

Image Classification in Brawlhalla



Preface	3
Where are the Main questions, Sub questions and all that stuff?	3
Domain Understanding	4
Brawlhalla Research	4
What is Brawlhalla	4
Cross-Platform Play	4
How do they make money?	4
Mammoth Coins	4
Battle Pass	5
Bundles	5
Social Media	5
Crossover Controversy	6
Esports	7
SpecialK	8
What is special K?	8
What does SpecialK do in Brawlhalla?	8
How did Brawlhalla respond to SpecialK?	8
Exploratory Research	8
Reinforcement Learning	9
Source Code	9
Colour Recognition	9
Object Detection	10
Object Tracking	10
Brawlhalla interview	10

Preparation	10
The interview	10
What do I actually need to create a Brawlhalla AI Bot (Scope)	11
Has it been done before?	11
Game information	11
Previous Bots	11
What do I actually need to create Brawlhalla Classification?	12
Skins	12
Analytic Approach	13
Target Variable	13
Nature of the problem	13
Good indicators	13
Societal Impact	14
Demonstration	15
Demo (no test plan/testing)	15
Demo Plan	15
Demo Requirements	15
Why no ordinary test plan?	16
Feedback	17
Transparency	17
TICT Tool	17
Quick Scan Canvas	17
Versioning	19
Sources	20

Preface

In this document you can find my Domain understanding, Analytic Approach, Societal Impact and my delivery phase. For everything else you can check out the notebook.(**Data Sourcing** is also in the notebook)

Where are the Main questions, Sub questions and all that stuff?

Initially I was making another project. Then I dropped that project and switched to legend classification. In the process I forgot to make main questions, sub questions and a purpose for this project. So that's just not here sadly. If I had a Main question/goal for myself it would be: *Is it possible to create a classification for brawlhalla legends and brawlhalla legend art?*

Domain Understanding

Before I start creating anything, it would be useful to understand my domain. Therefore I have done research on the game Brawlhalla.

Brawlhalla Research

What is Brawlhalla

Brawlhalla is a free to play fighting game developed by Blue Mammoth Games (BMG). The game was officially released in 2017 for the PS4 and PC. Later on in 2018 they also released it for the nintendo switch and xbox.

Cross-Platform Play

The Brawlhalla community has been asking for a few things over and over. One of these things is cross-platform play, also referred to as crossplay. Crossplay makes it possible for all platforms to fight against each other. This does bring a small issue. PC players have an advantage over any other platform because you can keep upgrading your pc. meaning you're able to play Brawlhalla on 240hz 1000fps, while all console players are capped on 60hz 60fps. Having more Hz than other players is a small issue, since you have more images in a second, you can react better on certain occurrences. FPS is the biggest issue here. Having more fps than your opponent makes the game straight unfair. PC players playing on 1000fps have 1000 frames they can input in. for console players it's just 60 frames. meaning most of the inputs are buffered to the next frame. This causes inconsistent delay for your inputs. Another thing that makes it unfair for console players is that consoles usually have additional delay. While on pc you can almost eliminate any kind of delay. So, with all this, as a console player its incredibly unfair to play against pc players. you might not notice this in the lower ranks of the game, but at the top everyone who plays on pc plays on the best setup possible.

How do they make money?

Brawlhalla is a freemium game, meaning it doesn't cost money to buy it, but there are in-game transactions they make money off. The game has a wide amount of products you can buy.

Mammoth Coins

First of all there is a special currency that can only be obtained using real money. This currency is called Mammoth Coins. With these mammoth coins you can buy skins, podiums, sidekicks, emotes, avatars, tiers inside of the battle pass, and crossovers (not to be confused with crossplay).

