The Capstone Experience

From Students...to Professionals

COMPUTER SCIENCE AND ENGINEERING 2021-2022

MICHIGAN STATE
UNIVERSITY

Auto-Owners
INSURANCE

The Capstone Experience

CSE 498, Collaborative Design

Dr. Wayne Dyksen
Professor of Computer Science and Engineering

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Academic Teaching Specialist

The Capstone Experience provides the educational capstone for all students majoring in computer science at Michigan State University. Teams of students build software projects for corporate clients.

During the Capstone Experience, students

- design, develop, debug, document, and deliver a software project for a corporate client,

- work in a team environment,

- develop written and oral communication skills,

- become proficient with software development tools and environments, and

- consider issues of professionalism and ethics.
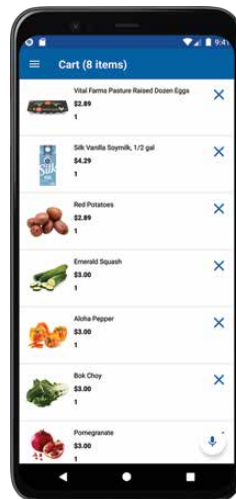
Corporate clients are local, regional, and national including Ally, Amazon, Anthropocene Institute, Auto-Owners Insurance, Atomic Object, Bosch, Dow Chemical, CSAA Insurance, Delta Dental, Evolutio, Ford Motor Company, General Motors, Google, Herman Miller, Kellogg's, Lockheed Martin Space, Malleable Minds, Meijer, Microsoft, Mozilla, MSU Federal Credit Union, Proofpoint, Rocket Companies, Stellantis, TechSmith, United Airlines, Urban Science, Vectorform, Volkswagen, and Whirlpool.

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Ally Financial
Digital Avatar Assistant

Ally Financial is a financial services company based in Detroit, Michigan, operating as one of the largest car finance companies in the United States. Ally has amassed an immense customer base, financing cars for over 4 million people and having 2 million depositors. Ally also offers online banking and online trading, bolstering the services they provide for their customers.

Ally is a strictly digital company, offering no physical locations for customers. Because of this, Ally has been innovating the online service field since their founding. As artificial intelligence (AI) has advanced, Ally has been exploring inventive methods of digital customer service rooted in AI.

Our Digital Avatar Assistant is a cutting-edge AI assistant that provides Ally customers with real-time communication relating to their accounts, as well as custom-tailored financial advice.

Customers interact with our assistant through a chatbot interface embedded in Ally's website. Users ask questions by typing or speaking with the assistant about a wide array of topics, including account information, budgeting, spending analysis, etc.

To provide a lifelike experience, our assistant reacts with animated movement and facial expressions depending on context, mimicking a conversation with a human.

We use machine learning, natural language processing, and AI to analyze customer spending and budgeting habits to provide user-specific financial advice. Our Digital Avatar Assistant keeps track of user spending and provides reminders and warnings if the user is in danger of not meeting their spending goals.

The Digital Avatar Assistant is developed using Rasa. Our application uses Amazon EC2 for machine learning, Amazon S3 for model storage, DynamoDB for conversation storage, and a combination of Amazon Transcribe and Amazon Polly for conversational functionality. The user interface is built with React.
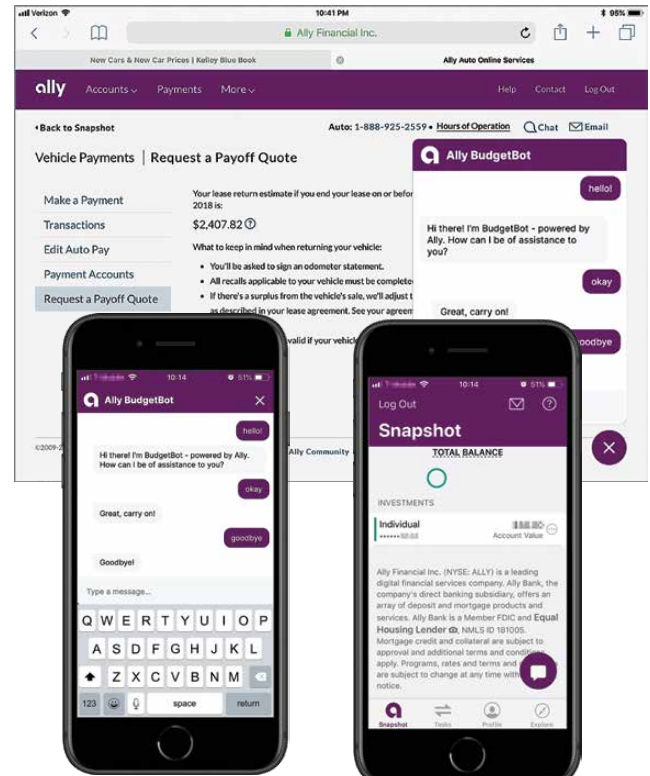
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Amazon
Amazon Web Services: AWSome Availability Zones

Founded in Bellevue, Washington in 1994, Amazon is a Fortune 500 company that provides a variety of services to customers as the world's largest online retailer and cloud services provider.

Customers using Amazon's cloud platform, Amazon Web Services (AWS), can choose to break their application up into many parts, each hosted in a different location (called an Availability Zone, or AZ). Such redundancy helps prevent service outages for customers.
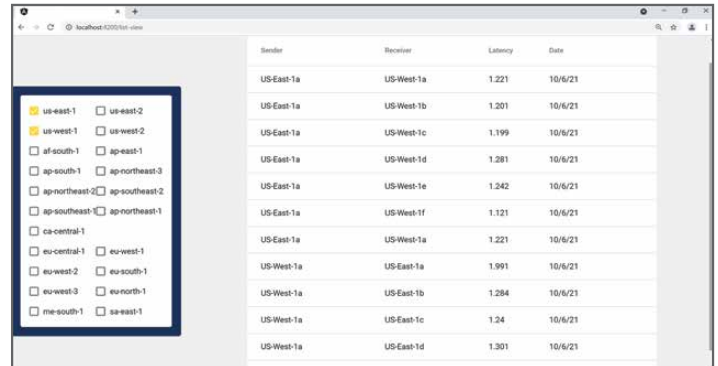
Distributed applications are spread across multiple servers, which need to communicate with each other for the application to function. This communication can take a significant amount of time, and minimizing the delay can lead to a better user experience. Choosing which AZs to use to minimize this delay traditionally requires extensive manual testing.

Our AWSome Availability Zones web application continuously and automatically measures the delay between Availability Zones, allowing Amazon Web Services customers to easily choose the fastest Availability Zones for their application, saving them time and money.
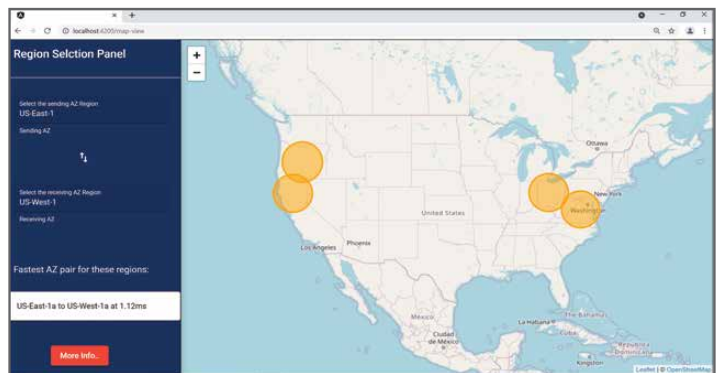
AWSome Availability Zones provides customers with an easy-to-understand visualization of the delay between Availability Zones using an interactive map with a familiar look and feel.

Experienced Amazon Web Services customers can opt to use our AWSome Availability Zones system to explore more detailed views of the network latency data, allowing them to answer specific questions they have, quickly and seamlessly.

Our software's front end is built using Angular, and its back end uses Amazon Web Services Elastic Compute Cloud (EC2) instances to measure network latency between Availability Zones, which it stores in DynamoDB.

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Anthropocene Institute
Air Pollution Health Outcomes Forecasting Tool

The Anthropocene Institute is an organization that partners with researchers, governments, experts and investors to address one of humanity's most pressing concerns, climate change. The organization provides support to projects related to clean energy, anti-pollution efforts and climate innovation and brings down any political or financial barriers they may experience.

The Anthropocene Institute has turned its attention towards air pollution in hopes of researching the effect that air quality has on premature deaths and health complications, such as increased asthma, infant mortality and lung cancer.

Our Air Pollution Health Outcomes Forecasting Tool is an intuitive web dashboard that provides the public with a detailed analysis of the air quality in their area, as well as the potential resulting health effects. Users visit our dashboard and are presented with a map view of the United States and a set of filters. These filters allow the user to pick a particular address or region to learn more about the air quality in that location.

We use state-of-the-art machine learning techniques to make predictions about air quality for every location in the United States. Whenever a request for air quality information is made we use historical air quality data as well as up-to-the-hour live air quality readings from sensors around the country to make accurate predictions on the current air quality in any given location.

Our tool is used by a wide variety of people, including people trying to find a safe and healthy place to live, as well as policymakers trying to determine areas in need of assistance.

The front end is developed with HTML, CSS and JavaScript. Our software is served via a Python Flask back end which communicates data from our scikit-learn machine learning models. Our live data is retrieved from Purple Air Sensors.
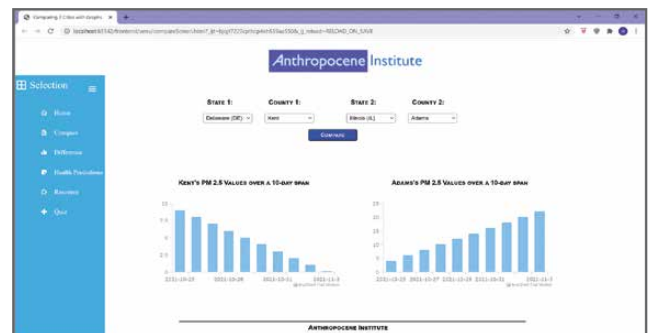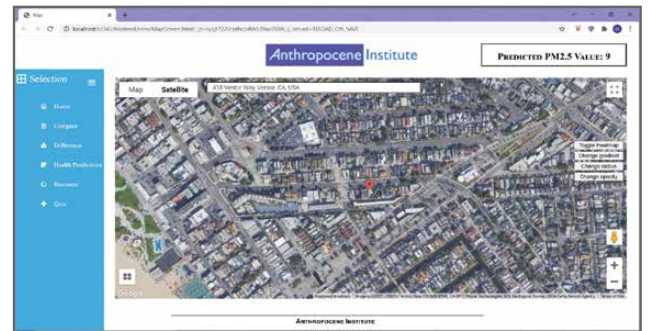
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Anthropocene Institute
Electricity Grid Planning Tool

The Anthropocene Institute is a non-governmental organization with the mission of utilizing science and technology to address the planet's needs. It drives and facilitates innovation in clean energy to address the urgency of climate change. The Institute also supports start-ups and universities to develop emerging and disruptive energy technologies that are clean, safe and reliable.

The Anthropocene Institute is interested in the possibility of Small Modular Reactors (SMRs) as a viable option for new sources of power generation in comparison to coal and gas plants that have significantly worse emissions that affect the atmosphere.

SMRs, however, must be placed properly in power substations based on power generation, power outage occurrence rates, and power consumption demands. Traditionally this would be done entirely by hand, which is time-consuming, error prone, and makes it hard to quickly compare multiple placements.

Our Electricity Grid Planning Tool is a web dashboard that uses machine learning to automatically simulate SMR power generation and SMR placement. Our tool uses historical energy consumption data to accurately predict the costs and benefits of placing an SMR at a particular power substation.

Our web application provides an easy-to-use interface used by electricity grid planners seeking to better understand the cost and benefits for deploying SMRs. Users simply view specific substations, and our application provides them with statistics and recommendations relating to the cost-benefits analysis of deploying a SMR in that area. Users can also easily compare two locations to make an informed decision without wasting time with manual calculations.

The machine learning models were developed in Python with scikit-learn. The user interface is built on JavaScript, CSS and HTML with an Apache web server and Google Maps API.
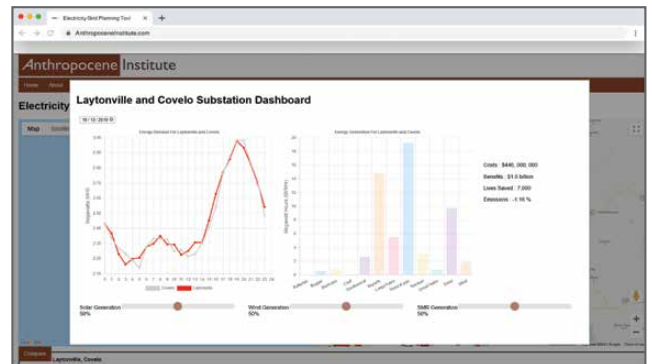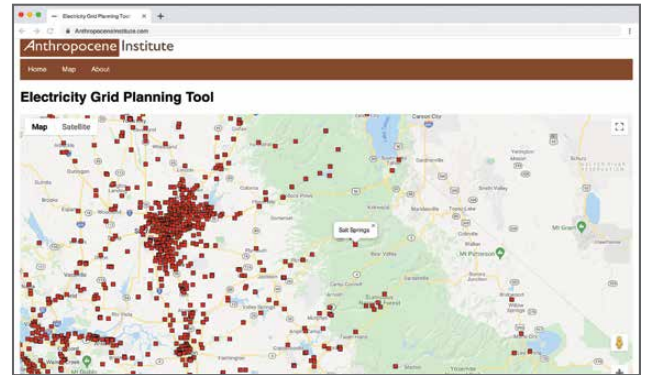
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Atomic Object
Stroodle: Learning Management System

Operating for over 20 years, Atomic Object is a software design and development consultancy based out of the Midwest cities of Ann Arbor, Grand Rapids and Chicago. Atomic Object has worked with over 175 clients and created over 250 applications across different industries, from tech startups to Fortune 500 companies.

Learning management systems are utilized by many educational institutions to administer, track and deliver course materials and student work. Popular offerings provide many features to manage and engage in course activities but fail to deliver them in a simple and intuitive application.

Our Stroodle: Learning Management System provides tools for students and instructors alike to participate in online courses while streamlining the user experience.

Students are provided a dashboard with a summary of important information for all their enrolled courses. They can access individual course pages to interact with material prepared by the instructor.

Instructors manage their course by uploading documents, such as reading materials or assignments, for their students to view. They can also organize upcoming events and deadlines for their students on the course calendar.

Easy quiz creation is supported to assess students. The results of these quizzes are available in a student's gradebook along with scores of other graded assignments. Students are sent push notifications when instructors send out announcements.

Our software supports all the key features of learning management systems without any of the confusing aspects, streamlining course management and decreasing wasted time.

The Stroodle front end is built using ReactJS and React Native. The back end is built using Node.js and Express.js, which communicates with a PostgreSQL database.
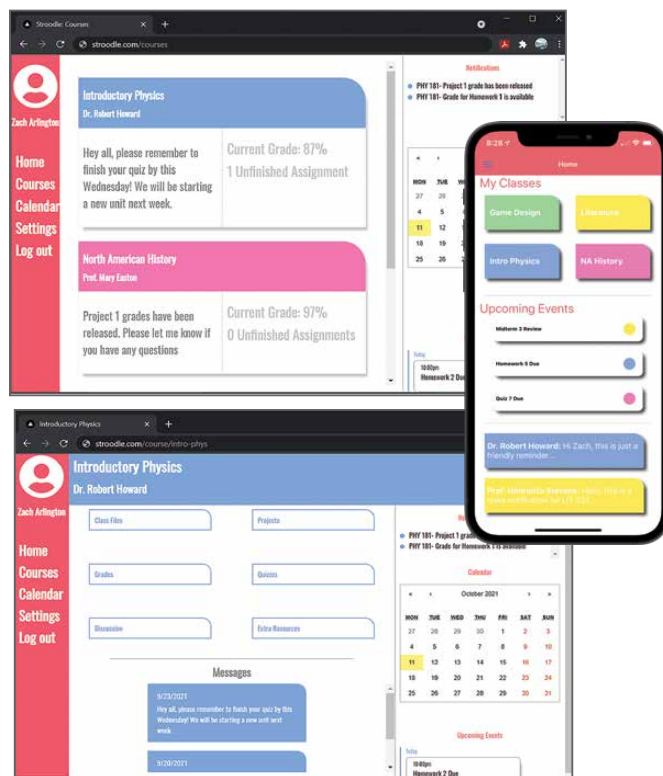
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Auto-Owners Insurance
Yard Wars: Weathering the Storm

Auto-Owners Insurance is a Fortune 500 company headquartered in Lansing, Michigan with over 48,000 licensed insurance agents. Auto-Owners provides automotive, home, life, and business insurance to nearly 3 million placeholders in 26 states.

As an insurance company, it is important for Auto-Owners agents to be able to gather and analyze data regarding causes for claims. This helps them better anticipate which clients could be at risk of property damage and may need to submit a claim in the future.

Our Yard Wars: Weathering the Storm project is a virtual reality application where storms are simulated on virtual residences. Any damage caused by the storms is viewable in real time and in first person. This data is gathered, stored and displayed on an external website for analysis.

Users start by selecting the difficulty for the simulation, which changes the severity of the weather and number of trees that can be placed. Then, the user is tasked with placing trees around the property in order to replicate an existing or planned residence. Once they have finished placing trees, the storm simulation begins.

As the storm progresses, trees can fall and possibly cause damage to the home. Data about the simulation, including fallen trees and any damage caused, is sent to an external database for viewing and analysis on the website by Auto-Owners agents.

Our Yard Wars is an engaging game that provides Auto-Owners agents with useful information, assisting them with providing high quality service.

Our virtual reality software is developed in Unity and written in C#. We use a MySQL database to manage the data from the simulation, and it is communicated using PHP to the website, which is hosted on the same server.

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Bosch
Hardware in the Loop (HIL) Vehicle Simulator

Bosch is a global engineering and technology company with roughly 395,000 employees worldwide. Founded in Germany in 1886, Bosch is the world's leading supplier of automotive components.

Currently, Bosch uses a Hardware in the Loop Vehicle Simulator to correct errors with their software and perform tests. This system connects to specific hardware to simulate a vehicle on the road. This hardware, however, is quite costly and therefore only two systems are available to all Bosch engineers in North America. To resolve this, Bosch selected the PEAK PCAN USB Pro FD as a low-cost replacement for the previous hardware.

Our Hardware in the Loop system reimplements the core functionality of Bosch's previous system on the PCAN hardware.

Our software allows the user to perform basic vehicle maneuvers and operations such as steering, braking, accelerating and more. The main functionality of our software system is adaptive cruise control (ACC), which users may engage and adjust at will.

The user interface is designed to allow anyone with driving experience to control the simulation with ease. A graph is displayable to show the signals being sent to and from the PEAK hardware with their corresponding values.

Above the controls for the vehicle is the dashboard. This displays the same basic information found in a real car including the current speed, rpm, fuel level and more.

Our software implements the same functionalities as the previous vehicle simulator but runs on much cheaper hardware, cutting costs and allowing more systems to be used concurrently.

The entire software system is written in Python 3. The front end is built using the open-source toolkit wxPython, while communication with the hardware is done using PCAN Basic API.
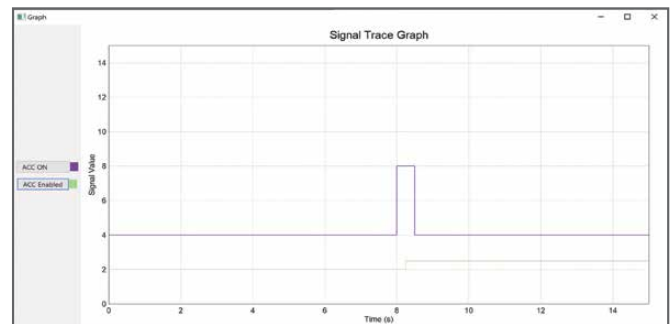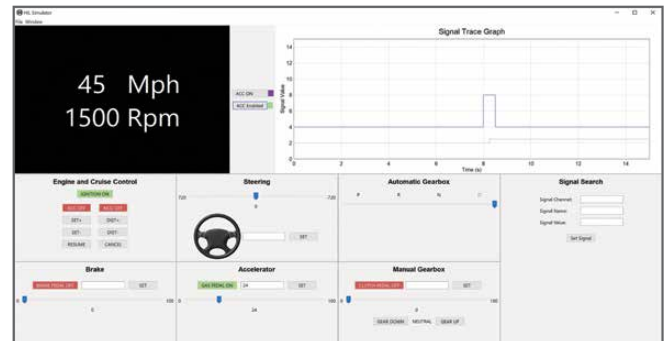
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Delta Dental of Michigan, Ohio and Indiana
Smart Benefit Plan Recommender Engine

Delta Dental is an insurance company that provides dental coverage to more than 80 million Americans, spanning across all 50 states, making them the largest dental care provider in the nation.

