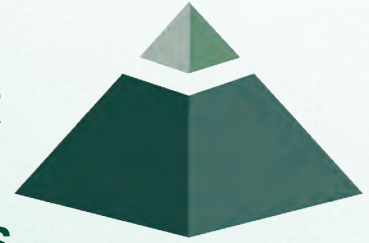# The Capstone Experience

From Students...to Professionals

COMPUTER SCIENCE AND ENGINEERING 2019-2020

MICHIGAN STATE UNIVERSITY

Auto-Owners
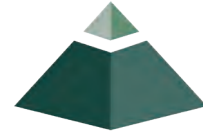INSURANCE
LIFE · HOME · CAR · BUSINESS

The Capstone Experience

Department of Computer Science and Engineering

CSE498, Collaborative Design

Dr. Wayne Dyksen
Professor of Computer Science and Engineering

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.

MICHIGAN STATE UNIVERSITY | The Capstone Experience, Fall 2019
COMPUTER SCIENCE & ENGINEERING

MICHIGAN STATE UNIVERSITY | The Capstone Experience, Spring 2020
COMPUTER SCIENCE & ENGINEERING

Corporate clients are local, regional, and national including Accenture, Amazon, AppDynamics, Auto-Owners Insurance, Bosch, Dow Chemical, Evolutio, Ford Motor Company, General Motors, Google, Herman Miller, Learning A-Z, Lockheed Martin Space, MaxCogito, Meijer, Michigan State University, Microsoft, Mozilla, MSU Federal Credit Union, Place Technology, Principal, Proofpoint, Quicken Loans, Technology Services Group, TechSmith, Union Pacific Railroad, United Airlines, Urban Science, Volkswagen and Whirlpool.

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.

THANKS TO AUTO-OWNERS INSURANCE

Auto-Owners
INSURANCE
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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).

Capstone Project Sponsors Fall 2019

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Accenture
Email Classification Using Machine Learning

Accenture is a Fortune Global 500 company that solves their clients' toughest challenges by providing services in strategy, consulting, digital, technology and operations. Accenture's iDefense provides contextual, timely and actionable security intelligence to the largest governments and organizations in the world, enabling them to make smarter decisions to defend against new and evolving threats.

Spam emails are a growing issue for many companies. According to SpamHaus, 14.5 billion spam emails are sent globally every day, accounting for nearly 45% of all emails sent. Spam emails can range from mild annoyance to exceedingly dangerous, possibly containing potent computer viruses and malware.

Due to the increased sophistication of spam emails, it is becoming more and more challenging for companies and employees to determine the legitimacy of their email messages. Any mistake by an employee can lead to a serious security breach.

Our Email Classification application utilizes machine learning and natural language processing algorithms to automatically classify and categorize incoming emails based solely on their content, thereby quickly and easily identifying spam emails.

Without the threat of malicious spam emails, employees and companies can more safely and securely manage their emails without worrying about potential security threats.

Administrators and security analysts from Accenture's client companies also have access to our web dashboard which enables them to easily view metrics and statistics of their email systems.

Our Email Classification Using Machine Learning system is hosted on a virtual machine running CentOS. Our web app is built using Flask and Bootstrap. Our data is stored in a Mongo database.
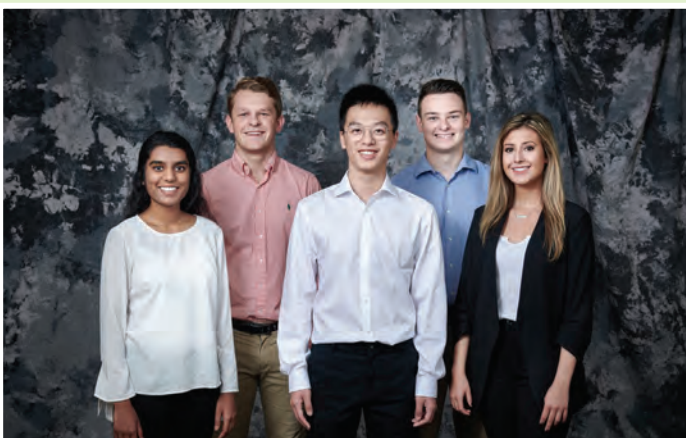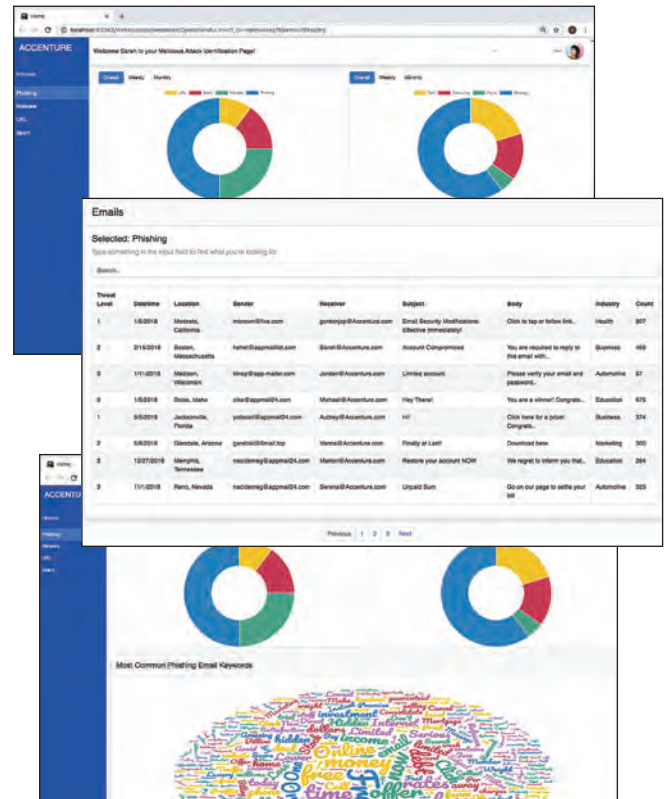
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Amazon
SPARTI: Selling Partner Application Ready to Integrate

Founded in 1994 as an online bookstore, Amazon is the largest online retailer in the world. Amazon has seen tremendous growth and success, making history by becoming the second U.S. company to be valued at $1 trillion. A key factor in Amazon's rise to the top is their e-commerce platform, which accounted for nearly 50% of all online retail purchases last year.

Today, more than half of the items sold on Amazon are managed and listed by third-party sellers. Amazon third-party sellers utilize the Amazon Seller Central portal to manually manage their listings and inventories on Amazon's platform. While the Seller Central site works well for small businesses, manual management becomes close to impossible for large and growing businesses.

Third-party sellers often create custom selling management applications. However, the process of creating these custom applications is often too difficult or overly time-consuming.

Our SPARTI application (Selling Partner Application Ready to Integrate) enables Amazon's third-party sellers to quickly and easily create custom selling management applications.

SPARTI provides users with a template application capable of fully connecting with Amazon's seller services. To deploy their custom site, a third-party seller merely needs to update the given template code with their own information.

Turnkey integration with Amazon Web Services (AWS) is also supported within SPARTI, giving third-party sellers the ability to automatically deploy and host their applications in the cloud.

Within the course of a day, a third-party seller is able to utilize the SPARTI project to build a containerized .NET application hosted on AWS ECS Fargate. The infrastructure for the application is instantiated by AWS CloudFormation.
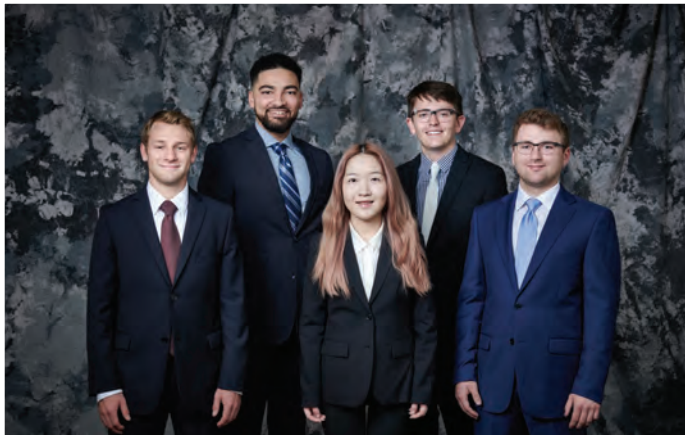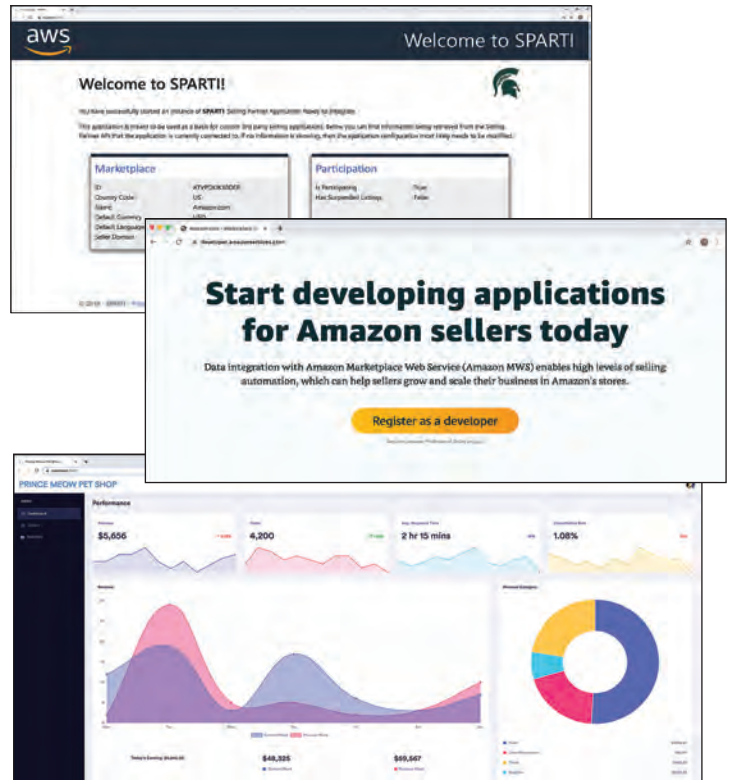
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AppDynamics
BizIQ Flow Map Using Sequential Analytics Data

Acquired by Cisco for 3.7 billion dollars, AppDynamics offers Application Performance Management (APM) solutions to their customers. These APM solutions monitor customers' application stacks and give them flawless experiences.

Currently, customers have access to linear flow map representations of individual applications. However, customers cannot represent business transactions that branch in multiple directions and across multiple application stacks.

BizIQ Flow Map Using Sequential Analytics Data augments AppDynamics' current offerings by allowing customers to represent multi-branch and multi-application business transactions. It enables users to create custom flow maps representing the various transactions and save the flow for viewing and editing purposes.

Flows are easily analyzed. The user sees the average time it takes for a particular business transaction to occur and the flow can be filtered to show specific instances.

Consider the manager of a car manufacturer. The manager is assessing the time it takes for a customer to unlock their car door using an app on their cell phone. When a user unlocks their car with the mobile app, events are collected and sent to a central interface.

These various events are connected to create a flow map. If there is an issue with the amount of time elapsed after the user unlocks their car, the manager sees this in the flow map. For example, if verification usually takes one second and the flow shows it took five seconds, a potential problem may be impacting this user. The flow map generated by BizIQ Flow Map Using Sequential Analytics Data alerts the manager to this potential problem.

BizIQ Flow Map Using Sequential Analytics Data is created using Node.js and utilizes the AppDynamics Analytics API to acquire data. The visuals of the project are created using d3.js, React and CSS.
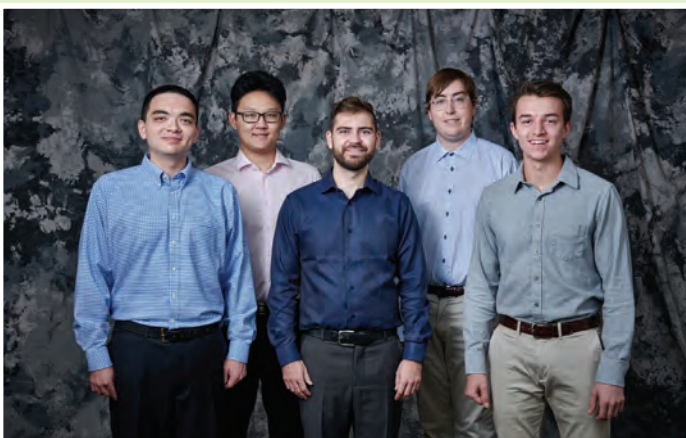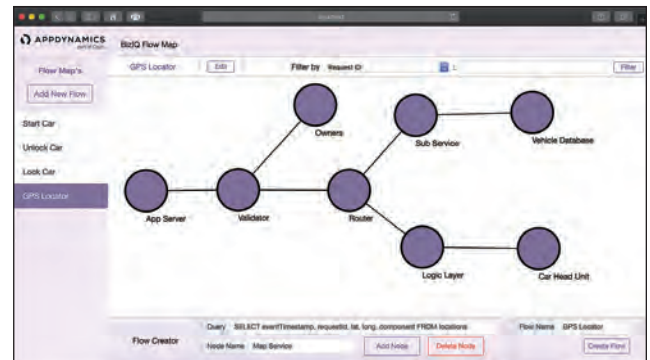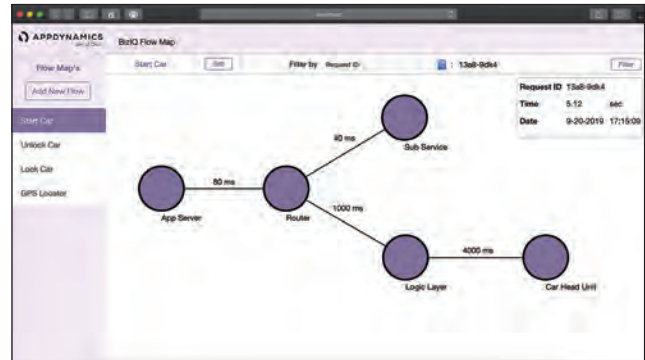
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Auto-Owners Insurance
"Danger Diner" VR Training

Auto-Owners Insurance is a Fortune 500 company that provides home, life, automobile, and business insurance to over 3 million policy holders. With over 47,000 independent agents, Auto-Owners has been serving the community since 1916.

Auto-Owners insures businesses throughout the Midwest. Therefore, recognizing good and bad safety practices is an essential skill for their insurers.

The best way to learn the principles of good or bad business practice is real-world experience. However, this can be prohibitively expensive and time-consuming.

Our "Danger Diner" VR Training is a competitive virtual reality game designed to teach Auto-Owners insurers to identify good and bad safety practices. Insurers learn in an immersive and interactive way providing them with a realistic experience.

Using an Oculus Rift headset, Touch controllers and sensors, insurers explore a virtual restaurant. A player is tasked with identifying potential safety and hazard items throughout the scene. Players are educated about business safety with a simulation of a realistic, everyday restaurant.

Each round features a unique selection of items. All item locations are randomly generated, ensuring that no two game sessions are the same.

To give our game a competitive feel, the scores are recorded and displayed on a leaderboard.
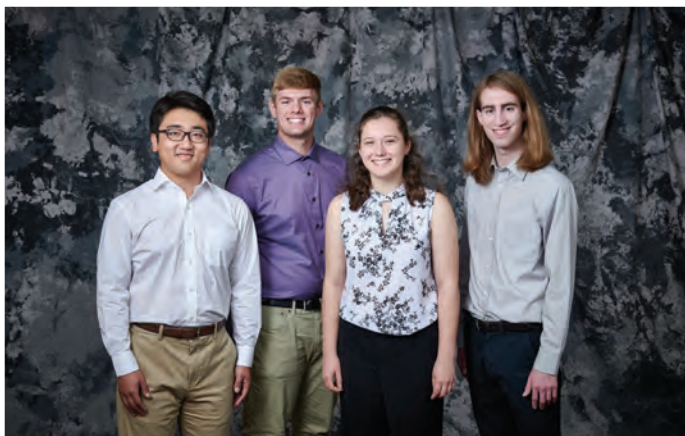
"Danger Diner" helps new insurers get hands-on training with no setup or expense and can also be played with large groups for training seminars and meetings.

"Danger Diner" is built using the Unity Game Engine. The game is played using an Oculus Rift headset, Oculus Touch controllers, Oculus sensors, and the SteamVR application.

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Bosch
Integration and Testing Suite for ADAS Radar Sensors

Founded in 1886 by Robert Bosch, Bosch is an engineering and electronics company with products sold in 150 countries worldwide. In addition to its industrial and building lines of products, Bosch is the world's leading supplier of automotive components.

Bosch develops sophisticated radar software for use in driver assistance systems. These radars are used to detect and identify obstacles and hazards on the road. Based on the output of the software, cars can notify drivers of hazards, and even automatically brake to avoid a collision.

Every configuration of radar and hardware requires a unique software system. Consequently, each configuration also needs a unique testing and deployment system. The testing and deployment of Bosch's radar software is currently done manually, requiring significant investment of time and money.

Our Integration and Testing Suite for ADAS Radar Sensors automates the testing and deployment of Bosch's radar software. Whenever an engineer updates their code, the resulting software undergoes extensive automatic testing. This testing verifies that any updated software does not compromise the radars or their functionality.

Automatic deployment and testing enable Bosch's developers to quickly identify malfunctioning software, patch any software bugs, and avoid introducing any new errors.

Our Integration and Testing Suite frees engineers to focus on implementing new features without the concern of errors, instead of manually running tests.

Automated flashing and testing use Jenkins. Flashing is communicated using CANape and CANalyzer. This provides functionality so that when a Bosch engineer changes the software in Bitbucket, a Jenkins job then starts and tests the software.
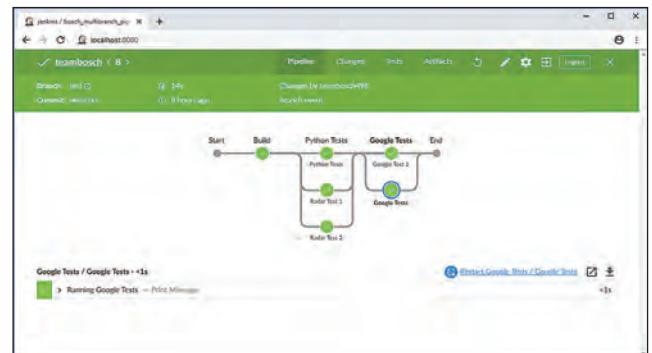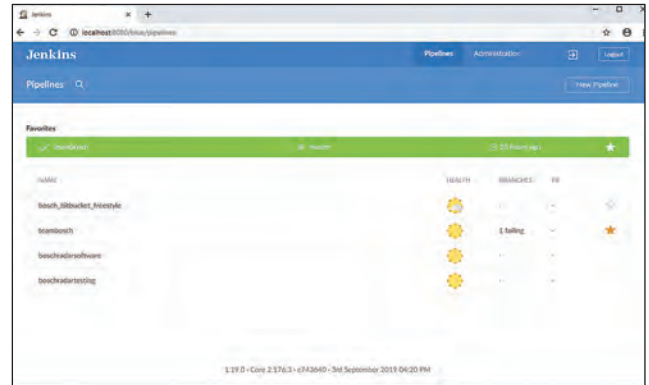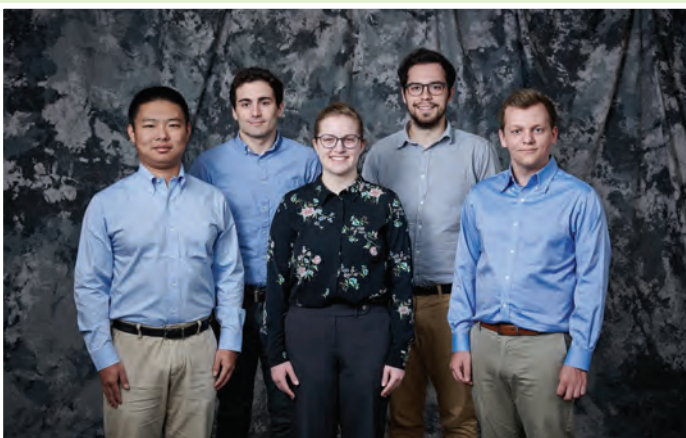
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The Dow Chemical Company
3D Product Showcase Application

With over a century of experience, Michigan-based Dow is a global leader in the innovation, creation, and distribution of specialty chemicals, advanced materials and plastics.

As a materials science company, Dow uses augmented reality applications to assist with marketing. Augmented reality is a technology that places a virtual object in the user's view of the real world (see image to the right). At trade shows, these augmented reality applications demonstrate the value of Dow's materials by providing interactive 3D models of their clients' products.

For each product, a new application must be created, or an old application must be manually updated. Dow's product catalog is continually expanding, requiring a significant time commitment on the part of Dow engineers.

Our 3D Product Showcase Application provides a standard platform for augmented reality experience creation. Customers can now use one application to view any of Dow's clients' products.

Viewing the world through a smartphone's camera and screen, Dow customers can view and interact with 3D product models as if they exist in the space around them. Users can place a product on any visible surface, allowing for easy customization and visualization through tapping interactive regions around the model.

Utilizing our platform, Dow engineers and sales teams can easily and quickly develop new augmented reality experiences. Dow customers can now navigate one application for all Dow products, as opposed to learning a new application for each product.

The 3D Product Showcase Application stores product information and models in an SQL database in the Microsoft Azure cloud. The front end is implemented in C# using the Unity Game Engine and the AR Foundation framework for augmented reality. Our application supports both iOS and Android devices.
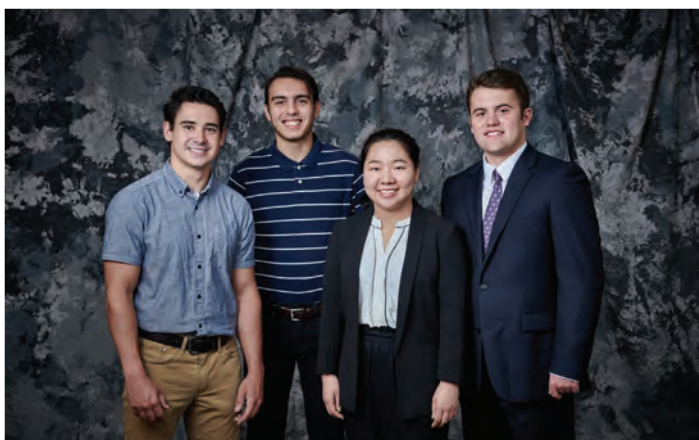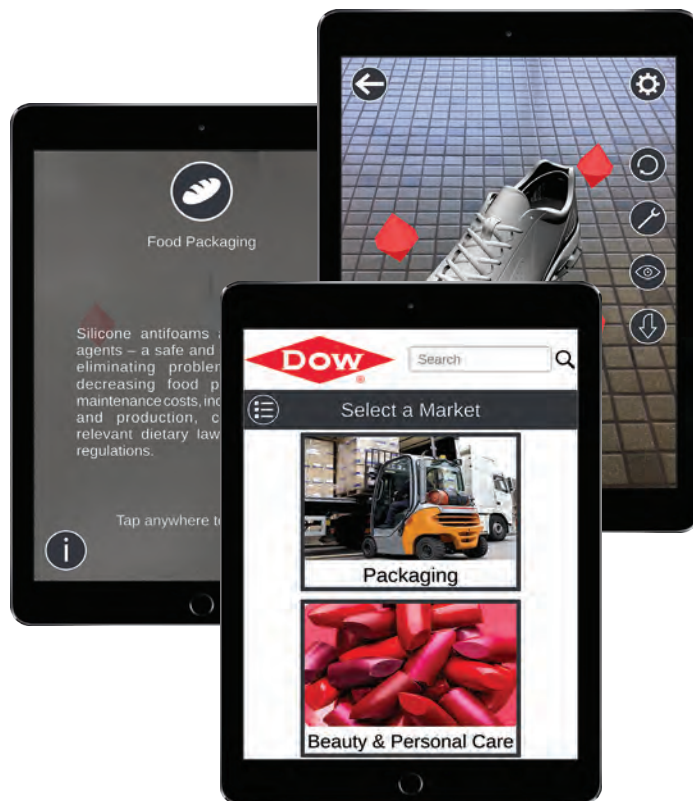
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Evolutio
ERP Air Force: Drone Elephant Recognition and Tracking

Evolutio is a group of technology professionals convinced that business problems have significantly simpler solutions than the market is led to believe. These solutions span across the globe, including the non-profit Elephants, Rhinos, and People (ERP), a group founded to preserve and protect Southern Africa's wild elephants and rhinos.

