Creating a Brawlhalla AI using reinforcement learning

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

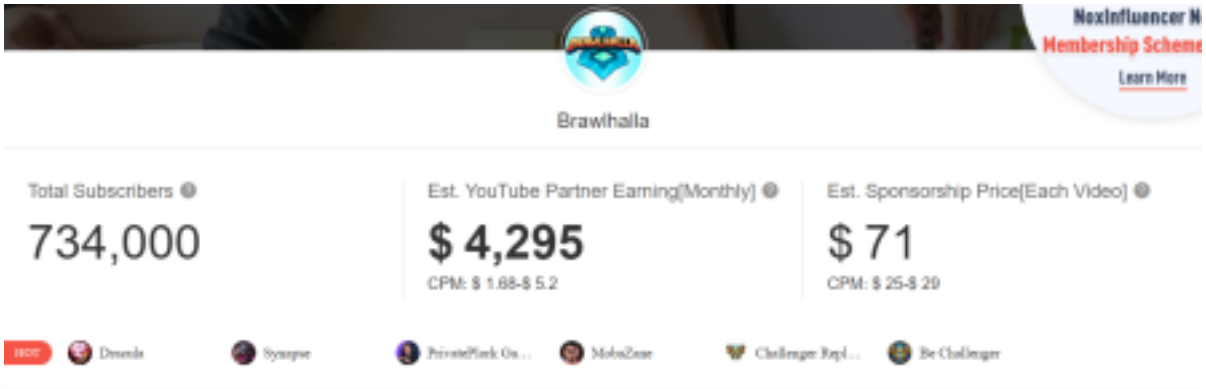
I just mentioned the battle pass. You might have heard of it lately since the idea of battle pass keeps growing. The battle pass is a road of missions. if you complete a mission you get crystals. The amount of crystals you get is decided by the mission (usually between 6 and 12 crystals). In the image 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.

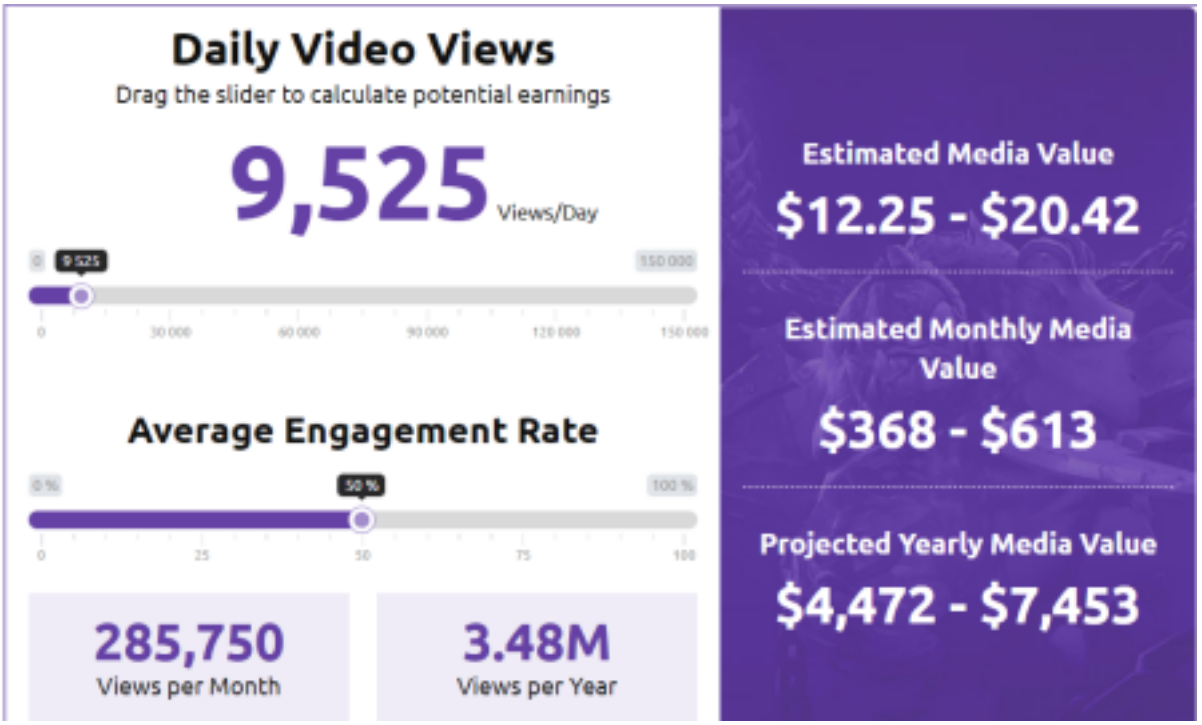
Social Media

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 the 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.



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 visualized 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.

