

UNIVERSITY OF
WATERLOO



**Computer Science /
Software Engineering
Capstone Design Symposium**

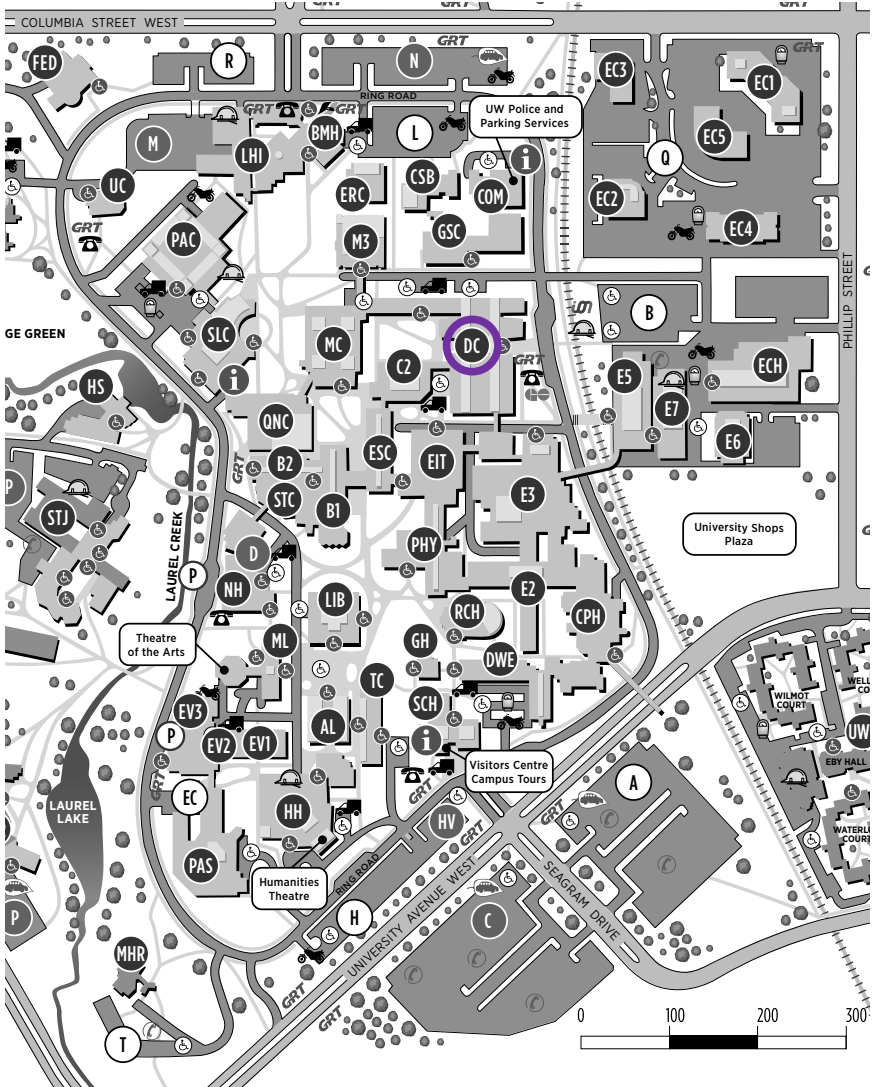
March 28, 2019

Talks: 9AM-5PM

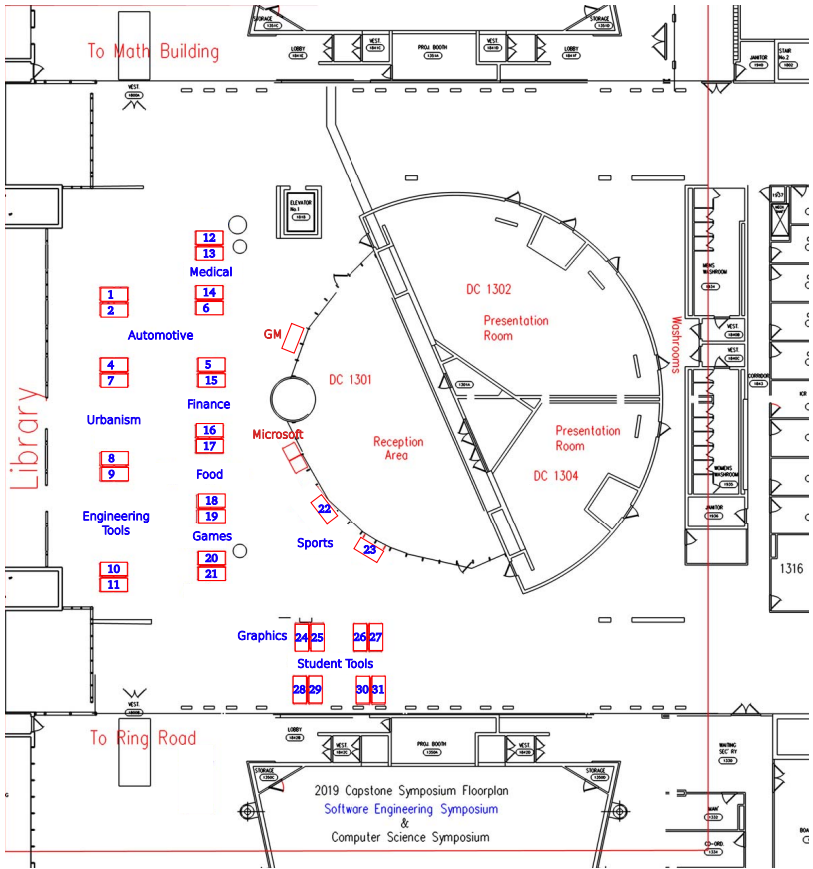
Awards: 6PM



UWaterloo Campus Map



Davis Centre Floorplan



Presentations will be in DC 1302 and DC 1304.



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Extracting Counterexamples from TCMC

Data Review Tool

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A food journaling app

Intermittent Fasting Tracking App

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TIE: A P2P In-Browser Game Platform

Mobile strategy game

Batter Up: Chrome Extension for Watching Baseball

Tournament management system

Controlling procedural modelling interactively

Hive: An app for connecting peer mentors

Graduation Verification & Planner

RezQ.io: Peer Resume Critiques

Resume ranking for focused recruiting

Campus social networking app

A Campus Events Discovery Platform

uwJAMS: Job Application Mngmt System

1 Lane Detection

Team WAtonomoVision

With a majority of new vehicles sold today featuring driver assistance technologies such as collision avoidance and lane departure warning systems, the idea of a self-driving car is not all too far off on the horizon. These systems, particularly in vehicles designed for operation without a driver, require computationally intense calculations and decision that need to be made instantaneously.

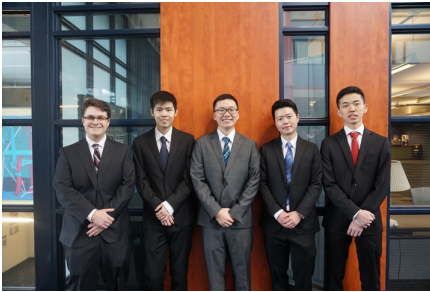
While autonomous vehicles are emerging in the automotive market, SAE International and General Motors have partnered to introduce the AutoDrive Challenge™, where teams of students from eight universities across North America compete in building a level 4 autonomous vehicle. At Waterloo, the WATonomous student self-driving car team consists of over 100 members, each with an integral part in helping the team succeed in the Challenge.

