



# MTU

**Ollscoil Teicneolaíochta na Mumhan**  
**Munster Technological University**

**Computer Science Final Year Project**  
**2021/22 Poster Selection**

**Nexus Centre,  
MTU,  
Bishopstown, Cork  
May 2022**



## Research Question & Objectives

Is there a relationship between mood, academic performance, and goal-setting? Can we develop a means of quantifying this relationship?

Students' academic performance can be hindered by large workloads and difficult course content. Mood and mental health can also have a significant impact on students' ability to succeed. Previous research has shown that goal-setting can improve students' academic performance [1].

This project aims to carry out a goal-setting study with the addition of a mood measurement component as well as improve infrastructure for future academic studies to be carried out.



Review and summarise previous research in the areas of mood, academic performance, and goal-setting.



Conduct a goal-setting academic study and perform data analysis on the data gathered.



Develop a mobile application for use in future academic studies.



Identify issues with an existing academic survey web platform and improve upon it.

## Methodology

### Marketing & Recruitment

- Email Recruitment Campaign
- Group Assignment



### Data Collection

- Demographic Info
- Cognitive Tests
- Mood Measurements
- Personality Traits
- Goal-Setting Task



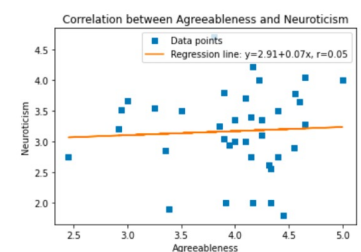
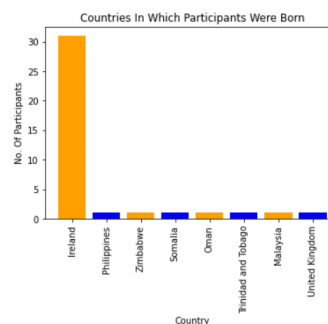
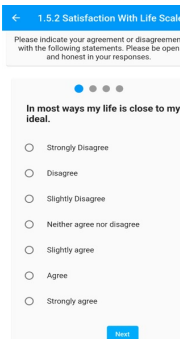
### Data Analysis

- Demographic Breakdown
- Variability
- Significant Correlations

## Results & Conclusions

- A review of previous research showed evidence of a relationship between goal-setting and academic performance. Our data analysis also shows a correlation between students who completed the goal-setting task and an increase in grades.
- Research has shown links between the four predictors that we used to measure mood (Depression, Anxiety, Stress, Life Satisfaction) and academic performance.
- A multi-platform mobile application was created to allow future academic surveys to be completed on the go.
- The functionality and usability of the existing academic survey web platform was improved by fixing numerous bugs and adding new questionnaires relating to mood measurement.

## Sample Of Data Analysed

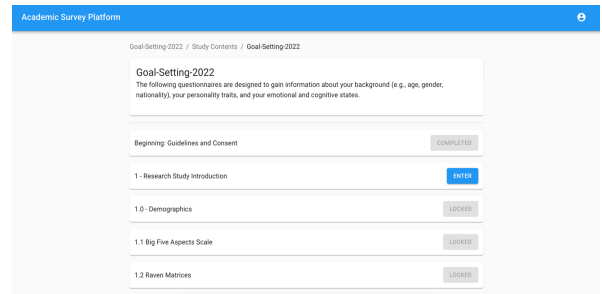
1.5.2 Satisfaction With Life Scale

Please indicate your agreement or disagreement with the following statements. Please be open and honest in your responses.

In most ways my life is close to my ideal.

Strongly Disagree  
 Disagree  
 Slightly Disagree  
 Neither agree nor disagree  
 Slightly agree  
 Agree  
 Strongly agree

Next



Academic Survey Platform

Goal-Setting-2022 / Study Contents / Goal-Setting-2022

Goal-Setting-2022

The following questionnaires are designed to gain information about your background (e.g., age, gender, nationality), your personality traits, and your emotional and cognitive states.

Beginning: Guidelines and Consent COMPLETED

1 - Research Study Introduction ENTER

1.0 - Demographics LOCKED

1.1 Big Five Aspects Scale LOCKED

1.2 Raven Matrices LOCKED

## References

1. D. Morisano, J. B. Hirsh, J. B. Peterson, R. O. Pihl, and B. M. Shore, "Setting, elaborating, and reflecting on personal goals improves academic performance." Journal of applied psychology, vol. 95, no. 2, p. 255, 2010.

## Acknowledgments

The author would like to thank Dr Ruairi O'Reilly for supervising this project, and Ryan Donovan for his knowledge and guidance in this area of study.



**MTU**

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# Web Based Application to Manage Company Assets and Associated Risks

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MTU Cork, May 2022

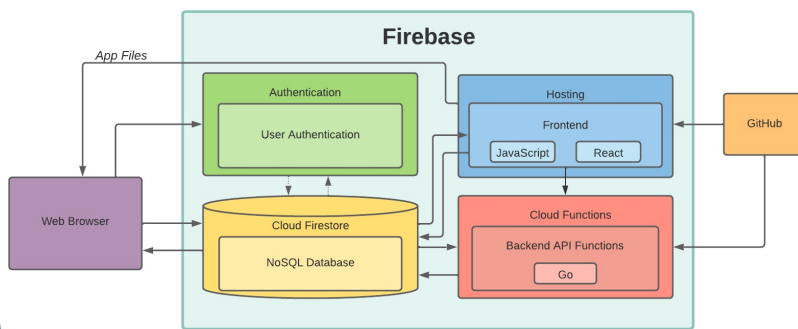


RISKABLE

## Introduction

In recent years companies have been hugely affected by attacks on their assets and though there are many standards to help mitigate these issues, companies have difficulties implementing these standards. To help companies better manage their assets this project aims to make a web-based application that can help companies manage not only their assets but the risks associated with those assets and the controls in place to protect against these risks. To help smaller companies such as start-ups and shops, the web application developed in this project will have templates that will allow companies to get set up on the application faster.

## Architecture



## Project Goal

This project aims to develop a web-based application that companies can use to manage their assets and the risks associated with those assets.

Within this application, companies will be able to enter assets by category, identify the risks to these assets, and then select what controls are being used to help mitigate those risks.

The project will also have templates which will be available for companies to use so that they can get set up on the application faster.

## Application

The application interface consists of several pages:
 

- Add Asset Page:** A form for adding new assets with fields for Name, Type, Risk Level, and various data points.
- Asset List Page:** A table listing existing assets with columns for Name, Type, Risk Level, and Actions.
- Asset Details Page:** A detailed view of a specific asset, including its Name, Asset ID, Type, Location, and associated risks.
- Risk Details Page:** A detailed view of a specific risk, including its Name, Risk ID, Status, Severity, and Last Reviewed date.
- Control Details Page:** A detailed view of a specific control, including its Name, Control ID, Last Reviewed date, and Description.
- Control List Page:** A table listing existing controls with columns for Name, Risk Level, and Actions.

 Navigation arrows indicate the flow between these pages: Add Asset Page to Asset List Page (Save), Asset List Page to Asset Details Page (Asset Click), Asset Details Page to Risk Details Page (Risk Click), Risk Details Page to Control Details Page (Control Click), and Control Details Page to Control List Page (Controls Click).

## Technology



**Acknowledgements:** I would like to thank my supervisor Clóna McGuane for her support and help with this project.



## Introduction

Selling/Buying a used product on an e-commerce website at right price is a challenge. So, we created a recommender system which uses AI to predict the right price of the product based on name, condition, category, brand name, item description, and shipping.

## Overview

A registered user can view listings of ads as shown in **Figure 1**, a user can select an ad and can view the details of the ad. If a user wants, they can create their own ad either clicking a “+” button on dashboard alternatively going to my ads page and create an ad from there.

## Buying Product

When a registered user wants to buy a product, they must find the product in the listing, and once they found the product, they can view it and while viewing the product there is a button “Predict Price” right under the price which they can use to see recommended price as shown in **Figure 2**

## Selling Product

When a registered user wants to sell a product, they simply have to create an ad and while creating it after filling all the details they can view recommended price by clicking “Predict Price” as shown in **Figure 3**

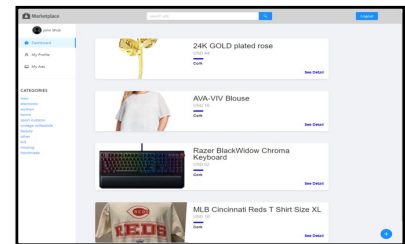


Figure 1

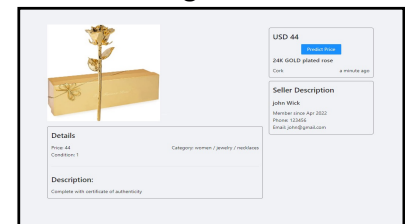


Figure 2

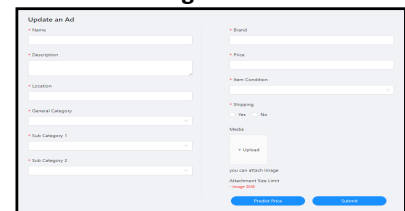


Figure 3

## Machine Learning

To achieve the recommending price, we used Machine Learning **Light GBM regressor** which is high performance gradient boosting framework based on Decision Tree algorithm.

## Data Insight

In **Figure 4**, the graphs are based on price with brand\_mean, brand\_median, gen\_cat\_mean, gen\_cat\_median etc. All these graphs show strong linear trend.

