Design, Implementation and evaluation of different strategies for playing Pokémon battles
Proposal

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1 Introduction

Pokémon is a video game series created by the Pokémon Company. The goal of the game is to not only catch Pokémon, but also to train them and use them to battle other trainers. In the mainline games, the focus lies on the story as well as exploring the world. The Pokémon genre has evolved quite a bit since its early days, Figures 1 and 2 contain screenshots of the first Pokémon games, Pokémon Red and Pokémon Green. Figures 3 and 4 contain in game footage

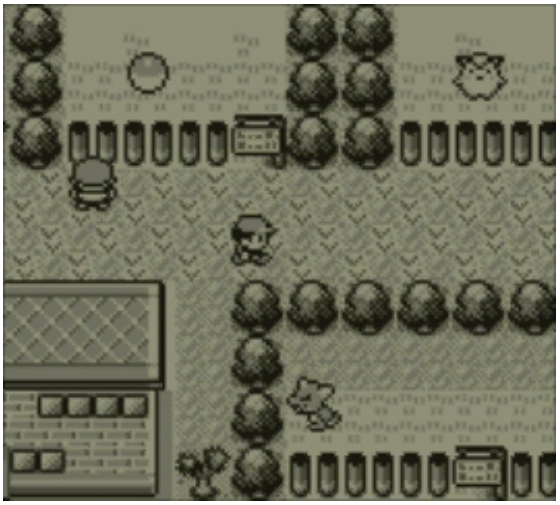

Figure 1: Exploring the map in Pokémon Red

Figure 2: Fighting another trainer in Pokémon Red

Image source: nintendo.de

of the latest games in the series, Pokémon Sword and Shield. This thesis will focus exclusively on battling as there are detailed lists of the locations of everything there is to explore within the games.

2 Prerequisites

Nintendo does not provide an API for the game, however, the fan project Pokemon Showdown is a free online tool that can be used to battle online trainers. On top of that, it provides the functionality to use their simulator offline in an CLI. The entire source code for Pokémon Showdown can be found at Github. Additionally, the python library poke-env is used as it provides a convenient interface to Showdown.
The combination of both tools allows to easily perform deep reinforcement learning on a local running instance of Showdown, and evaluating models against human players on the official Pokémon Showdown server. Figure 6 shows a battle between two human players on Pokémon Showdown. Lastly, the creators of Pokémon Showdown provided me with over 8 Million replays of games played by humans.

Figure 3: Exploring the map in Pokémon Sword.
Image source: pokemon.com

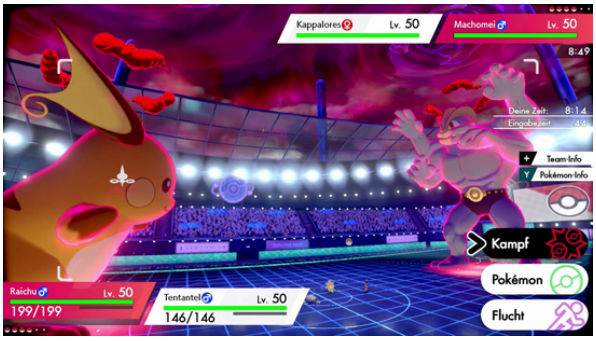

Figure 4: Fighting another trainer in Pokémon Sword
Image source: nintendo.de

3 Battling

There are multiple popular battle formats in Pokémon as well as in Pokémon Showdown. This research will focus exclusively on the most popular category on Showdown: Random battles with Pokémon from all different games.
Note: In the mainline games items also play a huge role in battle, as they for example allow the revival of a fainted Pokémon. In competitive play items are banned, only held items allowed. A held item can for example allow a Pokémon to more often be able to attack first or trade in defensive stats for offensive ones.

3.1 Fundamentals

At the start of the game, each player gets 6 different random Pokémon. A player knows all 6 Pokémon he has with all their available moves, yet, he only knows the active Pokémon of his opponent. Additionally, the player does not know what moves the opposing Pokémon is able to use. Each Pokémon knows 4 different moves, a move can either *attack*, *strengthen* himself or the own team, or *weaken* the enemy Pokémon or team by for example poisoning the enemy Pokémon.
Pokémon battles are turn based. Each turn, both players either choose a move for their active Pokémon, or switch to another Pokémon of the team.