Delta Dental takes pride in tailoring benefit plans to their customers' needs, whether they are a small business, a family or an individual. Before recommending the ideal benefit plan to a customer, Delta Dental underwriters must aggregate data from several sources and use their significant domain knowledge to properly recommend a benefit plan. Creating personalized dental plans for each customer takes a significant amount of time, as there are many factors that need to be considered.
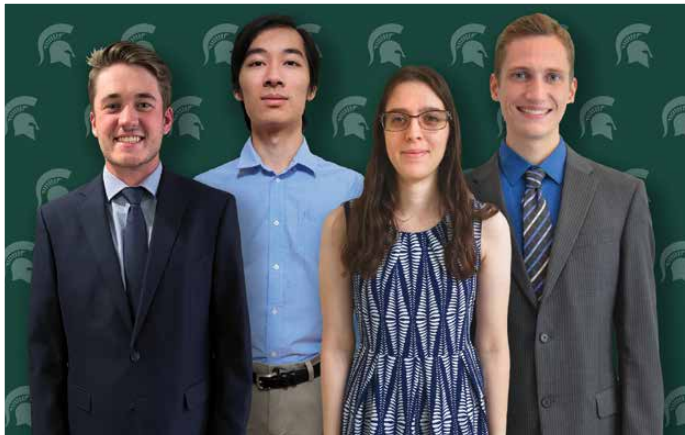
Our Smart Benefit Plan Recommender Engine aids underwriters by automatically matching new customers with benefit plans that are used by similar customers, with no input from an underwriter. Potential customers use our website to answer a series of carefully crafted questions that are used to recommend a benefit plan.

Our Recommender Engine uses advanced machine learning algorithms to divide customers into groups that share many similarities. Each group is assigned an ideal benefit plan and when the system is given new data, it can easily provide a recommendation by mapping the new data to a group and its respective benefit plan.

Our system makes the insurance shopping experience less stressful for customers by allowing users to input their information through an easy-to-use interface and providing immediate benefit plan recommendations and links to help them enroll in the plan.

The front end of our system is written using Angular, while the back end is written in Python. The data is stored in a Snowflake database, and the clustering models were developed in Jupyter Notebook using the pandas and scikit-learn libraries.

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Delta Dental of Michigan, Ohio and Indiana
Microsoft Excel Data Extractor/Modeler

Serving more than 80 million Americans, Delta Dental is America's leading provider of dental insurance. To provide quality service, the company must host and leverage complicated data.
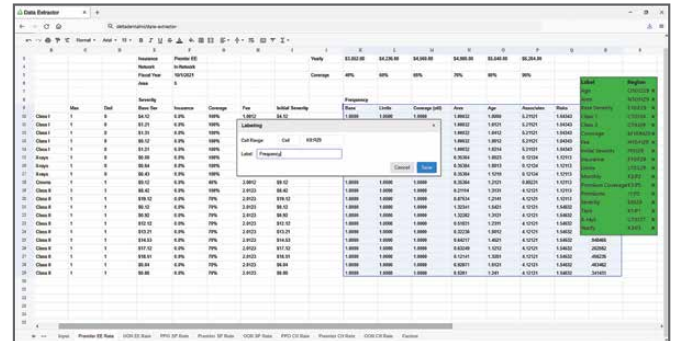
Delta Dental maintains a significant number of sophisticated Excel spreadsheets for various purposes. Comprehending these spreadsheets requires significant industry expertise. Furthermore, extracting the industry knowledge from the spreadsheets to use in other applications often requires the development of computer programs designed specifically for a single workbook, which is both tedious and costly.

Our Microsoft Excel Data Extractor/Modeler is a web-based tool that removes the need for developing single-use computer programs for extracting Excel data. Our system imports existing Excel workbooks and, with minimal user input, can extract the relevant information as well as the data hierarchies present in an Excel spreadsheet.

Our web interface is designed to look and feel similar to Excel, but with specialized functionality that allows users to formally define data hierarchies and dependencies. These hierarchies can then be visualized to understand the structure of an Excel spreadsheet, as well as to reformat an existing Excel spreadsheet into an easier-to-understand form.

The web application and resulting data visualizations and formatting help enhance employee comprehension of complex spreadsheets and add extensibility to the existing data. Our tool removes the need for development of single-use programs, saving valuable time for Delta Dental employees.

Users can access the Data Extractor/Modeler through a web application that uses JavaScript and TypeScript within the MEAN stack framework. We use X-SpreadSheet for our user interface and ExcelJS to extract the data and formulas from Excel workbooks.
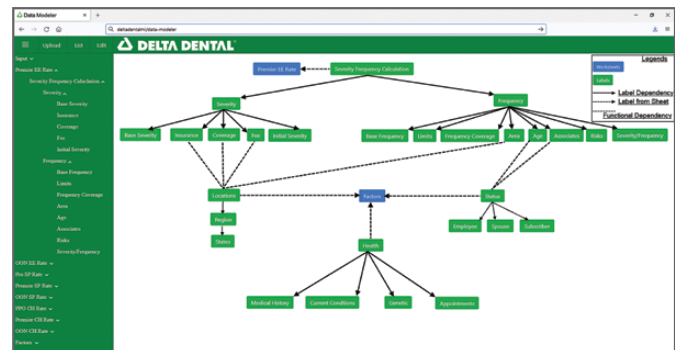
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The Dow Chemical Company
Virtual Computer Service Enhancements

Headquartered in Midland, Michigan, Dow is a world leader in the innovation, creation, and distribution of specialty chemicals, advanced materials, and plastics.

As a large company with over 35,000 employees worldwide, Dow provides its employees with a service called Dow Virtual Computer, which is a virtual machine array. These virtual machines grant access to anyone with Dow credentials and a device with internet connection to a physical Dow work computer without the use of a VPN.

Currently, Dow has a personal structure for assigning virtual machines to their employees and clients on Microsoft Azure. This means that each user has access to their own virtual machine.

Dow is moving to a non-persistent state, meaning a single virtual machine's resources can support multiple users, cutting down the required number of virtual machines running and therefore saving money. In order to do this, there are many manual processes that need to be managed.

Our Virtual Computer Service Enhancements software automates the previously manual processes associated with the transition to a non-persistent state by tagging user information, such as Dow identification number and login location, on each virtual machine. These tags help Dow with their billing process and the location assignment of the virtual machines.

Along with the automated tagging, our software generates weekly reports of users with multiple virtual machines. Dow's support teams use this data in their transition to a non-persistent state.

Our automation process is built within the Microsoft Azure Cloud Computing Platform and runs through Azure Automation Runbooks using PowerShell. The generated reports can be viewed through our mobile Microsoft Power App.
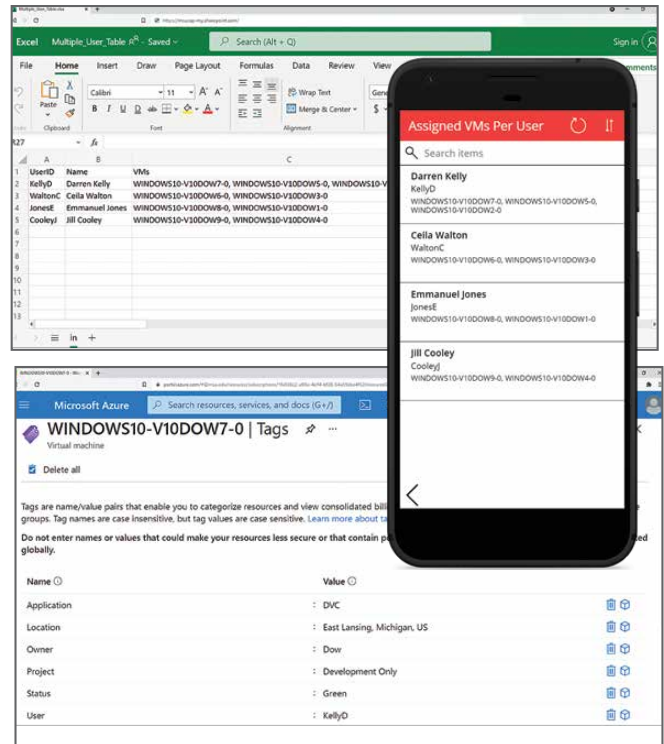
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Evolutio
ERP Kids: Wildlife Conservation

Evolutio is a group of technology professionals that provides elegant solutions for complex business problems by leveraging technology in novel ways. Evolutio has partnered with the non-profit group Elephants, Rhinos and People (ERP) to give back to the global community through a variety of programs.

ERP is continually educating the world about wildlife preservation through its various charities and social outreach. Part of their goals for educating includes reaching children in the 6-13- year-old age demographic.

ERP Kids: Wildlife Conservation is a top-down role-playing game that allows the player to live as a wildlife ranger on the Dinokeng Reserve in South Africa. The game is offered on all mobile devices and designed to teach elementary and middle school children about the efforts of wildlife conservation rangers.

The game is divided into days and nights, in which the player has different tasks to complete based on the time of day. The player moves their character around an expansive two-dimensional map modeled after the Dinokeng Reserve in South Africa. The game provides the player with fun mini games to simulate tasks that would be completed by real rangers.

During the days, the player cares for animals, raises funds, and secures the reservation. During the nights, the player tracks animals and scares away poachers. The player progresses through the game's narrative by completing tasks and improving the reservation.

The game informs the player of the importance of protecting wildlife and how this work is accomplished. The player also learns about the daily lives of rangers, the dangers faced by animals on reservations, and the ways in which people can help them.

Our game is developed using the Unity game engine and the C# programming language. Xcode and Unity are used to export the game to the iOS App Store and Google Play Store, respectively.

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Ford Motor Company
Crowd-Sourced EV Emergency Recharge

Ford Motor Company is a multinational automotive manufacturer headquartered in Dearborn, Michigan, with operations in over 125 countries and a worldwide workforce of 186,000 employees. Ford designs and manufactures a full line of cars, trucks, SUVs and electric vehicles under both the Ford and Lincoln brands.

Electric vehicles have recently experienced significant growth in popularity and technical advancement in the automobile industry. A common concern of consumers who are hesitant to switch from a gas-powered vehicle to an electric vehicle is the possibility of running out of charge with no recharge station nearby.

Our Crowd-Sourced EV Emergency Recharge mobile application provides a platform for owners of electric vehicles to request assistance from other electric vehicle owners in the area if they run out of charge while driving.

After logging in to the application, a user is greeted by a Help Center screen, from which the user can submit an assistance request or view the open requests in their area.

Users submitting a request can input information pertaining to their vehicle, current location, and destination. The application notifies nearby users that a new request has been submitted.

Users wishing to aid stranded drivers can select a help request from the screen, view details, and select a price for which the user is willing to charge up the stranded driver's car. Once the offer is accepted, the user is provided with the location, vehicle, and license plate information required to fulfill the request safely.

Our system addresses the concerns of potential customers, increasing sales and improving the reputation of electric vehicles.

Our mobile application is compatible with both iOS and Android. The front end is built with React Native and the back end is built using Swift and Java.
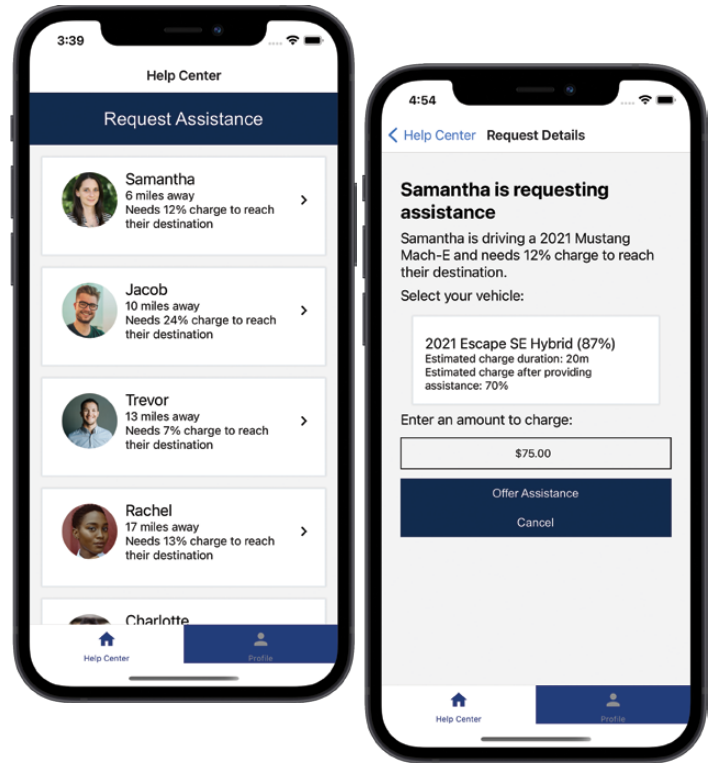
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General Motors
Enhanced MISP User Interface

General Motors is an American multinational automotive company headquartered in Detroit, Michigan. GM is ranked 22nd on the Fortune 500 for total revenue and is the largest automobile manufacturer headquartered in the United States. For more than a quarter of a century, GM has integrated their OnStar in-vehicle safety and security service into millions of vehicles to become the most connected automaker in the world, with more than 22 million members.

Real-time, open-source threat intelligence is imperative in mitigating the risk of successful cyberattacks against an organization. The threat landscape is ever evolving. Consequently, GM's security analysts need up-to-date information on all threats to ensure the organization's safety.

The Malware Information Sharing Platform (MISP) is an open-source sharing platform dedicated to sharing threat intelligence. However, MISP's user interface lacks several features, making it not very user-friendly or customizable.

Our Enhanced MISP User Interface provides for more customization within the MISP application and enriches existing functionalities.

The enhanced interface enables the removal and reordering of columns within the malware tables. Improved sorting functionality and search query filtering allow for more in-depth results from searches. The user interface boasts a more refined and intuitive design as well.

Using our software, GM cybersecurity analysts are able to create a version of MISP that is tailored to their specific needs and is easier to use, saving time and increasing productivity.

The front end of our software is developed using Bootstrap, a web application framework that utilizes CSS, JS, and HTML. Our back-end software functionality is implemented using PHP.
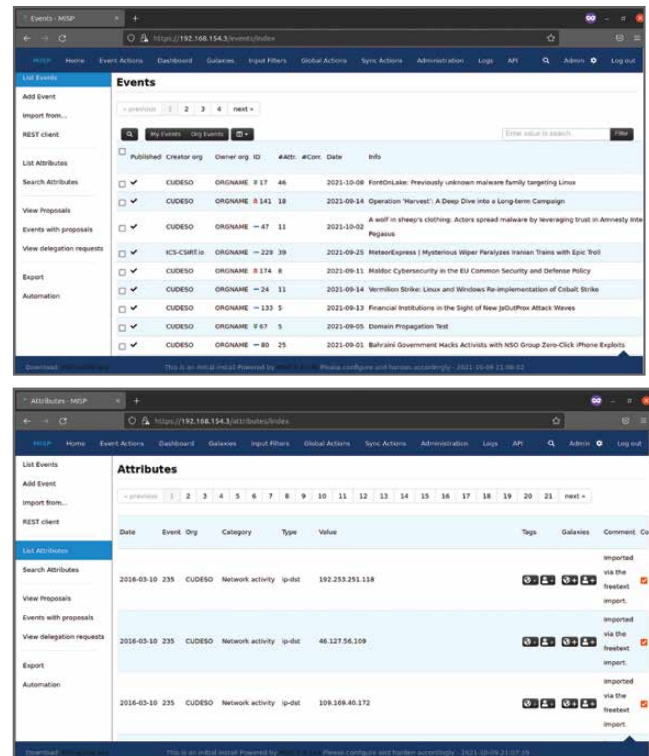
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Herman Miller
Live Platform CAD Ingestion

With over 100 years of experience, Herman Miller is a globally recognized provider of furnishings and related technologies and services. Headquartered in Zeeland, Michigan, Herman Miller has been innovating new ways to design and analyze the places people work, learn and live.

Herman Miller has created Live Platform, a service which allows users to visualize and analyze their workspaces. Live Platform uses sensors placed on furniture to monitor occupancy and usage of different areas in the space. Live Platform previously used simple images to display workspace floorplans, which resulted in a loss of important data.

Our Live Platform CAD Ingestion software allows Herman Miller administrators to use computer-aided design (CAD) files to display these floorplans.

Our software allows for the supplying of sensor positions and the checking of hardware constraints. An algorithm is used to convert CAD files into a format readable by our web application.

The web application displays information on all floorplans. Each floorplan has a tenant owner, name, and is part of a campus and facility. Administrators can filter floorplans based on their attributes. The navigator tab allows for the finding and editing of floorplans displayed by the filter. Floorplans can also be added and removed. The viewer tab displays the layout of the selected floorplan. Users can toggle various floorplan information, such as sensor locations.

Our system automates the process of ingesting CAD files with sensor data into the Live Platform service, saving Herman Miller administrators time and increasing productivity.

The front end of the web application uses React, Redux and Bootstrap. The back end uses Node.js and Amazon Web Services, including Lambda, Simple Storage Service, and DynamoDB.
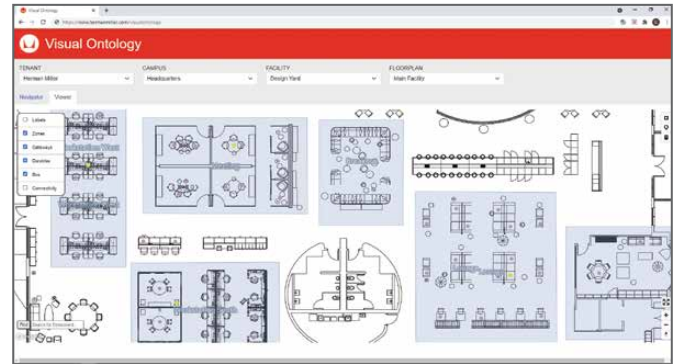
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Lockheed Martin Space
SmartSat™ Satellite App Store

Lockheed Martin Space, headquartered in Denver, Colorado, is one of the largest space defense contractors in the world, employing over sixteen thousand people that develop an impressive range of products from satellites to space probes to missile defense systems.

Currently, Lockheed Martin Space is revolutionizing the way new software is written, tested and deployed to their diverse range of satellites through their SmartSat system. SmartSat provides a standardized format for software applications.

Lockheed Martin Space's satellites can vary in a few key ways, specifically when it comes to computational hardware, software development kits, and operating systems. Because of this, certain satellites are incompatible with some specialized software.

Our SmartSat Satellite App Store is a web-based marketplace for browsing, uploading, and installing mission-ready applications to live satellites. The SmartSat App Store also includes rigorous software testing that automatically determines what software is compatible with which satellites.

Every new application uploaded to our app store is put through our automated compatibility testing to assess the Lockheed Martin satellites on which the software can be deployed. The test results are sent back to the App Store and displayed for application developers, saving them many hours of rigorous testing.

To ensure reliability, our App Store runs every new piece of software against every possible target hardware on real, physical devices. The ability to test on real hardware instead of simulation offers peace of mind to Lockheed Martin engineers.

The SmartSat Satellite App Store uses SmartSat Defined Services to perform the automated testing on the target hardware. SmartSat Satellites access these services through built-in file servers linked with the Flask back end. The front end of the SmartSat Satellite App Store is built with React.
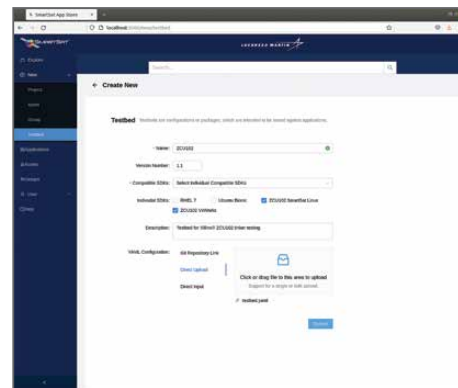
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Malleable Minds
Review Aggregator for Educational Programs

Malleable Minds is an emerging startup, building the world's most extensive collection of PreK-12 programs from the arts to the sciences so students can further develop academic, interpersonal, and communication skills.

The internet allows individuals across the globe to gain access to educational opportunities they previously could not. Despite this, children's educational programs are scattered across the web. This disorganization makes it difficult to make a custom education plan for a child. There is a need for a centralized way to explore and compare educational programs.

Malleable Minds' flagship program is a review aggregator that allows for easy browsing and comparison of PreK-12 educational programs. Parents and educators use the site to create and read reviews of these programs, offering the user a centralized platform for exploring educational programs online.

Our Review Aggregator for Educational Programs project builds many features on top of the existing review aggregator website and improves site performance.

The site's users benefit from several new additions. Our recommendation engine provides the user with tailored suggestions for new educational programs based on their interests. Parents can track their children's progress towards developing new skills with the new skill system. Additionally, users are awarded different statuses based on their contributions to the site.

Malleable Minds administrators can view usage statistics on the activity dashboard and use this information to improve the site.

Our enhanced site is faster, more efficient and includes new features that enrich the user experience.

Our software uses React on the front end and Python on the back end. We host our software on Amazon Web Services, and our user activity dashboards are stored on Metabase.
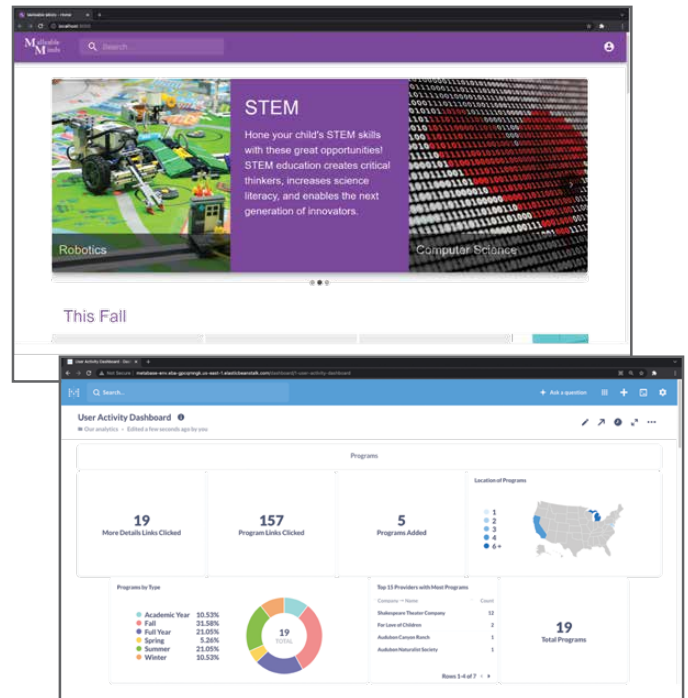
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Meijer
mHealthy: Healthy Eating Application

With over 250 supercenters, Meijer is one of the largest retailers in the United States based on 2020 revenue according to the National Retail Federation. Meijer offers a vast array of products ranging from home goods and furniture to pharmaceutical needs and groceries. They strive to assist shoppers to take care of the health and wellness of themselves and their families.