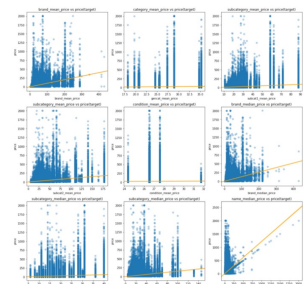


Figure 4



## Technology



# Video Game Immersion

## The Art of Creating a Virtual Experience

Chris O'Shea, BSc Honours in Software Development  
Department of Computer Science,  
MTU Cork, May 2022



### Introduction/Motivation

Video games offer us a medium of depth and expression like no other. However, games are plagued with controversies and negative outlooks which seems to bring about a feeling of social disconnection. My project aims to convey the positive attributes of games discussing educational, creative and personal benefits. The work presented conveys an accumulation of gathered knowledge on video games and translates it into a virtual 2d platform game experience.



Fig 1. Early game prototype depicting player collision

### Objectives/Requirements

The MDA(MECHANICS, DYNAMICS, AESTHETICS) depicts designer/ player roles in game design.

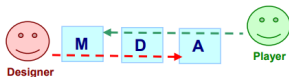


Fig 2(A). MDA Design Pattern

We consider both designer and player perspectives when designing the game.



Fig 2(B). MDA Design Pattern

1. SENSATION	Game as sense-pleasure	2. FELLOWSHIP	Game as social framework
3. FANTASY	Game as make-believe	4. DISCOVERY	Game as uncharted territory
5. NARRATIVE	Game as drama	6. EXPRESSION	Game as self-discovery
7. CHALLENGE	Game as obstacle course	8. SUBMISSION	Game as pastime

Table 1: Describing aesthetics of a game, What makes our game fun?

### Game Specific Requirements

Fig 3(A) depicts linear game object movement allowing for reliable, linear and responsive movement physics.

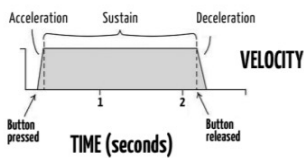


Fig 3(A)

Fig(B) depicts dynamic game object movement allowing for loose, fluid humanlike movement physics

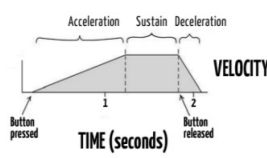
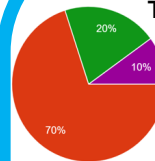


Fig 3(B)

### Results/Summary

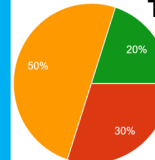
Table 2(A):



- Clunky and Unresponsive
- Responsive and Fluid
- Too fast
- Too slow
- It was responsive and great except the character felt slightly floaty when jumping

Table 2(A) displays user feedback for character responsiveness

Table 2(B):



- Was there an even a story in the game?
- thought the storytelling was alright
- liked the Storytelling
- The storytelling immersed me at points in the game
- The storytelling made me fully immersed in the game

Table 2(B) displays user feedback for Storytelling

Table 3(A):

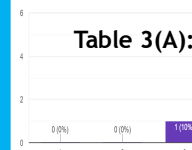


Table 2(B) displays user feedback for Artwork

Table 3(B):

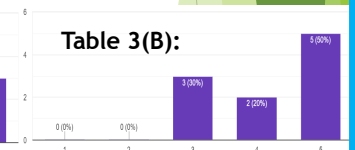


Table 2(B) displays user feedback for gun control

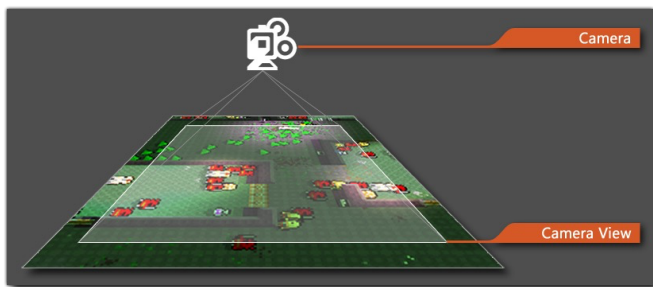


Fig 4. Camera schematic displaying camera and its view

Camera implementation required for side scrolling effect/Parallax backgrounds.  
Camera utilisation seen in Fig 5



Fig 5. Game screenshot depicting prototype character acting as storytelling NPC

### Future Work

- Implementing networking functionality (Local/Online Multiplayer)
- Machine Learning functionality (Random World/Object generation)
- Expand number of levels contained in the game.

- Extend controller/joystick functionality.
- Character Selection functionality.
- Redesign the game in a 3d format with similar core game concepts and design

### References

- Chris O'Shea "Early platform game prototype" GameMaker Studio 2, 2021.
- R. Hunicke, M. LeBlanc, and R. Zubek, "Mda: A formal approach to game design and game research.
- S. Swink, Game feel: a game designer's guide to virtual sensation. CRC Press, 2008.
- YoYo Games, GameMaker Studio 2, Gamepad manual, Available online at <https://manual.yoyogames.com/>
- Chris O'Shea "Platform Game Screenshot" GameMaker Studio 2, 2021.

### Acknowledgments

I Would like to acknowledge my project coordinators 'Paul Davern' and 'Brian Murphy' for giving me great advice, tips and guidance throughout the development of this project.

# Analysis of the Adversary Emulation Framework – SLIVER

Dylan Casey, BSc Honours in IT Management  
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MTU Cork, May 2022

## Introduction

- Red teams are those who act as advisories and emulate the actions an attacker would perform on an organisation in order to gain an understanding of how vulnerable the organisation is.
- Open source red team tools becoming easier for attackers to use and abuse these tools for malicious uses.

## Problem Statement

Having open source tools such as SLIVER being so accessible it is very easy for bad actors to abuse them. By highlighting the ease of use and capabilities of this tool it will hopefully help analysts detect these actions.

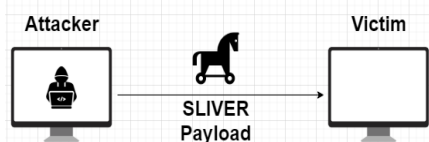
A few examples of the dangers presented by SLIVER:

- Remote access to machines.
- Ability to steal data from the victims.
- Upload other malicious files to the machine.



## Proposed Solution

- Demonstrating how this tool works and what types of payloads can be created
- Showing the methods of delivering these payloads to the victim machine
- Highlighting the effects of a successful infection using this tool



## Expected Outcome

- Gaining access to the victim machine by disguising the payload as a normal file and have it act as a trojan horse
- Exploiting the machine using the list of malicious actions available within the tool
- The victim machine will be compromised and data from it will be stolen and or other malware will be placed on the machine.



## Conclusions

- Successfully highlighting the dangers of SLIVER and showcasing the damage it can do.
- Future work would be to continue to research any new additions to the framework
- Helping those in cybersecurity to understand and recognise the magnitude of this open source tool

## Acknowledgments

The author would like to acknowledge the following: First semester supervisor Dylan Smyth, second semester supervisor Kapal Dev and Noreen Gubbins



# An IoT, Sensor-Based, Non-Invasive Dog Training Programme Assistant

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Department of Computer Science,  
MTU Cork, May 2022

## Introduction

In canine health research, studies have shown possibility in monitoring a dog's stress response through analysis of their Heart Rate Variability (HRV) [1]. Insights into a dog's stress levels in real-time can prove to be an invaluable asset to dog trainers who are wishing to enrich their canine enlisting programmes for further guide dog training. The proposed system acts as a analytics platform, providing owners/trainers valuable insights into a dog's stressors and identifying trends of stressful moments for a dog, to aid them in identifying the dog's overall temperament.

## Approach How can we derive stress levels from HRV?

HRV is the fluctuation of the inter-beat-intervals (IBI) between heartbeats. The IBI can be analysed to derive metrics of HRV used in stress evaluation [3]. The root mean square of successive differences (RMSSD) of IBI exhibits change in stressful situations while the standard deviation of IBI intervals (SDNN) remains unchanged. In the cases of low stress, SDNN exhibits change whilst RMSSD remains unchanged [2] (**comparison is made against a normal behaviour baseline**). The fluctuations in these HRV metrics can be combined to evaluate stress conditions.

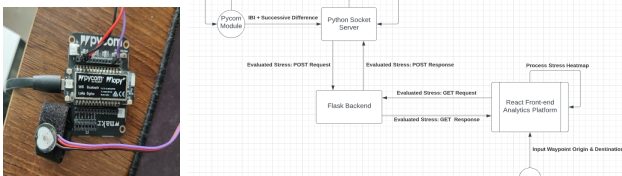
$$RMSSD = \sqrt{\frac{\sum_{i=1}^{N-1} ((IBI_{i+2} - IBI_{i+1}) - (IBI_{i+1} - IBI_i))^2}{N-1}}$$

$$SDNN = \sqrt{\frac{\sum_{i=1}^N (IBI_i - \text{meanIBI})^2}{N-1}}$$

## Data Collection & Pre-processing

*\*The following stress evaluation tests were performed on a human due to lack of sophisticated instrumentation. However, HRV stress evaluation metrics respond similarly for humans as for dogs and with better instrumentation, the system is expected to respond similarly to canine subjects [1] [4].*

1. Data was collected using a commercially available Pulse Sensor module, and Pycom FIPY ESP32 with Wi-fi for remote data transmission.



