Computer Science and Engineering

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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, Dow Chemical, General Motors, Google, HAP, Henry Ford Innovations, Kohl's, Launch, Magna, Meijer, Microsoft, Mozilla, MSU Federal Credit Union, Roosevelt Innovations, RPM, Stryker, TechSmith, Union Pacific, United Airlines, Urban Science, Vectra AI, Volkswagen, Whirlpool, and WK Kellogg Co.

AbbVie
Image Analysis Tool for Biphasic Solutions

Headquartered in North Chicago, Illinois, AbbVie is a Fortune 500 biopharmaceutical company dedicated to advancing healthcare through innovative research and the development of lifesaving treatments.

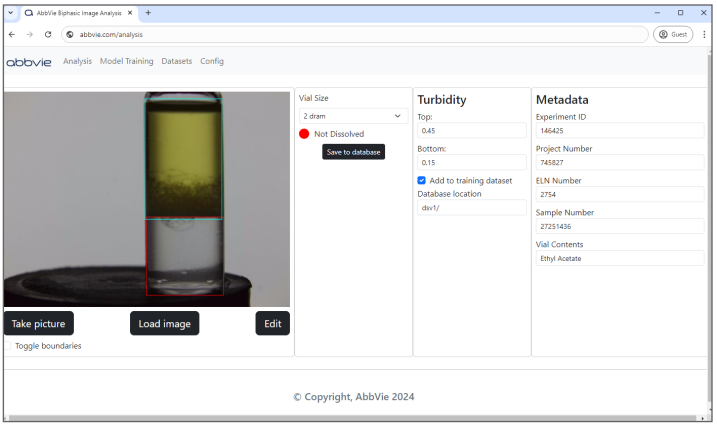
AbbVie researchers often work with special liquids that separate into two layers, called biphasic solutions. Measuring properties of biphasic solutions, such as phase boundaries (where two layers meet) and how layers are blended, is a manual process that limits high-throughput experimentation. The time this process takes inhibits AbbVie's mission of providing quality healthcare.

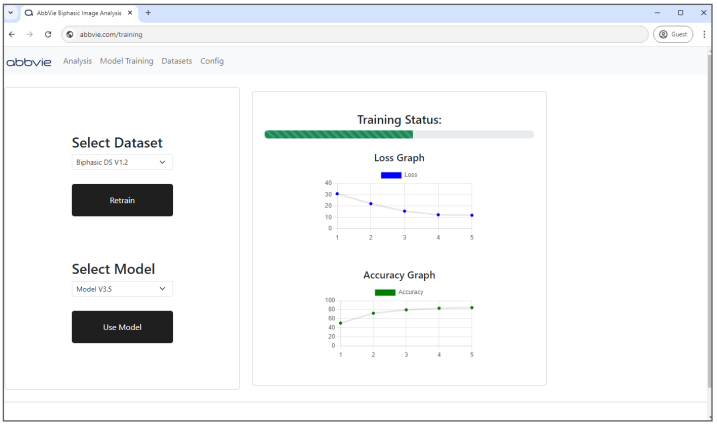
Our Image Analysis Tool automates this process by using a deep learning model to acquire metrics from images of biphasic solutions that AbbVie's chemists need to make critical decisions. First, a robotic arm positions each vial for the camera, capturing high-resolution images which are then processed by the model. Solution properties are located and displayed to the user for quick and accurate insights into the composition of the biphasic solution. Chemists save the image with its associated information, such as sample number or the chemicals used.

Our software also includes a model training feature, enabling researchers to adapt the model to specific chemicals and environments. This ensures that the model is as robust as possible, leading to the most precise and realistic results.

To support the model training feature, the application also supports the saving of images to a database. This enables users to create new datasets that can be used to train models. It also enables users to revert the software to use previous versions of the model depending on the current use scenario.

Flask, a Python webserver, constructs the back-end interface which applies the model to the acquired data. The front-end framework, Angular, enables users to view model results with ease.





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Ally Financial
Agentic Collaborator

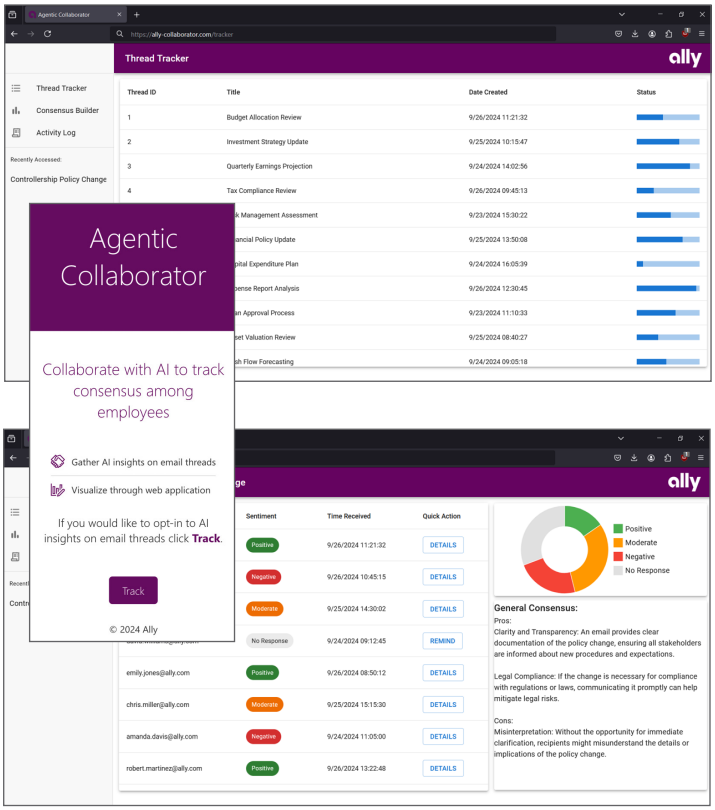
Ally Financial, headquartered in Detroit, Michigan is a leading entity in the U.S. financial services industry, known for its focus on digital banking and auto financing. The company serves approximately 11 million customers through a full range of online banking services. Being the nation's largest online-only bank, Ally is at the forefront of revolutionizing financial interactions through technology.

Ally Financial employees handle hundreds of emails daily using Microsoft Outlook, but large threads with multiple collaborators make it difficult to track employee sentiment. The process of analyzing email responses is time-consuming, as employees must sift through large email chains to ensure nothing is overlooked. Hence, there is a growing need for technological solutions that can streamline this process, saving employees time and energy.

Our Agentic Collaborator is an artificial intelligence-powered solution created to enhance sentiment analysis and improve decision-making for Ally projects. The collaborator enables employees to monitor multiple decisions simultaneously, providing an overview of stakeholder responses in an easy-to-read dashboard.

Ally internal users are provided with an Outlook widget to flag email chains for monitoring. A summary of the thread responses is displayed on the web application where users can track the sentiment of email chains and who has responded. Quick actions, such as sending reminders to non-responsive stakeholders and opening email instances, make it easier to track project progress.

Our software utilizes a Microsoft Outlook add-in and a web application to deliver a powerful email analysis tool. The back end is built with Python, PostgreSQL, LangChain, and the OpenAI API for parsing and summarizing emails. The front end is developed using React, supported by a Node.js environment. Python Flask is used to handle data exchange between endpoints.



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Amazon

Remediating AWS Security Gaps Using Generative AI

Amazon is a multinational technology company that has grown to become the world's largest retailer. Founded in 1994 by Jeff Bezos, Amazon has since expanded into various industries, including cloud computing, digital streaming and artificial intelligence.

As more users continue to use Amazon Web Services (AWS), they encounter challenges in configuring and monitoring their account's security. Due to the platform's complexity and broad range of services, it is imperative that users acquire a deep understanding of Amazon's security features.

Currently, when an AWS user reviews their account security, they run a security scanning tool named Prowler. This tool generates a file with thousands of lines detailing security assessments they have passed or failed. Many users find this file difficult to understand.

Our Remediating AWS Security Gaps Using Generative AI tool streamlines the process of identifying, tracking, and fixing security issues through our interactive web application.

To use our application, users simply upload their file generated from Prowler. When users upload this report, machine learning models trained on hundreds of AWS security blogs and documentation generate easy-to-understand instructions. These instructions can be sorted by factors such as cost or danger so users can prioritize their vulnerabilities. Users also are given a security rating that provides the percentage of security vulnerabilities they have secured.

By leveraging these powerful AWS services, our tool provides users with an efficient, intuitive, and easy way to enhance their account security, ensuring peace of mind as they navigate the cloud.

Our web application is responsive due to a robust set of features provided by AWS. The front end is hosted on AWS Amplify, whilst back-end requests are managed by API Gateway, Lambda and S3.

amazon

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Anthropocene Institute
Ocean Carbon Pollution Cleanup

The Anthropocene Institute is an organization based in California, whose goal is to solve the climate crisis by 2030. They promote education about the climate, connect experts with entrepreneurs and policymakers, and invest in technologies to make the Earth abundant and sustainable for future generations.

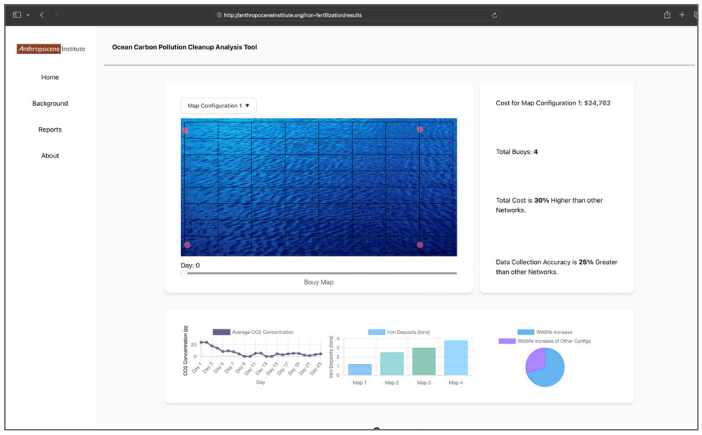
Removing excess carbon dioxide from the atmosphere is a crucial part of solving the climate crisis. Consequently, our client is partnering with the Grandparents Fund for Climate Restoration to design an ocean iron fertilization experiment. The experiment involves dispersing iron in the water to stimulate phytoplankton growth which sequesters carbon. Plankton growth is monitored by sensors mounted on ocean buoys. Usage of these sensors can be very expensive, so it is imperative that sensor locations are optimized to provide maximum ocean coverage with minimal cost.

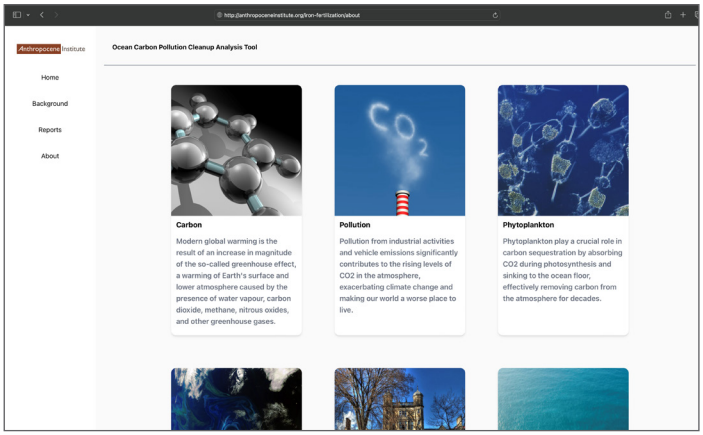
Our Ocean Carbon Pollution Cleanup software models various buoy configurations to compare their effectiveness. Our software gives suggestions about how many sensors are required and which sensor layouts are best for recording adequate data during the experiment without going over budget.

Most existing datasets only contain a single buoy, which poses a problem for our system. To model multiple buoys from this data, older compatible datasets are combined and newer datasets are extrapolated using complex statistical methods to get estimated sensor readings for the entire experimental area.

Our software highlights the benefits of this carbon sequestration technique by visualizing the positive experimental outcomes.

The software features an appealing user interface built with the React framework. It connects to a FastAPI back end that retrieves data from a PostgreSQL database. This data is used to generate buoy configurations and create descriptive visualizations using Chart.js.