As part of their initiative to preserve and protect elephants, ERP uses drones, or Unmanned Aerial Vehicles (UAVs), to monitor elephants on Dinokeng Reserve in South Africa.

Drone operation, however, is costly and time-consuming. Elephants are seldom captured in drone footage and, when present, are difficult to spot. Video data collected from drone flights require manually analyzing hours of uninformative footage to find the few video frames that contain footage of elephants.

Our Drone Elephant Recognition and Tracking application serves two main functions: elephant recognition and predictive elephant tracking.

Elephant recognition specifies where and when in the hours of drone footage elephants are present (shown on the right). Our automatic elephant recognition removes the need to manually analyze video footage, saving ERP hundreds of man hours.

Elephant predictive tracking predicts potential future elephant locations. Predictive tracking allows pilots to create flight paths that maximize the chance of flying over elephants, allows rangers to be deployed to the correct location for checkups or, in the case of an active poacher situation, to confront the poacher.

ERP personnel use our web dashboard to view video footage, as well as the results of our Elephant Recognition and Tracking.

The web dashboard is built with VueJS interfacing with a Python Flask RESTful API. Detection of elephants uses a YOLOv3 model. A recurrent neural network uses GPS collars to predict elephant movement.
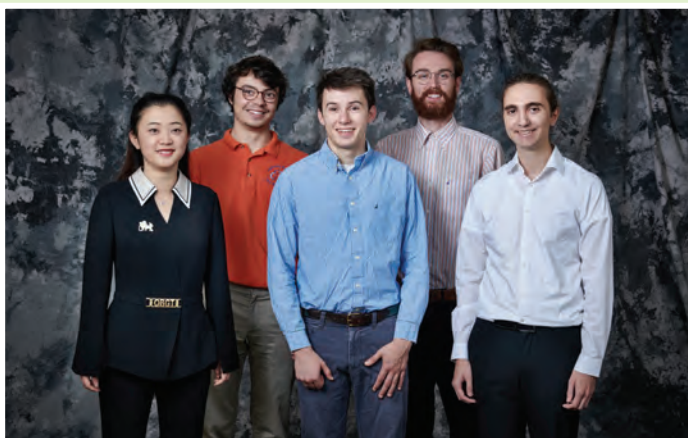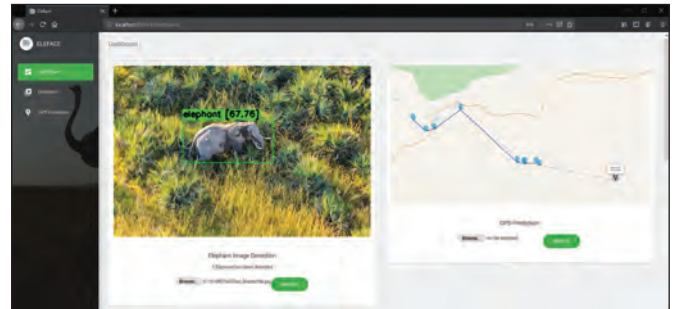
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Ford Motor Company
Ford Mobility Product Metrics

Ford Motor Company is an international automotive manufacturer based in Dearborn, Michigan. Ford employs nearly 200,000 people worldwide and is currently ranked among the top ten automobile companies in the world.

The car buying experience is becoming more and more digital as consumers are buying cars online in record numbers, spending about 60% of their time online. Ford embraces this reality and offers customers top-class online shopping experiences.

To keep their websites running smoothly, Ford's employees need to closely monitor the health of their websites to ensure excellent customer service, which can be time-consuming.

Our Ford Mobility Product Metrics platform includes intuitive, mobile, and easy-to-use chatbots, as well as a web metrics dashboard.

Ford's employees can ask our chatbots for information on a variety of topics, including Ford's software products, as well as website user metrics. Employees can also schedule regular report generation using our chatbots to stay up to date on the health and overall performance of Ford's websites.

Our chatbots give Ford's employees the ability to easily and quickly analyze the performance of Ford's websites and software. For a more comprehensive view, employees can use our web dashboard.

When a customer visits any of Ford's websites, their behavior is monitored and stored. Our web dashboard allows Ford's employees to view and analyze user behavior to monitor the success and health of Ford's websites and software.

Our Node.js chatbots serve Slack and Webex Teams applications. The data is collected from Ford's Azure Log Analytics API and a MySQL database. The dashboard is created with Grafana.
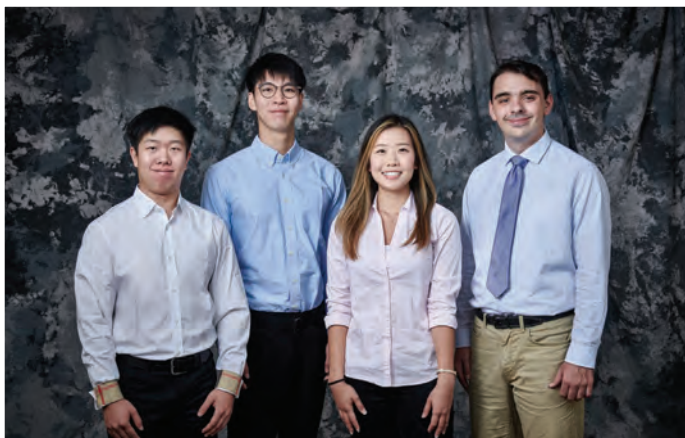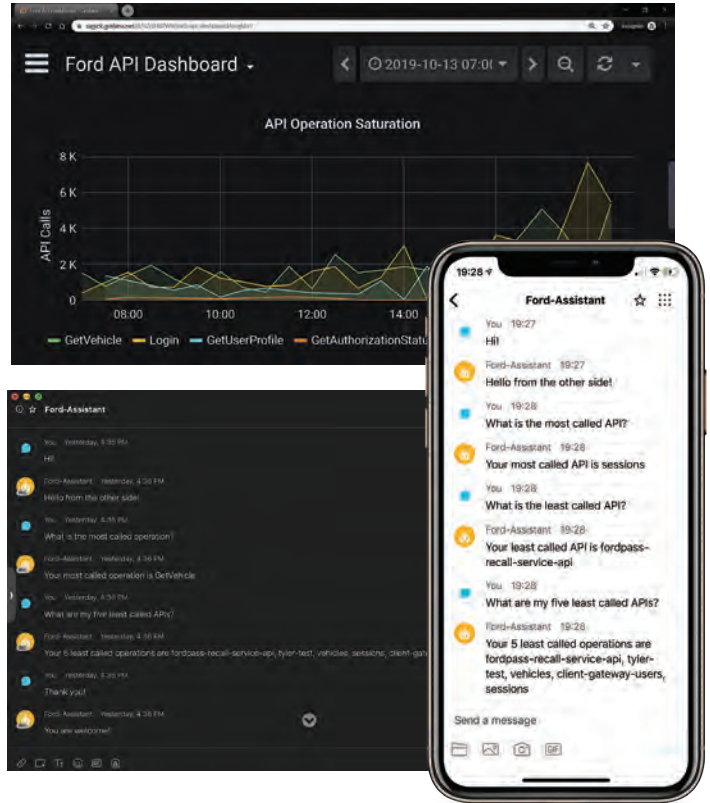
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General Motors
Profiling Manufacturing Plant Computer Network Traffic

General Motors is one of the world's foremost designers and manufacturers of cars and trucks, which are sold in more than 125 countries. Headquartered in Detroit, GM operates almost 400 facilities on six continents.

The Internet of Things is an up-and-coming computer networking and data collection paradigm that utilizes many individual computers all working together towards a single goal.

GM's manufacturing plants use the Internet of Things to increase efficiency and reduce errors in their manufacturing processes.

To protect their Internet of Things network, GM employs extensive real-time monitoring to alert them of any security threats or network malfunctions. As the Internet of Things network grows, the overhead of real-time monitoring increases, necessitating maximum efficiency.

Our tools for Profiling Manufacturing Plant Computer Network Traffic utilize machine learning techniques to efficiently identify potential network anomalies in GM's manufacturing plants. Users can view the data and results of our monitoring in a web dashboard.

GM's security analysts use our web dashboard to monitor and visualize the performance of the Internet of Things network. Any detected anomalies are ranked with a severity score, allowing the security analysts to solve the highest priority threats as soon as possible.

Our tools allow GM's Internet of Things network to grow without sacrificing security or introducing expensive overhead.

Network flow data is stored in a MySQL database and our machine learning models are implemented in Python. These models are trained with network logs collected from multiple GM manufacturing plants. Users can interact with the system via a Tableau dashboard.
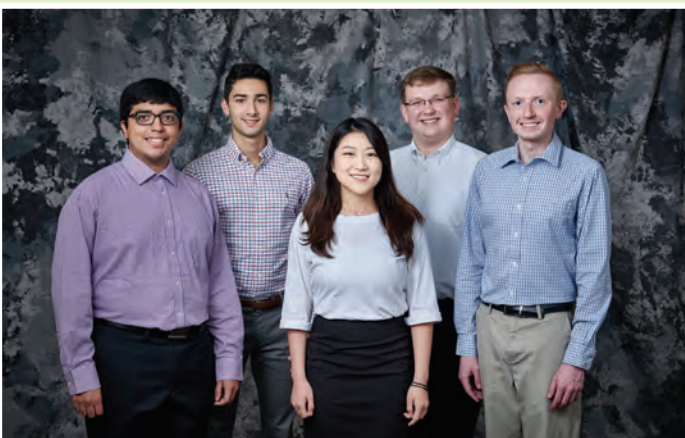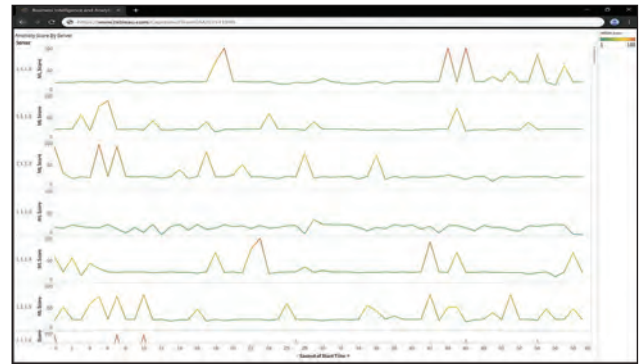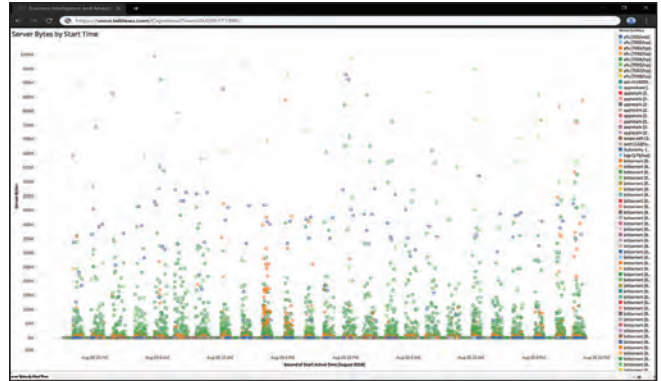
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Harvard Law School
"StackLife" Library Search and Display Tool

Founded in 1837, Harvard Law School is the oldest law school operating in the United States. Consistently ranked as one of the top universities in the world, an average of 560 students enroll in Harvard's prestigious law program each year.

The media presence surrounding Islamic news, policy, and debate makes easily accessing the millions of surviving Islamic/Sharia documents more important than ever.

Harvard Law School wants to consolidate the world's information on Islamic law and history with the hope of facilitating universal access.

Harvard Library currently has cataloged records from multiple data sources. Some of this data is inaccurate or misplaced, causing the information to be difficult, even impossible, to access.

Our "StackLife" Library Search and Display Tool consolidates the data from Harvard Library and stores it in one, easily accessible location.

Consolidating data not only allows for easier access, but also helps to remove inconsistencies and inaccuracies that may exist between multiple data sets.

Researchers use our website to customize searches to locate sources as well as save their searches, allowing seamless repeated querying.

As more users search for sources, our specialized search algorithm continuously improves the research experience, placing more relevant resources first.

Our application is built using Bootstrap and Python Flask and is contained within Docker. We are using Amazon Web Services to create a relational database server with MySQL 8.0.
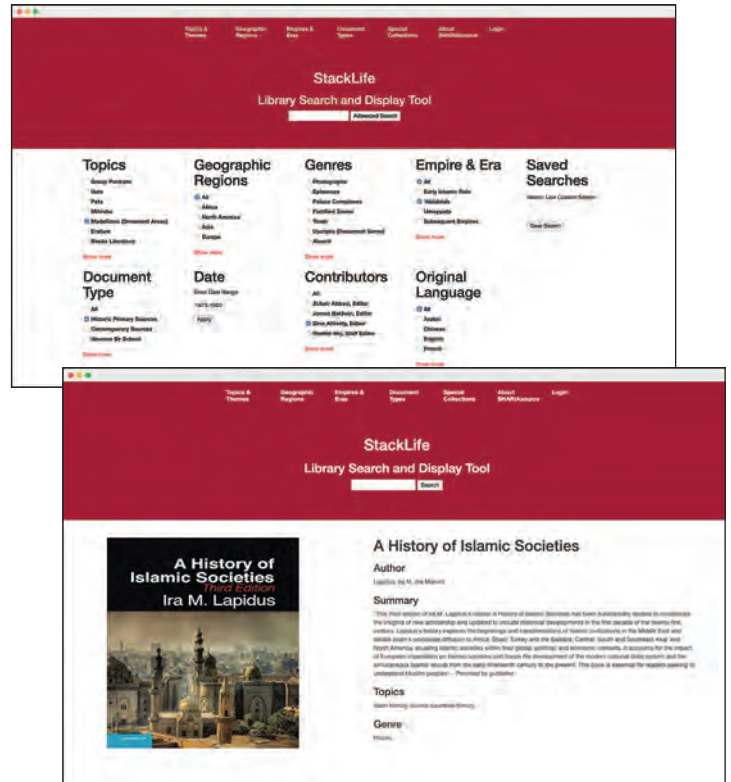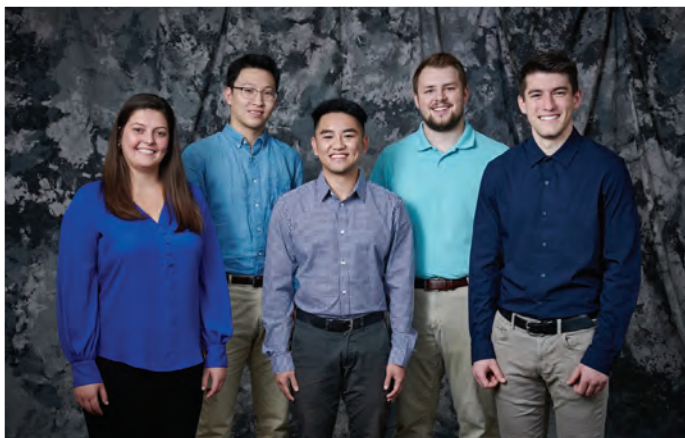
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Herman Miller
Computer Vision for Furniture Manufacturing

Headquartered in Zeeland, Michigan, Herman Miller is one of the world's largest producers of high-end office furnishings. The company's ergonomic office chairs are used in modern workspaces around the globe.

Herman Miller provides a wide array of customization and configuration options for each piece of furniture, including an extensive catalog of over 30,000 fabrics.

Every individual piece of fabric used in a product undergoes extensive human verification to ensure the correct fabric is used and no defects are present. Some fabrics, however, are very similar, with differences scarcely visible to the human eye.

Our Computer Vision for Furniture Manufacturing system utilizes machine learning to verify fabric color and pattern on each piece of furniture that passes through the assembly line.

First, Herman Miller's entire fabric catalog is analyzed to enable our system to know what fabrics are available.

When a panel passes through the assembly line, a barcode is scanned, processed, and an image of the furniture is taken and sent to our system. This barcode indicates what fabric should be present. If there is an error, the fabric and the barcode will not match.

The verification results are displayed for Herman Miller operators on our web dashboard. If an error is detected, the operator can rectify the problem before the product is shipped. Our system removes human errors that might occur from similar looking fabrics.

The Computer Vision for Furniture Manufacturing system uses Tensorflow and SageMaker to handle color and pattern verification. Flask, which is hosted on Amazon Web Services, provides a web interface to display verification results. A Raspberry Pi, barcode scanner, camera, and a light system are used to take consistent photographs on the assembly line and upload them to Amazon Web Services for analysis and verification.
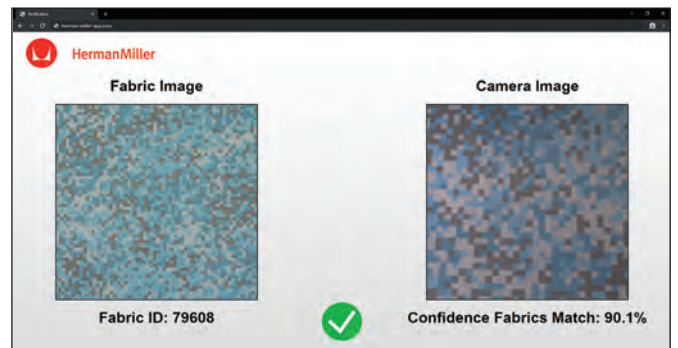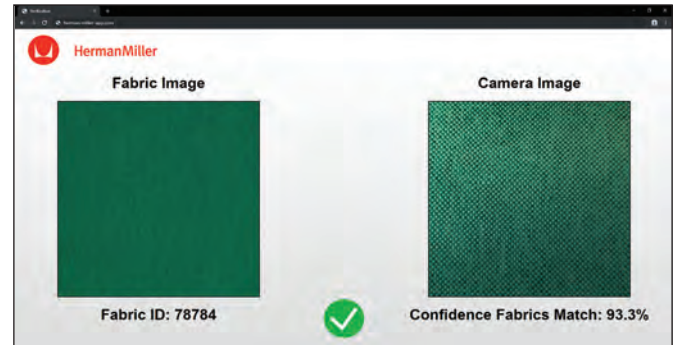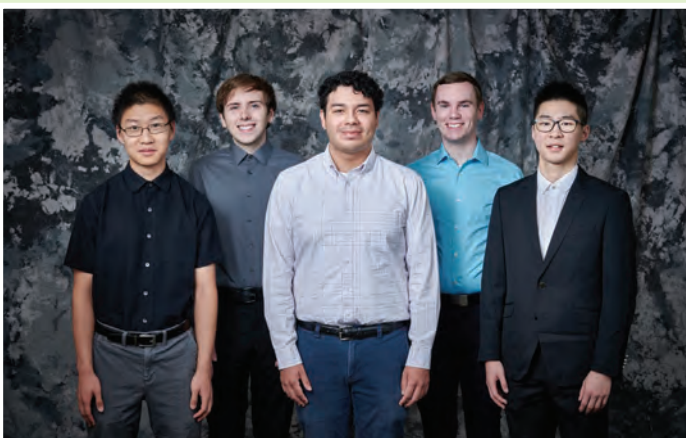
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Learning A-Z
Robot Builder Word Guessing Game

Founded in 2002, Learning A-Z is an education technology company dedicated to expanding literacy through an extensive collection of thoughtfully designed tools and resources. With nearly 8 million active students, Learning A-Z seeks to provide students with the 21st century skills they need to excel in the classroom and beyond.

Learning A-Z currently offers an extensive suite of educational resources. Students use Learning A-Z's software for a multitude of subjects and lessons and therefore are familiar with the content and style. When a new resource is added, students waste less time learning the software and more time learning the material.

Our Robot Builder Word Guessing Game provides a personalized vocabulary learning experience for students. The game is designed with Learning A-Z's style and content, allowing students to focus on learning vocabulary.

When a game is started, a word is chosen at random and an outline of the robot shape appears.

If the student chooses a correct letter, it appears in the word and a robot part is displayed (see image to the right). If the student completes the word, they are awarded a number of stars, which is the common currency for the Learning A-Z software.

Upon completing the word, students are given the option of entering a bonus round where they choose the definition of the word that was presented.

Based on previous results, words are chosen to best match the skill level of each individual player. If a student struggles with a particular word or set of words, our system exposes them to more words of the same difficulty.

Our Robot Builder Word Guessing Game is developed using Angular for the front end and Swift for iOS platforms. It communicates with our MySQL database using PHP.
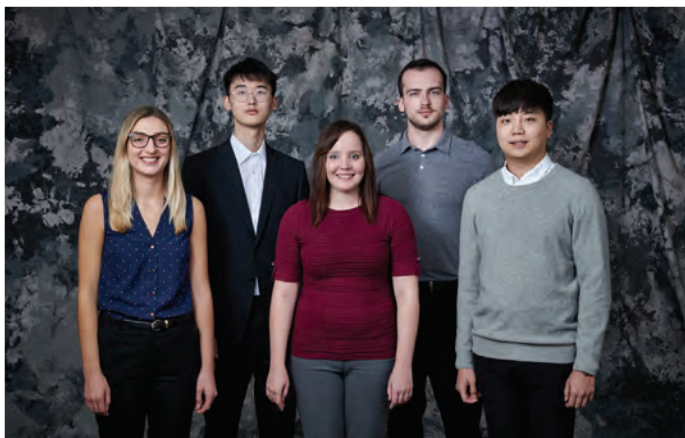
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Meijer
Creating Picking and Fulfillment Efficiency

Meijer, one of the country's largest supercenter chains, provides high quality groceries and merchandise to several states across the Midwest United States. Meijer has over 240 stores, 77,000 team members and is continuously improving today's shopping experience with cutting-edge technology like curbside pickup and online grocery ordering.

Third-party shopping services enable customers to order groceries online. A professional shopper then does the shopping for them and delivers the groceries directly to the customer's home.

The satisfaction of both the customer and the professional shopper is directly related to the speed of the overall delivery. If the professional shopper does not know the layout of a store, or chooses a non-optimal path, the order picking duration will increase.

Our Creating Picking and Fulfillment Efficiency system calculates the optimal path through Meijer supercenters to increase the efficiency of professional shoppers. Faster delivery leaves the customer satisfied, and allows the professional shopper to fulfill more orders, thereby increasing their profits.

Customers place orders online, which are then accepted by professional shoppers. The shoppers fulfill these orders by picking up the items a customer has ordered. Our application, running on Android and iOS devices, uses a sophisticated pathfinding algorithm to determine the optimal route to each item on the shopping list.

Our pathfinding algorithm is generalizable and can be used in any Meijer store. Also, our algorithm takes into consideration factors such as frozen and perishable items that need to be picked up at the end of the shopping trip.

The Android and iOS apps are written in C# and XAML using cross-platform interfaces created with Xamarin.Forms. These apps make requests to a SQL server database hosted in a Microsoft Azure Cloud environment via a .NET Framework API.
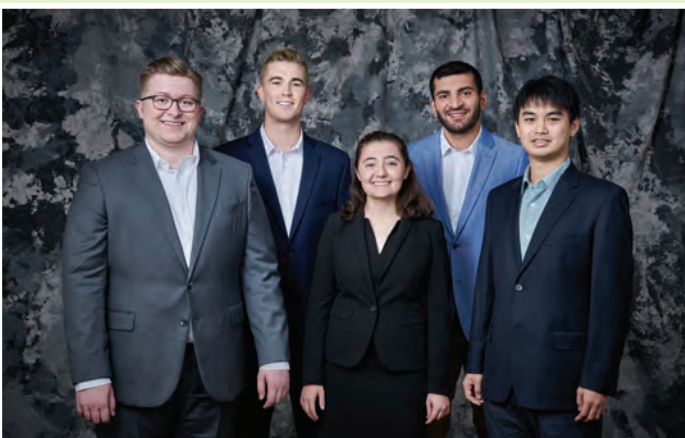
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Michael Sadler Foundation
GameChang3rs Learning Management System

The mission of the Michael Sadler Foundation is to inspire and empower students in building their personal legacies. The foundation uses six pillars of character as stepping stones for this growth, and does so with the GameChang3rs Program.