Our team, WAtonomoVision, completely redesigned the lane detection stack by using deep learning to tackle the problem. We trained a deep neural network to generate segmentations from a camera image, labelling each pixel in the image as belonging to a lane line or not. This model will be run on an FPGA in the car, which has been specially customized for this task, in hopes of giving us a performance boost over running it solely on the CPU. After this step is complete, our system performs post-processing to generate second-order polynomial representations for each lane line. Finally, we expose these lane lines to the rest of the vehicle's autonomous system, further being consumed by the path planning subsystem to allow the car to stay centered in its lane. In the field of computer vision, deep learning has consistently been shown to outperform traditional image processing techniques, as such, we are confident that our system will give WATonomous a competitive edge in future competitions.



Anish Chopra, Jason Milasincic

2 Address Querying and Routing for WATonomous Team GlobalMapping



*Jacob Moore, Siyi Shen, Richie Shi,
David Luo, Victor Duan*

For a self-driving car to navigate from one location to another, the car has to both find the coordinates of the locations and create a path between them. While the self-driving car WATonomous has created for the AutoDrive challenge can detect lanes and perform actions on a small obstacle course, it still lacks mapping software to perform routing.

Our project aims to aid WATonomous in building a mapping solution capable of completing the second-year challenges provided by the AutoDrive challenge. This involves the ability to accurately query for a location using multiple address formats, as well as providing routing capabilities between two locations.

A solution used to compete in the first-year challenges exists, but the solution has several issues. Location querying is missing some locations, and is unable to parse certain address formats. The UI also loaded extremely slowly, as it would load every single attribute in the entire database. The entire database would be loaded whenever any action was taken, whether it be a point query or zooming into the map. The solution also lacked routing functionality, the main challenge of the second-year challenges

Our team has decided that building a new product would be the best avenue to solve the problems with the first-year solution, while providing a solid foundation for us to implement the path routing. We have implemented a multi-database solution that performs faster point queries and handles a wider variety of address formats. We have also optimized the UI to not load the entire database, greatly increasing the performance. Most importantly, we have implemented full routing capabilities compared to the previous solution used for the first-year challenges. We are hopeful that WATonomous decides to move forward with our solution for the third-year challenges, when mapping is to be integrated into the self-driving vehicle.

3 WATOSCENGEN Team UnrealGoose

WATonomous is one of eight student design teams in North America that participate in building self-driving cars, as part of the SAE AutoDrive Challenge. The car, a Chevrolet Bolt, has to be thoroughly tested to identify possible use cases that can be worked on and improve up until the actual challenge in Michigan. This project generates 3D environments, as test scenarios, to ensure the car's main controller functions in different conditions and edge cases.



Gregory Desrosiers

This project must generate different 3D environments that can be used in WATonomous' own simulation program where the environments are suitable for the actual challenges SAE puts in the AutoDrive competition. It must be integrated into the team's own simulation program for these scenarios to be used right away.

WATOSCENGEN is built using Unreal Engine 4, a C++ game engine developed by Epic Games. Procedural generation techniques, such as Perlin noise, are utilized to create the landscape, the roads, and the points where the road signs and road marks are placed. This module uses randomization and the pipe-and-filter architectural model to build the environment in order, which is then loaded into the actual simulator to test the car in it. As this is an experimental project, MATLAB is utilized as well to allow the mock-up car recognize the environment setup.

WATOSCENGEN is tailored towards WATonomous' expectations. This module keeps the scope of the scenarios being generated to an arbitrary set that's similar to the test track in Michigan, but not set up the same way as the actual challenges. Unlike existing simulators, which are built for the general public, this one fits the existing simulator WATonomous has, which includes a mockup of the car. It also takes into account the mock-up build of the car's LIDAR, path prediction, and feedback systems.

Our minimal expected result is to have an initial-level prototype that generates at least one suitable scenario for WATonomous to use. An optimal expected result is for this to be in production and be part of WATonomous' critical operations.

4 ORB SLAM

Team SlamDunk



*Harkamal Jot, Michael Marek,
Pritham Marupaka*

One of the main technical challenges in the development of autonomous driving software is knowing a vehicle's surroundings and its location within them. This problem, known as Simultaneous Localization and Mapping (SLAM), has been an active area of research in recent decades.

Current SLAM solutions make extensive use of image processing techniques to find key points in images, a process known as feature extraction. These techniques predominantly rely on heuristics to alter, segment, and identify coordinates of interest. While the accuracy of such methods is lower than what a human can achieve, the resulting algorithms are fast and easy to add to a SLAM system. One notable algorithm

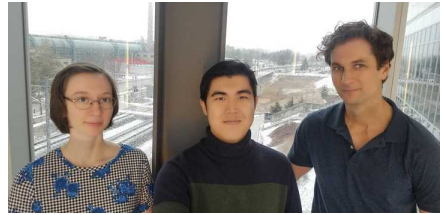
is Oriented FAST and Rotated BRIEF (ORB), which was developed by OpenCV Labs and is known for its accuracy and performance. [1] (<https://ieeexplore.ieee.org/document/7219438>)

Because the ORB-SLAM2 algorithm, developed by Raul Mur-Atal et al. at the University of Zaragoza, is designed to work in any unknown environment (without any prior knowledge), it is highly practical but also more prone to errors when identifying objects. For the purposes of the SAE AutoDrive Challenge, which WATonomous competes in, we're allowed to make certain assumptions about how signs, lane markings, and other objects look. Our group's aim is to incorporate this information into ORB-SLAM2 to make better key point predictions. The results from our augmented algorithm will provide valuable insight into how WATonomous can improve their existing SLAM algorithm for future competitions.

5 Daily inspection log for transport and heavy equipment

Team CircleChek

Canadian law mandates that owners and operators of trucks, construction vehicles and other heavy machinery complete a daily inspection log before they begin its use. These inspections are still commonly completed by pen and paper, a method inefficient in communicating vehicle status to management. Transitioning to a digitized format of check-completion offers reduction in physical storage, versatility in completion platform (mobile, tablet, etc.), the ability to readily aggregate information for management, and the potential to augment records with new sources of information. Additionally, it would reduce the cost of regular paper booklet purchasing for every vehicle in a fleet. Unfortunately, there has yet to be a successful software application that addresses this need.



*Rebecca Brown, Bingxu Hu,
Jason Williamson*

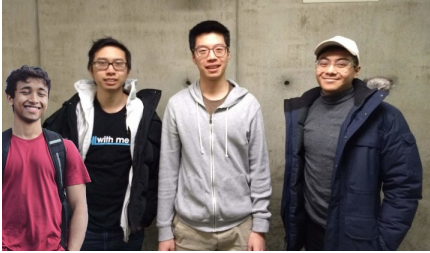
CircleChek is our solution to this problem. Our checklists vary by vehicle type, making inspection points specific down to the vehicle to increase accuracy of inspections and overall safety. The ability to add photos within individual reports helps communicate vehicle status beyond simple pen and paper solutions. We employ cloud syncing to maintain consistency between clients; management no longer needs to lose time collecting vehicle information or suffer communication delays with vehicles in remote locations—all vehicle information is aggregated directly to them. CircleChek is ideal for small- to large-sized companies that need to stay up-to-date with a multitude of vehicles' statuses without the hassle of handling paperwork. Our daily inspections comply with the legal standards of the province of Ontario, and Canada-wide. In summary, our mobile application simplifies and speeds up daily inspections, making it easier for managers to track their vehicles across locations.

