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4/24/2022
DS2500
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Project 2 Report

Problem Statement:

What are the most important aspects of a Pokemon that make them more viable for battle and how important is making smart move choices when predicting the outcome of a battle?

- Which Pokemon Types tend to win the most 1-on-1 battles?
- Which Pokemon stat is the best indicator of a Pokemon's likeliness to win?
- How important is making smart move choices when battling Pokemon?

Background:

Our motivation for answering this question comes from knowing what it's like to be both a new and a well experienced player in the mainline Pokemon games and wishing for a way to find some general rules by which to make more viable teams. Answering this question is important for new and veteran players of the Pokemon games alike. For new players, it can help give meaningful advice on how to craft a team strong enough to beat the main story of each game, as well as letting them know which Pokemon types are generally more "beginner friendly" (Pokemon that don't rely on debuffs or status moves to function). For more experienced players, the results of our analysis could help them decide which stats to "EV Train" or "IV Train" (training methods for advanced competitive players which focus on increasing a specific stat in one Pokemon) as well as which natures (an inherent trait for each Pokemon which can increase or decrease certain stats) to seek out for their Pokemon.

Alongside the players themselves it could also be beneficial for the developers of the game by allowing them to easily see which stats or Pokemon types need to be weakened in future installments for balancing reasons. A practical application can be seen with the introduction of Dark types in Gen 2 to help weaken psychic types - which were notoriously overpowered in Gen 1 - or the introduction of Fairy types in Gen 6 to help weaken the Dragon

type which has always been extremely powerful. This can lead to a decline of unbalanced Pokemon in future installments.

Introducing out Data:

Our data comes from *Competitive Pokemon Dataset | Kaggle* consists of two CSV files: the first being a list of all Pokemon (and their variations) with their names, stats, abilities, moves and generation, and the other being a list of all 710 moves including their names, stats, competitive contest, and generation. The data is up-to-date as of 2016, so it is missing the most recent Generation 8 titles, Pokemon Sword and Pokemon Shield. The data was scraped from *Pokemon | SM | Smogon Strategy Pokedex* and *List of moves - Bulbapedia, the community-driven Pokémon encyclopedia (bulbagarden.net)*, two community run wikis.

Important Data Points:

The Pokemon CSV file included 12 different attributes for 918 Pokemon. “Duplicates” were found due to Mega Evolutions and Regional forms being counted as different Pokemon; we ultimately decided to only count the base Pokemon. The specific attributes we looked at were name, type(s) (e.g. Fire, Water), health, attack, defense, special attack, special defense, speed, and their learnable move list. Aside from the name, which is needed as a way to refer to each Pokemon in testing, and speed, which determines who moves first in a battle, is necessary for calculating the amount of damage done with an attack. We decided not to factor in passive abilities such as regeneration or damage return, as that would require hard coding the effects of those abilities for each ability.

The Moves CSV file included 9 different attributes for 710 moves. The specific attributes we looked at were name, type, category (Special or Physical, as that determines what stats were used in the damage formula), and base power. We decided to ignore status moves, for the same reason we ignored abilities, and the fact that they usually do base 0 damage. In addition, we ignored both the accuracy and PP (number of times a Pokemon can use a move) of moves as we thought that would have too little of an effect on our simulations. Traditionally, Pokemon

could only use 4 different moves in battle, and we thought that players would seek out a varied moveset. Thus, we made sure that Pokemon were attributed with 4 moves such that there were at least 2 different types of moves, 2 different categories of moves, and the Pokemon had chosen the moves with the most power under the previous conditions.

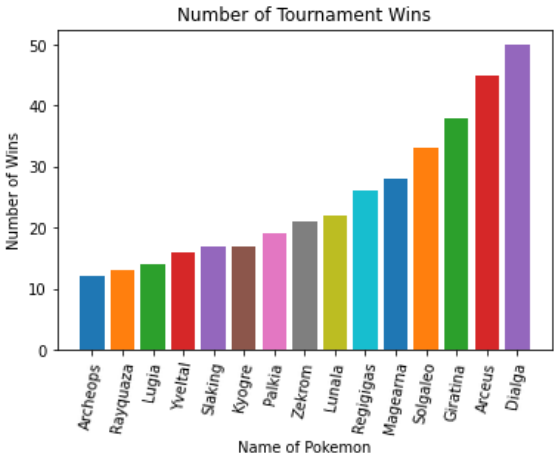
Data Science Approaches:

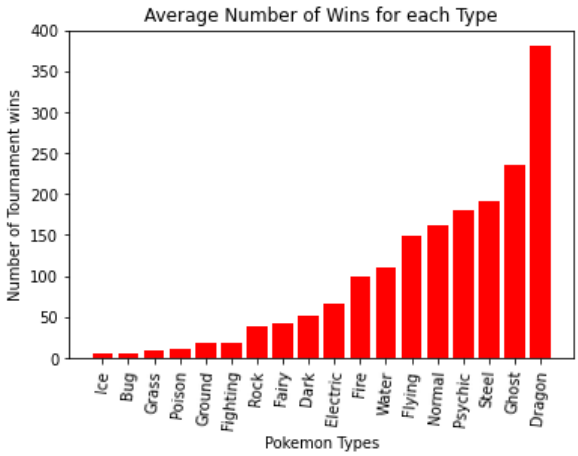
The first Data Science technique we applied was the **Monte Carlo Simulation**. We used a Monte Carlo Simulation to see the difference in number of games won between two scenarios: one where both parties fight with equal levels of strategy (using the move that will do the most predicted damage) and one where only the player Pokemon uses the strategy and the Opponent randomly selects from one of their 4 moves. By simulating hundreds of experiments over multiple trials, we could accurately graph the average number of wins per experiment on a histogram. These simulations could be run with any Pokemon to show how important smart move choices are for all Pokemon

The second Data Science technique we deployed was the **Linear Regression Model**. By applying a Linear Regression model to each Pokemon's stat value against the number of times the Pokemon won over large amounts of tournament simulations, we can easily look for any correlation between a specific stat and the chances of winning. Seeing this allows us to easily identify which stats are the most important when it comes to winning battles, as a stat with a high correlation with the number of wins implies that stat is a good predictor for a Pokemon's ability to win. We decided to omit any Pokemon that won less than 3 times overall, as those data points would drag our linear plots down significantly.

Results:

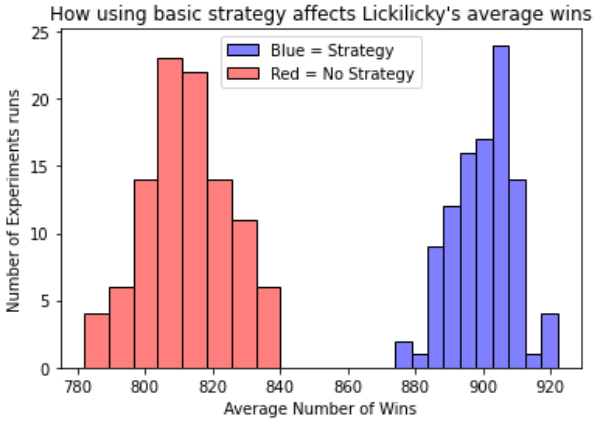
Below are the results for our simulation of 500 Tournaments between every Pokemon. We decided to plot not only the individual Pokemon that won the most tournaments, but also the Pokemon type that own the most overall.





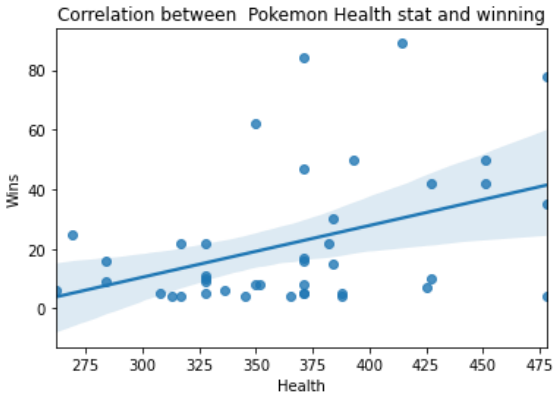
It appears that the most frequent winners of the tournament were Dialga, Arceus, and Giratina and the most common types which won were Dragon, Ghost, and Steel. These types generally had resistances and even immunities to popular damage types. Something to note in terms of the results of the types graph is that while Ice, Bug, and Grass may be at the bottom of the list it doesn't necessarily mean they're objectively worse than other types. This just means they might require more strategy to use effectively. For example, some of these Pokemon rely on status effects and debuffs, which were systems that we didn't implement. One interesting thing we can see from the frequent winners graph is the inclusion of Slaking and Archeops which are the only two non-legendaries on the list and both of which have limiters that hinder their abilities to make them more fair in-game. Because we didn't account for abilities in our simulations though, they performed abnormally well.

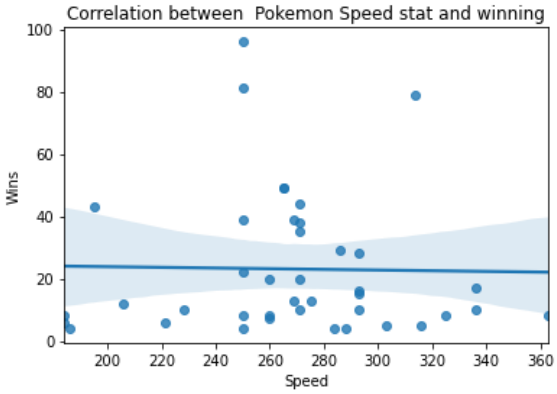
The results from a Monte Carlo simulation with 100 experiments of 1000 trials each using Lickilicky (our favorite Pokemon) as an example to investigate the importance of strategic move selection in battle is pictured to the left. As can clearly be seen, there is a significant difference in the average number of wins per battle given that a strategy was in place. The average number of wins jumped almost 10%

