are a few problems with the current way people try to play. Organizing times and places to play can be difficult depending on crowds or the lack of other people playing. Common problems are not having enough people around when you are trying to play pickup games or having too many people around when you would just like to relax and shoot basketball. Also forming a group of people and knowing who is planning on coming can be time consuming. Campus Courts is the solution. The application creates a simple way for players to plan games at locations all across Blacksburg and invite friends to play. The application uses both a map view and traditional list of games to keep track of activities in the area. The application also welcomes players that are new to the area by showing where people enjoy playing and if any of the games are open for extra players. Players can invite their friends to games with specific locations and times so everyone is on the same page. Alerts and notifications can also be used to know when you are invited to new games. The application was created using React Native, AWS Amplify, and Expo. Currently the application has been developed for iOS, but an Android version could be developed in the future. Campus Courts hopes to bring basketball players and communities together by saving people time and helping them play more of the sport they love.

C26: Travel Agency Management Site

Authors: Jason Pak, Thomas Park, Sara Grammer, Atif Haque, Sarah Cattigan

Advisor: Rich Charles

The travel industry has experienced significant growth in recent years due, in part, to the widespread adoption of digital tools to plan and book trips. With many travel agencies competing for clients, it is essential for these businesses to offer great service, efficient operations, and streamlined processes to stay ahead. GroupSource Travel is a small travel agency that largely works in group airfare with most of their business coming from return clients. Traditional travel agency management systems often consist of different tools and software applications that handle different aspects of the business, such as client management, trip planning, and invoicing. However, GroupSource is currently using an old system built upon Microsoft Access to manage clients, booking information, quotes, and invoices. The most significant downsides to this system are that it is locally hosted on an employee's personal computer, only one employee can remotely access it at any given time, and employees have to manually enter data and make computations. Without anyone currently maintaining the system, the lack of common quality-of-life features make the whole process burdensome and prone to human error which have caused them significant loss in the past. This project presents the development of a full-stack web application designed to enhance the efficiency of GroupSource's employees while providing a seamless and comprehensive platform for managing client interactions. It offers a responsive interface that enables employees to add clients, create tailored trips, generate quotes, and produce detailed PDF invoices containing costs and itineraries.

C27: ChefMeUp: A Cross Platform Application for Affordable, Healthy Recipes and Grocery Shopping

Authors: Neha Bhat, Herbert Ho, Avi Mehta, Aastha Mistry, Pranav Wadhwa

Advisor: Mohammed Seyam

Given the rising prevalence of wealth inequality in recent times, we decided to create ChefMeUp—a mobile app that aims to address the pervasive issue of food insecurity across America by targeting prone communities using a multifaceted approach. The app empowers users to create healthy, nutritious meals on a budget.
Our friendly, simple user interface allows our users to input their budget, and instantly provides them with a curated list of nearby grocery stores that offer groceries within that range. The stores are obtained by using the user's current location to geofence nearby grocery stores to match the desired location range. Further, the app has an extensive set of recipes, that are called using a recipes API, that can be customized based on the user's dietary restrictions and preferences and available ingredients. It also gives detailed step-by-step instructions to ensure ease of use, nutritional values, and total estimated costs for each recipe. Beyond the practical features of our app, one of our intentions of creating this app was also to promote awareness and advocate for food-insecure demographics across the country given that we, as college students on a strict budget, understand how important it is to ensure that we are well nourished to succeed in other aspects of life such as academics, career, sports, health, and more.

C28: Qi3353

Authors: Sarah Huang, Jenna Krebs, Felicia Seo, Ria Vadhavkar, Ethan Vasquez

Advisor: Mohammed Seyam

Currently, the sources to discover on-campus events are either limited or inefficient. The primary way to discover events for Virginia Tech students is GobblerConnect, however many students find it a hassle to use and some are also unaware of the site itself. This motivated us to create a mobile Android application, Qi3353 (pronounced: cheese), that offers students a platform where they can find on-campus events with ease. The app acts as a central place for users to look for details about a particular event, such as its time and location, the organization's name, and any other information about the event. We accomplish this by aggregating organizational events from other sources and display them on one centralized platform.

C29: PetPlay Adventures

Authors: Tam Vu, Karen Tran, Alina Tseng, Shivangi Sarkar

Advisor: Scott McCrickard

PetPlay Adventures is a single player virtual interactive pet owning game designed to encourage Virginia Tech freshmen to explore campus and the outdoors. Throughout the game, players will take care of their pet bear by using the steps they accumulate throughout the day to purchase food, toys, accessories, etc. The game's intention is to promote exercise and exploration of the outdoors. Furthermore, in order to take care of the pet, users will need to physically be in locations across the Virginia Tech campus in order to make purchases and care for the pet (ex: visit a dining hall to buy food, visit the bookstore to buy accessories).

