Computer Science and Engineering

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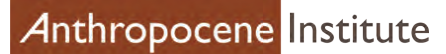
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CSE 498 Collaborative Design

CSE 498, Collaborative Design, provides the educational capstone for all students majoring in computer science. Teams of students build software systems for a variety of clients.

During the capstone experience, students

- design, develop, debug, document, and deliver a comprehensive software system,
- work in a team environment,
- become proficient with software development tools and environments,
- develop written and oral communication skills,
- build and administer computer systems, and
- consider issues of professionalism and ethics.

Our clients are local, regional, and national including Ally Financial, Amazon, Anthropocene Institute, Auto-Owners Insurance, Bosch, Corewell Health, Delta Dental, General Motors, Google, HAP, Henry Ford Innovations, Kohl's, Launch, Magna, McKesson, Meijer, Microsoft, Mozilla, MSU Federal Credit Union, NetJets, RPM, Stryker, TechSmith, Union Pacific, United Airlines, Urban Science, UWM, Vectra AI, Volkswagen, Whirlpool, and WK Kellogg Co.

Ally Financial
AI System Testing Framework

Ally Financial, headquartered in Detroit, Michigan, is a leader in the U.S. financial services industry. Recognized as one of the nation's largest online-only banks, Ally provides an array of online banking services to approximately 11 million customers.

Given recent increased interest in artificial intelligence, Ally Financial is experimenting with using generative artificial intelligence (GenAI) to automate various internal business processes. Research conducted thus far by Ally and others is promising, but GenAI's novelty and complexity create concerns regarding its reliability of performance.

Currently, there is no testing framework in place to accurately assess where GenAI excels and when it should be used in business practices. Without such a framework, it is time-consuming to identify use cases where it is appropriate to apply GenAI.

Our AI System Testing Framework evaluates how a GenAI model performs on a specific task. Given a prompt, the application indicates how well the GenAI model responds to the prompt by displaying meaningful evaluation scores associated with the interaction such as accuracy and relevancy.

After accessing the application, a user interacts with GenAI through a chatbot-like interface. The user prompts the GenAI with a professional use case and reference response, receives an output, and is then redirected to an evaluation page. The evaluation page provides a visualization of scores on how well the AI performed for that use case. Additionally, the user views past interactions and the scores associated with those interactions.

The front end of this system is built using HTML, CSS, and JavaScript. The back end is implemented in Python and uses the Flask library to create a web application. A server provided by the MSU Division of Engineering Computing Services (DECS) is used to host a PostgreSQL database where relevant data is stored.
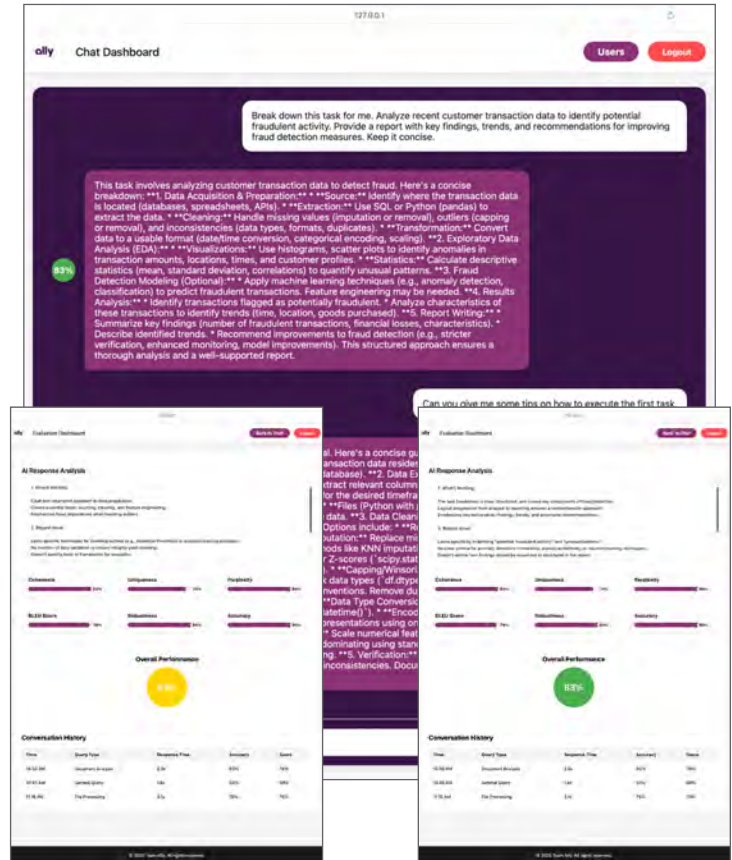
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Amazon
Semantic Search for Code and Architecture Assets

Amazon, located in Seattle, Washington, is a global leader in technology and a global e-commerce powerhouse. Originally founded by Jeff Bezos in 1994, Amazon has since expanded into a dominant force in cloud computing through Amazon Web Services (AWS) and is the parent company of over 100 subsidiaries.

Amazon software developers are responsible for creating Amazon's popular online products. These developers often utilize reliable assets from previous projects and advice from subject matter experts (SMEs) to increase productivity. However, manually navigating through multiple codebases to find relevant assets and experts is inefficient.

Our Semantic Search for Code and Architecture Assets web application centralizes resources and improves productivity by reducing the time developers spend searching for code assets and SMEs. Amazon developers simply create a search request, and our application recommends optimal code snippets. This enables Amazon employees to spend less time searching and more time developing Amazon's powerful services.

To use our web application, developers type a topic into the search bar, known as a query, and search. Upon entering a search query, our application utilizes artificial intelligence to locate and display optimal code assets. Developers filter by a variety of options to find the assets that best suit their needs.

Our web application mobilizes various codebases into a single platform for developers to access templated code, minimize workflow disruption, and contact the SMEs with ease.

Our web application utilizes a suite of technologies provided by AWS. The front end is built with React and hosted on AWS Amplify, while back-end operations are handled by Amazon API Gateway, AWS Lambda, and Amazon S3. Amazon OpenSearch is used to search for relevant code assets.
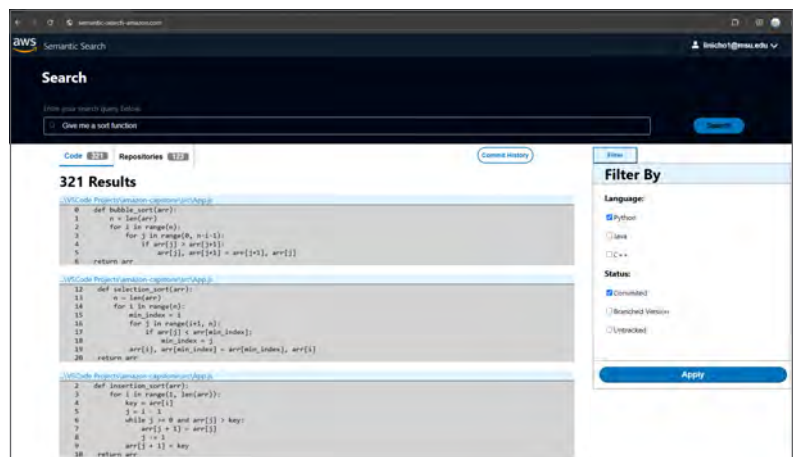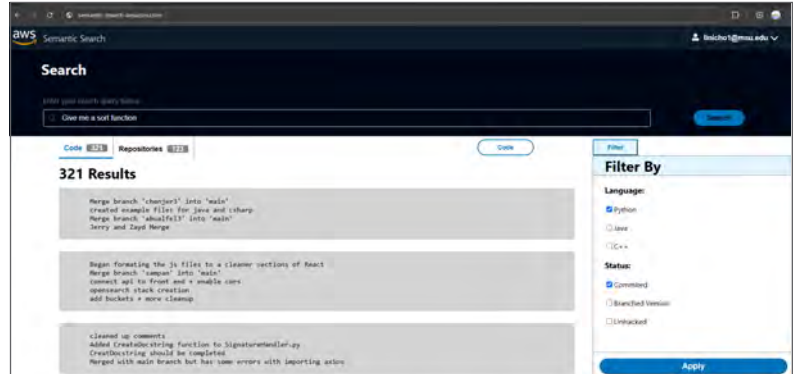
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Anthropocene Institute
Balancing the Power Grid with Nuclear Power

The Anthropocene Institute is an organization located in Palo Alto, California since 2012. Their mission is to unite entrepreneurs, thought leaders, and investors to advance clean energy, technology, and climate policy.

Anthropocene Institute promotes nuclear energy as a possible option for clean energy. However, nuclear energy is a controversial solution among policymakers, energy market traders, and even the general public. Despite this, there are many benefits to nuclear energy that the public may not be aware of.

Our Balancing the Power Grid with Nuclear Power system empowers consumers to be more informed about the current state of the California energy market. Our software collects real-time data from the energy market to build interactive data elements that users view to learn more about the current state of the energy market.

The first element is an energy forecast, which provides a visual of the current price movement within the energy grid. This forecast also ties to an alert system where users sign up to receive customized messages when there are spikes in energy market prices.

Additionally, there is an appliance calculator which enables users to input information about their energy bill and household appliances. The calculator displays the true cost in energy consumption that those appliances have on the grid over time, empowering the user to make informed decisions as a consumer.

The energy outlook page showcases multiple elements that display data on energy usages, prices, and carbon emissions. These visuals are interactive and downloadable into simple data formats for further individual research.

The front end of our web application is in HTML, CSS, and JavaScript. The back end is implemented with Python Flask and is connected to a MySQL database.
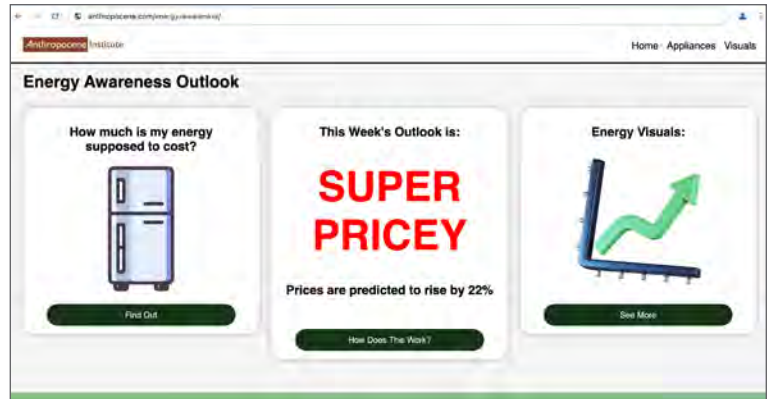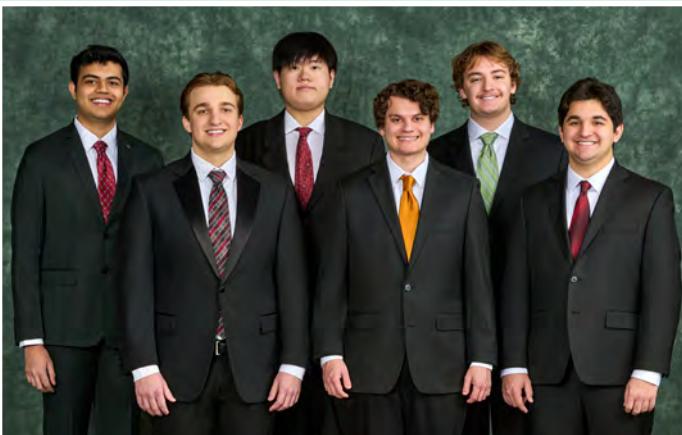
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Auto-Owners Insurance
Next Step Insight

Auto-Owners Insurance is a Fortune 500 company headquartered in Lansing, Michigan. Auto-Owners is represented by 48,000 licensed insurance agents in 26 states and provides insurance to nearly 6 million policyholders.

As a major insurance company, Auto-Owners employs around 6,000 associates across a wide array of positions and locations. As such, there are often employees who are ready for promotion or who need to be relocated.