Many shoppers want to make healthy decisions when shopping but feel overwhelmed trying to do so. Finding healthy replacements can be a daunting task and may discourage shoppers from learning about healthier options or better diets. Educating shoppers and improving their experience is imperative to establishing lifelong customers.

Our mHealthy: Healthy Eating Application guides shoppers with nutritional advice according to their selected dietetic preferences. Several unique profiles can be created to allow shoppers to curate their shopping experience for family, friends and special events.

In a shopping session, a single profile is enabled to filter products that are accustomed to the shopper's personalized preferences. As items are added into the cart, the application reviews these items and recommends additional products that better suit the shopper's dietary preferences. Shoppers ultimately benefit from an easier and more informative shopping experience.

Our application encourages shoppers to eat healthy and provides an easy-to-use interface. Health-conscious shoppers are more likely to visit a Meijer supercenter thanks to our intuitive application.

Our mHealthy: Healthy Eating Application is both a web and a mobile application. The website is written using PHP, HTML, CSS and JavaScript, while the mobile application uses Java, Kotlin, XML and Android SDKs. SQL is used to manage and store the data.
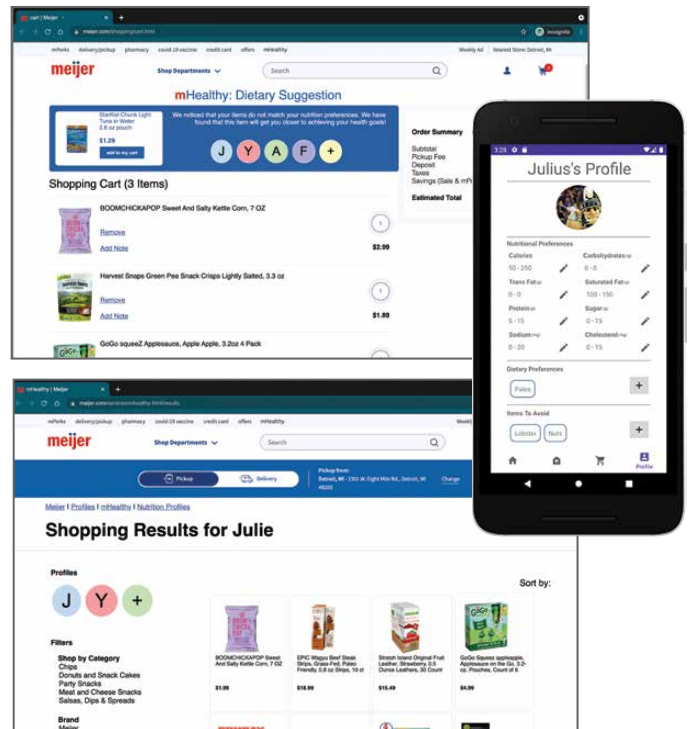
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Microsoft
Feedback Prompt for Ratings in Google Play Store

Microsoft is a multinational and industry-leading technology company best known for developing numerous operating systems, software, and online computing service platforms. Microsoft's Intune Company Portal is a data and device management system that is used by tens of thousands of companies worldwide and requires individual employees to install its app on their devices.

User feedback about Intune Company Portal provides insight that developers can use to create and maintain a premium user experience. However, collecting and analyzing reviews is a tedious and time-consuming task, requiring manually searching dozens of review websites and plotting the data.

Our Feedback Prompt for Ratings in the Google Play Store system improves the overall review collection and analysis through an easy-to-use in-app review prompt for users, and automated review collection and analysis for Microsoft engineers.

To facilitate easier and more representative review collection, we integrate an automated in-app review prompt that actively promotes user feedback for the Intune application on Android. Our system removes the need for users to navigate to the Play Store and makes leaving a review quick and easy.

Our system employs a suite of web scrapers that search the internet for reviews of Intune and saves them for future analysis. We use natural language processing and machine learning to search for patterns in user reviews that might signify any bugs or issues and to determine sentiment towards the app. The results of the analysis are sent to Microsoft engineers using a Microsoft Teams Bot that delivers monthly analysis.

The front end uses the Microsoft Bot Framework and Android Studio for the in-app prompt. The back end consists of a SQL Server database hosted on Azure. The analysis pipeline is hosted on Azure and utilizes Node.js web scrapers and Python scripts.
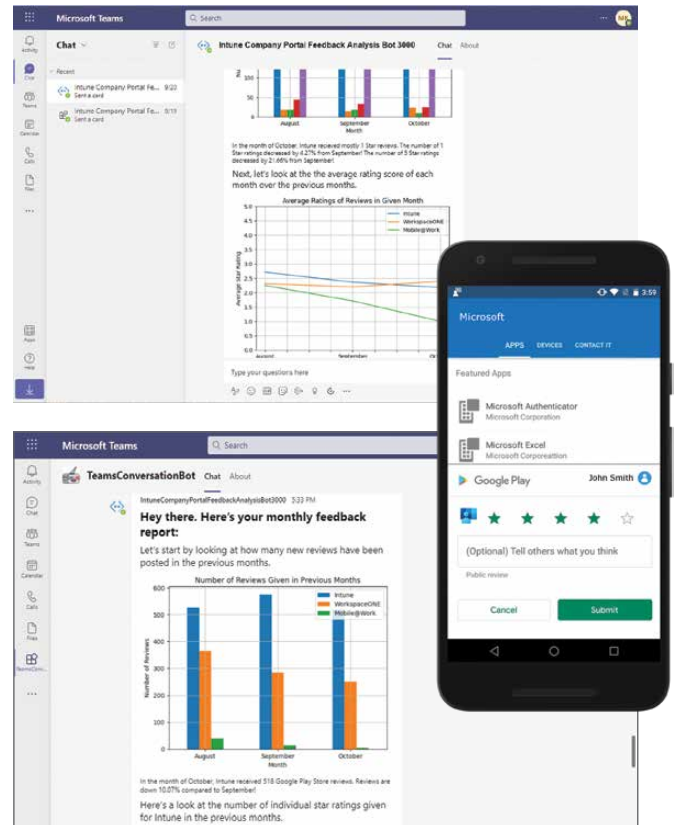
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Mozilla Corporation
Improve High Contrast Mode for Firefox

Mozilla is a global, not-for-profit organization dedicated to improving the World Wide Web. They have an international community of developers who contribute to open-source software.

Mozilla's most popular open-source project is Firefox, with over 210 million monthly active users. Mozilla's goal as a company is to promote an open and inclusive internet. Part of this is making sure Firefox is usable by as many people as possible.

To achieve this goal, Firefox offers high contrast mode, which is a huge part of making the browser as accessible as possible. High contrast mode improves the visibility of Firefox's user interface by changing the colors in order to maximize contrast. This is important as it allows people with visual impairments to be able to receive the entire Firefox experience.

While the high contrast mode currently in Firefox is an essential feature for making the browser more accessible, there is still more that can be done to make high contrast mode even better. Specifically, high contrast mode does not perfectly cover the entirety of Firefox's user interface. This leads to confusion among users with visual impairments and an overall non-optimal user experience.

Our Improve High Contrast Mode project focuses on fixing many of these smaller issues to greatly improve the user experience of high contrast mode inside of Firefox. Our additions include things such as adding outlines to tab buttons, improving icon visibility and adjusting button colors to improve contrast.

In the screenshots to the right, one can see various pages of the Firefox browser using our Improve High Contrast Mode for Firefox project.

To implement our fixes, we edit and improve the already existing CSS, JavaScript, and HTML of Firefox. Additionally, some of our edits are written in C++.
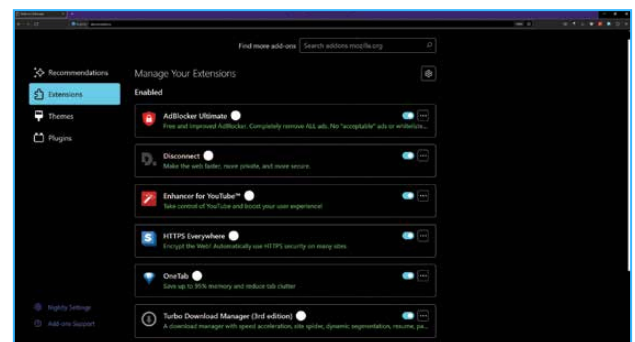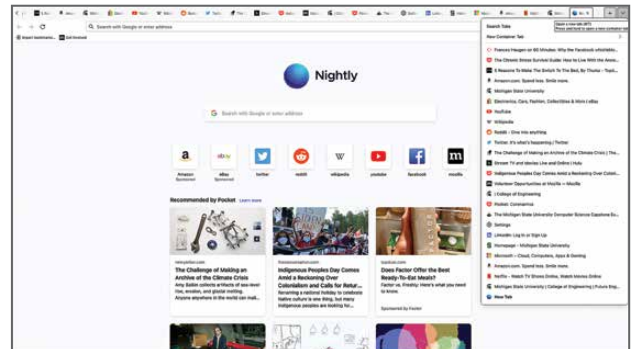
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MSU Federal Credit Union
Spaving: Giving based on Spending Habits

Founded in East Lansing in 1937, MSUFCU, also known as the MSU Federal Credit Union, provides various financial services to students, faculty, and staff at Michigan State University. With 21 branches, over 300,000 members, more than $6 billion in assets, and nearly 900 employees, it is the largest university-based credit union in the world.

MSUFCU provides a variety of financial education resources to its customers to ensure they are making the best monetary decisions possible. One of these resources, acquired by MSUFCU's Credit Union Service Reseda Group, is a banking app known as Spave. Spave is a mobile application that allows users to donate a small amount to chosen charities every time they make a transaction.

Our Spaving: Giving based on Spending Habits project enhances the Spave mobile application with a recommender engine, providing users with recommendations for which charities the user should consider donating to, as well as alerting them to these recommendations.

Our most significant addition to this mobile app is a new recommendations page where the user can see the various suggested charities. These recommendations range from simple comparisons to other users, to recommending charities they may enjoy donating to based on how they spend their money.

Users can like or dislike recommendations to influence what is recommended to them. Recommended charities can be clicked on to present the user with further information regarding the selected charity.

Our front-end additions to Spave are built using Android Studio, Xcode, React Native and Typescript while the back end utilizes Express.js, Node.js, machine learning and Amazon Web Services.
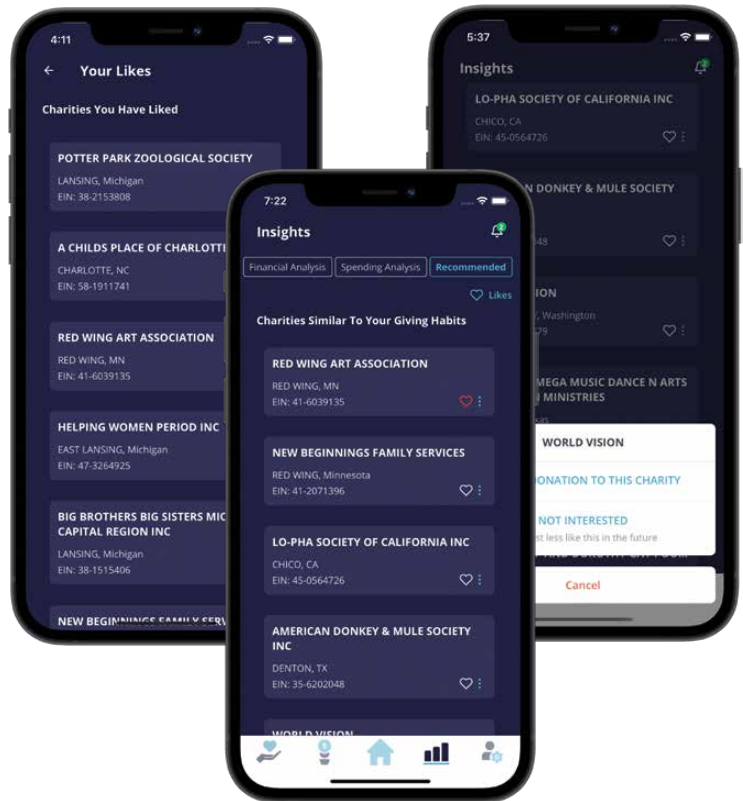
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PwC
Collaboration Bot for Microsoft Teams

PwC is a global leader in professional services, from tax and audit to technology and strategy consulting. PwC is a partnership of firms, consisting of over 250,000 employees operating under one brand, making it one of the largest professional services networks in the world.

Collaboration with clients is key to PwC's business, and as such, their clients want to use newer and more ubiquitous technologies, such as Microsoft Teams and OneDrive.

Currently, collaboration requires external users to be invited into the PwC Microsoft environment and given access to Microsoft Teams and OneDrive securely. This requires significant work from an IT administrator who has to manually set this up, and in some cases seek out and get approval from the PwC clients. The entire process takes a significant amount of time and energy that could be better spent elsewhere.

Our Collaboration Bot for Microsoft Teams allows PwC employees to establish collaborative partnerships with external companies within the Microsoft environment with little to no work from an IT administrator.

Our software provides an easy-to-use interface within Microsoft Teams that allows PwC employees to easily send bulk invitations to external collaborators without having to manually approve each user and grant them access privileges.

Once invitations have been sent to external clients, our bot automates the entire approval process in the background, allowing PwC employees and IT administrators to spend their time on more significant issues.

The front end of our Collaboration Bot for Microsoft Teams is built using Node.js and ReactJS, which communicates with Microsoft Azure Active Directory and an Azure Database via Microsoft Graph API calls.
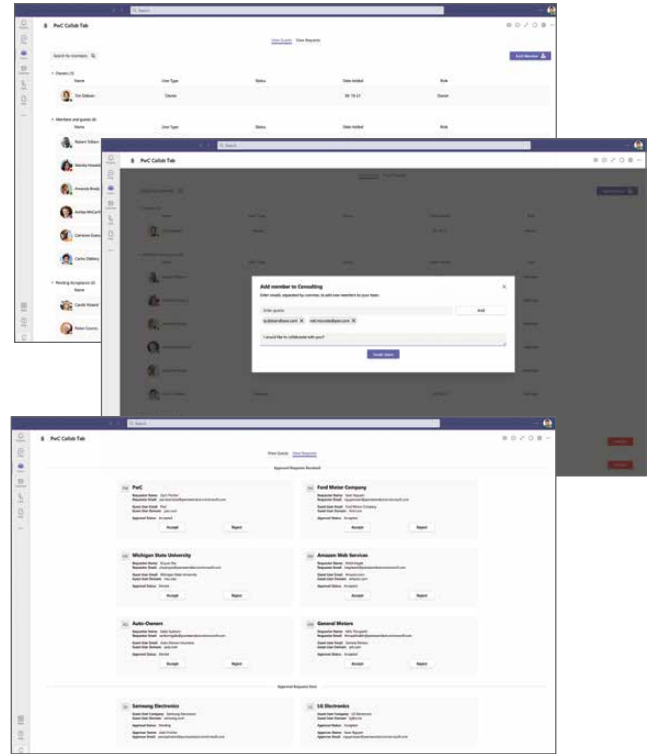
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The Rocket Companies
ROCKY: Team Challenge Application

The Rocket Companies are made up of 15 publicly traded companies involved in many different industries, including mortgages, fintech, real estate, automotive and more. They employ over 26,000 team members and are committed to providing the best team member experience they can.

More and more companies are taking strides to improve the mental and physical wellbeing of their team members. Our ROCKY: Team Challenge Application improves the team member experience by promoting wellness with a fun and interactive web application.

ROCKY provides a platform for Rocket team members to compete in challenges against other team members to promote wellbeing, community and productivity. Challenges can measure any number of attributes such as steps walked, hours volunteered, and loans closed.

Challenges can be created as either team or individual challenges. To join a team challenge, team members can create a team, join an already existing team, or enter the challenge as free agents, who are assigned to teams at the start of the challenge. Team members who create a team can send invites out to other team members to join their team.

The challenges page has a list of all active challenges a team member can join and details about the challenges. This list can be filtered by the category of the challenge, the attribute being measured, or whether it is a team or individual challenge.

The user's home page contains information about the challenges that user is currently participating in as well as any pending invitations to join a team challenge.

The front-end user interface of ROCKY is built in Angular. The back-end data is stored in an Amazon Aurora database with a .NET Core RESTful API to query the database.
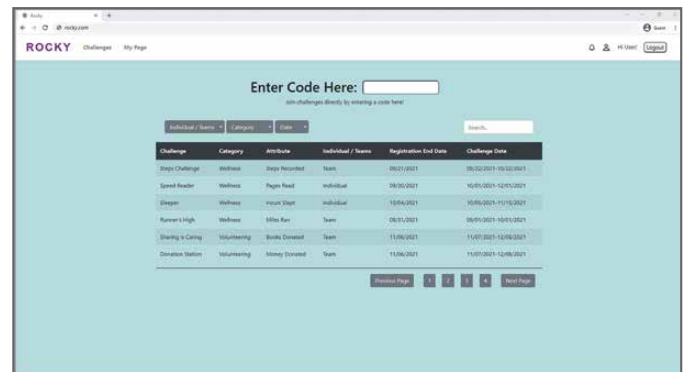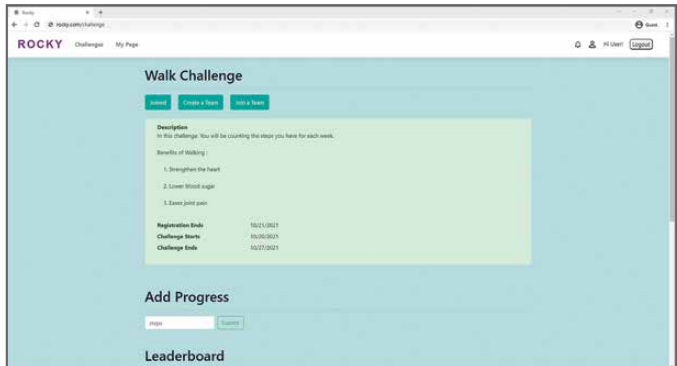
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Stellantis
Interactive Digital Assistant

Stellantis is a leading global automaker and a mobility provider headquartered in Amsterdam with operations in nearly 30 countries and a worldwide workforce of over 300,000 employees. Stellantis is guided by a clear mission: to provide freedom of movement through distinctive, appealing, affordable, and sustainable mobility solutions.

In today's fast-paced world with responsibilities spanning multiple projects, staying up to date with the latest information is critical for Stellantis employees to make timely decisions and reassess priorities.

Our Interactive Digital Assistant is a web-based chatbot that allows Stellantis employees to ask general form questions in a life-like conversation about a wide variety of topics, including project statuses, issues or incidents, business applications, process contacts, etc. in a timely manner.

Our Interactive Digital Assistant first asks general questions of the employee to ensure they have the proper credentials to access the documents in which they are interested. Once the user's identity has been confirmed, the user can ask any question they want.

Once a question has been received, our natural language processing algorithms parse the request and search multiple documents for the correct answer. Our Interactive Digital Assistant can provide answers to questions in less than a second, whereas manually searching all the relevant documents would take from minutes up to hours.

Our Interactive Digital Assistant helps employees find crucial information quickly, allowing them to spend their valuable time focusing on more important tasks.

Our front end is developed in CSS, HTML, JavaScript, and PHP. Our system utilizes the AWS Cloud Platform with Python. Our APIs are hosted by Google Cloud Platform and Drive IT.
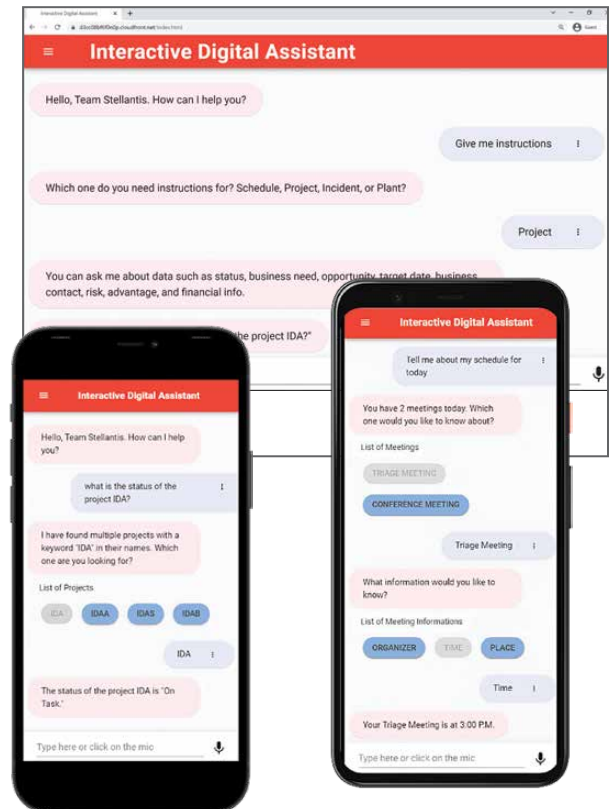
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TechSmith
Snagit Template Creator

Headquartered in Okemos, Michigan, TechSmith is a software company that develops screenshotting, screencast and video editing software. TechSmith's products have over 73 million users worldwide. Snagit, one of the company's flagship products, is a simple, but powerful screen capture and recording software that allows a user to quickly capture their screen, add additional content, and easily share with others.