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Initial deployment of CircleChek to a client company was done late in the fall term of 2018. The basic Android application was brought to the client for field testing. Feedback was mainly positive with an emphasis on design tweaks. Additionally, special interest was expressed in a cross-platform application (iOS and Android) and anticipated future backend features. Overall, CircleChek offered a more detailed checklist than market-purchasable booklets, aiding operators in performing more thorough daily inspections.

6 Real-Time Environment and Path Visualization

Team Seven



*Sadman Kazi, Samuel Wu, Justin Li,
Shan Phylim*

Autonomous vehicles collect and generate an enormous amount of data in order to understand the world around them and how they should behave. This includes raw data in the form of sensor readings, inferred and fused data such as the identification of lane lines or obstacles, and computed data such as the optimal path to drive along. A major challenge in developing and tuning algorithms for the vehicle's navigation is understanding what the vehicle "sees" at

any point in time.

Some of the subteams have previously built out graphical tools using custom libraries for their own needs, but WATonomous recognized the importance of having a cross-team "single source of truth" display which would unify visualization efforts and could be used during live runs for testing and debugging purposes.

Our solution consists of a highly decoupled and customizable module which creates a 3D view of the sensed and computed environment. This module subscribes to data streams over the network from other computation and sensor modules. It performs any transformations required to shift everything into the global coordinate system and then creates visual representations which are buffered until the next frame is ready. The visualizer is also compatible with recorded sensor data, so it can be used for offline testing and rendering. If the computation modules are running at the same time that the data is replayed, the visualizer can reconstruct all details just as they would appear live.

Significant effort was put into performance optimizations to ensure that the visualizer would remain scalable and performant in real-time applications regardless of the environmental complexity. These optimizations include rate-limiting the visualization to match incoming data rates, delta-encoding changes to reduce information over the network, and batching similar geometric elements into a single render request.

7 Learn more about your neighbourhood Team Abode

Abode is a web-based data visualization and query tool for data from various public data sets like the Canadian census, city open data sets, etc. We want to give researchers, journalists, and the general public an accurate way to understand their neighbourhood, their community, their city, etc as well as trends about its evolution.

Data that is presented includes things like age breakdowns, income breakdowns, transportation/commute patterns, household traits (number of people, number of children), density, etc. Both absolute data (eg. 3200 people under 15) as well as relative comparisons (eg. 5th densest neighbourhood in the city) are presented. We hope to indirectly address hysteria about the growth and future of a place through accurate and effective presentation of data.

Neighbourhoods can be compared on how similar their indicators are (eg. age breakdown), and in the future, how their future growth projections and trends compare. Neighbourhoods that are most similar to a given neighbourhood are listed.

We expect the initial user base to consist mostly of enthusiasts in the field as well as people evaluating neighbourhoods to move to. We will gain this market share through publishing tweets and blog posts about our product and having them shared in urbanist circles. Over time, we expect the academic community as well as the media to use our tool as a quick way to understand and compare neighbourhoods and cities on key trends and indicators.



*Bilal Akhtar, Saksham Sachdev,
Nakul Pathak, Naren Srinivasan*

ourabode.ca

8 Suadeo: Recommendations from friends Team Utepils



*Mart van Buren, Gillian Maducdoc,
Maria Kang, Noah Guld, Karel Casier*

When visiting or moving to a new city, it's not easy to discover restaurants, bars, coffee shops or tourists attractions beyond Googling "to do in New York". People want personalized results. Tools that improve the discovery process of a new city are incredibly useful to users. Furthermore, tools like this help new and unique businesses flourish by helping them reach their target audience, keeping cities lively and fun to explore even after living there for many years. Tools such as Yelp and Google Maps have drastically optimized the

way that people get connected with great experiences, but we believe there is still much room for improvement.

When deciding where to go for your anniversary dinner, or where to visit on your next trip to Paris, the experience is usually suggestions from total strangers writing online reviews. While better than exclusively sticking to places you know, we believe this is far from the best solution. We believe the best source of recommendations for great experiences is your friend who lived in Paris for 2 years, or your foodie colleague who knows exactly what food you like. If you're discovering a new city, the best place to get recommendations is from a friend, colleague or family member that knows you, and has been through the same discovery process before.

If you frequently travel to New York City and now a close friend of yours is planning their trip there, Suadeo is the ultimate way to share your experiences and suggestions. Whether it's your favorite restaurants for an affordable dinner, or the best coffee shops to get some work done, Suadeo helps connect people with great recommendations. For those that love discovering new places, Suadeo is a tool to express yourself and document great experiences. For those that love restaurants they can count on, and experiences that are reliably great, Suadeo is a tool to discover these places from people they trust, and that have similar taste. Suadeo reintegrates personality into recommendations.

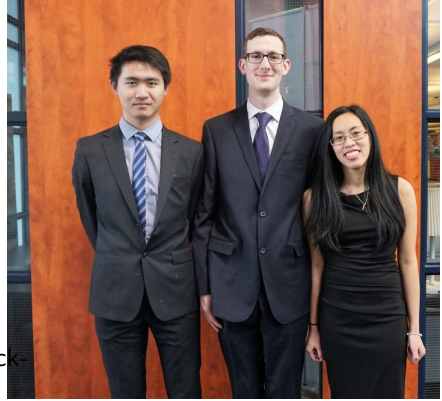
Initial deployment of the minimum viable product was done during the last work term. Based on user feedback and product testing, we have completely redesigned our app, and dramatically improved content discovery and sharing functionality.

9 Extracting Counterexamples from TCMC Team Counterpoint

Model checking is a technique for verifying software correctness. Rather than testing the software directly, users create a model of the system and describe properties it should satisfy. These properties are then automatically verified by model checking software. For example, given a description of a traffic light control system, a model checker could verify that both pairs of lights will never simultaneously be green.

Transitive-closure-based model checking (TCMC) is a model checking technique that uses first order logic to view a system as a set of states, and transitions connecting them (a transition system). It is implemented in the Alloy Analyzer, a tool for software modelling developed by the Software Design Group at MIT. One drawback of the current state of TCMC in Alloy is that the counterexamples it produces for incorrect properties are not very informative. Typically a bug is best explained by a single path in the transition system; however, TCMC produces an entire sub-transition system as its counterexample.

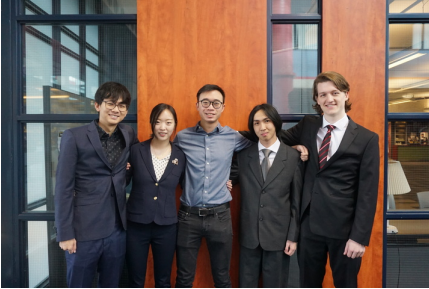
The goal of our project is to improve the real-world usefulness of TCMC by making it produce paths as counterexamples. We do this entirely by adding logical constraints, without the need for additional software or extensions to Alloy. We also characterize the possible forms of counterexamples, and compare its performance to regular TCMC. *Published to MiSE 2019.*



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10 Data Review Tool Team Runway



*Justin Stribling, Robert Lai,
Wendy Fu, Calvin Chan, Jacky Han*

Every year, engineers at Aviya, an aerospace systems company, spend hundreds of hours analyzing simulated aircraft engine output for correctness. Existing processes are time-consuming, and could benefit from automation. Our project automates some of this process and reduces the effort required to verify simulation output data, which could be spent elsewhere on more productive work. The addition of our tools into Aviya's existing workflows will allow more efficient utilization of their engineering

time.