Auto Owners currently uses an existing system to identify these individuals based on certain criteria. However, manually analyzing and updating the current system is a complex and tedious task, making the process needlessly labor-intensive and time-consuming.

Our Next Step Insight is a web application that significantly reduces the time needed to review possible candidates by filtering employees based on specified criteria. It utilizes a machine learning model to automatically recommend candidates who are a good match for the selected operation based on their employee summary.

Users start by selecting a position that needs to be filled, along with any filters to apply to the search. Our software eliminates potential candidates that do not align with the search criteria and highlights the employees that the machine learning model recommends for the job.

Our website decreases the time that the Human Resources department needs to spend organizing potential candidates' details, enabling them to more efficiently compare candidates. This gives Auto-Owners the ability to fill available roles quickly so they can continue to have a capable and well-staffed team.

The front end of our application is built with HTML, CSS and TypeScript, while the back end is implemented with Spring Boot 3. The data for our application is stored in a Microsoft SQL database.
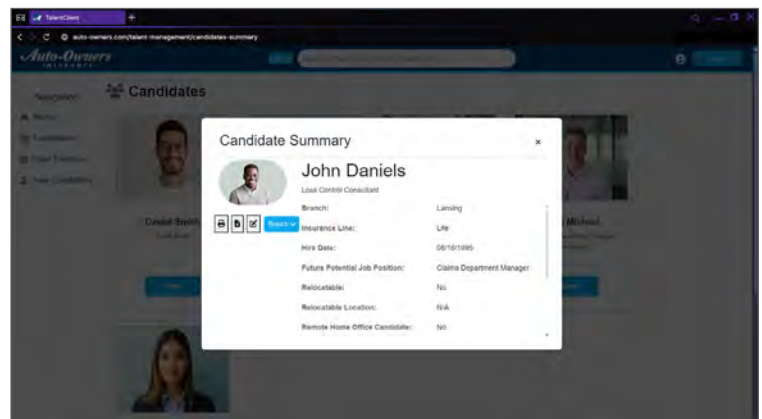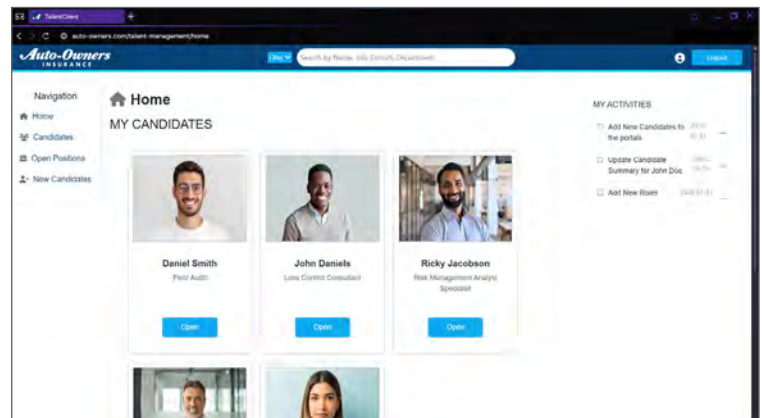
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Corewell Health
AI for Med Students Learning About Basket Management

In February of 2022, two Michigan hospital management companies, Beaumont Health and Spectrum Health, merged into what would become Corewell Health. Corewell Health is now the largest health system in Michigan, running 22 hospitals across Michigan, employing over 65,000 people, and treating over 1.3 million patients.

Electronic health records (EHRs) are a crucial part of today's healthcare. They are a convenient way for doctors to quickly check a patient's lab results, prescriptions, charts, messages, and more. However, medical students and residents lack the training required to use these systems efficiently in real-world environments.

Our AI for Med Students Learning About Basket Management is a web application that trains medical students and residents in efficiently handling patient messages, lab results, and prescription requests.

Our software provides students with daily tasks that consist of multiple questions for each of the three categories listed above. Students must respond to a variety of AI-generated questions that reflect a message that a physician might receive from an actual patient. Students must also review a patient's lab results and write the patient a message about any abnormalities or concerns the student may have. Finally, students must practice ordering or refilling prescriptions for patients.

Our system grades the students' responses to each patient case based on completion and provides an AI-generated example for the student's learning. The student then compares their answer to the LLM's to improve their responses for future cases.

Our front-end software is written with ReactJS, and our back end is written in Golang. We use Flask and OpenAI's API for the LLM microservice, and our data is stored in a Supabase SQL database.

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Delta Dental of Michigan, Ohio and Indiana
3D Analysis of Dental Patient History

Delta Dental provides dental insurance coverage to more than 90 million Americans. They operate in all 50 states, making them one of the largest dental insurance providers in the United States.

Delta Dental processes millions of claims per year from their subscribers. When the claims go through their claims processing system, further human review by adjudicators may be required to correct malformed data or to review the validity of the claim.

Claims are reviewed through the context of the patient's dental history, which Delta Dental has comprehensive access to. This includes any procedures or treatments performed on any patient, leading to a massive amount of data.

The 3D Analysis of Dental Patient History assists adjudicators by visualizing the dental patient history. Our web application features a 3D model that shows a patient's entire dental history where the user rotates, zooms in, and selects specific teeth on the model. Selecting a tooth displays all information about its previous procedures and treatments as well as a more detailed individual tooth model.

In the web application, users edit existing data and upload new data. Inputting information can be done manually through a form or by uploading other records that are kept on file.

Once new data is uploaded, users view the patient's information in the 3D model. With access to a patient's complete dental history, past procedures and treatments are viewed in chronological order.

Our application streamlines claim reviews by enabling Delta Dental employees to quickly and accurately visualize patient history, saving valuable time and effort.

The front end of our web application is built with Angular. Three.js is used to display 3D models and Bootstrap provides formatting for the front end. Java Quarkus is used for connecting Angular to the PostgreSQL back end.
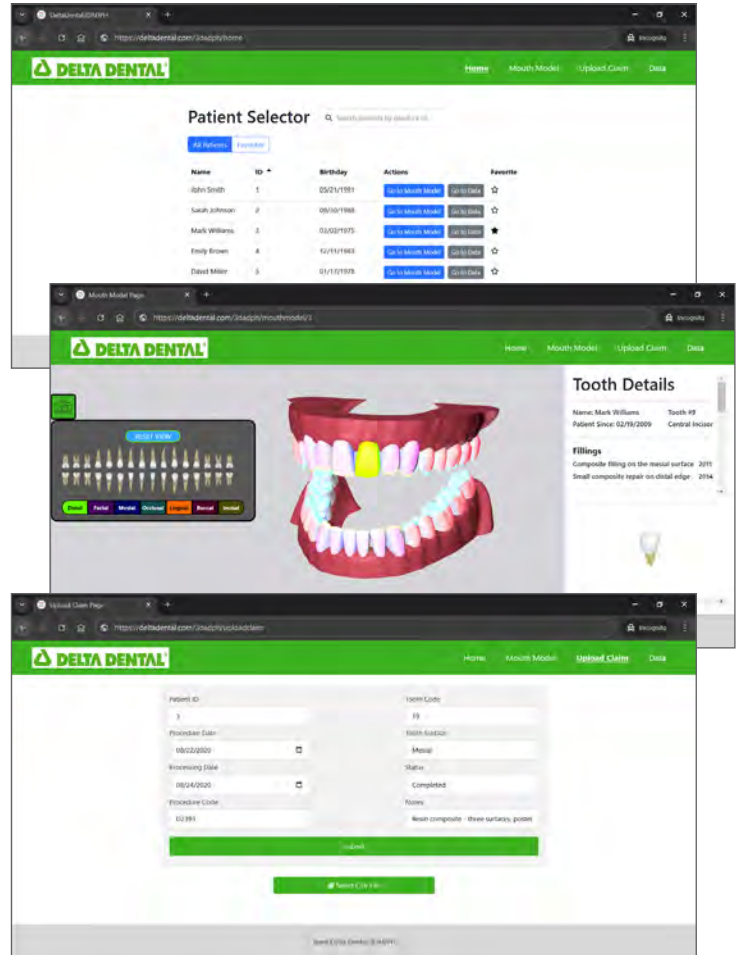
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Delta Dental of Michigan, Ohio and Indiana
DSL Tooling Ecosystem (dSLATE)

Delta Dental is the nation's leading dental insurance provider, serving over 90 million Americans in all 50 U.S. states, Puerto Rico and other U.S. territories. Delta Dental of Michigan is one of the 39 independent Delta Dental companies and has been serving the citizens of Michigan since 1957.

Delta Dental of Michigan developed their own domain-specific language (DSL) to handle complex insurance rate calculations alongside the use of Excel spreadsheets. The DSL is used in a variety of tools scattered across different platforms. However, this affects the efficiency of business operations because it is time-consuming to navigate between the various components.

Our DSL Tooling Ecosystem (dSLATE) is a web application that provides a user-friendly environment with all the necessary tools for underwriters and developers to perform rate calculations in Delta Dental's DSL.

The tooling ecosystem includes an overview with the ability to create, search, and navigate for active insurance formulas and factors within the system, aggregating any information needed for calculations into one convenient location.

Our web application also gives developers access to an integrated development environment designed specifically for the DSL. This tool streamlines the transfer of Excel data into DSL code and shows formulas and factors involved in the process. The environment enables editing and creation of new formulas as well.

Users ask further questions of the included DSL knowledge assistant. The knowledge assistant provides information to help users understand a formula and its factors.

The front end of our system is written using Angular. The back end uses Java Quarkus with a MongoDB database to host Delta Dental's existing core libraries and data. Microsoft's Azure OpenAI service is used to handle the DSL knowledge assistant.
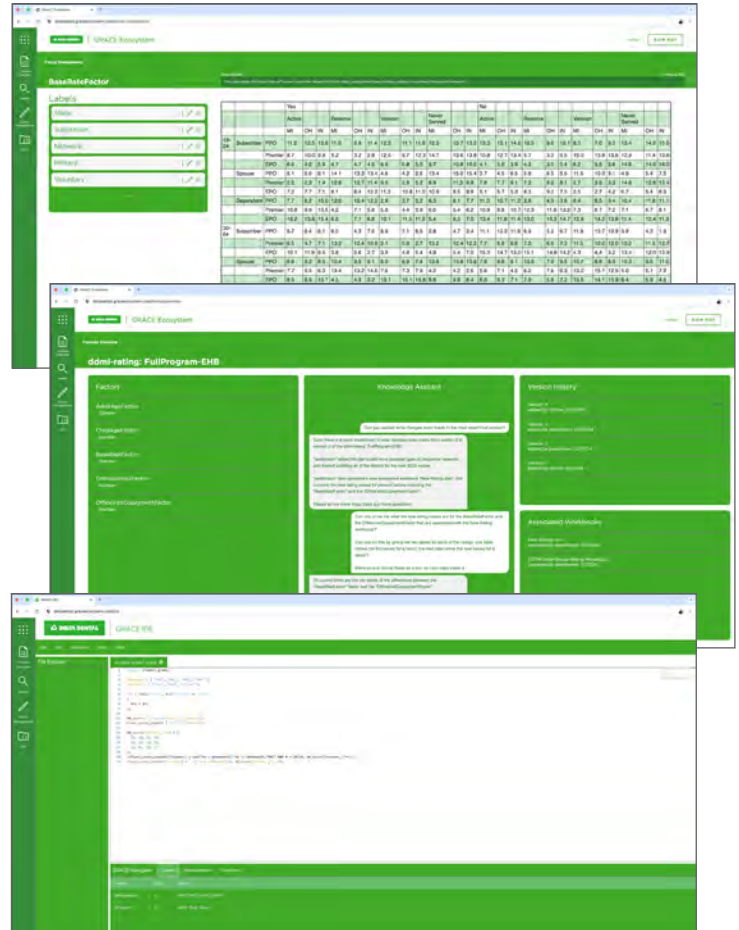
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General Motors
Global Waste Management System

General Motors (GM) is a global automotive company that has proven through more than a century of automotive design and engineering to be a force of continuous innovation.