(MISSING) The DexBot Incident

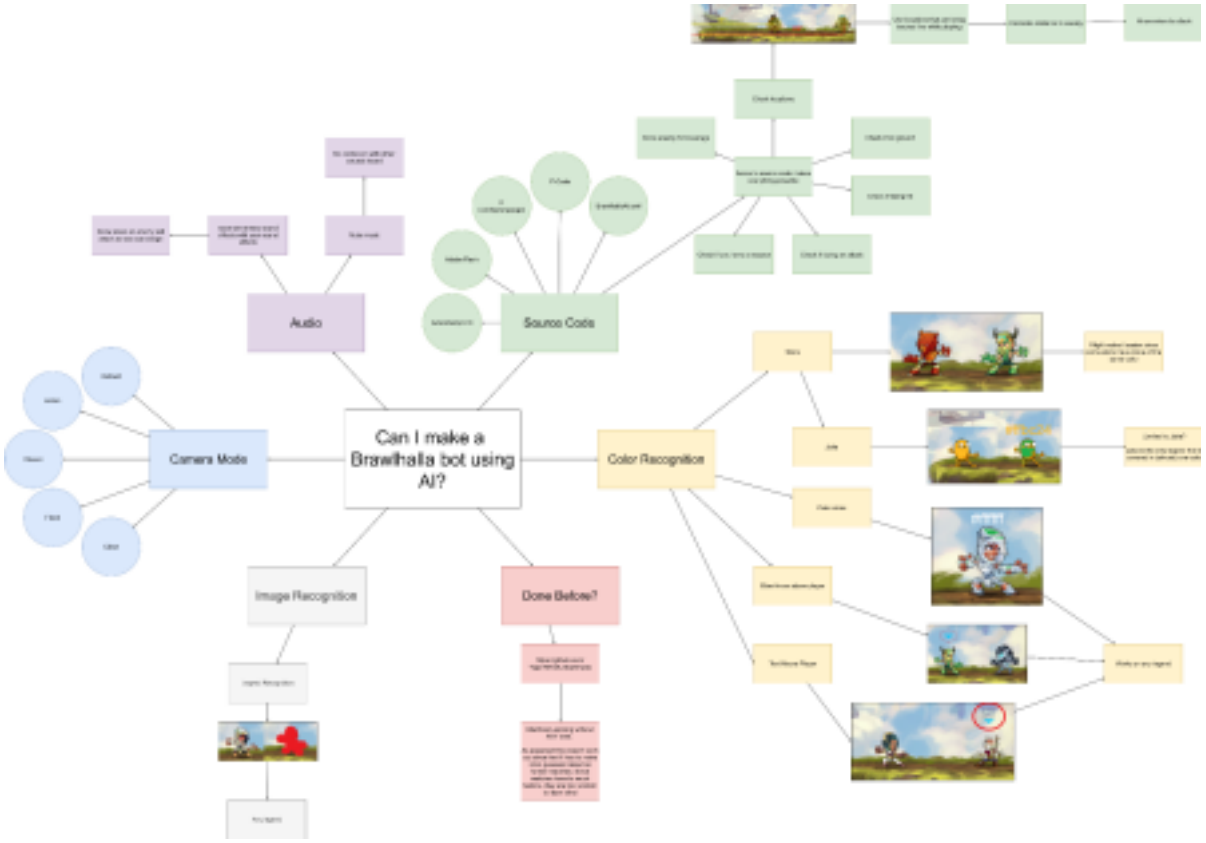
waiting for interview

(MISSING) Easy Anti Cheat

waiting for interview

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 was a big failure. I tried to understand why and found my answers. He used reinforcement learning without any additional information to base decisions off. This means his bot played the game blind without knowing what's going on around him. Since there is too much randomness going on, this will never work. My solution to this is to provide match information to the bot. Like locations of the legends so it has a minimal understanding of what even is going on. But how do we get match 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.

Color 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 color recognition. I could make a tool that could track down a certain color on my screen and use a specific skin on a legend that contains a lot of the same color. Whilst tracking down the color 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 color 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.

Interview

I want to interview 2 people for my challenge. Further explained down below.

Brawlhalla Interview

So for my interview I want to interview someone in the brawlhalla community that can tell me more about the following topics: DexBot, EAC and their business plan, and possibly confirm information I've found researching Brawlhalla.

Data sourcing

How do I get data for my project?

Really easy actually. I record my screen with an application called OBS. Next I hop in a Brawlhalla match and just play. While playing I try to keep in mind to do lots of specific actions. For example, hugging the wall, being in the air, picking up a weapon, just anything I can think of that could add up to training the model. Next up I open the recording and watch
it frame for frame. whilst doing this i try to get data of all possible occasions. Remember when I said I tried to hug the wall, be in the air, picking up a weapon. Now I get the frames for all these occurrences. This way we can prepare the model for anything that could happen

in a match.

How do I make it useful?

There is an application called LabelImg. This application allows us to put labels on images with a visual interface. when the labeled image is done it generates an TXT file. These TXT files will be fed to the model.

example of plain image from a match

example of a labeled image using LabelImg (useful data)

Downside of creating a dataset

As you might have understood, I don't have a dataset. Yes there might be an existing set of brawlhalla match images, that's not the issue. The real issue is labeling all images one by one. This will take a very long time but I'm willing to do it for my challenge.

Analytic Approach

In this section I'll mention technologies I will use to realize the challenge. When explaining the technologies I'll also go over how I will use my data and we'll cover the target of my challenge.

Object Detection Part

A tool that tracks down legends on screen. (This is the object detection tool mentioned in the part above)

Why am I going to do this?

I'm making this tool for the reinforcement learning part. Without this tool reinforcement learning won't have anything to base its decisions off. Without it the game is too random and the AI will try to learn making blind guesses and that won't work out.

I am basing this off an earlier ML project done by Tiger767. He tried to make a bot learn the game by giving it +points and -points based on ingame events. As expected the bot didn't perform well. Here is his project -> https://github.com/Tiger767/ML-Brawlhalla

What am I going to do?

Here are my goals inside of the object detection part,

Main Goal

Track legends on screen so we can give the locations to reinforcement learning bot.

Extra Goals

- Make the tool able to tell what weapon someone is holding
- Make the tool recognize if a weapon spawns and track the weapon -
Make the tool understand the stage boundaries
- Make the tool understand if someone is stunned and can't attack
- Make the tool understand how damaged someone is
- Make the tool understand if someone is airborne or grounded
- Make the tool be aware of the ingame timer

How will I do this?

I will train a live object detection model to recognize objects in a brawlhalla match.
for example. Stage, Legends, Weapons.

To train my model, I will feed it labeled images. I collected these images by recording gameplay and taking out frames of the footage. Next I created useful data for my model by labeling the images. With enough training it should be able to watch gameplay and detect the legends. Here is an example of data I collected and labeled images (useful data).

image from a brawlhalla match

an idea of what a labeled image would roughly look like

After labeling these images, I will feed them to my object detection model. In return the object detection model will give me values that describe the game. I wrote out the values I expect to get from my model down below. These are also the values that will be given to the reinforcement learning AI.

Expected Values (from the image above)

```
legend: "Koji"
location_x: xmax - xmin
location_y: ymax - ymin
facing_right: 1
facing_left: 0
grounded: 1
airborne: 0
stunned: 0
can_pick_up_weapon: 0
weapon: "unarmed" (i can split this up in 12 diff categories)
hugging_wall: 0
health: "white"
lives: 3
playable_character: 1

legend: "Volkov"
location_x: xmax - xmin
location_y: ymax - ymin
facing_right: 0
facing_left: 1
grounded: 1
airborne: 0
stunned: 0
```

```
can_pick_up_weapon: 0
weapon: "unarmed"
hugging_wall: 0
health: "white"
lives: 3
playable_character: 0

weapon_spawned: 0
location_x: null
location_y: null
```

Here's a different example. In this example you can see a weapon spawn, a legend being airborne, time changed and health bar changed.


```
legend: "Koji"
location_x: xmax - xmin
location_y: ymax - ymin
facing_right: 1
facing_left: 0
grounded: 1
airborne: 0
stunned: 0
can_pick_up_weapon: 1
weapon: "unarmed" (i can split this up in 12 diff categories)
hugging_wall: 0
health: "orange"
lives: 3
playable_character: 1
```

```
legend: "Volkov"
location_x: xmax - xmin
location_y: ymax - ymin
facing_right: 1
facing_left: 0
grounded: 0
airborne: 1
stunned: 0
can_pick_up_weapon: 0
weapon: "scythe"
hugging_wall: 0
health: "dark orange"
lives: 3
playable_character: 0

weapon_spawned: 1
location_x: xmax - xmin
location_y: ymax - ymin
```

Reinforcement Learning Part

Use the tool I made in the Object Detection Part, and make a bot learn how to play Brawlhalla.