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Auto-Owners Insurance
From the Ground Up VR

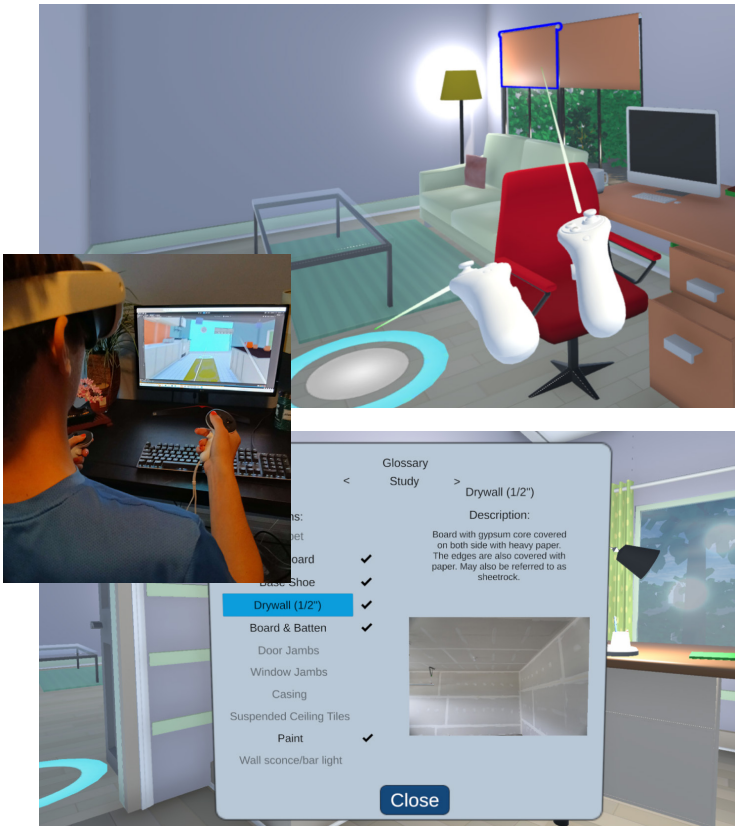
Auto-Owners Insurance is a Fortune 500 company that provides automotive, home, life, and commercial insurance to nearly 3 million policyholders in 26 states. They have been headquartered in Lansing, Michigan since 1917, and are represented by 48,000 licensed agents.

In the insurance world, training new associates is a process that can take a lot of time and manpower. There are many details about insurance that are important for employees to know. Traditional training practices are informative but lack hands-on experience and can be unengaging.

From the Ground Up VR provides an enhanced training experience through a virtual reality video game, creating a new way for property claims associates to learn and engage with Auto-Owners' policy. This software accelerates and personalizes the training process by enabling associates to navigate educational content at their own pace without the need for a human teacher.

Our software places users into a realistic virtual reality house. Associates navigate through the home and are tasked with discovering and identifying common building materials that are integrated into the environment. As the user finds items, information about relevant Auto-Owners insurance policies is displayed. After materials are collected, the game then asks the associate to use those materials to construct a home. Through these objectives, associates experience the process of building a home while also learning the basics of insurance, resulting in an informed and well-rounded employee.

The Unity game engine is used to model and represent the virtual environment. The game logic is implemented in C#, providing functionality and interactivity. The Meta Quest 3 VR headset is used by the player to access the virtual reality environment.



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DRIVEN-4

DRIVEN-4 Connect Application

DRIVEN-4 is a technology consulting firm based out of St. Joseph, Michigan. The firm's network of over 100 engineers and global partners drive solutions that have delivered over $50 million in business impact since 2017. Primary service offerings include product lifecycle management (PLM), connected product development (IoT), connected operations (IIoT) and cybersecurity.

The company's latest innovation, a programmable logic controller (PLC) known as the DRIVEN-4 Connect Module, enables customers to create customizable data streams. However, this data can take several forms, presenting a challenge as DRIVEN-4 strives to provide comprehensive services to all client needs.

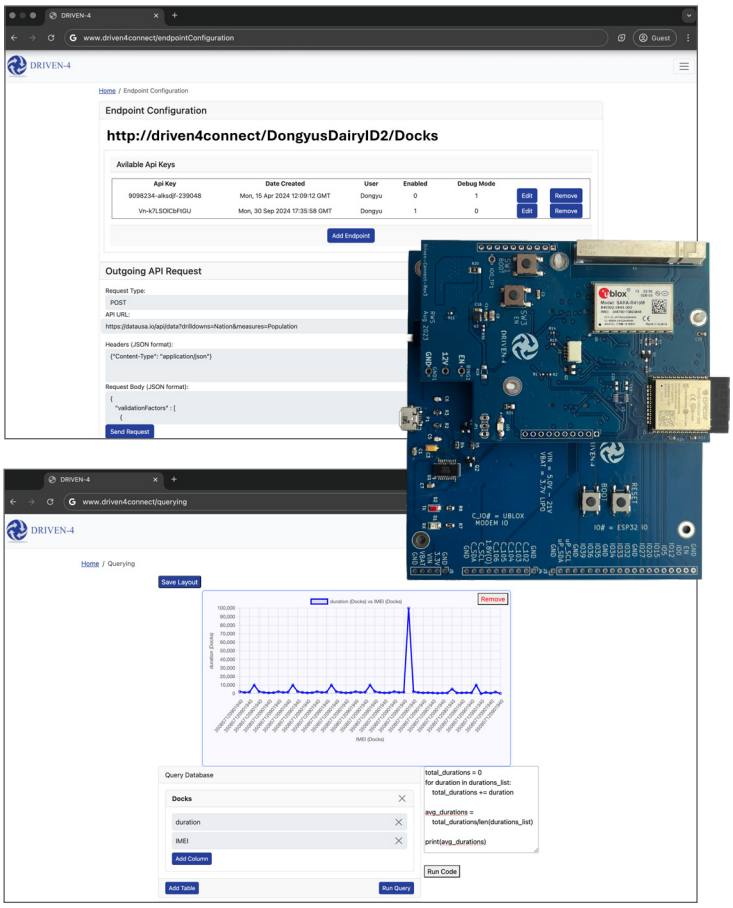
Our DRIVEN-4 Connect Application enables users to interact with their data streams from the Connect Module in a fast and easy manner. Users can manipulate data workflows and automate trivial processing stages for data analysis with only a few clicks.

Users first establish data storage capabilities by creating and editing project specifications on the web application's data modifications tab. This creates a custom database for the user.

Once a database is created, the system automatically transmits the relevant data to the database to be stored for further use.

Clients query, relay, manipulate, visualize and derive insights from collected data. The data analysis and querying pages of the Connect Application display all available databases and associated tables. Clients select desired data sources and create custom scripted instructions on how to analyze relevant information. DRIVEN-4 also provides common scripts to make client data analysis easy, along with tutorial resources to ease onboarding.

The DRIVEN-4 Connect Application is powered by the Flask framework. Data is hosted in a MySQL database and accessed via SQLAlchemy. The analysis is conducted using Python scripts.



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General Motors
Recycling Identification System

General Motors (GM) is a multinational car manufacturer headquartered in Detroit, Michigan. They are at the forefront of innovation when it comes to car manufacturing as well as being industry leaders in sustainability.

To recycle plastics in their facilities, GM must identify what type of plastic has been discarded. While this can be easier for standardized plastics used in the production line, miscellaneous plastics that are not as easily identifiable are often thrown away. GM requires a quick way to identify these miscellaneous plastics.

Our Recycling Identification System provides an improved method for managing plastics and reducing waste by ensuring accurate identification, preventing improper disposal.

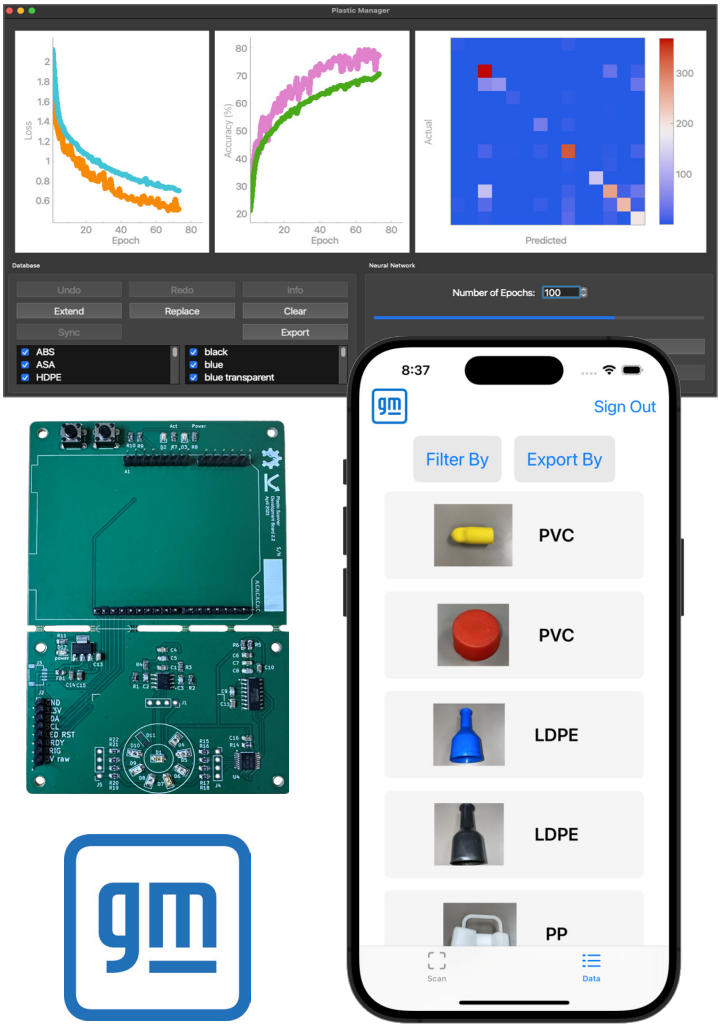
When an unidentified plastic is encountered, the plastic scanner swiftly identifies the material by scanning it and displaying the result on a connected smartphone.

Once the plastic is confirmed, the user places it in the appropriate bin. Additionally, the app tracks all previously scanned plastics, providing a convenient reference to the correct recycling bins.

Admins can train the model further whenever new plastic types are introduced in the facilities. This ensures accuracy is maintained when an employee is scanning unknown plastics in the bins. Composite plastics are supported seamlessly and automatically with our robust model.

Our system quickly and accurately identifies plastics for efficient recycling, reducing waste and carbon footprint.

Our Recycling Identification System is built with a handheld scanner integrated with an Arduino microcontroller. The scanner utilizes a feed-forward neural network, and the mobile app, developed using React Native, uses a SQL database to save and display the plastic data.



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General Motors
Remote Wildlife Habitat Monitoring System

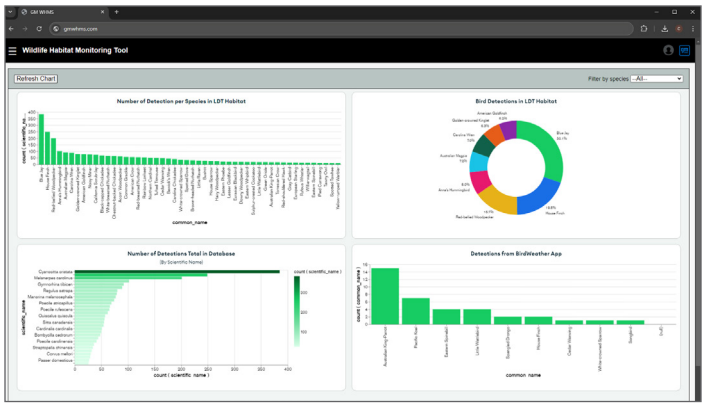
General Motors (GM) is a leading automotive company headquartered in Detroit, Michigan. GM produces and markets well-known vehicle brands including Buick, Chevrolet, GMC, and Cadillac. With many bold and innovative initiatives, including global carbon neutrality by 2040, GM is dedicated to sustainability and environmental protection for all.