GM is focused on reaching zero waste and emissions by 2035 as they lead progress among automotive manufacturers.

However, compiling accurate waste data across a multinational corporation to inform sustainable operations is no easy feat, and converting waste data spanning years into useful information is challenging. Accurate data collection at GM relies on waste managers avoiding error during manual input, however mistakes are inevitable.

Our Global Waste Management System addresses these problems and promotes informed sustainability progress in GM operations through an intuitive web application.

Our web application supports robust data filtering and editing all while ensuring proper authorization. However, it has two truly outstanding features. Those are statistical error checking of data entries and predictive waste trend analysis.

Statistical error checking software prevents manual data entry errors by using a variety of metrics to identify anomalies. When a waste data entry error is made, the waste manager is prompted to resolve the issue or bypass it. Our software also includes capabilities for users to define what qualifies as an error.

With accurate data, it is possible to make informed sustainability decisions if the data can be visualized in a meaningful way. Our waste trend analysis predicts what the near future will look like in terms of waste production at GM using advanced data analysis. Predictions are displayed in multiple easy-to-read ways.

The front end of the Global Waste Management is built using React while the back end utilizes Flask, Python libraries, and MySQL.

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HAP
# Customer Intent Engine and Training Tool

Health Alliance Plan (HAP), founded in 1960 and headquartered in Troy, Michigan, is an innovative and trusted health insurance provider with a mission "to enhance the health and well-being of the lives we touch." HAP was one of the first 21 health plans in the United States to publicly report on the quality of care.

Every day, HAP receives numerous customer service inquiries in their call center that range across a variety of customer needs. With such diverse inquiries, there is a lot of information that a call center representative needs to be prepared to both receive and relay. Training representatives for all these different scenarios is a time-consuming and overwhelming process.

Our Customer Intent Engine and Training Tool enables representatives to enhance their customer service skills by providing valuable insights from historical customer calls. Our software analyzes transcripts from past calls, identifies the customers' intents, and displays the information in numerous ways on our web application.

Our website offers interactive dashboards where users explore the details of past customer inquiries from various perspectives such as call frequency, commonly used words for specific topics, most frequently asked intents, and more. Users click on specific dashboard pages to gain further insight into a given topic. Our application also provides a smart chatbot to enable customer service staff to ask questions as they use the website for training.

Our front-end software is developed using HTML, CSS, and JavaScript, while the back end is implemented using Python Flask with PostgreSQL as the database. The software leverages Python for data analysis and generates interactive dashboards using the Python Dash library. The chatbot is trained and implemented using the Hugging Face library in Python.
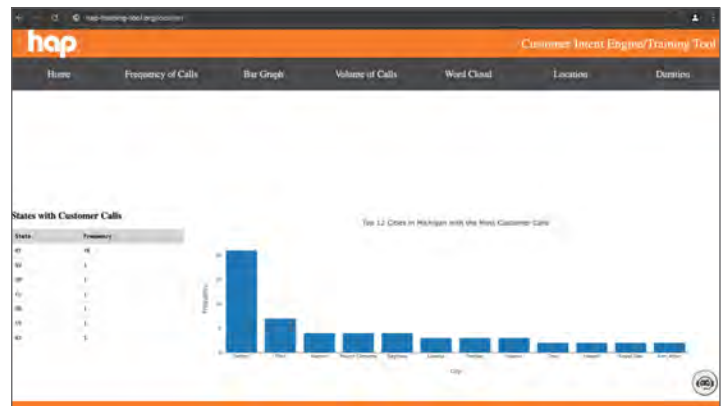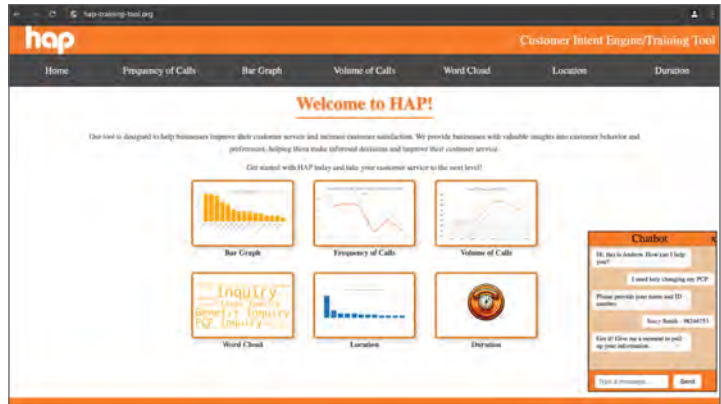
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Henry Ford Innovations
Electronic Laboratory User's Guide (eLUG)

Henry Ford Health is one of the nation's leading healthcare providers based out of Detroit, Michigan. More than 6,000 medical professionals and researchers work towards ensuring that Henry Ford Health is at the forefront of modern medicine. Their engagement in over 2,000 research projects every year proves their dedication to medical innovation.

It is crucial that clinicians and medical professionals can properly collect and handle specimens from their patients for lab testing. This is why Henry Ford Health created the Electronic Laboratory User's Guide (eLUG). The eLUG houses a lab testing catalog that provides guides on correct specimen collection methods.

eLUG was originally developed over 20 years ago, can be difficult to navigate, and many of its features are outdated.

Our improved eLUG features a modern, user-friendly interface improving the experience for day-to-day users, both internal and external. Along with a web application, we offer a mobile application to increase the guide's accessibility.

The improved search feature finds any guide within a few keystrokes. Additionally, shareability is a vital component of modern healthcare workflows. Our web application enables the simple sharing of test pages with unique links, while the mobile application provides direct access to corresponding web pages, ensuring smooth collaboration.

Security is a big concern in healthcare, and our application has three separate layers of secure access: a user, an admin, and a webmaster.

The eLUG web application is developed with HTML, CSS, JavaScript, and ReactJS, while the mobile application is developed with Xcode and Swift. Both are powered by a MySQL database, with the mobile application utilizing a RESTful API to fetch data.
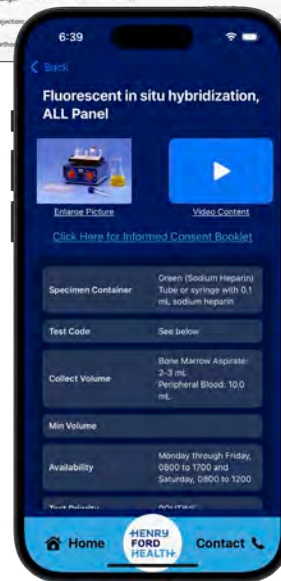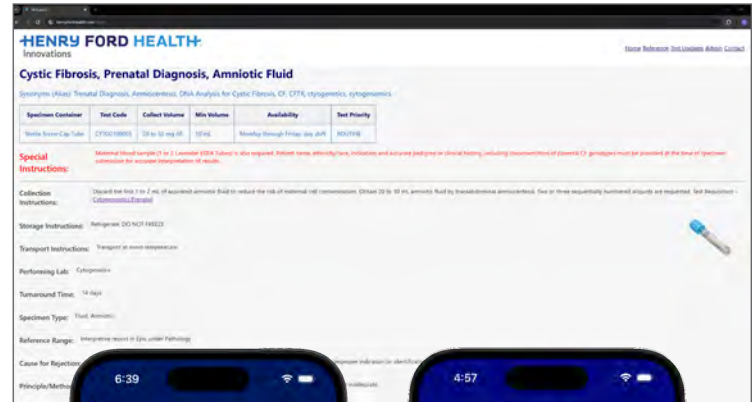
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Henry Ford Innovations
Modernizing Robotic Surgery Education 2.0

Henry Ford Health is a leading not-for-profit healthcare organization headquartered in Detroit, Michigan. Founded over 100 years ago, Henry Ford Health is recognized nationally due to its commitment to community care and breakthroughs in education, research, cancer treatment, and more.

As partners, Henry Ford Health and Michigan State University collaborate to innovate medical education and patient well-being.

Residents learning new surgical methods involving robotic equipment must first learn how to operate it effectively. There is a need for specialized software to adapt this education to newer generations of surgeons.

Our Modernizing Robotic Surgery Education 2.0 system improves the learning experience with new data analysis and discussion forums.

With our user-friendly focus, our updated software implements a personalized experience for both students and instructors. Employing a widget system, users enjoy a custom dashboard with valuable insights that streamlines the robotic surgery learning process.

Additionally, we have a mobile iOS application that connects to our web application. Data synchronizes between both applications, ensuring real-time updates.

Our software solution also features a discussion forum, where instructors and students collaborate, ask questions, and obtain feedback.

The platform links its data to a private and secure cloud server which stores data and settings, including login data. Users must undergo multifactor authentication to enhance security.

Our web-application uses Flask, PyTorch, Docker, JavaScript, Dash, HTML, and CSS to provide a seamless experience. We use Swift to extend the application to iOS platforms.
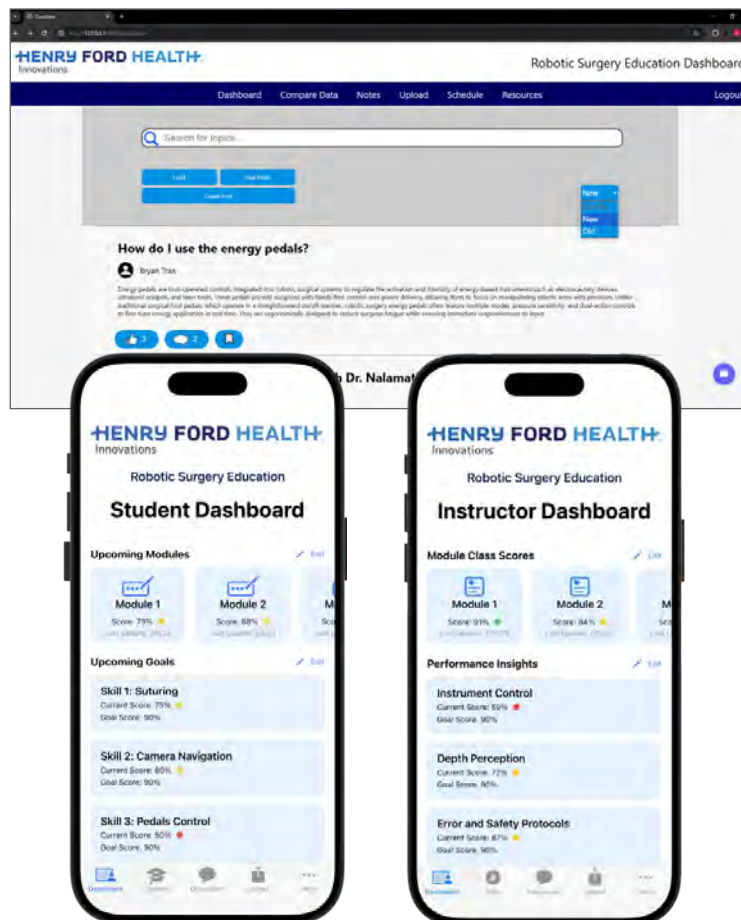
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Henry Ford Innovations
MSU-HFH Research Synergy Vanguard Portal (RSVP) 2.0

Henry Ford Health (HFH), based in Detroit, Michigan, is a leading healthcare system renowned for its commitment to innovation in medical research. In partnership with Michigan State University, HFH bridges the gap between clinical needs and academic expertise across both institutions.

Despite this partnership, clinicians at HFH and faculty at MSU face challenges in connecting across disciplines due to fragmented communication channels and a lack of centralized resources. This hinders the potential for interdisciplinary research and limits opportunities for collaboration among clinicians and experts such as engineers and scientists.

Our Research Synergy Vanguard Portal (RSVP) 2.0 addresses this challenge by providing both a web- and mobile-based platform that streamlines collaboration. The system helps users find research partners not only across institutions but also within their own organizations. The system intelligently analyzes user expertise and research interests to recommend ideal collaborators, creating a seamless and efficient networking experience.