Our project uses artificial intelligence techniques, including machine learning, in order to detect anomalous sequences of data, make predictions about expected correct sequences of data, make comparisons, and provide insights into detected anomalies. A key design challenge is tuning the machine learning algorithms by finding optimal parameters and configurations, and updating these values over time as we receive feedback on our results. The design of the system requires technical knowledge in artificial intelligence and data analysis.

The existing alternative involves hundreds of hours spent analyzing simulation outputs, so the primary advantage of our solution is the time that can be saved by automating parts of the process. Another advantage is the reduction of repetitive tasks performed by the engineers at Aviya, allowing them to spend more time focusing on other tasks.

11 X-ray analysis of lithium-ion batteries

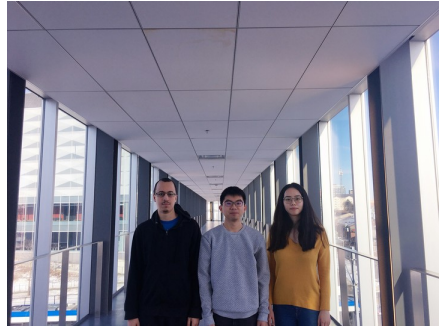
Team VagueRec

Lithium ion battery is a type of rechargeable battery that is widely used in electronic devices such as smart phones, laptops, and even electric cars. An increasing number of Li-ion batteries are exploding or catching fire in recent years, and it is vital to make sure that batteries rolling out of factories do not contain any manufacturing defects that contribute to these safety issues.

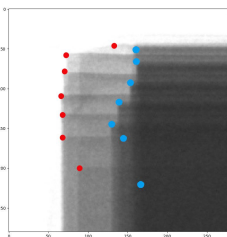
Working with an industry partner, the goal for our project is to accurately check the quality of battery

cells before they are packed together and delivered to customers. To analyze Li-ion batteries, x-ray images are taken. Traditional computer vision and image processing can only do so much when the internal structure for each of the battery cells varies from each other and that x-ray images are not as sharp as regular photos. Our team aims to use machine learning that learns to check the quality of each battery cell from specific characteristics.

We have manually labeled over 50,000 training images with the help of an OpenCV program. We then feed the images to a CNN (convolutional neural network) that we implemented which identifies most of the characteristics in a Li-ion cell. We then implemented a post-processing algorithm similar to non-max suppression to eliminate duplicated or undesired point of interests. After identifying these points, we are able to measure the distance between these points, and that determines the quality of the battery cell.

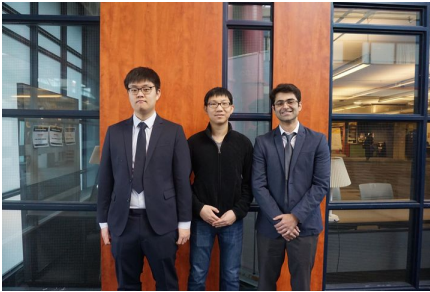


Yassin Zaoui, Tianxiang Liu, Wen Shi



An example of point of interest (dots in blue and red). There should be 6 pairs of blue and red dots marking the corners of the inner and outer squares. We let the algorithm marked 7 pairs of such points, thus there is one pair of dots that does not correspond to any corners.

12 Breast Cancer Research with MSHoloLens Team HoloVision



*Michael Bahng, Jiaqi Qian,
Pranaab Dhawan*

Breast cancer is the most commonly occurring cancer among women, and with over 2 million new cases worldwide in 2018 it is the second most common form of cancer. Current surgical procedures have complications that result in imperfect treatment; one quarter of women treated for early stage breast cancer must undergo repeated treatments and mastectomy to remove residual tumors. Improving the accuracy of breast-conserving surgery is an active area

of research that spans multiple disciplines.

One such complication with the current procedure is that MRI scans of the breast are taken in prone position, but the patient is moved into a face-up position during the surgery. The location of the tumors, accounting for possible warping and displacement, must be correctly determined during the surgery.

Our project aims to extend Dr. Oleg Michailovich's research on breast-conservation surgery to solve this complication, using Augmented Reality to assist the surgeons in locating tumors. Using proprietary surface projection and reconstruction algorithms in conjunction with the Microsoft HoloLens, which is equipped with various sensors and AR capabilities, we aim to project a 3D hologram of the tumors from a breast MRI, while accounting for changes in anatomical position.

Currently the system implemented on the HoloLens is not performant enough to render images in real time and is unable to fit a surface using the gathered points. Our goal is to create a framework that can scan the 3D surroundings, reconstruct and register the viewed MRI surfaces efficiently, and project a 3D surface at the aligned position in real time using the Microsoft HoloLens.

13 Improving the Canadian walk-in clinic experience

Team LuminousLabs

There are roughly 2500 walk-in clinics in Canada. Unfortunately, the waiting experience at walk in clinics have not caught up to today's modern Internet standards. Information regarding waiting times have only recently been accessible via the web. In order to check your position in-line, you must be physically in the waiting room talking to a receptionist – and the reported wait time depends on the receptionist's judgement.

People are time-sensitive. Users want to know how long a wait will be at each clinic before committing their

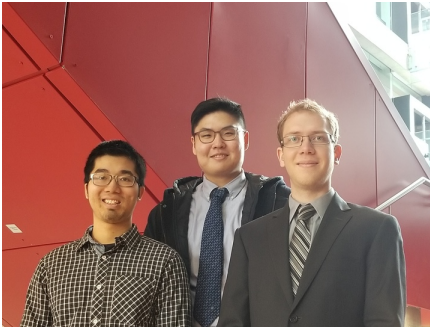
name down, and expect it to be reported accurately. Furthermore, waiting idly in the waiting room is not an efficient use of time. Users would prefer to make use of that down-time, and having an accurate representation of the current waitlist's progress at-hand will be extremely useful.

Utilizing a mobile app, information will be presented on-demand at the user's convenience. Utilizing smart algorithms, the wait times reported will be based on data points collected in reality.



*Jitin Dodd, Charles Bai, Yash Goel,
Meet Bhavsar, Zaid Shennar*

14 Medical Protocol Syncing Mechanism Team Sana



Felix Lam, Justin Kim, Michael Socha

The World Health Organization (WHO) estimates that around half of the world's population has poor access to essential healthcare services. Most of this population is in the developing world, and a common obstacle to delivering healthcare lies in distribution to remote areas. The effects of improved healthcare access are far-reaching, and include increased life expectancy, reduced poverty, increased workforce participation, and an overall improve-

ment in quality of life.

Sana is an MIT-based organization that focuses on improving healthcare access in developing parts of the world. A core part of Sana's solution lies in its mobile health (mHealth) app Sana Mobile, which allows remote healthcare workers to collect patient data and relay it to clinicians. Remote healthcare workers upload this data by filling out custom input forms built from underlying protocols. These protocols are defined in XML, making them tedious to edit without a dedicated tool. Previous FYDP groups have implemented a web-based tool for building these protocols.