Templates in Snagit are designs users can download to more easily create graphics instead of starting from scratch. Currently, Snagit templates can only be created using internal TechSmith tools, making it a challenge for partners or savvy customers to create their own templates.

Our TechSmith Snagit Template Creator platform provides a solution to this problem through an intuitive web application that allows users to easily create, download and share Snagit templates with others.

TechSmith Snagit Template Creator allows users to customize templates through a variety of graphics objects including drop zones, shapes and lines. Once the creation of a template is complete, users can download it, share it with colleagues or save it within the web application for later viewing and use.

When a user downloads a template, they can import the template into Snagit, where it can be utilized just like existing pre-defined Snagit templates.

The additional creative power and flexibility our system provides greatly enhances the Snagit experience and makes Snagit a more attractive option for those looking for a graphical editor.

TechSmith Snagit Template Creator uses Microsoft Azure for data storage and sign-in. The front end is built using ReactJS, and the back end is built using .NET Core.
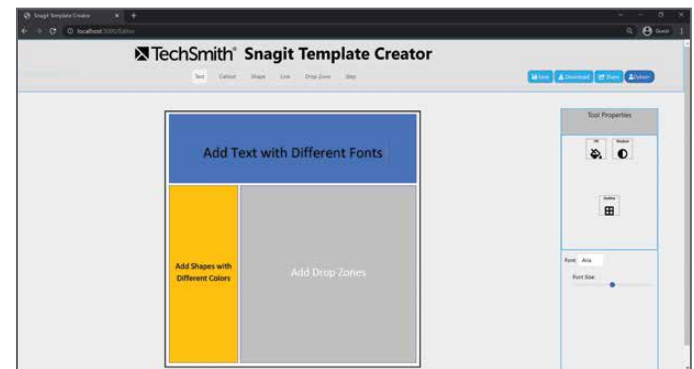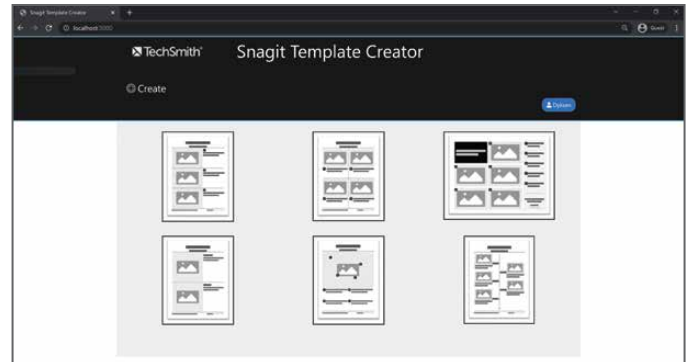
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United Airlines
Gate Hazard Geo-Mapping

United Airlines, Inc. is a leading American airline headquartered in Chicago, Illinois. In 2019, United and United Express operated more than 1.7 million flights carrying more than 162 million customers to their destinations safely.

Safety is United Airlines' highest priority at every airport. A major component of that commitment to safety is being aware of the hazards faced by aircraft and operations staff at each gate.

United Airlines Safety & Compliance staff record data on the hazards faced at each airport gate. This information is then referenced by employees when they begin working at the gate to ensure both their own safety, and the safety of their aircraft during operation. United Airlines is exploring ways to further standardize this process and make the information more accessible.

Our Gate Hazard Geo-Mapping software allows staff to enter observed hazards into their mobile device, and automatically generates GPS placement data, as well as an interactive map visualization to allow seamless cataloging and sharing of gate-specific hazard information.

When United Airlines staff identify a hazard, they can open our application and select an airport and gate. They then mark the area where the hazard exists, record a title, description, the level of risk the hazard poses, and which departments should be aware of the hazard.

When other United Airlines employees visit a gate to work, they use our application to quickly familiarize themselves with the hazards at the gate to ensure they are adhering to the strict safety protocols.

The website front end is written in HTML, JavaScript, and CSS. The back end consists of a MySQL database and PHP code for both the API and data processing. The Android and iOS application is written in C# utilizing Xamarin for cross-platform development.
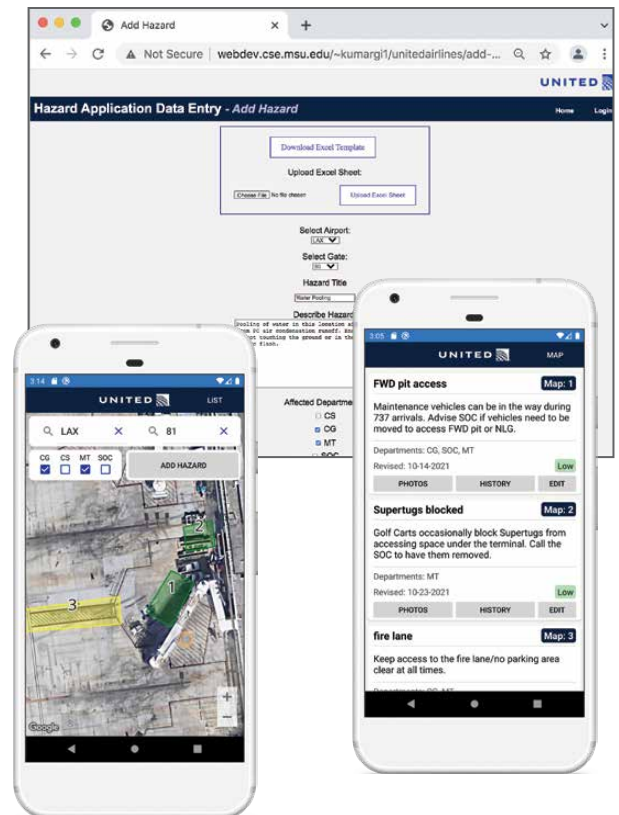
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United Airlines
QA Audit Center

United Airlines is a major American airline company headquartered in Chicago, Illinois. Every day, United Airlines unites the world using the most comprehensive domestic and international network routes possible. This network connection requires United Airlines to hold themselves to the highest standards in safety and reliability, promote trust, and ensure flights are on schedule.

Within United Airlines, the Technical Operations Quality Assurance division plays a vital role in meeting United Airlines' shared goals of efficiency, reliability, and safety.

To accomplish this, the United Airlines Quality Assurance team conducts live audits to ensure all equipment and services are maintained according to Federal Aviation Association (FAA) standards. Current audits require handwritten documents that are hard to keep track of and difficult to share.

Our Quality Assurance Audit Center Platform serves off-wing quality assurance auditors and provides them with a solution to have electronic access to audit documentation on their mobile devices. Our system converts a currently paper-and-pencil audit process to completely digital.

Our system recreates digital versions of forms used by auditors, which facilitates easier saving, editing, and submission of audit documentation. Additionally, our mobile applications allow real-time access to the camera to easily photograph and attach evidence to audit forms.

The time of auditors is valuable, and our system allows them to perform their duties in an efficient manner that reduces errors.

The front end of our application is written in Java for Android integration. The back end is hosted on Google Firebase. PHP performs government website scraping and stores updated data on the SQL Database hosted on the Michigan State University server.
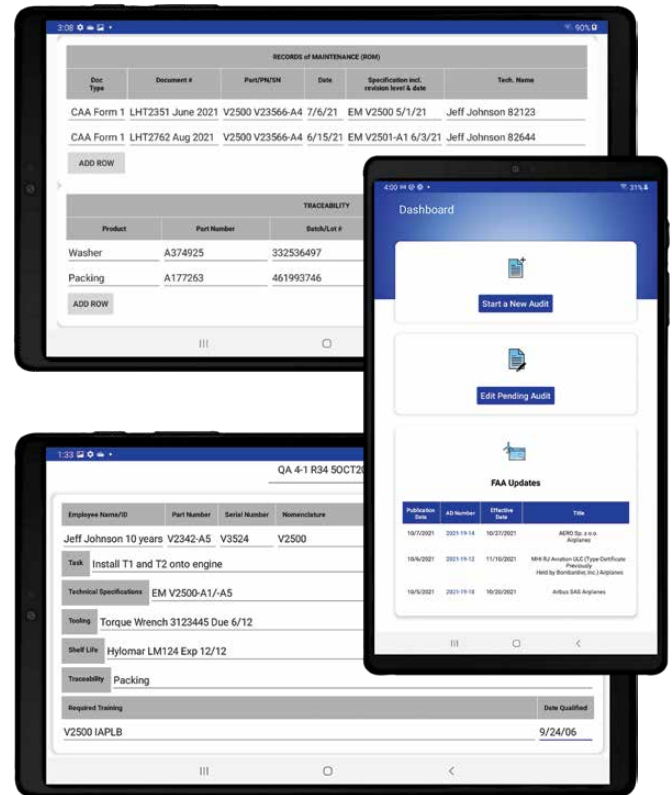
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Urban Science
Independent Repair Facility (IRF) Insights

Urban Science is a global data-driven company headquartered in Detroit that has provided tailored insights and solutions for the automotive industry since 1977. As a global company that has served every major automaker, Urban Science analyzes the market to pinpoint issues and propel success for their clients.

One of the most profitable components of automotive business is aftersales, the parts and services sold after a car is purchased. Independent Repair Facilities (IRFs) vastly outnumber dealers, dominating the aftersales sector. Without comprehensive information on IRFs, dealers miss an opportunity to increase customer retention and grow service revenue.

Our Independent Repair Facility Insights web application alleviates this gap of market knowledge through leveraging telematics data. Telematics systems in vehicles monitor a wide range of information including vehicle location, engine diagnostics and vehicle activity.

Using the telematics data, users are notified of what IRFs customers are selecting over the dealership for aftersales. This information is displayed on our web application and provides dealers with information such as IRF rankings and analysis on top-performing IRFs in their area of responsibility.

Users gain insights into the competitive landscape of aftersales through data visualizations and an interactive map. Leveraging clustering analysis and natural language processing, tailored solutions are generated for each dealer.

Our software enables the user to efficiently survey telematics data, explore critical components of IRFs, and utilize our data-driven solutions to better compete with IRFs and increase sales.

Our application is built using Angular, Typescript, HTML and CSS. The back end uses ASP.NET Core 5.0 APIs written in C# and is connected to an Azure SQL Database.
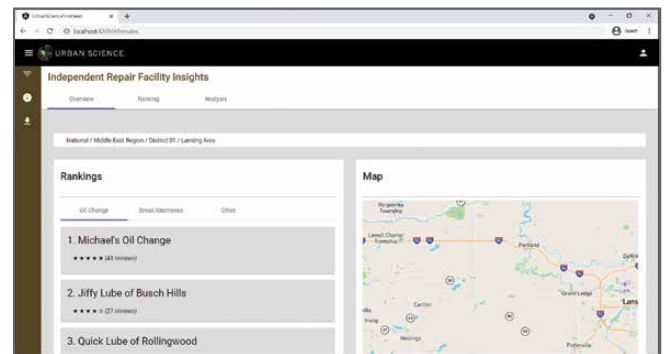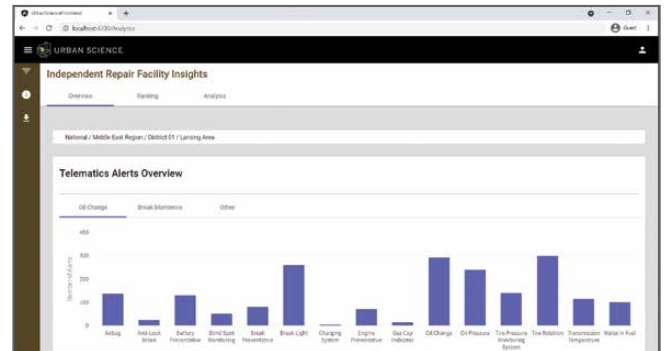
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Vectorform
Smart Auto-Time Logging

Founded in 1999, Vectorform is headquartered in Detroit with seven offices across the globe. It is a company designed to help organizations move from an idea to an invention with digital products and hardware solutions. They combine a variety of technologies such as the Internet of Things, augmented or virtual reality, and other emergent systems to develop solutions for their clients.

Employees at Vectorform work on multiple projects at a given time using various tools and software development platforms. Keeping accurate totals of time spent on a given billable project is extremely important to both the company and their clients. Entering time statements manually is time-consuming and error-prone. Previous automatic time tracking systems fail to properly distinguish between different projects within one program.

Our Smart Auto-Time Logging system solves this issue by generating accurate and reliable time statements for software development and communications.

Users start the program before beginning their workday. The system generates accurate time statements throughout the workday by monitoring the programs in operation on the user's computer and associating them to a project billing code through smart analysis.

Time statements are viewed through a web application to be confirmed before being sent to Vectorform's billing department.

Our system automates the time-tracking process, eliminating the need for Vectorform employees to do it by hand, saving time and increasing the accuracy of the billing process.

The front end of our Smart Auto-Time Logging system is built using ReactJS, while the back end is implemented using C#. Both sides of the program interface with an SQLite database through the use of Node.js.

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Volkswagen Group of America
Car-Net® DriveView Social Competition App

Volkswagen Group of America is the North American operation headquarters and subsidiary of the Volkswagen Group, which facilitates the U.S. operations of many brands of vehicles.

Car-Net was introduced by Volkswagen in 2013 with features that allow Volkswagen owners to easily access their vehicle with a mobile device, along with other features designed to improve the driving experience.

With nearly 5.25 million accidents per year in the United States, finding ways to encourage safe driving habits is an ongoing challenge. There is a need to encourage drivers to drive safely.

Our Car-Net DriveView Social Competition App is a social media mobile application that allows users to compete against each other by driving safely. Users who drive the safest are placed at the top of the leaderboards for other users to view.

Drivers achieve these safety scores by completing objectives relating to safe driving. With our application, users track their driving achievements by simply using their vehicle. A user's safety score is calculated using these achievements as well as vehicle data.

To promote competition between users, leaderboards allow users to track how well they are doing compared to other drivers in their region.

Our application also allows users to filter who they are competing against. These filters include an overall distance driven by other drivers, other users' overall safety scores and a radius of other drivers near them. In addition to those filters, users may also check how they stack up based on the current day, week, month or year to see how they have progressed against other users.

Our Android application is written in Java and uses Firebase for user authentication. The back end is written in Python with Flask libraries to communicate with the app through HTTP messages.

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Whirlpool Corporation
AI Recipe Converter

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is the world's leading major home appliance company with approximately $20 billion in annual sales and 75,000 employees. Whirlpool's goal is to improve home life through the production of a variety of home appliances.

To this end, Whirlpool provides smart cooktops that automatically set the temperature and timers according to recipe instructions. Recipes must be formatted in a specific way to be used by these devices. Previously, it was the task of Whirlpool's food scientists to convert recipes into the specialized format. However, manually converting these recipes is time-consuming.

Our AI Recipe Converter assists Whirlpool food scientists in this task by automatically converting recipes on cooking websites into the machine-understandable format. Using natural language processing, information such as ingredients, cooking temperatures, and cook times are extracted from recipes. The final automatically-generated recipe can be viewed on our web dashboard and exported to a Whirlpool smart cooktop.

Food scientists at Whirlpool upload a set of recipe URLs to our web application. These recipes are then converted by our software into the specialized format. Food scientists can then verify that the recipes have been converted correctly and make edits to the recipe. Finally, they can view all of their previously converted recipes.

The AI Recipe Converter saves Whirlpool time and accelerates the growth of their automated recipes library, ultimately alleviating the burden on food scientists and creating a better customer experience.

Our front-end web application is built with AngularJS while our back end utilizes MongoDB, Node.js, and Python. All components of the application are hosted on Amazon Web Services.
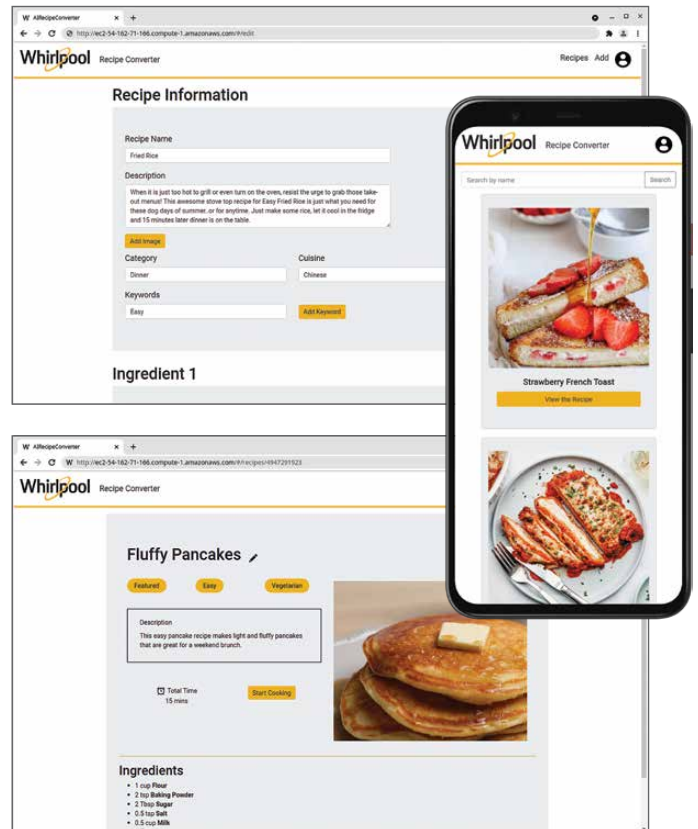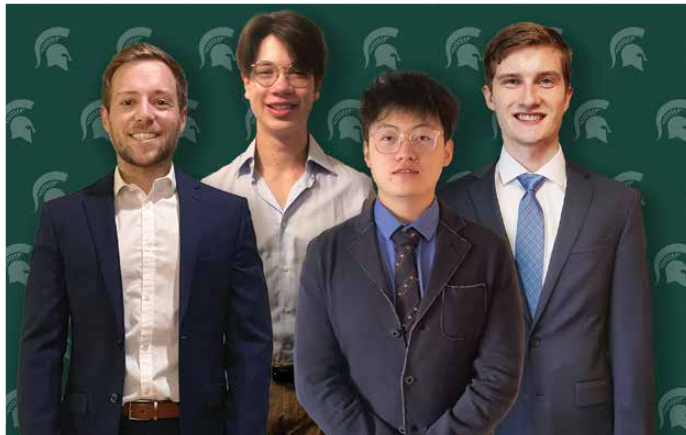
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DESIGN DAY

At the end of each semester, the College of Engineering sponsors Design Day, at which student teams from throughout the College showcase their Capstone projects throughout the Engineering Building.

Computer science capstone teams demonstrate the software projects that they have designed, developed and delivered for their corporate client. Teams compete for four awards, which are conferred by a panel of corporate judges.

MSU President Samuel Stanley addresses the Design Day attendees.

College of Engineering Dean Leo Kempel presents Ross Hacker of Auto-Owners Insurance with a commemorative framing.

THANKS TO AUTO-OWNERS INSURANCE

We thank Auto-Owners Insurance, a Fortune 500 company headquartered in Lansing, Michigan, for their continued support of Michigan State University and the Capstone Experience, including the printing of The Capstone Experience booklet.

Check out the Capstone Experience web site at www.capstone.cse.msu.edu. For more information about the capstone experience or becoming a capstone project sponsor, contact Dr. Wayne Dyksen by email (dyksen@msu.edu) or by phone (517-353-5573).

Project Sponsors Spring 2022

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Ally Financial
Ally P2P Lending Platform

Ally Financial is a financial services company based in Detroit, Michigan, operating as one of the largest car finance companies in the United States. Ally offers online banking and online trading, bolstering the services they provide for their customers.

Acquiring loans is an important utility Ally provides its clients. However, sometimes customers desire to borrow a small sum of money and don't want to go through a potentially lengthy process of submission and approval to do it.

Our P2P Lending Platform enables Ally clients to quickly loan each other money without the need for a bank to be a middleman.

Both lenders and borrowers can enroll in the platform. If a borrower is looking for a loan, they can simply post a loan request. Lenders can view this request and choose whether to accept it or not. Competitive interest rates are charged, and instant loan payout is supported.

The ability to combine loans ensures the best possible rate, granting even more flexibility. Lenders earn money by funding these loan requests from interest when clients repay their loans. Our software calculates risk scores for each loan to help lenders understand how likely the borrower is to be able to repay the money.

Our system facilitates quick and streamlined moneylending between users in a decentralized system, providing clients a quick way to acquire a loan.

Our front end is created using React and backed by Node.js, enabling us to manage and communicate among different software technologies.