Our mobile app introduces a swipe-to-match feature, enabling users to quickly browse and connect with potential collaborators. This new feature, along with automatic message suggestions, further encourages meaningful collaboration in a manner that fits the fast-paced schedule of many users.

With advanced semantic search capabilities, users refine their searches using multiple inputs, ensuring precise and relevant results in seconds.

Our portal is built using a ReactJS front end and a Flask back end for application logic. We utilize Bidirectional Encoder Representations from Transformers (BERT) for natural language processing to enhance search capabilities, and Elasticsearch for efficient search performance.
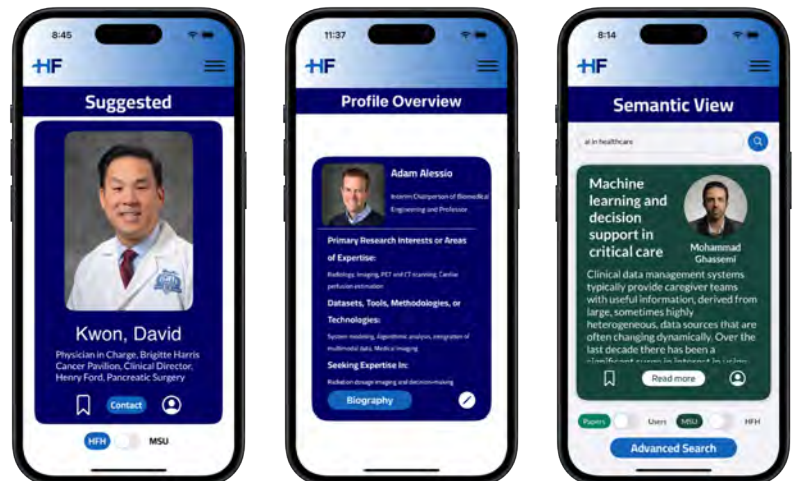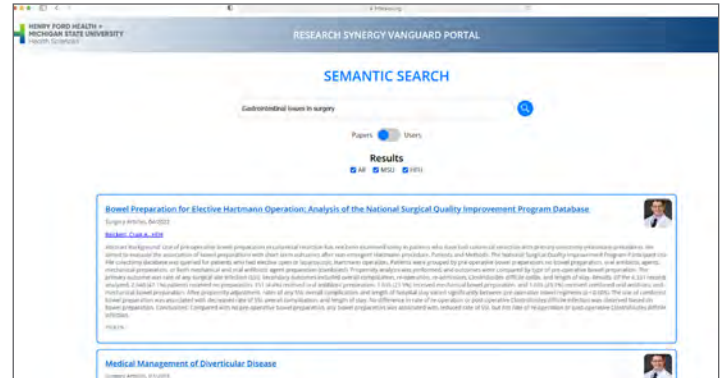
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Launch by NTT DATA
Everyday Agent

Launch, a subsidiary of NTT Data, accelerates product development by delivering innovative engineering solutions. With offices across the Americas, Launch partners with industry leaders like Jeep and Adidas to transform ideas into scalable technology.

People frequently misplace essential items like keys and wallets, leading to frustration and wasted time. Existing solutions, such as tracking tags, require manual setup, while voice assistants lack real-time object detection. A more intuitive, hands-free solution is needed to seamlessly integrate item tracking into daily life.

Our Everyday Agent is a wearable device powered by artificial intelligence that tackles this problem. Equipped with a compact camera, the device continuously scans the user's surroundings to detect and log their items' locations. Using this information, Everyday Agent provides the last known location of an item. If an object cannot be accurately located, the system analyzes past user habits and suggests the most likely location.

Users interact with Everyday Agent by saying, "Hey Agent," followed by their query. When they request location services, the device responds with either a precise location or an estimate. It also functions as a voice assistant, answering general questions.

A companion mobile app provides users with a dashboard displaying their most frequently misplaced items. Each item is listed alongside a description, such as "on the kitchen counter," and its last shown GPS-based coordinate, plotted on an interactive map.

Our Everyday Agent uses a Raspberry Pi Zero 2 W with a camera, speaker and microphone. The mobile app is written in Swift, and the product software is written in Python using multiple models. You Only Look Once, Places365, Roboflow and ORB-SLAM are used for image recognition. Microsoft Azure is used for speech, text and natural language processing as well as a virtual machine. PyTorch is used for the predictive location algorithm.
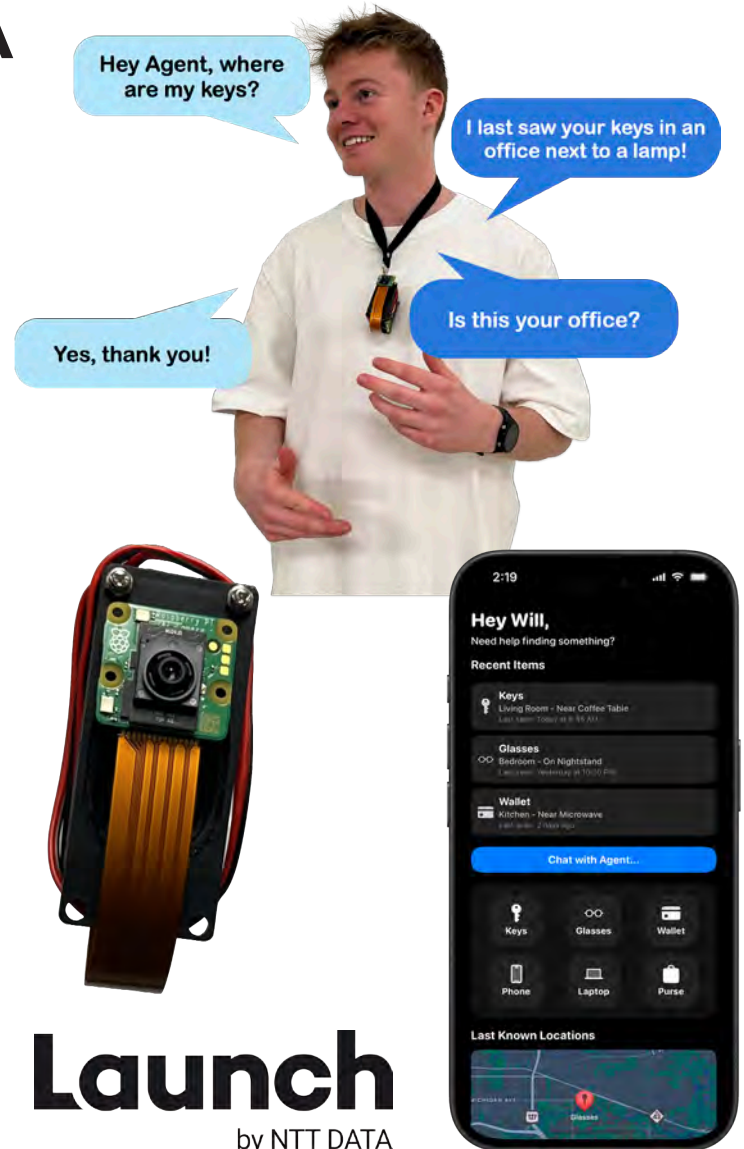
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Magna
Manufacturing Tracking System

Magna, founded in 1957 as a small tool and die shop, has evolved into a global automotive technology and manufacturing powerhouse. They are a key player in the automotive industry, supplying components and systems to major vehicle manufacturers worldwide, and shaping the future of mobility solutions.

In order to stay ahead of the competition, Magna needs to keep track of all of its goods and materials throughout the manufacturing process. Unfortunately, with so many factories and products, this can be very difficult. Manufacturers need a more efficient way to track and identify materials that make up their products.

Our Manufacturing Tracking System solves this problem for Magna by creating a digital record of materials as they pass through the manufacturing process. Our web app interface provides key information about material details and movement history.

Users gain real-time insight on the most recent material movements in the factory as well as the ability to find what materials make up a product. Our system displays factory sensor data in real time, enabling operators to detect manufacturing problems early, reducing waste and improving production.

Our software is built on blockchain technology, ensuring that every record is permanent and cannot be altered. The blockchain also enables users to view the entire history of a product as it navigates through Magna's supply chain. Operators visualize these chains of events using our web app.

By combining real-time monitoring with secure digital records, our software improves efficiency and reduces costly errors.

Our system runs on Hyperledger for blockchain security with a Node.js back end to efficiently handle large volumes of real-time data from IoT sensors and material tracking logs. The front end uses Vue.js for a smooth UI interface that enables operators to view updates instantly as the material moves through production.

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McKesson
Vulnerability Scan and Detect

McKesson is a Fortune 10 healthcare company that streamlines pharmaceutical delivery and patient care across the globe. McKesson strives to improve patient outcomes by seamlessly integrating technology into pharmaceutical services worldwide.

Healthcare environments depend on strong cybersecurity measures to protect sensitive patient data and prevent disruptions in critical hospital operations and pharmaceutical supply chains. Even a single vulnerability in a web application might serve as an entry point for cyber threats, putting patient privacy and healthcare infrastructure at risk. Identifying these weaknesses before they can be exploited is crucial in maintaining a secure digital environment.

Our Vulnerability Scan and Detect tool provides a proactive approach to cybersecurity by analyzing web applications for potential security flaws. After a user simply enters a URL, our system conducts a thorough scan, detecting vulnerabilities that could be leveraged in cyberattacks.

Once the scan is complete, a detailed report is generated, highlighting identified risks along with actionable recommendations to mitigate them. Risk statistics are visualized with easy-to-read charts, enabling users to understand risks at a glance. All reports are stored in a secure database which is linked to the web application for a seamless view of scan history.

This system enables healthcare organizations to address security gaps efficiently, reducing the likelihood of data breaches, system outages, or unauthorized access to critical information.

The application is built using a Flask-based back end to manage scan requests and process results. The front end is built with HTML, CSS, and JavaScript to provide an intuitive user experience for entering URLs and reviewing reports. The scanning process utilizes industry-standard security testing frameworks to provide accurate and comprehensive vulnerability detection.

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Meijer
Online Customer Experience with Meijer Branded Products

Meijer is a prominent Midwest supercenter chain headquartered in Grand Rapids, Michigan, with over 260 stores across six states. Meijer is committed to offering value and quality throughout its 18 in-house brands.

With consumers having several options to choose from when selecting a grocery store, it is important for Meijer to foster their brand and provide incentives for people to continue shopping at their stores.

Our Online Customer Experience with Meijer Branded Products promotes the Meijer brand by providing a centralized location for customers to interact with Meijer products and business practices. The experience features a website for customers to peruse Meijer's in-house brands, including two brand new product lines. Our software hosts an online ordering and pickup system to facilitate purchase of these items.

Online order pickup from the customer-side website modernizes the grocery shopping experience. It eliminates traditional checkout lines and enables customers to select pickup times, check-in from their phones, and receive real-time updates on their order.

By leveraging Meijer team member specialization, orders are fulfilled optimally by assigning an employee with the best knowledge of each of the given products.

A new promotion and campaign management page enables Meijer administrators to edit and promote products, create coupons for shoppers, and have access to current promotion and product analytics.

