Pokémon Six vs Elite Four

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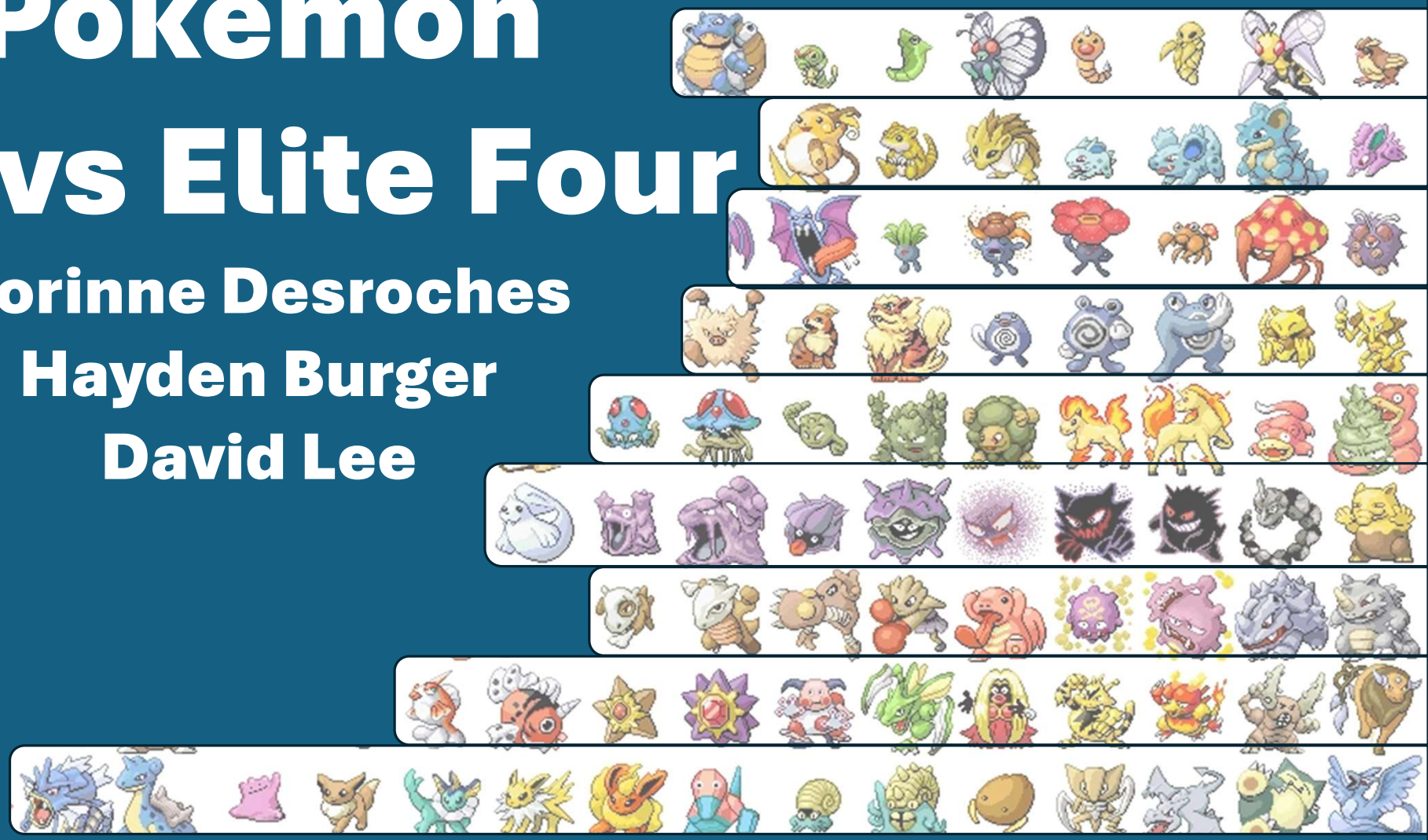