Our back end is handled over the Ethereum blockchain to ensure quick and private ether transfers. This decentralized approach makes it possible for clients to use our P2P Lending Platform anywhere.
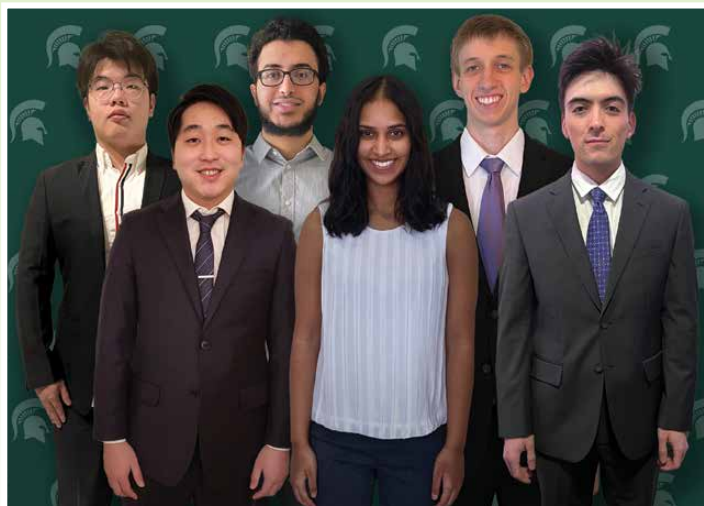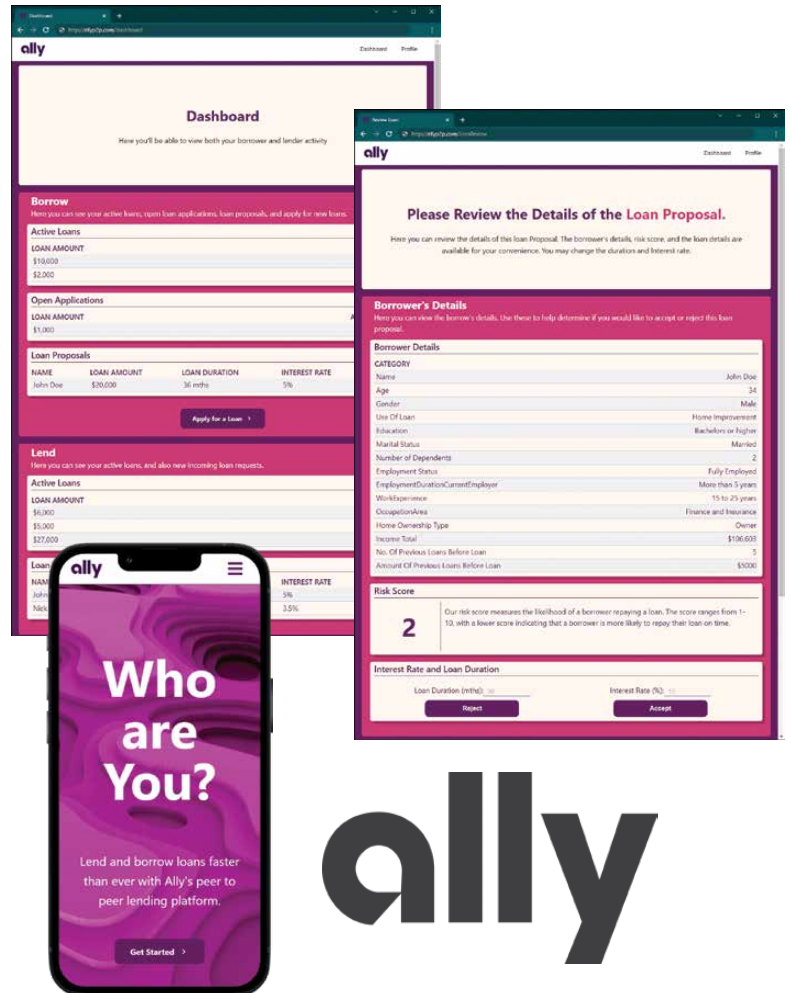
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Amazon
## Amazon Shop Smart: Web Extension for Shopping

Headquartered in Seattle, Washington, Amazon is a Fortune 500 company that started out as an online bookstore but has grown to become one of the world's largest online retailers and cloud services providers with Amazon Web Services (AWS). Amazon also provides various services such as audio and video streaming through their subsidiaries: Amazon Music and Prime Video.

Amazon works tirelessly to provide products to their customers that offer the best variety, price and convenience. As part of this endeavor, Amazon wants to ensure its customers are taking full advantage of Amazon's prices and services when shopping on Amazon and other retail sites.

Our Amazon Shop Smart: Web Extension for Shopping is a browser extension that aids customers in finding the best deals on Amazon. Amazon Shop Smart tracks products indicated by customers, then periodically checks for price drops on Amazon's marketplace. A notification is sent to the customer when their desired product is being sold at their ideal price point. Graphs of a product's price history can be viewed to determine the optimal time to buy.

While browsing any supported E-commerce website, our Amazon Shop Smart extension provides customers with links to similar items that can be found on Amazon, as well as detailed information such as savings and shipping costs.

The front end of our Amazon Shop Smart: Web Extension for Shopping is built using HTML, CSS, and JavaScript, while the back end is implemented using AWS tools, including DynamoDB, Elastic Compute Cloud, Lambda, and Cognito. Our extension is available on Google Chrome and Microsoft Edge web browsers.
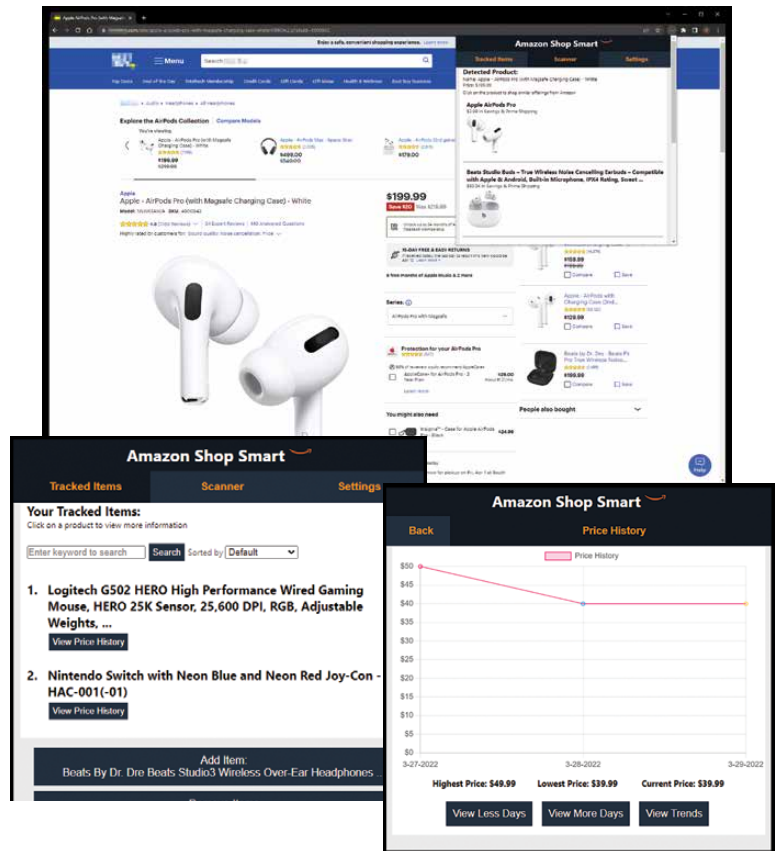
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Anthropocene Institute
Wildfire Risks Forecasting Tool

The Anthropocene Institute is a non-profit organization located in Palo Alto, California. They unite entrepreneurs, thought leaders and investors to advance clean energy technology and climate policy.

The National Interagency Coordination Center reports that in 2020, 58,950 wildfires burned 10.1 million acres (about twice the area of New Jersey), the second-most acreage impacted in a year since 1960. Nearly 40% of these acres were in California. A vital component of wildfire safety is public awareness and education.

Our Wildfire Risks Forecasting Tool provides users with an interactive web application that helps them understand the impacts of wildfires in their communities. Our tool provides visualizations of wildfire spread, as well as educational information about damages posed by wildfires and strategies for wildfire mitigation.

Our tool utilizes decades of research conducted by the US Forest Service to create an accessible, physics-based wildfire simulation interface that shows how a wildfire might spread.

Individuals can simulate fires under a wide variety of conditions, including current or historic weather conditions, and can also manually adjust parameters such as temperature, humidity, wind speed, and wind direction. In addition to wildfire spread, users can view estimates of damage caused by these fires as well as footprints of historic fires. Our tool provides users with strategies to enhance their own safety and the safety of their communities.

The simulation model is based on FARSITE, utilizing weather and fuel data curated by US Government agencies. The tool is fully implemented in Python. Our back end uses the robust geospatial data frameworks of Xarray and netCDF, as well as the numerical efficiency of NumPy and Numba. Our front end is a Flask-based web server utilizing Plotly for visualization.
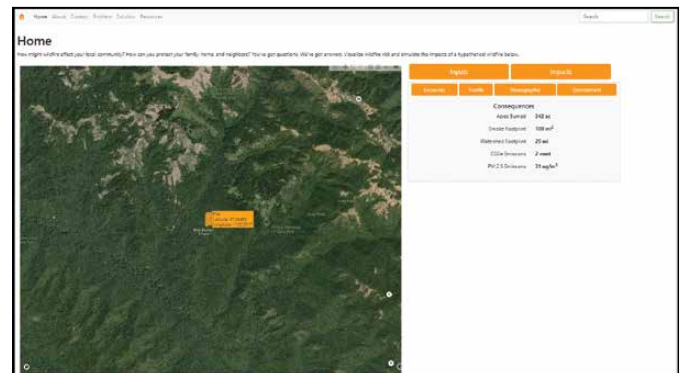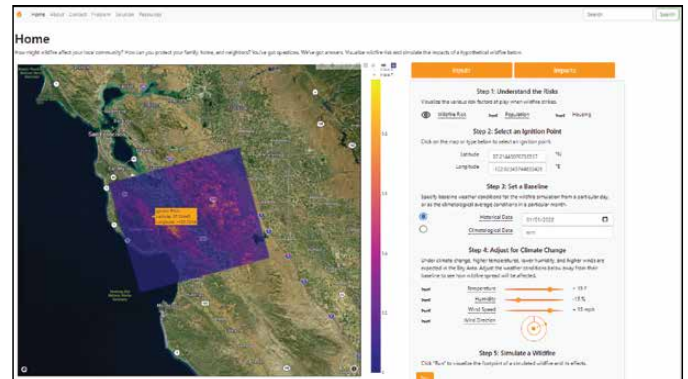
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Auto-Owners Insurance
RecruiTrack

Auto-Owners Insurance is one of the largest insurance companies in the United States. Operating in 26 different states, along with the corporate office based in Lansing, Michigan, Auto-Owners services almost 3 million policyholders.

With such a large company, there is a plethora of employees throughout the states of operation. Every one of these employees must perform to the standards of the company, and the recruiting team plays a significant role in this. This team works diligently to find the best people for the numerous positions that exist at Auto-Owners. With so much potential talent, there is a great deal of work involved in finding the best candidates.

Our RecruiTrack system is a web application that alleviates the amount of labor that recruiters must use to keep track of all the different places from where they recruit talent, as well as tracks the information that must be noted to make sure all the recruiting events they attend are properly staffed and fully funded.

As RecruiTrack is populated with the data that recruiters at Auto-Owners must keep track of, this application becomes a one-stop shop for all things recruiting. It can be accessed through any device that has a web browser.

The app automates reports that must be generated by recruiters to get funding approved for all the events that they organize each year, provides accessible, easy-to-read tables with all the essential recruiting data they currently have, and enables users to manually input and edit data in the application.

With RecruiTrack, recruiters spend less time on manual data entry and writing reports, instead spending more time out in the field finding the best, new talent through this intuitive website.

RecruiTrack is hosted on a Windows server with our front-end software built with Angular, our back-end software built with Java, and a Microsoft Azure SQL Server Database for database hosting.

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Caxy Interactive
Remote Energy Distribution Payment Platform

Caxy Interactive is a full-stack digital development company based in Chicago, Illinois. For over 20 years, they have offered solutions for a variety of sectors, including non-profits, startups, and educational programs.

Reliable energy access is not only essential but also fundamental, for developing regions. Caxy Interactive's focus is to provide accessible energy for central African regions where energy is needed, such as in Cameroon, where less than 27%, or 8 million rural Cameroonians, have minimal access to energy.

Our Remote Energy Distribution Payment Platform (REDPP) offers a lightweight solution for hardware charging stations to support off-grid charging by providing the ability to access, track, and manage energy transactions with SMS and an online interface.

REDPP provides a customer with the capability to credit an account by text. Preloaded with a balance, customers send text messages to the server to withdraw funds for charging electronic devices.

The web application provides different insights depending on the type of the user account. Customers can view their transaction history and add funds. System administrators can set rates, view information about customers, and manage charging stations.

Our application aids in the mission of providing rural regions access to energy sources to support the development of those areas.

Express supports the back end, while the front end uses Pug, an HTML pre-processor. Web app sessions use Firebase Authentication to manage users' web interactions. Non-sensitive account information and transactions use MongoDB. Stripe is used to process fund additions to accounts by using secure API calls. The cloud application platform, Heroku, provides the server to host the web application. SMS is connected to the server through the Twilio API.
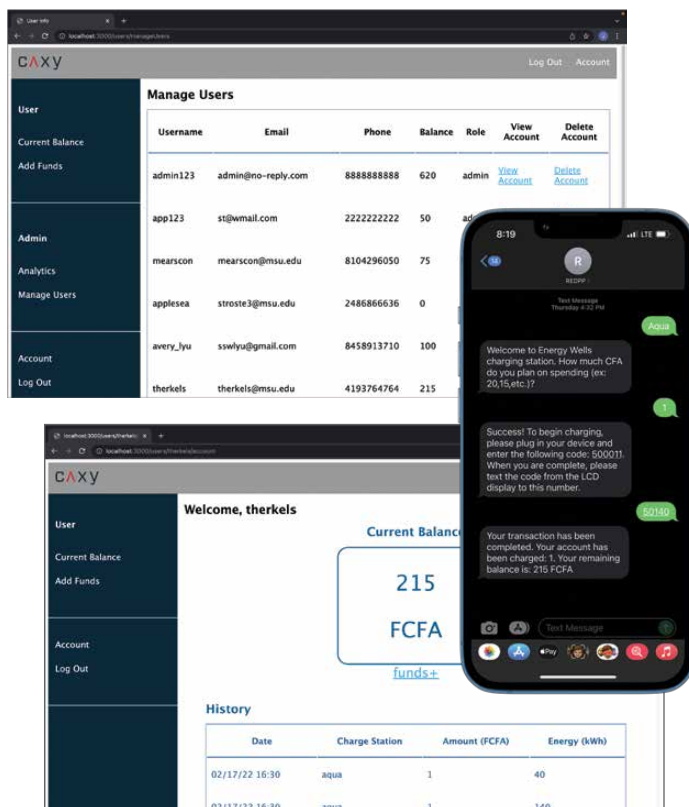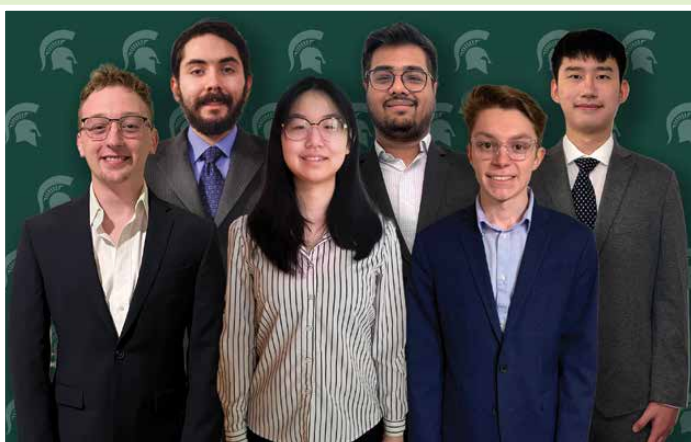
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CSAA Insurance Group
## 3D Scene Reconstruction of Vehicle Accidents

CSAA Insurance Innovation, a subsidiary of AAA Insurance operating out of Walnut Creek, California, is a top-tier insurance group dedicated to aiding clients in the prevention, preparation, and recovery from life's uncertainties, challenging itself to serve with the utmost care. Advocating for vehicle and road safety since 1907, they now offer home, auto, and other lines of insurance across 23 states.

To support members, CSAA analysts must accurately investigate auto claims. Improper analysis slows member recovery and planning by presenting a poor understanding of vehicular damage.

Our 3D Scene Reconstruction of Vehicle Accidents provides thorough annotation and damage analysis capabilities within an interactive 3D environment. This augments CSAA's current system by increasing the speed, detail, and precision with which analysts produce cost estimations.

Using a virtual reality headset or desktop application, analysts can rotate and pan within the generated scene to better examine vehicle conditions, while comparing the original and claimant vehicles as the tool highlights damages. Analysts can create and place annotations on the vehicle to include information regarding the location, severity, cost, and description of damages. Alongside annotations, analysts have access to vehicle and claimant information, a menu for conclusions, the ability to export results, and multiple options regarding screen preferences. Our application improves the ability of analysts to accurately assess vehicular damage for precise analysis of claimants' vehicles.

The Unity-built user interface leverages a Python back end. It uses API endpoints to verify claimant data against CSAA's databases, highlights vehicle damages, and reconstructs a 3D model from claimant vehicle videos through NeRF Modeling, producing an interactive OBJ file for analysts.
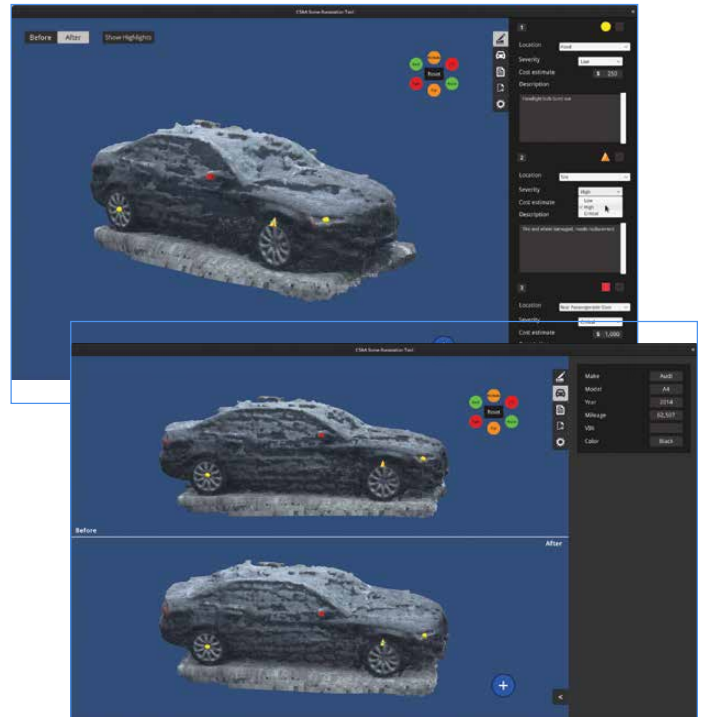
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Delta Dental of Michigan, Ohio and Indiana
General RAte Calculation Environment IDE

Delta Dental is the leading provider of dental insurance in the United States. They operate in all 50 states and provide high-quality and cost-effective coverage for nearly one in four Americans.

Professional underwriters and actuaries collect and analyze data to quantify risk for insurance policies in a process called "rate calculation." In the past, Delta Dental employees performed these calculations manually, which was time-consuming.

Delta Dental's solution to modernizing this system is the General RAte Calculation Environment (GRACE). GRACE uses a specialized programming language where users can easily process insurance data.

Our GRACE integrated development environment (IDE) assists Delta Dental developers in effectively writing code for the GRACE system by making it easier to develop programs.

Our software colors important areas of code and underlines errors while typing. Additionally, GRACE IDE suggests variable names and common code structures to save time writing code.

An outline of variables appears alongside the code editor as a quick reference for what kind of information the variable holds. Users can also select one of these variables to instantly go to where the variable first appears in the file.

Our software uses a workspace system for users to quickly navigate between related code files while working on projects. As users open a folder in our software, the files and subfolders add to the workspace. New files created in the software are saved to the workspace at a user's option.

Our system provides the tools needed in order to expedite GRACE program development, increasing productivity.