Battle Pass

I just mentioned the battle pass. You might have heard of it lately since the idea of battle pass keeps growing. The battle pass is a road of missions. if you complete a mission you get crystals. The amount of crystals you get is decided by the mission (usually between 6 and 12 crystals). In the image you can see Crystal Progress. If you collect enough crystals to fill the progress bar, you go up by a tier. A battle pass has 85 tiers. and 84 missions. if you complete all missions you will hit around tier 70. meaning you're missing out on crystals. You can get more crystals by playing online matches of brawlhalla. This is a very slow process so make sure you start early. otherwise you might end up buying tiers with mammoth coins



Bundles

Brawlhalla has multiple bundles you can buy, 2 in total. You have the all legends pack unlocking every current and future legend in the game, this costs €20. Also you have the Collectors pack, this pack gives you a special skin, weapon skin for each weapon, sidekick, title, ko effect, insignia, avatar and a whopping 3500 mammoth coins. This pack does cost €100. (and yes people seriously buy this). There also used to be a Valhalla Pack, this one only cost €10. This pack contained a sidekick, insignia, avatar and 500 mammoth points. This pack got removed from the store for unknown reasons. Furthermore Brawlhalla used to release seasonal bundles for €10. But with the release of stream rewards there are no seasonal bundles anymore.

Social Media

Brawlhalla makes lots of money with their Twitch and Youtube channels. They have their main channel on both platforms called Brawlhalla, and then they even have a second account called ProBrawlhalla. On the Twitch accounts they stream championships and do streams where they talk about the game and play with the viewers. On Youtube they upload games from the championships, and upload other relevant things that were on stream on Twitch. On both Twitch and Youtube you can get money for views. You can check how much any Youtube channel earns monthly by visiting a website, Here is an estimate.

Brawlhalla

NoxInfluencer Net
Membership Scheme
[Learn More](#)

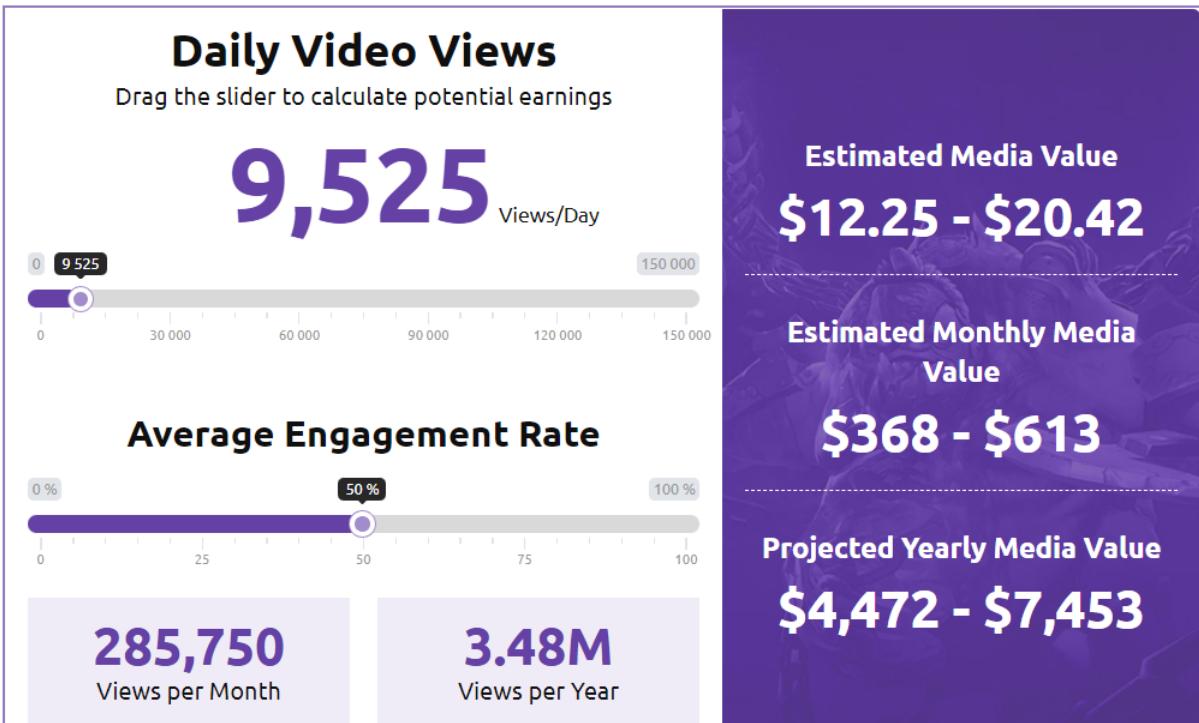
Total Subscribers ? **734,000**

Est. YouTube Partner Earning[Monthly] ? **\$ 4,295**
CPM: \$ 1.68-\$ 5.2

Est. Sponsorship Price[Each Video] ? **\$ 71**
CPM: \$ 25-\$ 29

HOT Dracula Synapse PrivatePlork Ga... MobaZane Challenger Repl... Be Challenger

I tried the same for twitch but for some reason the servers were down on all websites, so the following is a very rough estimate. **without monthly subs.**