Experiments

Mechanics

Data

Assumptions

Background

- *Pokémon*: game franchise where players battle with teams of fantasy creatures
  - Complex rock-paper-scissors-etc style elemental types give advantage and disadvantage
  - Speed, attack, defense, type advantage, hit points, status effects, move sets, etc. for each Pokémon
  - Teams of up to six
  - Elements of strategy show up via team order, team type, team stat composition, and multi-team strategies
  - Elements of luck from the battle equation which involves RNG for damage and critical hit calculations
  - The Elite Four are one of the final challenges for a player
    - A sequence of four teams to beat and become the Pokémon Champion

When we last left our heroes…

- Previous model only handled 1v1 battles at level 1, and did not track any time component

Experiments

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Problem statement

- How can we most efficiently beat the Elite Four's teams of five Pokémon?

Measures of performance

- Time (6 seconds per round of actions)
- Player's team must survive the gauntlet of all four teams sequentially (20 total opposing Pokémon)

Background

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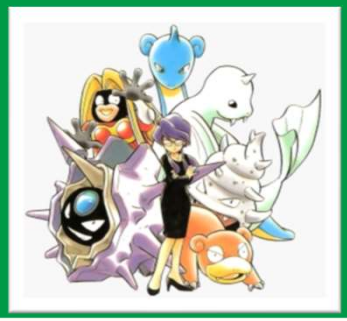
Elite Four Composition

- Lorelei (Water/Ice type)
  - Dewgong, Cloyster, Slowbro, Jynx, Lapras
- Bruno (Rock/Fighting type)
  - Onix, Hitmonlee, Hitmonchan, Onix, Machamp
- Agatha (Poison/Ghost type)
  - Gengar, Golbat, Haunter, Arbok, Gengar
- Lance (Dragon type)
  - Gyarados, Dragonair, Dragonair, Aerodactyl, Dragonite



Experiments

Mechanics

Data

Constraints, Limitations, Assumptions

- Only Pokémon from Generation 1
- All Pokémon now at Level 50
- Base stats used (ignored IV and EV values)
- Moves are randomly picked from all available moves for each Pokémon (to reduce modeler bias)
- Full video game battle/damage equation is modeled
- PP (move use limits) are ignored, no switching, no items
- Testing all 11,853,911,588,401 team combinations repeatedly is computationally expensive
    - Testing a subset of teams will provide data to make further decisions
- Full health reset between the Elite's teams
- Sourced data includes the stats for each Pokémon, equations from the video games, and Generation 1 Elite Four composition
- Experiment of 1,000 attempts per player team against the full gauntlet of the Elite Four

Assumptions

Background

- All the data and equations are available readily on sites like Bulbapedia and Serebii, with the collected data files on Kaggle
- This data was folded into our model to govern the behavior of every entity and their attacks and interactions
- This original, bespoke, high-fidelity model provided us the inputs for the new model

	P	Q	R	S	T	U	
on	against_psychic	against_rock	against_steel	against_water	attack	base_egg_steps	base
1	2	1	1	0.5	49	5120	
1	2	1	1	0.5	62	5120	
1	2	1	1	0.5	100	5120	
1	1	2					
1	1	2					
1	1	4					
1	1	1					
1	1	1					
1	1	1					

	A	B	C	D	E
1	name	level	move	type	power
2	Bulbasaur	1	Tackle	Normal	3
3	Bulbasaur	1	Growl	Normal	—
4	Bulbasaur	7	Leech See	Grass	—
5	Bulbasaur	13	Vine Whip	Grass	35
6	Bulbasaur	20	Poison Pov	Poison	—
7	Bulbasaur	27	Razor Leaf	Grass	55
8	Bulbasaur	34	Growth	Normal	—
9	Bulbasaur	41	Sleep Pow	Grass	—
10	Bulbasaur	48	Solar Bean	Grass	120