Why am I going to do this?

At first I wanted to create a bot that is better than the bots provided by the game, so I have a very good practice partner. Also am I very curious if it's all even possible and how it will work out.

How will I do this?

Use the tool object detection tool to get the locations of the legends on screen. By giving the AI the locations of the legends and telling the AI how to input attacks, it should be able to figure out how to play.

I could give the AI so called “points” when he does something good and take away points when it does something bad. Here’re lists with good and bad occurrences.

Good
- opponent takes damage
- opponent gets knocked out
- picking up a weapon

Bad

- taking damage
- getting knocked out
- throwing away your weapon

inputs

- right
- hold right (for a while idk)
- left
- hold left
- up
- hold up
- down
- hold down
- light attack
- heavy attack
- hold heavy attack
- weapon throw
- emote (emote after a kill should gives points to the bot to win the mental game)
- Dodge

note: these inputs should be able to get pressed together. if necessary I might make a new list of inputs where I also show all combined inputs.

What is the target?

Minimal Target

The average Brawlhalla rank is Silver 5. Silver 5 is the last tier of the Silver rank. So if my bot can beat silver people it means it's considered a better than average player. That sounds like a reachable goal.

Advanced Target

Beat everyone at school with the bot that plays Brawlhalla.

Data Requirements

Here I explain the requirements to get my data.

Domain

Brawlhalla is the only game I need to collect data. it’s a free to play game so no additional costs. Also could I use already existing footage from YouTube.

Stakeholders

For who is my data beneficial? For everyone who wants to work with labeled images. But I'm not sure yet if I'm allowed to share anything I'm making at the moment so I might keep everything to myself.

Actual Requirements

In my data it's important that I label consistently, meaning everything that has been labeled on image 1 also has to be labeled in image 2, 3, 4 and so on. Here is a list of stuff I wanna make my model be able to recognize.

- Legends
- Holding Weapon
- Weapon Spawns
- Stage
- Health Bar
- Time

Down below I explain why the listed elements are important.

Legend

The game currently has 56 legends. All these legends look different from each other. It's important to make my tool recognize what legend he is playing since every legend has it's own 6 unique moves, also called signature moves or short, sig. If the tool doesn't know what legend it is using, it also can't know when to use what sig. Same for its enemy. If it doesn't know the enemy its sigs are, it doesn't know what to look out for.

Holding Weapon

It's important for the AI to know what weapon he is holding. Why? Because every weapon has different combos and strings. If the AI does not take the weapon into account, it might input combos for a sword while holding a spear.

Weapon Spawns

Every legend has chosen 2 weapons for him. As soon as you start the game you don't have a weapon yet. also if you respawn you lose your weapon, and after a given time you can lose your weapon due to knockback. If you don't have a weapon you are in a disadvantageous position, because weapons outrange no weapon. So in a neutral game where both players are doing the exact same thing, the armed player will always win because of the bigger range. So it's very important for the AI to recognize a weapon spawn so it can get it to be in an advantageous position.

Stage

Being in the center of the stage gives you an advantageous position. That's because if you are center stage, it means your opponent is at either one of the sides or in the air. Being in

the air or on the side of the stage gives you less options to go for, and the fewer options someone has, the easier it is to read.

Health Bar

Based on someone's health bar you sometimes wanna change the combo/string you are going for. If someone's is less damaged you often can go for longer strings since the opponent won't get knocked far away. If someone is damaged you wanna go for combos/strings that knock your opponent far away. This might get you a kill or at least give you stage control.

Time

I can use the time to keep track of how long my AI lives or how much time it took to kill an enemy. Also to see the damage per second he got or gave. Also a small addition, a competitive match takes 8 minutes. If a game has 1 minute left and you are losing, it's often the better choice to stall out a minute. and go for sudden death. Entering sudden death takes away any advantage and perfectly equalizes the game.

Data Collection

Some parts of this topic are also mentioned in Data Requirements so I won't go over it again.

Where will I store my data

Right now I save all data to my laptop and I haven't encountered any problems yet. If it takes up too much space I always have the backup plan to put everything on fontys onedrive.

Naming Data

As you might now my data is based off of games played by myself. for the first 50 images i made a map and called it koji_vs_volkov_data because Koji was fighting Volkov. also did i intentionally put the legend the bot should be in the first spot. so looking at the map name i can understand the AI should understand Koji was the playable character here.

How often do you want to retrieve data

To answer this question I feel like I have to work on my project for a while and see what I'm missing. This way I can target the data I'm missing for my object detection tool, and get that data.

Extract data to program

I can just put all .txt files in a data folder and split it up into train and test split.

Data Collection Analysis

As if right now I only have 50 images of 1 match, meaning the tool is only learning koji is the playable character and volkov is the enemy and that brawlhaven is the only existing stage in the game. Of course I'd have to include images of all stages and all legends. but for now, since we're in iteration 0 it's just all testing and seeing what happens. if it actually works out as planned with these 2 legends and this specific map, i could expand.