Crossover Controversy

Crossovers are currently the most controversial thing in Brawlhalla. First of all, what is it? A crossover is a representation of a Brawlhalla legend with the looks of a very different character. So it's basically a skin right? Yes! It's a skin that's a little over double the price of a skin. The big difference is that a skin looks like the original legend, so fighting someone that uses the skin is all good since you know what legend you are fighting. On crossovers, the legend gets completely changed. Here is an example.

Koji (Legend), Koji skin, Michonne (Koji Crossover)



So one of the issues is that you have no idea what legend you are fighting. And since only a small number of people use the crossover you can't get used to it. It sadly doesn't even end here. There is a bigger problem going on with these crossovers. Just like their different visuals, their signature moves are visualised differently, while the hitboxes remain the same. Again this gets people confused on what's actually going on.

Bödvar Neutral Signature startup, Xavier Woods Neutral Signature startup (Bödvar Crossover)



So on the animation on the left, everyone knows what's coming, but on the animation on the right it causes confusion for a majority of people (based on all crossover drama on twitter). Due to these problems people have been requesting a feature to disable crossovers for the people who's fighting them. We haven't heard anything from Blue Mammoth Games yet about disabling crossovers. I speculate they can't do it due to an agreement with the companies they work together with for the crossovers.

Esports

Brawlhalla has a yearly world tournament called BCX. This is an offline event usually in America where people all over the world from all regions come together to fight for the world title. The first BCX was in 2016 and the next one is just a month away. The prizes for these tournaments can get pretty ridiculous. The prize pool for the upcoming BCX 2022 is \$500.000. That's the biggest prize pool in fighting game history. Also they have 4 Major tournaments for every region, every year. These are called the Winter, Spring, Summer and Autumn Championship Chronologically. In these major seasonal tournaments the prize pools are different per region, giving bigger prize pools to North America and Europe than Brazil,

South East Asia, South Africa and Australia. So all seasonals + BCX are 5 tournaments a year. BCX is always the last tournament of the year. Sometimes they also put in sponsored tournaments in between the seasonals. Examples of these sponsors are Steelseries and MTN DEW AMP.

SpecialK

What is special K?

SpecialK is a program that was known for enhancing graphics.

What does SpecialK do in Brawlhalla?