C30: VTreasure

Authors: Anusheka Khullar, Mary Pletcher, Nik Buckwalter, Karan Sharma

Advisor: Scott McCrickard

When moving to a new town or city, one of the first things to do is learn about the important buildings and landmarks. However, something that is only evident once living in the area for some time is the smaller, more local hidden gems. This could be a cozy coffee shop, an ambient study space, or a secret shortcut to a frequented location. These places aren't always easy to find, and a common way to learn about them is by word of mouth. Given the recent shift to at-home work and an increasingly isolated environment, discovering new places this way has become difficult. This project concerns the following research question: how can we gamify learning to share knowledge engagingly? Specifically, can users understand more about the topic at hand with points of interest? After developing a location-based game using MapBox in Unity and a flexible text file, we can observe how users interact with the environment, how they intake information, and how much they learn from it. By making the game a treasure hunt, we found an enjoyable activity that exposes users to the new, surrounding area. Using a survey, we can collect feedback about how enjoyable, usable, and educational the game is. It remains to be seen what appeals to the consumer, but with further testing, we can grasp improvements that need to be made.

C31: UpLift

Authors: Mitchell Decker, Kevin Krupa, Bryce Cullen, Adharsh Jayaseelan

Advisor: Mohammed Seyam

The fitness industry is growing, resulting in more mobile fitness apps being developed. However, these apps often overlook experienced weightlifters and may not motivate novice lifters. UpLift is a social media platform for fitness enthusiasts of all levels that creates a sense of community and belonging. It incorporates a core feature called "gym streak" to encourage users to maintain their routine, and also provides the ability to search for workout partners. UpLift addresses significant shortcomings of other fitness apps and invites users to try out our demo.

C32: Outdoor Survivor

Authors: Ana Mancini, Catalina Lemus, Keith Espinosa, Justin Lee

Advisor: Scott McCrickard

Outdoor Survivor is a capstone project that uses a 2D platforming game created with Unity which aims to teach students about some of the Leave No Trace principles. Our target audience is within the 10-14 year old range. We chose this project and audience because the Leave No Trace principles are very rarely taught outside of boy scouts/girl scouts. However, they are important rules to abide by when going outdoors. Teaching these concepts and principles early in life is a great preventative measure for preparing children to go outside on hikes and etc. Teaching environmental awareness and the impact of humans activities in the environment shows children that even small actions can have significant impact on nature.

The game takes place on a gamified, abridged virtual rendition of Blacksburg's own Huckleberry Trail, which implements some features and sights one might see on a hike through the 15 mile trail. Players are presented with choices as they progress through the trail which reflect some of the Leave No Trace principles that will show different results depending on the choices they make.

Overall, we used elements that would appeal to our target audience and capture their attention without boring them with the education aspect of our application. We use vibrant colors, pixelated art and "cute" designs that are familiar to other games targeting their age group. Also, we use humor and storytelling in our decision-based game because the target age group responds well to this concept. It also includes a challenge where they collect coins and have a stamina bar to keep track of during their gameplay to keep them challenged to the point where it is slightly difficult but rewarding in the end.

C33: Sobek Transit

Authors: Keshav Bhateja, Mohammad Soliman, Youssef Bedraldin

Advisor: Mohammed Seyam

Sobek Transit aims to track and manage bus transportation for students, faculty members, and staff at AIU. The system will provide services such as tracking buses, rating drivers, making payments through the app, providing information on route stops and timings, and storing transaction and travel data. The main stakeholders are the third-party transportation company, the AIU representative to the transportation company, and the AIU transport unit, while the end users are bus drivers, students, and the AIU transport unit. The project will gather user input through a mass survey, and potential users include students, faculty members, and staff who travel to and from the university. The system will serve the student population and faculty members who are mainly located in Alexandria, Cairo, Mansoura, Behira, and Damanhour. The system developed based on user feedback and available on most internet browsers and iOS devices. The app will provide a practical way for users to book trips, make payments, and get information on bus routes, stops, and timings. The system aims to provide a user-friendly and efficient solution that bridges the gap between users and drivers/administrators.