2. To identify heartbeats, on\_threshold (blue) and off\_threshold (purple) cut-off points are established based on the maximum and minimum serial value read.



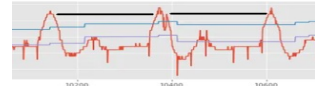
### 3. Calculate IBI

IBI: 545  
on\_threshold time elapsed (0ms) on\_threshold 2 time elapsed (545ms)



### 4. Calculate Successive Difference

Successive diff: 645 - 545 = 100  
IBI: 545 IBI: 645



## Stress Evaluation & Visualization

5. Processor receiving the data establishes a baseline of IBI and Successive Differences where the subject is in a neutral psychological state (~5 minutes). The distribution's SDNN, RMSSD, and mean IBI values are calculated for evaluation stage.

*\*Establishing a baseline is imperative for the significant change comparison between a neutral psychological state and incoming values deriving real-time psychological states.*

#	baseline
1	IBI_Successive_Diff
2	622, -32
3	568, -54
4	509, -59
5	398, -111
6	578, 172
7	621, 51
8	605, 44
9	599, -75
10	543, -47
11	462, -81
12	342, -120
13	366, 54
14	421, 25
15	489, -12
16	396, -13
17	392, 2
18	387, -11
19	482, 15
20	443, 41

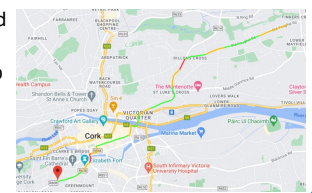
6. Stress is evaluated through hypothesis testing for every 30 IBI and Successive Differences received from the Pycom module.

- 6.1. Perform one-sample t-test hypothesis on IBI values against mean IBI of baseline to identify significant change.

- 6.2. Perform significant change test between incoming/baseline RMSSD and SDNN to identify significant change

```
SDNN baseline: 93.73419818799746
RMSSD incoming: 96.8868444193272
RMSSD baseline: 70.15973611287724
Stress state: Feeling Ok...
IBI pval: 1.9738873389473539e-21
SDNN incoming: 93.88120818764641
SDNN baseline: 93.73419818799746
RMSSD incoming: 95.93678474217627
RMSSD baseline: 70.15973611287724
Stress state: Feeling Ok...
IBI pval: 6.586568541951699e-22
SDNN incoming: 83.68124298997886
SDNN baseline: 93.73419818799746
RMSSD incoming: 92.8692888715887
RMSSD baseline: 70.15973611287724
Stress state: Feeling Ok...
```

7. Processor issues the evaluated stress data to a flask backend, which is leveraged by a Web app using Google Maps API. This visualizes an insightful stress heatmap over a given simulated walk route.



## Conclusions

- Evaluation of HRV into stress levels in a dog through the leveraging modern IoT, and visualization solutions provides an unprecedented amount of insight into a dog's well-being and overall psychological performance during activities.

- React is a powerful front-end tool for performing real-time data visualization
- The system, if implemented with more sophisticated health monitoring sensors capable of stable monitoring under ambulatory conditions, could actively map a route based on incoming device location data.

## References

1. M. Katayama, T. Kubo, K. Mogi, K. Ikeda, M. Nagasawa, and T. Kikusui, "Heart rate variability predicts the emotional state in dogs," vol. 128. Elsevier, 2016, pp. 108–112.
2. H. Y. M. S. Jeonghee Chi, Chaeun Lee, "Stress monitoring system based on heart rate variability of dog," vol. 9, no. 2. Journal of Scientific Technology Research, 2020.
3. F. Shaffer and J. P. Ginsberg, "An overview of heart rate variability metrics and norms," Frontiers in public health, p. 258, 2017.
4. Kim, Hye-Geum, et al. "Stress and heart rate variability: a meta-analysis and review of the literature." *Psychiatry investigation* 15.3 (2018): 235.

## Acknowledgments

The author would like to acknowledge Autism Assistance Dogs Ireland (AADI) for their help in inspiring the focal point of the research paper.

### Introduction

Data backup systems has never been more needed, with possible attacks, information robbery or an event as simple as a system failing and data becoming lost or corrupted. With the cloud being an ever changing part of the world around us, we too see the reliance we have developed with the process of Cloud computing.

The presented project is a lightweight easy to use data backup system that is designed to make the users life much easier when dealing with backing up their contents. 'Restoration' allows for the user to upload and download their files to a cloud storage site (for this example Google Drive) as they please, a system that is easily the navigate and one that is both safe and secure for the user and their files.

Existing cloud backup solutions such as Dropbox & Google Drive do exist, but this system acts as a universal interface for the user to choose which storage site they prefer to secure their data/files on.

The motivation to work with cloud API's is that is a combination of both working with familiar technologies, while allowing for the creation of new systems, having interact and communicate with one another.

### Restoration

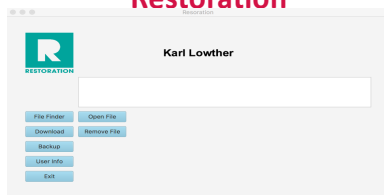


Fig 1: Restoration Main Screen

Fig 1 shows the main screen for the implemented project. Find in the **Features** section the key points of the system and their interaction with the system. This will be the most interacted with region.

### Features

As shown in Fig 1, there are several features that make up was is Restoration. These features include:

- **File finder** allows for the user to look through what is currently on their system and add files they wish to upload.
- **Download** allows the user to list and download files from their linked cloud account using a Driver ID.
- **Backup** enables the user to backup their selected files.
- **User Info** allows the user to see their information and change their email, password, download location and their Driver ID.

### Extra Features:

- Additional features that were not shown in the home page include **Login, Signup, Help** and **About**.

### Challenges

Several Challenges were encounter during the development of 'Restoration'. These include:

- **Google Drive API** connection was difficult at first due to the lack of examples and resources, particularly in Java.
- **API Development** was difficult, resulting in the implementation of Python scripts opposed to Java.
- **Client/Server** issues between Java and Python proved to be complicated when passing messages.
- **Protocol** deployment took some time to settle on.

### Architecture

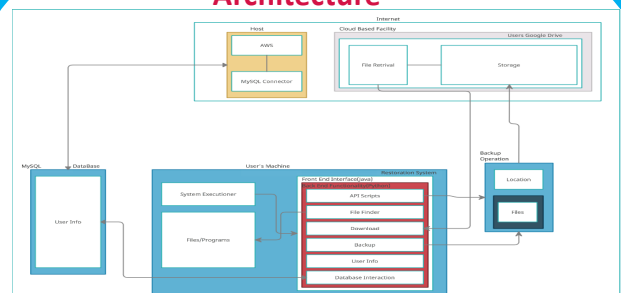


Fig 2: System Architecture

Fig 2 as shown above showcases the overall architecture of the project, the interaction between systems and technologies all working towards that of safely and securely backing up the users files and contents.

### Technology

Development of this project brings together multiple languages:

- **Java** was used to develop the interface that the users would see and interact with.
- **Python** was chosen to run backend operations such as scripts and client operations to act as a conduit between the interface the Cloud Storage Site.
- **MySQL** was implemented to query the database, puling and/or storing information for system users.
- **Google Drive API's** were used to connect the system to Google Drive and allow for the uploads and downloads of files.
- **JSON** was used to pass information between Java and Python in a message form.



Fig 3: Java



Fig 4: Python



Fig 4: MySQL



Fig 6: GoogleDrive API



Fig 7: JSON

### Future Work

To conclude, the development of 'Restoration', there lies room for growth and addition to the system's features that could not be include in this iteration. Features such as:

- A machine learning algorithm that scans incoming and outgoing files and will block a file if there lies any malicious content within.
- Implement a decryption solution where the sent files to the cloud site can only be opened when a decryption key is used on the file to open it.
- Develop a website that allows for anyone to download 'Restoration' for free to use when they wish.
- Develop API scripts to allow for access to other storage facilities such as Dropbox, Mega, OneDrive, etc.

### Acknowledgments

The author would like to acknowledge the support and help of both Victor Cionca and Mubashir Rehmani and thank them both profoundly for the assistance and personal input they gave during both the research phase and the development phase of Restoration.



### Introduction

In this day and age, we no longer rely on doing basic tasks such as spelling and mathematics, as we have access to tools such as auto-correct and calculators, meaning we heavily rely on technology to do even the most basic of tasks. It has been proven that doing activities that keep the brain working, such as crosswords, Sudoku's, conundrums, and other brain training games help slow down the brain aging process, while being an educating and fun experience, and strengthening our critical thinking abilities. This project will involve the development of an educational game to see if we can regain some of the control we lost after handing said control over to technology we rely on everyday. This game will be developed in the Unity engine, and will take elements from games that are considered 'fun and challenging', and will use these to enhance the learning environment this game strives for.

### Motivation

After playing games for over 17 years of my life, I have learned that video games are a medium that allows users to learn while simultaneously having fun; I am a firm believer that if you make something interactive and fun, people will have an engaging experience and will walk away having learnt something new, and will more than likely return again for that experience. Games today like 'Wordle' and 'Chess' are great examples. By adding fun game elements like fast-paced rounds, and leaderboards to add a sense of competition, the game I will develop will add an extra layer of enjoyment for the player, all the while educational.