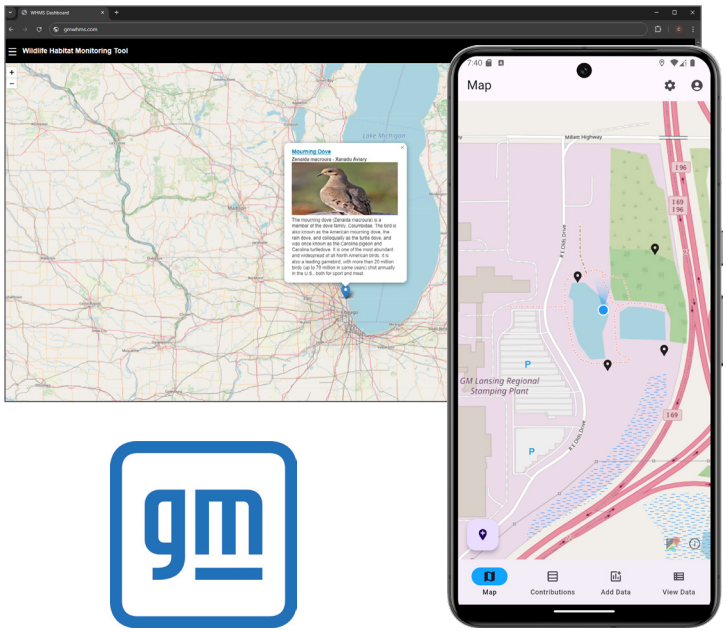
GM has established 17 wildlife habitat facilities across the U.S., each spanning many acres. These habitats serve as sanctuaries for local wildlife, especially species of concern. Monitoring habitats and collecting wildlife data is essential for general analysis and habitat certification but it is very time-consuming for environmental engineers, diverting them from their other duties.

Our Remote Wildlife Habitat Monitoring System enables GM employees to access and analyze wildlife data directly from their computers and mobile devices. The system centralizes existing biodiversity data, automatically collecting real-time data using existing GM monitoring hardware and cloud-based data storage. Data is presented in an easy-to-understand format through graphs and charts for comprehensive analysis.

The system also includes an interactive map where users can record, share, and view wildlife sightings, updating the database in real time. This feature fosters a collaborative approach to habitat monitoring, making it simpler and more efficient for experts and laypeople alike.

The Habitat Monitoring System is comprised of a web application developed using Flask, which leverages Python on the back end and HTML, CSS and JavaScript on the front end. It is also available as a mobile application for both Android and iOS platforms, developed using Flutter for optimal cross-platform performance. MongoDB, hosted on a Linux server, supports the database needs of both the web and mobile applications.





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HAP
Healthcare Payer Price Transparency

HAP is a Detroit-based healthcare insurer that that strives to offer quality healthcare plans and innovation to their customers. With a workforce of more than 1,000 employees, HAP provides insurance solutions for just over 400,000 members across Michigan with 50,000 healthcare provider partners.

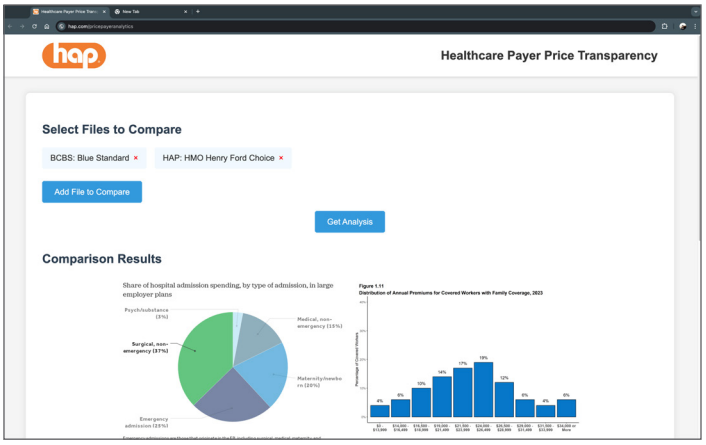
Modern healthcare providers face a competitive field. Since 2021, the Centers for Medicare and Medicaid Services has required healthcare and health insurance companies to publish their rates in standardized, machine-readable files. With this, large amounts of previously unknown data are now being published to the public, which creates a new avenue for data analysis.

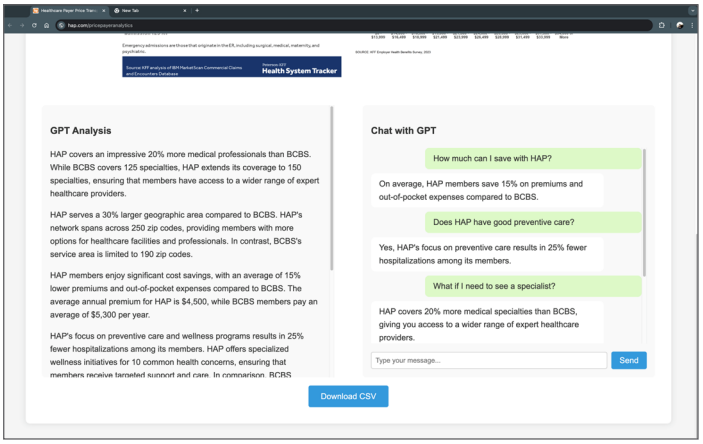
Our Healthcare Payer Price Transparency tool uses these machine-readable files to provide business insights that were previously difficult to assess. The application leverages modern artificial intelligence with big data analysis to draw conclusions about healthcare plans such as plan coverage, covered providers, and costs to both the company and customer.

The Healthcare Payer Price Transparency web application stores files that contain information about healthcare rates from both HAP and external competitors. Users select which files they are interested in analyzing and have the option of uploading new files. The application reads the files and creates data visualizations that make it easy for the user to draw conclusions.

If the user has further questions about the files or data, they can begin a conversation with our AI chatbot that provides quick analysis of anything that interests the user.

The front end of the web application is built using industry standard HTML and CSS. For our back end, we leveraged Parquet files to store large quantities of data in smaller pieces. Python is used to manipulate data to produce insights. ChatGPT API is used for generative artificial intelligence.





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Henry Ford Innovations
Modernizing Robotic Surgery Education

Henry Ford Health is one of the nation's largest and most respected healthcare providers located in Detroit, Michigan. At Henry Ford Health, medical professionals and expert researchers collaborate to develop and adopt new healthcare technologies. The partnership made between Henry Ford Health Innovations and Michigan State University advances medical education and improves patient well-being.

Many modern surgical techniques involve the use of some robotic components. Modern learners have an advantage in robotic operation due to the proliferation of technology in recent years. Modern students achieve high proficiency in robotic operation faster than previous generations, and therefore the training systems for robotic surgery tools need to be updated.

Currently, each completed training run requires a review from an expert-level provider, costing the healthcare system money and costing surgeons time.

Our Modernizing Robotic Surgery Education system reduces how many trials it takes a modern learner to gain expert-level status for each educational task. This reduces training time for learners and saves valuable time for surgeons who review the training.

Using statistical analysis and machine learning technology on robotic surgery training data, our dashboard displays visuals that find the most effective training modules and predict success rates of residents based on metrics collected from the robotic surgery console.

Our system identifies redundancies in the robotic training program, reducing training time and saving money.

Scikit-learn is used to identify the most important metrics that indicate success for surgeons as they complete various training tasks. The dashboard is developed by importing this data into Microsoft PowerBI.

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Henry Ford Innovations

MSU-HFH Research Synergy Vanguard Portal (RSVP)

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 (MSU), HFH bridges the gap between clinical needs and academic expertise across both institutions.

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.

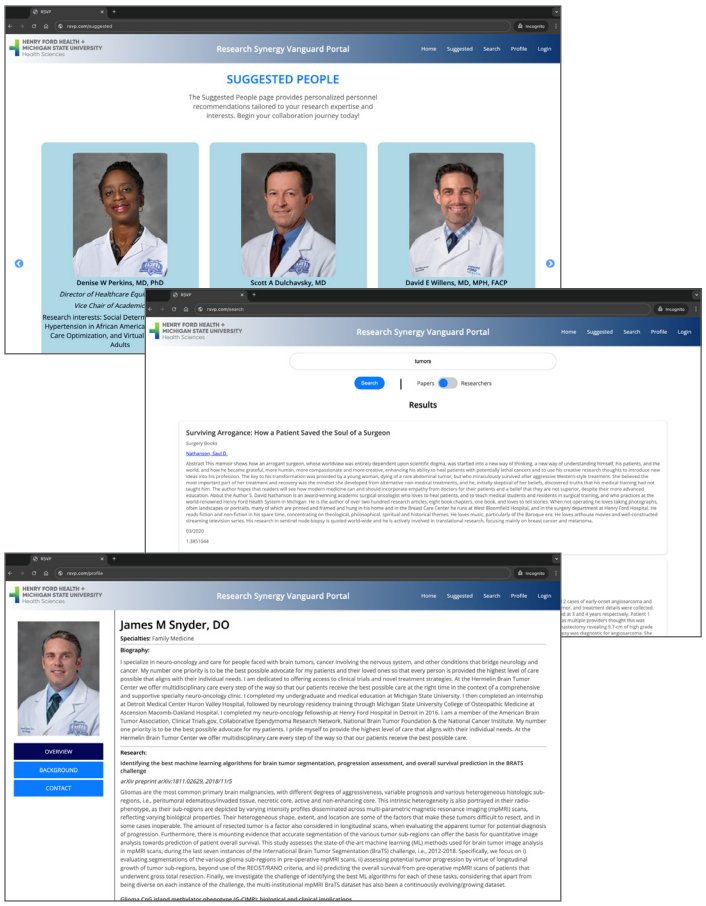
Our Research Synergy Vanguard Portal (RSVP) solves this by providing a platform that automatically suggests potential collaborators. Our system analyzes user expertise and interests to recommend ideal partners, fostering interdisciplinary connections that might not occur otherwise.

Our portal integrates data from HFH and MSU and enables researchers and clinicians at both institutions to find research collaborators with a simple and intuitive keyword search.

With our profiles connection page, users manage their own detailed profiles, highlighting their expertise, interests and the resources that they have available. This facilitates direct communication, enabling users to connect, share ideas, and initiate collaborative projects seamlessly.

Our system connects MSU and HFH researchers and clinicians, improving collaboration and reducing time spent searching.

Our portal is built using a ReactJS front end for a dynamic user interface 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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Kohl's

Governance of Expense in Kohl's Cloud Operations

Kohl's, founded in 1962 by Maxwell Kohl, is a leading omnichannel retailer with over 1,100 stores across 49 states. Offering a wide range of apparel, home goods, and lifestyle products, Kohl's is committed to using cutting-edge technology to enhance customer experiences and optimize its vast operations. As part of this effort, Kohl's leverages the Google Cloud Platform (GCP) to manage over 7,000 cloud-based projects.

Despite GCP's powerful infrastructure, the scale and complexity of Kohl's operations poses challenges in monitoring costs, managing resources, and ensuring overall cloud efficiency. Existing tools are not equipped to handle the high volume and complexity of data, which makes it difficult for Kohl's to gain real-time insights into their cloud performance.

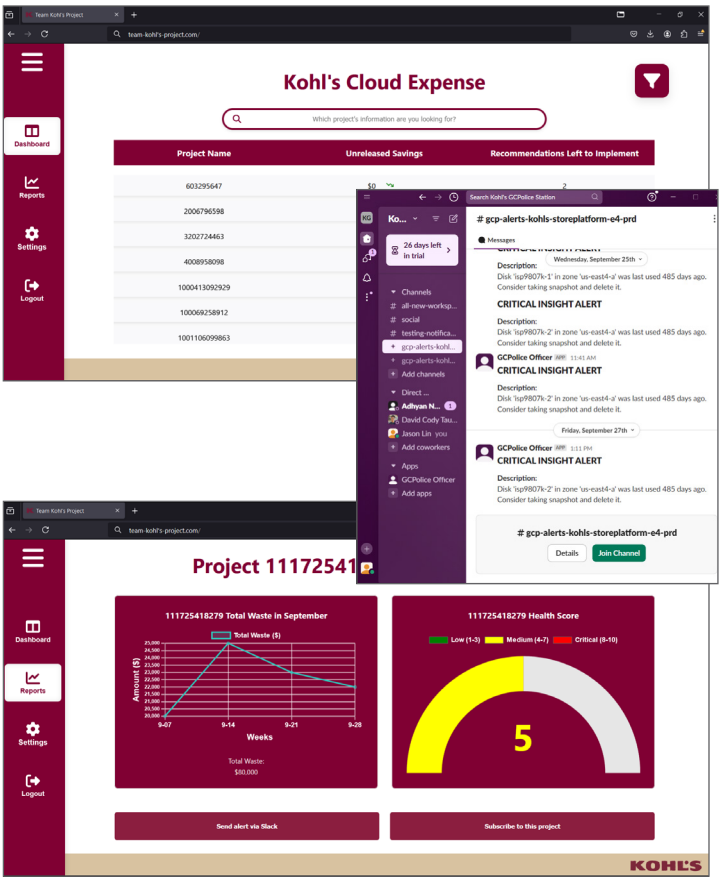
To address these challenges, our Governance of Expense in Kohl's Cloud Operations platform provides real-time monitoring and actionable insights into GCP data.