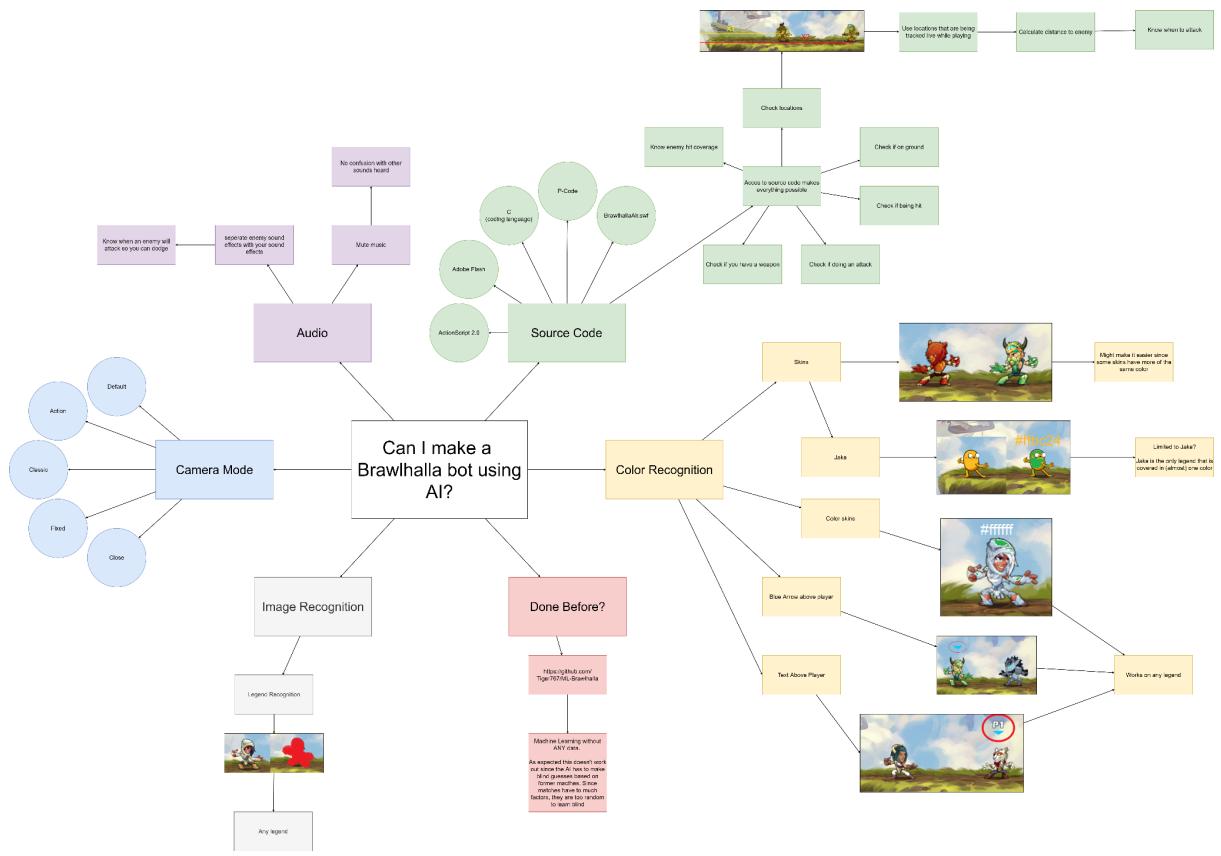
Inside of Brawlhalla, SpecialK increases fps and decreases input delay. It disables vsync and fixes a timing issue in the pc version of Brawlhalla. So basically it improves the gameplay overall.

How did Brawlhalla respond to SpecialK?

Brawlhalla added an anti-cheating software into the game. Called EAC. EAC stands for Easy-Anti-Cheat. If you try to use SpecialK these days, EAC will ban you off the game.

Exploratory Research

I explored what there is to find about Brawlhalla and AI. I mainly searched for information on the internet. Also have I used discord servers and the game itself. I took all the information I felt like could add up to the challenge.



Reinforcement Learning

Making the bot learn the game by reinforcement learning is something I wanted to try for quite a while. I looked up what already existed and found a GitHub project from Tiger767. I looked around in his project and his project kinda failed. I tried to understand why and found a possible point of improvement. He used reinforcement learning with in game images as input. I want to improve this step and try to give actual game information to the bot. But how do i get game information?

Source Code

From the exploratory research it looks like it would be perfect to use the game's source code for my project. The source code contains all match related data in real time. Sadly the source code is very hard to reach. In my opinion it's not worth trying to make the source code accessible since it will take very long and it doesn't add up anything for this semester.

Colour Recognition

So I can't access the real time game information, but who says I need to? In my exploratory research the biggest sections were source code and colour recognition. I could make a tool that could track down a certain colour on my screen and use a specific skin on a legend that contains a lot of the same colour. Whilst tracking down the colour on my screen I could generate locations and send them to reinforcement learning. This way the AI has something to base decisions off. When I was looking on the internet for colour recognition I quickly found image recognition. But the problem was that image recognition isn't exactly what I need. I don't want a tool that can say this is that legend and this is that legend. I want a tool

that looks at my screen and can point out everything it recognizes on my screen and track them down live. That brought me to the following topic.

Object Detection

I can use object detection to make it recognize legends, weapons, time, damage and more on my screen during a match. By recognizing these terms, we can generate our own match information. Finally I can give the match related information to the reinforcement learning tool to create a bot that learns by playing.

Object Tracking

Also something that's out there for me to use is Object Tracking. With object tracking I can track all pixels on my screen that move. Since we can enable a setting that keeps the camera still the entire match, we can simply use object tracking to track the legends.