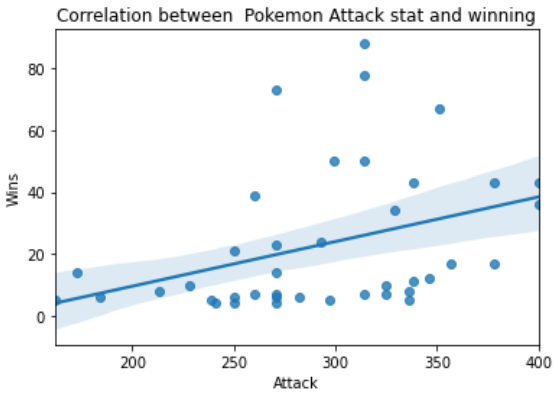


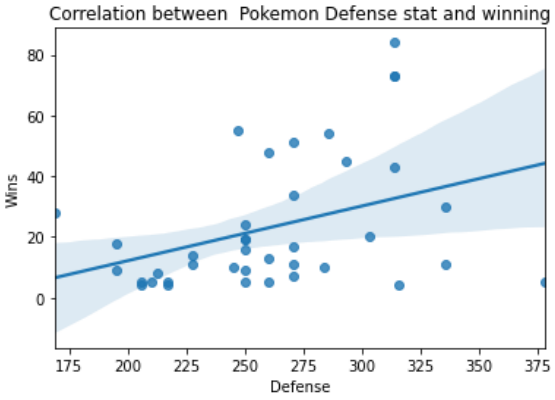
with just the implementation of a simple strategy (using the move which will do the most predicted damage). While players might find it tedious to calculate damage for each possible move-Pokemon combination, this shows how vital conscious move selection is.

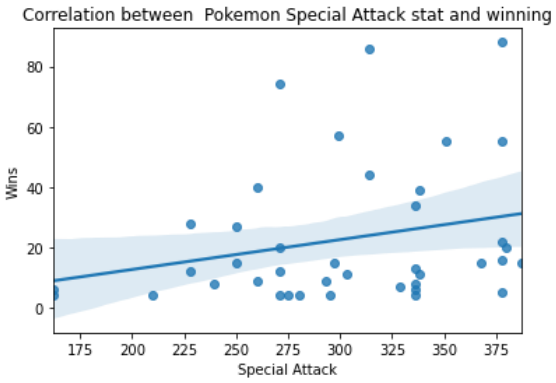
The results of the Linear Regression plots for each individual stat can be seen below.

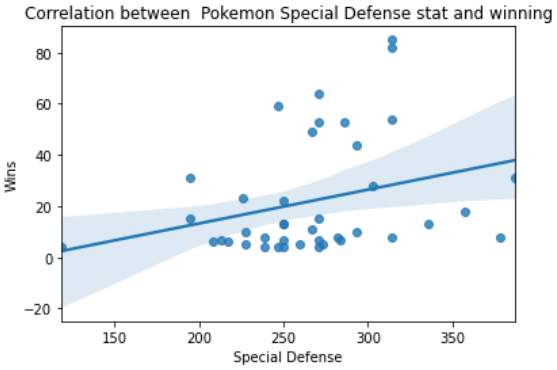












Not pictured in the graphs, but equally as important, the correlations for health, speed, attack, defense, special attack, and special defense are .4096, -.0196, .3629, .3752, .2530, and .2948

respectively. Drawing from this, we can see that the health stat has the strongest correlation with winning and the speed stat has the least amount of correlation (almost 0, implying that speed barely influences a Pokemon's chance of winning) with the rest being somewhat similar, although attack and defense seem to be somewhat better than special attack and special defense but that could be the result of not taking accuracy into account. Special attacks generally tend to land more often, but are weaker for balance.

Conclusions:

From the results of this project, we can gather a few findings that are applicable for new players, veterans, and developers alike. For new players, it's important to at the very least understand the different type match-ups and STAB (Same Type Attack Bonus) damage modifiers to best utilize their attacks and pick the most damaging moves. New players should also stick to types that are easy and straightforward to use in battle, such as Dragon, Ghost, Steel, and Psychic and avoid harder to use types such as Grass, Ice, and Bug. More experienced players should focus on training their Pokemon in their Health stat since it has the highest correlation with winning and maybe be more lenient with having a lower speed stat as a payoff since speed had no correlation with winning. Developers could take from this that Dragon types tend to be dominating the tournament results and might need to be weakened in future installments to create a more level playing field.

Future Work:

There are many complexities to battle which we didn't include in our battle simulations that we could account for in future work. Such features include: Non-Damaging moves, move accuracy and PP, weather effects, status effects, items, and abilities. Adding these features to battle could not only help create a more accurate representation of what types and Pokemon are "good," but also add another layer of complexity to the simulations. Another element to look at could be to remove legendaries from the running as they are only available in the post-game, making them poor candidates for a realistic in-game team. Overall, while our work leaves out

quite a bit of core game mechanics from the real Pokemon games, we found an important look into what's important when choosing which Pokemon to add to your team and the strategies of battling.