The front end of this application uses ReactJS. The back end is implemented in C# with .NET, and the platform is hosted on Microsoft Azure. Microsoft SQL Server handles all data storage. The mobile app is written in Swift and SwiftUI.
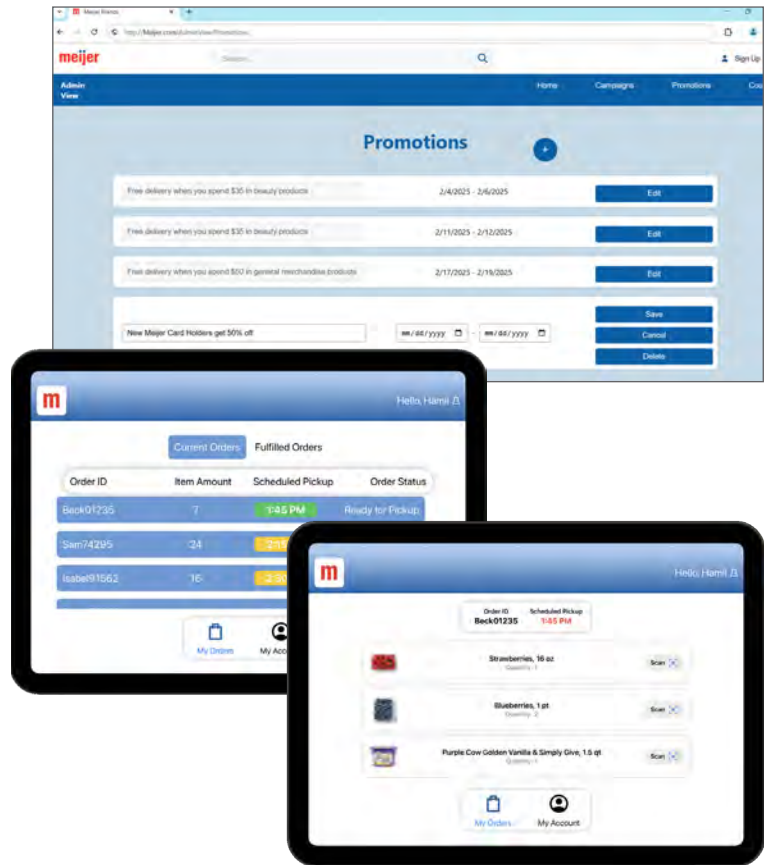
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Michigan State University
Robotic Job Coaching 2.0

The department of Computer Science and Engineering (CSE) is the largest academic unit in the College of Engineering at Michigan State University (MSU). The department hosts 20 laboratories, each equipped with cutting-edge technologies that facilitate research in a wide spectrum of topics. MSU CSE boasts an array of industry-leading research in collaboration with departments such as robotics, special education, psychology, and more.

Research professionals from various fields are collaborating with the CSE department to develop an industry-leading system for workplace training. Job coaching is a valuable resource for employees with disabilities to thrive in a workplace. In-person job training requires a coach to be on-site. Virtual job coaching enables a job coach to reach multiple clients without the limitation of physical presence.

Our Robotic Job Coaching system alleviates many of the challenges with in-person job coaching. Using our system, coaches connect with any of their clients virtually through a teleconference call. Clients request assistance from a coach and enter a queue.

The client devices are mounted on a robotic arm and coaches remotely manipulate the robotic arm, enabling coaches to view the complete work area remotely. The coach is able to gain a full understanding of any problems that the employee may be experiencing, thereby facilitating better coaching.

Our system combines the effectiveness of in-person job coaching with the flexibility of virtual coaching to offer an effective and innovative solution for job coaches.

The front end of the Robotic Job Coaching system is built in Java for Android and Swift for iOS. Our back end is hosted on a docker container running a Python Flask application with a Gunicorn server client. The robot is controlled over UDP using ROS noetic and the ROSbridge package.
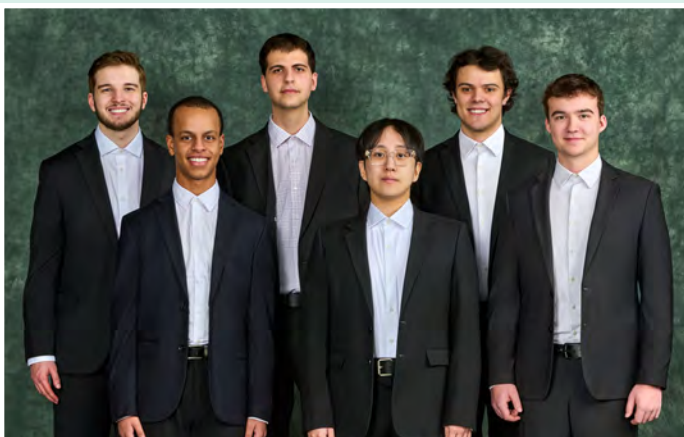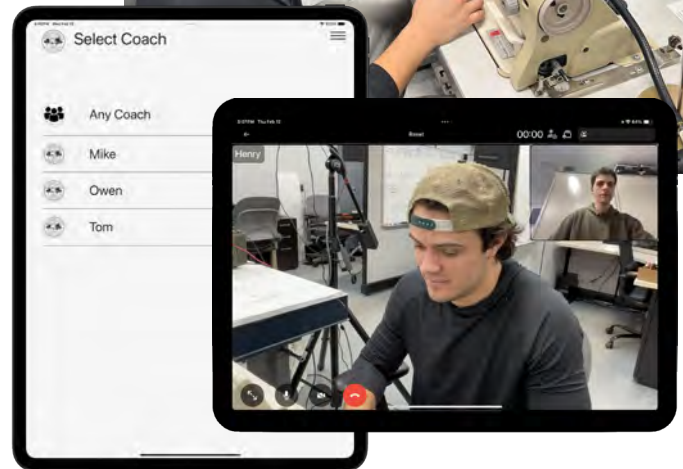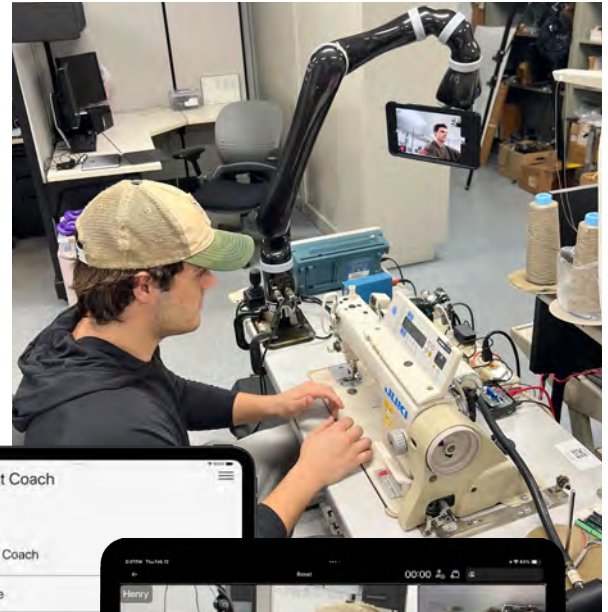
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Michigan State University
Test Platforms for Self-Driving Race Cars

The PoliMOVE-MSU Indy Autonomous Challenge team, a collaboration between Michigan State University and Politecnico di Milano, is a leading force in autonomous racing. The team secured first place in the 2024 Indy Autonomous Challenge, showcasing their cutting-edge innovation and engineering expertise.

To maintain their competitive edge, the team requires high-quality, real-world sensor data to help train and test their autonomous vehicles. Currently, the PoliMOVE-MSU team does most of their data collection and autonomous systems testing within virtual environments. To create realistic environments, it is essential that realistic sensor data is utilized. However, collecting enough sensor data can be very difficult and time-consuming.

Our Test Platform for Self-Driving Race Cars (SDRC) bridges the inherent gap between the virtual testing environments and real-world autonomous driving by enabling users to collect real-world data easily with a scale model vehicle.

Our design features two main hardware systems: a 1:10 scale model of the real Indy Autonomous Vehicle and a base station, which in turn consists of a laptop, a driving chair, a steering wheel and pedals.

The base station uses a web application to control the vehicle. It sends control data from the steering wheel and pedals to the vehicle, enabling the user to control the system remotely. As the vehicle is driven through its environment, it utilizes a variety of real sensors to map its environment, which it sends back to the base station to be saved and displayed.

Using this web application, users are able to record, replay and download sensor data for any use case. The web back end is written in Python and the front end is written in HTML. The laptop communicates with the vehicle using the node system employed by the ROS2 middleware.
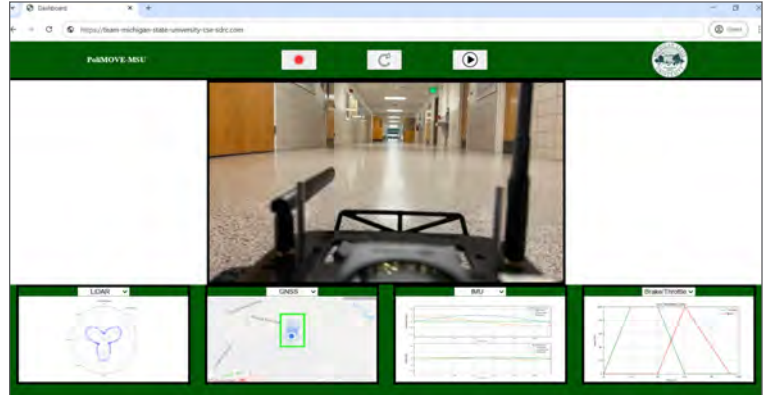
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Michigan State University
Crowd-Sourcing Intuitions of Vowel Classifications

The Michigan State University Linguistics Department provides theoretical foundation in the science of language sounds, structures, and meanings, with a focus on language variation.

One variation in language is dialect evolution. While dialect boundaries in North America have remained relatively unchanged, the ways in which people pronounce words continue to evolve.

Traditional dialect atlases rely on methods that limit their accuracy and scope, and traditional linguistics research relies on limited data points to study these shifts.

Our Crowd-Sourcing Intuitions of Vowel Classifications system reimagines linguistic data collection by introducing a web application that enables real-time vowel classification. Linguists classify thousands of words efficiently, contributing to a more comprehensive and dynamic understanding of dialect evolution.

The web application streamlines the process of vowel classification. Users begin with a pre-test to determine their dialectal distinctions. During classification, a word appears in a central display box with the targeted vowel highlighted for identification. Below the word, classification buttons displaying available lexical sets for selection are arranged into a trapezoidal shape familiar to linguists.

As users engage with the platform, their progress is displayed on a dashboard with a point system to motivate consistent participation. Researchers download classification data to conduct their own data analysis.

Our vowel classification system reveals modern dialectal trends and propels linguistics research forward.

The front end is built with React.js and structured with HTML, CSS and JavaScript to handle various data. The back end is powered by Flask which handles API requests and communication with the database.
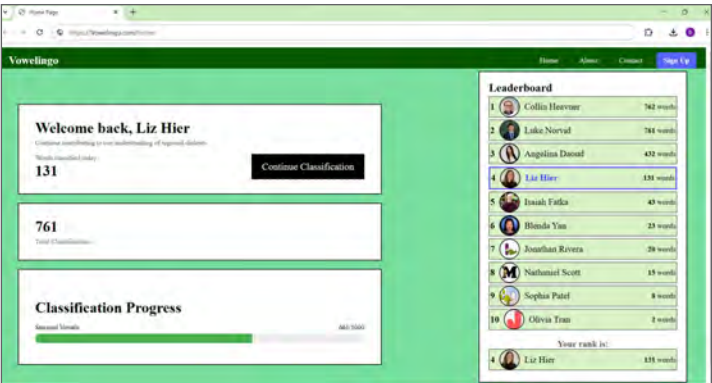
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MSU Federal Credit Union
Logged-In Branch Experience

Established in 1937, MSU Federal Credit Union (MSUFCU) has been serving Michigan State University and the greater Lansing area for over 88 years. With over 24 branch locations statewide and 367,000 members, MSUFCU strives to help its local communities thrive and achieve financial freedom.

When visiting a branch, MSUFCU currently provides a standard check-in process that requires a member to input their name and wait for a teller to assist them. This process can be lengthy and contribute to member dissatisfaction. MSUFCU is looking to provide a more seamless experience where the branch recognizes members upon arrival.

Our Logged-In Branch Experience streamlines the in-person banking experience by using the organization's security cameras to identify members as they enter the building. Once a member is identified, MSUFCU staff can easily pull up relevant data and prepare to help the member.

Members are enrolled in the system by entering their name and a reference photo, which is stored securely in our system's database. When anyone enters the building, facial recognition compares their face to those stored in our database.