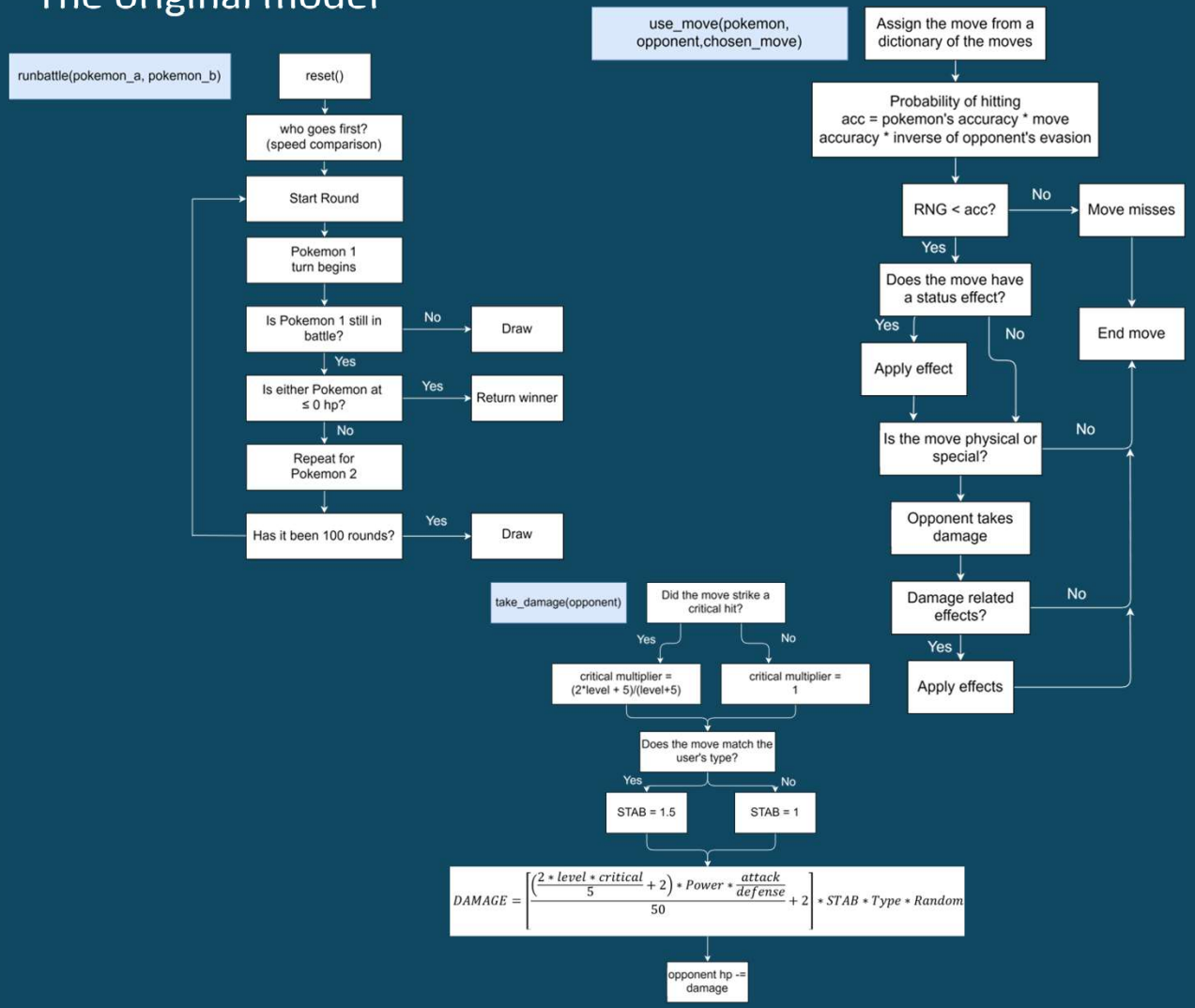
	A	B	C	D	E	F	G
1	Name	Type	Cat.	Power	Acc.	PP	Effect
2	Absorb	GRASS		20	100	25	User recovers half the HP inflicted on opponent.
3	Acid	POISON		40	100	30	May lower opponent's Special Defense.
4	Acid Armor	POISON		—	—	20	Sharply raises user's Defense.
5	Agility	PSYCHIC		—	—	30	Sharply raises user's Speed.
6	Amnesia	PSYCHIC		—	—	20	Sharply raises user's Special Defense.
7	Aurora Beam	ICE		65	100	20	May lower opponent's Attack.
8	Barrage	NORMAL		15	85	20	Hits 2-5 times in one turn.