### Objective

The ultimate goal is to develop a game that operates similarly to the gameshow 'Countdown', where players are encouraged to hone their critical thinking abilities as they are put through rapid spelling and math game modes with only 30 seconds per round. A sense of competition is a good drive to encourage players to engage; a leaderboard will be put in place to allow players to compete for the top spot on the leaderboard. These are the main components of the game that will work in tandem to create an educating, yet challenging experience for players.

### Features

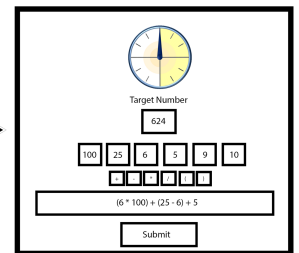
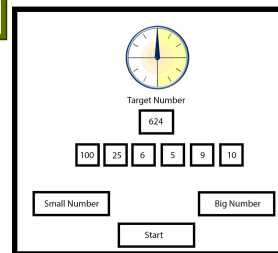
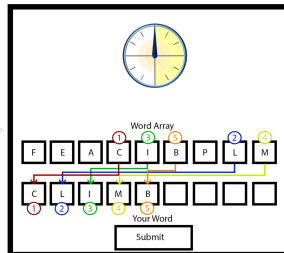
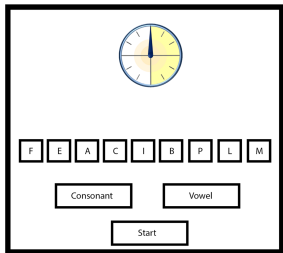
Offers an educational element to those who are learning math and spelling for the first time.

Allow players to practice at their own pace and strengthen their current cognitive skills.

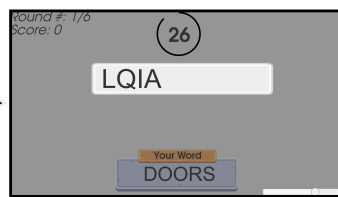
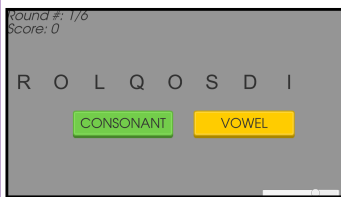
Players can put their skills to the test and compete with others for a place on the leaderboard.

Game is account-based so players can note their current statistics and try to improve their scores.

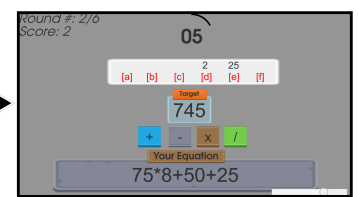
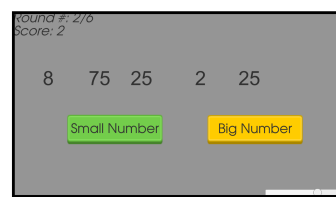
### Sample Build



### Spelling Mode



### Final Builds



### Maths Mode

### Technologies Used



**Spelling Mode:** The players select 9 letters, any combination of vowels and consonants, and must create as big a word as possible that exists in the English dictionary. The larger the word, the more points the player earns for that given round.

**Math Mode:** The player selects 6 "small" and "big" numbers in any combination, and is assigned a target number. Using these numbers, and basic operators, they must quickly create an equation to get as close as possible to the target number; the closer they get, the more points the player is rewarded.

### Evaluations & Conclusions

- From the player base that was given access to this game, the general consensus is the game succeeds in delivering a fast-paced educational experience that does encourage rapid critical thinking, while remaining entertaining, which is vital for any gaming experience.
- Adding a GUI 'game-like' interface to a learning environment adds a layer of interaction for the user that significantly helps in their learning experience.
- Players are granted a lot more freedom and learn at their own pace when gaming is used as an alternate method to traditional education.

### Future Enhancements

- AI to teach players alternate solutions for math equation.
- Offer alternate words player could have created during spelling round.
- Implement customization so players can alter the GUI to their satisfaction.

### Acknowledgements

I would like to acknowledge Dr. Paul Davern & Dr. Nauman Qureshi in supervising this project over the past two semesters.

### References

- apa.org/monitor/2015/04/gaming
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- academic.oup.com/psychsocgerontology/article/75/3/474/5628188

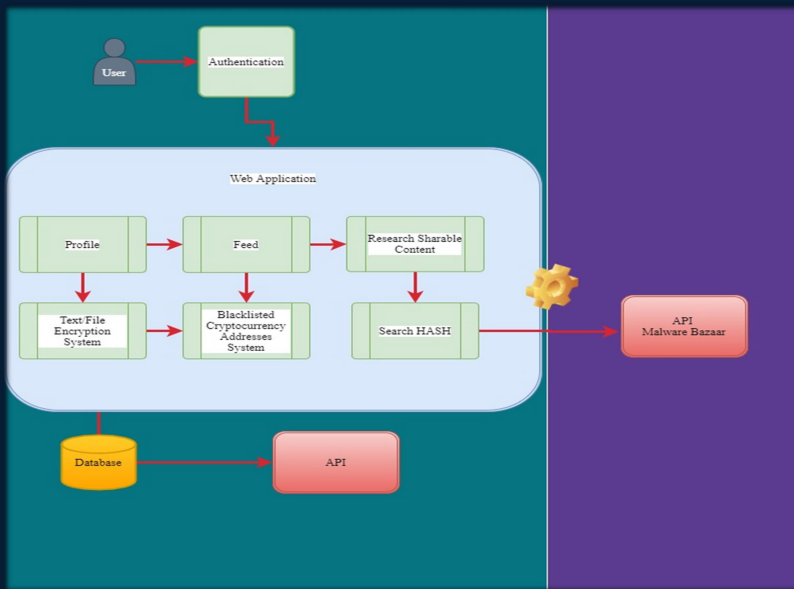




## Introduction / Motivation

How can we OSINT within Cybersecurity? is the main question addressed in this project. The answer found was to build a community driven cybersecurity platform where users can share their findings and within interests the space while interacting with other researchers. Implementing a malware search system powered by publicly available Cybersecurity resources was a key point into answering the proposed question. The main motivation came from being able to identify certain aspects of the industry where there was a lack of centralized information. I noticed that cybersecurity platforms such as VirusTotal used to detect malicious content, would create a lot of false positives by scanning content with outdated engine models provided by vendors. In that scenario the community section of the platform becomes the most important place of valuable information as users can down vote, communicate about falsely flagged files.

## System Architecture



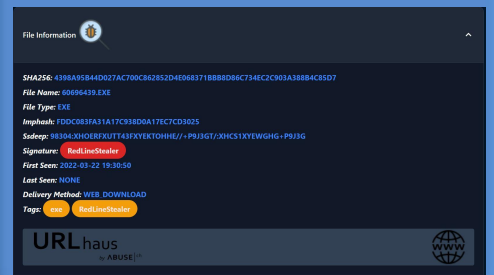
## Methodology / Key Findings

Research was carried out on what is the best development technology stack in order to develop a secure and maintainable database-driven application, given the requirements of the system architecture.

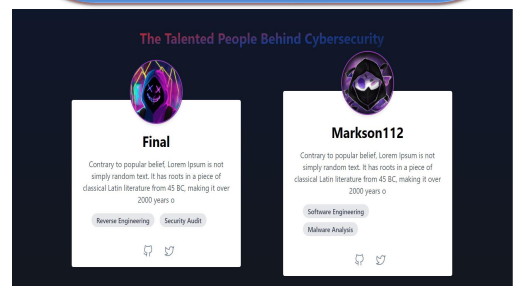
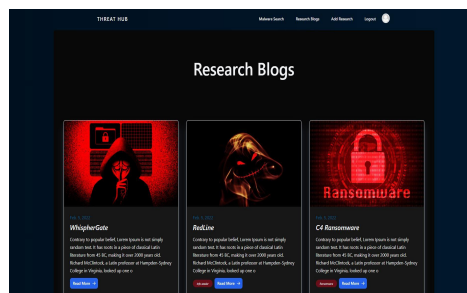
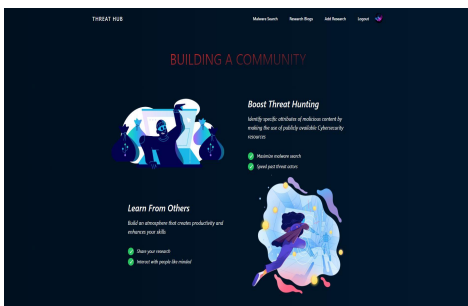
Research was led on finding out the best way to gather open-source information on emerging threats in order to develop the malware search functionality, resulting in the implementation use of the Malware Bazaar API.

## Malware Search Results

The figure below details the malware search functionality where all open-source information available on the file is displayed.



## Web Application Overview



## Conclusion / Future Work

A community driven cybersecurity platform can provide solutions regarding the falsely flagged content problem in the industry. Overall I feel that the main project objectives were successfully implemented.

For future work I plan on implementing extra features to the platform, one of them being a graphical system of statistics available e.g. the most submitted malware family in the prior 24 hours using the Malware Bazaar "daily batches" dataset.

## Background

According to the United Nations High Commission for Refugees, there are approximately 82.4 million displaced people worldwide. This same report indicates, due to climate change and pandemics, this figure is set to rise [1]. Over the course of this project the global community saw two, sudden refugee crises. First in Afghanistan, and then Ukraine.