When our system detects a face, the teller receives a notification on their computer. If a member is recognized, the teller then quickly accesses their account information and prepares to assist the member. Conversely, the teller also has the option to ignore the notification if they won't be assisting the member or if the person detected is not an enrolled member. This process enables MSUFCU members to skip the sign-in process and fulfill their banking needs quickly and easily.

Our Logged-In Branch Experience utilizes a front end built with HTML, CSS, and JavaScript with a Python back end. Information is stored and updated using a MySQL database.

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NetJets

Airport Capacity and Ground Space Management

NetJets is the world leader in private aviation, having pioneered the fractional ownership model. Today, NetJets operates the largest and most diverse fleet of private jets, and safety is their top priority.

To serve their owners effectively, NetJets fleet operates in over 3,000 airports to provide a responsive on-demand service. Balancing the capacity levels of each airport is therefore a constant challenge in the quest for a high level of service in the air and on the ground: if an airport starts to near capacity, they must relocate planes to other Fixed Base Operators (FBOs) or airports to accommodate incoming flights.

Currently, NetJets employees must calculate the available ground space of airports and determine the best distribution of their planes with very limited automation. Our Airport Capacity and Ground Management system provides a visual representation of the capacity levels at their busiest airports, as well as provide recommended actions to be taken for optimal fleet management.

The user can select an airport to view by either clicking on the pin for that airport on the map view page, or through text search. Once selected, a satellite view of the parking lot layouts and locations are displayed, as well as information such as traffic overview, incoming flights, and the status of FBOs, which provide parking and plane storage.

The recommendation engine of our system provides the best course of action for the distribution of the fleet currently located at a specific airport. It considers factors such as aircraft size, repairs needed, airport capacity and weather to give recommendations on where to park the planes at that airport, including if they should be moved to a different airport.

The front end of our system is built with React, while the back end utilizes Node.js. The website is hosted on AWS with our data stored using an Amazon Relational Database Service (RDS).
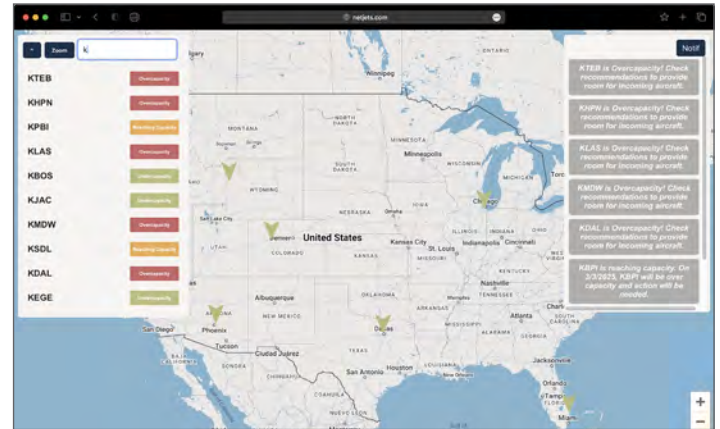
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RPM
# Automated Damage Logging for Truck Drivers

RPM is an international logistics and supply chain company based in Birmingham, Michigan. RPM specializes in freight transportation and vehicle logistics across North America and Europe. As a non-asset-based logistics company, RPM invests heavily in modern technologies and automation solutions.

RPM connects business clients with truck drivers to complete vehicle deliveries. Before transportation, truck drivers must manually log damages on each individual vehicle. This is a time-sensitive process and, when done incorrectly, can lead to costly disputes.

Our Automated Damage Logging for Truck Drivers provides drivers with a mobile app that automatically logs and classifies damages to a vehicle using photos of it. When a driver recognizes damage, they capture a photo of the vehicle and input its model and VIN. Our AI models analyze the images, identify the matching AIAG damage codes, and populate the report with a description of the damage that drivers edit before submitting. This reduces the time and effort needed for the logging process.

Our software also includes a companion web interface through which RPM's operational teams view damage reports, track user metrics, and visualize analytics. The dashboard provides real-time insights into damage trends, vehicle conditions, and reporting frequency, helping RPM optimize operations and reduce disputes. Reports from the mobile app are seamlessly transmitted to the web platform, ensuring efficient logging and retrieval.

Our mobile app is developed using Flutter, while the web interface utilizes React. A FastAPI back end, containerized with Docker and hosted on Azure, ensures scalability. Damage reports and user data are stored in a PostgreSQL database, and TensorFlow Lite enables real-time, on-device damage classification without requiring an internet connection.
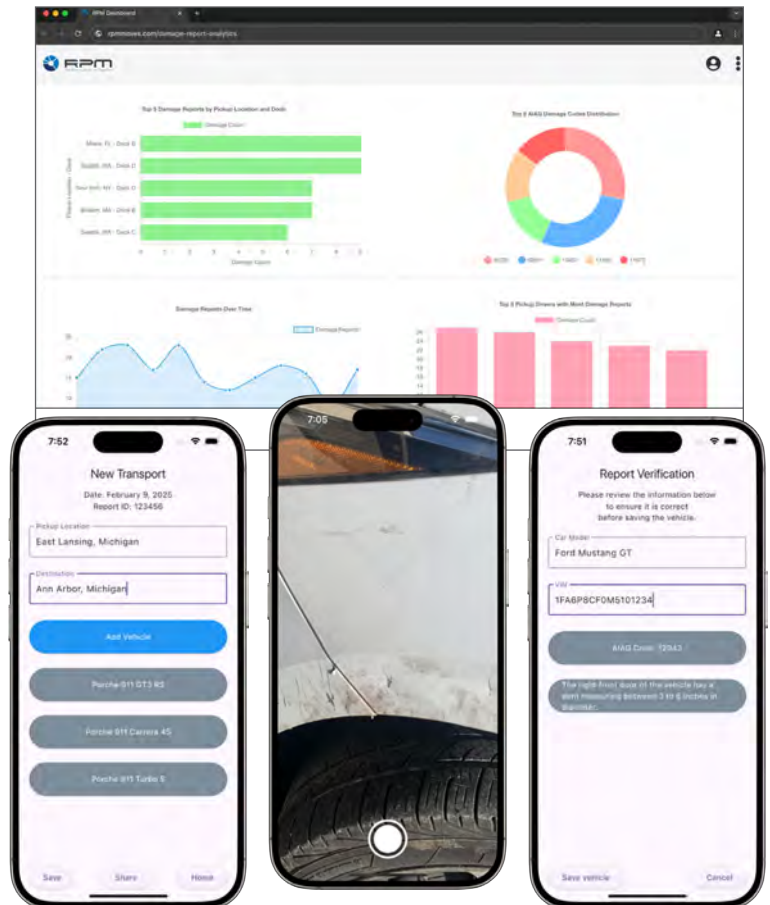
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Stryker
Surgical Needle Tracking

Stryker is a global leader in medical technologies that offers innovative products and services to improve patient and healthcare outcomes.

Every day, millions of medical procedures are performed by surgeons who face the critical issue of retained surgical needles. These small but essential tools sometimes go missing during procedures, leading to severe complications, extended hospital stays, and costly corrective surgeries for the patient. The traditional solution is to perform additional X-rays and time-consuming manual counts, which are far from foolproof.

Our Surgical Needle Tracking system is an iOS app designed to detect, track, and document surgical needles in real-time during an operation to enhance patient safety and streamline surgical workflows.

Hospital administrators use the app to manage essential tasks such as inputting data for surgical procedures, creating user profiles, scheduling surgeries, and accessing valuable analytics.

Meanwhile, the app enables surgeons to focus on performing a successful procedure and worry less about needle logistics. During a scheduled procedure, the operating room staff opens the app to gain access to an intelligent camera system that detects and tracks surgical needles during the procedure. The app holds a count of needles that have been used during the surgery. If a needle goes missing, the system immediately alerts the surgery team with a visual and audio notification, preventing potential harm.

By reducing instances of retained surgical needles, our app enhances patient safety and saves time and money for hospitals worldwide.

Our app is available exclusively on iOS devices. It is developed in Swift and leverages YOLO real-time object detection and API calls to PostgreSQL for database communication.
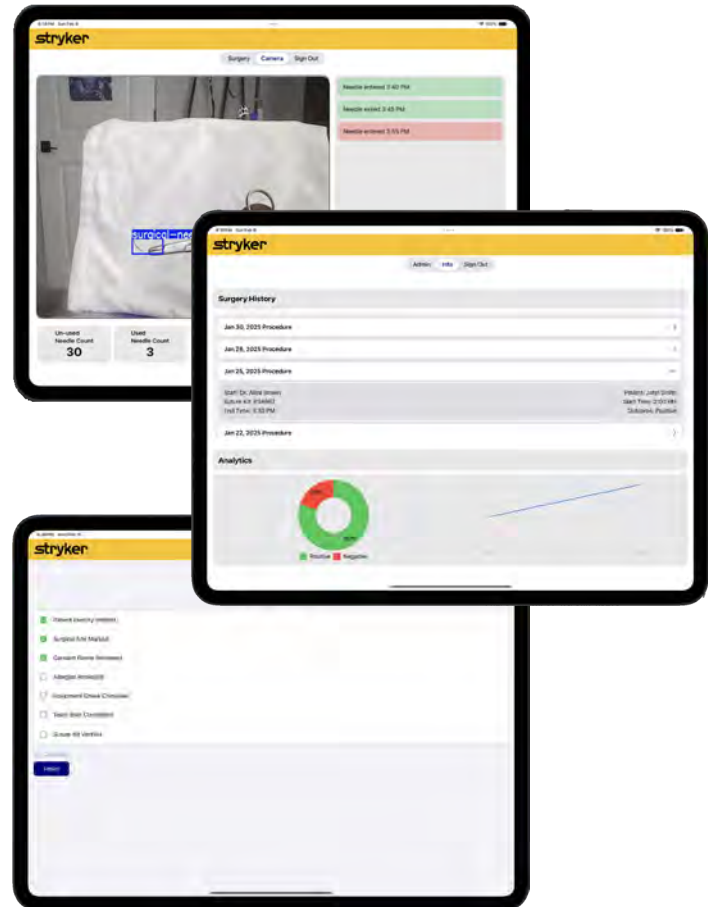
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TechSmith
Watcher of Attuned Video Experiences (WAVE)

TechSmith's mission enables users to communicate and share their message through media capture and editing software. Founded in 1987, based in East Lansing, Michigan, TechSmith's products, notably Snagit and Camtasia, are employed by over 80 million users worldwide and within all Fortune 500 companies.

In the modern day, it is essential that videos cater to individual user's preferences to keep watchers consistently engaged. Unfortunately, on most video platforms, the video shown to the viewers is the final edited version from the creator. The video watcher is unable to express any live feedback as they watch the video and are limited to the small interaction interface underneath the video playback.

Our Watcher of Attuned Video Experiences (WAVE) web application enhances the video watching experience by editing videos according to the viewer's needs.

WAVE gives users a pre video questionnaire to declare their viewing intention. The user's preferences and viewing intention are used to determine which parts of the video the user may want to skip. Skipped sections may be added back later if the user requests additional context. Additionally, a chatbot is available next to the video player to enable users to ask questions or make requests. Over time, WAVE gains more insight into a user's preferences, enabling WAVE to tailor a better viewing experience after every video.

By continuously adapting to the viewer's behavior and feedback, WAVE ensures an increasingly personalized experience. The system not only improves viewer satisfaction but also increases video retention and engagement across diverse audiences.