However, the Sana Protocol Builder and Sana Mobile remain largely unintegrated. The most common technique for adding protocols to Sana Mobile deployments is manually through the app's APK, which is tedious and does not keep protocols on mobile up-to-date with changes on the Protocol Builder. The goal of this project is to connect the Protocol Builder with Sana Mobile using Sana's Medical Data Store (MDS) as an intermediary. Protocol Builder users can push protocols to an MDS instance, where they can be organized into protocol groups that are periodically pulled by Sana Mobile. In addition, we are extending the protocol definition language to support further UI customization of input forms, such as interface skinning.

Development of this new functionality to Sana Mobile, the MDS, and the Protocol Builder was carried out in 2018 and early 2019 in close collaboration with Sana's leadership. We aim to have these new features rolled out in February 2019 as part of a major release. This release will be used in Sana's existing deployments in Lebanon and sub-Saharan Africa.

<https://sana.mit.edu/>

15 Sandboxing for Algorithmic Trading Team AlgoWiz

Algorithmic trading is a method of trading where a computer program uses a set of rules (trading strategy) to automatically perform trades on an exchange. This method is used in institutional settings as well as individual settings where it serves as an attractive field and hobby for programmers. Our project is a domain-specific language designed for algorithmic trading with performance, ease of use, and security in mind.

The problem at hand is how to execute user-written code while offering performance and security. A common solution to this problem is containerization. However, the time cost of starting and managing containers makes it unsuitable for trading applications. The memory footprint of containers also limits the amount of "sandboxes" one can have on a given machine. This project will explore a domain-specific language based solution.

Our project aims to explore the performance opportunities when core financial actions are embedded in a programming language by extending a subset of JavaScript. By embedding these novel functions in the language, we also hope to simplify the automated trading experience for less technical users. Furthermore, we hope to identify and prevent security exploits by controlling the set of programming language constructs that people can use.



*Josh Carnide, Jean-François Bisson,
Keith Carscadden, Jeff Hudson,
Bryan Lo*

16 Foodie: Crowd-sourced photos of restaurant dishes

Team JAY



Jack Wang, Yemin Shou, Austin Du

Foodie is mobile app that provides a unified crowd-sourced directory of restaurants and their menu items, aiming to provide quality images and information for every menu item in any given restaurant as well as contextual information about the restaurant itself. A flexible search feature allows for querying by specific dishes or cuisines across all restaurants in the area, with an authentic and comprehensive image-based feed of results. This product aims to be the de facto directory for all restaurant

menu items.

Currently, many consumer dining applications depend largely on personal reviews – where the overall rating of a restaurant can often be skewed as customers who have had a bad experience are much more likely to leave a review than customers who have had a good experience. We also find reviews may be skewed positive by restaurants giving away discounts or free items to review. Our product explicitly does not support reviews of the restaurant or its dishes – it allows the photos of the dishes to speak for itself.

Foodie is meant to be a visual dictionary of restaurants. By acting as a non-review-based channel for sharing restaurant information, we hope to garner more support from restaurants than existing alternatives.

Starting in a relatively small area, this product first concentrates in the Waterloo region before expanding. A large challenge for this project is the problem of data acquisition – receiving enough information and photos about restaurants to be considered useful by users. To incentivize the population of data, the app offers rewards to users based on how much they contribute to the directory of restaurants – either through providing photos of menu items or providing the menus themselves.

beafoodie.com

17 A food journaling app

Team Edacious

Everyone's a critic, that's the saying. We're all born with a natural tendency to provide our opinions and insight into different human experiences. Edacious will allow users to release their inner critic in a private, simple, yet detailed approach to restaurant critiquing. We are proposing a mobile app that gives the user a thorough critiquing experience on their restaurant endeavours while keeping their opinion unpublished. With a focus on user freedom,

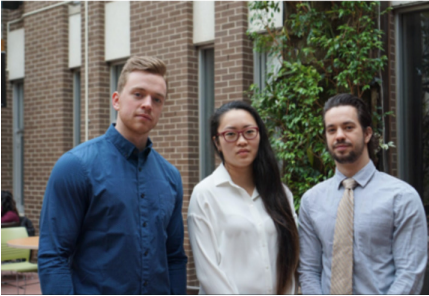
we want to allow a review to include a variety of customizations that will keep the user's journal descriptive and clean. The app would be released to both Android and iOS devices using Google's leading-edge mobile development tool, Flutter. With collectable badges and restaurant promotions, we will give users incentives to discover or revisit excellent restaurants along their path. In addition, we want to enhance the excitement of exploring new nearby locations by providing personalized recommendations for their next food adventure. As a personal journaling package, Edacious will supply an improved experience from existing overly shallow and public critiquing formats such as Yelp or Google Reviews. Edacious can meet the mark by creating an app where the interface is both clean and intuitive, granting the user an ideal journaling experience.



*Aishwarya Gupta, Matthew Kwong,
Daniel Podlovics, Kokul Subendran,
Daniel Tchorni*

[edacious.app](#)

18 Intermittent Fasting Tracking App Team Glue



*Casey McLewin, Olivia Cao,
Peter Lakner*

Intermittent fasting is a method of dieting that has become more and more popular recently. It is when you limit the time period in which you're allowed to eat. They vary and an example would be daily fasts in a 16 hour period or 24 hour fasting for twice a week. However, like many types of diets it is difficult to keep track of metrics. This one in particular is difficult because involves not only keeping track of food, weight but also timing. The objective of this

app is facilitate this type of diet and keep track of metrics so the user can measure the effectiveness of this diet in terms of weight loss. Our initial platform is iOS. An important feature is to keep track of the timing of the diets. This is crucial to the diet as it is important to remain consistent and this is something that people new to the diet struggle with. It also sends notifications and reminders as to when the diet ends/ starts. Another important feature is that we keep track of weight loss throughout and show users how they compare to their projected goals to monitor progress over time. This is different from the intermittent fasting apps that currently exist since the existing ones are complicated to use and are less aesthetically pleasing. Our app improves the user flow and enhances the user experience to diminish the barrier of documenting the progress of their diet to improve the odds of success of the diet. The legitimacy and feedback for this app has been verified with multiple conversations with users who currently are intermittent fasting, people who are experienced fasters and people who have just recently started. Future implementations as part of the next version would include adding a web version as well.

<https://itunes.apple.com/us/app/zen-fast/id1453590412>

19 OrbitX: Educational spaceflight simulator Team Zero

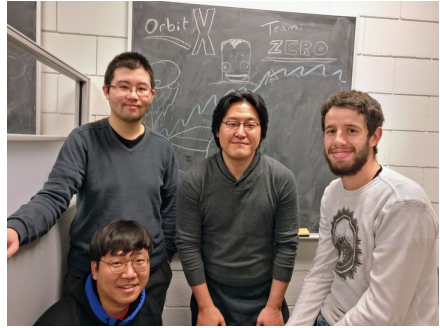
OCESS is an Ottawa-area volunteer high school club for spaceflight simulation. It uses a combination of 1) physical astronaut living quarters and 2) a software simulation of spaceship piloting and other aspects of spaceflight.