Our GRACE IDE is a client-side browser application built with Angular for its user interface, Antlr4 for language processing, and the Monaco Editor for the code editor component.
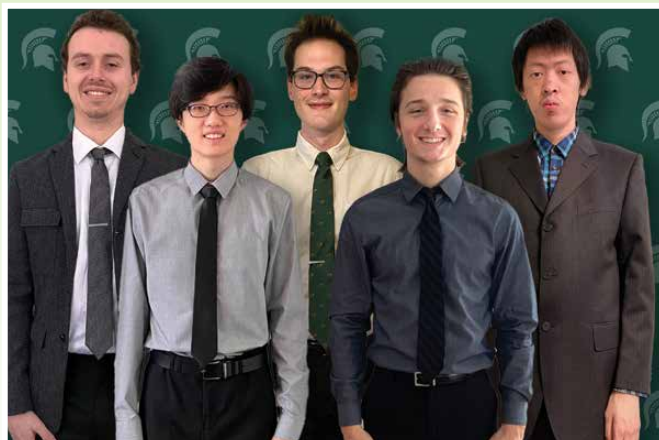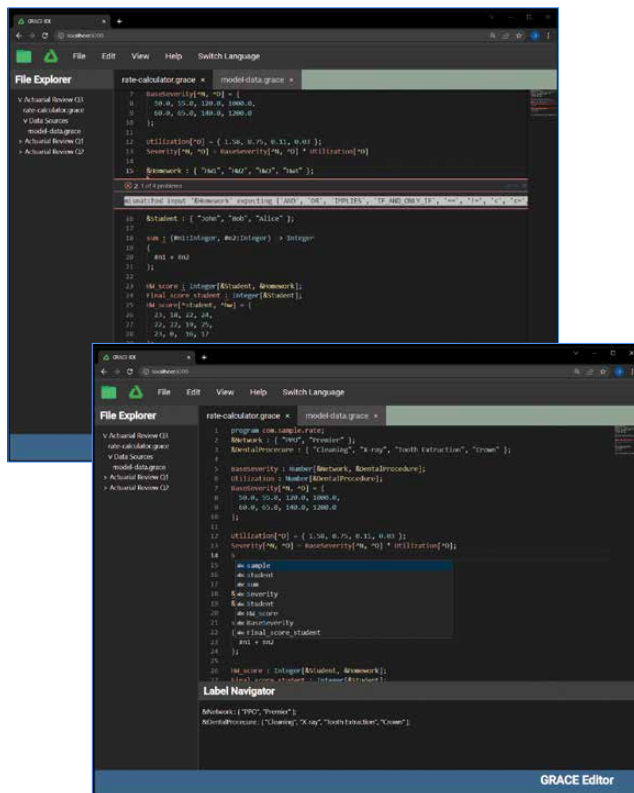
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Delta Dental of Michigan, Ohio and Indiana
General RAte Calculation Environment Shell

Covering more than 78 million Americans, Delta Dental operates one of the largest dental plan administrators in the United States. Over the past 70 years, Delta Dental has created innovative, data-driven technology that increases quality of care while decreasing customer costs.

As an insurance company, Delta Dental continuously compiles and analyzes insurance data to build better plans that decrease costs to their customers and partners. This is achieved through the General RAte Calculation Environment (GRACE), which enables insurance data to be processed efficiently.

Our GRACE Shell enables users to streamline their development inside of Delta Dental's vast ecosystem of tools with an emphasis on utility and accessibility.

Our command line interface offers a powerful but simple tool to enable fast prototyping, testing, and debugging across the complex rate calculation domain. Programs can be run, tested, and debugged quickly through intuitive commands. Furthermore, the simplicity of our software enables non-technical users, such as actuaries or underwriters, to easily navigate and build models.

The GRACE shell creates an environment where users can dynamically build their prototypes. As the user develops, they can easily create, undo, load, save and share their work in a responsive and robust environment.

Our system facilitates simple building and testing of GRACE programs, enabling non-technical users to develop software quickly without prior training, saving time and cutting costs.

The front end of our software is built in Java, utilizing the Picocli command line interface framework and Maven project management software. The back end uses Delta Dental's existing core libraries containing fundamental calculation algorithms and data structures.

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Evolutio
ERP Reserve Preservation Platform

E volutio is a group of technology professionals convinced that business problems have simpler solutions than the market is led to believe. Evolutio works with the non-profit, Elephants, Rhinos and People (ERP), to preserve and protect wild elephants and rhinos in Southern Africa through a distinctive strategy based on rural poverty alleviation. The desired result is that community members have access to income through non-lethal alternatives to poaching.

ERP is constantly taking steps forward to ensure that the poaching problem is being mitigated in the short term, while working towards alleviating poverty in the long term. These steps include elephant relocation, veterinary emergency response units, drought relief programs, threat detection, drone air force, and an extensive reserve ranger program.

Our ERP Reserve Preservation Platform is an intuitive web and mobile application makes the lives of those working on the reserve easier by aiding in the success of these short-term goals.

The platform includes a community member and ranger work scheduling system with notifications built in, a system to view live-stream footage of the reserve for security purposes, a place to view footage from the drone air force, and GPS tracking of elephant migration. The platform contains a quizzing system to evaluate the skills and knowledge of those seeking to be a community member or ranger as well.

The community members and rangers benefit from a single platform to view all reserve security tools and management systems in one single place. This platform makes the quality of life better and daily tasks go smoother for those on the reserve, while dealing with very busy, yet engaging, lives.

The ERP platform is developed with the React Native and Flask framework, alongside Python and JavaScript, and deployed onto Heroku.
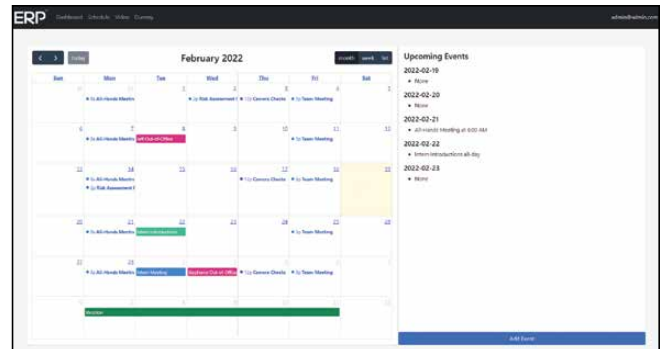
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General Motors
High Frequency Data Ingestion

General Motors, headquartered in Detroit, Michigan, is the largest vehicle manufacturer based in the United States. OnStar, a subsidiary of General Motors, provides in-vehicle communications, security, navigation, and remote diagnostics.

Within a week of COVID-19 being declared a national emergency, General Motors and OnStar shifted approximately 12,000 OnStar service agents from extremely predictable call center environments to largely variable home offices.

OnStar agents conduct phone calls to vehicles via an internet connection requiring fast and reliable speeds for phone calls to be clear. General Motors IT must know when internet speeds drop, as poor call quality can result in customer dissatisfaction.

Currently, connection speed records are automatically gathered on OnStar agents' computers into files, which are then regularly transferred to a centralized server for processing. When thousands of OnStar agents are online and making calls, the server processing often becomes backlogged, and data is sometimes lost.

Our High Frequency Data Ingestion application resolves the bottlenecks induced by influxes of data by providing efficient file reading, processing, and writing operations. Furthermore, existing backlogs of files are resolved by limiting the number of data points for any given OnStar agent.

In addition to data ingestion, our software features interactive web dashboards. Data from the ingestion application can be analyzed on multiple webpages. This data includes the OnStar network metrics, OnStar agent comparison tables, and ingestion application processing statistics.

The ingestion application is written in C# and is optimized to work with Microsoft network-attached storage drives and a Microsoft SQL Server. The web application is written in Python Flask and uses Socket-IO and Plotly for plotting.
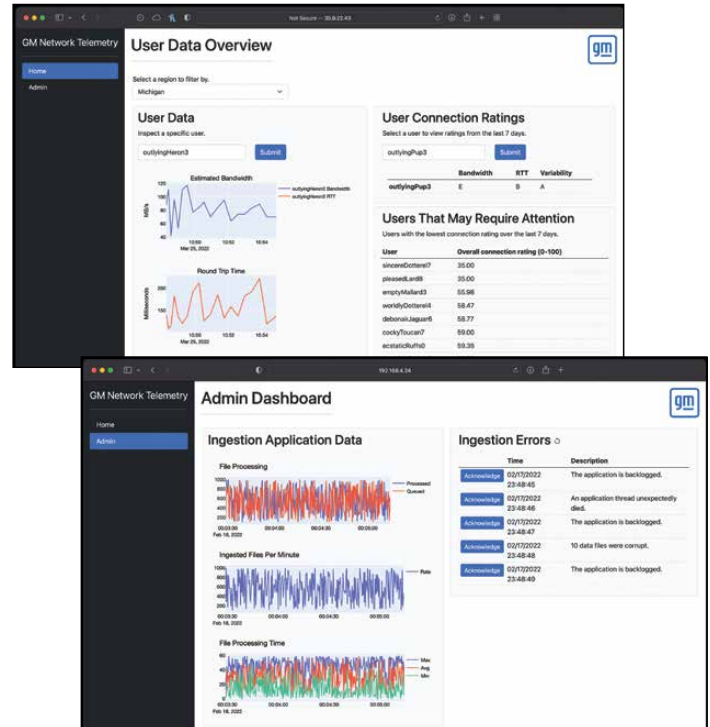
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Kellogg's
Global Business Services Customer Satisfaction

Kellogg's, headquartered in Battle Creek, Michigan, is the world's leading producer of cereal and a leading producer of snack and convenience foods with commonly known brands like Pringles, Cheez-Its, and Frosted Flakes.

With products manufactured in 18 countries and marketed in over 180 countries worldwide, Kellogg's works to provide quality products and services to all its customers and clients. To this end, Kellogg's Global Business Services (GBS) team distributes a quarterly customer satisfaction survey to stakeholders.

The GBS survey contains a series of standardized questions related to the quality and ease of the stakeholders' use of GBS services as well as open-ended questions where stakeholders can provide suggestions and feedback for improvement. In the past, the survey has not reached the target response rate, which makes it harder for Kellogg's to provide the customer service that meets their high standards.

Our Global Business Services Customer Satisfaction system includes a redesign of the user interface of the survey and a web dashboard used to visualize analytics.

Our new Global Business Services customer satisfaction survey has built-in user behavior collection, automated data visualization, automatic survey translation and easier survey question updating mechanisms.

The analytics provided by our web dashboard regarding user behavior and responses has led to an increase in the response rate of the survey from 7% to 15%. This increase in response rate enables Kellogg's to develop a more detailed and strategic plan to provide customers with better products and a more fulfilling experience.

Users access the survey on a web application built in R with R-Shiny for the user interface. The data is stored in Amazon S3, and the data visualization is done through Tableau.
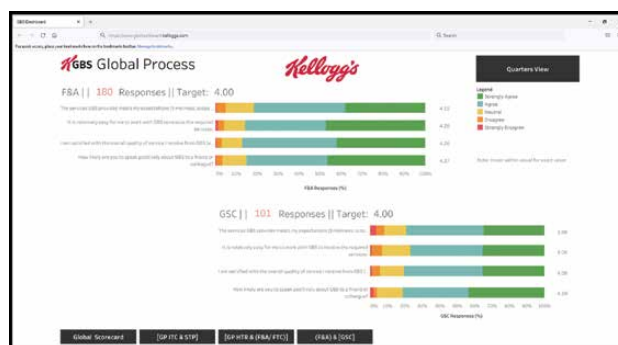
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Kohl's
Athenaeum

Headquartered in Menomonee Falls, Wisconsin, Kohl's operates as one of the largest department store chains in the world. The company's business line features apparel, footwear, accessories, beauty and home products through its stores and website.

At Kohl's, technology teams are constantly exploring, designing, and developing new ways to make the customer's shopping experience more effortless and unique to them. In order to accomplish this, developers need to be able to share their questions and technical issues with each other.

Previously, the Kohl's development teams shared a massive group chat of over 500 developers, where their questions were not only difficult to track, but were also redundant, creating a very disorganized and confusing forum.

Our Athenaeum web application provides an effective solution to this disorder by acting as a centralized platform for the Kohl's development teams to better coordinate collaboration.

Athenaeum is an organized platform that brings order and clarity to the Kohl's development teams; with Athenaeum, Kohl's developers can find solutions to their technical issues with ease. Athenaeum's web interface provides an easy place for developers to ask questions, receive feedback from other developers, search for related questions, and collaborate with their colleagues.

The platform's simple and intuitive user interface gives developers the visual clarity for their collaboration, so that they can easily navigate their way to a solution for each technical issue that arises. Moreover, Athenaeum makes collaboration fun, utilizing a point system to gamify the experience of sharing solutions and resolving each other's issues.

With a ReactJS front end, Flask back end and MySQL database, Athenaeum is deployed on Google Cloud Platform, making the web app fully cloud native.
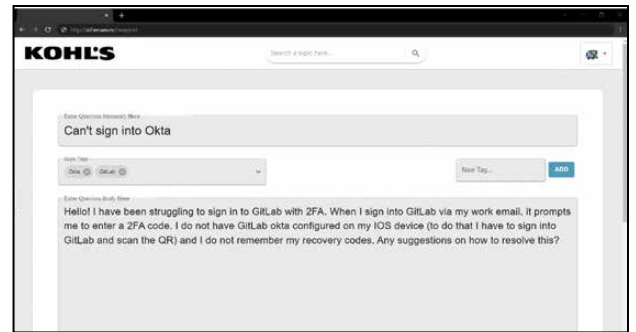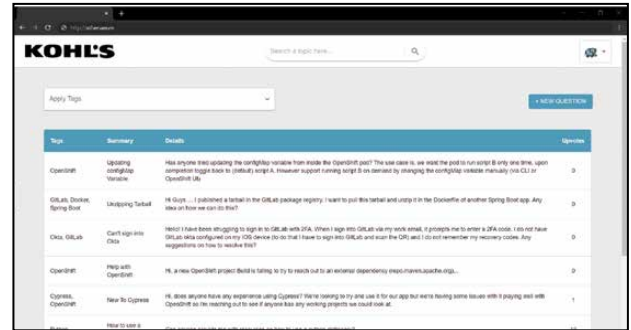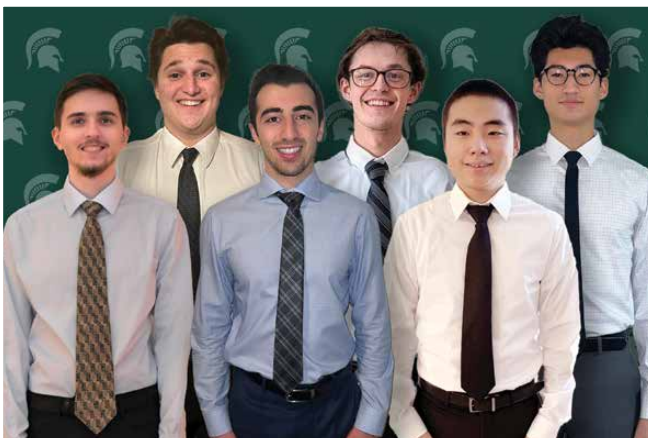
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Lockheed Martin Space
SmartSat™ Satellite App Store

Lockheed Martin Space, headquartered in Denver, Colorado, is one of the largest space defense contractors in the world, employing over sixteen thousand people, with the goal of developing an impressive range of products from satellites and space probes to missile defense systems.

Storage space, processor utilization, and memory utilization are important factors to consider when deploying software to satellite assets. Applications may also require additional dependencies that must be present on an asset before an application can run.

Our SmartSat Satellite App Store is a web-based marketplace for uploading and installing applications to live satellites with rigorous software testing capabilities to guarantee the software runs successfully on these satellites.

During the testing process, the app store monitors the system resource utilization of the application. When an application is uploaded or deployed, the system ensures the correct dependencies are installed on an asset.

During the testing process, an application manager monitors the resource utilization of the target application. These metrics are sent back to the app store and displayed for operators to view.

The app store automatically keeps a record of an application's dependencies to ensure the required packages necessary for an application to run are installed on the asset. Our SmartSat App Store provides satellite software with assurances that the software is reliable and functional when uploaded to a satellite.

The app store uses a Jenkins pipeline for testing. Data is stored in a Nexus repository, as well as a PostgreSQL database, which is managed by pgAdmin. The web back end is built with Flask, while the front end is built with React. All components of the SmartSat Satellite App Store are built in Docker containers to ensure system portability.

LOCKHEED MARTIN
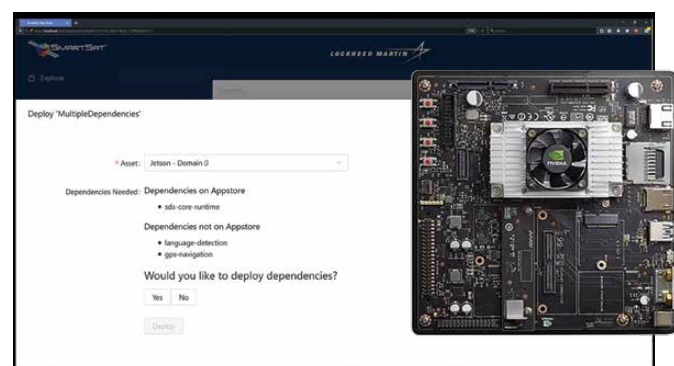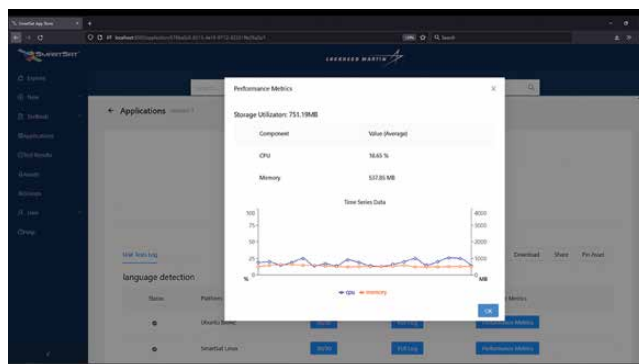
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Malleable Minds
Advancing PreK-12 Educational Opportunities

Malleable Minds is an emerging startup building the world's most extensive collection of PreK-12 programs, from the arts to the sciences, so students can further develop academic, interpersonal, and communication skills. The Malleable Minds web app connects students to programs that interest them and contributes to their academic success.

However, it can be difficult for users to navigate the vast collection of programs and plan their customized education path. Displaying such a large collection of information can also lead to slowed site loading speeds.

Our Web App for Advancing PreK-12 Educational Opportunities helps users find the programs best suited for them, track their progress in-site, and improves website performance.

Better navigational features include website subject pages, such as art or science, enabling users to see all of the programs offered in categories of interest. Clicking on a program redirects users to the program page, which holds information such as the provider, location, and cost. This page also includes the program's ratings and reviews left by users after experiencing the program.

The skill tree feature enables users to plot out how to achieve their future goals. Users can track their progress and explore future opportunities in a given subject area. Any progress made on skill development is tracked and the next steps for skill growth are clearly displayed.

Our system improves the existing application by better guiding users to find the programs that are right for them, increasing engagement and customer satisfaction.

The front end is written in React JS, and the back end is in Python. Our site also makes extensive use of Amazon Web Services. By using AWS Lambdas, the back end is serverless to improve site-wide performance.
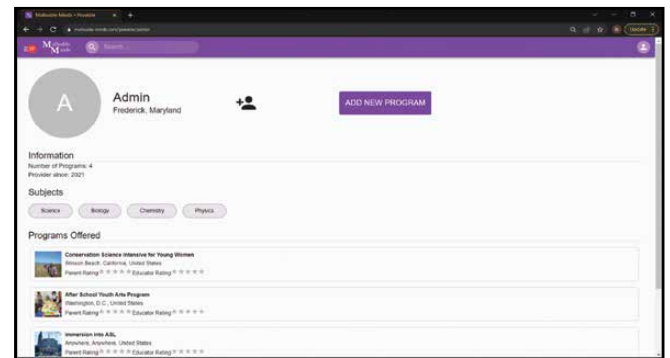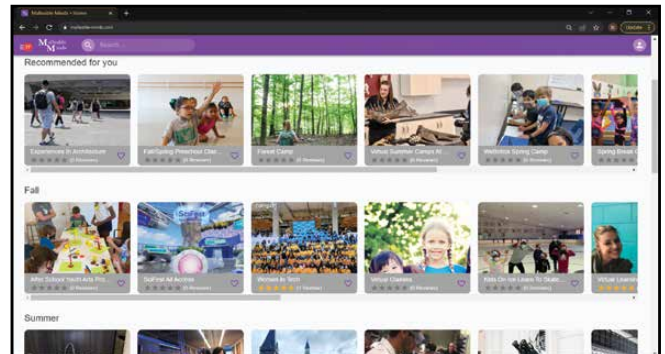
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MaxCogito
Blockchain Based Vaccine Passport System

MaxCogito, founded by Steve Akers, is a young company that provides high value cloud services to their clients. They focus on providing their clients with strategies for protecting and appropriately managing sensitive documents and communications.

With the onset of the COVID-19 pandemic, humanity has faced new challenges, and different types of vaccinations have been provided as a response to the virus. However, the paper-based immunization status cards currently provided by clinics and hospitals can be stolen, lost, or falsified.

Our Blockchain Based Vaccine Passport System provides reliable and secure vaccination status of users, which cannot be falsified and are secured on the internet.

Our system is accessed by patients and vaccine administrators through an easy-to-use web interface. After receiving a vaccine, users upload a copy of their vaccine record as well as some supplementary data. Vaccine clinics and hospitals then use our web application to validate any vaccine records uploaded by their patients. Once a patient's vaccine record is verified as authentic, the patient can request a vaccine passport from our system that can be used to verify their vaccination status whenever needed.

The vaccine verification is built on Blockchain technology that provides a safe and secure way to apply for vaccination status, which cannot be changed or deleted following verification by the client's health care provider.

Our system provides ease of use for individuals wanting absolute proof of their vaccination status and peace of mind for anyone needing to verify vaccination status beyond any doubt.

The front end of our system is developed using HTML, CSS, Angular and TypeScript. Our back end uses Spring Boot, Web3j, and a PostgreSQL database hosted on AWS. Our Blockchain is built on Ethereum, utilizing Solidity for our Smart Contracts..

MaxCogito
The company with big ideas

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Meijer
Meijer Smart Shopper

Meijer is a family-owned business founded in 1934 that has pioneered the one-stop shopping experience. With over 240 shopping centers operating in the Midwest, Meijer provides a wide array of products from household items to pharmaceuticals.