WAVE consists of a React Typescript front end and a Python Flask back end. The application is hosted on an Azure web server and uses an Azure SQL server and Blob storage. In addition, WAVE leverages Open AI's Whisper, ChatGPT-4o, and FFmpeg.
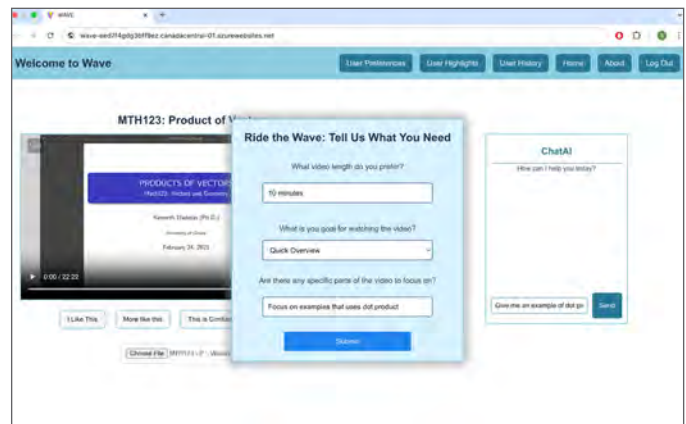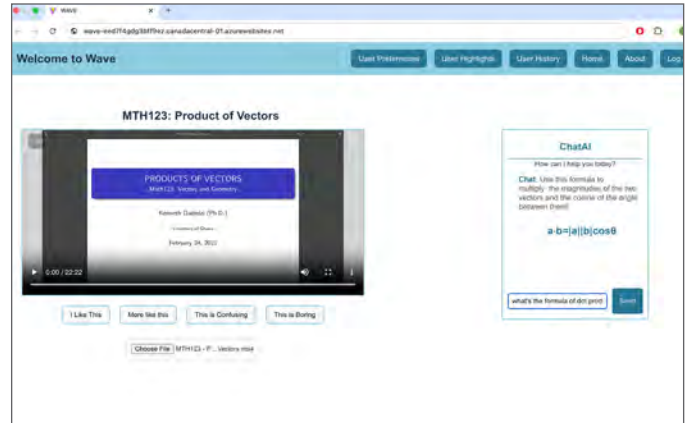
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Union Pacific
Training Simulator Using GPS-Indexed Video

For more than 160 years, Union Pacific has been building America. Union Pacific was founded July 1, 1862, following the signing of the Pacific Railway Act. Today, Union Pacific operates across 23 western states and maintains over 32,000 miles of track, making it one of the largest railroad companies in the country.

To meet the needs of consumers, Union Pacific requires experienced and knowledgeable engineers to operate the locomotives, however, training engineers on an expanding territory is difficult. The current digital training simulation requires significant time and resources to maintain and update. An expandable solution to train engineers on operating a locomotive in a variety of scenarios is desirable for Union Pacific.

Our Training Simulator Using GPS-Indexed Video trains locomotive engineers in an expansive and realistic simulation by using real-world video. Building on top of an existing training simulator, our software plays video footage from the current track according to GPS-indexed data. Engineers operate the simulation as if it is a real locomotive, improving the training experience.

Our software reads the latitude and longitude data from the training simulation and plays the real-world video from those coordinates. The video player dynamically renders the real-world footage and adjusts the video speed to match the speed of the train in the simulation. With this, the user can reverse, accelerate, decelerate, and navigate between different scenarios.

Our software adds additional 3D objects, such as weather, lights, signage, and switches, on top of the video to create an immersive and accurate training experience.

Our system uses Unity as the front-end platform for video display, with C# scripts handling the core logic and functionality. The application programming interface is built using a .NET Core and C# to efficiently receive and process data from the back end.
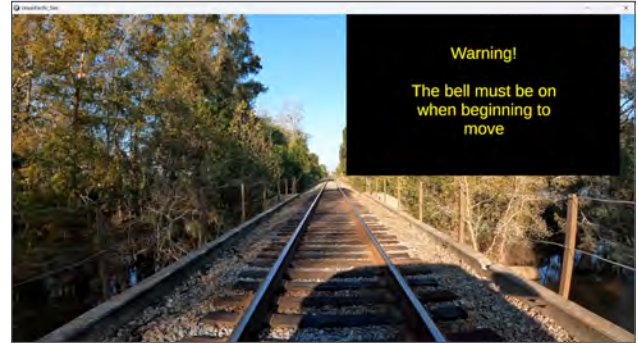
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Urban Science
Automotive Service Advisor AI Assistant

Urban Science is a leading global data-driven consulting firm based in Detroit, Michigan, specializing in providing insights and solutions for the automotive industry. Founded in 1977, the company has leveraged data and business science to help clients increase market share, improve profitability, and enhance customer satisfaction.

Due to technical knowledge gaps and varying levels of sales expertise, service advisors often face challenges when trying to connect with customers. This disconnect can result in missed sales opportunities, inconsistent service recommendations, and an unpleasant customer experience. With recent advancements in artificial intelligence (AI), Urban Science can create innovative solutions that enhance customer interactions and drive business growth.

The Automotive Service Advisor AI Assistant is a mobile application that closes the experience gap between advisors. Our tool identifies and recommends services to customers, while delivering clear and insightful sales strategies to dealerships based on individual customer personalities.

Our software captures a vehicle's identification number and mileage, immediately displaying the customer's information and service history, along with key relevant insights.

Our system then crafts a personalized sales strategy for the advisor informed by the customer's past visits and generates service recommendations tailored to their current vehicle's mileage.

Utilizing our recommendation software and generated media, dealerships easily extract insights, resulting in a refined and optimized sales experience.

Our application is built with C# featuring a .NET MAUI front end and a .NET Core web API back end. Azure AI Services, along with Synthesia, are used to generate personalized media.
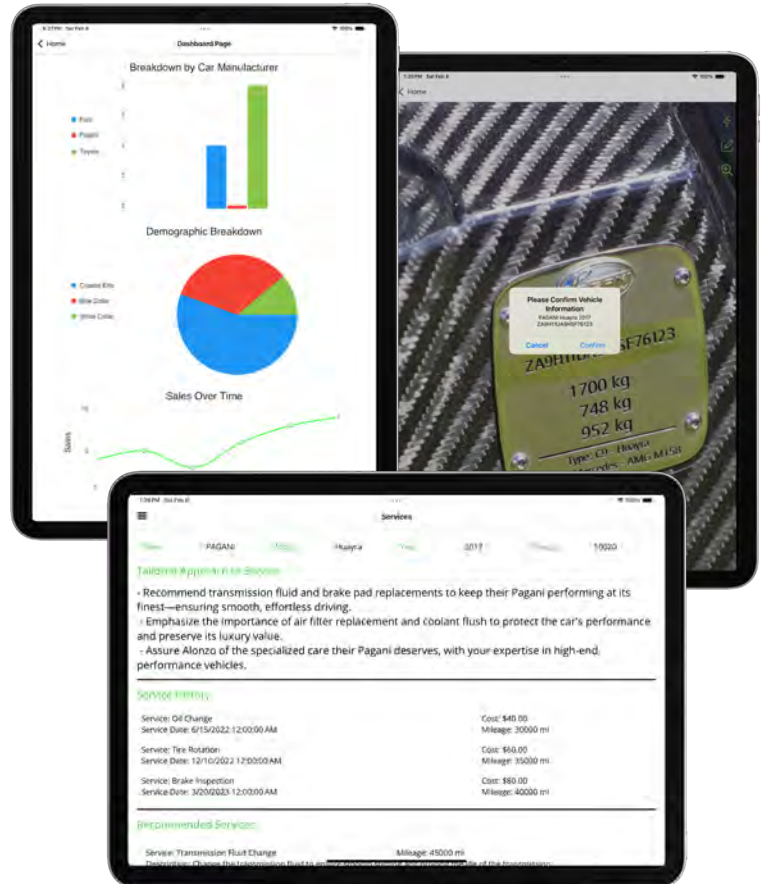
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UWM
Centralized Comment History Microservice

Headquartered in Pontiac, Michigan, United Wholesale Mortgage provides mortgage products and services to mortgage brokers all over the country. They are the nation's largest wholesale mortgage broker due to their innovation, efficiency and commitment to excellence.

Because of the scale of their operations and the number of brokers they cater to, UWM houses a vast amount of data. Finding pertinent transaction information, like comments, becomes tiresome and cumbersome, as they must sift through all other relevant data to find just the comment history.

Our Centralized Comment History Microservice fixes this issue by hosting all transaction comments on a separate database, which enables a faster and more streamlined retrieval.

Users filter the comment history they want to find by specifying relevant information pertaining to the transaction, whether it is the loan number, the client or employee name, or the date.

Once the history is found, our software quickly shows the user the comments of that transaction, alongside the time of that comment and who wrote it. Comments are sorted in newest or oldest order. Users can also see edit histories of the comments.

Finally, relevant employee data pertaining to the transaction, including the name of the commenter, is seamlessly shown accompanying the comments.

Our system aggregates comment data into a single platform, speeding up transaction review and increasing productivity.

Our microservice is written in C#, using React as our front end and SQL to contain the comment data. We utilize UWM's proprietary architecture and code to write an efficient and comprehensive software. We also use ASP.NET Core to connect the UI to the database.
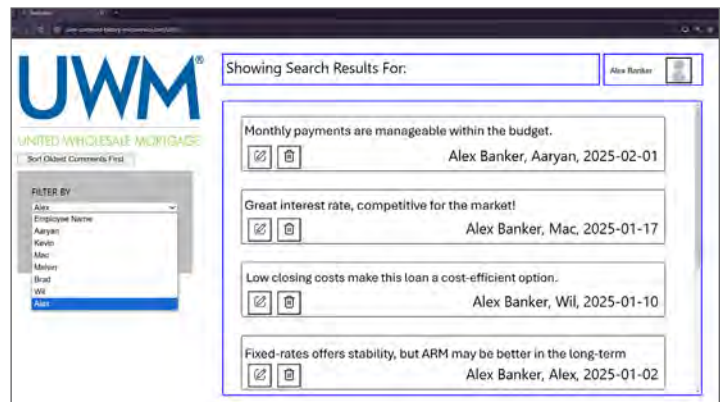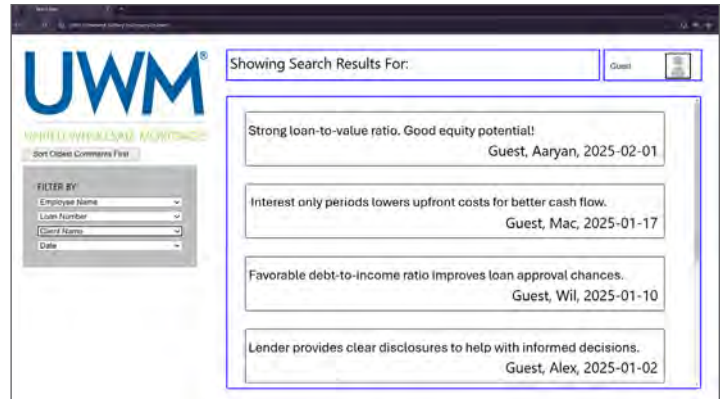
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Volkswagen Group of America
Safe Journey AI 2.0

The Volkswagen Group of America is the North American subsidiary of the Volkswagen Group based in Wolfsburg, Germany. They are a global leader in automobile manufacturing and employ more than 10,000 people across the United States, distributing vehicles through a 1,000-dealer network.

Nearly everyone uses a variation of maps to navigate from their starting point to their destination. However, many maps overlook the importance of customer safety. Therefore, users need a reliable, safe method to plot them a route that is not only fast, but safe.

Our Safe Journey AI 2.0 provides users with the fastest and safest route to their destination, considering a route's unique safety rating and real-time alerts on weather, crime, and other hazardous events that may fall on their path as they drive to their destination.

Our software doesn't just stop monitoring user safety when they leave their vehicle. Safe Walk is a feature that tracks the user from the moment they leave their vehicle until they reach their final destination. If the user takes longer than estimated or diverges onto the wrong path, a registered emergency contact is alerted, notifying them that the user may be in danger and providing them the location of the user and their vehicle.

Our system integrates into Android Auto, improving the user's safety by keeping them off their phones and streamlining their driving experience. Our program provides coverage over the entire state of Michigan, enabling reliable route planning for users. By using Safe Journey AI 2.0, users easily navigate faster and safer than ever before.