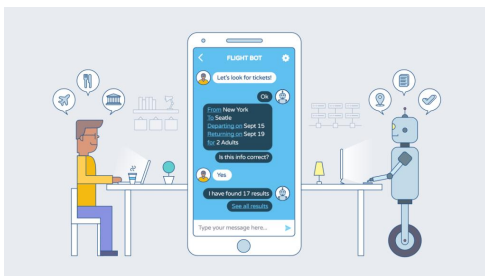
The current Program for Government in Ireland has made a commitment to undertake a new, more innovative approach in refugee settlement [2]. From this came a research question; can technology assist in this new approach?

The research was consistent in highlighting the language barrier as the largest obstacle between a refugee and settling successfully into Irish society [3].



Source: AFP Photo

## Solution Approach



Source: Chatbots Magazine

The background research for this project concluded that there is room to improve on imparting key information to the refugees in their native language. Currently refugee’s are provided with a 100 page PDF for referencing information on living in Ireland.

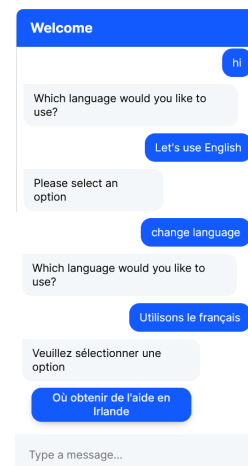
The chosen solution is to create a multilingual chatbot, with modular language pack capabilities, to improve the flexibility of the approach.

Chatbots are a growing industry, combining Artificial Intelligence, Human-Computer Interaction, and Social Studies. Siri, Cortana, Google home, and Alexa are all examples of commercial chatbots in use today.

Changes were made to an existing chatbot framework’s code to allow for referencing CSV files containing translation values, instead of hard -coded utterances.

This approach saves on time spent training script prediction models, whilst maintain system response time. Most importantly, the cost of implementing a new language is extremely low, requiring only a translation of the existing values to the language of choice.

## A conversation with FáilteBot



The above is an example of a conversation with FáilteBot. The example conversation demonstrates the ease of changing language, with dialogue free of translation error.

Content has been transcribed from the Department of Justice’s current refugee guidebooks, entitled “The Guide to Living Independently”.

Four detailed conversations were created for this project; Where to get help in Ireland, Finding Accommodation, Healthcare in Ireland, and Education in Ireland.

The system can be easily integrated into a website or mobile application, for easy distribution to users.

## Conclusions and Further Research

- The FáilteBot system succeeds in providing a flexible and dynamic multilingual chatbot solution. The system is open-source and can be deployed on a web page or via mobile applications.
- Open source technologies can be easily leveraged by developers to create bespoke solutions for unique and challenging use cases.
- A deployment of the chatbot to a focus group of newly arrived refugees should be a topic of investigation if this concept is taken further.

## References

- [1] - "Figures at a Glance", UNHCR, 2022. [Online]. Available: <https://www.unhcr.org/en-ie/figures-at-a-glance.html>.
- [2] - Department of the Taoiseach, "Programme for Government: Our Shared Future", Department of the Taoiseach, Dublin, 2020.
- [3] - "Pleading for Sanctuary Through a Language Barrier", Dublin Inquirer, 2022. [Online]. Available: <https://www.dublininquirer.com/2021/07/28/pleading-for-sanctuary-through-a-language-barrier-was-tricky-enough-doing-that-online-is-even-harder-some-asylum-seekers-say>.

## Acknowledgments

The author would like to thank Dr Alex Vakaloudis, Indika Dhanapala MSc, and the staff of the Nimbus Research Centre for their assistance in this project. Gratitude is also extended to the Department of Justice for use of their materials.

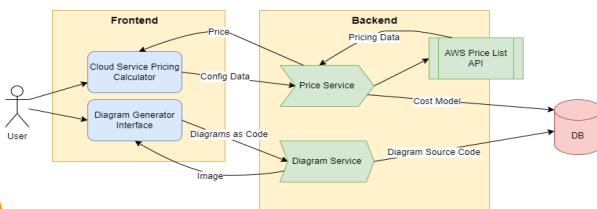




## Introduction

The goal of the project is to streamline the cloud services cost modelling process into one tool. This eliminates the need to manage multiple applications such as CSP pricing calculators and spreadsheets. The project allows developers to easily specify a proposed cloud architecture and examine the costs. These architectures and cost estimates can be saved and users can edit the architectures to allow for investigation of alternatives. The application provides an interface for generating architecture diagrams using 'diagrams as code' and its own pricing calculator to generate financial estimates to allow for more efficient project planning.

## Architecture Overview



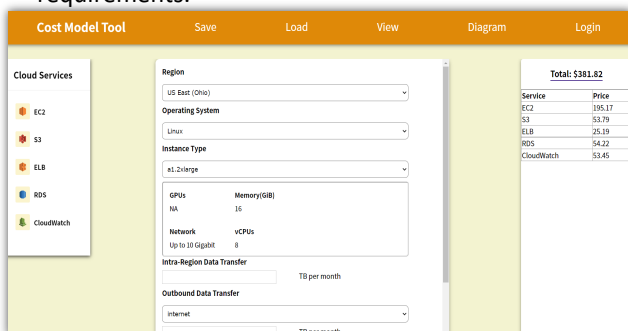
## Technologies Used



Diagram as Code

## Cost Modelling Tool

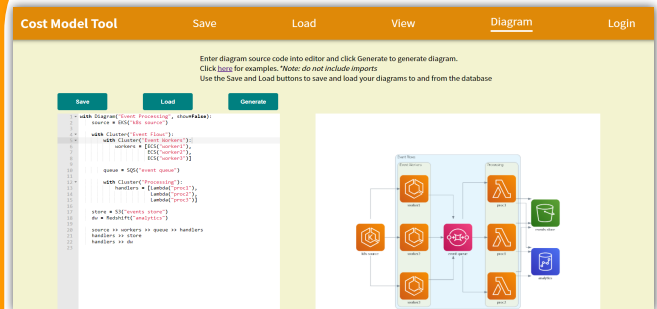
The cost modelling tool utilises the AWS Pricing API for the dynamic retrieval of pricing info based on a set of input configuration data. It has support for some of the most widely used AWS services in the categories of compute, network, storage, database and management. The aim is to provide clarity and better understanding of the financial estimates of the running costs of a project. The financial estimates can be saved so that running costs can be updated in the event of changing requirements.



The screenshot shows the **Cost Model Tool** interface. It features a sidebar with **Cloud Services** (EC2, S3, ELB, RDS, CloudWatch) and a main configuration area. The configuration area includes a **Region** dropdown (US East (Ohio)), **Operating System** (Linux), **Instance Type** (t3.2xlarge), **GPUs** (NA), **Memory (GiB)** (16), **Network** (vCPU), and **Outbound Data Transfer** (Internet). A **Service** table is displayed on the right, and a **Total: \$383.82** is shown at the top right.

Service	Price
EC2	195.17
S3	53.79
ELB	25.19
RDS	54.22
CloudWatch	55.46

## Architecture Diagram Generator



Architecture diagrams are used to visually represent a system. They are useful for prototyping new designs and for facilitating better communication among stakeholders. The diagrams interface takes a 'diagrams as code' script as input and generates an image based on the script. It provides functionality for saving and loading 'diagrams as code' scripts so that new designs can be tested with speed and efficiency.

## Conclusions

The project has the benefit of incorporating multiple tools to assist in the planning stages of cloud projects. The cost modelling aspect provides a streamlined and flexible approach for estimating running costs of cloud based projects. The 'diagrams as code' generator provides an alternative to traditional drawing tools for prototyping cloud architectures. The project solution currently supports a number of AWS services but has the capacity to be extended with the addition of more AWS services in the future.



# Cybersecurity for Electric Vehicles



## Introduction

- Global warming is increasing at an alarming rate and one major contributor is motorised vehicles.
- Electric vehicles (EVs) is reducing the impact on CO2 emissions.



## Problem Statement

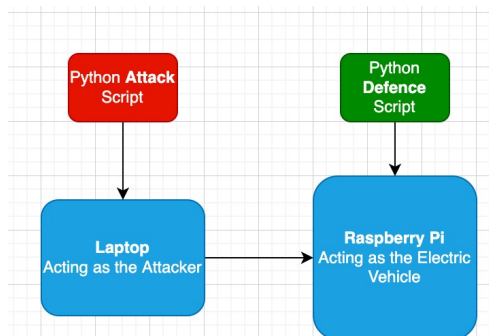
**Security** is a big factor when it comes to electric vehicles and I am focusing on **Bluetooth attacks**. Hackers can intercept and redirect phone calls, access bank details, send or receive files, etc.

- Bluetooth attacks
- Ransomware attacks
- DOS attacks



## Proposed Solution

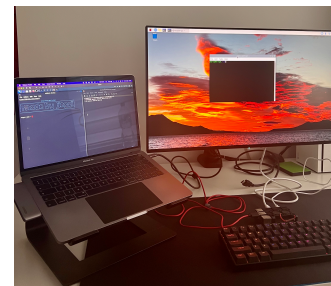
- The Python defence script will counteract the attack script.
- Both the Raspberry Pi and the Laptop have **WIFI** and **Bluetooth** of their own.



- Any connected devices to the Raspberry Pi via Bluetooth can be irresponsive from the attack. The script can target any Bluetooth addresses.

## Expected Outcome

- The Python defence script should prevent/stop the attack script.
- This should secure the Bluetooth communications from interceptions and access to data.