GameChang3rs is a program to give students tools that will help them develop strong character, make good choices, and become socially and emotionally engaged. GameChang3rs student ambassadors are volunteer high school students who teach and mentor elementary school students.

As the foundation expands, organizing and analyzing the accrued data becomes challenging and complex. Current data analysis and organization exists in Excel spreadsheets and paper.
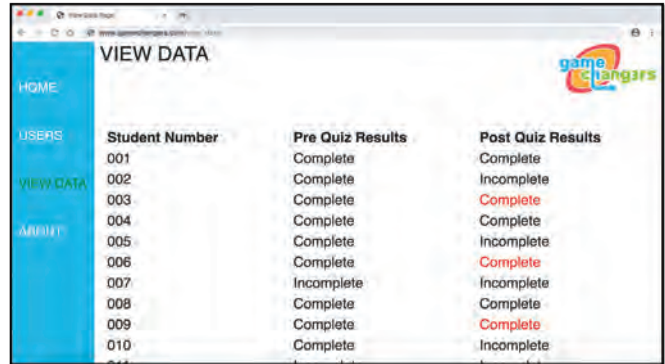
Our GameChang3rs Learning Management System helps to automate and digitize this process. Our web application allows administrators to manage staff and training material, as well as collect student metrics on the effectiveness of different lessons and initiatives.

Used by administrators, student ambassadors, and foundation sponsors, our application is a hub for all foundation materials, including lessons, quizzes and presentations.

Google applications, which are used for presentations, videos, and quizzes, are fully embedded in our site, ensuring that GameChang3rs members can access all of their data and materials in one convenient application.

With the end goal of rapid expansion, our Learning Management System is designed to be fully scalable to include more ambassadors, schools, and even organizations in the future.

The Gamechang3rs Learning Management System front end is built using JavaScript, HTML and Bootstrap. The back end uses PHP and is hosted on Amazon Web Services through AWS Elastic Beanstalk.
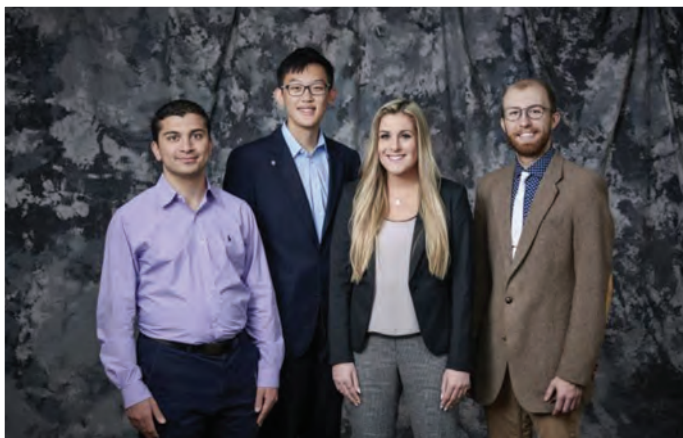
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Michigan State University ITS
Spotlight: Discovering Clubs and Student Organizations

The nation's pioneer land-grant university, Michigan State University (MSU) is one of the top research universities in the world. In addition to nationally ranked and recognized academic programs, there are over 900 registered student clubs.

Among the 50,000 students on campus, around 9,000 are first-year students. Many join clubs to find friends and de-stress from school activities, but identifying interesting clubs is a challenge. Research has shown that students who take part in campus activities are happier, healthier and have better grades. This is why MSU ITS, MSU's primary IT division, is committed to helping students find clubs with Spotlight. Spotlight is a mobile app and website that suggests clubs and events to students. Unlike mass emails and fliers, Spotlight is tailored to the students' specific interests, allowing them to pinpoint clubs they want to join.

Students using Spotlight input their general interests upon first using our application. Spotlight then provides students with club and event recommendations based on these interests, as well as shared interests with similar students.

When searching for events, students have many options. If proximity is important, a map view of campus shows nearby events for students to attend and provides directions to get there safely.

If a student has a busy schedule, time of day might be more important than location. Spotlight allows users to filter events by meeting time in addition to location, member count and other characteristics on the Discover Page (shown on the right).

Spotlight's personalized home view (shown on the right) provides an updated feed of announcements and information from joined clubs. Spotlight is developed with Swift for iOS, Kotlin for Android and Vue.js for Web. The AWS Lambda API is written in Node.js and uses MySQL as the underlying database.
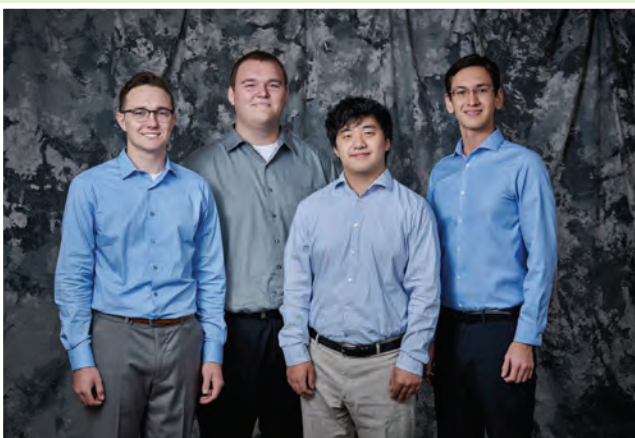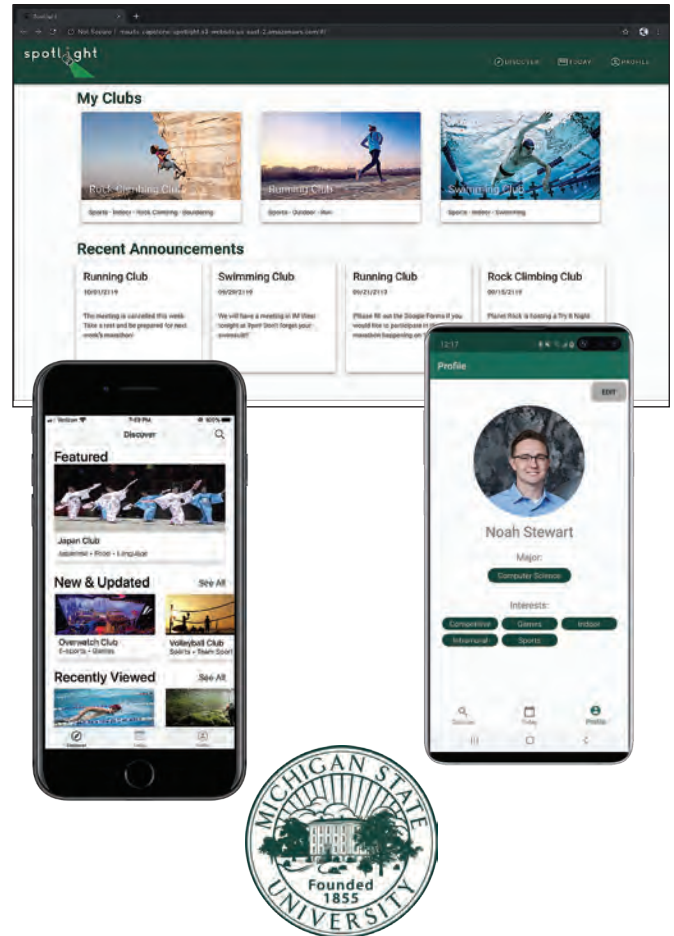
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Microsoft
ITPro Company Portal

Microsoft is a longtime leader in the technology industry, providing enterprises with a comprehensive suite of software solutions created to drive productivity.

As the world evolves technologically, more and more people are using their personal mobile devices to perform company work, both inside and outside of the office. This allows for more flexibility and productivity for employees, and lowers the hardware costs for companies.

However, as more personal devices connect to corporate networks, it becomes important to keep corporate information safe from unwanted access and malicious attacks.

Our ITPro Company Portal is a system that enables information technology (IT) administrators to ensure that all company employees' personal mobile devices are both secure and reliable.

Prior to using one's personal mobile device for work, the user downloads the ITPro app, which allows an IT professional to check that it is indeed secure and reliable. ITPro does so with very limited access, which maintains an employee's personal privacy and complete control over their device's non-work information. Our application comes with a variety of features for the user such as status updates on the system, policy creation, and user control.

Using ITPro, IT administrators can be confident that all mobile devices company-wide are compliant with corporate security and reliability policies. And, since ITPro itself is a mobile cross-platform app that supports Google Android, Apple iOS, and Microsoft Windows devices, administrators can do so using any device, from anywhere in the world, at any time.

Our ITPro Company Portal app is written in C# using the Xamarin framework within Microsoft Visual Studio. It communicates with Intune via the Microsoft Graph API.

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Mozilla Corporation
Splitting the Atom. Again.

Mozilla is a global, nonprofit organization dedicated to improving the World Wide Web. Mozilla places a strong focus on open-source projects that prioritize the privacy and security of its users. Mozilla's most popular project, Firefox, is the second most used desktop browser, serving over 250 million users worldwide.

Recently discovered security vulnerabilities, "Spectre" and "Meltdown," have reiterated the need for computers to maintain the security and privacy of their users. To this end, Mozilla has started to convert Firefox to a new system, called Fission.

Currently the Firefox browser runs each webpage in a single process, which can be thought of as a physical container. Each webpage consists of multiple parts. If these parts all reside in the same container, then they can interact with each other's parts, thereby enabling potential security vulnerabilities.

Fission is a new paradigm developed by Mozilla to split webpages in Firefox into multiple processes, or containers, to protect the user from potentially malicious web pages or advertisements. Using Fission, a malicious web page can no longer access private information because it no longer resides in the same container as anything else.

To implement Fission, Firefox's underlying infrastructure must be reworked. Firefox is massive, containing over 5 million lines of code, so converting the entire browser to Fission is not trivial.

Our "Splitting the Atom. Again." project updates various parts of the Firefox browser, such as picture-in-picture video, pop-up blocking, and page thumbnail creation, to use Fission. From a Firefox user's perspective, this transition is unnoticeable, but it is essential to ensure a secure browsing experience.

These advancements are implemented using JavaScript, with Mercurial used for version control and Phabricator used for code reviews.

Firefox Browser
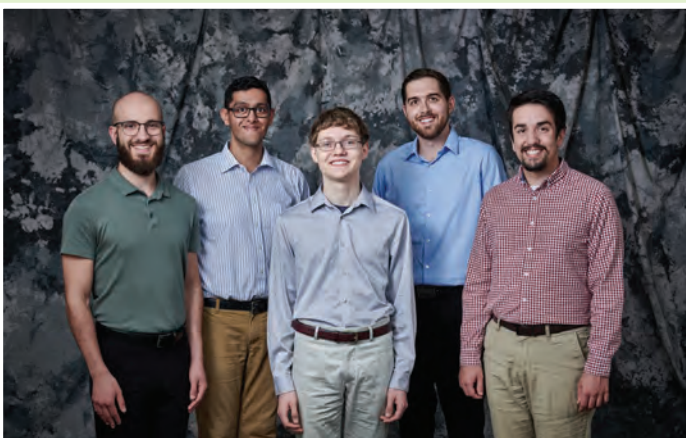
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MSU Federal Credit Union
Building Hopes and Dreams Together

Founded in 1937, Michigan State University Federal Credit Union offers financial services to members of the Michigan State University and Oakland University communities. With 280,000 members and over $4.5 billion in assets, MSUFCU is the largest university-based credit union in the world.

As the age of digitization progresses, banking has become increasingly automated and impersonal. Now, more than ever, it is imperative for businesses to provide a more personal, engaging experience for consumers.

Our Hopes and Dreams system is a hyper-personalized banking platform aimed at understanding members' financial needs and life goals to ultimately provide a better, more personal user experience.

As a user first logs into the Hopes and Dreams application, they are prompted to complete a short quiz. This quiz helps our system understand each user's spending needs and goals on a more personal level.

With a deeper understanding of our users, Hopes and Dreams provides personalized offers and spending tips, tailored to each specific user. An example tip from our system might be: "to afford your dream trip to Europe, you should spend less money at Starbucks."

Our offers and tips are generated based on a user's quiz responses, as well as demographic spending data related to a user's income, age, and spending habits.

Users can also set their own spending goals and keep track of their progress through any of their iOS or Alexa devices.

Hopes and Dreams is available on Amazon Alexa, and mobile devices running iOS. The CRM is available on all web browsers. The iOS app is built using Swift, and the website is primarily HTML, CSS and PHP. All applications call an API running Python Flask.
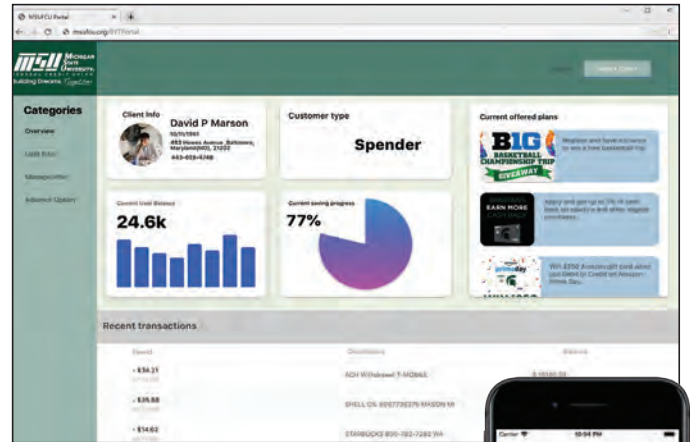
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Proofpoint
Detecting State-Sponsored Cyber Security Threat Actors

Headquartered in Sunnyvale, California, Proofpoint is an innovative cyber security company offering protection to a wide range of Fortune 100 corporations as well as public institutions such as Michigan State University.

For those with sensitive data, the threat of cyberattacks is constant. Companies, and those who protect them, find themselves locked in an endless battle with rapidly advancing, malicious, and highly coordinated foreign threats.

Our Detecting State-Sponsored Cyber Security Threat Actors platform is designed to swiftly analyze and study these state-sponsored threats to better understand their attack patterns and to thwart future attacks.

To gain adequate data from threats in a controlled environment, the cyber security industry often turns to a mechanism known as a honeypot. Honeypots appear to contain information an attacker would find valuable, but in reality is effectively worthless. Upon accessing the honeypot, the attacker's actions are monitored, and their methods analyzed.

Our Detecting State-Sponsored Cyber Security Threat Actors system simplifies the process outlined above. It enables researchers to quickly generate honeypots, depicted as the bottom website and paper to the right, place them in high-traffic areas, and stream obtained data back to an intuitive dashboard.

The web dashboard enables security researchers to investigate individual attacks and the efficacy of each lure, allowing them to package related attacks in a controlled environment, and to design more effective lures.

The web dashboard consists of a React front end with a Python Flask and PostgreSQL back end. HTTrack is implemented to quickly develop lure websites, GPT-2 generates believable documents, and Suricata continuously monitors traffic and accumulates data.
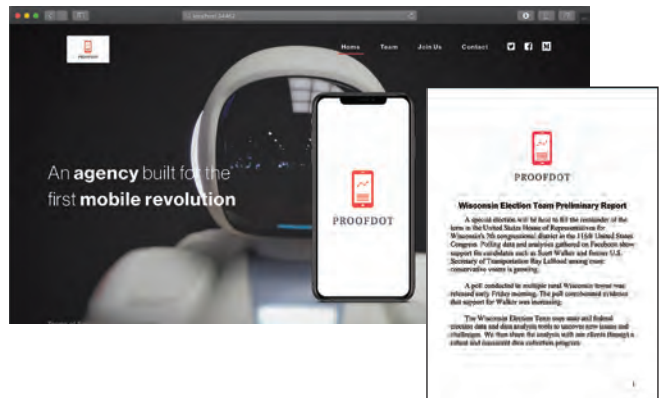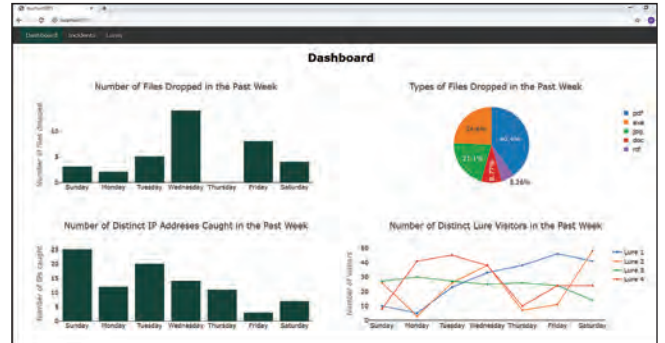
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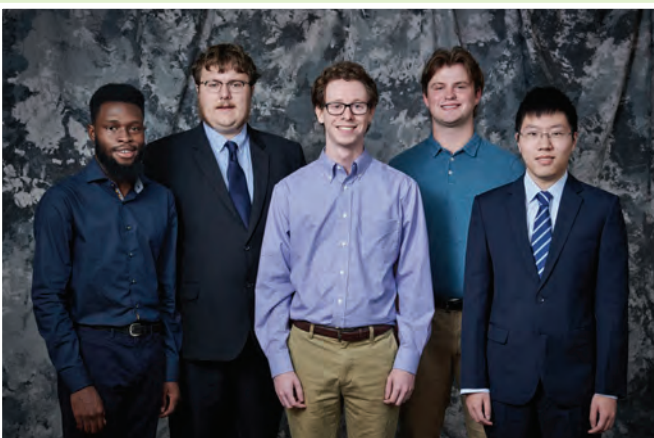
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Technology Services Group
Document Management Using Google Cloud Platform

Founded in 1996 in Chicago, Technology Services Group (TSG) focuses on helping companies manage and store their data. TSG has many clients across a wide range of industries and is a leading provider of content management solutions.

Clients of TSG include car insurance companies, whose claim agents take multiple phone calls and receive documents and images regarding new incidents. Claim agents spend copious amounts of time re-listening to phone calls and manually checking images to retrieve information regarding a specific incident.

Our Document Management Using Google Cloud Platform system integrates the power of Google Cloud Platform (GCP) with TSG's existing software, OpenContent Management Suite (OCMS).

Our system offers the ability to transcribe and analyze audio and image files and perform searches based on the output of the analysis.

When a media file is opened in OCMS, the option to transcribe the audio becomes available through an action button. A new file is generated containing the transcription of the audio and is linked back to the original media. A claim agent is able to search the transcription by keywords or scroll manually to find the information.

Additionally, claim agents are able to search by image content. For example, if a claim agent searches the words "car crash," all images containing a crashed car are displayed in the results. This saves time since each image does not need to be opened to determine its content.

Our Document Management Using Google Cloud Platform system utilizes Angular, Apache Solr, Apache Tomcat, HTML, Java, JavaScript, and GCP Services: Cloud Bigtable, Cloud Storage, Speech API, and Vision API.

technology services group
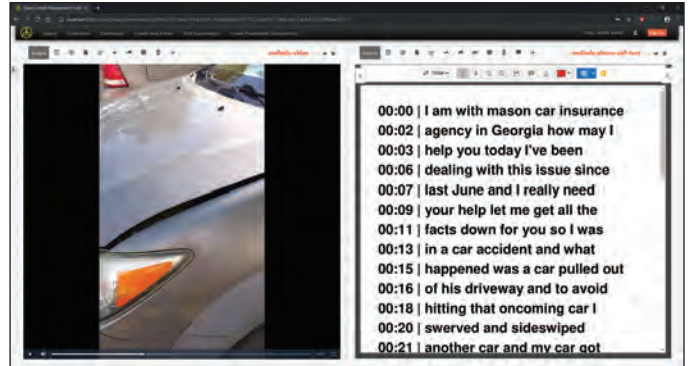
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TechSmith
Smart Automatic Video Creation

TechSmith provides software that empowers people to communicate more effectively by easily creating visual content such as images and video. Their flagship products, Snagit and Camtasia, are used by more than 30 million people worldwide.

Creating videos is a difficult, lengthy, and potentially expensive process. Many content creators are looking for an efficient way to automate the video creation pipeline.

Our Smart Automatic Video Creation platform automatically generates high quality, unique videos based on a single text input.

In particular, our system takes any script or article as input and automatically creates video content composed of relevant images, videos/animations, sounds, and text annotations.

Users start by accessing our web application where they are given the option to upload or paste a script or article. After the text is submitted, natural language processing algorithms are used to generate a concise summary of the article. This summary is used as subtitles for the video (shown to the right). At this point, users can also choose to translate their summary to any language, allowing content to reach a broader audience.

The summary is analyzed to find keywords and ideas. These are used to find suitable visual content. Images and videos are found using the TechSmith Assets API, and Bing's image search.

After the visual components of the video are selected, the text is again analyzed for sentiment. The sentiment of the text is then used to find audio that fits the mood of the text.

Once the assets are all collected, our system stitches together all images, videos, music, and text and automatically generates a video for the user based on their initial input text.

The front end of our web application is made using JavaScript and the back end is written using C# and .NET core framework. The web application and SQL database are both hosted on Microsoft Azure. FFmpeg is used to render and complete the final video.
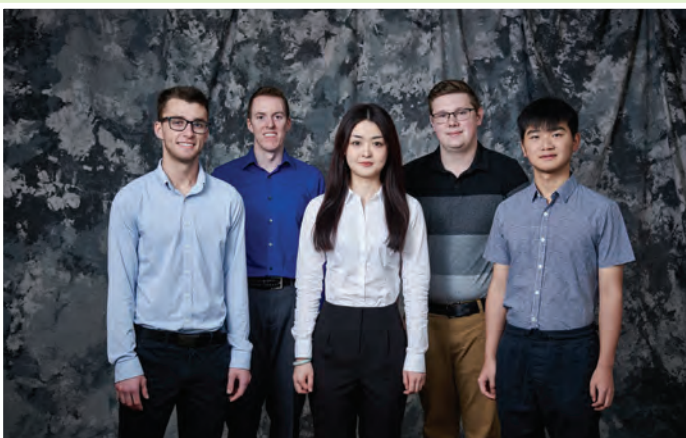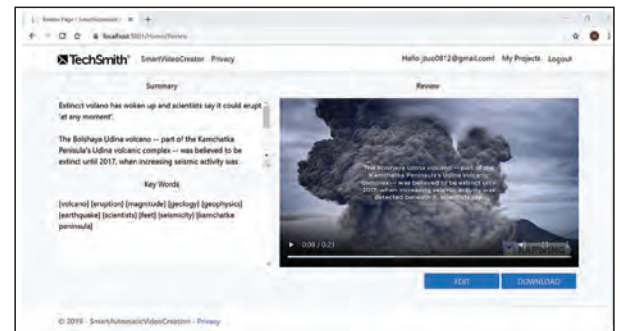
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Union Pacific
Railroad Physics Data Visualization

Union Pacific was founded in 1862 and is now the leading railroad transportation company in America. With over 32,000 miles of track in 23 states, 8,600 locomotives, and 43,000 employees, Union Pacific plays an important part in the transportation of goods in the nation.

Derailments cost transportation companies millions of dollars 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 Physics Data Visualization platform provides a web-based user interface that converts a simulation's raw data files into clean, readable, and intuitive graphical output. These interactive graphs aid in the analysis of derailment simulations.

After a successful simulation, the raw data file is uploaded to our system via a web dashboard page. A user can then access the web dashboard to analyze a file.

Graphical output from our Railroad Physics Data Visualization platform can be viewed on our web UI (shown on the right) or downloaded as a generated Excel file.

In addition to static graphs and charts, our platform produces animated graphs that visualize train elevation, as well as the forces between train cars over time.

Using our system, Union Pacific employees can more quickly and accurately determine the cause of derailments and accidents, saving Union Pacific valuable time and money.