Our platform provides comprehensive visibility into cloud project expenses, showcasing potential cost-saving opportunities for each. Detailed instructions on how to reduce costs are listed in an easy-to-understand way so users can cut costs effortlessly.

Our software also features visual graphs for historical data, tracking trends in resource usage over time, helping stakeholders identify inefficiencies and optimize cloud operations.

Finally, the platform sends automated alerts to key stakeholders through Slack, helping employees make informed decisions in a timely manner on cost management, resource utilization, and security improvements.

Our system is fully dockerized and hosted on GCP powered by Kubernetes. On the back end, data is pulled from Big Query database and processed through a Python Flask server. This is displayed on the front end via a ReactJS web interface.



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Launch by NTT DATA
Spatial IoT Control using Apple Vision Pro

Launch by NTT Data is a global digital business that helps their clients to strategize, ship and scale digital experiences. They have developed innovative solutions for brands such as Ford, Epic Games, and Adidas.

As virtual and augmented reality technology matures and becomes more usable, virtual experiences continue to have an ever-increasing role in how we go about our daily lives. As a leader in creating innovative digital experiences, Launch explores how new devices like the Apple Vision Pro can be used to enable users to interact with their environment, specifically to control smart devices in their homes.

To this end, our Spatial IoT Control using Apple Vision Pro is a visionOS and iOS application that controls home appliances like plugs, lights and other appliances through a sleek and seamless interface.

Our software recognizes and tracks devices in the user's view. When a device has been identified, a pop-up appears over it that the user can interact with to change the state of the device. For example, when a smart lamp enters the view of the Vision Pro, a toggle switch view is displayed above the lamp, which turns the lamp on and off when selected.

Our software enables actions involving other smart home appliances using various hand gestures recognizable by the Vision Pro, including sliding, pinching, and twisting.

In addition, IoT devices can be controlled via iPhone using our iOS application, which has the same features and functionality as the visionOS app. This provides more flexibility in how users can control their home appliances.

Both applications are written in Swift. Interaction with tracked objects is enabled through the RealityKit and ARKit frameworks, and devices are controlled via HTTP and MQTT protocols.

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Magna

Offline-Ready Mobile App for Delivery Optimization

Magna International is a leading global automotive supplier, focusing on delivering value to their customers through innovative processes and world class manufacturing. Magna New Mobility wing is committed to solving the complex challenges involved in the development of advanced mobility solutions.

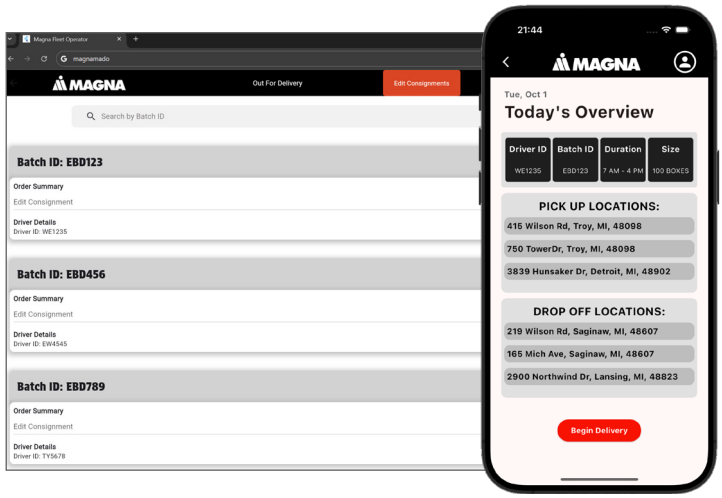
Delivery drivers often face challenges with network connectivity and efficient route planning. This can impact their ability to complete deliveries in a timely manner. Similarly, fleet operators who oversee deliveries need real-time updates into the progress of deliveries to ensure everything runs smoothly.

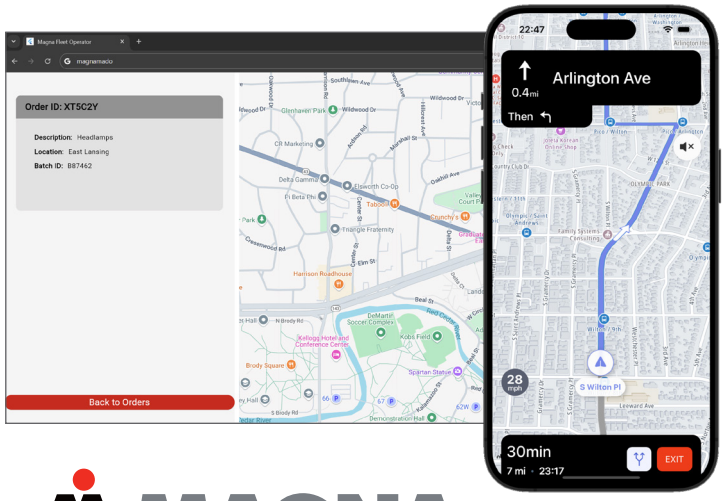
Our Mobile App for Delivery Optimization enhances the efficiency of delivery operations by providing an application that works in areas with poor network connectivity. It optimizes drivers' delivery routes, managing multiple consignments, and tracking their progress in real time. The mobile application leverages artificial intelligence to batch orders based on pickup and drop-off locations, while accommodating for configurable truck sizes.

Our system enables drivers to access the navigation system even if they are not connected to a network, ensuring the delivery process is not hindered by the loss of a network connection.

For fleet operators, the web dashboard provides a comprehensive view of the progress of deliveries. The dashboard displays real-time locations of the drivers and status of each order. This web application offers options for operators to intervene in a delivery if necessary, such as manually editing a consignment.

The front end is implemented in Flutter separately for both mobile and web applications. The back end encompasses route computation using NextBillion.ai and Node.js. Moreover, remote and local data storage is synchronized between both platforms using MongoDB.





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Magna

Test-Driven Development for Embedded Software

Founded in 1957, Magna is a leading global manufacturer in automotive parts, providing innovative products and services to nearly every automaker worldwide. As an industry leader, Magna has significantly advanced vehicle safety and technology through systems such as advanced driver assistance, blind-spot detection, and lane departure warnings.

One of the most innovative areas in the automotive industry today is autonomous driving systems, and Magna is at the forefront of this technology. To ensure the reliability of these systems, it is crucial that vehicles' vision cameras are thoroughly tested.

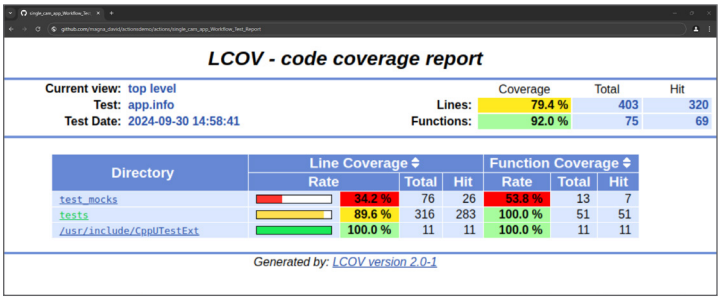
Managing and testing the software behind vision cameras is not an industry standard due to the difficulties of testing hardware dependent code. Regardless, a test-driven approach can avoid critical errors, reduce the time required to diagnose errors, and increase code quality.

Our Test-Driven Development for Embedded Software platform introduces test-driven development to Magna's existing surround view camera system and creates an automated testing process for a continuous integration and development pipeline.

Whenever a Magna employee publishes code to their GitHub repository, our platform runs a series of tests on the published code. Our tests fully probe the code base for any new errors that may have been introduced. This ensures the updates do not negatively impact other parts of the system.

Users are also able to analyze the percentage of the code tested to ensure that the platform has full coverage of the code base.

The test cases are written in the C++ language, using the CppUTest framework. The code is tested automatically whenever a push is made to GitHub, using the workflow automation platform GitHub Actions. Our workflow also uses LCOV and Python scripts to collect and display test metrics.

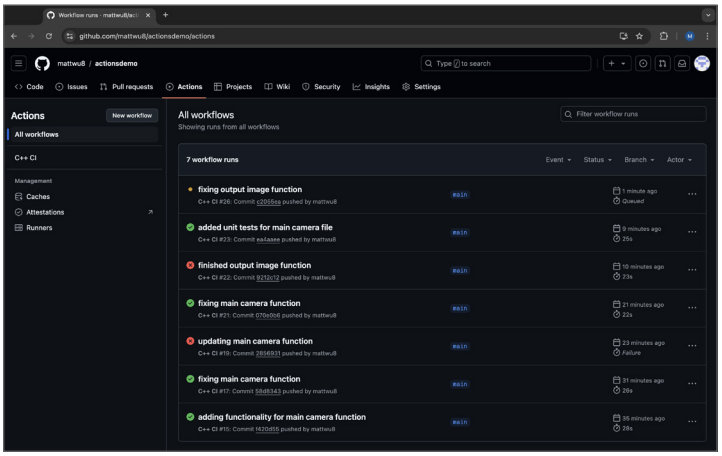


LCOV - code coverage report

			Coverage	Total	Hit
Current view:	top level	Lines:	79.4 %	403	320
Test:	app.info	Functions:	92.0 %	75	69
Test Date:	2024-09-30 14:58:41				

Directory	Line Coverage Rate	Line Coverage Total	Line Coverage Hit	Function Coverage Rate	Function Coverage Total	Function Coverage Hit
test_mocks	34.2 %	76	26	53.8 %	13	7
tests	89.6 %	316	283	100.0 %	51	51
/usr/include/CppUTestExt	100.0 %	11	11	100.0 %	11	11

Generated by: LCOV version 2.0-1



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Magna
Visualizing Neural Network Gradients

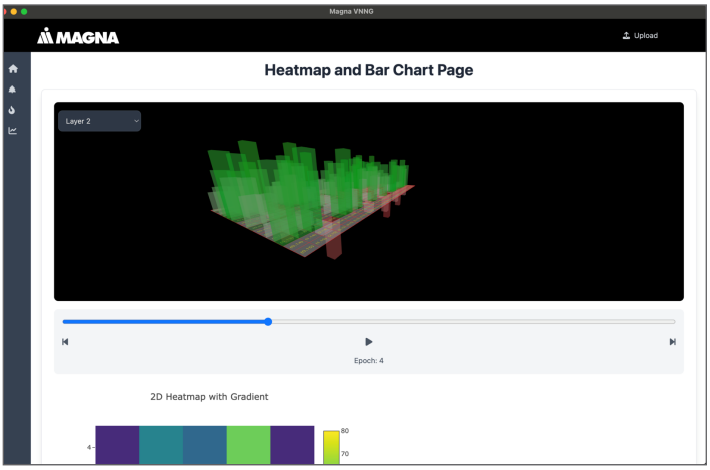
Founded in 1957, Magna has established itself as the largest automotive supplier in North America. With over 60 years of experience supplying components and systems to manufacturers worldwide, Magna is a visionary leader, driving the evolution of the automotive industry.