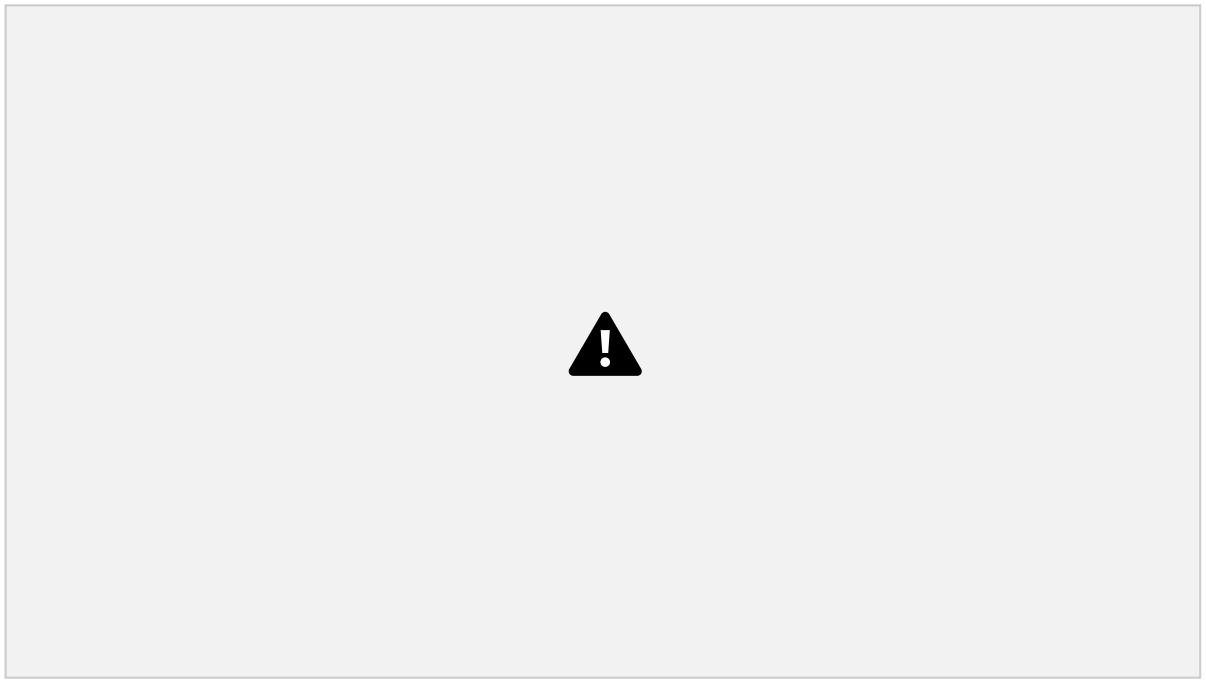
Data Understanding

Usually you would do data understanding by visualizing your data and trying to understand what all values mean. In my data we have images, meaning everything is visual already. Even though my data is a bunch of images, I still can try to understand what is happening inside of the images.

What is Neutral Game

Neutral game in a fighting game is the moment where both parties don’t have any advantage and so the game is neutral. If we translate this to Brawlhalla, the neutral game would look something like the following.

(I added black- and red lines and text to point out certain terms, to make the explanation more understandable)



This situation is as neutral as it can be. Both Legends have an equal distance to center stage, and an equal distance to their closest edge. But what makes the game not neutral anymore? In other words, how do you gain the advantage in neutral game?

How to win Neutral Game

A neutral situation can be made in-neutral. This can be done in mainly 2 ways.

Movement

Movement and attacks, movement allows you to close in the area between you and your opponent giving your opponent less movement space. And remember, the less movement space someone has, the less options they have, and the less options someone has, the easier he is to predict.

Attacks

attackwise, you can also break neutral, by landing a hit on your opponent, you stun the opponent and knock the opponent away. while the opponent is stunned and knocked away you have time to close in the area to your opponent to give your opponent less movement space again.

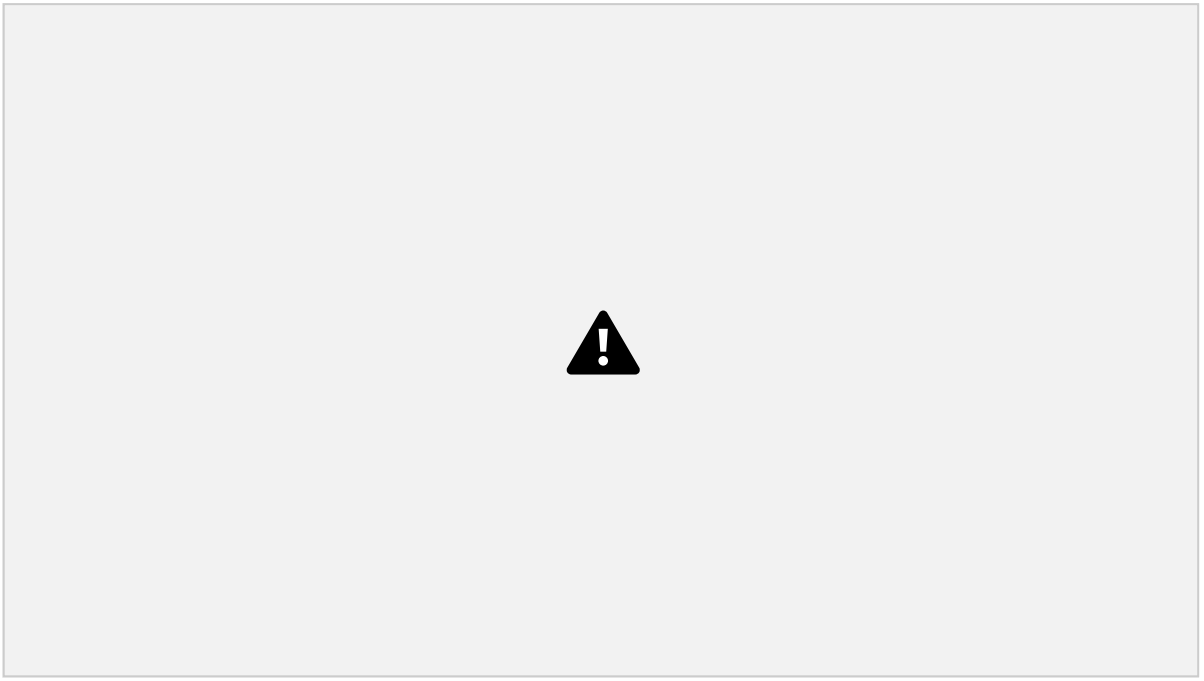
A downside to breaking neutral with attacks is that you can miss your attack. If you miss an attack, also called *a whiff*, you will be stuck in the attack animation. If your opponent is close enough while you *whiff*, he can hit you. Giving your opponent the advantage.

Neutral Game Examples

If you want you can guess yourself who has the advantage in your head to see if you understand the concept