Our Railroad Physics Data Visualization project has a front end web UI that uses the Angular framework and is written in TypeScript and CSS. Our back end is written in Java, runs in a Tomcat environment, and communicates with an Oracle MySQL database.
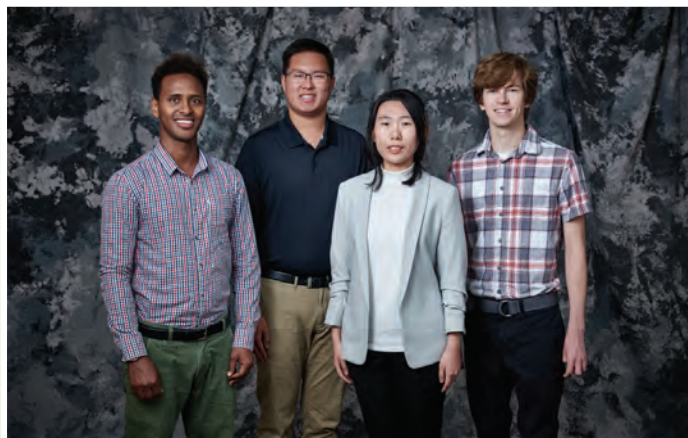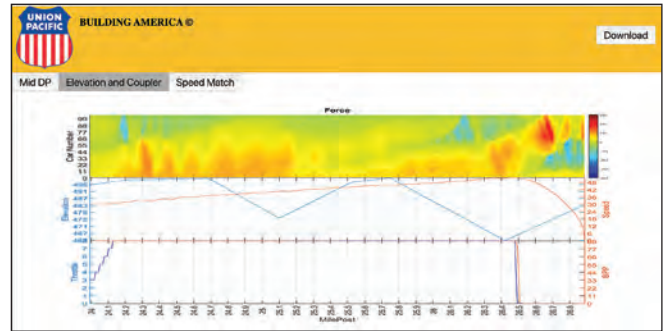
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United Airlines
Training Scheduling and Optimization System II

United Airlines is the world's second largest airline company, operating 4,600 flights a day to 357 destinations. To maintain its fleet of 1,300 aircraft and ensure successful flights, it is crucial to have properly trained personnel. United's Technical Operations division has 45 instructors who teach around 700 classes yearly to over 7,000 employees.

Our Training Scheduling and Optimization System II provides a web app to facilitate United's maintenance training schedulers to schedule instructors, students, and courses across the country.

When the scheduler wants to schedule a course, they must take into account a number of factors, including instructor availability, venue availability, instructor travel distance, and instructor qualifications.

Using our mobile compatible website, users can schedule classes manually, or through our automated schedule optimizer. Manual scheduling can be used effectively for a few classes in a short time frame. However, when dealing with a large number of classes and taking into account all relevant factors, manual scheduling is an arduous task.

Our schedule optimization feature allows a scheduler to input a given time frame, a set of classes, and a set of locations. The optimizer then recommends an optimal schedule, including instructor and classroom assignments.

The optimized schedule minimizes the distance traveled by instructors and takes into account instructor qualifications and room availabilities.

An optimized schedule saves United Airlines significant time, money, and resources.

Our Training Scheduling and Optimization System II web app is built with ASP.NET Core, Angular 8, Node.js, an Entity Framework, and an Azure SQL database. The web app is hosted as an app service on Azure Cloud Platform.
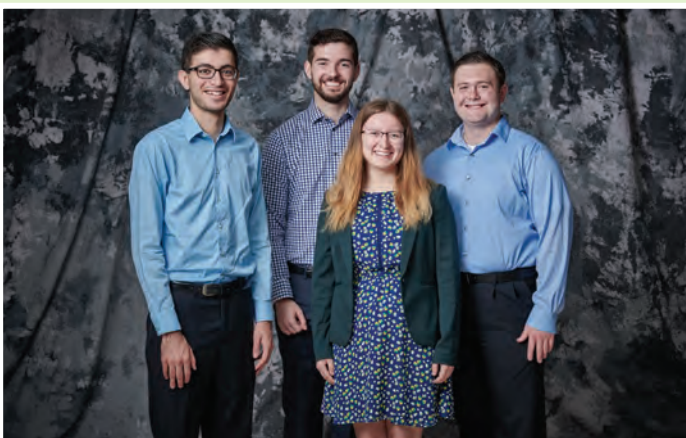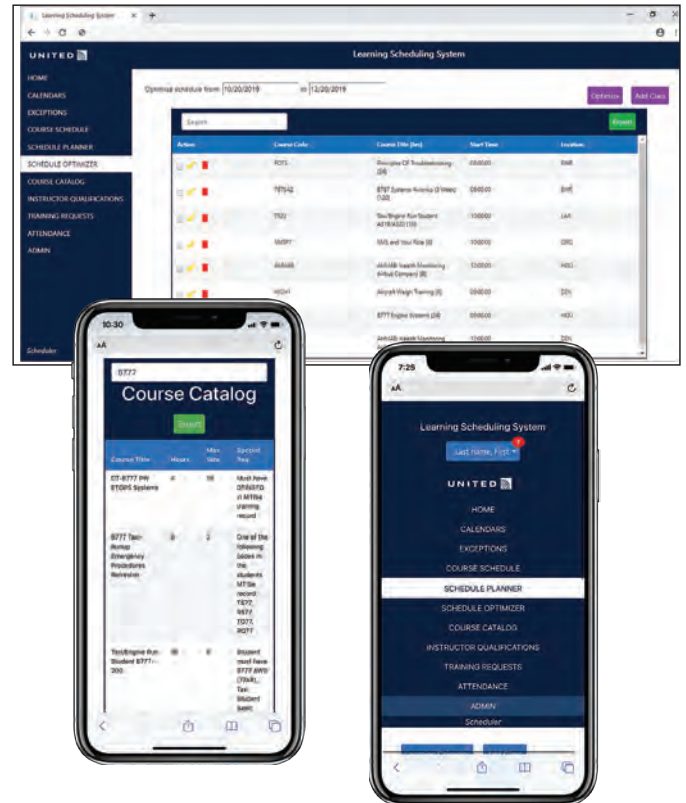
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Urban Science
AutoHook Creative Tool

Headquartered in Detroit, Urban Science is internationally renowned for providing data-driven, science-based solutions to problems in the automotive, health, and retail industries. AutoHook is a subsidiary of Urban Science and assists automotive dealers and OEMs in increasing walk-in customer traffic.

AutoHook provides custom, incentive-driven forms and web pages to dealers and OEMs to help increase vehicle sales. Each online form needs to be created to fit a specific dealer or OEM. Currently, AutoHook's system for updating and creating new forms is effective, but also time-consuming. To view an updated form, the developer has to redeploy the web page after every change. To create a new form, a developer must start from scratch, even if the form is like one already developed.

Our AutoHook Creative Tool application is a file management system and an in-browser form editor used by AutoHook to simplify and expedite the updating and creation of online forms.

With our intuitive web interface, AutoHook employees can update existing online forms using our in-browser form editor (shown on the right). If a designer wants to make a small change, they can update the code in-browser, and a representation of how the change affects the form is shown. This removes the need for designers and developers to redeploy their forms after every minor change.

Our AutoHook Creative Tool file management system allows existing online forms to be imported into any new project, thus providing an already polished starting point.

AutoHook Creative Tool is an ASP.net web application that is hosted on Microsoft Azure, using bootstrap styling for its front-end components and C# for its back-end functionality. The OEM form data is updated and loaded from an SQL database that is hosted on Microsoft Azure.
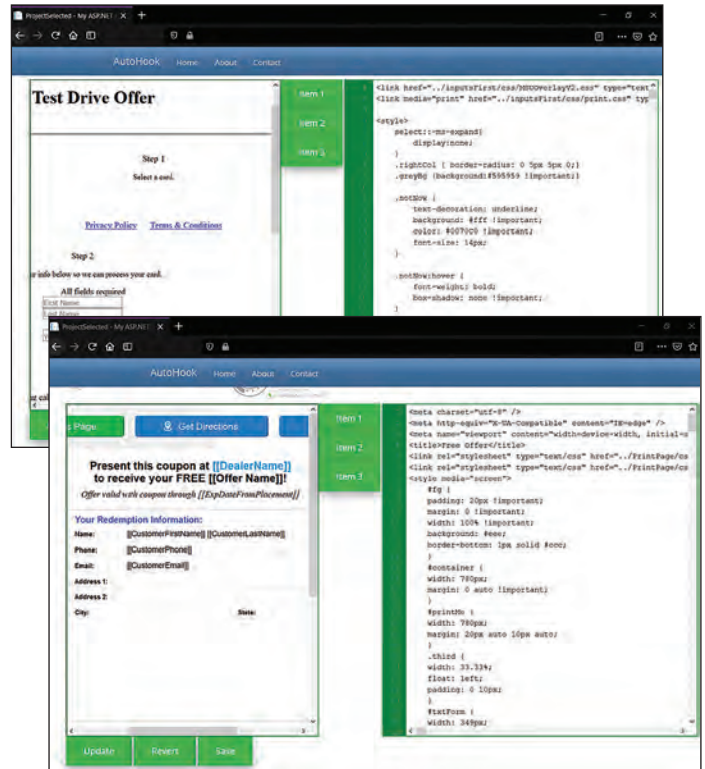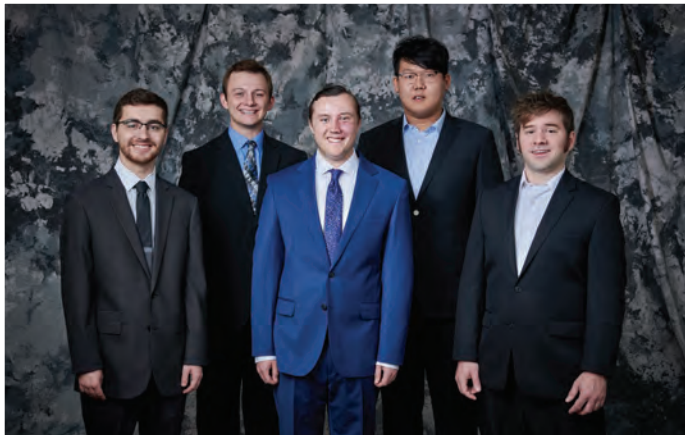
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Vectorform
Rumble

Founded in 1999, Vectorform creates digital products and experiences for the world's leading brands, with a focus on immersive technologies, mobile experiences, Internet of Things, smart homes, connected vehicles, and wearable technologies.

Life in modern society can be very busy, and it can be easy to forget that a load of laundry was started.

Our Rumble system keeps people aware of the wash status of their machines by integrating their washing machine into the Internet of Things and providing updates based on sensor readings from their washing machine.

Accelerometer sensors are devices that measure acceleration caused by movement. These sensors are attached to washing machines, and the vibrations of a wash cycle indicate the current status of a washing machine.

Using deep learning techniques, our Rumble sensors predict when a wash cycle is running, and when a wash cycle has ended. Once a cycle has been predicted to be over, the user will be notified via our web application.

Our deep learning solution to wash cycle prediction is generalizable, allowing the user to place their accelerometer sensors anywhere and in any orientation on their washing machines. The overarching goal of Rumble is to predict different cycles of a wash, and also to predict if a washing machine is malfunctioning.

To the right, you can see our Rumble sensor mounted on a miniature model washer. Our solution works for any appliance that moves and vibrates while operating, allowing our work to be duplicated across many devices.

The Rumble sensor uses Adafruit ESP32 as the main microcontroller, our neural net is implemented in C++. Readings from the Rumble are pushed to the server via MQTT, and stored in a MySQL database. The web app is implemented using HTML, CSS and the React.js extension Victory React for data visualization.
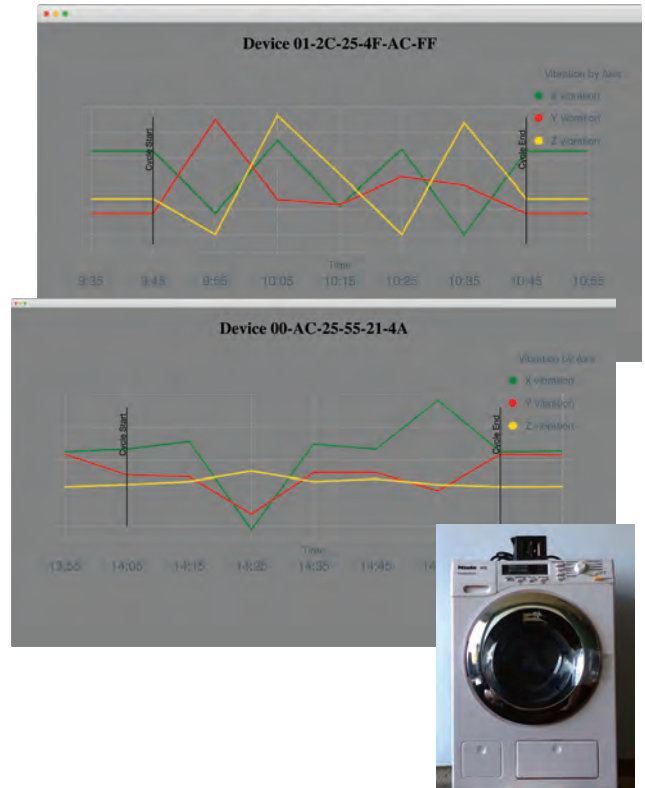
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Volkswagen Group of America
VW Car-Net Smart Hub Web App

Volkswagen Group of America is the North American operation headquarters and subsidiary of the Volkswagen Group, which is comprised of 16 brands and produces a variety of cars, motorcycles and commercial vehicles.

In 2013, Volkswagen introduced VW Car-Net, a connected service system that offers convenience and ease-of-access to Volkswagen owners through a variety of features and tools. Drivers currently interact with Car-Net through a mobile app. To reduce driver distraction resulting from drivers using their phones, the Car-Net team is building web apps that are available in the car's screen called the Human Machine Interface (HMI).

Working with the garage door and smart home company, Chamberlain, our VW Car-Net Smart Hub Web App enables users to automate interactions with Chamberlain products without any user input.

Using our web app, a driver encompasses their house with a so-called geo-fence, which is simply a geographic area that triggers an action when the border of the geographic area is crossed. Once set, the garage door automatically opens when the vehicle crosses this border when approaching the house, and automatically closes when the vehicle crosses the geo-fenced border when leaving the house.

In addition, our app also supports other Chamberlain smart home devices such as lights, gates and door locks.

Our app enables control of all smart devices, regardless of location, from the VW HMI screen. Drivers also receive notifications relating to their smart devices directly in their car.

VW Car-Net Smart Hub Web App utilizes the Google Maps and Chamberlain APIs to enable customer ease with setting up and activating the boundary alerts. Our web app is written in TypeScript, HTML and CSS using the web development framework Angular.
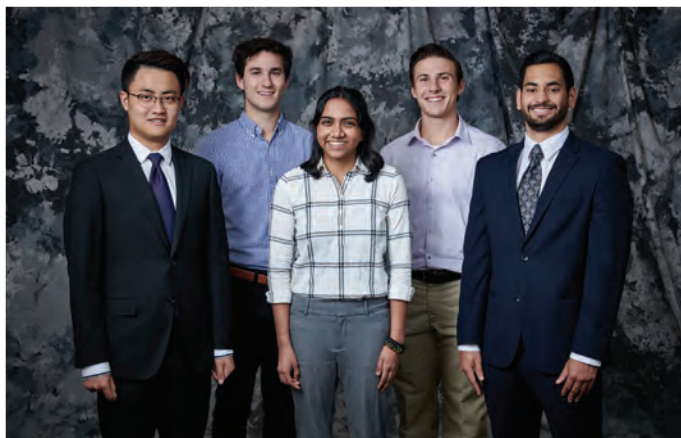
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Yello
Intelligent and Adaptive Data Mapping

Yello is a Chicago-based company that provides software for talent acquisition. Their products help recruitment teams hire the right talent at the right time.

Collecting applicant data at recruiting events is a valuable tool for every company during the hiring process. A problem arises when submitted data is not standardized.

If a recruiter feels they have had a great conversation with an applicant from Michigan State University and wants to schedule an interview, they will search the applicant data for "Michigan State University." However, if the applicant listed their university as "MSU" or "Mich. State," the recruiter might not be able to find the applicant's information.

Our Intelligent and Adaptive Data Mapping application mitigates the issues related to non-standard input through use of Yello's wealth of collected university data.

As an applicant is entering their data, our application suggests to the user the standardized input based on historical data. For example, "MSU" is the abbreviation of 15 different universities. As a user inputs their information, any non-standard input is mapped to a list of accepted standardized inputs for the user to select.

Standardized input suggestions are available for applicant input fields including degree type, academic major and college.

Ensuring standardized inputs enables recruiters to make informed decisions about a candidate with the most accurate information.

Our Intelligent and Adaptive Data Mapping web app is built with the JavaScript library React. Our back end utilizes Django REST framework and Python to best match user input based on current data. This data exists in our NoSQL database, which is hosted through Firebase.
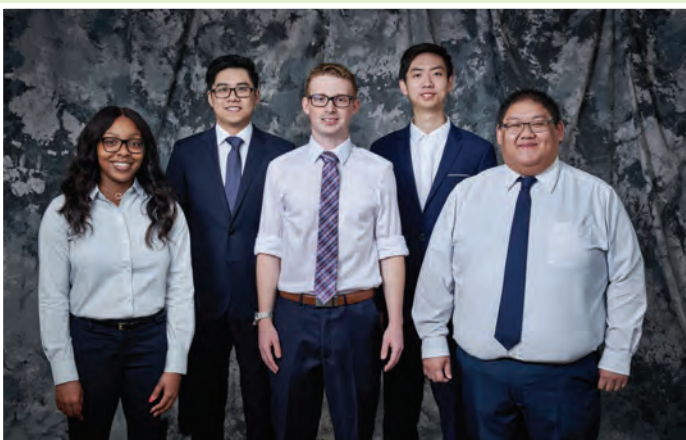
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Amazon
Amazon Data Hub

Headquartered in Seattle, Amazon is the world's largest online retailer and is also the world's largest cloud services provider with their Amazon Web Services (AWS) products.

As a leader in the technology sector, Amazon has access to massive amounts of data. They employ teams of data scientists to analyze this data to improve Amazon's various offerings, including their product recommendations.

The task of finding the best dataset for a problem is time-consuming and requires significant manual work, including looking through thousands of individual files that are stored in many different locations. This process takes up a substantial amount of time that could be better used for development.

Our Amazon Data Hub software streamlines dataset acquisition with an easy-to-use website that allows data scientists to automatically search through Amazon's collection of data.

When an Amazon data scientist uploads a dataset to our Amazon Data Hub repository, it undergoes automated analysis. This includes object detection and speech recognition for images, videos and audio, as well as statistical analysis of numerical data.

Data scientists use the web application to search through our catalog of datasets. Search results include information provided when the dataset was uploaded, as well as information from our automated analysis. Intuitive visualizations of each dataset allow users to quickly evaluate the relevance of each dataset.

The Amazon Data Hub decreases the time it takes to find suitable datasets from hours to minutes, allowing data scientists to spend their time on more important work.

Our system uses AWS's scalable products, including S3, DynamoDB, Rekognition, Transcribe, Lambda, Elastic MapReduce, and Elasticsearch, to store, process and search the datasets. Python Flask is used to connect our back end with our ReactJS front end.
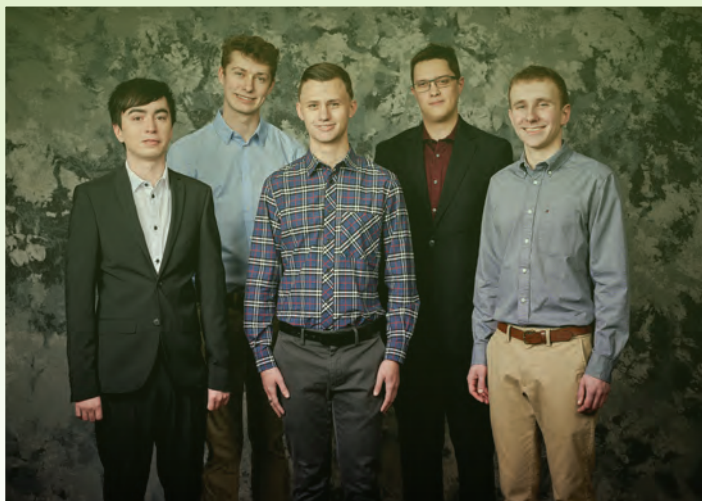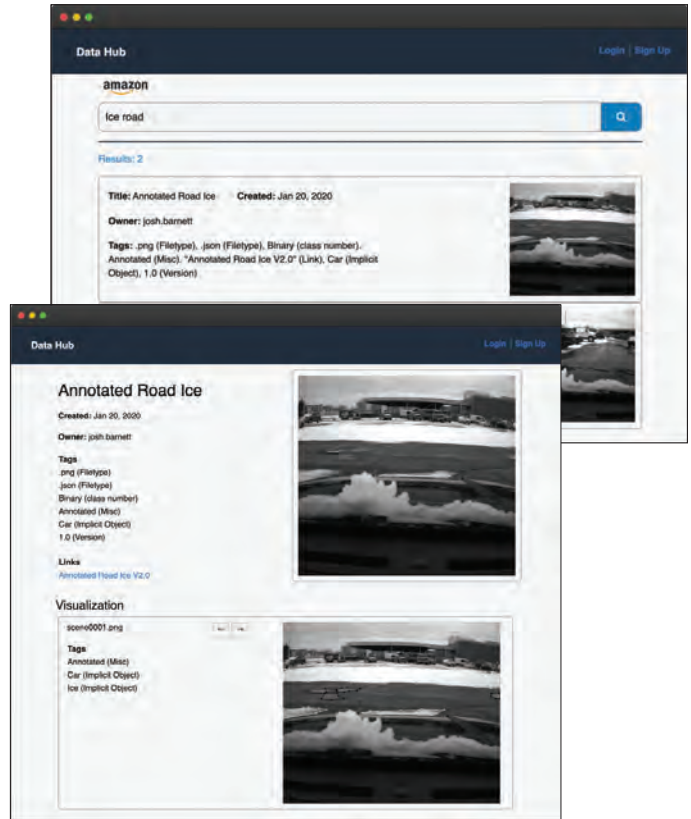
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AppDynamics
Segmented Data Anomaly Detection

AppDynamics, headquartered in San Francisco, provides a leading application performance management (APM) platform, which is used by corporations around the world to monitor the performance of their software systems.

Application owners and developers use the BizIQ feature of the APM to quickly correlate business consequences with application performance.

For example, imagine that users with Acme credit cards and hyphenated surnames are experiencing lengthy response times while making purchases on an e-commerce store. Lower customer satisfaction rates ensue, leading to quantifiable revenue risk.

BizIQ monitors this software issue, investigates the root causes of the performance bottlenecks, and delivers actionable insights. However, BizIQ is currently unable to automatically recognize unique combinations of factors, such as Acme users with hyphenated surnames that are causing issues.

Segmented Data Anomaly Detection utilizes the copious amounts of customer data collected by the APM to improve the diagnostic aspect of BizIQ with machine learning.

Leveraging cluster analysis and unsupervised machine learning, anomalies are explored across hundreds of performance metrics. This leads to the discovery of specific combinations of factors that cause performance issues.

Automating this diagnosis in parallel with data collection saves time and determines the root cause of an issue more accurately.