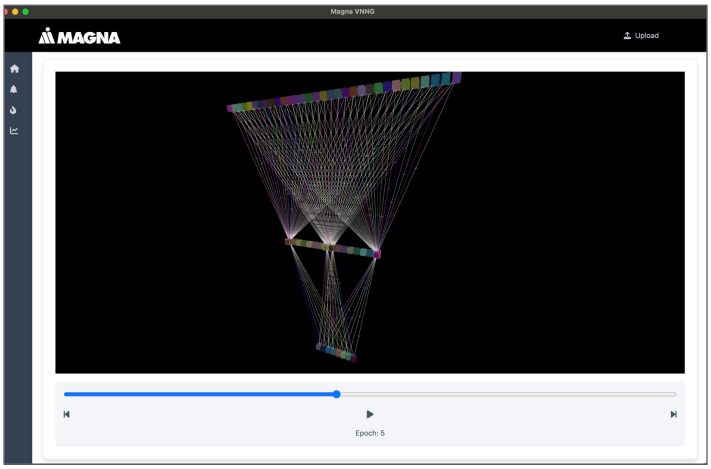
In the ever-evolving world of artificial intelligence, understanding how neural networks learn has been a complex challenge for engineers. Monitoring model performance, diagnosing issues, and optimizing architectures can be a daunting task, especially when working with large-scale networks.

Our Visualizing Neural Network Gradients software solves this problem for Magna, offering an innovative two-part solution: a logger, and a visualization tool. The logger seamlessly integrates into engineers' existing machine learning pipelines, collecting data in real time. The visualization tool offers an interactive interface that provides an intuitive representation of the model's learning process, revolutionizing how engineers analyze their networks, placing an emphasis on convenience and actionable insight.

Our platform provides detailed 2D and 3D visualizations of the neural network structure, with each layer and gradient dynamically visualized to reflect performance metrics like gradient flow and magnitude. Engineers can monitor performance in real time and identify potential issues with the network, such as vanishing or exploding gradients, enabling more efficient troubleshooting and model optimization.

Built using Electron, our platform leverages Three.js for 3D visualization, creating a fully immersive environment. The Python-based logger supports two widely used machine learning frameworks, PyTorch and TensorFlow, recording gradient and network data in HDF5 files that smoothly integrate with the visualization tool for real-time analysis.





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Magna

World Feature Generation for ADAS Simulation

Headquartered in Aurora, Ontario, Magna is one of the world's largest automotive suppliers that designs, develops, and manufactures automotive systems, assemblies and components. Magna provides services for major automakers across vehicle development, engineering, and manufacturing.

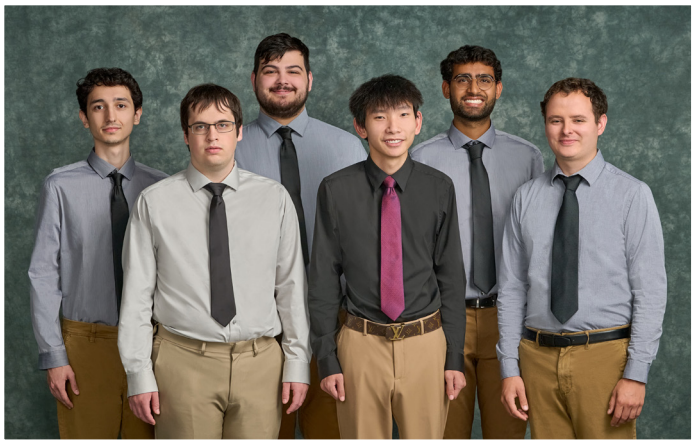
Currently, a major focus for Magna is to expand products relevant to self-driving vehicles. Unfortunately, testing these systems is quite difficult. Simulators are often used to ease this difficulty, but these simulations require hand-created environments for virtual vehicles to navigate and take hours to create.

Our World Feature Generation for Advanced Driver Assistance Systems Simulation streamlines the process by procedurally generating environments in Unreal Engine 4. Road layouts are generated from real-world street map data. These are preprocessed to apply modifications such as variable numbers of lanes. They are then imported to Unreal Engine where the maps are created before a postprocess scrubs over them and applies parameters such as weather, debris, and visibility. Individual world features are then randomized with additional parameters. This enables more fine-grained variation, such as a stop sign that has bent due to impact with a car, or a flickering streetlamp.

Our software enables further detailed alterations in an easy-to-access manner through an intuitive UI present in Unreal Engine. This trims down the time and manpower required to simulate edge cases while also enabling minute adjustments. This transforms hours of work into as little as the click of a button.

Our tool utilizes Unreal Engine in cooperation with several other technologies: Carla built from source, a program for importing sensors and actors to test self-driving car software; OpenStreetMap, which provides detailed road data from around the world; and Blender for asset modification.

MAGNA



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Meijer

Increasing Awareness of Meijer-Branded Products

Meijer is a prominent Midwest supercenter chain headquartered in Grand Rapids, Michigan, with over 250 stores across six states. Meijer is committed to offering value and quality through its 18 in-house brands.

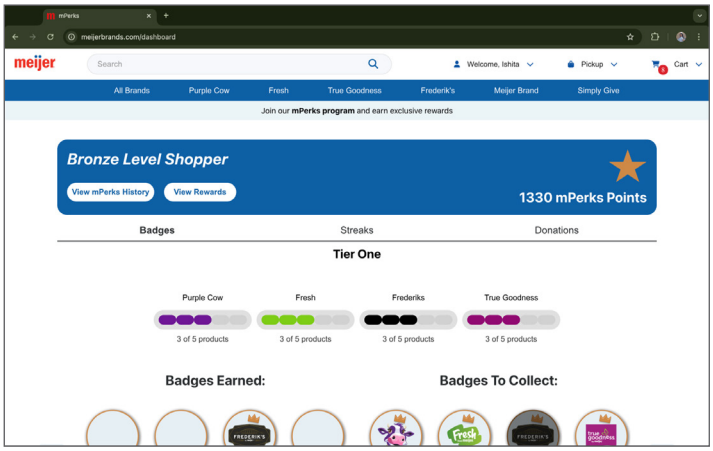
With consumers having several options to choose from when selecting a grocery store, it is important for Meijer to foster their brand and provide incentives for people to continue shopping at their stores. Our project, Increasing Awareness of Meijer-Branded Projects, is a web application that achieves this goal by promoting Meijer-branded products and business practices.

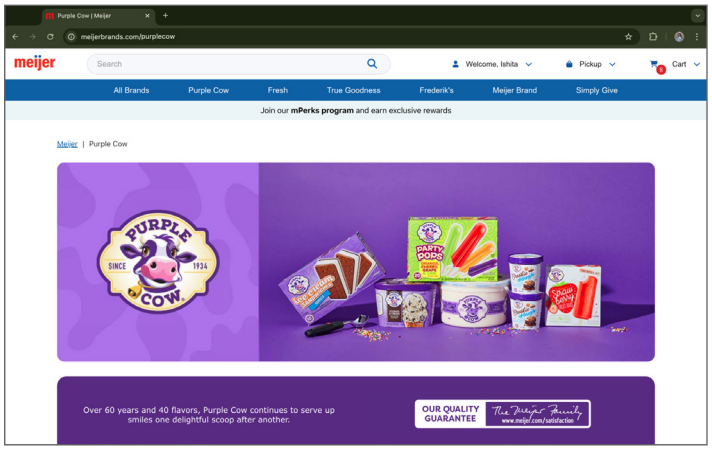
The core of the website is the integration of product purchases and donations. When customers purchase three Meijer-branded products, Meijer donates the value of the highest priced item in the customer's cart to one of the many food pantries it supports through its 'Simply Give' donation program.

The web application also incorporates gamified rewards through the rebranded mPerks program. A personalized mPerks dashboard tracks every customer's order history, rewarding them with coupons as they accrue points and surpass specific point thresholds. Customers earn badges for milestones like 'first timer' for their first purchase and 'century' when their order history exceeds 100 dollars.

The dashboard features two meters: a shopping streak meter that tracks consecutive weeks shopping at Meijer, rewarding the customer with coupons as their streak increases, and a donation impact meter showing total donations made on behalf of the customer's purchases.

The front end of the system used ReactJS. The back end utilizes C# and .NET, while the entire platform is hosted on Microsoft Azure. Data is managed through Microsoft SQL Server, and Power BI dashboards provide real-time analytics for tracking engagement.





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Michigan State University
Robotic Job Coaching

The Department of Computer Science and Engineering (CSE) is one of the largest academic units at Michigan State University. The department is home to 20 laboratories equipped with cutting-edge technologies that enable research in a wide spectrum of topics. The department leverages its impressive research capabilities in collaboration with other departments in areas of robotics, mechatronics, special education, psychology and more.

The CSE department hosts many research professionals from various fields who are collaborating to develop an innovative system for workplace training. Job coaching is a powerful tool for supporting the employment of individuals with disabilities, especially cognitive and behavioral disabilities. Existing methods of job coaching face several issues. On-site job coaching faces limitations because a coach must be physically present.

Our Robotic Job Coaching system solves many problems with modern job coaching techniques. Job coaches can now oversee many clients simultaneously and remotely. Coaches connect in a teleconference call with any one of their clients instantly using a queue system. Importantly, job coaches control a robotic arm to empower better teaching. The arm holds an iPad, which is running our application, and thus the coach can change their view of the work area at will.

Our system extends the influence of job coaches beyond in-person training to efficient remote conferencing. Unlike traditional conference software, our solution gives coaches the ability to manipulate their point of view, increasing effectiveness of coaching.

The front end of our application uses the SwiftUI framework. The back-end server uses the Flask web framework. The application communicates to the back-end server over the WebSocket protocol. The server initiates a peer-to-peer connection over WebRTC between the client and coach users.

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MSU Federal Credit Union
Branch Pickup Lockers

MSU Federal Credit Union (MSUFCU) has been serving Michigan State University and the greater Lansing area for over 84 years. MSUFCU strives to help its local communities thrive and achieve financial freedom.

MSUFCU members are currently restricted by traditional operating hours when they need to pick up essential items such as debit cards or important documents. MSUFCU is looking to introduce a more efficient, self-service solution that provides members with flexibility and convenience.

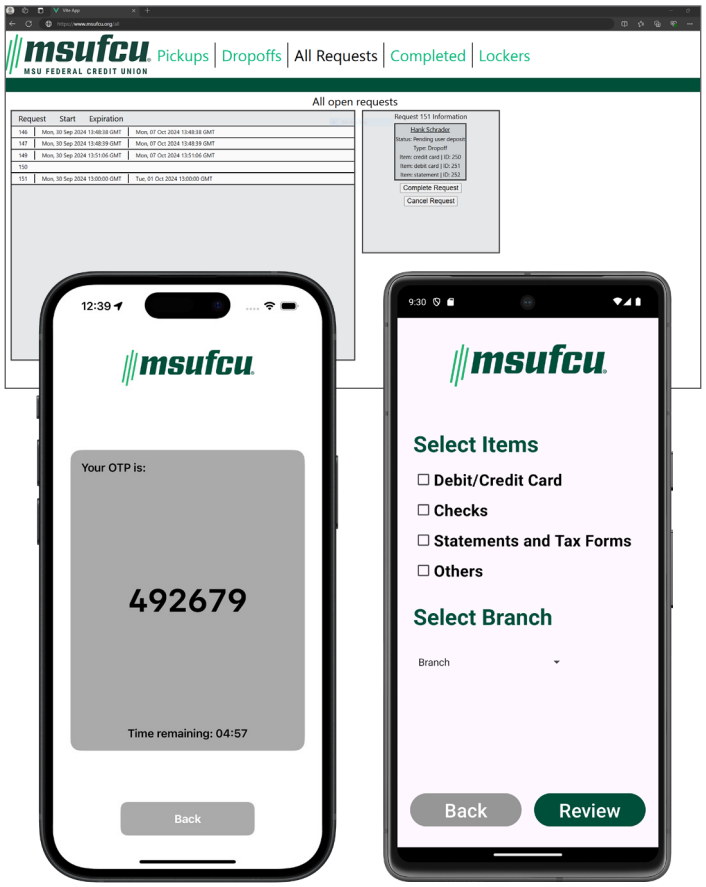
Our Branch Pickup Lockers system is a mobile application that enhances the customer experience by providing convenient access to banking items outside regular branch hours. Customers can request these items and securely retrieve them at any time using a One Time Passcode (OTP).