- If the attack is successful, data will be compromised.

## Conclusions and Future Analysis

- Successfully stopping the attack is crucial and motor companies need to be more aware.
- Future areas can be worked on for EVs such as DOS and ransomware attacks.

## Acknowledgments

- The author would like to acknowledge support from the supervisor Kapal Dev and the department of Computer Science as part of the BSc in ITM.

### Introduction

It is very difficult to keep track of the needs of a single cat. Just like humans, a vast amount of information and data is required to know and determine the well being of a cat.

Successful monitoring can provide a peace of mind and overall positive experience for both the cat and the owner.

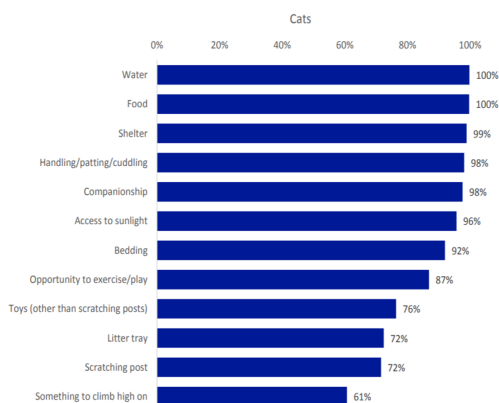
### Objective

Research and develop a web application to monitor and track the cat's needs and implement a tangible and efficient way for the owner to store, read and share their respective pet's details



### How Much Care do cats Need?

What cat owners provide for their pet cats (n = 4244)



There are several important things to consider in the realm of cat care. There are many kinds of crucial information for owners to keep track in order to maintain the cat's health and if need be, uncover underlying health issues that may otherwise be overlooked if not monitored enough or properly



### Features

User login Management

Custom Reminder/ Notification system

Routine Monitoring posts

Note taking system

Chat bot

### Research Findings

Database	Number of Search Results	Number of Selected documents for full reading	Number of Selected relevant documents
IEEE Explore	338	25	11
ACM Digital Library	206	28	4
Science Direct	142	12	2
Google Scholar	611	13	5
<b>Total</b>	<b>1,297</b>	<b>78</b>	<b>22</b>

FIGURE 2.2: Summary of the paper's search results[1]

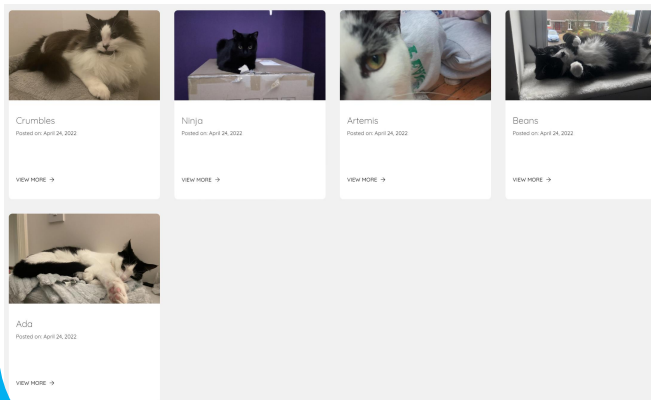
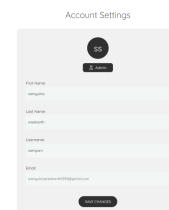
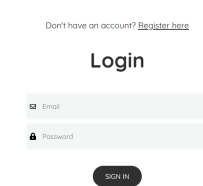
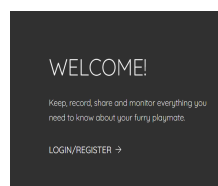
Technologies: Sensors, Smart animal clothing

languages & Tools: HTML, CSS, JS, Cloud Database

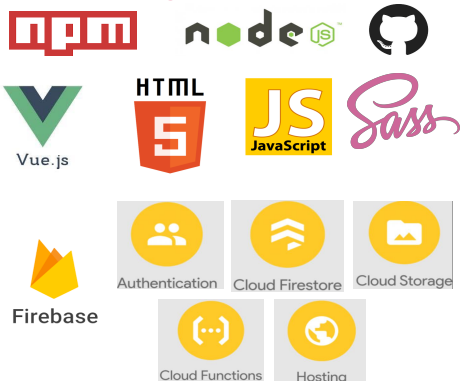
Platforms : mobile and web applications

Target users: vets, pet owners and entrepreneurs.

### Web Application



### Technologies & Tools Used



### Introduction

Sign Language is the fastest method of communication that is available for deaf people. With a low percentage of the population knowing sign language, it is often not utilised and other methods like written communication or using translators are used instead which is slow or costly. The purpose of this project is to investigate if classification algorithms can be used to translate sign language and aid in communication.

### Implementation

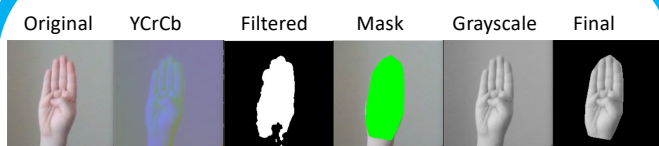


Fig 1 – Image Processing Flow

- Image processing techniques are utilised to detect skin in the image
- The image is converted to YCrCb colour spacing which allows for a certain range of values to be filtered[2].
- These values represent anything that can be skin which, after being filtered out, the general area is highlighted.
- The highlighted area is then used to create a mask that is applied to a grayscale image resulting in a final image comprising of just the hand

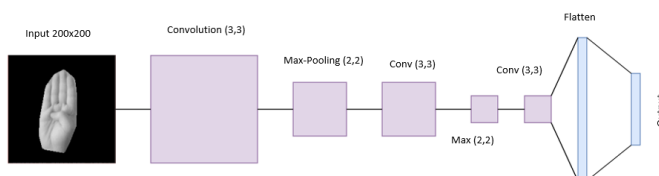
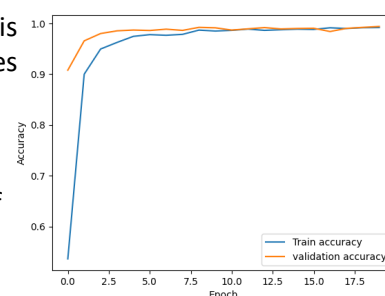


Fig 2 – Convolutional Neural Network

- CNN uses 3 convolution layers and 2 max-pooling layers
- Input layer takes an image of size 200x200 containing pre-processed image of a sign
- Output layer consists of 25 nodes with a SoftMax activation function
- Dropout layer and Kernel Regularisation implemented to reduce overfitting
- Data Augmentation is applied to increase training data

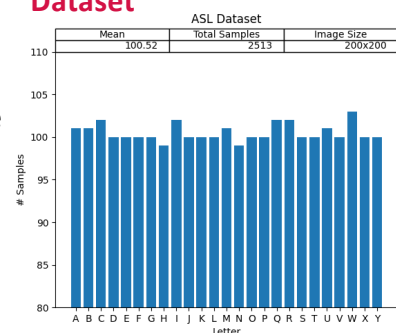
### Results

- Convolutional Neural Network is trained on images of the American Sign Language alphabet
- Final accuracy of the model is roughly 98% on both training and test sets.



### Dataset

- Dataset contains images of ASL alphabet of size 200x200
- Dataset is split into a ratio of 80:20 used for training and testing



### Conclusions

- CNN model does well on classifying single handed signs of the ASL alphabet.
- Model has issues when classifying signs that require movement. To handle this issue, the final position of the sign is recorded and trained on.
- Hand Segmentation works under good lighting which could cause the process to not work to its full potential if there isn't enough light as it can include some background noise in the image.

### References

1. S. Albawi, T. A. Mohammed, and S. Al-Zawi, "Understanding of a convolutional neural network," in 2017 International Conference on Engineering and Technology (ICET), 2017.
2. K. B. Shaik, P. Ganesan, V. Kalist, B. Sathish, and J. M. M. Jenitha, "Comparative study of skin color detection and segmentation in hsv and ycbcr color space," Procedia Computer Science, vol. 57, pp. 41–48, 2015, 3rd International Conference on Recent Trends in Computing 2015 (ICRTC-2015)
3. M. A. Nielsen, Neural networks and deep learning. Determination Press, 2015.

### Acknowledgments

The author would like to acknowledge.

- **Kashif Ahmad** and **Alison O'Shea** for their advice and support in the research and implementation phase.
- **Munster Technological University**

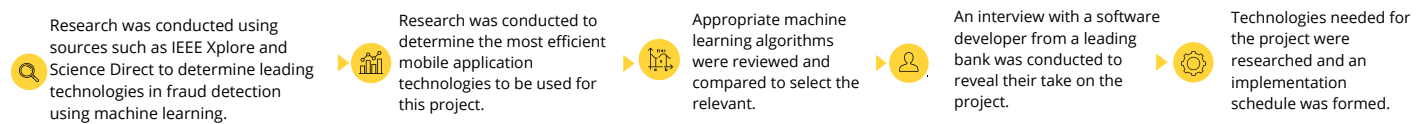
## Introduction and Motivation

According to the most recent Nilson Report data, payment card fraud losses reached US dollars 28.65 billion worldwide in 2020 and is predicted to reach US dollars 38.5 billion by 2027. Credit card fraud detection is widely used by financial services as a method of identifying and preventing fraudulent financial activities. To understand the underlying technology of this process this particular project was chosen for research and implementation.