Segmented Data Anomaly Detection uses Node.js to pull data from the APM, and scikit-learn running on Python to perform data analysis. The results of the analysis are rendered on a web app, which will be developed using JavaScript and includes cluster visualizations powered by D3.js.
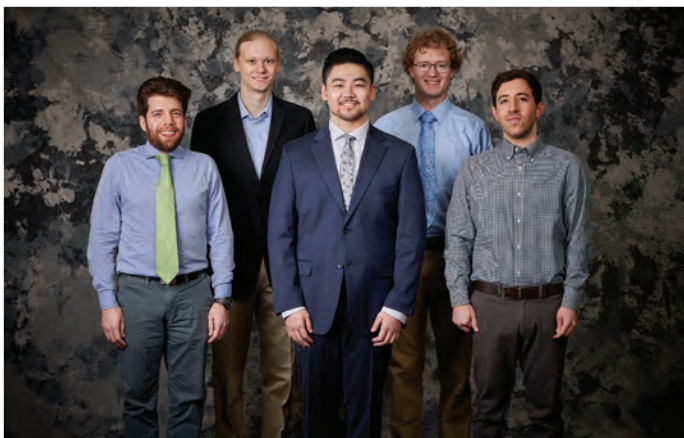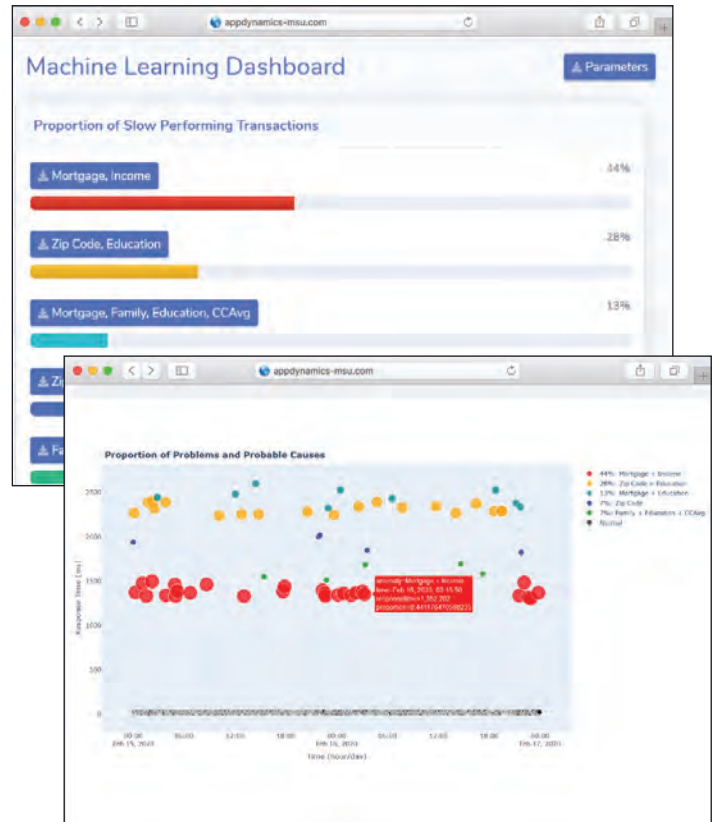
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Auto-Owners Insurance
Phish Phinder

Headquartered in Lansing, Michigan, Auto-Owners Insurance is a Fortune 500 company that is represented by over 47,000 licensed insurance agents across 26 states. Auto-Owners provides automotive, home, life and business insurance to nearly 3 million policyholders.

Every day, associates at companies like Auto-Owners receive phishing emails that attempt to obtain sensitive personal and company information. Educational awareness programs, while common, do not protect a company against all phishing attempts and lead to extremely cautious employees. As a result, cyber security departments are flooded with emails forwarded to them by concerned associates.

Our Phish Phinder is an Outlook add-in which automates the phishing detection process for wary professionals. When a user sees a suspicious email and clicks the add-in button, our software scans the email and returns a categorization and confidence score. In an Outlook sidebar, the email is categorized as a confirmed phishing attempt, a suspected phishing attempt, spam or harmless.

The user is also given an educational tutorial detailing and explaining the suspicious parts of the email. This gives associates a method to better understand the characteristics of spam and phishing attempts.

The email data gathered by Phish Phinder is visible to executives and administrators in an analytics dashboard, and the emails themselves are available for review within a webpage. This allows companies to keep track of phishing targets in a streamlined manner.

The technologies involved in the Phish Phinder back end include Azure SQL, Python Flask API and Azure Web Services. The front end incorporates an Angular framework for the webpages and CSS, HTML and JavaScript for the Outlook add-in.
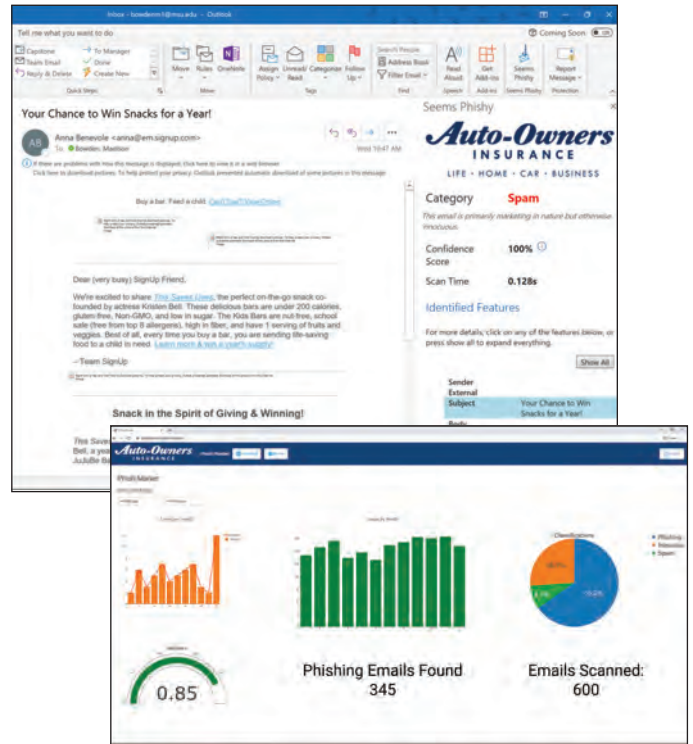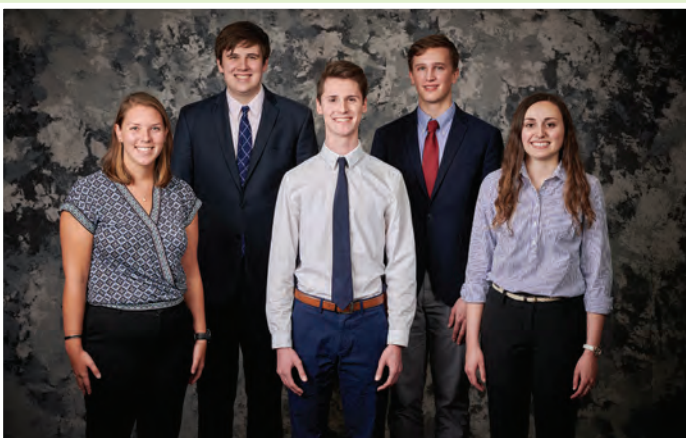
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Bosch
Classifying Target Vehicles for Adaptive Cruise Control

Bosch is a global engineering and technology company with products sold in 150 countries worldwide. Founded in Germany in 1886, Bosch is the world's leading supplier of automotive components.

Bosch's adaptive cruise control is an advanced driver assistance system that allows a vehicle to automatically change its speed based on traffic conditions. Using software that processes radar data and video footage from the vehicle, the behavior of surrounding vehicles is labeled.

For example, if the system determines that a car is cutting into the lane directly in front of the host vehicle, it will identify and label the new vehicle, and intelligently adjust its pace in real time.

Currently, Bosch employees determine the accuracy of the adaptive cruise control software by manually labeling video files and comparing them to the behavior of the vehicle. While necessary, this labeling process is costly and difficult because Bosch collects thousands of hours of video footage.

Classifying Target Vehicles for Adaptive Cruise Control is a tool that automates the label generation process. Using machine learning, video is analyzed to detect lane lines and surrounding vehicles. Then, a combination of statistical logic and machine learning labels the environment in a time-series fashion. Each label is assigned a confidence rating, allowing Bosch employees to easily identify and fix incorrect labels.

This tool significantly reduces the time and effort required to manually label testing videos.

Our software is deployed to both Windows and Linux. The user interface is built with PyQt. The YOLOv3 algorithm is used to recognize vehicles, and ERFNet for lane line detection. A combination of machine learning and logic is used to compute the labels.
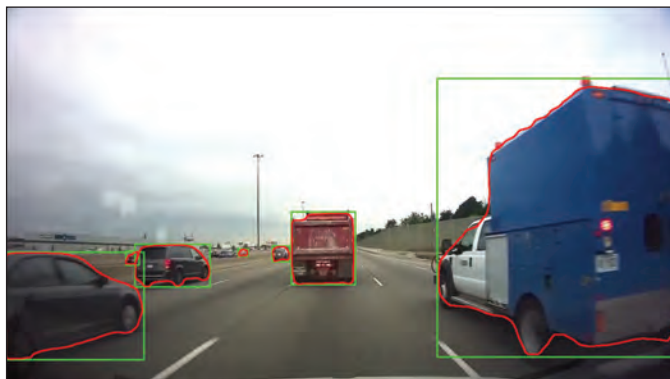
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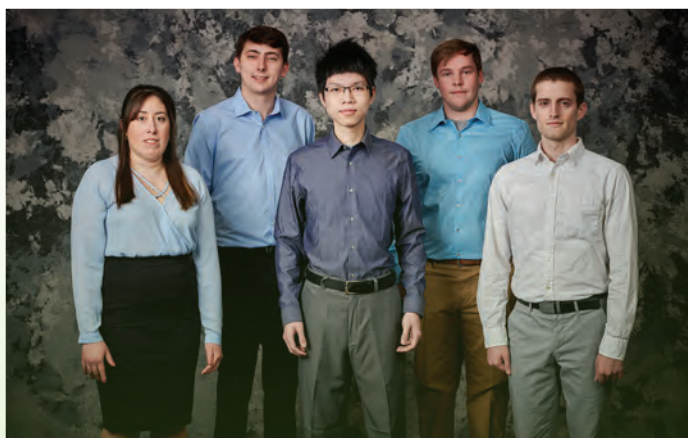
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The Dow Chemical Company
Manufacturing Avatar Plant Twin (MAPT)

Headquartered in Midland, Michigan, Dow is a global leader in specialty chemicals, advanced materials, and plastics. Dow provides a world-class portfolio of advanced, sustainable, and leading-edge products.

Working with chemical products requires extreme precision to ensure the safety of all involved. This necessitates the need for precise equipment location and tracking records. Currently, Dow's technical experts manually complete these monotonous, non-uniform reports. With plants in 160 countries, it is increasingly difficult to coordinate this information.

Our Manufacturing Avatar Plant Twin (MAPT) system provides Dow's experts with the simple and precise tools needed to report accurate equipment locations and build a centralized database with up-to-date information.

Our system streamlines the sensor assignment process for different pieces of equipment at Dow plants. Using our web application, a user analyzes assets such as pumps, compressors and furnaces, then reports the locations of sensors attached to these pieces of equipment.

Once the user is finished reporting sensor locations, the information is propagated to the database, where it is compared with other reports assigned to the same asset. Discrepancies and errors are flagged in the background.

To aid in the reporting process, machine learning is used to suggest potential layouts to the user for new assets, based on trends in previously submitted data.

Our web application is built using the Microsoft Azure Cloud Computing Platform. The user interface runs on CSS, HTML, and JavaScript. All the records are stored in an SQL database that is managed and implemented with C#. The Manufacturing Avatar Plant Twin supports desktop and mobile browsers.
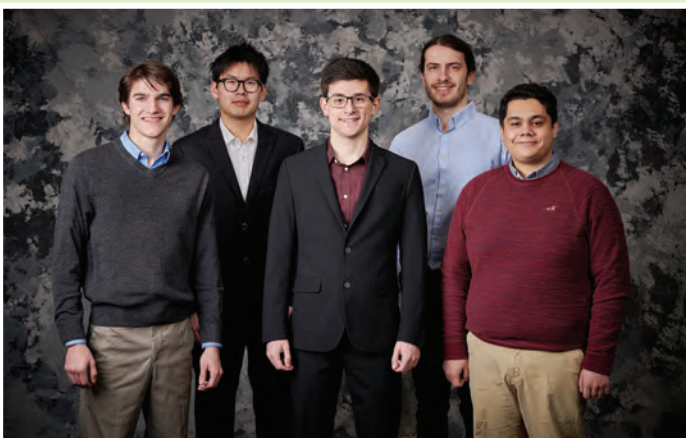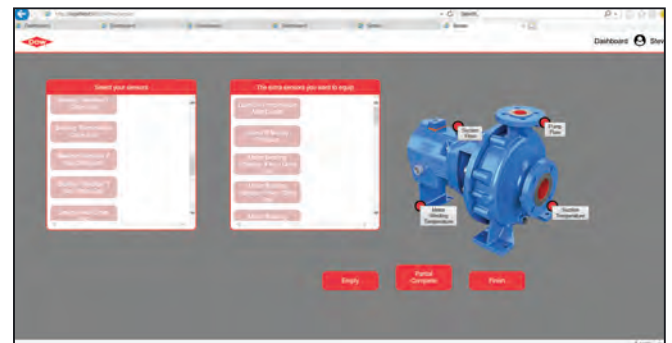
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Evolutio
ERP Air Force: Conservation Threat Detection

Evolutio is a group of technology professionals convinced that business problems have significantly simpler solutions than the market is led to believe. These solutions span across the globe, including the non-profit Elephants, Rhinos, and People (ERP), a group founded to preserve and protect Southern Africa's wild elephants and rhinos.

As part of their initiative to preserve and protect wildlife, ERP uses drones, or unmanned aerial vehicles (UAVs), to monitor elephants at the Rietvlei Reserve in South Africa.

Wildlife is threatened every day by not only poachers, but also by the destruction of food sources, the disruption of habitat by tourists and natural threats such as floods, wildfires, and drought. In a 400,000-acre park, it is impossible to detect and monitor threats without an automated system.

Our Conservation Threat Detection system serves two primary functions: auto-identify threats in drone footage and inform rangers of these identified threats in real time.

ERP pilots fly drones equipped with cameras throughout the reserve and our system automatically detects any threats, including cars, humans, fires, and floods, from the camera feed in real time.

If a threat is detected, nearby rangers are informed of the threat and its location through a graphical user interface (shown on the right), together with silent notifications conveyed through vibration motors mounted in our custom-designed ranger vest.

Our system allows ERP to monitor large areas of land in real time without the need for ERP personnel to manually analyze hundreds of hours of drone video footage. This allows ERP to more quickly respond to imminent threats.

Our threat detection is done using neural networks built with TensorFlow. All components of the system communicate through Ethernet protocol and the main system runs on a Jetson Nano.
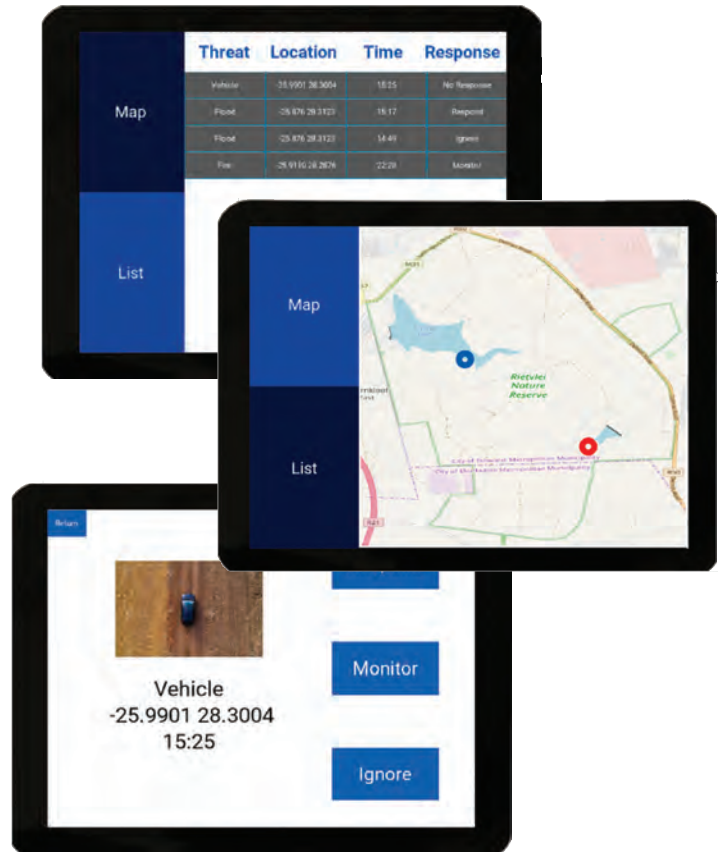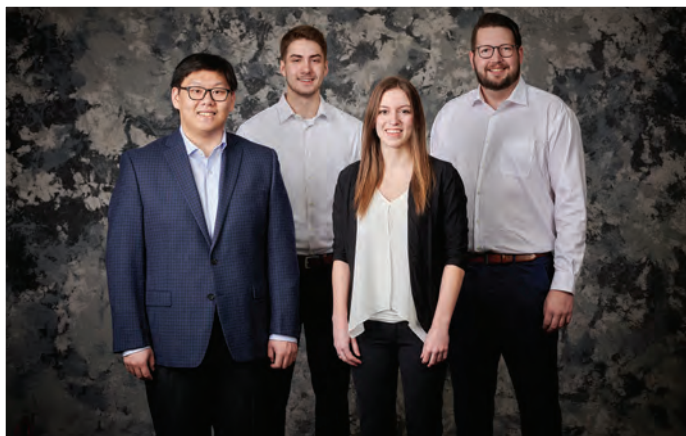
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Ford Motor Company
Ford Augmented Reality Owner's Manual

Ford Motor Company is a multinational automotive manufacturer headquartered in Dearborn, Michigan, employing 199,000 employees and producing a total of 5.9 million vehicles in the last recorded year. Ford designs and manufactures a full line of cars, trucks, SUVs and electric vehicles under both the Ford and Lincoln brands.

Every Ford vehicle comes with a printed owner's manual containing more than 300 pages of basic information pertaining to the operation and maintenance of the vehicle. This manual is cumbersome, difficult to navigate, and has not evolved with the technology inside the vehicles.

Our Augmented Reality Owner's Manual application provides an intuitive and accessible digital version of the owner's manual with augmented reality (AR) capabilities.

The interior of the vehicle is displayed from the driver's perspective using the phone's camera. From this screen, interactive digital content is overlaid using AR, enabling users to quickly access resources.

When a user clicks on an interactive component of the augmented reality display, a list of relevant content is displayed. This content includes a digital version of the corresponding owner's manual section, tutorial videos and answers to frequently asked questions. Alternatively, the same content is accessible through the search bar from the app's homepage.

Authorized Ford employees create, edit and delete vehicles and manage any associated content through the web application. This content is accessed via the iOS app for the respective vehicle.

Our iOS application leverages Swift and ARKit to provide an AR experience. The web application is built using the ReactJS framework. The web application and iOS application are linked through an API and database hosted by Amazon Web Services.
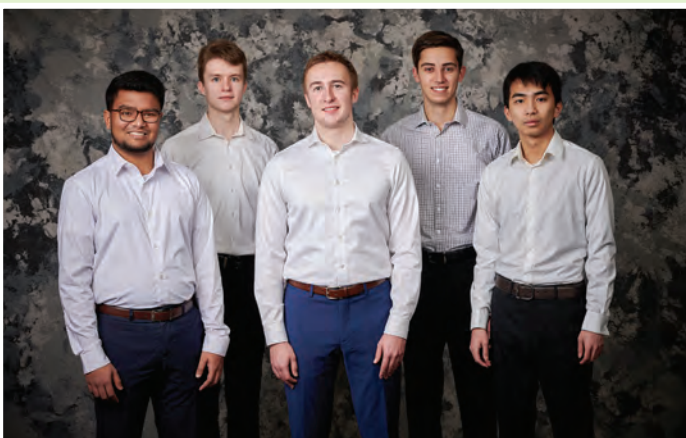
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General Motors
Open Source Intel

General Motors (GM) is a multinational automotive manufacturer headquartered in Detroit, Michigan. GM is ranked #13 on the Fortune 500 for total revenue and is the largest auto manufacturer headquartered in the United States.

Maintaining strong information security is a priority for GM to protect sensitive information that could compromise asset security and communication privacy. Publicly visible credentials grant unauthorized parties the opportunity to infiltrate GM assets and view private communication networks.

Our Open Source Intel system automates the discovery of security threats by collecting and analyzing information from various public code repositories on the internet such as GitHub, GitLab and Bitbucket.

Confidential intellectual property (IP) such as GM usernames, API keys and code snippets are displayed on a user-friendly web application. When a threat is discovered, relevant information about the IP leak is displayed so that GM employees can quickly act to mitigate the threat.

A machine learning service gives each discovered leak a confidence score. If a threat is assigned a high enough confidence score, employees are notified via text message and/or email.

Open Source Intel automates the currently manual process of discovering the warning signs of a leak and drastically increases employee effectiveness by letting them focus on threat mitigation instead of threat discovery.

The Python data collection pipeline is orchestrated using Celery, pipeline data is stored temporarily in Redis, and code is processed using PyDriller. A trained scikit-learn machine learning model quantifies each hit discovered by the pipeline. Open Source Intel stores data in a PostgreSQL database. This database then feeds the Python Django web application for display.
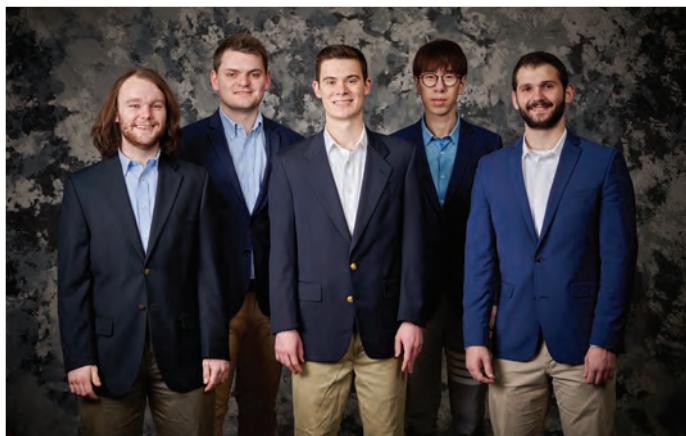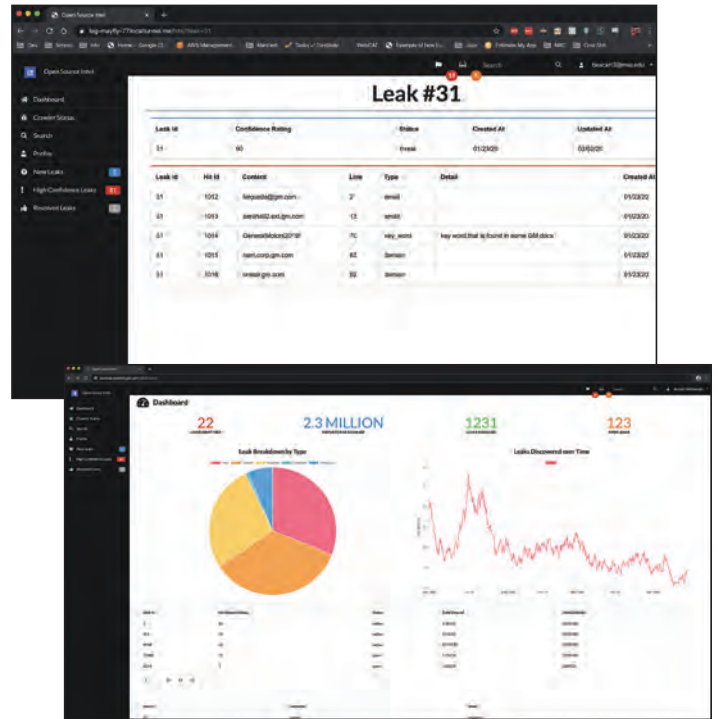
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Harvard Law School
StackLife 2.0: Library Search and Display Tool

Located in Cambridge, Massachusetts, Harvard Law School is arguably the most prestigious law school in the world and is home to the world's largest academic law library. The school's faculty consists of more than 100 full-time professors and more than 150 visiting professors, educating students and delivering research on traditional and emerging legal fields.