Users select the items they need and choose the most convenient branch for pickup through the MSUFCU app. Once the user arrives at the selected branch, they can request a unique six-digit OTP from their app. This code grants immediate access to the locker containing the requested items.

Employees can easily manage requests and unlock lockers through a responsive web application that notifies members when their order is ready to be retrieved.

Members can easily track the status of their order and retrieve items whenever they are ready. This system improves operational efficiency for MSUFCU and offers members flexibility.

The front ends for the web, iOS and Android apps are developed using Vue.js, Swift and Java respectively. These communicate with a back-end API written in Python Flask and store data in a PostgreSQL database. The smart lockers are controlled through a Raspberry Pi, which communicates with the system to manage the locks using 12V relay modules and magnetic locks.



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Roosevelt Innovations

Intelligent Benefits Parser and Knowledge Assistant

Roosevelt Innovations, a subsidiary of Delta Dental of Michigan, develops software for insurance processing. Based in Okemos, Michigan, they support over 23 million customers with their reliable software platforms. With years of experience, Roosevelt helps health and dental insurers streamline group rate calculations and claims processing.

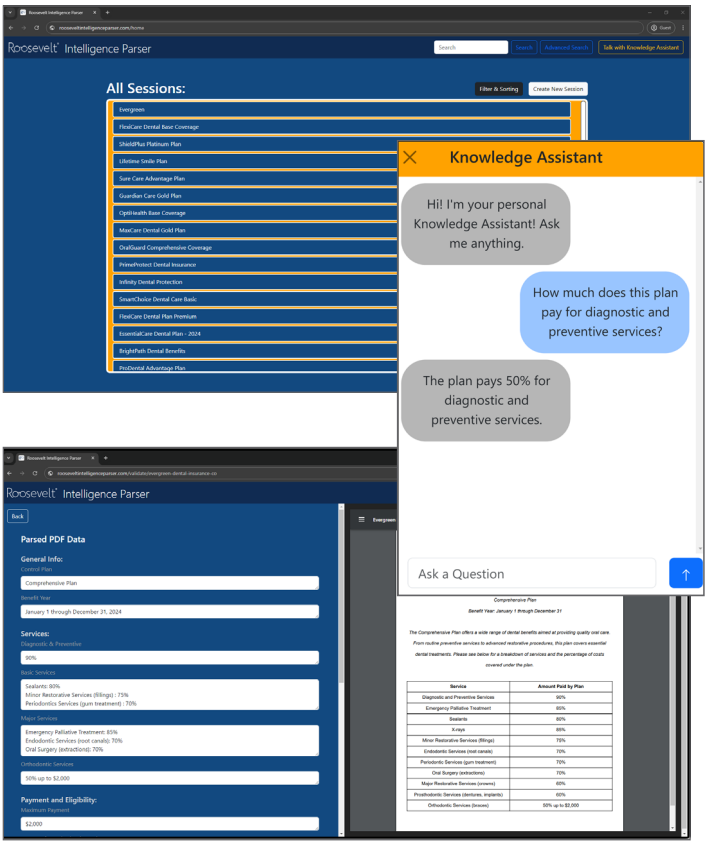
When a new business user transfers data to Roosevelt's applications, they must translate the terminology of their insurance to a standardized format that the Roosevelt platform uses. This is a time-consuming process, since the files containing insurance information are lengthy and differ in formatting depending on the insurance company. During this process, the user often has to read and reference this insurance file multiple times to extract all of the required information.

Our Intelligent Benefits Parser and Knowledge Assistant software solves this problem through a web application that automatically extracts important insurance information from insurance benefit documents.

The extracted information is stored and displayed in fields on a validation page. Users on the validation page review and adjust the data to align with Roosevelt Innovations' standardized format. The software includes storage and organization for many PDFs, enabling users to work within many different sessions.

The application is also equipped with a knowledge assistant chatbot. The knowledge assistant provides relevant, context-specific answers when asked about the content within an insurance document.

Our system's front end is built using the Angular framework. The back end utilizes FastAPI. All data for our application is stored on MongoDB Atlas. The knowledge assistant runs on the OpenAI API.



Roosevelt
simple. seamless. smart.

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RPM
Automated VIN Integration for RPM Logistics

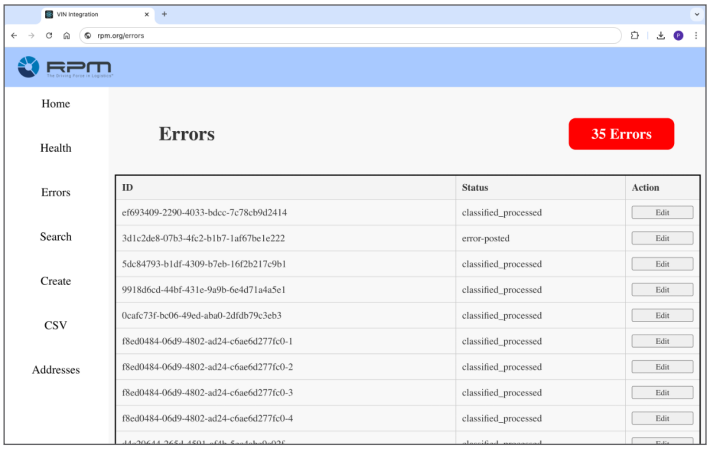
RPM is an international logistics and supply chain solutions company based in Royal Oak, Michigan. RPM specializes in freight transportation and vehicle logistics across North America and Europe. As a non-asset logistics company, RPM invests heavily in modern technologies and automation solutions.

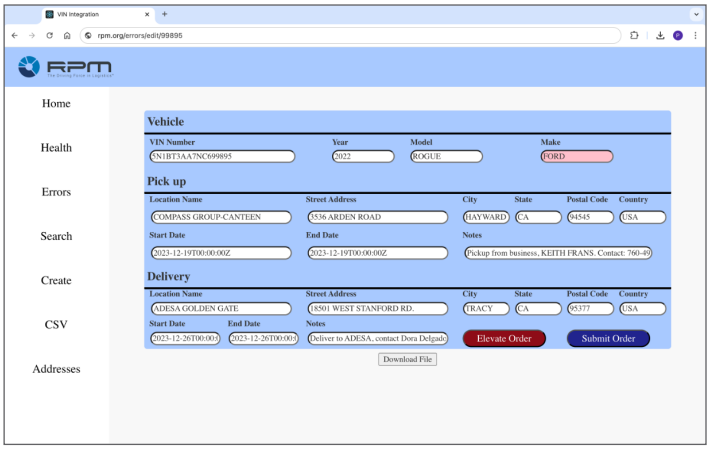
RPM uses an internal whiteboard to display and process orders that come in as email attachments. This is a time-intensive process that requires employees to manually hunt down orders. To reduce human involvement, RPM wants to automate incoming order emails and significantly minimize manually processed orders.

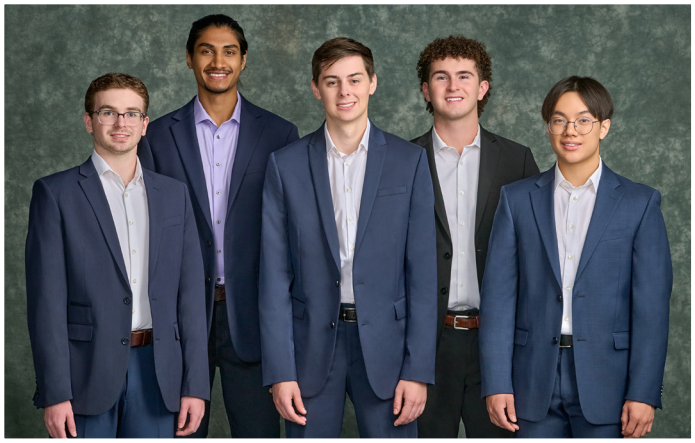
Our Automated VIN Integration Software achieves this by automating vehicle order types processed by email. The software receives incoming email orders, classifies the attachments and extracts details for order creation. Our AI models analyze text and CSV files, providing manual order creation for additional file types. Our software improves error detection by using external tools and common data input patterns for order validation.

The software visualizes order statistics and customized metrics tailored to the customer or specific date ranges, enabling improved customer insight. Brokers can access the software on RPM's internal company apps platform for simple integration into current processes. Our software provides automated support to RPM brokers, minimizing overhead costs and significantly reducing order processing time.

The React front end and Flask back end are containerized using Docker and hosted on Azure hosting services. Our software uses Python and JavaScript, in addition to various Azure services. Utilizing Azure functions and HTTP triggers, the software classifies and uploads documents. OpenAI's API extracts text and returns a structured JSON output. After error checking, the JSON formatted order is posted to the RPM order API from Flask.







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Stryker
Surgical OR Instruments and Needle Tracking

Stryker is a Fortune 500 company that provides world class medical technologies to hospitals worldwide. From surgical equipment to neurotechnology, Stryker impacts over 150 million patients annually across more than 75 countries.

Millions of surgical procedures are performed each year. Throughout each procedure, safety is critical to ensure the best outcome for the patient. The impact of retained surgical items is a major safety concern. Nearly 12 times daily, retained surgical items occur in the USA. Retained surgical items lead to financial strain, malpractice allegations, and threaten a patient's wellbeing.

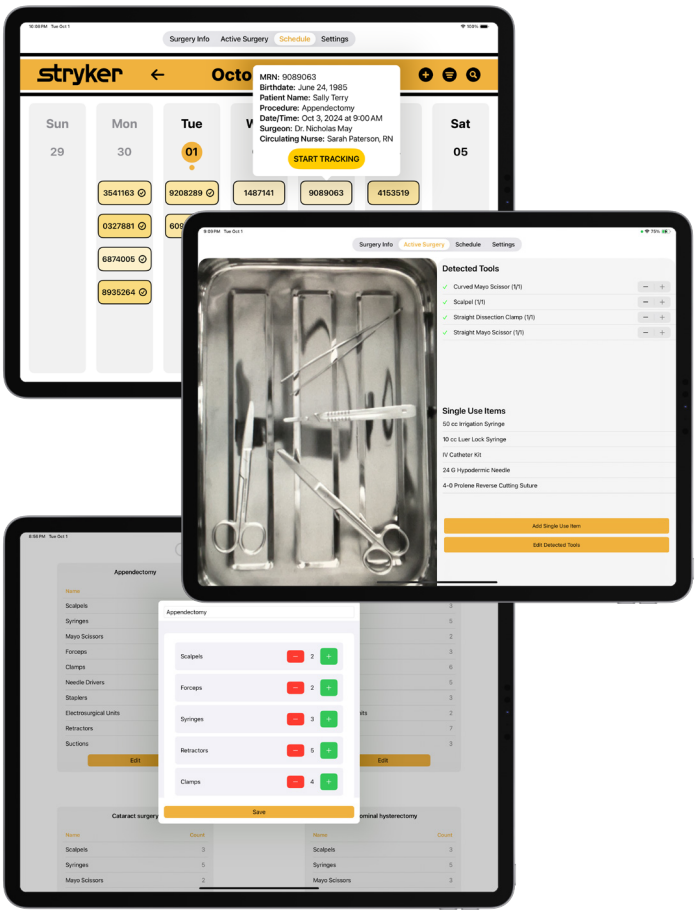
Our Surgical OR Instruments and Needle Tracking iOS app uses real-time tracking and verification checkpoints to improve accuracy and efficiency of tracking instruments within the operating room (OR).

When opening the app, the surgical operating room schedule is displayed. From there, the user may select a procedure to begin tracking. Once selected, the user is directed to pre-check, where initial scans of surgical tools are taken for automated tracking in addition to manual verification. During active surgery, a live feed and the use state of surgical tools is shown. A final post-check is enabled to verify all instruments and needles are accounted for.

Users view, update, and add surgical procedures with corresponding tool catalogs. If circumstances require, tool catalogs may be updated mid-procedure as well. Status logs from completed operations are also available for audit and analytical purposes.

Our app aligns with Stryker's mission to make healthcare better by saving surgical personnel time, minimizing error and decreasing retained surgical items.