C34: Voqan - Real Estate For All

Authors: Saisreekar Singam, Andrew Fitter, Caeden Erickson, Wai Yan

Advisor: Rich Charles

Many people and small businesses aspire to enter the real estate industry, wishing to make investments of their own. However, the real estate business has a steep learning curve that serves as an effective “gatekeeper”, making it difficult for beginners to perform proper research on real estate opportunities. This results in limited opportunities to join the real estate business and make a profit or worthwhile return on investments.

Voqan is a project, led by Hudson Aikins, that aims to simplify the investment evaluation process by helping real estate beginners obtain meaningful insights on real estate investments and opportunities, while along the way granting them a competitive edge in the market. With this web app, users can create accounts and receive advice on potential beneficial real estate opportunities. They can view dashboard pages that provide insights such as summarizations of complicated real estate documents, forecasts on their investments, and chart visualizations. Users can access a dashboard to learn about new investment opportunities that match their investment patterns and view an analysis of their various decisions on real estate investments. In the development of this app, we preemptively focused on implementing secure authentication to our website, requiring users to create an account. Voqan also enables users to receive clear summaries from documents and highlights the most important concepts in these documents by running them through a sentiment analysis that generates these concepts. Our web application aims to help people or small businesses who are attempting to join the real estate community, helping to smooth the process of property investment while learning the proper techniques and knowledge needed for the industry.

In the future, we will pass the website details to Hudson for further development. It is our hope that Voqan will ultimately aid beginners by providing knowledge and insight into real estate investment without being impeded by the gatekeeping that prevents so many from entering this arena.

C35: Expanding a Key Management System across the entire College of Engineering

Authors: Luke Janoschka, Justin Mathias, Ryan Kaviani, Tsion Woldeab

Advisor: Rich Charles

Across Virginia Tech, professors and students will require access to certain rooms for a variety of reasons, such as research. There are already systems in place for key management, but each department has a unique solution. Some departments are still stuck using paper and filing cabinets. The key management system is the solution to this problem: a website where administrators can manage keys and ensure that they are assigned and returned responsibly. People who need access to a certain room can request keys using the website and manage the keys that are assigned to them. The system supports CAS authentication and does not require a separate account to be created. This project is a continuation of previous projects over the last year. This semester the application was expanded to include all departments within the College of Engineering. In addition to normal software development challenges, this project had unique challenges due to the span of the application. In addition to this expansion, the app was also designed such that new applications created in capstone classes can be added into the same working space as the key management application. While this has the ultimate goal to reduce login-fatigue, this integration also has its unique challenges.

C36: ByteBox: Developing a Multiuse Recipe Database

Authors: Akash Mittal, Goral Pahuja, Melanie Verna, Reece Yankey

Advisor: Rich Charles

From the invention of the wheel to the advent of the smart refrigerator, technological advancement has always served to make our day-to-day lives more convenient. Alongside the smart fridge, there have been many other advancements aimed to assist us in the kitchen. However, In today's culinary landscape it can still be tedious to keep track of recipes. Recipes are scattered throughout the world wide web, on various platforms in various formats with various amounts of fluff that one might need to wade through before they can access the information that they need to start cooking. The goal of our project is to create a locally-hosted, easy to use application with which a user can add, edit, and remove recipes as they see fit. Users can search for recipes by name and they can use a number of filters to narrow down the results, such as which ingredients are in a recipe or how long it takes to prepare.

C37: Without a Trace

Authors: Katie Geibel, Sasha Holt, Grady Orr, Matthew Soohoo

Advisor: Scott McCrickard

The Leave No Trace Principles focus on minimizing the ongoing impact of outdoor recreation by spreading awareness of sustainable and low-impact outdoor practices that individuals can implement in their everyday experiences. This project aims to spread awareness of the Leave No Trace principles through a 3D open-world desktop game that guides players through a stylized forest trail to reach a waterfall. Development focused on four of the seven principles, specifically “Travel & Camp on Durable Surfaces,” “Dispose of Waste Properly,” “Leave What You Find,” and “Minimize Campfire Impacts.” The principles are communicated first through the menu screen guidebook which describes the principles in detail. The player is then able to interact with the world freely, with each of their interactions privately rewarded or penalized through an invisible point system. When the player finishes the game, they are given a total score and point values for each of the four principles covered. How well they did is also reflected in the ending screen that they are shown, as the picture of the waterfall that is displayed at the end is different depending on how well the player behaved. A clear, sunny day is shown if they did well, a foggy day if they did poorly, and a forest fire ending is shown if a fire is left lit. The design encourages users to consider the score that they received, look through our provided principles guidebook, and then play again in an attempt to improve their score. This way, the player learns by making mistakes and fixing them, which we hope will be more fun and memorable than telling players the proper actions to take before playing. To test if the game prototype helps users learn the Leave No Trace principles, users complete a pre-evaluation before playing the game and a post-evaluation after playing. We can then observe if answers improved when asked situational questions where Leave No Trace principles apply. So far in our testing, we have seen some improvement in score between the pre- and post-evaluations. Our work indicates that 3D games may be a useful tool to spread awareness of Leave No Trace principles to young adults from the comfort of their own homes.