Our project focuses on 2) the software simulation. The current software simulation suite has been developed by OCESS supervisor Dr. Magwood over (at least) the past decade, and has been used to accurately and reliably simulate countless space missions. However, its codebase is not easily maintained by the volunteer students of OCESS, and has other technical limitations imposed on it by its implementation language (Microsoft QBasic).

Our project is to rewrite the spaceflight component of this simulation software, which is the largest component of the software suite. We aim to faithfully replicate as many features of the software suite as possible; specifically its scientific accuracy, its simplicity, and its integration into other pieces of the QBasic software suite. Additionally, it should be maintainable by students of OCESS.

By keeping the original features of the QBasic software suite, we have to do significantly less feature design, and we also keep our project familiar to its users: student members of OCESS. As well, these students will be able to gain experience maintaining a real-life piece of open-source software. Simultaneously, OCESS supervisor Dr. Magwood will be able to focus less on maintenance of the QBasic software suite.

The success of the project will be determined by how readily student members of OCESS adopt the rewritten software, both through maintenance and through actual use of the software. Ideally, a "mini-mission" of several real-life hours will successfully make use of the rewritten software.



*Ye Qin Xu, Seun Ho Kim,
Kyoung Jeon, Patrick Melanson*

<http://www2.spacesim.org/>

20 TIE: A P2P In-Browser Game Platform Team GreenDuo



Jay Park, Tim Baek

The game industry has traditionally been dominated by large corporations such as Steam, GOG, and Epic Games. Because of these giants, it is difficult for game developers to publish their games online for a reasonable price. In addition, the rising number of developers globally suggests the need for a flexible game platform. TIE perfectly fits into this category.

TIE provides a platform for both game publication and game play. Game developers can easily upload their games to TIE, similar to how people upload videos to YouTube. The uploaded games, like YouTube

videos, are displayed on the home page of TIE, or can also be searched for to play. These games are in web compatible format HTML/CSS/JavaScript and utilize templates and APIs provided by TIE.

Game development has been a common aspiration for developers but at the same time it has a high entry barrier. TIE offers developers simple game development by using more friendly languages and a set of templates and APIs. Even novice developers can build a game in a short period of time and publish it to play with friends. Players will also benefit by having large numbers of games to play with their friends.

tiegames.ca

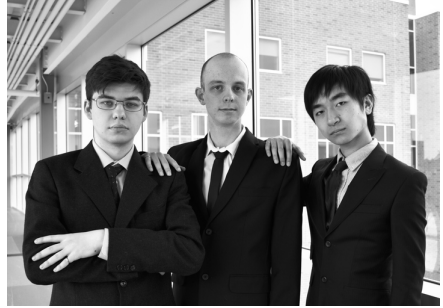
21 Mobile strategy game Team Adrestia

Real-time strategy games like StarCraft are rewarding to play, but require significant time commitment. Mobile games are accessible, but lack strategic depth.

Adrestia is a mobile strategy game that we designed in response to these shortcomings. Unlike a real-time strategy game, it is easy to pick up and fast to play, but unlike a mobile game, it has significant strategic depth. We designed Adrestia in such a way that interesting strategy arises naturally from simple mechanics.

Our game mechanics are also amenable to AI players. We implemented an AI using counterfactual regret minimization and machine learning, and we use this AI both as an opponent for offline play, and for testing the game to ensure that there is no single dominant strategy. Implementing an AI for a real-time strategy game that could be used in such a way would be much more difficult, since the search space is intractable; most AIs for such games simply execute known strategies and cannot be used to test for balance.

We hope that Adrestia will combine the intellectual stimulation of StarCraft with the accessibility of Candy Crush.



*Dmitri Sclear, Charles Zinn,
Jim Zhang*

adrestia.neynt.ca

22 Batter Up: Chrome Extension for Watching Baseball

Team Batter Up



David Zhang, David Qian

Baseball games take an average of about 3 hours, and with up to 15 MLB games playing at once, it can be hard to keep up with multiple players while juggling a busy schedule.

With Batter Up, it is now easier for people to keep up with their favourite players and get more enjoyment from the MLB season.

Batter Up empowers users by monitoring the state of all active baseball games, and then sending the user a notification to tell them that a player they are following is about to bat or pitch. The user can then switch over to the game so that they can watch the player's at bat. The

app itself will be a Chrome extension.

The main advantage of Batter Up is that it fills a need that is not addressed by any other solution. Currently an user would have to actively monitor the boxscores of every game. With Batter Up, the user will be free of this burden and focus on whatever they're doing.

We expect Batter Up will be installed by a number of users that regularly engages with the app and notifications, which would indicate that we are fulfilling a need in their baseball watching routines.

<https://chrome.google.com/webstore/detail/batter-up/jnafaeneojiefchaegfgoiehafbdfob>

23 Tournament management system

Team Tournament Timeline

Esports is an industry undergoing extraordinary growth as the proliferation of computers makes gaming increasingly popular amongst today's youth. As the scene matures, significant efforts are being made to foster a competitive atmosphere at lower levels of play. While the advent of services like Discord has proven useful for organizational efforts, the lack of an integrated solution for tournament administration remains a pain point for many parties.

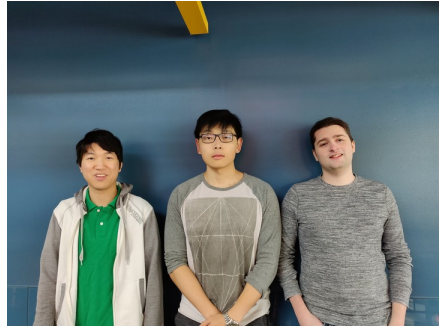
Our objective is to make a tournament matching system that reduces the work on administrators by automating creation, pairings and the recording of results through Discord commands that participants can use themselves.

Since the esports scene has grown so rapidly in recent years, there are few incumbent players in the space. Discord is a dominant force in the market, but its core competency is being the place for gaming communities to chat. They expose a feature rich API which enables us to leverage their market dominance by integrating directly into Discord channels.

The back-end of our application handles the matching algorithms that go into generating a custom tournament bracket. Our goal in this area is to offer several different algorithms that align with different types of games and tournaments.

We also have an appealing integration with Discord so that people who talk in one channel can easily set up a tournament bracket if they want to play right away. This implies that we must communicate with the Discord API in an efficient manner.

We will make a system that can generate tournament brackets in various formats. We will have Discord integration functioning, so you can control the tournament bracket from commands from Discord. Furthermore, participants themselves will update their own scores in order to reduce administration overhead. The system also will automatically flag cases where two players update the same score with a different result, which should prevent any abuse cases from happening.



*Benjamin Wang, Howard McLaughlan,
Szilard Balla*

24 Controlling procedural modelling interactively

Team Calder



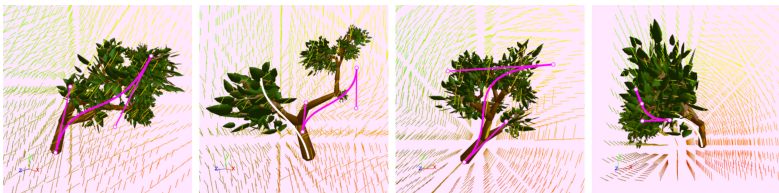
*Tammy Liu, Abhishek Madan,
Paul Bardea, Andrew McBurney,
Dave Pagurek*

Procedural modelling has been an essential tool in the 3D artist's toolbox for many years, used in applications such as games and movies. It provides a way to add a level of detail and richness that would be impractical to create by hand.