Example 1

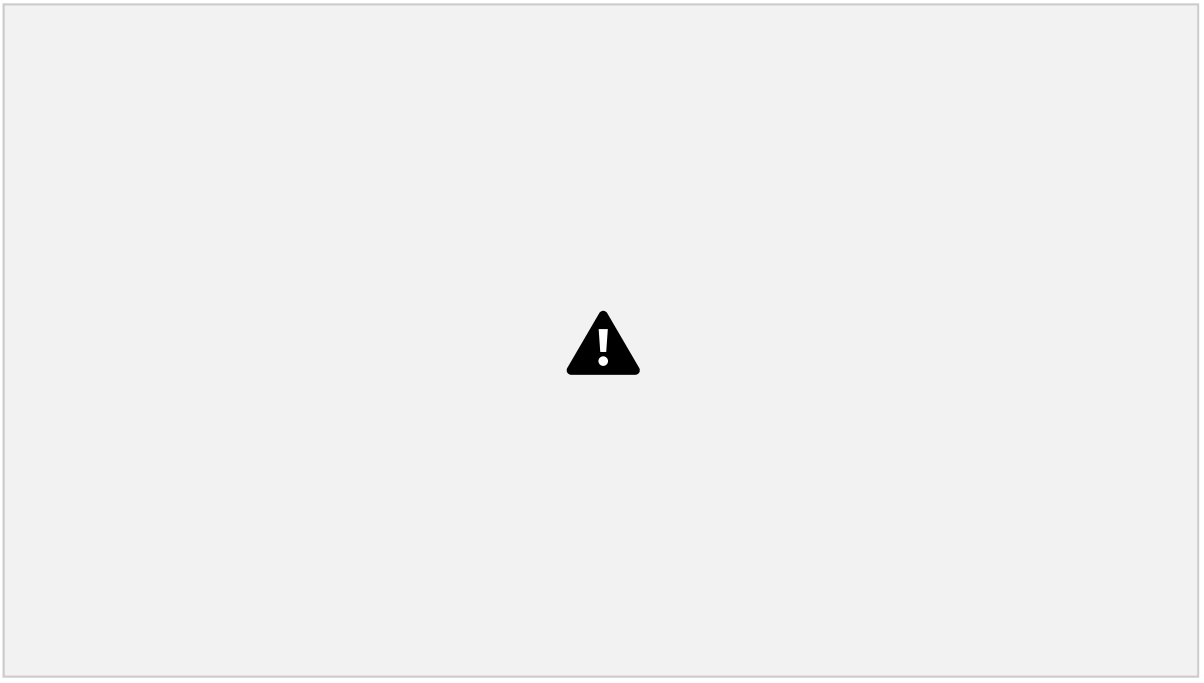
Is this position Neutral? If not, who has the advantage?



Here we see Caspian standing on stage and Jiro, airborne, trying to get back to stage. In this position Caspian clearly has the advantage. Why? Because Jiro is forced to get back to stage, meaning Caspian already knows where Jiro is going, making it easy for Caspian to hit Jiro.

Example 2

Neutral? Or advantage?

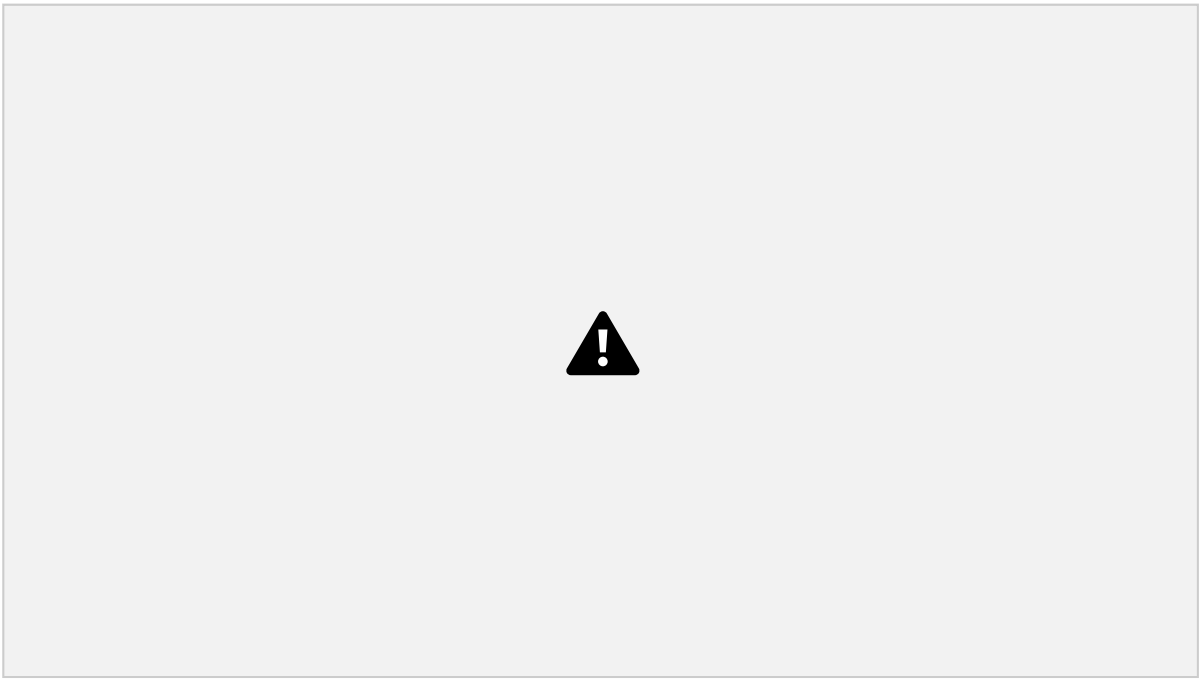


Here we see Ada (left), and Koji (right). Koji is standing in center stage giving him a slight advantage. Koji is advantageous because he can move everywhere he wants to. On the other hand, Ada can only move right or up. Of course she can also go left, but going off the stage puts you automatically in a way worse position, so you want to avoid that. So in short,

Koji has a better position on stage. Another thing to mention, Koji is holding a bow, Ada isn't holding a weapon. Bow has an insane range meaning Koji can outrange Ada and make Ada unable to move close to him. So in the end, Koji has quite a good advantage.

Example 3

easy one, who has the advantage?



Koji clearly has the advantage, Koji hits Volkov with a sword *side light*. This attack leaves Volkov stunned for a bit and knocks Volkov back. This means Koji can move pretty much where he wants to and can try to make himself ready for a follow up, giving Volkov even more damage.

Why is Neutral Game important to understand?

Later on in the project I will use reinforcement learning to make the bot better. In reinforcement learning you give +points for good events and -points for bad events. I could give the AI +points for making a kill and -points for dying but this might be too broad. It might be a really good idea to make the AI calculate advantages and analyze neutral game to base decisions off.

Data Preparation

Data Cleaning

This is basically a copy paste of [How do I make it useful?]

Missing Data

I will train my object detection model by providing labeled images. But in the end, it should be able to apply everything it learned on a live Brawlhalla match. The live match isn't just images, it's live gameplay. Therefore the object detection model will try to fill in the missing data with everything it learned in the training phase. So missing data will get filled in by itself. The more I train my model, the better it will be able to handle missing data.

Preprocessing

Feature Selection

Throughout my project I expect to do this step multiple times to figure out what the best selection might be. For now it looks like it's going to be a trial and error process. In the first iteration I want to use the following features.