Brawlhalla interview

Preparation

Going into the interview I prepared a few questions together with the person I was going to interview, since we wanted to make sure I would only be asking questions he knows the answers to. Here are the questions we agreed upon together.

1. Who are you in the community / what is your role?
2. What is special K?
 - I might ask you more sub questions on this one after question 2.
3. What do I need to create a bot in brawlhalla? (look at this questions of a brawlhalla perspective not the coding perspective)

The interview

1. So who did I interview?

I interviewed a player of the Brawlhalla community called CrossyChris. He used to be more active, especially in the German community. But due to the terrible state of the game he isn't so active anymore. Also was active on youtube

- 1.1 What content did you make on youtube?

Mainly clips, short clips of doing impressive combos. After a while he started to edit his clips but since no one cared about it, he stopped.

2. What is SpecialK?

SpecialK is a controversial mod that increases fps and decreases input delay. It was a tool that was created in 2015 and was added to the steam market for pc players. SpecialK itself wasn't specifically made for Brawlhalla. It was a general tool that optimises gameplay in a lot of games. SpecialK could for example make your game go from 60hz to 360hz without spending any money. It also disables vsync and fixes a timing issue on the pc version of Brawlhalla.

- 2.1 How did Brawlhalla respond to SpecialK?

Easy Anti Cheat. EAC was made to detect mods that modified the game files. Everyone that still used SpecialK while EAC was a thing would automatically get banned. In response to the entire controversy, Brawlhalla came up with their own built in SpecialK. But since he plays on ps4 he doesn't know if the built in SpecialK is as good as the one on the steam market.

3. Is there anything about Brawlhalla I should know before I start making a bot?
Brawlhalla is a 2d fighting game. Its also useful to know what inputs there are in the game, like the attacks you can input. Players move and attack, you could create a bot that reacts to these signals. There are hitboxes and hurtboxes, try to scan these so you know where a player is and what zone to stay out of.

3.1 What if I go out and create an exact copy of a pro player and implement it in a bot?
Wouldn't that be guaranteed to be one of the best bots ever?

Maybe. The playstyle of pro's aren't always the same. In a game a pro could decide to play very differently and do different things in different situations. It would all take a really long time to exactly replicate all of these situations. On top of that. You would also have to copy the pro player playing with different weapons. Also playstyles can completely change over patches so i don't think it would be possible.

4. Is there anything I should know before getting into Brawlhalla Image Classification?
You are just scanning images of legends so it might be useful to know the legends of the game but other than that I don't think the project is too much Brawlhalla related.

What do I actually need to create a Brawlhalla AI Bot (Scope)

There are a few things we need to know/are useful to know in our project. Let's sum them up.

Has it been done before?

It actually has been done before and the project failed. But that doesn't mean we can't learn from it. I have looked over Tiger767 his project and saw a point I can improve. Tiger used screenshots as input. I was wanting to bring this to a next level and give coordinates as an input. I believe this HAS to give at least better results.

Game information

To train the reinforcement learning bot, we need any kind of game information so the RL bot has something to base its decisions off. We learned multiple ways to collect game information, such as: The Source Code, Object Detection and Object Tracking.

Previous Bots

In the history of Brawlhalla there has been a bot called DexBot. This bot was being used to play ranked against actual humans. It might be useful to know how this bot has been made so I can use the knowledge for my own bot, and possibly prevent securities.

What do I actually need to create Brawlhalla Classification?

There are again a few things that help us in this topic.

Skins

As we know there are different types of legends. That's obvious. In our Exploratory Research we found out there are also multiple skins per legend. Knowing this, we can try to not make use of skins in our classification problem, since this might only make the classification harder.

Analytic Approach

Target Variable

The target for my project is to recognize images of Brawlhalla legends. The images can be from the game or legend art from social media.

Nature of the problem

Is this legend A, B, C etc. so it's a classification problem. There are multiple algorithms you can use to solve the classification problem. I want to use Support Vector Machines since we already exercised with this algorithm in the exercises.

Good indicators

Since I'm using images there aren't any features I can filter on.

Societal Impact

If we get the brawlhalla-legends-recognition working with a high accuracy, what would the consequences be? Basically nothing for now. My project could be part of a Brawlhalla AI bot. Where the bot understands who he is fighting by brawlhalla-legends-recognition. This Brawlhalla AI bot is a very specific case and i don't think it's too likely to actually happen

Demonstration

As demonstration, I will demonstrate the brawlhalla legend classification notebook I made this semester.