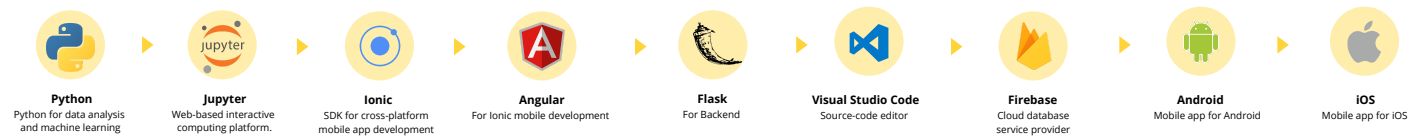
## Objective

To create a mobile application that uses machine learning to predict credit card fraud and determine the probability of fraud prediction.

## Methodology Completed during research phase

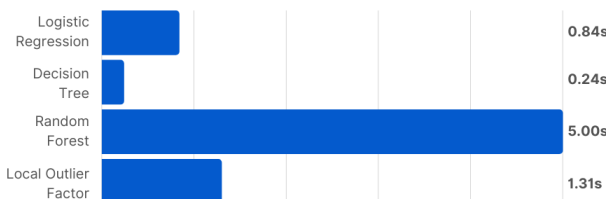


## Technologies



## Key Findings Calculated during implementation phase

Algorithm comparison based on performance (training time)



Algorithm comparison based on model accuracy

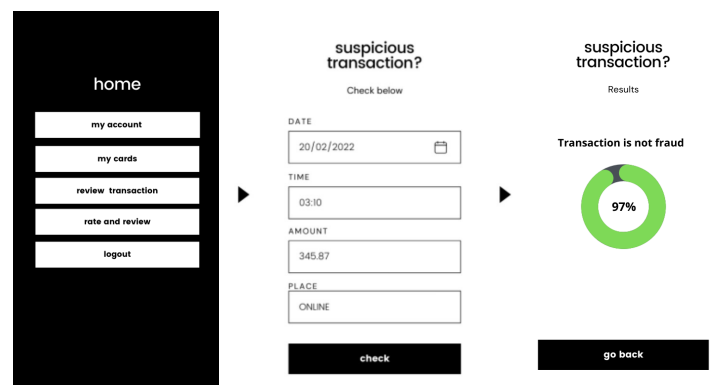


For the purpose of this project it is much ideal to use Decision Tree as it is the fastest in terms of training time and has 90%+ accuracy.

## Discussion

- The synthetic dataset containing 20 million transactions and 30 attributes is chosen from **Kaggle**. The dataset has a 'class' column that labels every existing transaction as fraudulent or legit and for this reason, supervised learning algorithms is tested and used.
- Data is cleaned and pre-processed to prepare for machine learning algorithms such as Logistic Regression, Decision Tree, Random Forest and Local Outlier Factor.
- Algorithms are implemented and compared to produce the results above and a prototype input system is created to input custom data and receive predictions using the best performing algorithm - Decision Tree.
- The model is integrated into a cross platform mobile application for iOS and Android with a Flask backend which will predict the probability of a fraud transaction on the user's account.
- The mobile application is created using Ionic Framework and Angular and will have several other features apart from credit card fraud detection such as registration and login, viewing transactions, account details, rate and review and updating account details.

## Application Preview



## Conclusion

- The development and application of financial fraud detection systems is an important step towards the improvement of digital financial services and open banking.
- Factors such as date and time of purchase, transaction amount, transaction location (online are more prone to fraud) and transaction category (e.g. groceries, clothing, hair care, jewellery, etc) help determine an anomaly i.e. a fraudulent transaction.

## Future Work

- To allow real world use of this application, real-time fraud detection for both credit and debit cards will be required. For the purpose of this project, such transactions can be simulated via a web-application and directed to the mobile device so that fraud can be detected in real-time using push notification alerts with Google Cloud Messaging.
- To further enhance this project, the user will be able to log into various banking platform with a single mobile application and can receive fraud alerts on the app regardless of which one of their bank account and credit card has been compromised.

## References

- "Card fraud losses reach 28.65 billion," 2021. [Online]. Available: <https://nilsonreport.com/mention/1313/1link/>
- "Detect credit card fraud," 2021. [Online]. Available: <https://plat.ai/blog/how-to-use-machine-learning-to-detect-credit-card-fraud>

# Predicting the user's next move



## Introduction

The **performance** of web applications has become a predominant factor for a company's successful growth. Depending on the type of web application, the **data** might require a significant amount of **time** to be retrieved, which eventually causes the user to wait until the entire process is completed. The outlined project is based on a **prediction system** that takes advantage of the user behavioural patterns to predict the **next user interaction** on web applications. Predicting the next user interaction allows the web application to exploit this information by pre-fetching the required data.

## Methodology and Prediction System Architecture

The selected features for training the AI model such as the **user type**, **current interaction**, and **user local time**, along with the powerful **extreme Gradient Boosting trees algorithm** (XGBoost), allow it to generate accurate predictions, facilitating in this way the integration of our system in almost any modern web application.

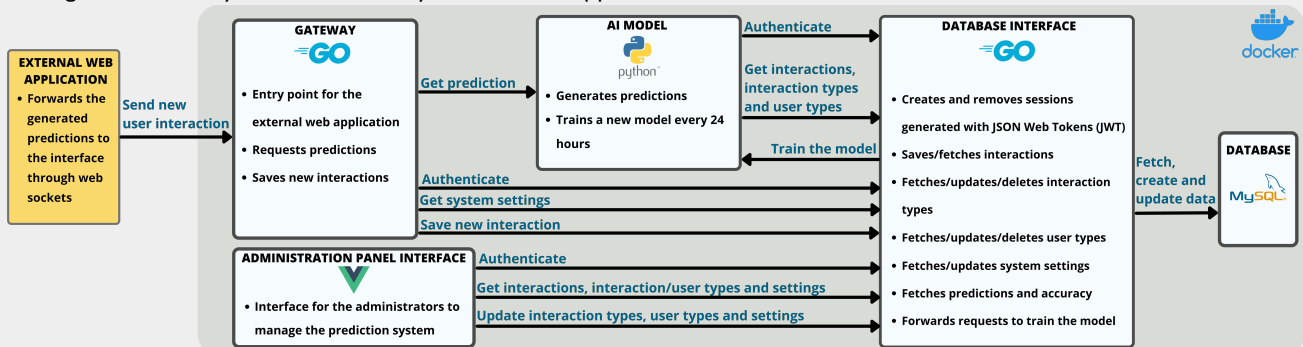


Figure 1: High level overview of the prediction system based on a microservice architecture[1]

## Administration Panel Interface Main Page

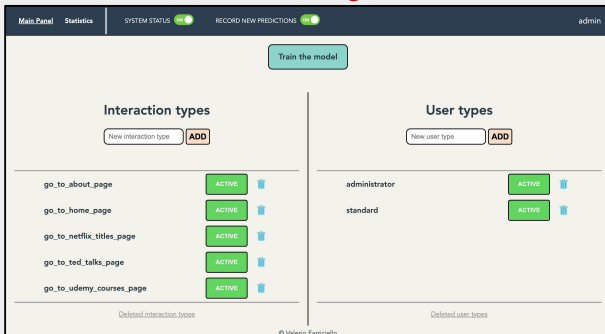


Figure 2: Main page of the administration panel interface

From the main page the administrator can

- Create
- Delete (or deactivate)
- Restore

the interaction and user types

Moreover, the administrator can

- Manually train the model
- Manage the system settings
- Register a new administrator
- Log out

## Administration Panel Interface Statistics Page

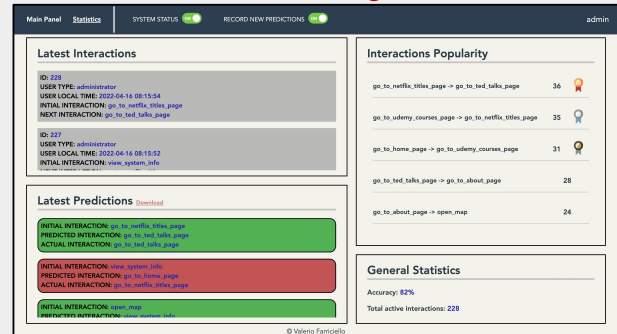


Figure 3: Statistics page of the administration panel interface

From the statistics page the administrator can visualize the

- Latest interactions and their popularity
- Latest predictions
- Overall accuracy of predictions

Furthermore, the administrator has also the option to download the predictions

## Conclusions

We evaluated the prediction system by integrating it with a sample web application. The results extracted from the evaluation process indicate an **efficiency mean** of 634 milliseconds for the time required to individually handle 50 interaction requests received at once, with an **average increase** of 43.8% for every 10 extra interactions. Furthermore, by **pre-fetching** the required data based on the generated predictions, we observed a significant **enhancement of the user experience**, and an **accuracy loss** of only 10% for every interaction type removed due to structural changes on the web application. In future, more features such as the option to stop generated predictions can be added to our solution.

## References

1. L. De Lauretis, "From Monolithic Architecture to Microservices Architecture", 2019 IEEE International Symposium on Software Reliability Engineering Workshops (ISSREW), 2019, pp. 93-96.