	Z	AA	
	fense	experienc	he
	49	1059860	
	63	1059860	
	123	1059860	
	43	1059860	
	58	1059860	
100% 40	45	Flame PokÃ©mon	78 1059860
90% 10	45	Tiny Turtle PokÃ©r	65 1059860
100% 10	45	Turtle PokÃ©mon	80 1059860
75% 35	45	Shellfish PokÃ©mc	120 1059860
95% 25			
—% 40			
75% 15			
100% 10			

Results

Experiments

- The original model

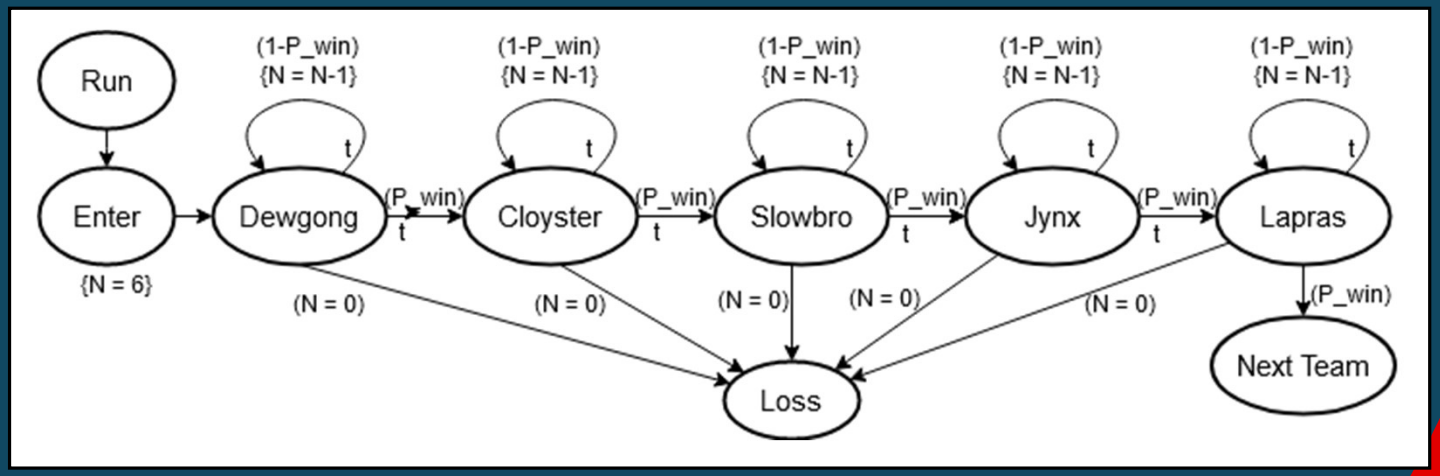


Mechanics

Data

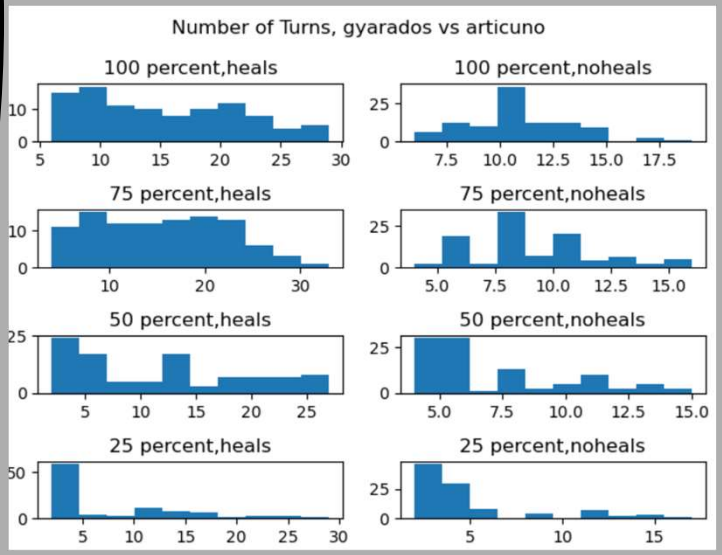
Assumptions

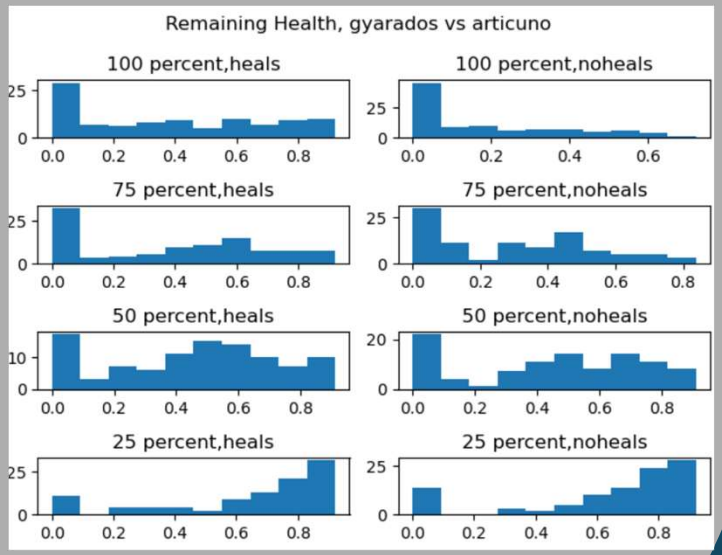
- The new model pits pairs of Pokémon against each otherin turn-based combat until a winner is determined (batch arrivals, turn based serving)
- When a Pokémon is knocked out, the next member of the respective team is entered into combat (FIFO server and customer)
- Whichever team has surviving Pokémon at the end of the battle is declared the winner
- If the player's team is victorious, they are returned to full health and pitted against the team of the next member of the Elite Four (sequential queues)
- All the while, the timer is running



Results

- Initial tests were conducted to seek distributions for the Simio model
- Every pairing of Pokémon returned different data sets with numerous distributions depending on initial conditions and availability of health resets
- Every fitted distribution was fidelity lost, and complexity added to the Simio model
- Python was chosen to ultimately run our simulation