Demo (no test plan/testing)

Instead of writing out a huge test plan and collecting user input and all that. The least I could do is demonstrate my application to a (stakeholder).

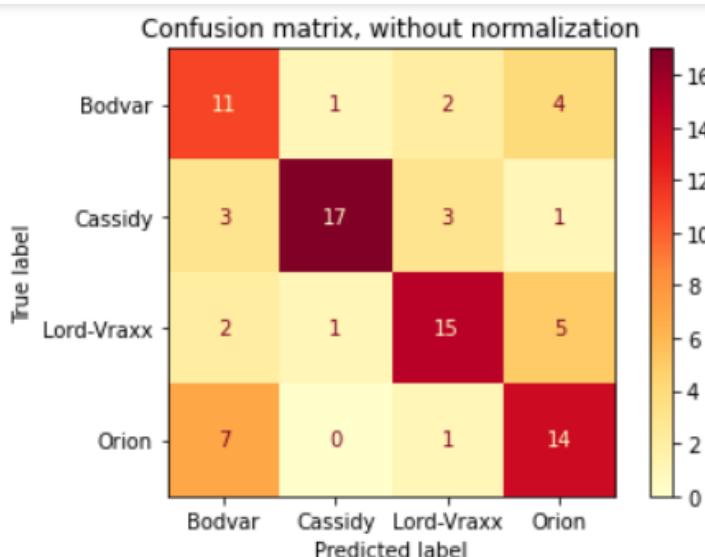
Demo Plan

In the demonstration I will give a little introduction on what I made. Next, I show my application. As last, we will fill in the TICT quick scan canvas with my user.

Demo Requirements

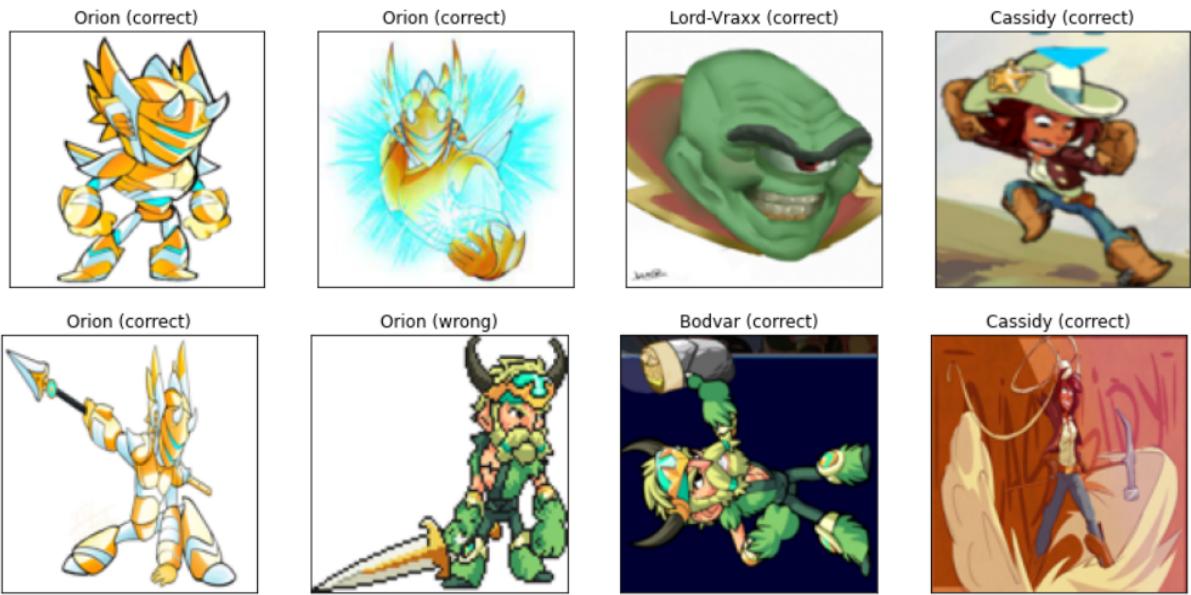
To make the results understandable for the tester, I want to have some sort of understandable visualisation. I chose to show a confusion matrix in a heatmap. This heatmap shows the amount of times a legend has been classified as itself or as another legend

Heatmap



Also will i output all tested images with the answer, for if the user is interested in which ones were wrong and correct.