The app's front end uses Swift, SwiftUI and UIKit. CoreML integrates our YOLO model and PyTorch. Node.js and Express.js are used to run the back end. The data is hosted on an Ubuntu Server.



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TechSmith
Video Insight and Knowledge Interface (VIKI)

Founded in 1987, TechSmith is the global leader in screen recording and screen capture technologies. TechSmith creates software that empowers people to produce extraordinary videos and images. TechSmith's software products, notably Camtasia and Snagit, have over 65 million users across 222 countries.

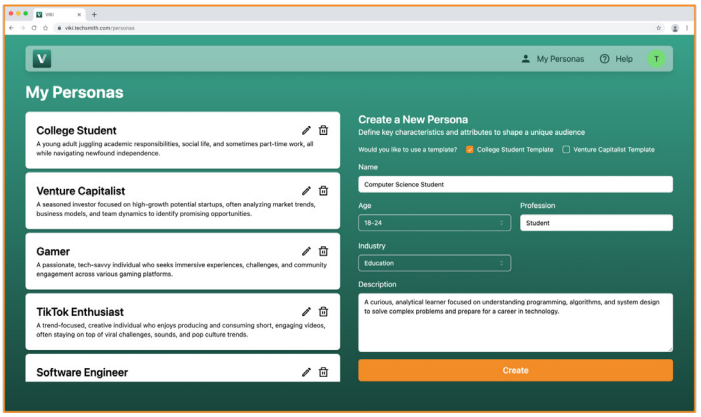
In the modern world of short form content, social media, and hyper-personalized content everywhere, reaching your intended audience is crucial. Unfortunately, tailoring videos for specific audiences is very difficult for beginners. Furthermore, making sure videos are clear, concise, and entertaining is hard without receiving outside opinions. There is currently not much guidance and recommendation built into the editing platforms.

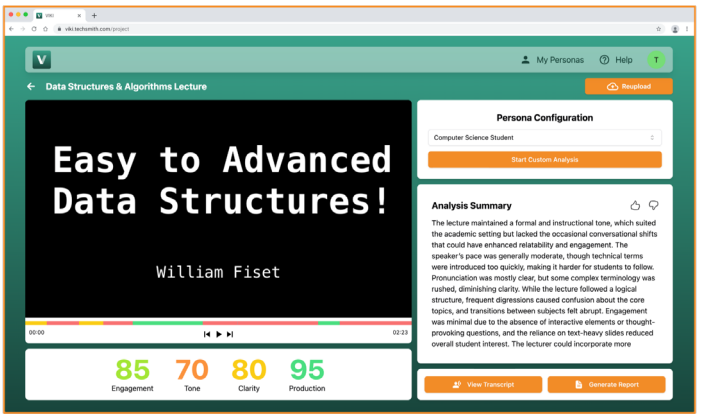
Our Video Insight and Knowledge Interface (VIKI) web application enables video creators to upload videos and receive tailored feedback based on custom AI audience members.

Users create AI reviewers and detail unique characteristics of each persona. For example, a professor uploads a video to VIKI and creates a student persona to give constructive feedback specifically tailored to videos in a university setting. There is no limit to the personas that can be created, ensuring any video can be properly tailored to any audience.

This feedback is based on multiple metrics such as tone, clarity, pace, content, etc. A final engagement score is also provided along with recommendations for improvement. VIKI has an integrated interactive timeline that is segmented into sections, where each section has feedback on the different metrics. This enables users to pinpoint exact moments where their video could be improved.

The front end of VIKI is built using ReactJS while our back end is built with FastAPI. Our web application is hosted using Microsoft Azure. VIKI uses OpenAI and Hugging Face models, and Azure AI Video Indexer to provide feedback.





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Union Pacific
Virtual Reality Inspection Training

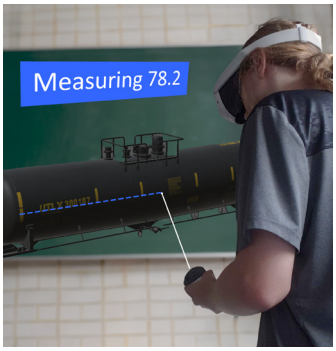
Union Pacific has been building America for more than 160 years. Founded July 1, 1862, they are one of the largest railroad companies in the United States. With over 32,693 miles of track in 23 western states, Union Pacific boasts an impressive lineup of over 7,154 locomotives and a team of over 32,973 employees.

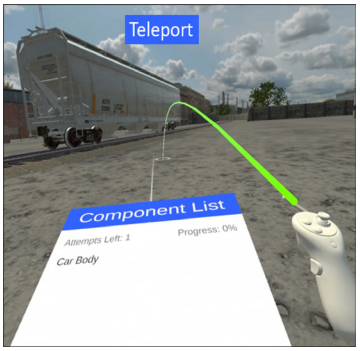
Identifying defective or faulty equipment is a safety-critical task performed by all Union Pacific engineers. However, it is challenging to train employees to perform this task as defective equipment is either repaired or discarded. A remote and easily available solution is needed to train engineers on how to inspect railroad equipment.

Our Virtual Reality Inspection Training system modernizes Union Pacific's training by converting existing training modules into a virtual reality (VR) format, creating an engaging and immersive environment for railcar inspection. Employees practice inspections in a hands-on manner, significantly improving both safety measures and operational efficiency. By shifting traditional training into a virtual space, workers receive more interactive experiences while gaining immediate feedback on their performance.

Our solution handles user interaction across different platforms, such as the Meta Quest 3 headset and an online learning management system (LMS). Each training session generates a unique PIN, which manages a user's details and tracks their progress. With the LMS integration, scores are automatically recorded and stored, simplifying the overall process.

The back end of the system, using Java and Spring Boot, connects to a PostgreSQL database, while the React-based interface handles the user experience and course setup. The VR headset communicates with the back end to access necessary data and submit completed course results, ensuring smooth interaction between all components.





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Urban Science

Predicting Automotive Sales Using Generative AI

Urban Science is a leading global consulting firm headquartered in Detroit, Michigan that has provided tailored insights and solutions for the automotive industry worldwide since 1977. They leverage data and business science to help clients increase market share, improve profitability, and enhance customer satisfaction.

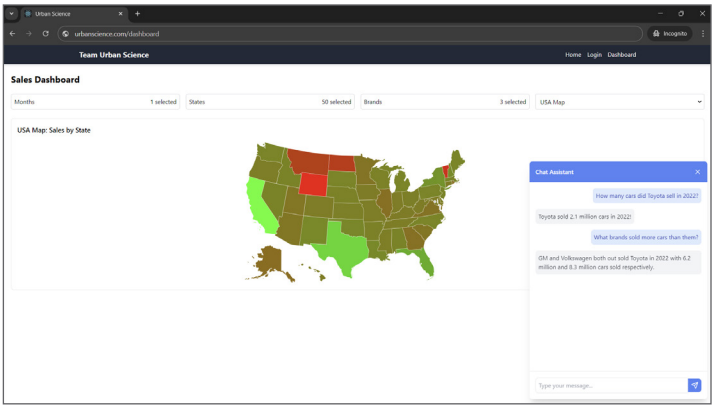
Automotive companies rely on Urban Science to make effective and efficient insights based on rapidly updating statistics. This helps them to increase their profitability in the competitive automotive industry. Urban Science is called upon to help these automotive dealers make decisions and strategize, but with constant data changes it can be difficult and time-consuming to give each company personal recommendations.

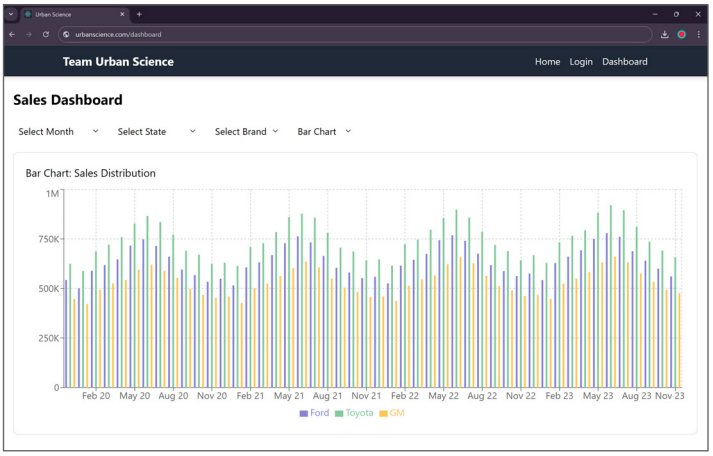
Our Predicting Automotive Sales Using Generative AI web application uses generative artificial intelligence to give recommendations to dealers based on automotive sales predictions, delivering analytics faster and easier than ever.

The Insight Portal web application interface has multiple data analysis pages. Users select options from four categories: brand, state, date and model, and receive a display of unique data pertaining to the options selected. Users also interact with the artificial intelligence model in the form of a chatbot to gain insights from the data on the fly.

The application displays data unique to automotive dealers statewide in several different forms, including traditional charts and graphs, and also an intuitive heat map. The application uses sales predictions data to create recommendations via our artificial intelligence model, encouraging improvement in profitability, market share, and customer satisfaction.

Our web application is built using React and Tailwind for the front end, MySQL for data storage, and C# and .NET framework for the back end. The software utilizes Azure cloud services for hosting.





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Vectra AI
AI Cyberattack Early Warning System

Vectra AI, founded in 2011, is an industry leader in cybersecurity and artificial intelligence. One of the many highlights of Vectra AI is that they successfully utilize artificial intelligence to detect complex cyberattacks before they occur. Additionally, they can do so without decrypting their client's sensitive information. Vectra AI serves clients in 113 countries and is on the CRN Security 100, as well as the Forbes AI 50 List.

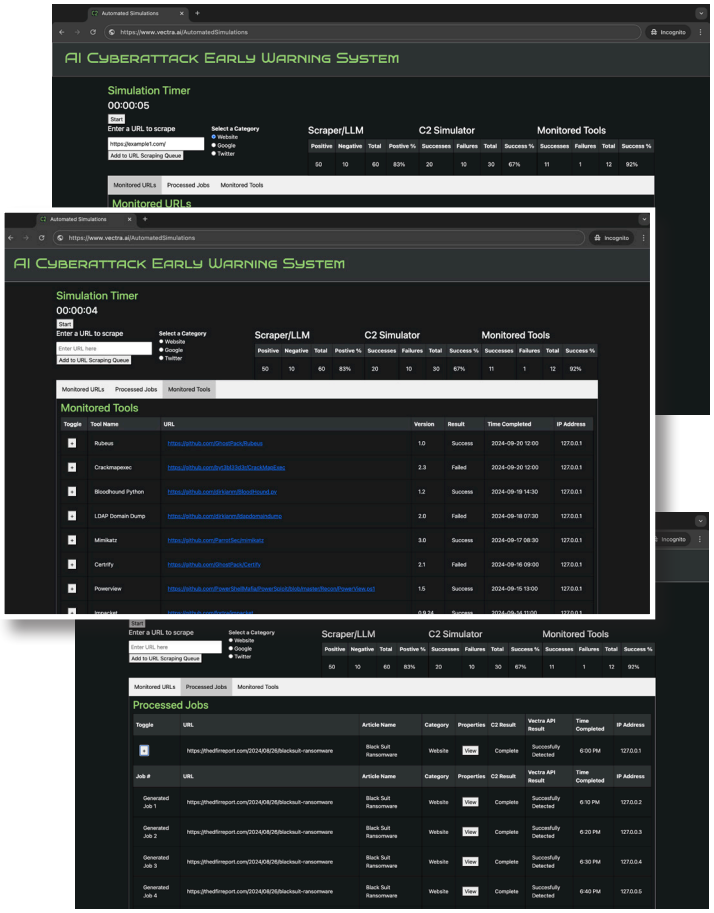
Vectra AI has a system that simulates cyberattacks before they occur. This state-of-the-art simulator replicates complex attacks when given valid parameters. However, Vectra AI needs to spend dozens of manhours to extrapolate data about new cyberattacks from online articles and reports to accomplish this.