Our software is an Android Application written in Kotlin, leveraging the Mapbox SDK for navigation. Our back end is developed with FastAPI and Python, utilizing Scikit-Learn for our machine learning implementation and Firebase for data storage.
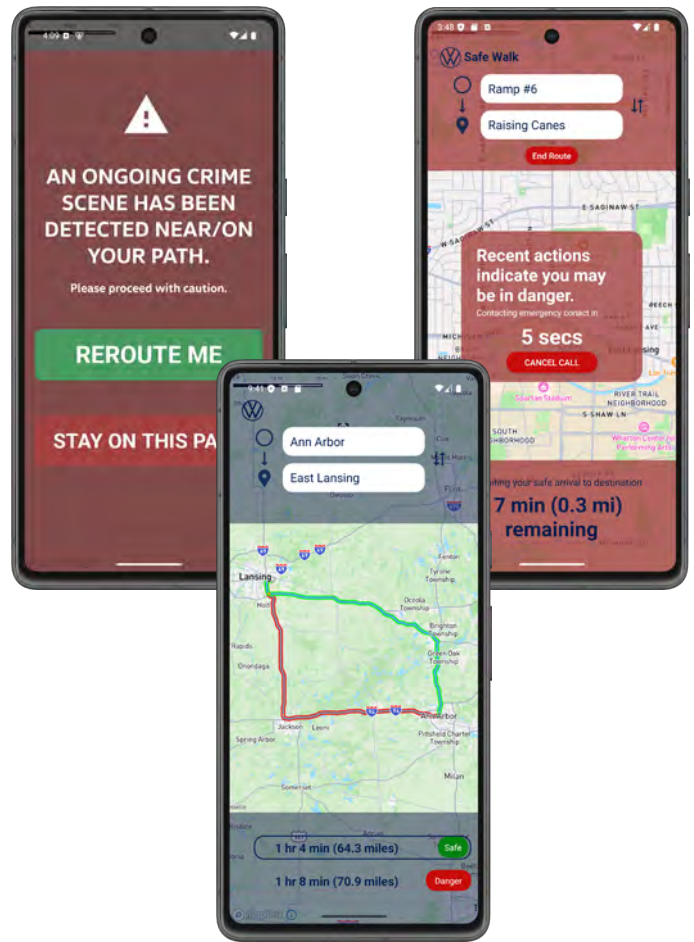
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Whirlpool Corporation
AI-Powered Precision Cooking with TasteLogic

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is a global home appliance manufacturer with approximately $17 billion in annual sales, 40 manufacturing and research centers, and 44,000 employees. Whirlpool's mission is to improve satisfaction and engagement with their home appliances.

Kitchen appliances have evolved notably over the last decade. With appliances having new features, and many food options to choose from when cooking, it can be overwhelming for individuals to determine the best way to cook their food. It requires previous knowledge, trial and error, or expansive time spent on research.

Our AI-Powdered Precision Cooking with TasteLogic curates a more enjoyable user experience with Whirlpool appliances by utilizing an on-product system and a mobile app that simplifies the cooking process when using an oven.

Users begin the process by using the mobile app to identify the food they intend to cook. This is done through a manual search, verbal speech or camera detection by taking a picture of the food.

From there, the software analyzes and suggests cooking settings for the food based on attributes that the user has approved in the past. If the user does not have previous history with the current food item, the system enables them to choose their desired cooking settings based on food type specific attributes. These attributes may include browning, texture and crispiness. After cooking, the user then provides feedback to the system based on the settings used. From this feedback, the system learns and suggests the desired settings for that food in the future.

Our mobile application is built with Dart to provide a modern and simple user interface. The application is supported by a Firebase server, with API calls facilitated by OpenAI. Flutter framework is utilized to connect the front end to the back end. The oven interface utilizes Java.
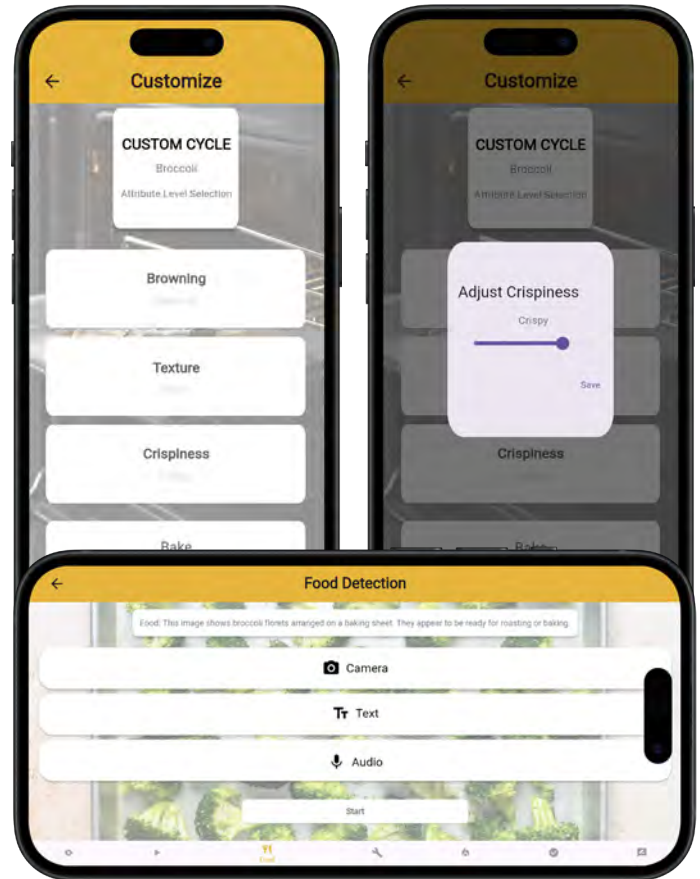
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WK Kellogg Co
Intelligent Ticketing and Release Management

WK Kellogg Co, one of the world's leading food companies, is renowned for its iconic breakfast cereals. Based in Battle Creek, Michigan, the company has expanded its presence worldwide, delivering unfaltering quality and sustainability for over 100 years.

When a WK Kellogg Co employee requires technical support, they create an incident report through a third-party service desk web application. Each incident report needs to be manually processed by a member of WK Kellogg Co's IT team to determine the relative priority and proper responding team.

The WK Kellogg Co enterprise architecture team is responsible for tracking new releases of third-party software used by the company. It is time-consuming for them to determine whether a given release is relevant to the company's application landscape.

Our Intelligent Ticketing and Release Management system saves valuable developer time by leveraging large language models to automatically determine the priority of an incident report based on its potential impact to the business and route the report to the proper responding team.

The system also routinely checks vendor websites for updates and summarizes important changes that might affect the company's application landscape. Our web application serves as a portal for WK Kellogg Co employees to open new incident reports and enables members of WK Kellogg Co's IT team to audit the company's extensive incident report history.

Our software expedites the incident report ingestion and release note analysis processes automatically, saving time and keeping WK Kellogg Co's technologies up to date.

Our system uses Amazon Web Services to improve the sustainability of the technology footprint at WK Kellogg Co. Our web application is built using React and Tailwind for the front end and Node.js for the back end.
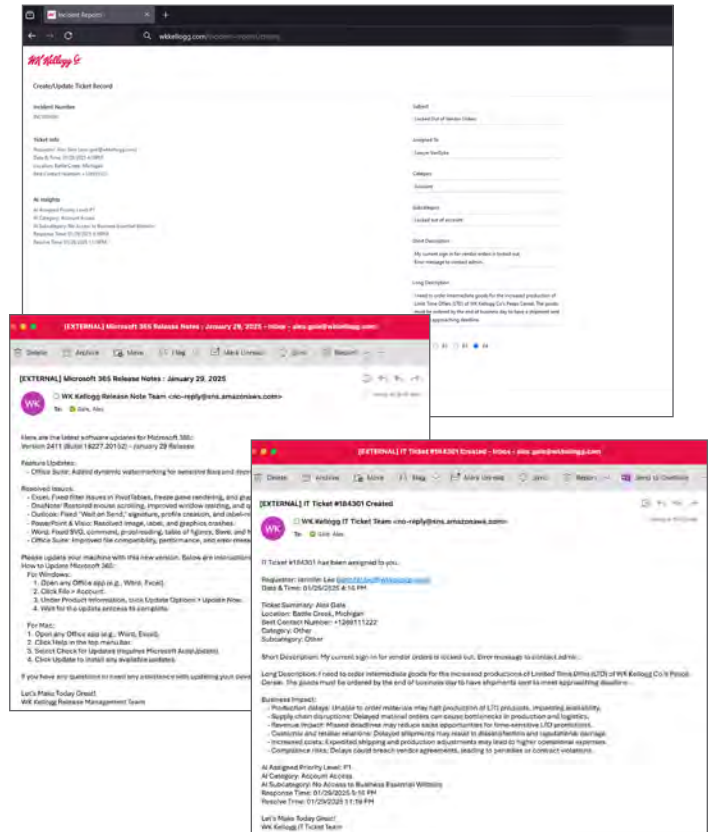
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Design Day Awards

CSE 498, Collaborative Design, is the senior capstone course for students majoring in computer science. Teams of students design, develop and deliver a significant software system for corporate clients. The CSE capstone teams compete for four prestigious awards. Here are the winners from the fall of 2024.

Auto-Owners Insurance Exposition Award

CSE 498 capstone teams present their projects on Design Day in a variety of ways. Teams create and set up an exhibit where they demonstrate their software systems and answer questions from Design Day attendees including the Design Day judges.

The CSE capstone team with the best overall Design Day performance is honored with the Auto-Owners Exposition Award, which is sponsored by Auto-Owners Insurance Company of Lansing, Michigan.

Team Vectra AI
AI Cyberattack Early Warning System

Alex Fortsch, Ajay Kumar, Jacob Sock
Morghane McAnelly, Graham Holley, Aleksa Popovic
Presented by Brad Shafer and Ross Hacker of Auto-Owners

MSU Federal Credit Union Praxis Award

One of the hallmarks of CSE 498 capstone projects is that of praxis, the process of putting theoretical knowledge into practice. Teams apply a wide variety of information technologies to produce solutions to complex problems in areas such as business, engineering, computing, and science.

The CSE capstone team that engineers the software system that is the most technically challenging is recognized with the MSU Federal Credit Union Praxis Award, which is sponsored by MSU Federal Credit Union of East Lansing, Michigan.

Team Launch
Spatial IoT Control using Apple Vision Pro

Jacob Hakala, James Ashworth, Noah Wolf
Ethan Egger, Nathan Motzny, Sanaye Lewis
Presented by Ben Maxim of MSU Federal Credit Union

While each of the awards has a principal focus, every winning team is required to deliver a comprehensive software system, and to demonstrate outstanding communication skills by presenting, demonstrating and defending their work.

TechSmith Screencast Award

Each CSE 498 capstone team produces a video that describes and demonstrates their software product. Starting with a storyboard and a script, teams use Camtasia Studio to synthesize screen recordings, video, audio and other multimedia to produce their project videos.

And the TechSmith Screencast Award goes to... the CSE capstone team with the best project video. The award is sponsored by the creators of Camtasia Studio, TechSmith of East Lansing, Michigan.

Team Kohl's
Governance of Expense in Kohl's Cloud Operations

David Lingan, Jason Lin, Samay Achar
Meredith Heberling, Aiden Dixon, Adhyan Negi
Presented by Wendy Hamilton of TechSmith

Amazon Sigma Award

The CSE 498 experience represents the capstone of the educational career of each computer science major. An intense semester of teamwork produces impressive deliverables that include a formal technical specification, software, documentation, user manuals, a video, a team web site, and Design Day participation. The resulting sum, the capstone experience, is much greater than the parts.

The capstone team that delivers the best overall capstone experience is recognized with the Amazon Sigma Award, which is sponsored by Amazon of Seattle, Washington and Detroit, Michigan.

Team Meijer
Increasing Awareness of Meijer Branded Products

Ishi Saripalle, Sonia Thalatoti, Robby Dewar
Mackenzi Steinmetz, Viraj Shah
Presented by E.J. Dyksen of Amazon