Images with answers



Why no ordinary test plan?

I don't think a test plan fits the style of my application. In my application you can just feed data I collected and press run and that's it. So I don't see the use in writing a test plan. The only user input that is being collected, is the user pressing Shift + Enter to run the code block and that's it really.

Feedback

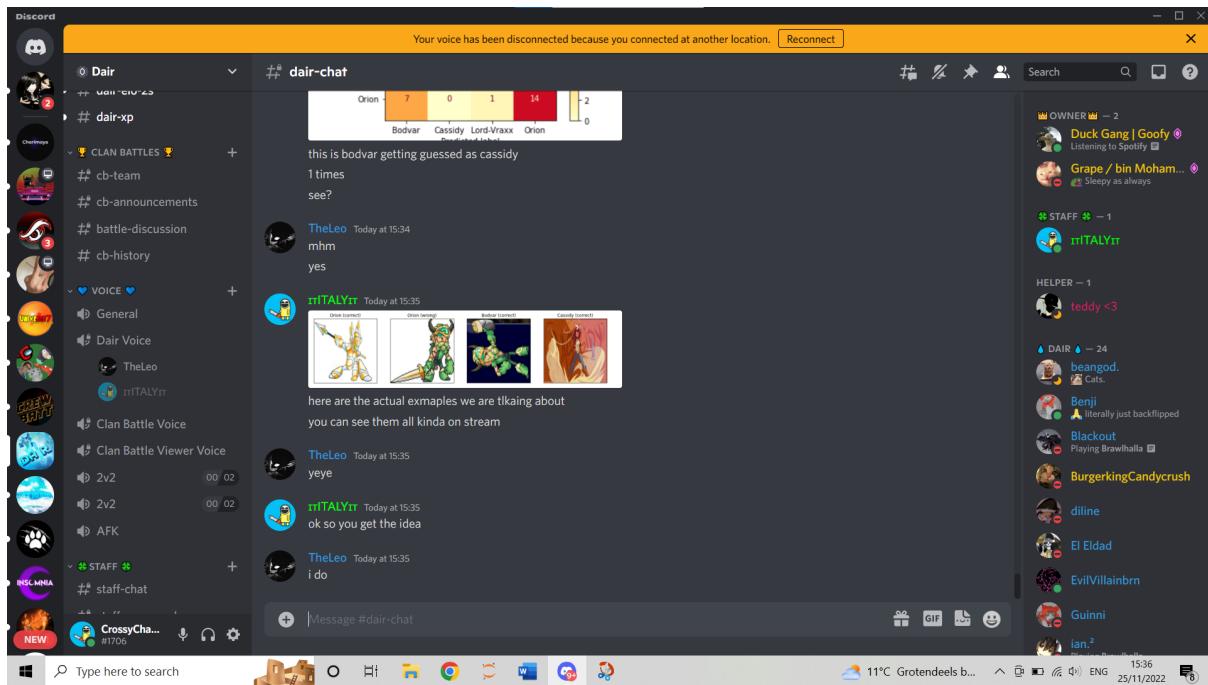
I demonstrated the program to a Brawlhalla pro called TheLeo

Transparency

Well, I showed my demo to TheLeo and simultaneously explained how the program works. But if I didn't explain it to him there would've been no chance that he could understand what was going on since he's just a Brawlhalla player, not an AI expert.

TICT Tool

So i started off by explaining TheLeo what I made. Then I explained how the program works. That it learns by images and makes decisions based on that. By sharing my screen and sending images, I showed the process to TheLeo. (I am ITALY

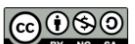


Quick Scan Canvas

To fill in the canvas, I asked all the questions to TheLeo. TheLeo couldn't answer every question since it was just too irrelevant in this case. Here is the canvas.