The Harvard Library has consolidated approximately 15 million records describing documents from multiple sources surrounding Islamic policy, law and history. Access to this data is very limited with no user-friendly way of viewing it, depriving researchers of valuable information that could be beneficial to their research efforts.

Harvard Law School wants to facilitate universal access to this data in order to preserve a significant part of our shared world heritage, as well as promote new and data-centric research.

Our StackLife 2.0: Library Search and Display Tool consolidates the data for these resources and allows researchers to access it in an easy-to-use web application.

Our system allows researchers to filter records based on multiple search parameters in order to find the resources that are most relevant to them. It also enables users that are registered with the system to save search parameters to their profile and then build their own custom collection of resources.

Once a user finds a desired resource, our application provides the relevant data about that resource, including where the user can retrieve it. Our system also provides data visualization capabilities to enable researchers to plot data.

Our application is built using the Flask web microframework for Python with HTML, CSS, JavaScript, and Bootstrap. The data is stored inside of a relational database system using MySQL 8.0 that is hosted using Amazon Web Services.
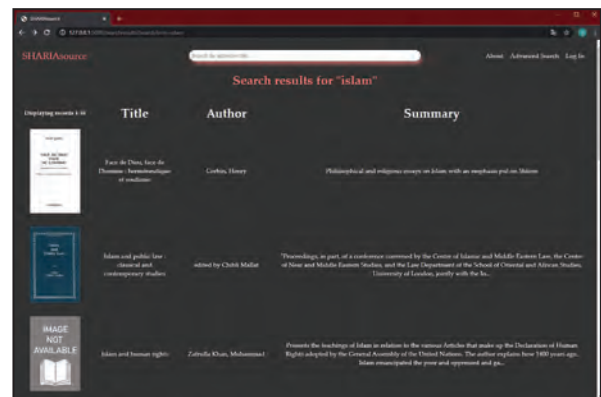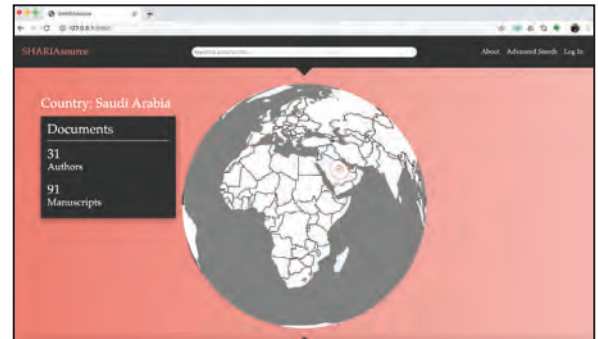
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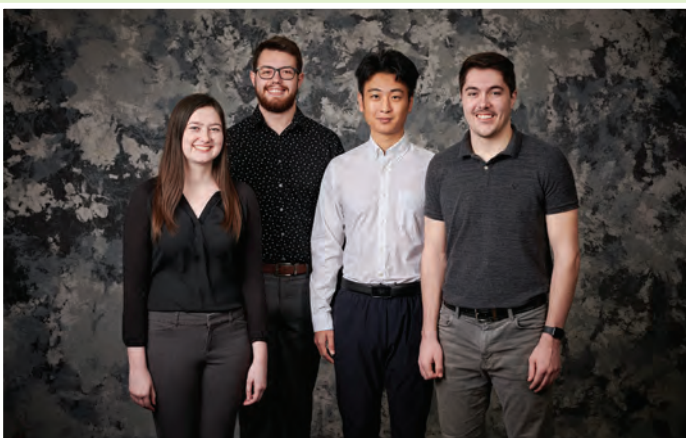
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Herman Miller
Measuring Workspace Impact on Employee Experience

Herman Miller, a 100+-year-old company from Zeeland, Michigan, is an industry leader in home and office furniture. Known for its history of design innovation, Herman Miller dedicates research to office space quality in an effort to quantify the effectiveness of different workspace layouts. Currently, sensors are employed to measure utilization of workspace areas.

Sensor solutions, however, do not provide information regarding employee satisfaction, or sentiment, towards a specific workspace.

Our Measuring Workspace Impact on Employee Experience application allows employees to use kiosk stations and their mobile devices to input sentiment about specific workspaces. Additionally, our sentiment analysis web platform derives quick data insights from the survey results.

Users have the option to log in to the mobile application using their company code and either their user identification or continue as a guest. Registered users can view their rewards and statistics pages.

When a user with the mobile application leaves a workspace, a proximity beacon sends a notification prompting sentiment questions about the workspace. Kiosk stations are available in key workspace locations across a floor plan.

Collected data is displayed through the analytics web platform, accessible only by Herman Miller administrators. The platform allows users to better understand how to alter workspaces to increase employee satisfaction.

Our software uses Amazon Web Services including their relational database service, natural language processing, and API gateways for our back end to collect and analyze data. Estimote Proximity Beacons detect participating user locations on their Android or iOS devices. The web analytics platform is built using ReactJS and displays data using the Google Analytics API.
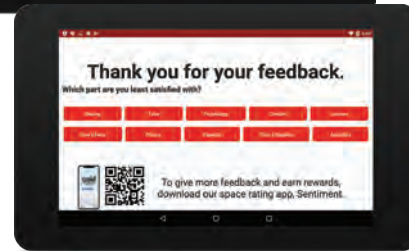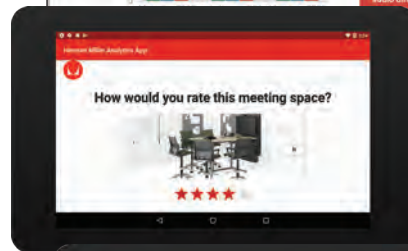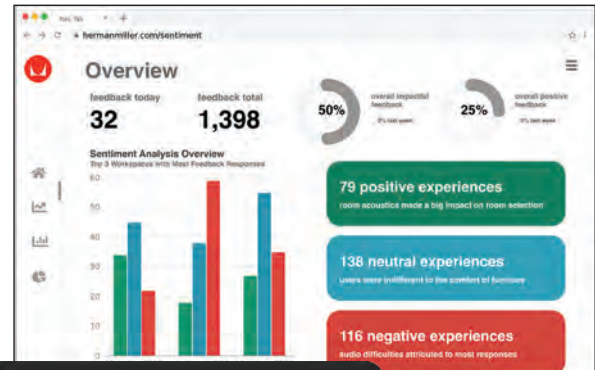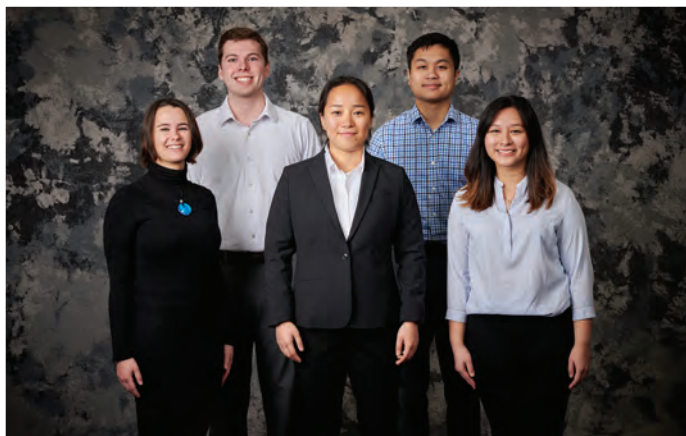
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Learning A-Z
Sandwich Builder Parts of Speech Guessing Game

Learning A-Z is an education technology company that expands students' literacy through thoughtfully designed tools and resources, equipping students with the skills they need to succeed in the classroom.

Elementary school students use Learning A-Z's software for multiple subjects and are familiar with the content and style. When a new resource is added, students spend less time learning the software and more time learning the material.

Our Sandwich Builder Parts of Speech Guessing Game provides a fun and interactive learning experience for students. The game is designed with Learning A-Z's style and content, allowing the students to focus on learning the parts of speech of different words.

When a game is started, an empty outline of a sandwich with a part of speech in each layer is displayed in addition to a list of randomly chosen words.

If the student drags a word to the correct part of speech, the corresponding layer of the sandwich fills with a pleasant, correct color. If the student is incorrect, the layer of the sandwich fills with a mold-like color.

Once all parts of the sandwich are displayed, the student submits their work. If correct, the student is awarded 50 stars, the common currency for Learning A-Z software.

After correct completion of the sandwich, the user enters a bonus round, where they must correctly select a single word that matches two parts of speech. This round is worth an additional 10 stars.

Our Sandwich Builder Parts of Speech Guessing Game is developed using Angular for the front end of the web application and Swift for the iOS platform. It communicates with the MySQL database using PHP.
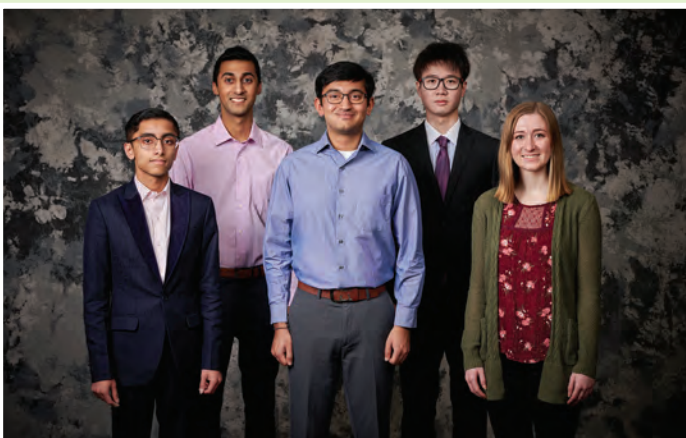
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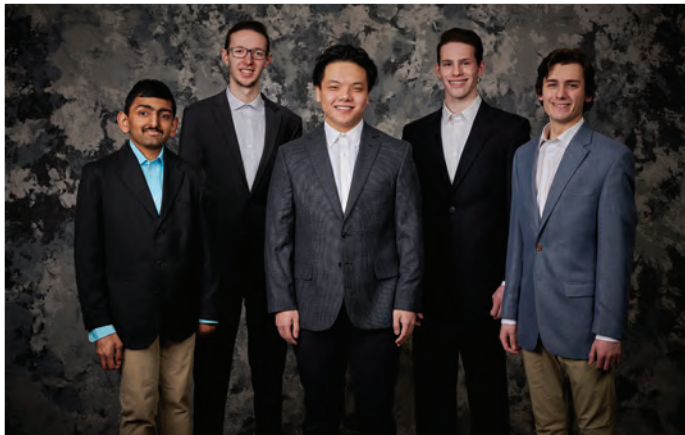# Lockheed Martin Space
SmartSat™ Satellite App Store

Headquartered in Littleton, Colorado, Lockheed Martin Space is one of four business areas comprising Lockheed Martin, an American global aerospace, defense, security and technologies development company that employs 110,000 people worldwide. From the Orion spacecraft to satellites that can be reconfigured while in orbit, Lockheed Martin Space is a global leader of the space sector.

The Lockheed Martin Space SmartSat™ system introduces a universal software format that secures and standardizes satellite applications, allowing for frictionless collaboration on projects and compatibility across many different Lockheed Martin satellite models.

Our SmartSat™ App Store provides a web-based marketplace for browsing, uploading, and installing mission-ready applications directly to live satellites. Operators manage their entire fleet directly through our web page, enabling and disabling applications installed on satellites with the press of a button. Lockheed Martin Space and third-party satellite application developers alike are granted tools to collaborate efficiently on our platform, with shared access to projects and satellites.

Every new application uploaded to our app store is put through our automated compatibility testing to assess on which Lockheed Martin satellites the software can be deployed. This can save hundreds of hours of development by allowing a single piece of software to be deployed on multiple different satellite models.

Our web application stack consists of ReactJS UI components, Flask for back end, and a PostgreSQL database. The storage and distribution of SmartSat™ applications is done through Nexus, and compatibility testing is automated using a continuous integration server.

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MaxCogito
Identity Based Communication and Content Services

Founded in 2019, MaxCogito provides software tools for customers to understand and work with their data.

Most companies are blind to the content of the messages passing through their servers. However, recent regulations such as the European Union's General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA) require enterprises to understand the data they store.

Our Identity Based Communication and Content Services platform automatically categorizes and analyzes every message that passes through a company's servers to help them remain compliant with any regulations, and also to identify any valuable information that might otherwise have been missed.

Businesses using our product select the types of information to monitor, which can include data that could result in regulatory violations, contain trade secrets, or personally identify an individual.

As internal and external messages are sent to and from the employees of an enterprise, our platform automatically searches for content based on each company's indicated needs. Any messages containing sensitive information are automatically tagged before being forwarded to the final recipient.

Our service generates intuitive reports on the content of the messages that come through their servers so that administrators and compliance officers can easily find and assess the quantity and type of sensitive data they currently have on their servers.

Our platform greatly simplifies the data analysis process, saving companies hundreds of man-hours while also avoiding fines for policy violations.

The Identity Based Communication and Content Services platform uses an SMTP server to collect messages, Apache Tika to extract text from each message, and Elasticsearch to index the data. Connecting the back-end services are RESTful APIs written in Java.
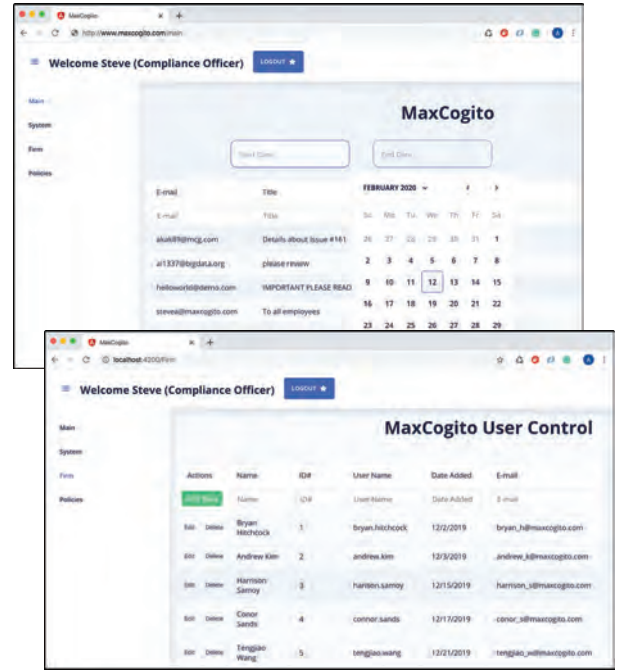
MaxCogito
The company with big ideas
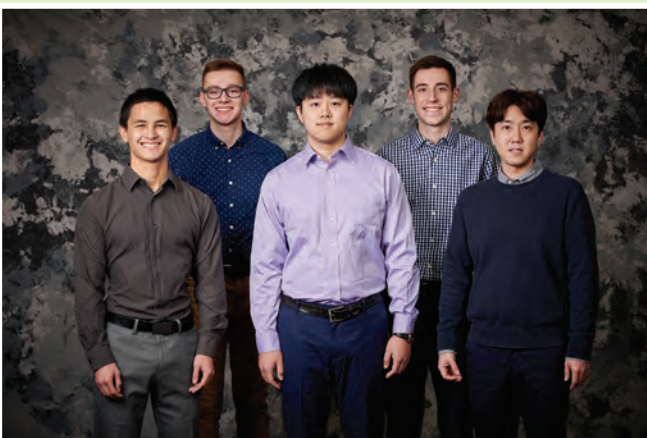
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Meijer
Reducing Shoplifting Using Machine Learning

Founded in 1934, Meijer is the pioneer of the modern supercenter with 242 stores across the Midwest.

Every year, an estimated $10-30 million in assets are lost due to organized shoplifting. Meijer has identified behavior strongly associated with shoplifting, including short or long dwell times in high risk areas, leaving the store without passing through a point of sale, as well as leaving the store using employee or emergency exits.

However, Meijer stores do not have the manpower to watch and monitor every shopper who comes through their doors.

Our Reducing Shoplifting Using Machine Learning project automatically tracks Meijer shoppers throughout the store to identify suspicious behavior to prevent shoplifting.

Meijer has installed Mist wireless access points throughout their stores, which gives them the ability to track the general location of shoppers during their time in the store.

Our system tracks, in real time, the paths various shoppers take. It then uses machine learning to determine the probability that a given shopper is engaged in illegal shoplifting behavior.

If any suspicious activity is identified, the Meijer Asset Protection team receives an alert on their smartphone regarding the incident. The employee then uses that information to review the incident using the store surveillance system integrated into our desktop app. If an incident is confirmed to be shoplifting, the device number associated with the shoplifter is stored for future alerts.

Whenever a device that has previously engaged in shoplifting reenters a Meijer store, employees are notified and action can be taken to prevent further acts of shoplifting.

Our desktop app and mobile apps are written in C#. Our database is on Azure SQL. Our machine learning algorithm is written in Python and devices are tracked via Wi-Fi and Bluetooth using Mist access points.
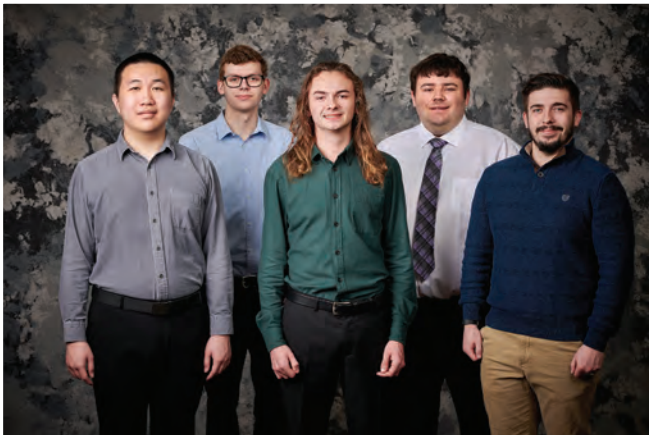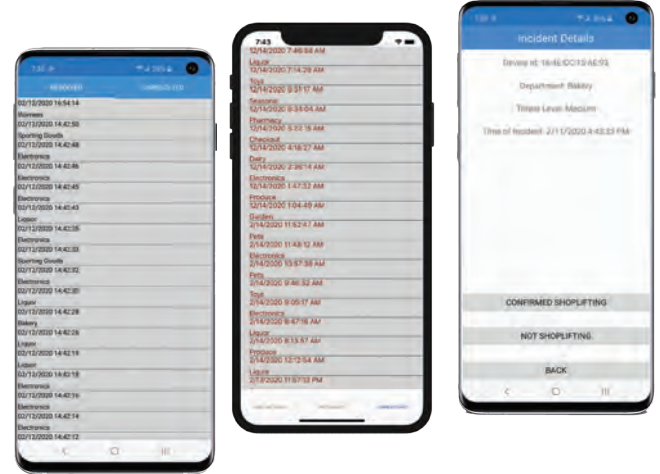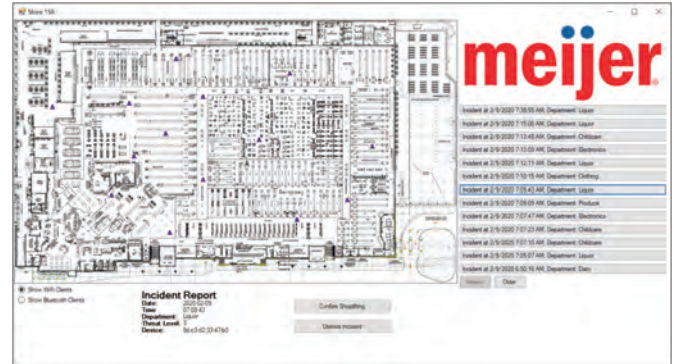
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Michael Sadler Foundation
Gamifying GameChang3rs

The mission of the Michael Sadler Foundation is to inspire and empower students in building their personal legacies. The foundation uses their Six Pillars of character as stepping-stones for this growth and does so with the GameChang3rs Program.

GameChang3rs is a program that provides K-8 students with tools to help them develop strong character, make good choices, and mature both socially and emotionally. GameChang3rs ambassadors are volunteer high school students who teach and mentor elementary school students.

Students and ambassadors meet once a month during the school year. However, between these meetings, the Michael Sadler Foundation is concerned that their students do not retain the important information from the GameChang3rs lessons.

Our Gamifying GameChang3rs project is a web-based platform designed to keep students continually engaged with the Six Pillars material throughout the time between meetings.

Gamifying GameChang3rs contains a variety of educational games designed to teach K-8 students lessons about the Six Pillars of character. Students have fun and earn points all while interacting with material in a fun and educational manner.

GameChang3rs administrators can view statistics about which games are the most popular, how many games are being played a day, and how many students are logging in to the system. To adhere to privacy regulations, no information that can identify students is stored. Instead, this information is used to identify which games are effective to guide the development of future games.

The front end of our system is built using Angular 8, while the back end is implemented using Express. In addition, the Unity game engine, along with WebGL provides a simple solution to develop native web games. Game and user information is stored in a MongoDB database.
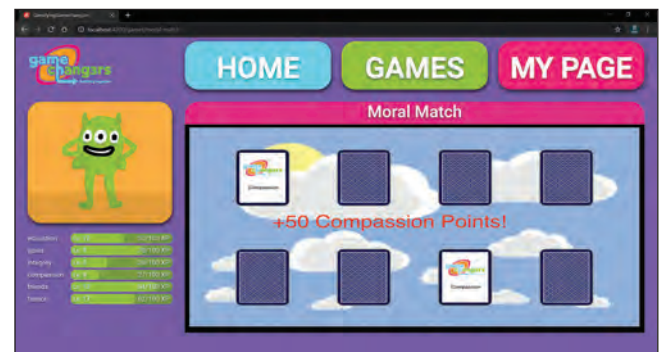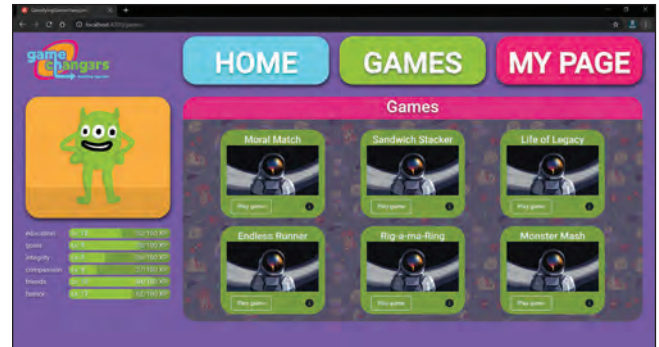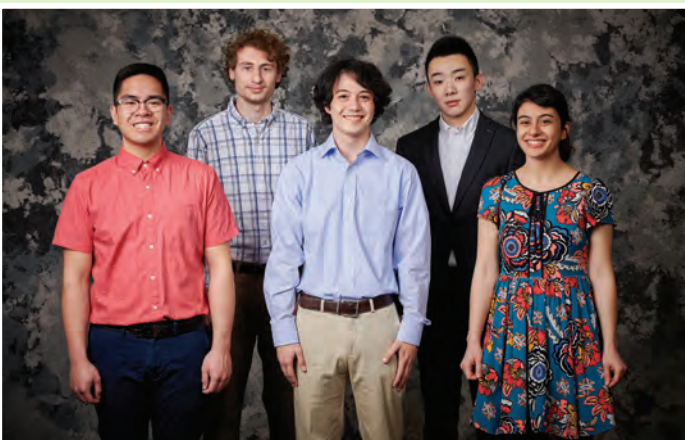
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Michigan State University CSE
Using Sensors to Study Human Behavior

The nation's pioneer land-grant university, Michigan State University (MSU) is home to nationally ranked and recognized academic, residential college, and service-learning programs.

Among the fastest-growing academic programs at MSU, the Department of Computer Science and Engineering (CSE) hosts nine research laboratories and equips students with practical skills that enable them to adapt to changing technology.

Dr. Mohammad Ghassemi is an associate professor in the computer science department at MSU. Dr. Ghassemi researches human health and behavior using machine learning, and is the director of a study at MSU in which the behavior and interactions between small groups of individuals are examined.