Grocery shopping is a task that takes organization and planning. Adding an item to a shopping list requires resources like time, memory and a list itself. Often, shoppers think of an item they need but don't have those resources readily available. Moreover, shoppers can be unsure of what Meijer coupons, called mPerks, apply to the items on their list, or if that item is available at their local Meijer.

Our Meijer Smart Shopper enables customers to use Alexa to interact with the Meijer application, simplifying the shopping experience. A shopper can interact with our application using their phone's microphone or an Alexa-enabled device.

In a verbal interaction with Alexa, a shopper can add or remove items from their Meijer shopping cart and list. Our application recognizes shopper patterns to improve Alexa's accuracy when determining what brand of item a shopper wants. Alexa uses these preferences to alert the shopper when their favorite items are on sale. Additionally, Alexa informs the shopper when an added item is unavailable at their local Meijer and suggests an alternative.

Meijer Smart Shopper modernizes Meijer's pioneered one-stop shopping experience. Shoppers can now be confident they are utilizing every available mPerk and that their shopping list is complete.

Meijer Smart Shopper is a website, iOS and Android application. The website uses React and is written using HTML, CSS and JavaScript. The iOS application is written in Swift and the Android application in Kotlin. Our back end is hosted using Microsoft Azure and is written using Python.
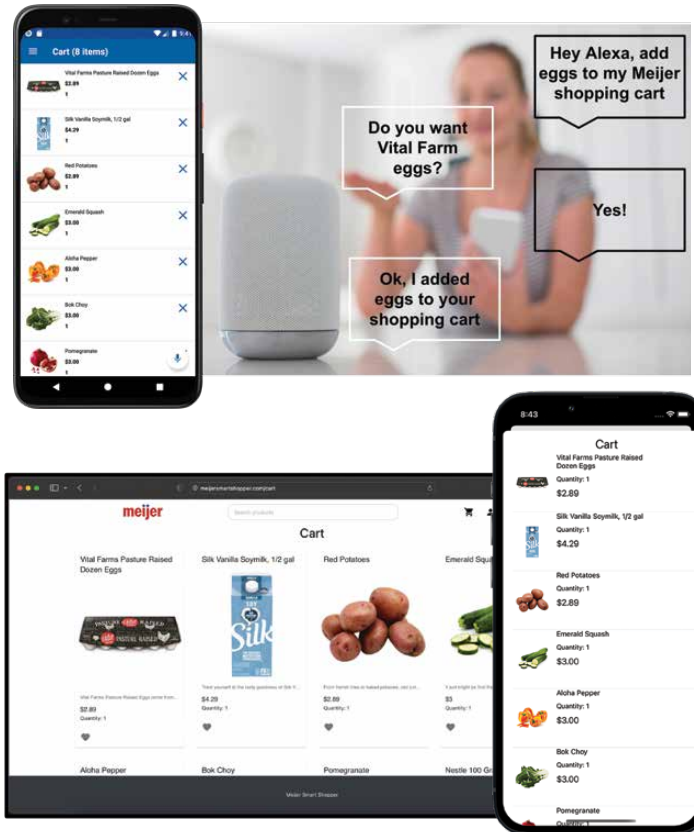
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Michigan State University Computer Science
Data-Driven Mechanic: Applications and Infrastructure

The DeepTech Lab at Michigan State University conducts research into the use of machine learning algorithms and vibroacoustic (sound and acceleration) signals to improve the maintenance of diverse physical systems.

An estimated 290 million vehicles operate below optimal efficiency due to delayed service or unaddressed faults. The DeepTech Lab has developed algorithms that can identify the make, model, and certain fault types for vehicles using audio captured by mobile devices.

Developed under the supervision of Dr. Josh Siegel, the Data-Driven Mechanic application helps everyday people benefit from the DeepTech Lab's algorithms to improve the maintenance and care of their vehicles.

Users record audio and vibration data from their vehicle in our software with the native microphone and accelerometer on their mobile device.

When the user selects the classify option, the data are processed by the DeepTech Lab's algorithms, and the results are displayed to the user, outlining details and detected faults of their vehicle.

When the user chooses the annotate option, they are shown a series of form pages populated with dynamic fields to fill in with information about the vehicle. After annotation, the labeled data are stored in a server for later use by the DeepTech Lab. The annotate function enables users to participate and contribute to the improvement of the DeepTech Lab's algorithms for diagnosing vehicles and other physical systems.

Our software runs on both Android and iOS mobile devices that have a built-in microphone and accelerometer. The front end is written in JavaScript using the React Native Expo framework. The back-end server is written in Python Flask and the underlying database is MySQL.
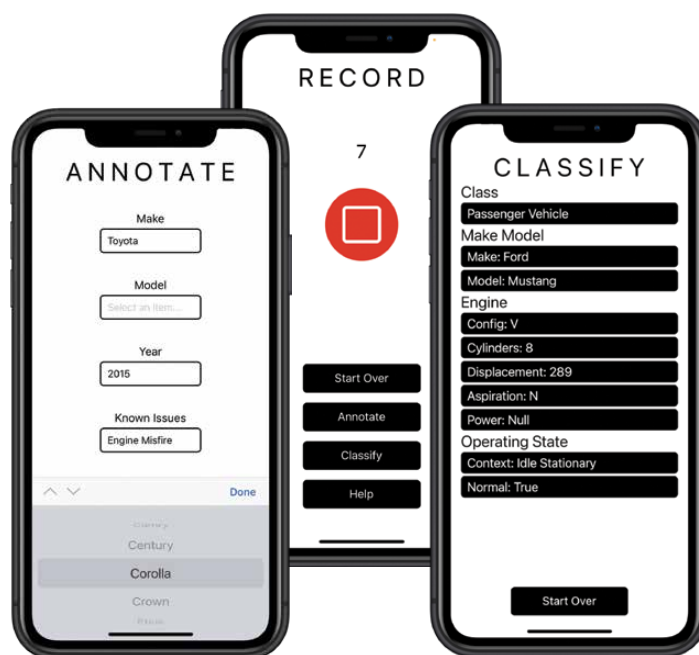
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Michigan State University Linguistics
On-Premises Automatic Speech Recognition Pipeline

The Sociolinguistics Lab within Michigan State University's Department of Linguistics, Language, and Cultures hosts Michigan Diaries, which chronicles the changes in the lives and languages of people throughout and after the Covid-19 pandemic, as well as provides insight into language change over time.

Michigan Diaries collects long form audio recordings from volunteers and then uses Google's Automatic Speech Recognition (ASR) commercial software to create time-aligned transcripts needed for researchers to conduct linguistic analysis. Currently, there is no robust open-source ASR software package for researchers to circumvent Google's platform. This leads to unnecessary costs and privacy concerns as private data is getting sent to a third party.

Our On-Premises Automatic Speech Recognition Pipeline is an open-source all-in-one speech-to-text software package that creates time-aligned transcripts from audio files.

After users upload their audio files, the system automatically constructs a time-aligned transcript. This transcript is separated into sentences, along with metadata including timestamps of when the sentence begins and ends, speaker identification, and confidence values for the predicted text.

The training feature is used to improve performance. Users upload their own datasets to fine-tune various models used for inference including, speaker diarization, ASR, punctuation restoration, language modeling and entity extraction.

Our system avoids the need to use Google's speech recognition technologies, reducing operational costs and protecting user privacy.

Our ASR pipeline is containerized through Docker and implemented using state-of-the-art machine learning libraries Hugging Face, NVIDIA NeMo and Pyannote.
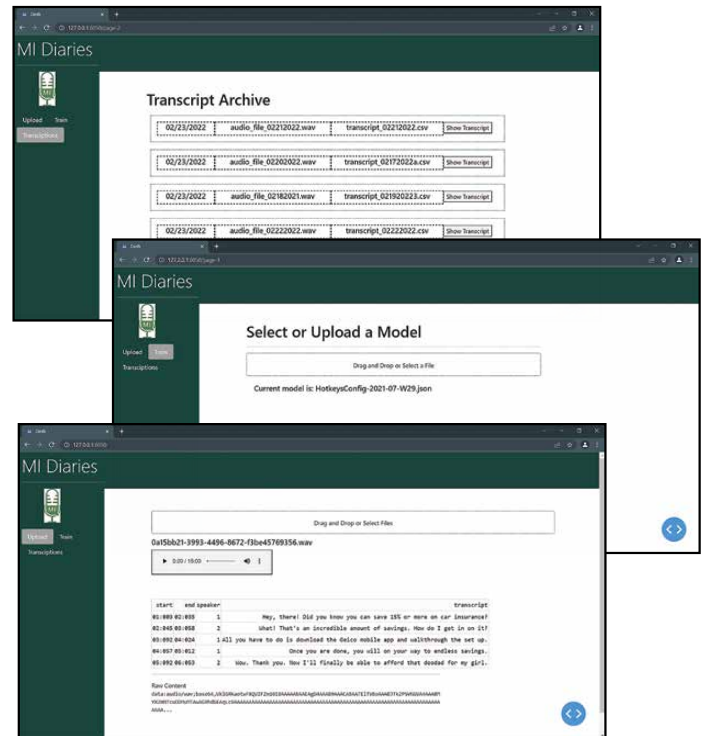
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Mozilla Corporation
## Improve Firefox's Reader View

The Mozilla Corporation is behind Firefox, one of the world's largest web browsers. Mozilla boasts the only browser made by a non-profit, mission-driven organization. Firefox's open-source development allows users from all over the world to contribute to its improvement and advancement.

Browsing websites can be frustrating due to clutter from ads and images. Firefox's Reader View feature solves this problem by reducing a page down to the essentials, which is perfect for those accessing websites with a screen reader or requiring better accessibility. Reader View must remove distracting ads, background images and other noisy elements on the page, along with allowing users to customize their web browsing experience.

Our version of Firefox's Reader View builds on many of the requested additional features, fixes, and improvements to make the website's raw information even simpler to read and the Reader View experience more enjoyable.

The improved Firefox's Reader View expands Reader View to cover more heavily used sites, such as Wikipedia. Mozilla's mission is to make the internet open and accessible to all, and our improvements to Reader View are created with this goal in mind. Fixing previously identified bugs and implementing enhancements expands Reader View's ability to facilitate uncomplicated online reading for users. By addressing these problems, the user experience and the functionality of Reader View are substantially improved.

Reader View is a feature that lives within the Firefox codebase: a vast piece of software spanning multiple languages, including HTML, CSS, JavaScript, and C++. The enhancements to Reader View are developed within the Visual Studio Code IDE and released to users in stages via the Firefox Nightly, Beta and Full Release browser applications.
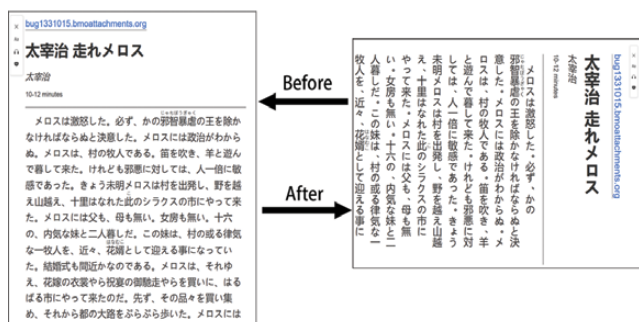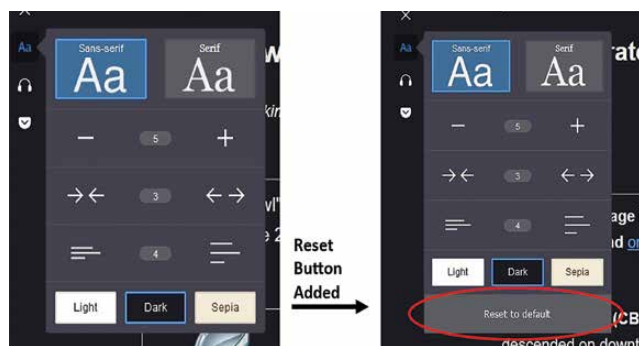
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MSU Federal Credit Union
Ever Green 3C: Financial Education Content Library

Founded in 1937, Michigan State Federal Credit Union has been working towards financial freedom and security for over 320,000 members. With $6.6 billion in assets, over 900 employees, and 21 branches, MSUFCU provides services to help members achieve big dreams.

MSUFCU's goal to help members achieve big dreams spreads beyond the company. Other credit unions seek support from MSUFCU's vast financial education content library and have requested to purchase a detailed organization of the content library.

MSUFCU created Ever Green 3C to spearhead the organization and management of the content library. Ever Green 3C has to manually label its library of content, which is a time-consuming process. They need an accurate and efficient way to organize thousands of articles into detailed categories.

Our Ever Green 3C: Financial Education Content Library is a sorting tool used to remove the burden from the Ever Green 3C team manually sorting thousands of documents.

The software enables the Ever Green 3C development team to efficiently identify thousands of articles, their content, their financial categories and their targeted demographics.

Our software stores the financial articles and the respective labels for each article in a database for quick, accurate searching rather than classifying each article on a search-by-search basis. This provides improved speed and efficiency when searching.

The development of this application saves weeks of time for the Ever Green 3C team and turns an otherwise tedious process into a simple push of a button.

Our back-end software is primarily a Python application utilizing ASP.NET to handle the transfer of data to and from a MongoDB database including articles and user searches from the front-end UI developed with a mix of HTML, PHP and JavaScript.
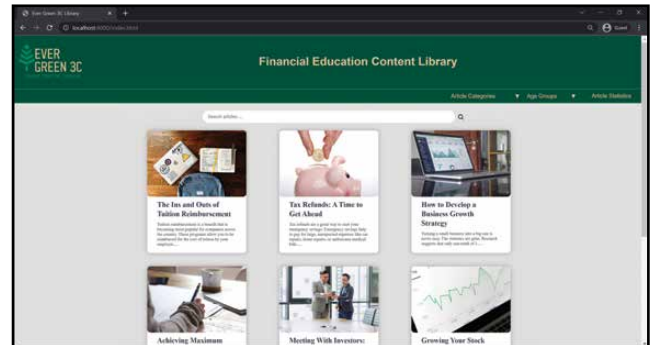
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Rocket Companies
## Team Member Mapping Application

Headquartered in Detroit, Rocket Companies is an expansive family of financial service enterprises, ranging from Rocket Mortgage, the nation's largest mortgage lender, to Amrock, a leading title insurance provider. Always striving for improvement, Rocket Companies succeeds in helping their clients achieve homeownership and financial freedom.

With the shift to remote work schedules during the pandemic, two major aspects of the work environment important to Rocket Companies have been stifled: natural collaboration and community building. Working from private residences, connections beneficial to productivity and essential to a meaningful work experience are partially lost.

Our Team Member Mapping Application helps to alleviate the issues present with remote workplace communication through a location-based application, enabling Rocket Companies' employees to find nearby team members for any host of reasons.

The Team Member Mapping Application displays the location of employees in a general area on a map, as well as contains the ability to filter team members that share similar interests or are within certain companies. The user also has the ability to opt out of having their precise location shown, instead having their associated zip code displayed. The user can create events that other users can see and join on the map, whether it is for a work conference or a book club. Through our Team Member Mapping Application, connectivity between employees at Rocket Companies is greatly simplified and enhanced, most notably in a remote setting.

Our front end of the web application is generated using the REACT framework and hosted on Amazon's AWS Amplify service. The back end is implemented with Node Js within a serverless AWS Lambda. It is used for storing and updating user locations and event data within our MongoDB NoSQL database.
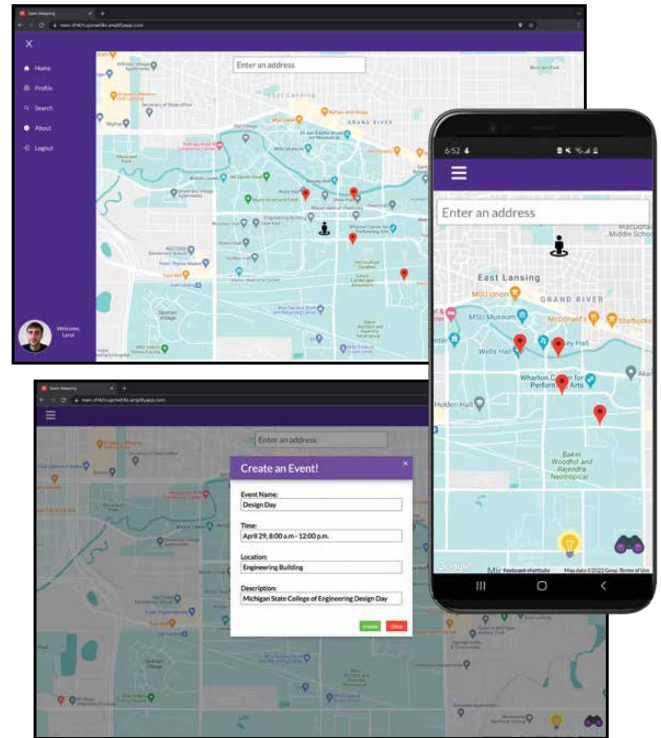
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Scout
Smart Little Hunter of Fakes

Scout provides agile software solutions that enable organizations to make calculated decisions derived from data collection and analysis. With specialized solutions for financial fraud, counterfeit detection, and brand protection, Scout makes its clients' lives easier by bridging the gap between information and action.

Online shopping has become a massive industry. As a consequence, it has led to the rise of fake product listings. Companies employ brand protection specialists to combat the issue, but they are limited in what they can do. Fake product listings are far too common for specialists to identify and remove them all.

Our Smart Little Hunter of Fakes application provides users with a simple and interactive way of locating, identifying, and removing fake product listings.

This application uses brand specific information and hunts through online marketplaces, such as Amazon and eBay, searching for matching product listings. The massive number of returned product listings are sorted and cleaned to ensure that only the reliable listings are presented to the user.

Users review the presented data and provide their expert responses for each product listing, labeling each as "Real," "Fake," or "Unknown." Our system analyzes user responses and returns its own prediction. Over time, this system learns from its users in order to provide more accurate predictions. Our Smart Little Hunter of Fakes application lowers the risk of receiving knockoff products to create a safer shopping experience.

The front end is implemented in C# using the ASP.NET framework. The back end stores information in a SQL database in the Microsoft Azure cloud and implements the prediction model using ML.NET Model Builder. Our system is available for all Windows devices.
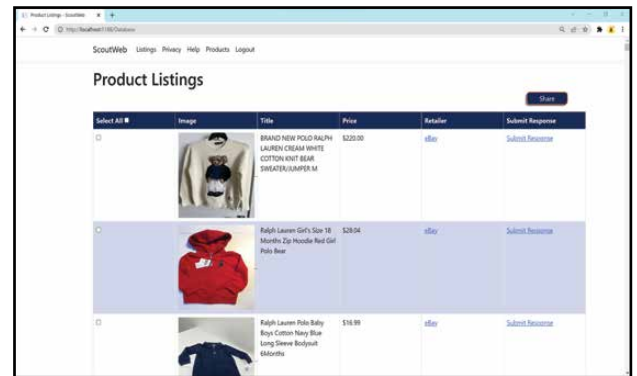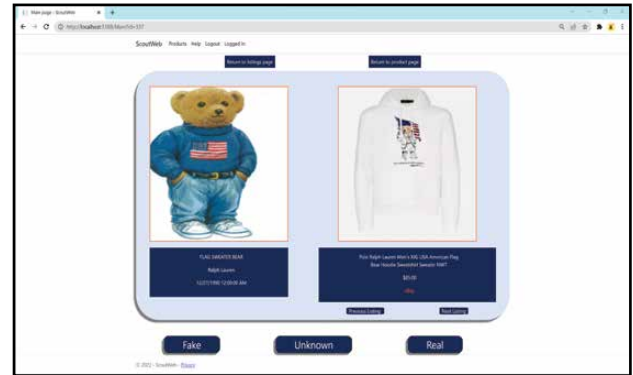
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TechSmith
ViSUI : Video Simplified User Interface

TechSmith is the global leader in screen recording and screen capture software and solutions. The company's goal is to make content creating for trainings, tutorials, lessons, and everyday communication an easier and more effective process. TechSmith's flagship products, Snagit and Camtasia, have more than 34 million users worldwide.

The ability to create content that does not require translation is a challenge that many TechSmith customers face as they work to generate material for speakers of varying languages. Screen captured images or videos that contain text in another language or that is irrelevant to the goal of the video is confusing and distracting to the audience. There is a need for a system that helps customers create more language agnostic content for their audience to consume.

Our ViSUI: Video Simplified User Interface web application enables customers to effortlessly remove distracting text from a video by replacing it with simple shapes, such as rectangles. This makes videos simple and understandable to all audiences.

When the user uploads a video, they can press a button that prompts our software to scan the entire video for text. Once the scanning is complete, the user is presented with suggestions for simplifying the text on each frame of the video. The user can then edit the Simplified User Interface rectangles as desired.

Users also have the option to remove the audio track from the video they upload. Once editing is complete, users can save their project to a video library and export it to another application for sharing.