QUICKSCAN - CANVAS

Brawlhalla Legend Classification

<p>NAME: Brawlhalla Legend Classification DATE: November 25, 2022 2:25 PM DESCRIPTION OF TECHNOLOGY Classify Brawlhalla legend images with use of Support Vector Machines</p> 	<p>HUMAN VALUES</p> <ul style="list-style-type: none"> - 	<p>TRANSPARENCY</p>  <p>My user did know what was going on without giving any additional information. But this was due to I have showed him results of the program before. On the other hand, the way the program works and makes it's decisions wasn't clear without my explanation.</p>
<p>IMPACT ON SOCIETY</p>  <p>My user can see this program be used to make mods. He can't imagine a problem this application solves.</p>	<p>STAKEHOLDERS</p>  <p>Modders, since they are the ones making mods. In the end also the players who use the mods.</p>	<p>SUSTAINABILITY</p>  <ul style="list-style-type: none"> -
<p>HATEFUL AND CRIMINAL ACTORS</p>  <p>It could be used to make game breaking mods like bots. This is a problem because they could be used in tournaments. And by playing in tournaments you can earn a lot of money.</p>	<p>DATA</p> <ul style="list-style-type: none"> - 	<p>FUTURE</p>  <p>The project could be expanded to giving human images, and asking the program what legend they look like.</p>
<p>PRIVACY</p>  <ul style="list-style-type: none"> - 	<p>INCLUSIVITY</p>  <p>There is bias since I collected the data.</p>	<p>FIND US ON WWW.TICT.IO</p>    <p>THIS CANVAS IS PART OF THE TECHNOLOGY IMPACT CYCLE TOOL. THIS CANVAS IS THE RESULT OF A QUICKSCAN. YOU CAN FILL OUT THE FULL TICT ON WWW.TICT.IO</p>

Versioning

Version	Changes
v1.0.0	Completed Iteration 0
v2.0.0	<p><u>Major</u> Decided to drop object detection for object tracking.</p> <p><u>Minor</u></p> <p>Domain Understanding > Exploratory Research:</p> <ul style="list-style-type: none">- Add Heading "Object Tracking" <p>Data Sourcing:</p> <ul style="list-style-type: none">- Rewrite "How do I get data for my project?"- Rewrite "How do I make it useful?"- Delete "Downside of creating a dataset" <p>Analytic Approach:</p> <ul style="list-style-type: none">- Rename "Object Detection" to "Object Tracking" <p>Analytic Approach > Object Tracking:</p> <ul style="list-style-type: none">- Rewrite "What am I going to do?" <p>Analytic Approach > Object Tracking > What am I going to do?:</p> <ul style="list-style-type: none">- Delete "Main Goals"- Delete "Extra Goals" <p>Analytic Approach > Object Tracking:</p> <ul style="list-style-type: none">- Rewrite "How will I do this?" <p>Analytic Approach > Reinforcement Learning Part:</p> <ul style="list-style-type: none">- Add Heading "Has it been done before?" <p>Data Requirements:</p> <ul style="list-style-type: none">- Edit "Domain"- Rewrite "Stakeholders"- Rewrite "Actual Requirements" <p>Data Requirements > Actual Requirements:</p> <ul style="list-style-type: none">- Add "Legend Locations"- Delete "Legend"- Delete "Holding Weapon"- Delete "Stage"- Delete "Health Bar"- Delete "Time" <p>Data Collection:</p> <ul style="list-style-type: none">- Rewrite "Where will I save my data?"- Delete "Naming Data"- Delete "How often do you want to retrieve data?"- Rewrite "Extract data to program"- Delete "Data Collection Analysis" <p>Edit "Data understanding"</p>
v3.0.0	<p><u>Major</u> Dropped Reinforcement Learning and Object Tracking and changed project subject to Image Recognition</p>

v3.1.0	<u>Minor</u> Add "Societal Impact" Data Understanding: - Add Data Visualisations Modelling / Evaluation: - Edit "Support Vector Machines (SVM)"
v3.2.0	-
v4.0.0	<u>Major</u> Moving everything below Societal Impact to the Notebook (and data sourcing) <u>Minor</u> Edit "Societal Impact" Add "What do i actually need to... parts" Edit "Reinforcement Learning"
v4.2.0	<u>Minor</u> Domain Understanding - "Add SpecialK" - "Add Interview"
v4.3.0	<u>Minor</u> Add "Demonstration" Add "Feedback" Add "Preface"

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