Our Using Sensors to Study Human Behavior system transforms the laboratory dedicated to this study into a "smart" meeting space. Human movement is captured using cameras, dialogue is collected using microphones, and an electroencephalogram (EEG) is used to study brain activity.

The collected data is used to train machine learning algorithms, detect anomalies in human conversation, and track eye movements using strategically mounted cameras.

The data is streamed to our website (called The Data Hub) where it is viewed and analyzed by researchers and stored for later research and analysis. Additionally, The Data Hub allows researchers to set event triggers in response to data. Triggers can be as simple as a text notification or as complex as a change in the environment of the lab.

The lab contains an EEG as well as multiple cameras and a microphone connected to Raspberry Pis that stream data to our remote server running MySQL. The Data Hub is written in Python using the Flask web framework.
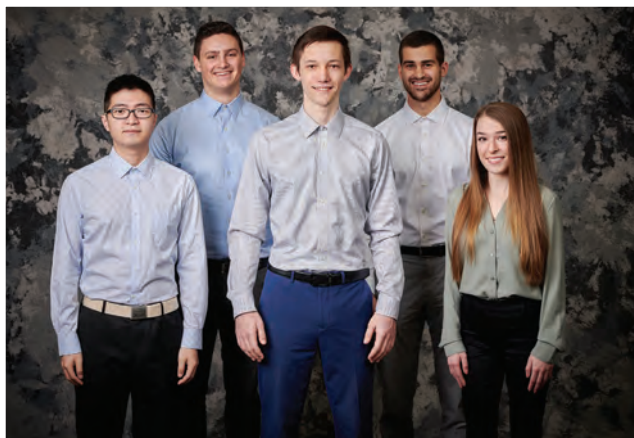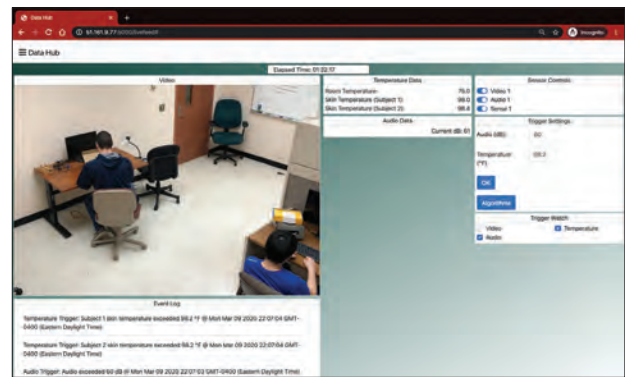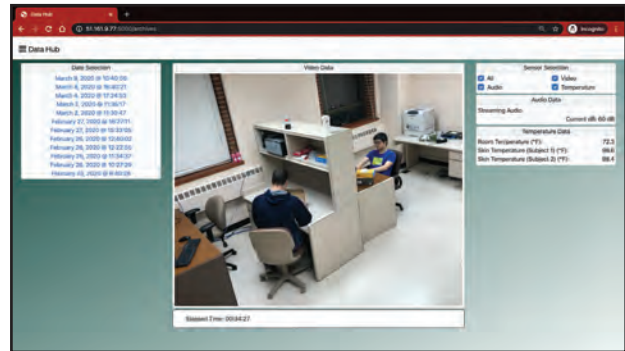
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Michigan State University ITS
Degree Navigator

Michigan State University is a public research institution founded in 1855. The Information Technology Services (ITS) unit delivers and maintains effective technology resources for students, faculty and staff.

There are 97 majors of study and more than 100 minors available to students. While only required to complete one major, students can complete any combination of majors and minors as well as participate in the Honors College. Each of these programs has a unique set of graduation requirements, causing students to struggle to keep track of which have been met and which still need to be completed.

Our Degree Navigator application provides an easy-to-use interface for students to check their progress in each of their chosen programs. The landing page displays a summary of each program in which the student is participating – a major, a minor, or the Honors College.

Clicking on any of these programs navigates the user to a list of program requirements in the form of either a specific course or a list of courses. Incomplete requirements are listed at the top. The user can expand a requirement and get more detailed information about which classes can fulfill that requirement or can expand all requirements to view a detailed description of the program.

In addition, students can view recommended four-year course schedules for each major provided by Michigan State. Each course is accompanied by a symbol that represents whether the course was already taken, currently being taken, or not yet taken by the student.

Degree Navigator is developed with Swift for iOS, Kotlin for Android, and ReactJS for web. It uses an AWS API to access information stored in a DynamoDB database via Lambda functions written in Python.
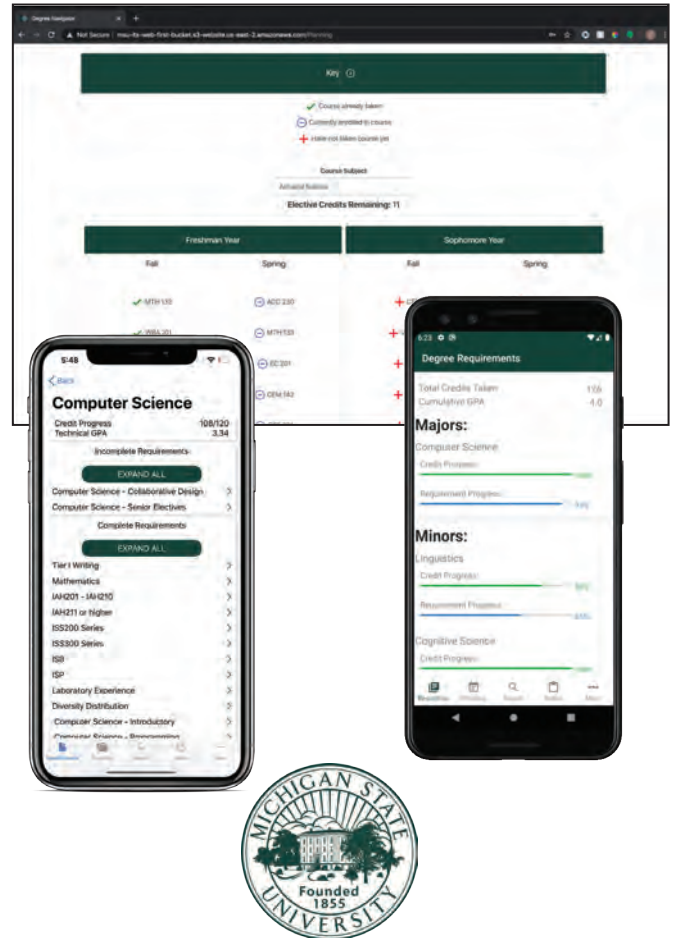
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Mozilla Corporation
No More Yellow Screen of Death in Firefox

Founded in March 1998, Mozilla Corporation is a free software community whose mission is to keep the internet open and accessible for all. They are best known for the popular internet browser, Firefox.

Over 250 million people use Firefox every month. To accommodate the 60% of users whose preferred language is not English, Firefox is available in over 100 languages. Localization is the term for supporting languages other than the default, which in Firefox's case is American English. Localizing Firefox requires translating menus, buttons and many other parts of the browser.

Previously, to change from the default language, the user had to either download a separate version of Firefox or go through a labyrinth of configuration steps. Worse, even if the user managed to change their language, sometimes tiny translation mistakes would render Firefox unusable. This led to the Yellow Screen of Death (shown on the right). The only solution for the Yellow Screen of Death would be to uninstall and then reinstall Firefox.

Our No More Yellow Screen of Death in Firefox software eliminates the Yellow Screen of Death by integrating Fluent, a technology Mozilla specifically developed to help with localization, throughout Firefox.

Integrating Fluent throughout Firefox also simplifies the process of changing languages, allowing the user to quickly change languages with the click of a button.

Additionally, our system uses Python scripts to automatically update certain old files to Fluent. Specifically, programmers only need to integrate Fluent in one language, by convention American English, after which our software automatically updates the other 99+ with no additional work from the programmer.
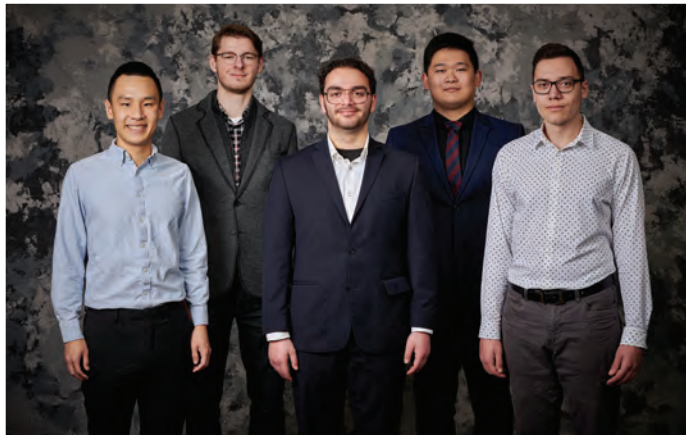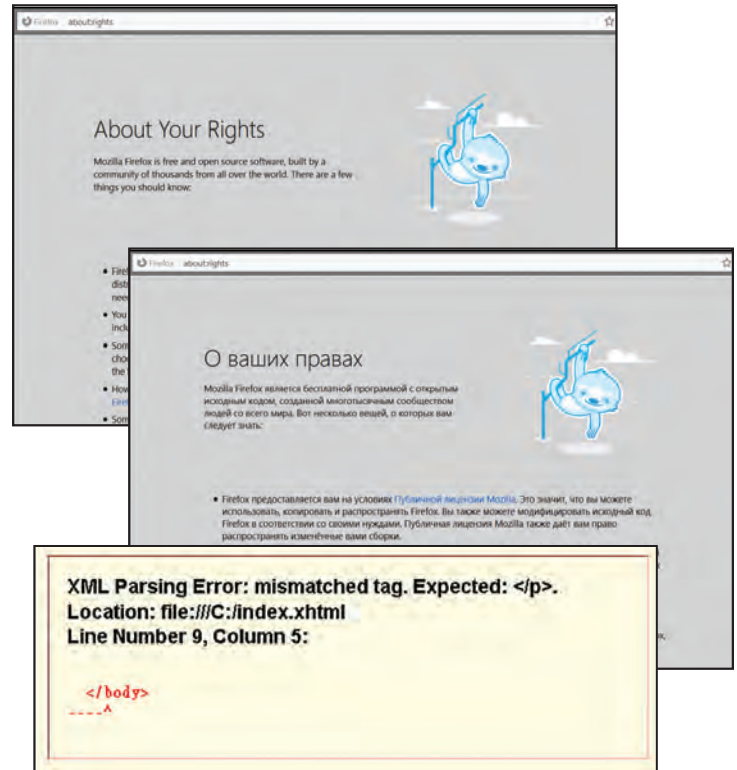
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MSU Federal Credit Union
MSUFCU Achieve It

Founded in 1937, Michigan State University Federal Credit Union offers financial services to students, faculty, and staff of Michigan State University and Oakland University. With over $4.1 billion in assets and 280,000 members, MSUFCU is the largest university-based credit union in the world.

MSUFCU offers superior service while also helping their members and employees achieve financial security, their goals, and ultimately, their dreams. A cornerstone of their customer-focused offerings is educational content to inform and guide members.

Our MSUFCU Achieve It platform is a family-oriented educational tool to help children develop a healthy relationship with money and banking at an early age.

The customer applications of Achieve It are available on Android, iOS, web and Google Home, and enable children to learn about finances in an environment controlled by their parent.

Our applications allow parents to set tasks, goals, and lessons for their children to complete in order to earn real money. These tasks can include anything from household chores to watching videos on financial education.

Children learn the value of money while completing tasks or lessons on our child Achieve It application and earn a monetary reward provided by the parent. Achieve It teaches children about the fundamentals of saving money, and also allows them to obtain loans administered by their parent to learn the difference between borrowing and saving.

Additionally, MSUFCU administrators can view statistics about Achieve It utilization through our web-dashboard to enable them to develop new and engaging content more easily.

Our software is developed in Kotlin and Swift for Android and iOS, ReactJS for web, and Google's DialogFlow for Google Home. The back end is built on the Google Firebase suite of products.
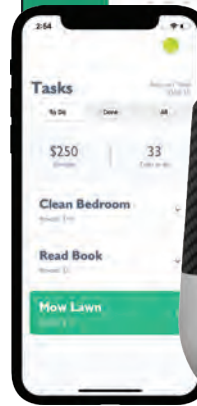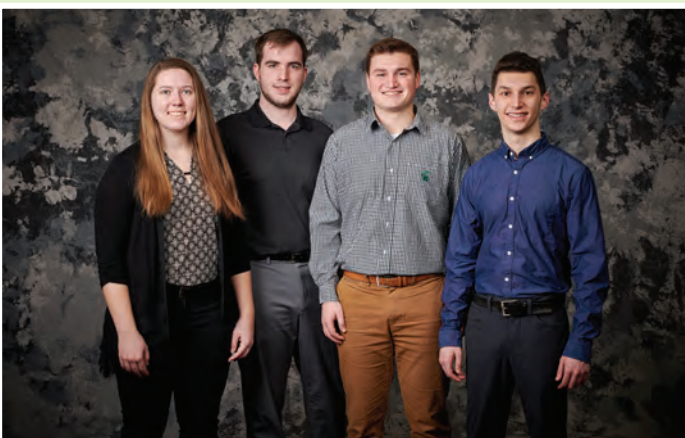
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Place Technology
Predictive Support Module

Place Technology is a Salesforce Independent Software Vendor partner based in Austin, Texas. Salesforce is a cloud-based software company that provides companies with customer relationship management services and solutions.

Place Technology has developed a Salesforce product, PlaceCPM, which enables customers to create future forecasts based on historical accounting transactions imported into their Salesforce environments. Place Technology is expanding this product with our Predictive Support Module, enabling customer support teams and other clients to easily extract and store data.

Each customer has their own personalized version of Salesforce installed in a cloud environment called a Salesforce Organization. It is necessary for independent software vendor partners to provide customer support for the products they sell using the Salesforce customer base.

Our Predictive Support Module makes it easier for customer support to retrieve log data and analyze it so that they can resolve issues the customer may have. This is achieved through a Salesforce Managed Package that sends data to a log aggregator for further analysis by customer support.

The Predictive Support Module is available on the Salesforce AppExchange for installation onto a customer's Salesforce Organization, similar to downloading an application onto an iPhone from the App Store. After being installed and configured, the module sends data from Salesforce objects to a log aggregator either on demand or at a predetermined interval specified by an organization's administrator.

The customer can create a support issue, add additional information to the issue (including log data), and forward it to customer support. The two log aggregators the customer can choose between are Datadog and the ELK Stack.

place.CPM
simplify financial forecasting
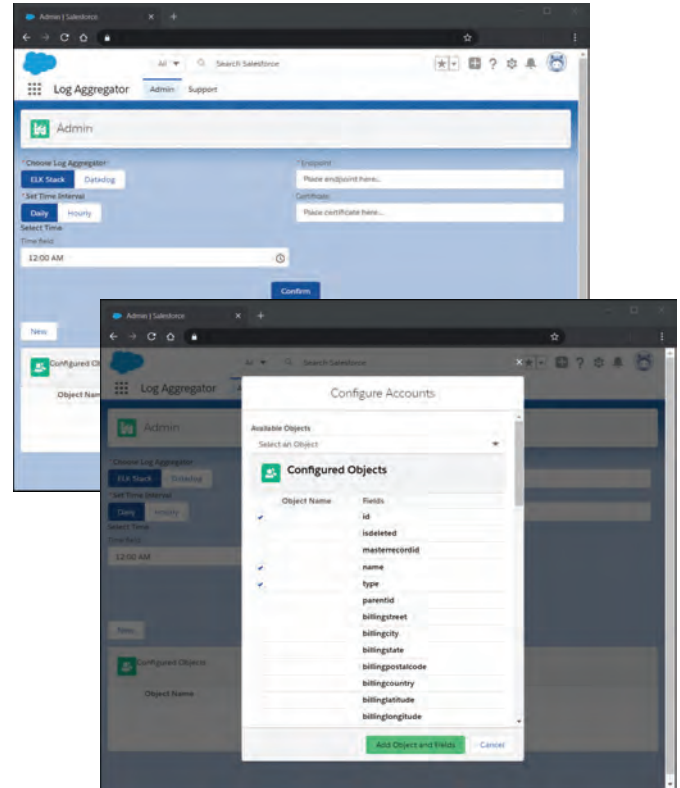
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Principal Financial Group
ARIN Application Launcher

Principal Financial Group of Des Moines, Iowa is a leading global investment manager. Their financial services include retirement planning, insurance, and investment. They are a Fortune 500 company and manage over $735.3 billion in assets.

The Data Science team at Principal Global Investors (PGI) is responsible for building systems, models, and frameworks to analyze large data sets and produce forward-looking insights. To this end, the Data Science team builds and deploys many web applications.

As these applications are built, user management and authentication adds a significant amount of overhead to the development process. Our Analytics Research Intelligence Network (ARIN) Application Launcher eliminates this overhead by providing a single point of access for employees to manage, request access to, and launch applications.

After logging in, users see a dashboard showing all of the applications to which they have access. They can either launch an application or browse through a list of applications. A user can click on an application to view a description, image, and list of all approved roles. They can request access to the application, which is either approved or denied by an administrator based on the role of the requestor.

When a user launches an application, they are redirected and receive context-sensitive information provided by our ARIN Application Launcher.

The ARIN Application Launcher is built with a serverless architecture, using the React JavaScript framework and a suite of Amazon Web Services for storage (S3, DynamoDB), routing (CloudFront), authentication (Cognito), and the hosting of our functions (Lambda).
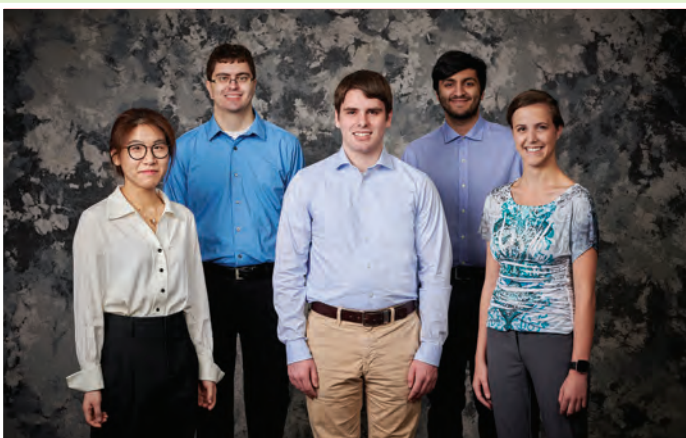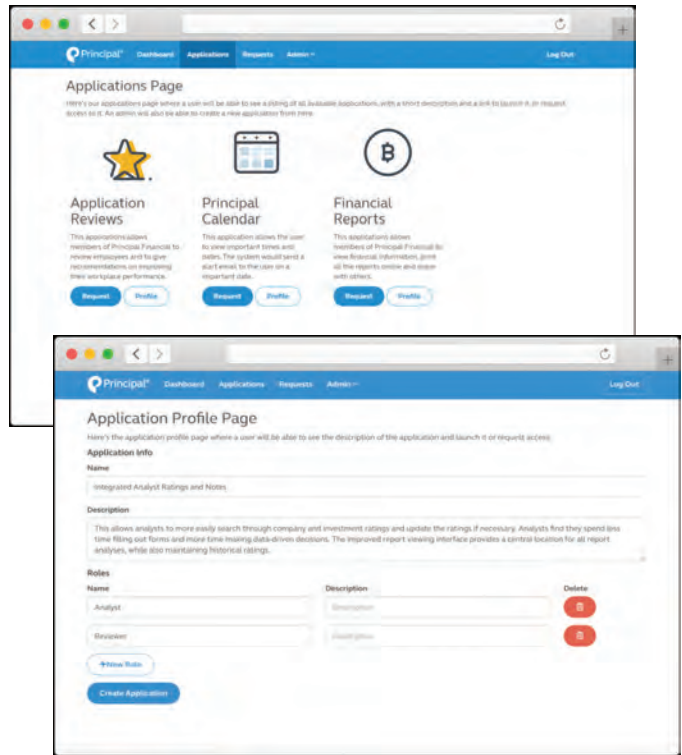
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Principal Financial Group
Investment Portfolio Construction

Founded in 1879, the Principal Financial Group is a financial services company headquartered in Des Moines, Iowa. They are a member of the Fortune 500 and a global investment management leader, managing $735.3 billion in assets as of December 2019.

The company's success as an asset manager is contingent on their ability to construct a variety of investment portfolios that are optimized to provide returns for their individual and institutional investors. Thus, investment analysts at Principal need an efficient way to generate and tweak portfolio constructions based on different constraints and quantitative signals.

Our Investment Portfolio Construction system is a web application that provides a user interface for investment analysts to communicate with Principal's existing optimization engine and generate portfolio constructions.

The application allows users to specify a set of constraints and an objective around which to construct a desired portfolio. Once the user specifies all desired parameters, the application sends this information to Principal's optimization engine, which uses the data to construct an optimized portfolio. Our application retrieves this portfolio construction and displays it to the user.

Additionally, the Investment Portfolio Construction system provides users with the ability to save constraint sets and portfolio results as scenarios within the application. The scenarios can either be saved so that only the saving user can access them, or the scenarios can be saved to be accessed by a user's entire group within the company. This allows analysts to collaborate and iterate on portfolio constructions based on changing factors and signals.

Our application is built according to the serverless architecture model using Amazon Web Services (AWS). The technologies utilized include the Angular framework, AWS S3, AWS API Gateway, AWS Lambda, and AWS DynamoDB.
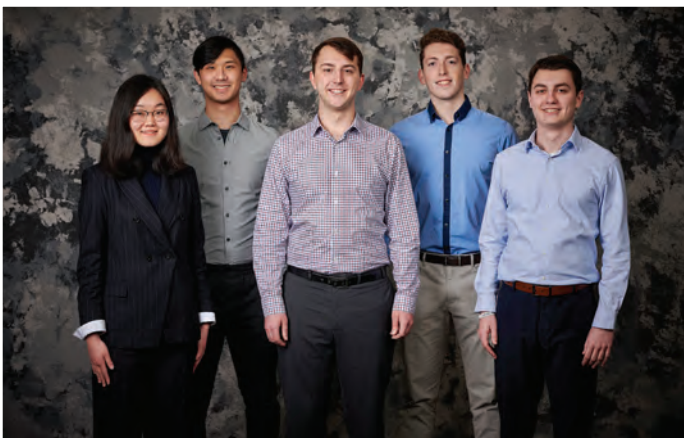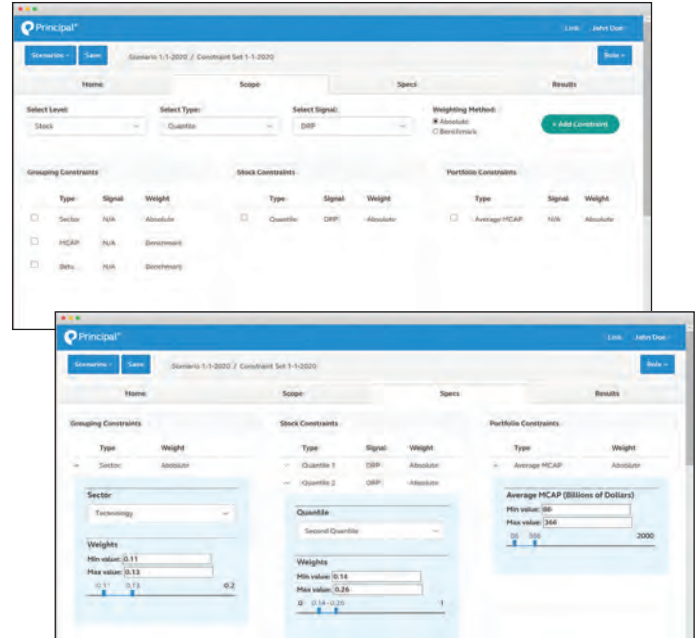
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Proofpoint
Predictive Engine for Long-Term Malware Detonation

Headquartered in Sunnyvale, California, Proofpoint is a cybersecurity firm focusing on enterprise-level threat tracking, mitigation, and elimination. While Proofpoint is known for client endpoint protection, they also employ an extensive R&D infrastructure for handling and analyzing new malware.