Object Detection

- Legends
- Legend Locations
- Time
- Health
- Lives

Reinforcement Learning

Good

- opponent takes damage
- opponent gets knocked out
- picking up a weapon

Bad

- taking damage
- getting knocked out
- throwing away your weapon

You might have seen I had ideas for reinforcement learning involving neutral game. It might not be useful to dive in neutral game for reinforcement learning since it can figure that out by itself but later on in the project I might give it a try. For now I don't detect the weapon they are holding but i might do that in a later iteration.

Scaling

Thanks to my domain understanding, scaling is not necessary in this project. Inside of the game we can enable a certain camera mode that will keep the camera fixed at one place the

entire match. This results in every ingame object staying the same size the entire game. Since the train data and the test data both are making use of the fixed camera setting, nothing has to be scaled.

Bias/Variance Trade-Off

I have watched a video where they would make an AI learn how to play a racing game. A mistake he made at first, was that during his training he made the bot train on a track with lots of turns. When the AI came to a straight section it didn't know what to do since it had been trained so hard to make turn after turn. This is a good example of overfitting.

Prevent Overfitting

To prevent overfitting, I want to use data that provides different scenarios, legends and maps. Basically everything that can be different, should be provided in data. Also while learning with reinforcement learning, it's important not to fight the same legend on the same difficulty over and over. Since the AI provided by the game itself might make the same mistakes over and over, anf that could also provide overfitting.

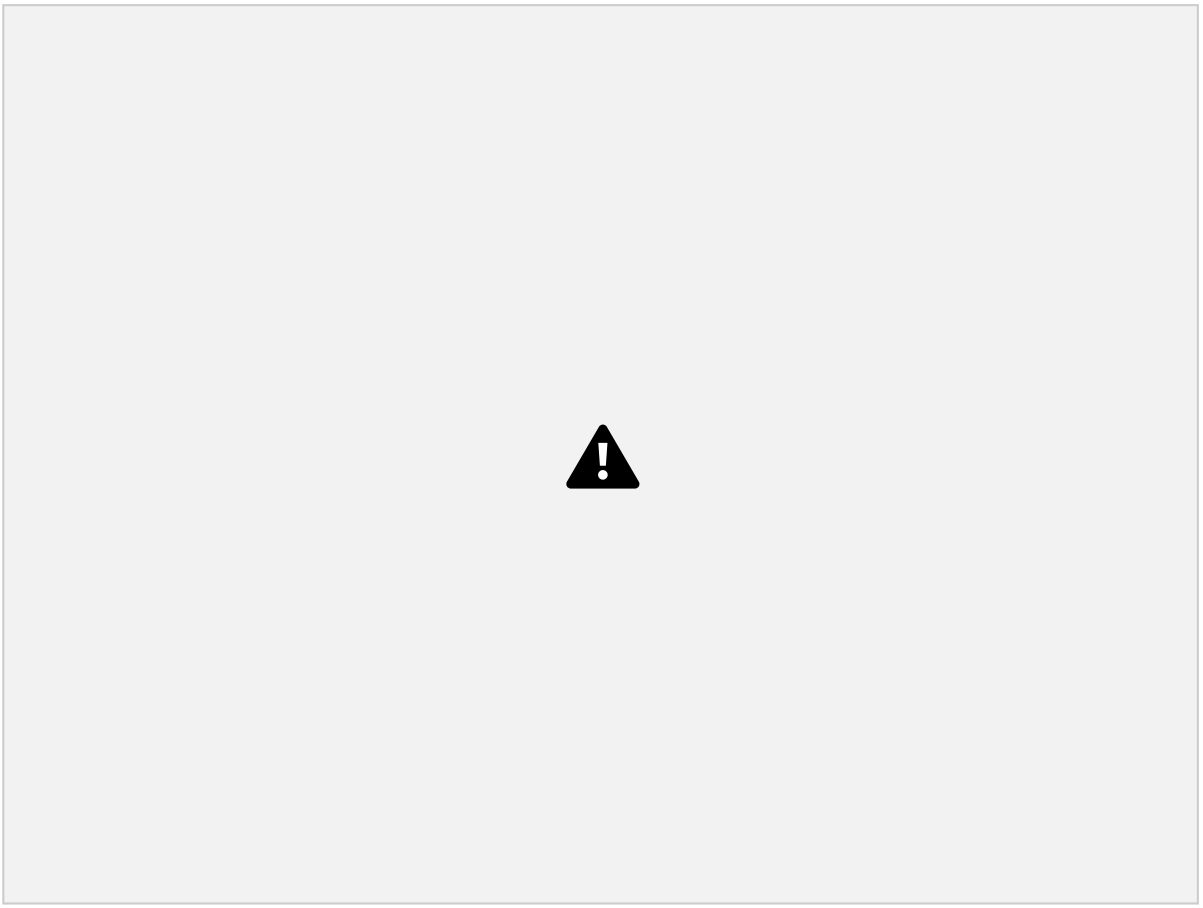
Modelling

What model will I use

As model I want to use a YOLO type model. This type of model is the quickest model in object detection. Because it's so quick it becomes possible to detect objects in real time. The downside of a quick model is that it's less accurate.

To be exact, I want to use YOLOv5. Currently v6 is the newest version but since it's so new it might be hard to find help for it. Therefore I will use v5. YOLOv5 is a Convolutional Neural Network (CNN). The output will be boundary boxes and accuracies.

Here is the YOLOv5 architecture. As if right now I have no idea what's happening in this image.



What is my target

The most important two things will be detection speed and accuracy, so both have to be at a certain level.

Detection Speed

For detection speed I want to try to hit at least a speed of 60fps (since the game itself runs in 60fps). The majority of the players play at 60fps so it sounds like a nice goal. The faster the detection, the faster the AI will move inside of the game. There are specific settings you can enable inside of Brawlhalla to enhance the fps. Enhancing your fps can lead to a max of 1000 fps. So if we can hit a higher detection speed, we might wanna improve the game's fps.

Accuracy

Accuracy wise I can’t tell too much since it's quite a complicated process. I don’t know how much the accuracy will influence the reinforcement learning AI (since that's what we're all doing it for). Of course we want to hit the highest possible accuracy but for now let's aim for an accuracy that’s not too inconsistent. 0.75.

Evaluation

I wasn't able to get the object detection working. I feel like that if I would take more time it might work at some point, but the last few weeks I've only been trying to fix errors. And made no code progress.