3.2 Type advantages

The game implements rock-paper-scissors-like system. Each Pokémon has one or two types, each move has a type as well. A Pokémon has a *type advantage* against another Pokémon, if his moves deal extra damage against the opposing Pokémon. Figure 5 shows how every type interacts with every other type. For example, a **Fire** deals normal damage against **Electric**, twice as much damage against **Bug** and only half amount of damage against **Rock**.
Note: These damage modifiers are multiplied with each other, so if a fire move were to hit a Pokémon with type electric and bug, the move would deal the usual amount of damage.

3.3 Showdown battle interface

Figure 6 is taken from an ongoing battle on Pokémon Showdown. The red marking shows the remaining hit points (hp) of player one's active Pokémon. As the bar is completely full, the Pokémon still has not taken any damage. Once a Pokémon has no health remaining, it faints, and the player has to switch to another Pokémon. The enemy Pokémon only has 33% of its health remaining. As highlighted by the green marking, the enemy Pokémon is called "Kommo-o", is male and has level 80. In the blue marked area, the status effects are displayed. For example, the attack-stat of "Kommo-o" is raised by 50%. Framed yellow is the team of the opposing player. Both grayed out Pokémon are fainted and therefore can't be sent into battle, the fully colored Pokémon are still alive and the ball in the bottom right corner indicates one unknown Pokémon the player hasn't sent out yet.
Below that, the four moves the Mewtwo can pick from are displayed. In this case, these moves are **Fire Blast**, **Recover**, **Psystrike** and **Nasty Plot**.

3.4 Advanced battling strategies

In section 6 a simple rule-based approach is introduced that always picks the move that deals the most amount of damage. However, picking an optimal move is a lot more complex than this. Pokémon battles are not just strict one