Analyzing malware is challenging. Viruses, spyware, ransomware and other malicious programs come in many forms. To protect its customers, Proofpoint analyzes malware using tools called sandboxes, which are isolated computing environments where malware can be tested safely. The industry standard is a short-term analysis on malware samples for 2 to 15 minutes each.

However, malware developers know of sandboxes and often design their malware to change its behavior weeks or months after infecting a system. Because of this, short-term malware analysis is not always effective in determining the effects of certain malware.

Our Predictive Engine for Long-Term Malware Detonation platform offers an intuitive web dashboard to efficiently manage malware samples and analysis, as well as a service to quickly identify unique and duplicated malware samples.

Our website allows Proofpoint analysts to upload malware samples, view the results of previously analyzed samples, monitor currently running malware, and view overall system statistics.

When a malware sample is uploaded from our dashboard, it is automatically analyzed in a few minutes to determine if it is unique or similar to previously run samples. Because running the sandbox for long periods of time is expensive, our system will prioritize unique malware samples for long-term analysis and discard duplicated samples to save on processing time and money.

Our predictive engine is implemented in Python, using Cuckoo, YARA, and OPNsense. Our web app uses Angular 8 for the front end, and Python Flask and MongoDB for the back end.

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Technology Services Group
Volunteer Onboarding and Patient Visit Management

Founded in 1996 in Chicago, Technology Services Group (TSG) is an expert in data and document management. TSG has many clients across a wide range of industries and is a leading provider of content management solutions.

TSG also works with nonprofit companies in the medical industry who are often burdened with large volumes of documents and forms. Two of the most common include employee onboarding documentation and patient forms. Human resource representatives spend much of their valuable time tracking and collecting these documents.

Our Volunteer Onboarding and Patient Visit Management system integrates the power of the Microsoft Azure cloud with TSG's existing software, OpenContent Management Suite (OCMS) to create new OCMS dashboards to streamline the creation, upload, and management of employee onboarding documentation and patient forms.

Our newly designed web dashboards simplify the employee onboarding process by aggregating the completed and outstanding necessary documentation to one central location. Employees can use our visualization tools to quickly track the progress of a new employee's onboarding and monthly patient visits.

Additionally, employees can automatically record, save, and track patient visits without the need for paper forms. Employees can search, add, and update any required patient documents quickly and easily.

Our system saves employees significant time and energy. Patient tracking is now automatically handled in one convenient location that can be accessed by anyone at any location.

Our Volunteer Onboarding and Patient Visit Management system utilizes Apache Tomcat, HTML, Java, JavaScript, and the Microsoft Azure cloud service HDInsight.
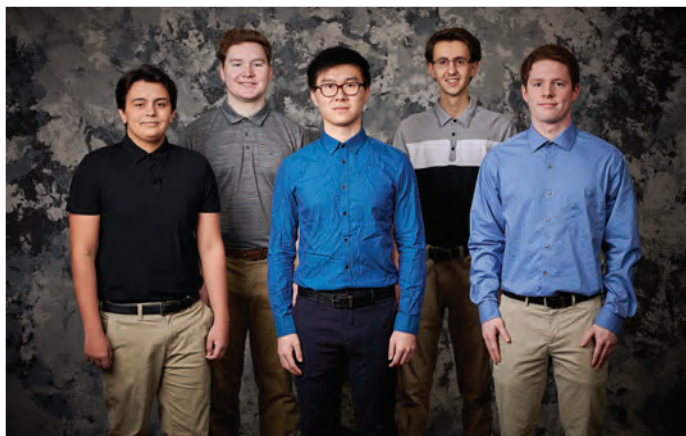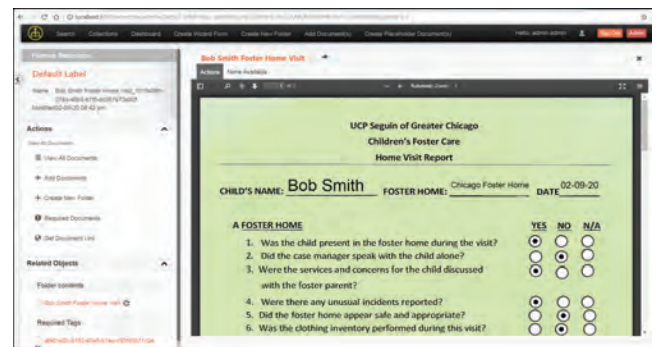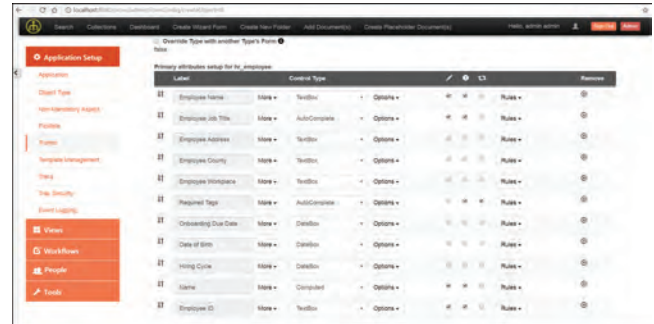
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TechSmith
Smart Camera

To help its customers communicate more effectively, TechSmith assists in the creation of images and videos. Its flagship products, Snagit and Camtasia, are used by more than 30 million customers, worldwide.

Many customers of TechSmith do not have a background in video production. This lack of experience can often lead to less than professional content.

Our Smart Camera software assists TechSmith users in creating better video content through intuitive, easy-to-use mobile and web applications. The content created using our system can be easily used with TechSmith's video editing software, Camtasia.

The Smart Camera iOS application offers a suite of tools to give video creators feedback and advice on filming in real time. As the user films a video, our software automatically analyzes video frames continuously to provide feedback on the lighting quality, as well as the framing of their video scenes. Example feedback can be seen in our screenshots on the right.

Smart Camera also supports a live teleprompter feature on mobile devices to display prepared scripts during filming. The teleprompter non-obtrusively overlays the user's script on the camera view (shown on the right).

The Smart Camera web dashboard allows users to create and manage their scripts, which can be exported to the Smart Camera mobile application for filming. Additionally, the web dashboard aggregates all completed video assets, including scripts and raw video files. These assets can be exported automatically from the Smart Camera mobile application.

Our web application is made using JavaScript, C# and the ASP.NET core framework. Our web application, video storage, and database are hosted on Microsoft Azure. The mobile application is written in Swift.
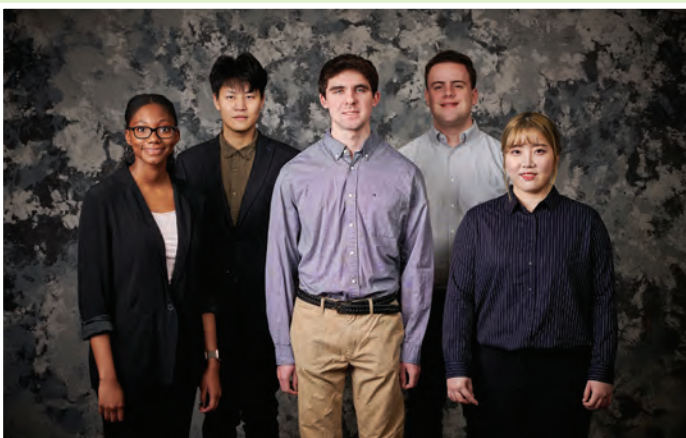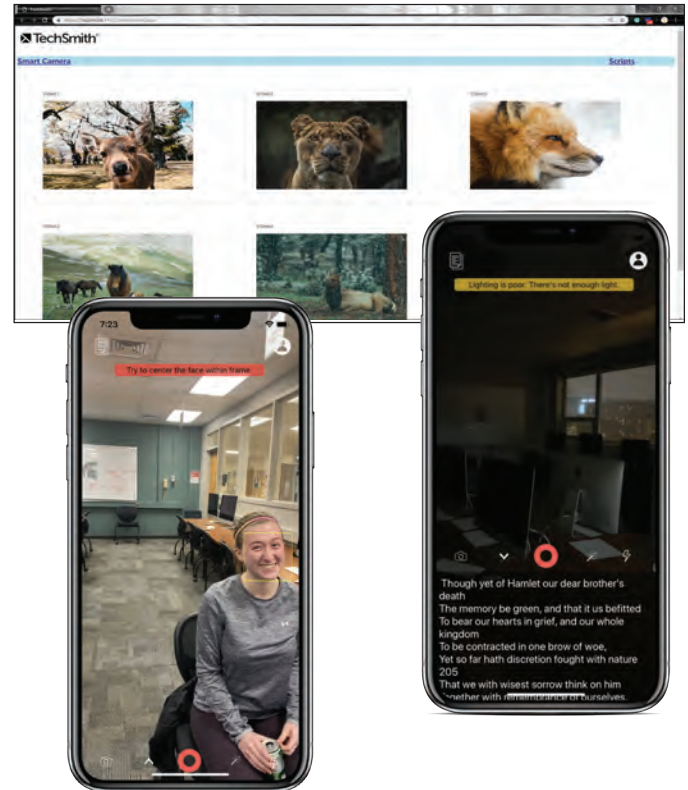
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United Airlines
Safety Reporting and QC Audit Center Mobile App

United Airlines is the world's second largest airline, operating approximately 4,900 flights a day and transporting over 150 million passengers a year out of 362 airports around the globe. To maintain its fleet of 1,300 aircraft and ensure successful flights, it is crucial to identify and resolve safety concerns and hazards.

Over 88,000 employees work for United Airlines, yet less than 10% of the airport operations employees fill out safety reports, called GSAP forms. This is because GSAP form submission can only be done on a desktop computer, meaning that employees in the field must go inside and find an available computer in order to fill out a form.

Similarly, the Quality Control (QC) Audit forms are currently filled out with pen and paper while the employee is in the field, and then require additional time for the employee to input that information onto a computer.

Using our Safety Reporting and QC Audit Center Mobile App, employees can efficiently and effectively fill out GSAP and QC Audit forms in the field.

Within the application, users can create, save and submit forms. Saved forms can be accessed at a later time via desktop or mobile app, and are available until the employee submits the form or the form expires. The application caters to an employee's position and only shows the types of forms that are applicable to their specific role.

This application helps employees save time and effort by enabling the completion of GSAP and QC Audit forms in the field. The ease of use incentivizes more employees to fill out safety reports, increasing participation in the GSAP program.

Our Safety Reporting and QC Audit Center Mobile App is built with Swift and Texture for iOS, Kotlin for Android, Python and Django for the API, and a Microsoft SQL Server database.
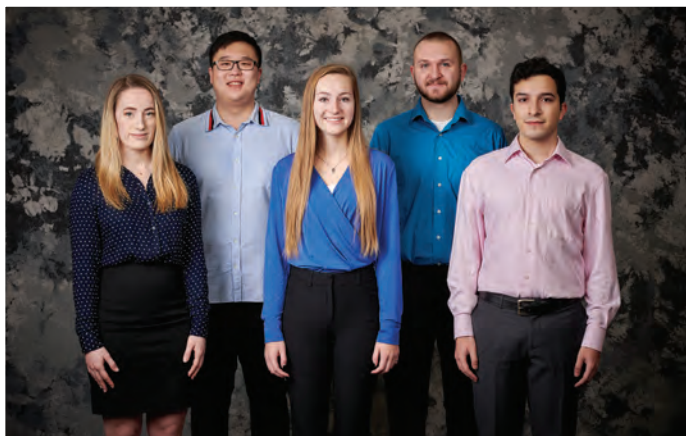
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United Airlines
Virtual Reality Aircraft Walkaround

United Airlines is one of the world's largest airline companies. Headquartered in Chicago, they operate 4,900 flights a day from 362 airports worldwide.

Prior to each of these flights, technicians perform an aircraft walkaround to identify potential defects and issues with the aircraft. Training for this task is mainly done on the job, with little control over the types of defects or issues that can be demonstrated.

Our Virtual Reality Aircraft Walkaround software mitigates this problem by allowing technicians to be trained through virtual reality simulations on iPads and Oculus Quest headsets.

Virtual Reality Aircraft Walkaround features both user training and testing modes. In training mode, the technician performs a guided walkaround in virtual reality. Defects appear on the aircraft with popup boxes that display information about what the technician should look for in that location.

In testing mode, the technician spots and marks defects in an unassisted walkaround. After the technician completes the walkaround, a report that provides a summary of the technician's performance is generated. The report is saved for instructors to assess a user's progress. The technician is given the opportunity to return to the aircraft and review any mistakes.

A variety of aircraft models are available for both training mode and testing mode walkarounds. Each aircraft has a number of preset scenarios with predetermined defects. In testing mode, the technician may also choose a randomized scenario that spawns different defects on the aircraft each time.

Our software allows United Airlines to train technicians quickly, effectively, and cheaply.

Our software is developed with the Unity game engine. Scripts are written in C#, and the reports are saved using Unity Analytics. The software is available on both the iPad and the Oculus Quest.
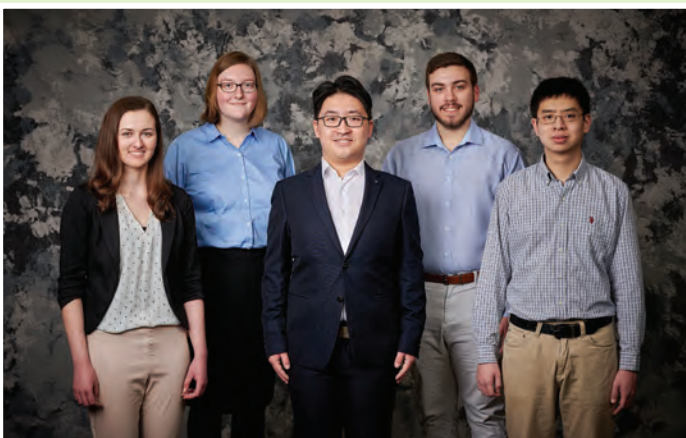
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United Airlines
Training Scheduling and Optimization System III

United Airlines is a major international air-carrier operating 4,900 flights per day from 362 airports. Operating an airline requires diligence in all logistical and technical aspects to ensure the proper flight experience for "Every customer. Every flight. Every day."

Within United Airlines, the TechOps training division is responsible for the operations of aircraft and their important maintenance. The TechOps team leverages a sub-team of 45 instructors to teach a catalog of 100+ courses for around 700 classes per year to their skilled team of 7,000 technical staff members. Currently, the orchestration of scheduling these courses is the responsibility of a single individual.

Our Training Scheduling and Optimization System III provides a production-ready web app to facilitate United's maintenance training schedulers to schedule instructors, students, classrooms and courses across the country.

A scheduler uses our mobile compatible website to add classes to the schedule manually or make use of the schedule optimizer. The schedule optimizer automates the scheduling of multiple classes at a time. Our optimizer can schedule months of classes in a few minutes, compared to the many hours it currently takes to schedule these courses.

An automatic email system alerts the scheduler of important changes, including when new training requests or employee availability changes arrive.

Our platform streamlines the scheduling process for United Airlines' TechOps division, allowing their employees to spend their time on more important tasks.

Our software is built using ASP.NET Core 3.1, Angular 8, Node.js, an Entity Framework, and an Azure SQL Database. The web app is hosted on Azure Cloud Platform.
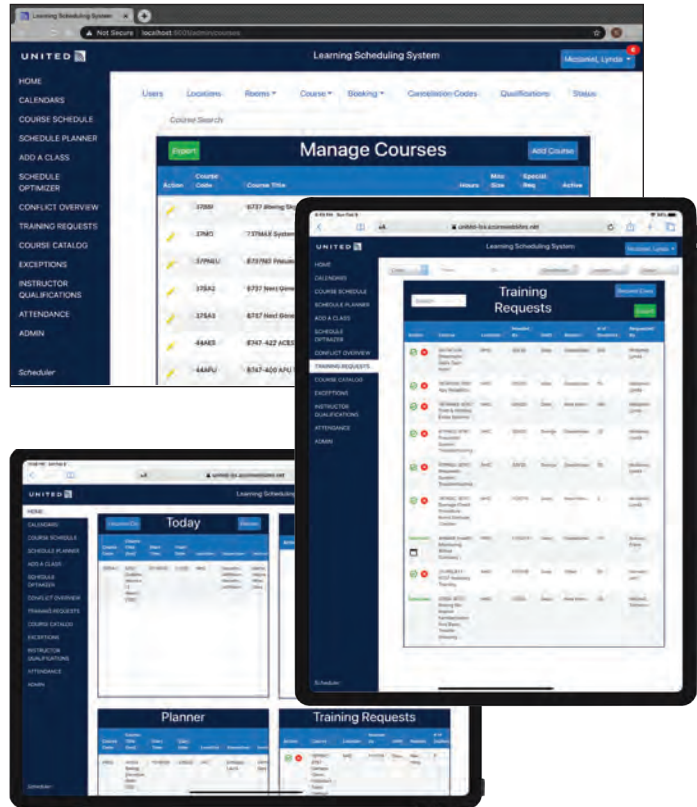
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Urban Science
AutoHook Mobile Redemption Tool

Headquartered in Detroit, Urban Science is internationally renowned for providing data-driven, science-based solutions to problems in the automotive, health, and retail industries. AutoHook is a subsidiary of Urban Science and assists automotive dealers and OEMs in increasing walk-in customer traffic.

AutoHook currently provides a voucher redemption service used by auto dealerships. This service allows dealers to redeem customer's vouchers at the dealership for rewards, such as gift cards. Currently, the redemption service is solely available as a desktop website, meaning that all redemptions must be performed using a computer.

Our AutoHook Mobile Redemption Tool enables auto dealers to utilize any mobile device with a web browser to redeem vouchers for their customers.

Dealers have access to our redemption tool from anywhere, including the vehicle lot or during customer test drives. Additionally, our redemption tool utilizes the camera found in most mobile devices as a barcode scanner. This allows dealers to scan the barcode located on a customer's voucher instead of being required to manually enter the relevant information.

Additionally, our AutoHook Mobile Redemption Tool offers intuitive visualizations and graphs of helpful statistics and calculated metrics to enable dealers to understand the effectiveness of their voucher campaigns. Also included in our platform is a dedicated question and answer section, which includes useful documentation and training videos.

AutoHook Mobile Redemption Tool is an online web application designed to work on all modern mobile browsers. The front end, created with Angular 8, is easy to extend and modify. The tool makes use of a supporting ASP.NET back end on 4.8 .NET Framework.
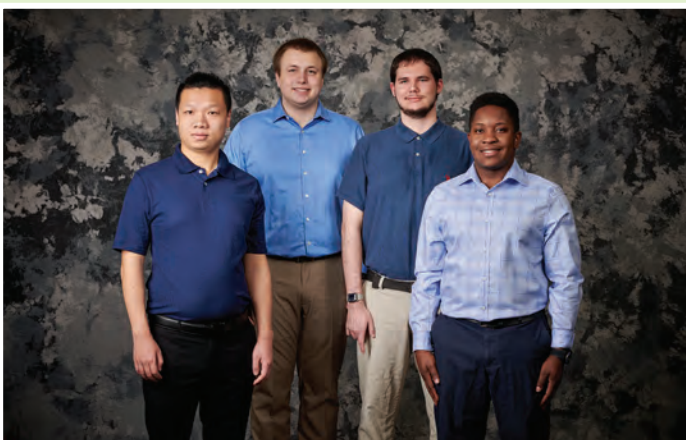
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Vectorform
Rumble Test Suite

Vectorform, headquartered in Royal Oak, Michigan, invents digital products and experiences both for their own products and for the world's leading brands.

Our Rumble Test Suite includes a Rumble device, an iOS application, and a web application. The Rumble Test Suite upgrades washing machines by recognizing, in real time, when a washing machine has finished running.

The Rumble device contains a sensor that detects the vibrations coming from a washing machine. Additionally, the Rumble device contains communication technology to wirelessly transmit the information from its sensors across the internet.

Using the data collected from the Rumble device, our Rumble Test Suite distinguishes when a washing machine is operating, and when it has finished. Our solution uses deep learning to make predictions on the state of the washing machine. Additionally, our solution is generalizable to any type of washing machine and wash cycle. This allows our platform to be widely deployed without any additional development overhead.

The iOS application alerts users when their laundry finishes, affording people more freedom to do other activities without worry of forgetting their laundry.

The iOS app configures the Rumble device while it is deployed, allowing developers to quickly diagnose and fix any problems. Our web app displays all wash cycle data from the Rumble device for analysis by Vectorform employees.

The Rumble Device contains an ESP32 and an accelerometer. The ESP32 is connected to an iOS device using Bluetooth Low Energy. The accelerometer reads vibration data that is pushed to our MySQL database over MQTT. The web application is implemented using HTML, CSS and the ReactJS extension Victory React for data visualization.
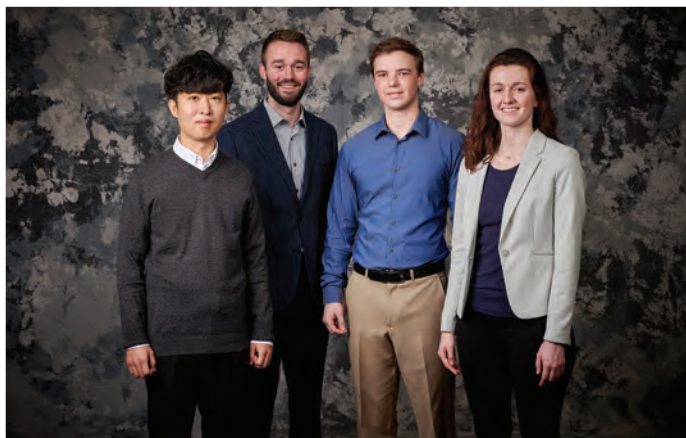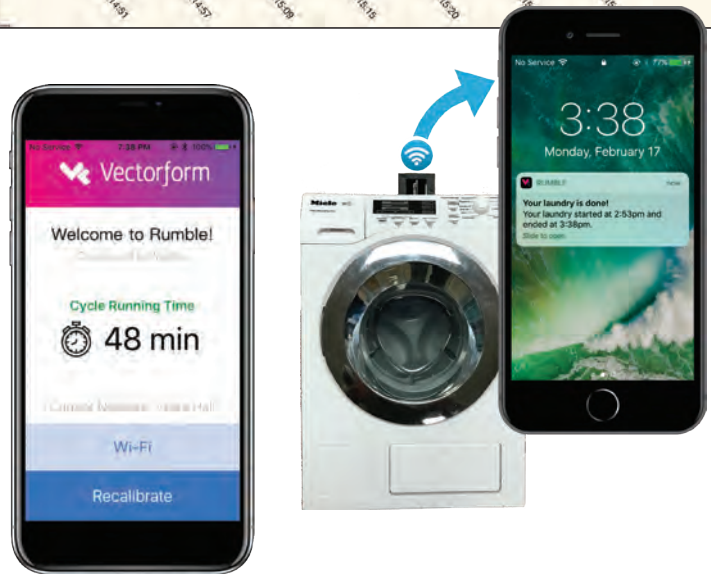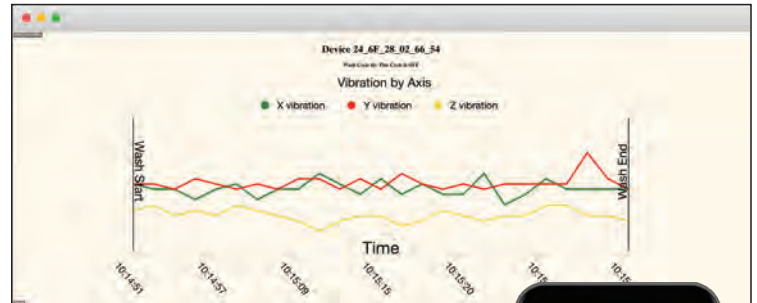
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