To remedy this problem, advancements to Vectra AI's system must be made. That is where our AI Cyberattack Early Warning System comes in. Utilizing large language models, we gather parameters from credible cyberattack reports, relevant threat intel resources, and other URLs gathered by trusted engineers.

With this data, the AI Cyberattack Early Warning System then runs simulations using Vectra AI's C2 Simulator, as well as other common cyberattack tools. From there, this data is stored in Vectra's database and is presented back to users in a user-friendly interface.

Our system predicts and identifies impending attacks before they happen, based solely on web traffic data. Vectra AI can then stop the attack before sensitive data is compromised.

The AI Cyberattack Early Warning System is a local web application that uses a Flask framework for the UI, Playwright as a webscraper to gather information from articles, Gemini as a large language model to extrapolate the configurations, and MySQL as the database where all valid new information is stored. Rubeus, and Mimikatz are used as additional cyberattack tools.



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Volkswagen Group of America
Safe Journey AI

Volkswagen Group of America, a subsidiary of the global Volkswagen Group, continues to lead in automotive innovation and sustainable transportation. Volkswagen operates in over 140 markets with production in 12 countries.

Drivers often face various external risks during their journeys, including areas with unpredictable weather, crime, and traffic hazards, all of which can compromise their safety.

Safe Journey AI addresses these concerns by using intelligent routing features to enhance driver safety. Our software is powered by artificial intelligence, dynamically updating route recommendations based on real-time safety ratings.

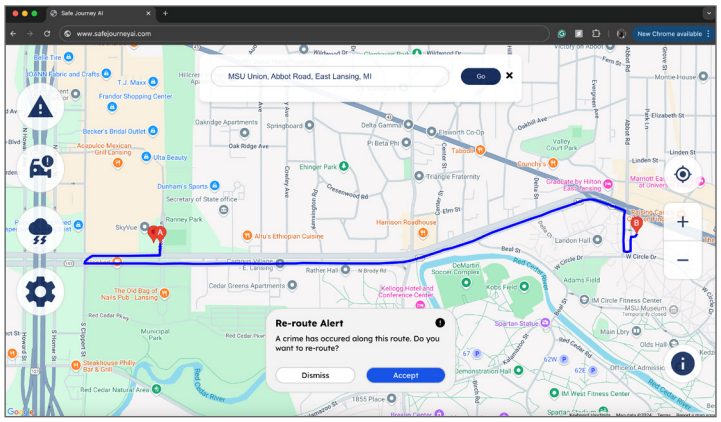
Drivers are provided with continuous updates on the safest paths, avoiding high-risk areas and offering alternative routes when necessary. The system provides suggestions for safe parking and refueling options, ensuring a secure journey from start to finish. Drivers can set their own safety preferences for a more customized experience.

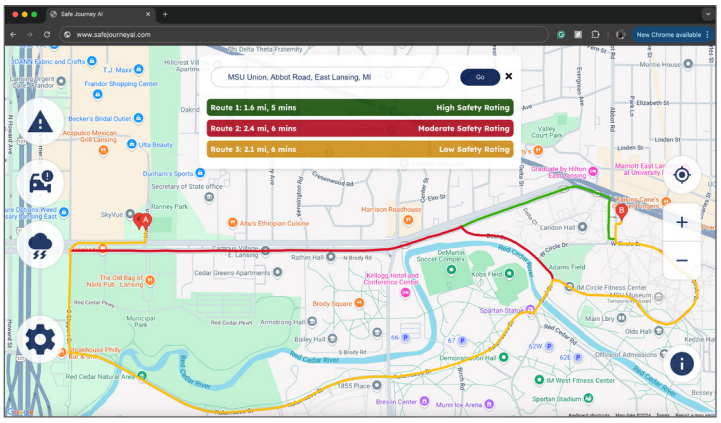
The system is integrated directly into Volkswagen's in-car navigation system, offering an easy-to-use interface that keeps drivers informed without distracting them.

Our platform offers real-time updates while on the road and gives drivers unparalleled control through intuitive and adjustable safety settings, helping drivers stay safe without distractions.

Safe Journey AI offers a reliable approach to route planning, aligning with Volkswagen's focus on safer and smarter transportation solutions.

Our software leverages React for the front end, Quart for the back end, and Google Cloud Platform for scalable hosting. Machine learning models built with TensorFlow process vast amounts of crime and weather data, providing accurate and dynamic safety ratings for use in routing suggestions.





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Whirlpool Corporation
Cooking GPS

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is a global home appliance manufacturer with approximately $19 billion in annual sales, 55 manufacturing and research centers, and 59,000 employees. Whirlpool's mission is to improve satisfaction and engagement with their home appliances.

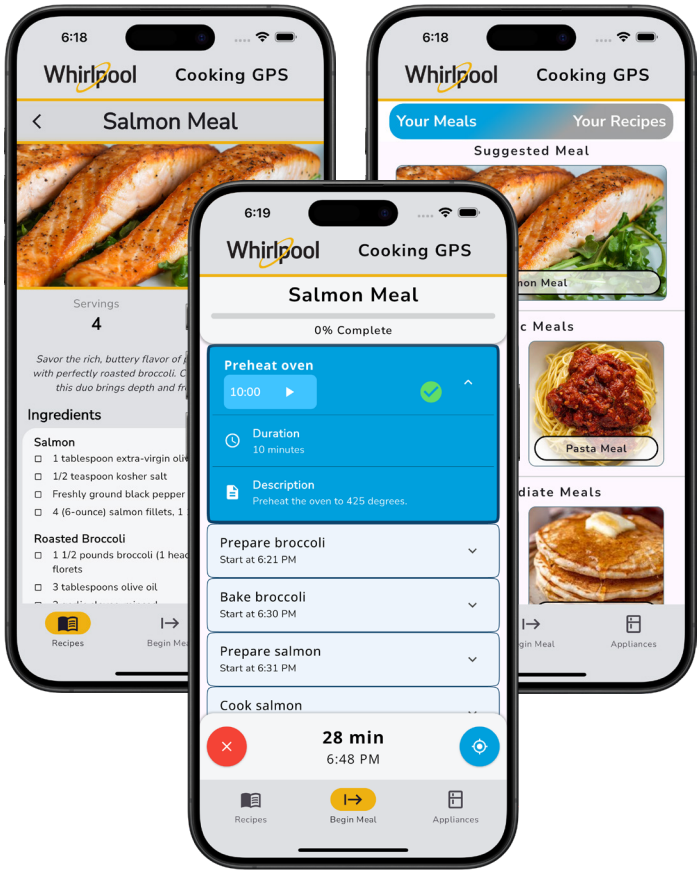
Kitchen appliance technology has advanced significantly over the last decade. However, the consumer experience and interaction has stayed relatively stagnant. The responsibility and effort to prepare a meal at home falls entirely on a home cook, often with very little assistance.

Our Cooking GPS alleviates the mental stress involved with meal coordination. The mobile application enables users to choose from pre-curated meals or incorporate singular recipes into a customized meal. When the user is ready to start the cooking process, the software compiles all preparation steps into a single easy-to-follow instruction list that accounts for time and efficiency.

Once meal preparation begins, the user is taken to a screen that displays all cooking steps ordered by start time. The current step is highlighted, displaying specific preparation instructions and necessary ingredients. In addition, a progress bar and estimated completion time is shown to communicate preparation progress. Once a step is completed, the user dismisses it. Completed steps are available to view by scrolling up on the meal preparation screen.

The Cooking GPS system is fully integrated into Whirlpool appliances, displaying steps in progress with relevant information such as timers, oven cycles, and stovetop burner temperatures.

The front ends for the Cooking GPS mobile application and smart appliance application are built using the Flutter framework. The back end consists of a Flask server connected to our job-shop algorithm and a WebSocket server to facilitate communication between the mobile application and appliance application.



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WK Kellogg Co

Cereal Industry Analysis Tool Using Generative AI

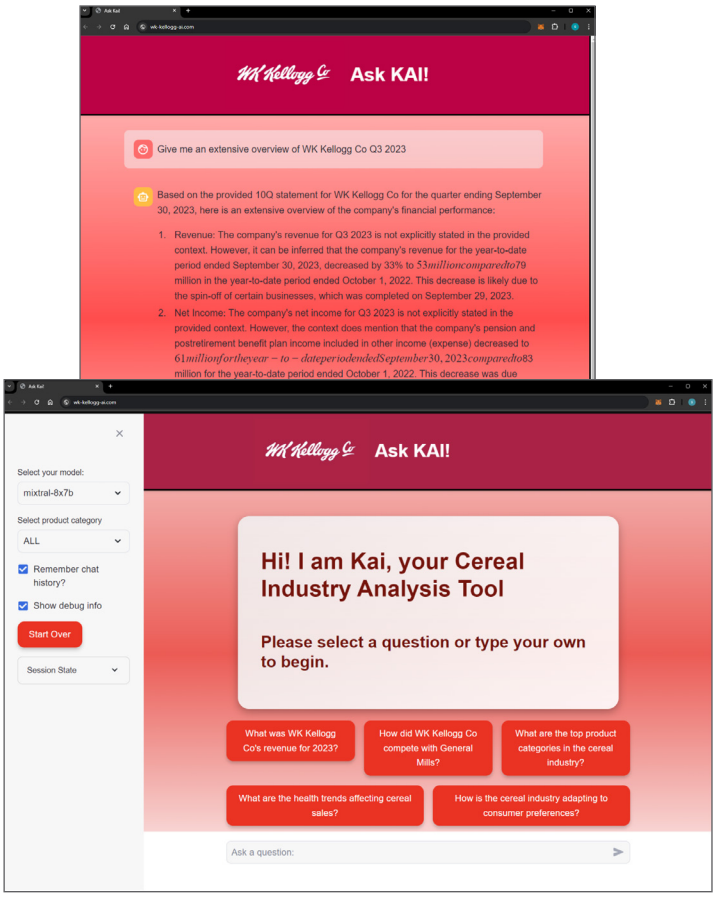
WK Kellogg Co, home to some of the world's most iconic cereal brands, is one of the largest food manufacturing companies in the nation. Headquartered in Battle Creek, Michigan, WK Kellogg has grown into a major player in the food industry, thanks to its global reach and ability to adapt to shifting consumer demands.

WK Kellogg currently operates in the competitive global food market in over 180 countries. Operating at such a large scale, it is important for the company to stay up to date on current business and market trends.

Our Cereal Industry Analysis Tool Using Generative AI automates data analysis through a web application. The website enables analysts and financial professionals to extract valuable insights regarding WK Kellogg and their competitors. This information can then be used by the company to assist in making business decisions and developing strategies to enhance the WK Kellogg brand.

WK Kellogg employees navigate to the web application and select a large language model to perform analysis on the large amount of stored data. Users then pose questions to our intelligent chatbot to gain valuable insights into business performance. Users can ask questions about industry shifts, market trends, business strategies, and more. The chatbot provides detailed responses throughout the conversation, empowering users to make informed business decisions.

The platform uses public datasets stored in Snowflake, which serves as the primary data warehouse. SQL commands interact with the Snowflake database and extract information from stored files. Streamlit, a Python framework, powers the front end of the web application. The application enables user interaction via a chatbot, which leverages large language models for generating detailed responses.



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Computer Science and Engineering CSE 498

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 spring of 2024.

Auto-Owners Insurance Exposition Award

Auto-Owners INSURANCE

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 TechSmith
Enhanced Video Assistant (EVA)

Carter Salna, Chirag Rudrangi, Sriram Seelamneni
Kyle Nowak, Albert Cho, Emmett Barrett
Presented by Julie Wilkinson and Ross Hacker of Auto-Owners

MSU Federal Credit Union Praxis Award

msufcu

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 MillerKnoll
Product Lifecycle Tracing System

Felix Liang, Mohammad Zaman, David Xiong
Ashley Jarria, Keshav Babu
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 GM
Recovery of Lost and Stolen IT Assets

Hunter Jones, Joel Marshall, Jemin Han
Seth Youngstrom, Auden Garrard
Presented by Tony Lambert 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 Vectra AI
Hybrid Cyberattack Simulator

Henry Barton, Andrew Talbott, Campbell Robertson
Alisha Brenholt, Nathan Motzny
Presented by E.J. Dyksen of Amazon