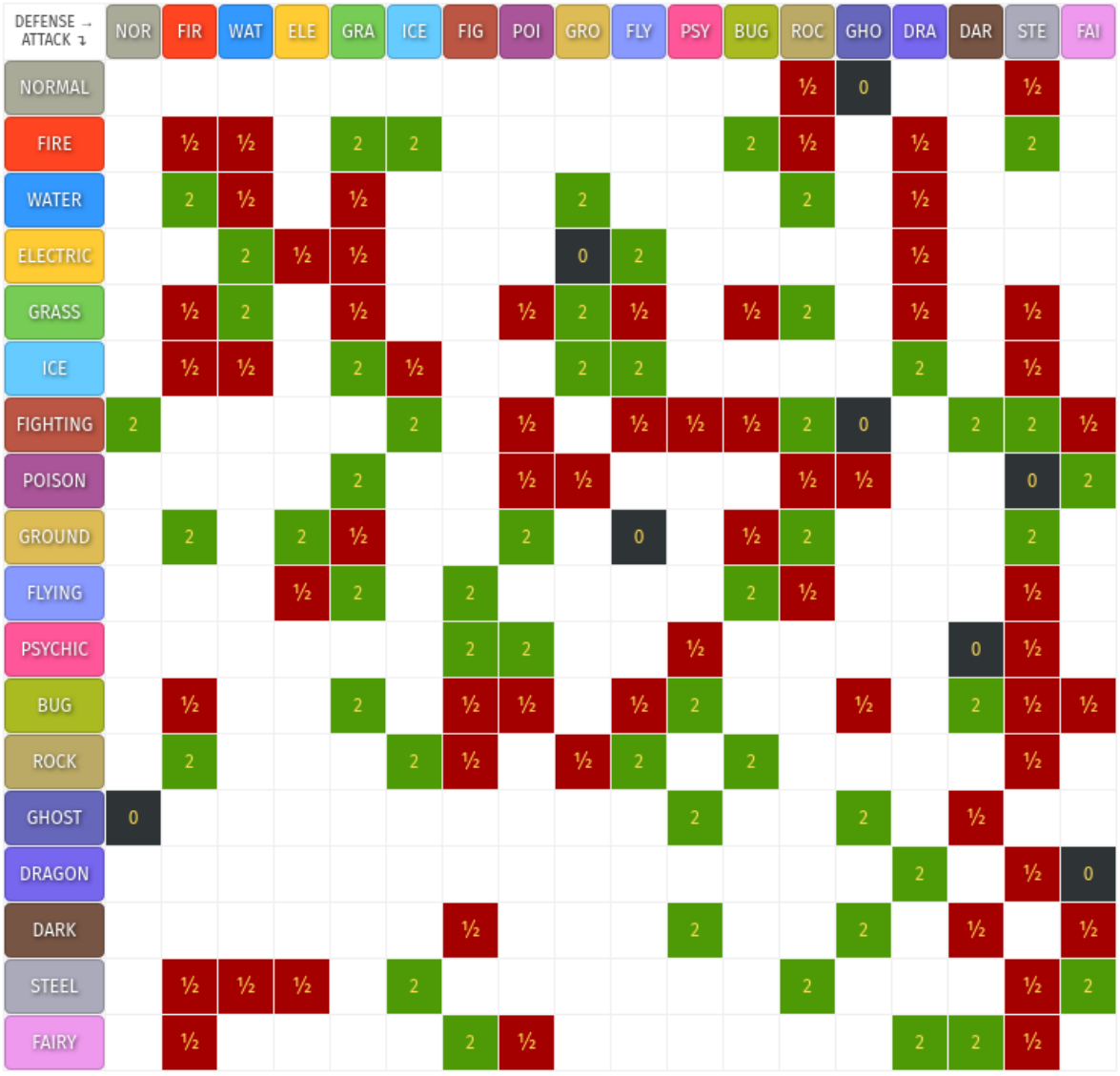

Figure 5: Type chart
Image source: pokemondb.net

on one battles where the player with the most damage dealing Pokémon always wins. In competitive play, a wide variety of non- or low-damaging moves is used. Dragon Dance for example, does not deal any damage to the opponent, but increases the damage the Pokémon deals in the next turns.
Additionally, each Pokémon can play one or more different roles where the play styles, again, counter each other in a rock-paper-scissors-like fashion. Identifying in a random team what play style to pick for which Pokémon is essential to winning battles. This decision is also based on the play styles the opponent chooses.
Lastly, predicting enemy decisions is a key component of competitive play. For example, if the Pokémon of player one has a type advantage against the Pokémon of player two, the opposing player may switch to another Pokémon. As a possible counter-play, the first player could pick a move that will deal less damage against the current opposing Pokémon but is also good against the Pokémon he assumes the enemy to switch to.
These elements turn competitive Pokémon in a game where traditional strategy and probability management are combined with information management.