# Augmented Reality-Based Indoor Navigation on Android Mobile Phones

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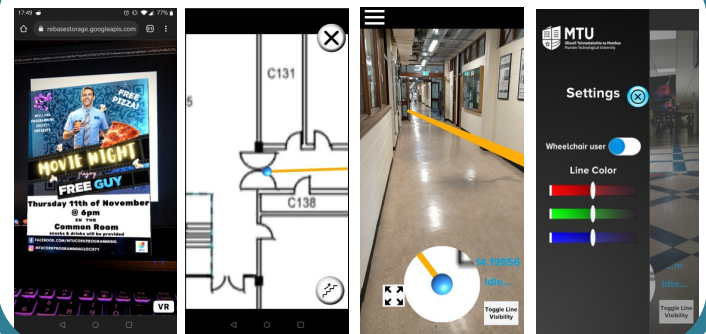
## Introduction

Munster Technological University can be overwhelming with its size for visitors and students alike, especially when looking for a certain room in the building. This application makes it possible to find the shortest route to a destination location using QR codes and displaying the path with the help of augmented reality arrows. The QR code reader can be used to view AR posters made by societies that was created on the website.

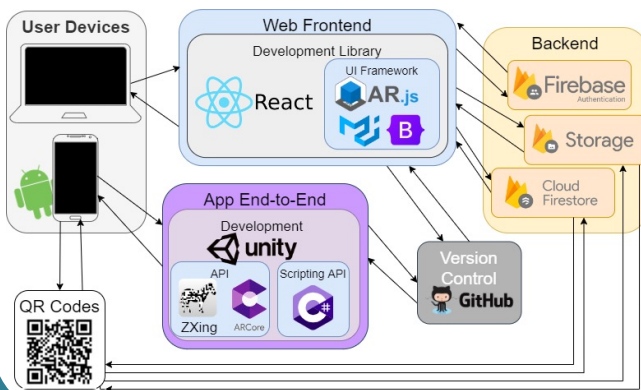
## Project Goals

The goal of this project was to use augmented reality technology that is gaining popularity in the recent years. With the combination of Android devices, and open source technology the application is valuable for the end-user. The QR code reader feature can be also used to promote societies by displaying an AR poster. The website helps administrators generate these QR codes to create AR posters to promote societies.

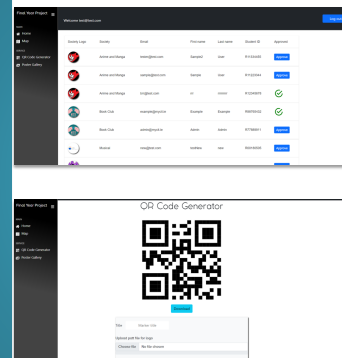
## Application screenshots



## Architectural diagram



## Website screenshots



## Technologies used



## Tests and Results

### QR code size testing:

The following test display's results for time it took for different QR code sizes scanned under optimal lighting conditions.

Size (cm)	19.5	18.5	18	17.5	17	
Time (s)	0.89885	0.8662	0.8328	0.8332	0.8661	
	16	15.5	11	10	9	Average
	0.8998	0.8662	0.8994	0.8828	0.7996	0.864495

### QR code angle testing:

The QR code is deployed on the ground, the tests observe the angle from which the QR code can be read.

90°	+10°	+20°	+30°	+31°	+32°
Yes	Yes	Yes	Yes	Yes	Yes
90°	+33°	+34°	+35°	+36°	+37°
Yes	Yes	Yes	Yes	Yes	No

## Conclusions

The use of QR codes makes it cost efficient and friendlier for the environment over the use of battery operated devices. It is also easier to set up and maintain. The project has room to add future features that can be used for analytics and could be also developed for Apple iPhone devices.

## Acknowledgments

I would like to thank my supervisor, Victor Cionca for the help and discussions on the challenges of the project.

### Introduction

Traffic data for Ireland's road networks is gathered and made available to the public by TII (Transport Infrastructure Ireland). Traffic data is very valuable and appropriate analysis/visualisation of it could lead to actions which help to improve safety of the roads and alleviate the congestion in an area [1]. Unfortunately, the data is poorly structured and meaningful analysis of it is difficult and time-consuming.

### Methodology

How can actionable insights be derived from traffic data?

The most important step involved in enabling the derivation of actionable insights from this and other traffic data is data pre-processing [2]. This relates to the re-structuring of TII data so that it may be stored in a single data store whilst also allowing for any analysis/visualisation carried out on the data to be accurate.

### Pre-Implementation workflow of TII data analysis

Prior to the completion of the implementation phase, a typical workflow for performing some analysis of the TII data would look like this:

1. Access traffic counter location dataset.

```
151. NRA 000000001715 TMU N71 190.0 W N71 Between Bantry and Glengarriff, North of Bantry, Co. Cork 51.70235 -9.44237
152. NRA 000000001716 TMU N40 002.5 N N71 Between Ballinhassig and N40 51.85265 -8.52882
153. NRA 000000001717 TMU N71 007.0 W N71 Between Aghadowan and Ballydehob 51.56283 -9.42626
```

2. Access a file for the date you are interested in and filter for the site ID and time.

Class count per day dataset

	A	B	C	D	E	F
1	cosit	class	year	month	day	VehicleCount
309	1716	1	2020	6	1	36
454	1716	7	2020	6	1	71
1021	1716	4	2020	6	1	4
1109	1716	5	2020	6	1	77

Individual vehicles recorded per day

	A	B	C	D	E	F	G	H	I
1	cosit	year	month	day	hour	minute	direction	class	speed
310	1716	2019	7	1	3	21	N	3	97
311	1716	2019	7	1	3	21	N	6	77

Once these steps are done, analysis of the data may begin, either through the use of external programs or within Excel. This process from start to finish is quite time-consuming and certainly not very intuitive.

### Post-Implementation workflow

One of the primary contributions of this project is the web platform. This web platform was built following a MERN stack, alongside additional node packages.

The workflow of analysis of TII data now looks like this:

1. Select desired date-range / date + time-range.

Class count per day dataset

Start Date

2018-01-01

End Date

2018-01-02

Individual vehicles recorded per day

Start time

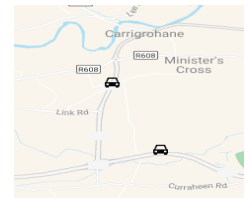
2019-07-23

End time

6:00 AM

Vehicle Class

ALL



Class	Count	W: 7
MBIKE	E: 9 Avg Speed: 81.89 km/h	Avg Speed: 85.00 km/h
CAR	E: 2356 Avg Speed: 76.59 km/h	W: 2143 Avg Speed: 70.72 km/h
LGV	E: 233 Avg Speed: 75.45 km/h	W: 198 Avg Speed: 70.22 km/h
BUS	E: 1 Avg Speed: 66.00 km/h	
HGV_RIG	E: 62 Avg Speed: 68.13 km/h	W: 55 Avg Speed: 62.15 km/h
HGV_ART	E: 40 Avg Speed: 65.67 km/h	W: 26 Avg Speed: 65.58 km/h
CARAVAN	E: 24 Avg Speed: 70.92 km/h	W: 20 Avg Speed: 63.45 km/h

2. Click on a traffic counter present on the map and see the data in a table as well as a visualisation chosen by the user.

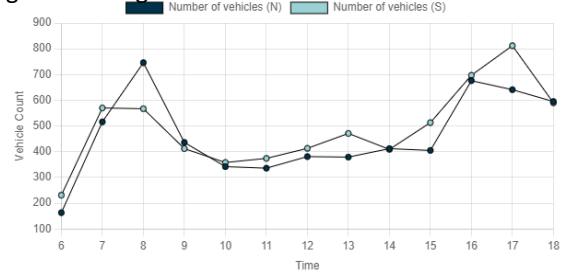
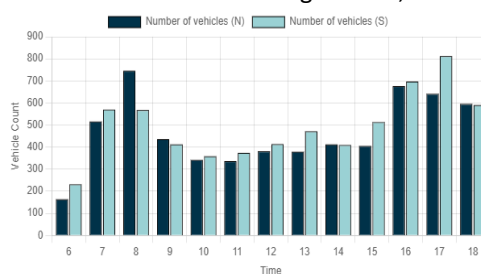
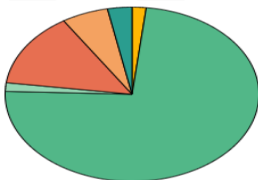
### Analysis/Visualisation of the N22 South of Carrigrohane traffic counter @ 6am-6pm 23/07/2019

Direction of travel - N

Filtering for cars, excluding other categories of vehicle.

You may click on the legend to show/hide a class.

- Unknown
- MBIKE
- CAR
- LGV
- BUS
- HGV\_RIG
- HGV\_ART
- CARAVAN



### Conclusions

- Enabling the derivation of actionable insights from traffic data is made possible through the appropriate pre-processing and storage of the data in a data store.
- MongoDB works well when dealing with large amounts of time-series data, e.g. traffic data.
- A standardised format for different aspects of road traffic data would make this work and any future road traffic data work much easier.

### References

- M. Juh'asz and C. Koren, "Getting an insight into the effects of traffic calming measures on road safety," Transportation research procedia, vol. 14, pp. 3811-3820, 2016.
- W. Chen, F. Guo, and F.-Y. Wang, "A survey of traffic data visualization," IEEE Transactions on Intelligent Transportation Systems, vol. 16, no. 6, pp. 2970-2984, 2015.

### Acknowledgments

The author would like to acknowledge Transport Infrastructure Ireland for sharing traffic data with the public.