Context-free grammars provide a convenient way of encoding the structure of such patterns. While it can produce great results, the challenge with grammar-based procedural modelling is efficiently sampling the model space to produce a broad range of interesting results while also

excluding unfavourable results.

We aim to provide a useful probabilistic search function that can be run at interactive rates to enable the short feedback loops artists require for incremental, exploratory design. We present a constraint for use with probabilistic sampling where artists draw curves, and a model that aligns with the curves is generated. These guides allow us to produce a final model in 200ms that is of comparable quality to those which were generated in 45s using existing methods. This is accomplished by reformulating the search problem so that it operates on the inherent skeletal structure of grammar-generated models rather than examining vertices, pixels, or other concrete artifacts of the model. We also present a real-time model editor to demonstrate the artistic utility of our method.

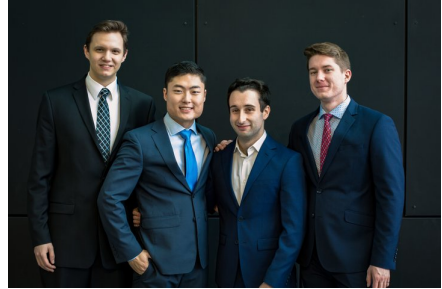


Examples of various tree models produced by the same generating grammar, selected by different guiding curves.

<https://github.com/calder-gl/calder>

25 Hive: An app for connecting peer mentors Team SyncUp

Many students struggle making the transition from high school to University. For a sizeable portion of students, there is a lack of social support; students are taken away from their support system – their families and existing friend networks – and are placed in an unfamiliar environment where the challenges they face are arguably more difficult than any they have experienced in the past. The pressure of stepping up to try and overcome these challenges forces students to adapt quickly.



*Adam Klen, Steven Kong,
Andrew Codispoti, Wojtek Swiderski*

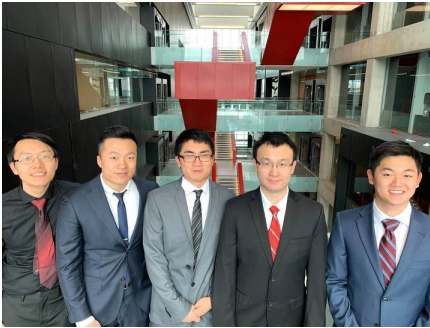
Mentorship is a great way to transfer knowledge and wisdom. The co-op program at the University of Waterloo believes so strongly in the power of mentorship that they mandate each company to provide a student with a mentor to guide them through the challenges of the workplace, technical and otherwise. Incoming students can benefit from having similar support: Hive provides students with a mentor. Hive's primary mission is to create relationships that help students navigate their university experience.

The University of Waterloo hosts a talented and diverse group of students. Though, it is often the case that students silo themselves into cliques exclusive to their programs and cohorts. Hive helps bridge the gaps between the various disciplines and helps students expand their networks. A big part of Hive's mission is to build stronger relationships, not only between cohorts, but also programs. Through strengthening the networks that already exists at the university, we aim to empower a student to grow a more diverse network.

After having talked to early users through interviews, we have very promising results about the overall positive reaction towards the community we've created. Through partnering with many existing mentorship initiatives, at the time of this writing we have more than 600 users signed up on our platform, creating almost 500 connections. After conducting surveys, we have determined that most first year users met up with their mentor at least once. Our ongoing goal is that all users are able to make at least one strong connection that they otherwise would not have the chance of making.

hiveapp.org

26 Graduation Verification & Planner Team DegreeCompass



GuangZhi Xiao, Jack Zhou, Ken Torii,
Calvin Hua, Ian Zhang

Computer Science students at University of Waterloo currently deal with complicated graduation requirements such as “3 courses having the same subject forming a prerequisite chain of length three”.

Our project goal is to make these students’ lives easier by creating a webservice that faculty and students can use to determine graduation eligibility.

Current objective is to let student user upload a transcript to our web service and be told whether graduation

is possible or not. For department admins, let them specify a new program’s requirements using DSL which our app can parse.

Currently, our app model has 3 main components: *Satisfaction*, *CourseRequirement*, and *ContainerRequirement*.

CourseRequirements consists of the following children classes: *AllOf*, *SomeOf*, *OneOf*. You use this by initializing a children class with: a list of required courses (ECE124, SE350), a required faculty (CS*), or a required faculty plus a course number range (PHIL200+). We intend to model each degree requirement to one of these class objects (like the CS prereq chain of 3).

ContainerRequirement consists of the following children classes: *AndContainer*, *OrContainer*, *XorContainer*. These containers can contain a list of other container classes or requirement classes.

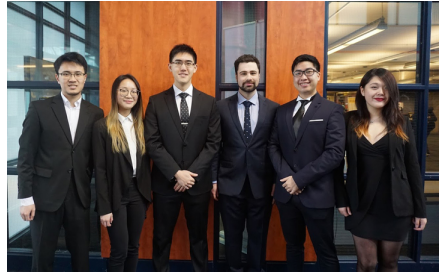
After the entire degree requirements are prepared, our solver then tries to fulfill requirements with a different course at each stage of the solving process and does this for all remaining requirements and unused courses. In essence, we try out each possible combination of courses with requirements and take one with the most requirements fulfilled.

Preliminary testing indicates that our app can figure out whether the student can graduate within seconds. This is a vast improvement compared to manually checking the requirements’ fulfillment.

27 RezQ.io: Peer Resume Critiques

Team RezQ

Over 19,800 undergraduate students are enrolled in a co-op program at UW each year. Students often face difficulties obtaining feedback for their resumes. In the most recent “Resume Critique Megathread” on the UW subreddit, there were over 200 comments within 8 hours. Evidently, there is a large demand for resume critiques from co-op students. We will fill this demand by offering a peer-to-peer resume critiquing platform open to anyone for use.



Ian Yuan, Fanny Deng, Gary Zheng, Andrew Gopic, Evan Cao, Judy Chen

RezQ offers several unique features including industry-specific critique matching, sharable resume critiquing links (similar to Google doc sharing), and a public pool of resumes which anyone can review at any time.

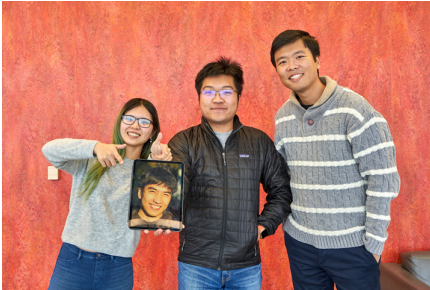
The key challenges we face include securing user information, providing a good UI/UX, and designing a scalable and reliable service. Naturally, RezQ stores a lot of personally identifiable information. In order to protect user information, we have applied various security concepts to ensure our platform is secure. In terms of UI/UX design, we aim to continuously improve RezQ by iterating upon user feedback. Finally, our platform applies ideas and concepts from courses in software architecture and distributed systems so that it is both scalable and reliable.

One clear advantage that our platform offers over other solutions such as a Reddit thread is that our platform offers annotations. This allows critiquers to write directly on top of a user’s resume. Our philosophy is that a picture is worth a thousand words. Another advantage is that our platform offers the ability to comment on critiques. This promotes discussion between both parties (and the community if the resume is publicly available).