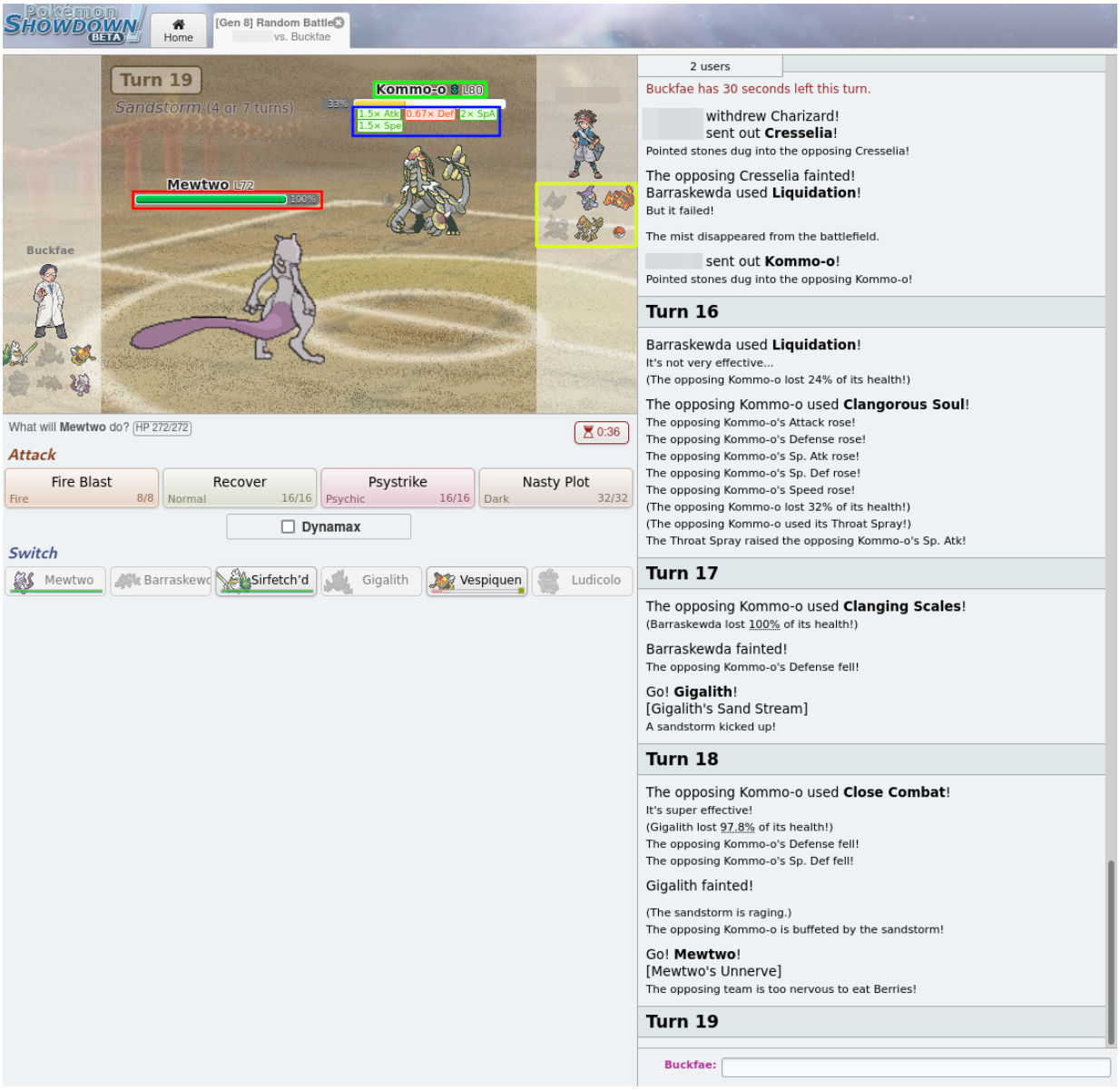

Figure 6: Screenshot of me battling a random opponent

4 Execution

This thesis will investigate multiple possible approaches to optimize battling. The first approach will be rule-based. Different complexity levels will be tested against each other. Knowledge extracted from replays will be used to design the rules.
In addition, a reinforcement learning algorithm will be tested. The possibility to pretrain the network using either rules or replay data will be investigated as well.

5 Evaluation

The poke-env library provides not only a random player, but also a max damage player that always chooses the move with the highest base damage. A simple RL approach is given as well. These three agents will be used as baseline.
Pokémon Showdown also has an elo rating system similar to chess. The authors of Showdown allow bots to compete in ranked matches, so the approaches developed in this thesis will also be evaluated by playing ranked games against actual humans.

6 Example rule-based approach

During testing of the technical feasibility of this approach, I developed a simple rule-based approach.

6.1 Damage Calculation

The expected damage a move will deal to an opposing Pokémon is calculated as follows:

$$\text{Expected Damage} = \text{Move Base Damage} \times \text{Move Type Modifier} \times \text{Stab Modifier} \times \text{Move Accuracy}$$

Stab Modifier: If the type of the move is equal to one of the possibly two types of the Pokémon, the move will deal 1.5 times more damage.

6.2 Rules for playing

Deciding on the next move is purely based on the expected damage in the current turn. If a Pokémon faints, the next Pokémon to switch in is picked based on the expected damage it can deal to the opposing Pokémon.

6.3 Evaluation

This approach was evaluated against a random player and a player that always chooses the move with the highest base damage. In 500 games, this approach won 484 out of 500 games against the random player and 419 / 500 games against the player that always chooses the move with the highest base damage.
After training the example DQN-Agent proposed in the poke-env documentation for 1 Million steps, this rule-based approach was able to win 666 out of 1,000 games. In ranked matches against actual players, this rule-based approach was only able to win about one in three games, resulting in the player getting stuck in the lowest elo group[1].

7 Time Management

Following table shows the general timeline for this thesis.

	Time in weeks									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mechanics of the game	x									
Extracting Data from replays		x								
Rule-based approach: Implementation			x	x						
Buffer					x					
Reinforcement learning: Research						x				
Reinforcement learning: Implementation							x	x		
Writing	x	x	x	x	x	x	x	x	x	x

Table 1: Time Management in weeks

[1] In Pokémon Showdown, you can't have less than 1,000 elo