Solution

Whilst trying to get the object detection working, I came across object tracking. I followed a youtube tutorial for object tracking and it worked out. The object detection I used for the object tracking is based on pixels changing color. Why is this a solution? The main goal of this project was to create an AI for brawlhalla that learns to play using reinforcement learning. The object detection part was just a quick fix because I didn't have any game related data and thus no information to feed the AI. The object tracking i found already works and outputs game related data, that means i can focus more on the reinforcement learning part.

Sources

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Made me understand how object detection works
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Racing Game AI (Trackmania)
https://www.youtube.com/watch?v=SX08NT55YhA&t=680s

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https://www.analyticsvidhya.com/blog/2021/12/how-to-use-yolo-v5-object-detection-algorithm-for-custom-object-detection-an-example-use-case/

(old stuff i might need later)

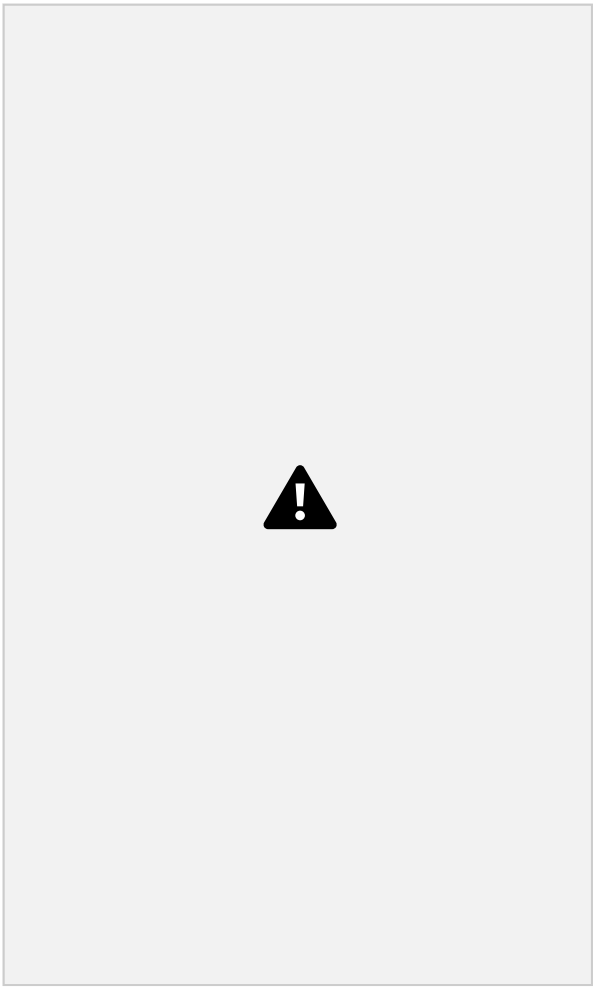
no name chapter

here i explain stuff that went wrong, possible solutions, future problems. **Labeling Images**

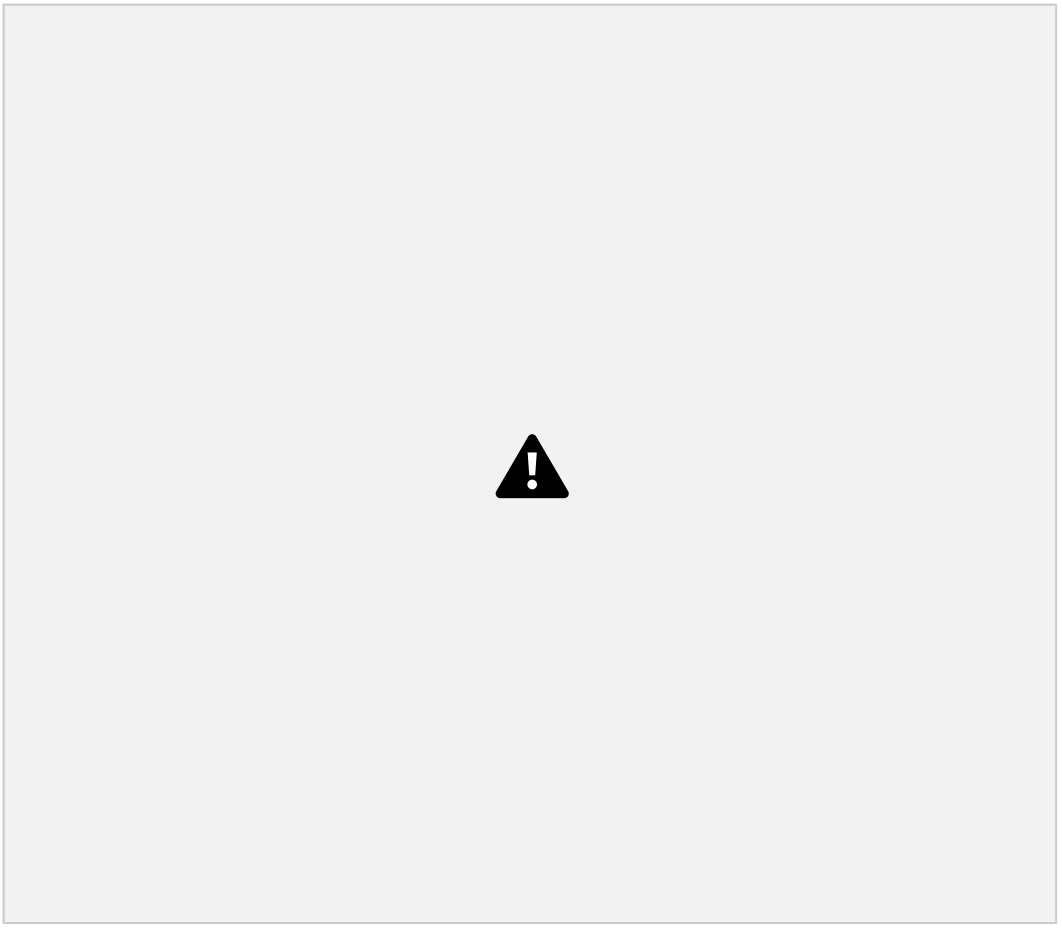
As expected, this takes ages. but I might have encountered some issues that might make everything even more complicated. Also did I write down general things I noticed which I might be able to improve in future iterations.

Graphic Overlap

Volkov just landed on the wall generating orange clouds. Koji just jumped away leaving a gray cloud trail. Both of these graphics overlap with Volkov making it harder to detect Volkov. I don’t know if this will be an issue. I also would have no idea how to fix it.