C38: VT CS Job Hub

Authors: Fariha Rafa, Aram Min, Julia Chen, Lauren Brennan, Adnan Chowdhury

Advisor: Rich Charles

Imagine having a “LinkedIn” just for computer science students at Virginia Tech. The purpose of this project is to assist fellow students and help Virginia Tech work with companies to provide job postings to students. There are always students in the computer science department who are looking for employment opportunities to expand their experiences, and this project allows them to easily search and find jobs that match their needs. Companies who are interested in hiring Virginia Tech students also benefit from the project by being able to post jobs and see statistics related to their jobs. Virginia Tech will benefit from the company partnerships that arise from these and have more of their students hired as a result of implementation of the website.

With our website, Job Hub, students have the opportunity to upload their resume and search for jobs, admin can monitor activity, and companies can post job openings and connect with students. This project is a continuation of the previous capstone project and we were given the task to improve the UI allowing users to efficiently use JobHub while maintaining the current functionality of the application. Part of improving the UI is implementing a filter process for the search bar where results appear immediately for students and employers looking for specific jobs or candidates with a specific skill as well as creating a dashboard for companies and admins.

C39: Hokie Bucketlist

Authors: Ross Shaffer, Kevin Yang, Jordan Rudman, Karthik Nair

Advisor: Scott McCrickard

Hokie Bucket List is a web application designed to incentivize physical activity and foster community connections among users. The app encourages users to explore the greater Blacksburg area by completing hikes and campus activities, which earns them points towards a group competition. Users can form groups with friends to compete against other groups to get the most points. To keep users motivated, customized bucket lists are generated with activities suitable for their fitness level. The app offers a variety of popular hikes in the Blacksburg area, including scenic and challenging trails such as the Cascades Falls and McAfee Knob. The hikes are suitable for all levels of hikers, from leisurely strolls to heart-pumping climbs. The app uses geolocation tracking to monitor the distance traveled by the user during hikes. The Hokie Bucket List app was built using React and is optimized for mobile devices. User information is stored on Google Firebase and Firebase Storage for image hosting, with access rules implemented to protect user privacy. The platform offers a user-friendly interface for discovering new outdoor activities and fostering connections within the Hokie community. Overall, the Hokie Bucket List app is an excellent tool for individuals looking to improve their fitness levels while exploring the great outdoors with friends. With its user-friendly platform and customized bucket lists, the app provides a fun and engaging way to stay active and discover new adventures.

C40: Generalization Ability using Neuro-Evolution

Authors: Andrew Dunetz, Carter Koehn, Pierre Quan

Advisor: Hoda Eldardiry

We used a genetic algorithm (GA) to train a variety of feedforward neural networks (NNs), which is called neuro-evolution. We compared the performance of these neural networks to determine which ones would be able to generalize the best. We were interested in finding three things: Would a larger structure allow for more generalization capability? Would there be a relationship to structure and performance, and if there is, could we use that relationship to predict ability before training? Would training more complex models with complex genetic algorithm tactics allow for models to generalize better?

C41: Mordo

Authors: Aydin Gokce, Nadia Khokhar, Ashita Anuga, Vaani Andleigh

Advisor: Sang Won Lee

In a world where sci-fi narratives often depict negative outcomes of robotics and AI, it is essential to provide inspiring visualizations of positive and collaborative human-robot interactions. Mordo, our robotic snake project, seeks to challenge this prevailing zeitgeist of negativity and anxiety by showcasing the potential for harmonious cooperation between humans and robots. Designed to be worn around a person's neck, Mordo features head-tracking capabilities that allow it to move in sync with the wearer, creating an immersive and engaging experience. As a central element of a short film that celebrates technology and its potential for self-actualization, Mordo aims to inspire viewers to envision a future where human-robot interactions foster innovation, empowerment, and creativity. By reimagining the role of robotics in our lives through the lens of positive collaboration, our project aspires to influence the trajectory of technological development and foster optimism about the possibilities that lie ahead.