We recently launched a public beta for our platform and have received almost 75 signups on the first day. There were 25 resumes uploaded, 15 critique requests, 25 requests to critique, and 10 sharable critique links created. Our Reddit post has over 50 upvotes, suggesting that users are happy with the product idea. We even had one user from Carleton University.

<https://rezq.io/>

28 Resume ranking for focused recruiting Team u2careers



*Lingyun Guo, Jingyang Gary Zhang,
Minyang Jiang, Jiale Sun*

Everyday, millions of resumes are submitted by job seekers to recruiters, in hope of getting the recruiter's attention and being considered for a follow-up interview. Needless to say, resume screening is one of the most critical steps in the application process, as a turned down resume most definitely means that the application is hitting a dead end. In fact, talent acquisition leaders generally agree that screening resumes is the hardest part of recruitment.

Nowadays, many companies use an ATS (Application Tracking System) or search engine to aid the screening process. Nevertheless, most of the resumes are reviewed by real people and bigger companies even have specific roles to screen resumes. Due to the large influx of resumes to the recruiters, each resume usually gets less attention than it deserves. Most resumes are just glanced over by a single person, who may miss important details, and who's experience and expertise may be limited.

U2careers is capable of inspecting the applicant pool thoroughly and consistently in the blink of an eye. Given the list of job requirements, it produces a score for each resume, which can be used to filter out a large majority of applicants that do not meet the bar. It is estimated that usually up to 88% of received resumes are unqualified for an open job position. U2careers helps identify the 12% that meet the requirements, while providing insights on why others failed to make it under the spotlight. Users have reported that all the resumes that meet the minimum qualifications are in the top n th percentile of the score range, meaning that recruiters generally only need to look at $n\%$ of the resumes, saving a considerable amount of time spent on manual screening.

The system could be extended to a broader range of applications. As part of the project, we have built a platform that connects job seekers with internal referrers using the matching scores. This gives the qualifying job seekers a better chance of getting an interview opportunity by utilizing referral programs run by many companies. As another example, our resume scoring system can be integrated into a resume critique application to give valuable suggestions on how to target your resume towards certain categories of job positions.

<http://u2careers.com/>

29 Campus social networking app Team MeetUW

The social networking app market has been growing since the early 2000s. For example, Facebook, Twitter and Snapchat etc, these apps help make better connections between people to share their moments and thoughts in the community.

From a survey we conducted in Fall 2018, 70% of students from the University of Waterloo stated that they would like to be more involved on campus and have more friends when they are either in school or on a Co-op term. From the result of the survey, the two major reasons preventing students from making friends are overloaded school work and social-anxiety. Therefore, UWMeet is aiming to target students with desire to make friends around campus more easily and conveniently.

Our survey indicates that there are many blockers preventing UW students from making new connections. Some are too busy with school. Some are afraid of approaching others. Others might lose connections when moving to a new city for Co-op. It is obvious that their social needs cannot be satisfied with current apps. Our app is designed to help them match with someone who has the same intention to lower the cost of making new connections between UW students. Besides, the matching results would be optimized by applying our matching algorithm which guarantees the matching quality.

Our application reduces the cost of approaching new friends because it limits users in one community such as the University of Waterloo. This creates a sense of safety and closeness, which makes it easier for discussion happens between matched pairs. Also, since the match is based on some common interests, there will be more drive for users to engage in talking.

We aim to deploy our first soft launch in early March. Through marketing on reddit and other venues we hope to attract active users quickly and initiate activities between matched pairs.



*Tina Lu, Mingyuan Li, Fred Chen,
Xin Yan Wang, Da Wei*

30 A Campus Events Discovery Platform Team Habitat



*Phoebe Li, Zhenyi Zhang, Zhen Song,
Pengfei Zheng*

There are many interesting events happening on campus, including club events, info sessions, or events organized by a faculty or program. To find out what are the upcoming events, students need to go to different platforms to access the information, such as the Facebook page of different clubs for club events, or the school website for info sessions and academic events. Sometimes, students might miss the events they are interested in only because they were not aware of these events.

Currently, using Waterloo Portal, students are able to view a list of upcoming academic events; through Facebook, students are able to discover club events shared by friends or different groups they have joined. In our project, we aim to combine everything together, thereby helping students to discover what is going on at the campus.

The goal of the project is to provide a useful application to UW students, which allows them to quickly view the events happening at the moment, or the events that will happen in the coming days or weeks. It also allows users to subscribe to events of interest and be notified immediately after an event update. The application is built across platforms (web, Desktop, Android, IOS) so that students could view events information from different devices. The platform also adapts a containerized micro-service architecture which could be easily scaled to include more universities' events and users or even events in the local area.

31 uwJAMS: Job Application Mngmt System Team Fergus

Students at the University of Waterloo are very focused on the job search with 19,800 students enrolled in co-op programs every year. The job search can be highly stressful as students spend a lot of time finding positions to apply to and keeping track of the status of their job applications. Each term, students make up to a hundred job applications with no easy way to track the status and tasks involved in all of their applications.

uwJAMS is a centralized place for students to track and manage their job applications so that it is the one place they go to during their job search process. This is achieved by creating a system where UW students can import their job applications from WaterlooWorks through a simple copy-and-paste mechanism and add external job applications manually. Through this application, students will have the ability to update and track the status of all of their applications, record interview dates and times, and document any other useful information such as employer contact information. This product facilitates the job search process, allowing students to focus more of their time and effort into more productive tasks such as interview preparation.

Unlike many other job tracking tools, uwJAMS is catered specifically to UW co-op students. The only existing UW-student focused tool, WaterlooWorks, does not allow for any customizability as students are unable to add external job applications to the system, which is an increasingly common occurrence. In addition, job statuses on WaterlooWorks are oftentimes inaccurate and interview schedules on WaterlooWorks are incomprehensive as the recruiting process for many employers happens behind the scenes. Therefore, uwJAMS does not intend to compete with WaterlooWorks, but acts as an extension to provide a centralized and fully customizable system, solving all of the aforementioned problems.

To demonstrate the effectiveness of our product, we will record user-based data to collect statistics such as user retention rate over the job search period per term. A consistent user base implies that our tool is superior to its alternatives, and thus more effective in facilitating one's job search process.



*Wenting Hu, Tyler Boyd, Robbin Xu,
Cynthia Liu*



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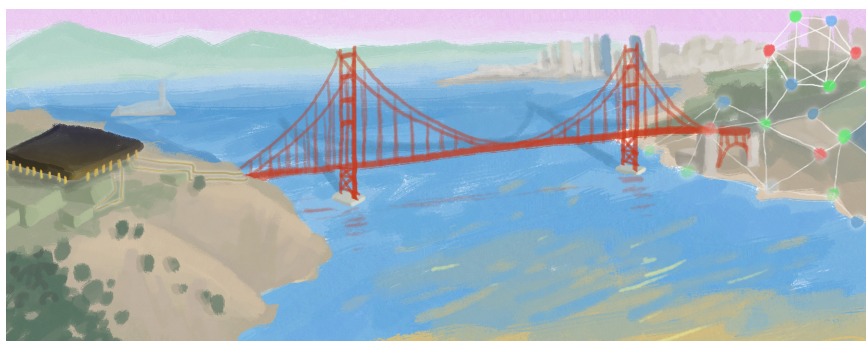
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