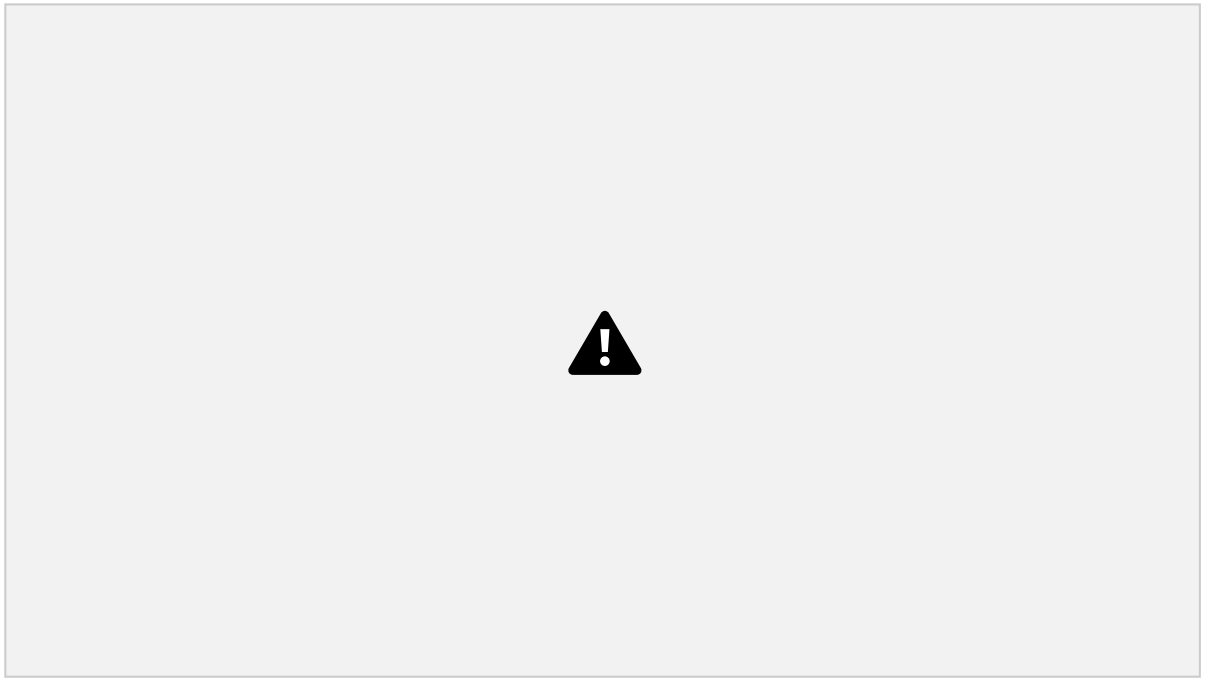


Alsorememberthebluearrow I enabled? italsooverlapsVolkov, so I shouldonlyenablethe bluearrow if i’mactuallygoingtouse it



Hit Colors

If you hit someone or get hit. Your body will have a different color while you are stunned. Your body color represents the amount of damage you took. As you can see Volkov changes orange, and his damage is orangish. Brawlhalla has 4 body colors: white, yellow, orange, red.

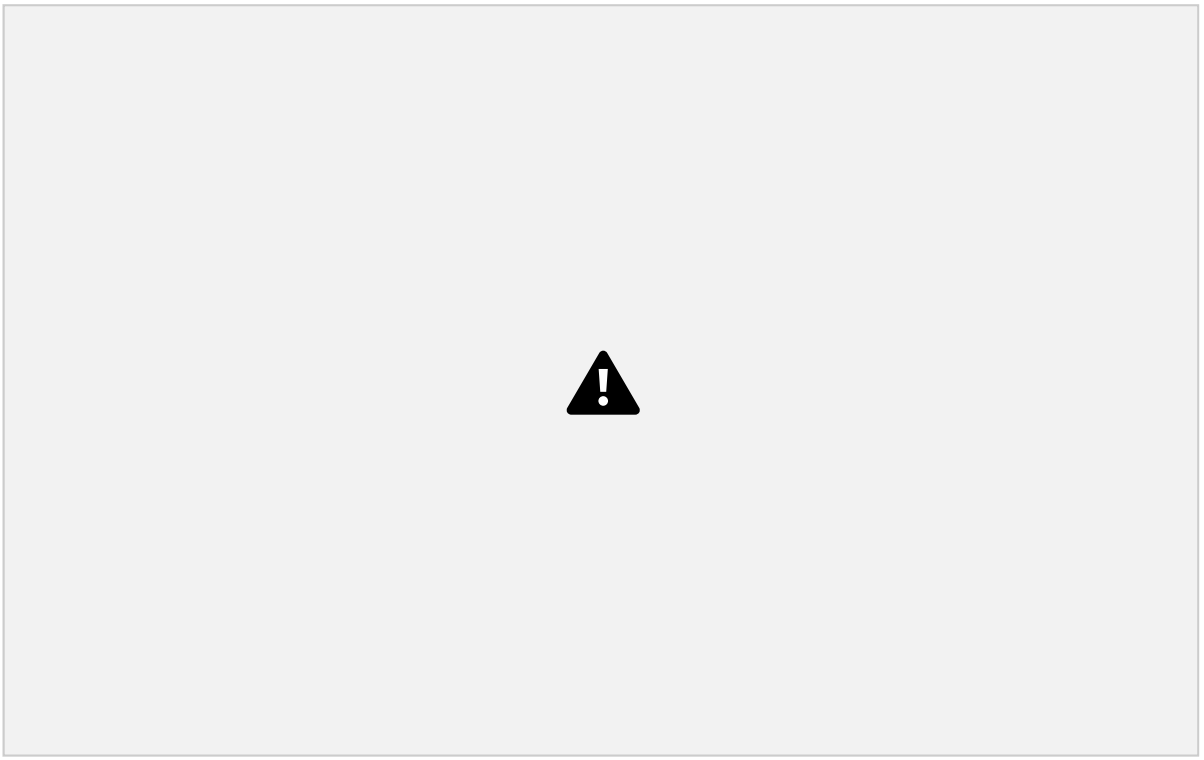


This might mess with the object detection since most of the training data is just volkov with

his normal colors. Few of the training images are volkov with a damage-body color. Meaning the model might have a hard time with these. The lesson I can learn here is to get more training data of someone damaging the other. As last, since Volkov changes color, object detection might understand roughly what someone his damage is, meaning the top right damage detection might be unnecessary.

Bubble

If you leave the screen you don't instantly get knocked out. instead, a bubble gets put around your legend. if you go further a bit, then you get knocked out. Here’s a drawing of what I'm trying to explain.



You might see the issue here, the AI will get confused with the actual area of the enemy. I might fix this by detecting the bubble. On the other hand, since the legend is inside of the bubble, the AI might understand he’s in the bubble by the brightened background. So for now I’ll keep this hanging.