Our web application is made using JavaScript and React. The text detection is accomplished with Microsoft's Optical Character Recognition API and the frame-by-frame video manipulation is handled with the FFmpeg framework. Our web application, video storage, and database are hosted on Microsoft Azure.
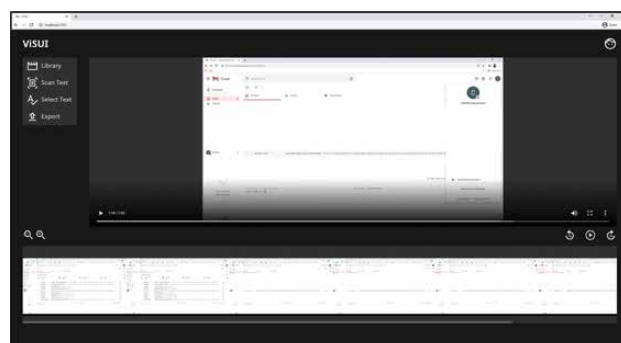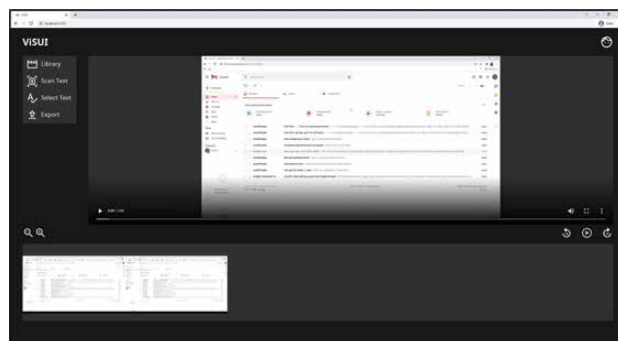
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Union Pacific
Railroad Data Visualization

Union Pacific, founded in 1862, is now the leading railroad transportation company in North America. With over 32,200 miles of track, 8,300 locomotives, and 43,000 employees, Union Pacific plays a major role in the transit of goods throughout the nation.

Derailments cost transportation companies millions every year due to missed deliveries, additional employee time, and equipment repairs. Union Pacific uses simulations to analyze such incidents and diagnose causes. These simulations record data, such as speed and buff/draft forces, and this information is output as a raw data file.

Our Railroad Data Visualization tool provides a web-based user interface that converts a simulation's raw data file into clean, readable, and intuitive visualizations. These interactive graphs aid in the analysis of derailment simulations.

After a simulation is completed, the raw data file is uploaded to our system via a menu on our web page. A user can also select to view a historical data visualization set instead.

Our platform produces animated graphs that visualize train elevation, as well as buff/draft forces between cars over time. Users can control the animation through buttons on the page's toolbar.

Using our system, Union Pacific employees can more quickly and accurately determine the cause of derailments and accidents, in addition to predicting future incidents, saving Union Pacific valuable time and money.

Our Railroad Data Visualization software system has a front-end web user interface that uses the Angular framework, along with the Plotly visualization library. Our web application is also written in TypeScript and HTML. Our back end is written in Java, built around a Spring framework, and stores data in an Oracle MySQL database. The front end and back end communicate with each other via a REST API.
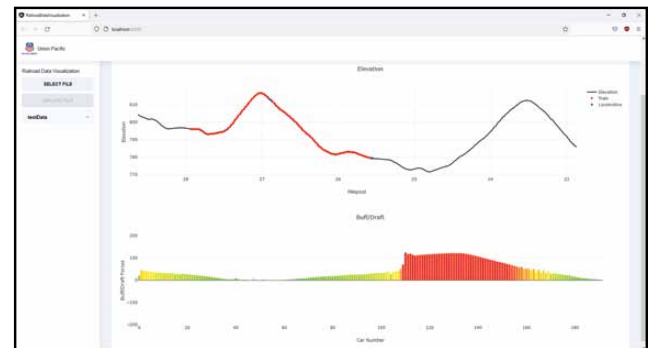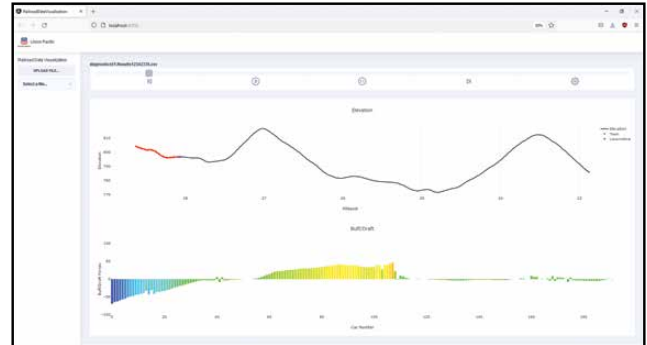
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United Airlines
Performance Scorecard Automation

United Airlines is a Fortune 500 airline company that flies over 850 aircraft and has flights to hundreds of destinations. In 2019, over 160 million passengers flew on United Airlines flights, an all-time-high for the company.

When it comes to air travel, safety is of the utmost importance. That is why at United Airlines, various safety and compliance metrics are used to keep track of safety at each of their seven hubs in the continental United States. These metrics, however, are currently created and managed manually, which takes a significant amount of time for United Airlines employees.

Our Performance Scorecard Automation quickly generates attractive safety metric scorecards, which eliminate human error and the tedium of manually selecting and entering data.

The Performance Scorecard Automation tool automatically reads data from several Excel files that contain the raw safety and compliance data for various airports. The tool then automatically generates a PowerPoint containing pertinent data based on a specified PowerPoint template.

Users can specify any combination of raw Excel data, template PowerPoints, and our own proprietary design files. These design files easily generate associations between raw Excel data and the finalized PowerPoint presentations and maintain the desired look and feel of a manually created PowerPoint.

Our tool enables users to easily create future scorecards without manual adjustment, while also making the program customizable in case the data needs to be changed.

The Performance Scorecard Automation saves time for United Airlines' employees and improves the safety of United Airlines.

The Performance Scorecard Automation is written using C# with the .NET Framework. It uses Microsoft's Office Interop Libraries for interfacing with Excel and PowerPoint.
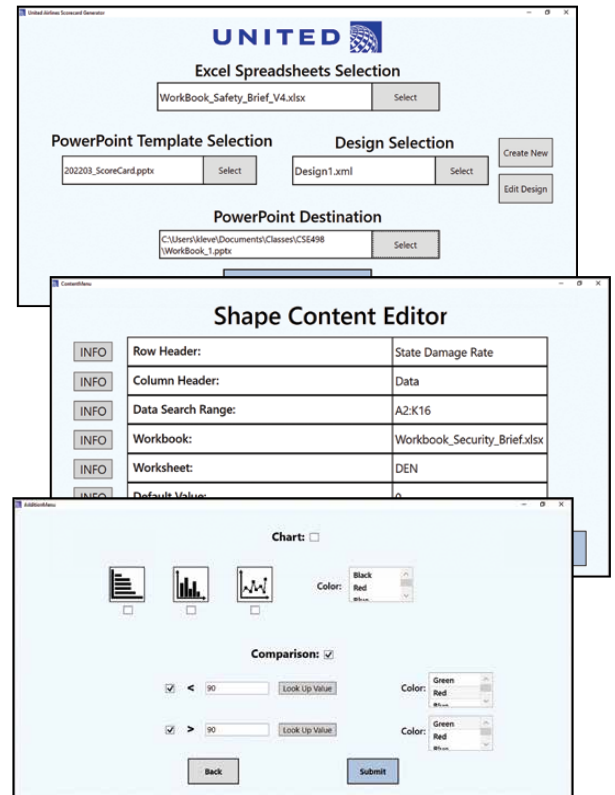
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United Airlines
Audit Management System

United Airlines, Inc. is a leading American airline headquartered in Chicago, Illinois. In 2019, United Airlines operated 4,900 flights a day from 362 airports. Running an airline requires diligence in all logistical and technical aspects to ensure the best flight experience for "Every customer. Every flight. Every day."

Within United Airlines, the Technical Operations Quality Assurance division plays a vital role in meeting United Airlines' shared goals of efficiency, reliability, and safety.

To accomplish this, the United Airlines Quality Assurance team conducts live audits to ensure all equipment and services are maintained according to Federal Aviation Administration (FAA) standards. However, current audits require handwritten documents that are hard to keep track of and difficult to share.

Our Audit Management System enables quality assurance administrators to create new audits and assign them to their respective auditors more easily. Our system also provides auditors with a solution to have electronic access to audit documentation on their mobile devices.

Our system recreates digital versions of forms used by auditors, which facilitates easier editing, saving, and submission of audit documentation. Additionally, our mobile application facilitates real-time access to the device's camera to easily photograph and attach evidence, such as photos and notes to audit forms. Web scraping of the FAA website is included as well, to relay even more information to users of our system. The time of auditors is valuable, and our system enables them to perform their duties in an efficient manner in order to reduce errors and simplify the auditing process.

The front end of our application is written in Swift for iOS integration. The back end is hosted on Amazon Web Services (AWS). Python performs FAA website scraping and stores updated data on a MySQL database hosted through AWS.
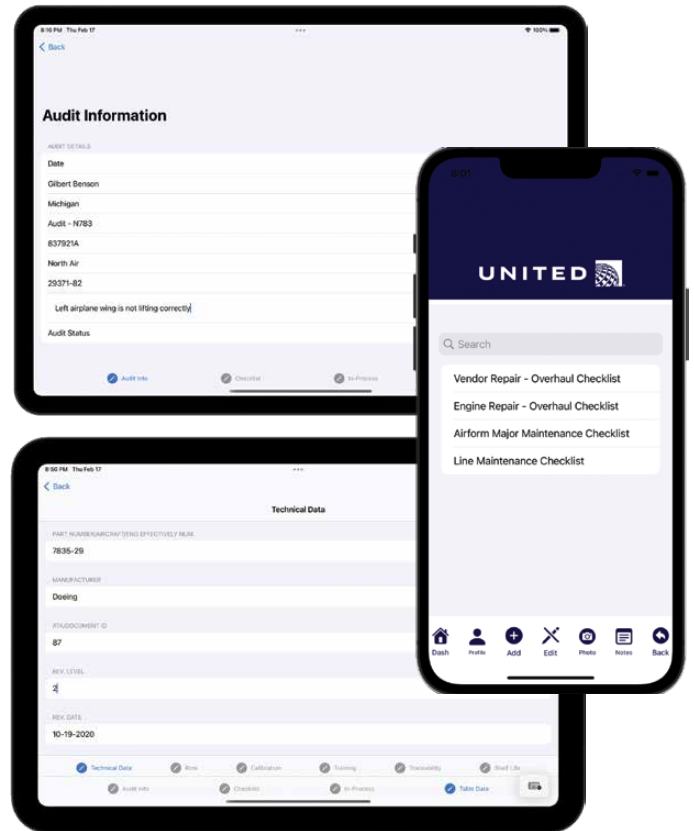
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United Airlines
Training Forecast Model

United Airlines is a leading American airline headquartered in Chicago, Illinois. United Airlines connects people and unites the world with over 330 destinations served and over 3,000 departures daily in 2021 across its comprehensive network. With a workforce of over 70,000 employees throughout the world, United Airlines is positioned strongly to provide outstanding service to its customers.

To uphold its rigorous standards for safety and reliability, United Airlines requires routine inspection and maintenance for the hundreds of aircrafts in its fleet, which in turn requires properly trained technicians stationed in the right places at the right times across all of the airports it serves. Training resources must be allocated carefully to keep the skills of technicians in line with the demands of evolving flight schedules and fleet composition.

However, determining what training must be provided to keep United Airlines' network operating smoothly is a complex task due to the large numbers of flights and airports involved.

Our Training Forecast Model predicts when and where unmet needs for technicians arise and guides decisionmakers toward where to provide additional training to bridge those gaps.

When United Airlines training staff opens our dashboard, displayed is an overview of understaffing risks at various airports, relaying key insights to staff. They are provided the ability to dig deeper into flight schedules and training data to analyze the most pressing needs on a finer scale. Predictive forecasting is included as well, to help determine what future risks may appear.

The information from our Training Forecast Model application enables United Airlines to reliably catch training risks in advance, reducing threats due to shortages of trained staff.

Our front-end interface is written as an SPA in TypeScript using the React framework. Back-end APIs written in Python are deployed on Azure Functions, backed by an Azure SQL database.
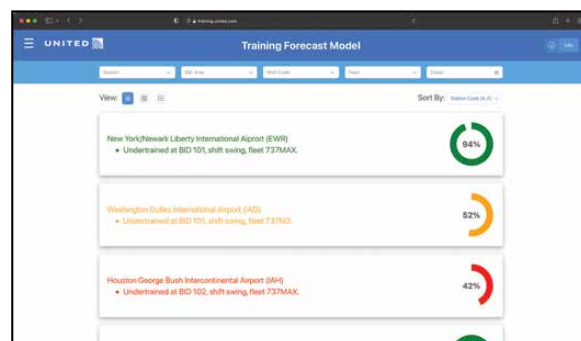
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Urban Science
Customer Insights Dashboard

Urban Science is a global automotive consulting firm that works with major automakers. Headquartered in Detroit and founded in 1977, Urban Science transforms market information into success, utilizing data and business science to improve profitability for their automotive partners.

Urban Science constantly receives massive amounts of market information from various sources. With so much information, it is vital for dealers to spend their limited time chasing the most attractive opportunities.

Our Customer Insights Dashboard identifies the most promising opportunities for dealers to pursue. The dashboard provides dealers with customer contact information and the factors that contribute to a good sales opportunity.
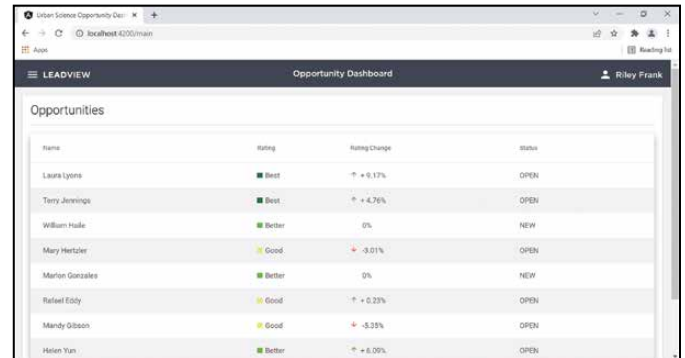
Our Customer Insights Dashboard can be opened in any web browser. When a dealer accesses the dashboard, they are taken to a main page that displays opportunities in a table format. Opportunities are rated by their potential. The default sort on the dashboard is by rating. Dealers are also able to sort opportunities by name, rating change and status.

Dealers can click on a table row to navigate to the row's respective opportunity page, which contains the opportunity's customer contact information, vehicle model information, and the main factors that contribute to the opportunity's rating.
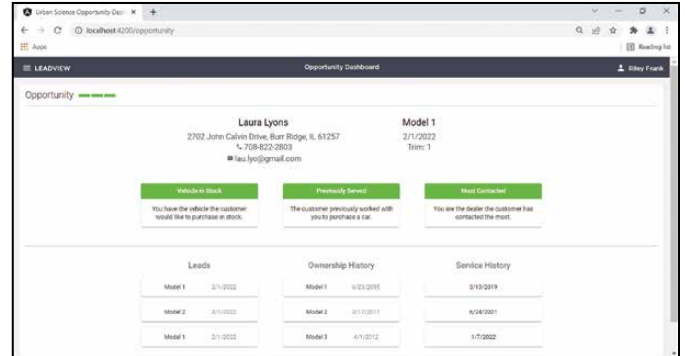
The main opportunities page displays only open or new opportunities. Closed opportunities are found in a different page of the web application and are accessible in the menu.

Our system identifies the most promising leads for dealers to pursue, cutting wasted time and increasing sales.

The front end of our Customer Insights Dashboard application is built using Angular. The back end is written in Python and uses a MySQL database with a .NET Core API.

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Vectorform
Employee Recognition on Blockchain

Founded in 1999, Vectorform is headquartered in Detroit. Vectorform helps organizations move from an idea to an invention with digital products and hardware solutions. They combine a variety of technologies such as Internet of Things, augmented or virtual reality, and other emergent systems to develop solutions for their clients.

Recognition is an important aspect of Vectorform's culture. Employees at Vectorform frequently congratulate each other in many informal ways on Microsoft Teams or in meetings. This recognition happens in real time and is not always visible to other employees.

Our Employee Recognition on Blockchain software solves this issue by making recognition publicly accessible to everyone in the workplace. Recognition is viewed through a web application and as messages in the Vectorform Microsoft Teams channel. Our software is integrated in Microsoft Teams as a new tab that mirrors the web application.

When a user sends recognition to a coworker, the system logs it as a transaction in a public ledger. The sender writes a message and specifies the number of tokens they wish to send. These tokens are used to measure appreciation and calculate rankings for a workplace leaderboard. Descriptions and keywords are generated from received messages for each user.

Our system ensures employees are recognized for their performance, improving company morale and culture.

The front end of our software is built using ReactJS, while the back end is implemented using Node.js. Microsoft Azure is used to host our SQL database and web application. Our application utilizes the Harmony blockchain, an Ethereum Virtual Machine compatible blockchain. OpenAI is used to create the user descriptions and keywords.
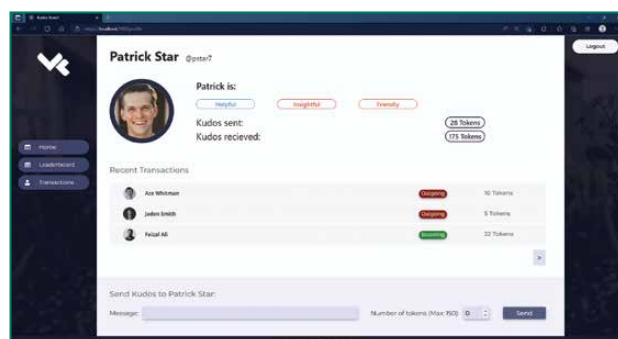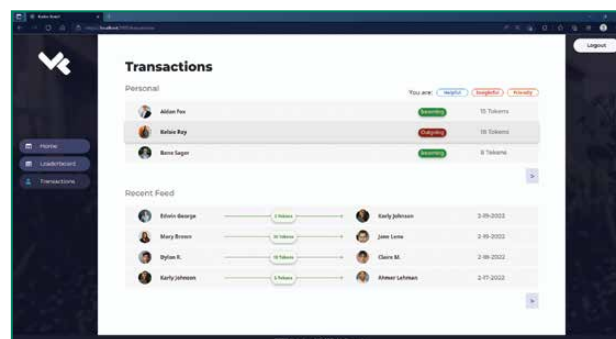
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Whirlpool Corporation
Recipe Progression Tracking

Whirlpool Corporation, based out of Benton Harbor, Michigan, is one of the world's best-known appliance manufacturers with over $22 billion in annual sales, 69,000 employees, and 54 manufacturing and technology research centers across the globe. Whirlpool's current focus is improving the home-cooking process.

With the global pandemic leaving its mark everywhere, many are left lacking guidance on how to properly prepare meals themselves. Typical recipes include step-by-step instructions on how to cook the recipe, but they have no real-time feedback on if the steps are being completed correctly.

Our Recipe Progression Tracking application provides users with step-by-step instructions on how to prepare dishes, along with motion-based feedback on if the directions are being followed properly.

This application runs on both an Apple Watch and iPhone. While cooking, the user is guided through each instruction, which is displayed on both devices.

An Apple Watch records motion data gathered from a user's arm. Using neural networks and machine learning algorithms, the cooking data recorded from the sensors within the watch is analyzed to provide feedback in real time on how well the user is completing a step.

The Recipe Progression Tracking application helps advance the future of cooking by combining traditional cooking methods with machine learning to produce an innovative style of preparing dishes. Our application helps Whirlpool achieve their vision of making cooking easy and accessible to everyone.

Our back end utilizes an Ubuntu server, MySQL, and TensorFlow to store and transmit the recipes and sensor data, while our front end is built using Swift and XCode. Both components communicate using a Rest API.
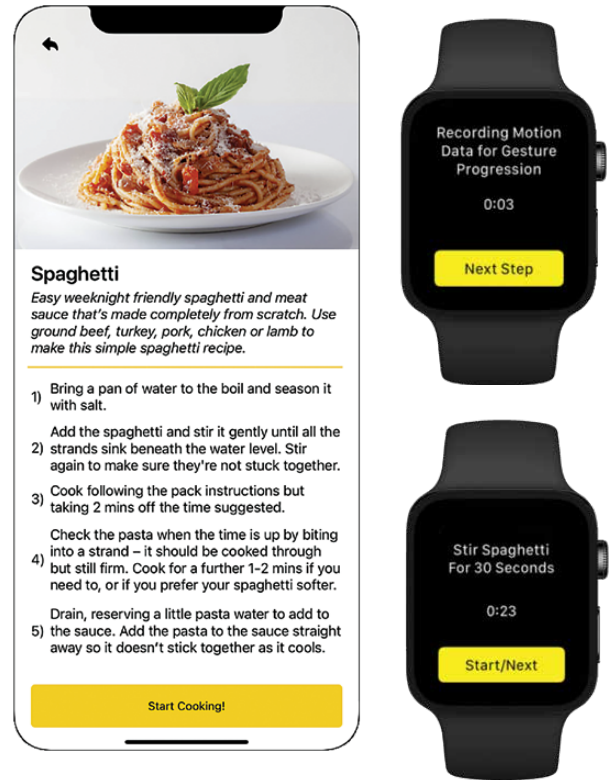
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Design Day Award Winning Teams

Fall 2021

Spring 2022

Auto-Owners Exposition Award
Team Anthropocene Institute 1

Auto-Owners Exposition Award
Team Michigan State University Linguistics

MSU Federal Credit Union Praxis Award
Team TechSmith

MSU Federal Credit Union Praxis Award
Team TechSmith

TechSmith Screencast Award
Team Evolutio

TechSmith Screencast Award
Team United Airlines Airport Operations

Urban Science Sigma Award
Team Amazon

Amazon Sigma Award
Team Anthropocene Institute

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