Experiments

Mechanics

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Assumptions

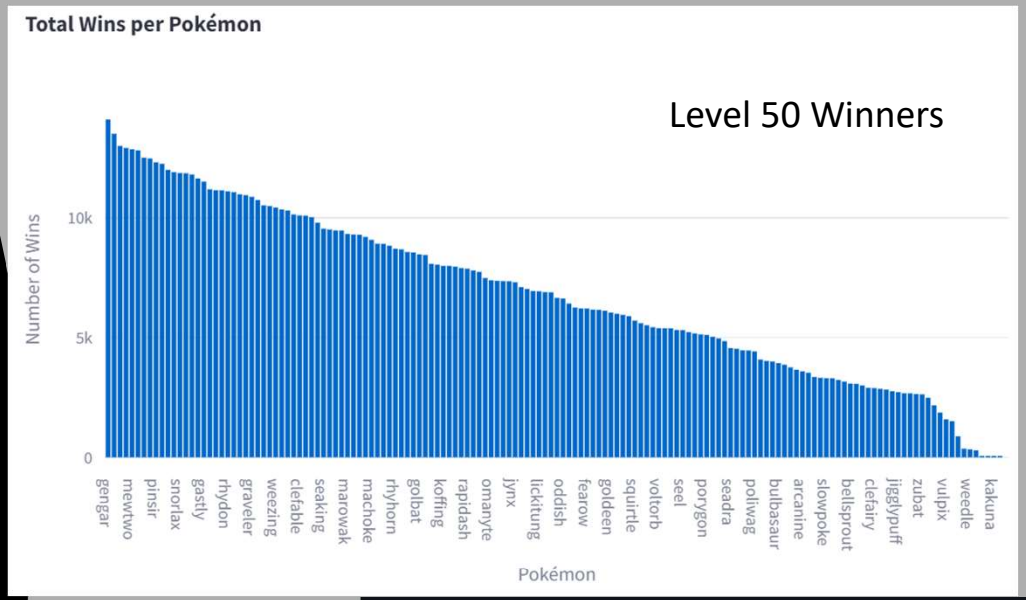
Results

Experiments

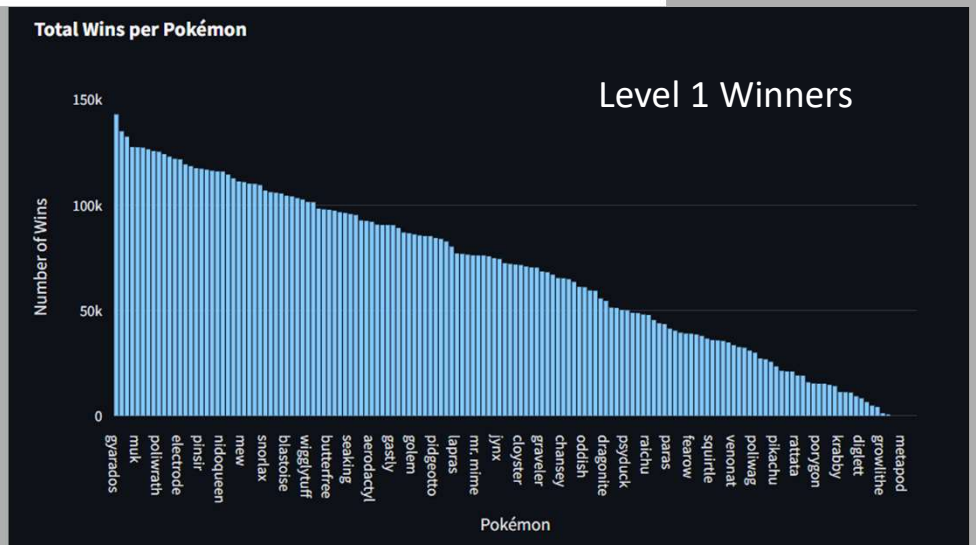
Mechanics

Data

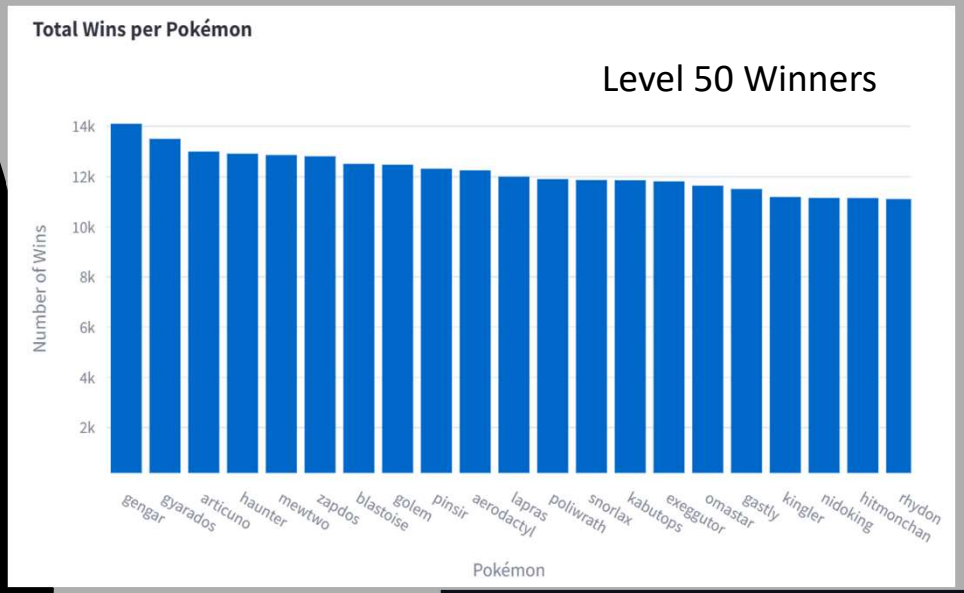
Assumptions



The initial testing showed different winners at level 50 than we had at level 1, with the advent of new and more powerful attacks being available to our competitors

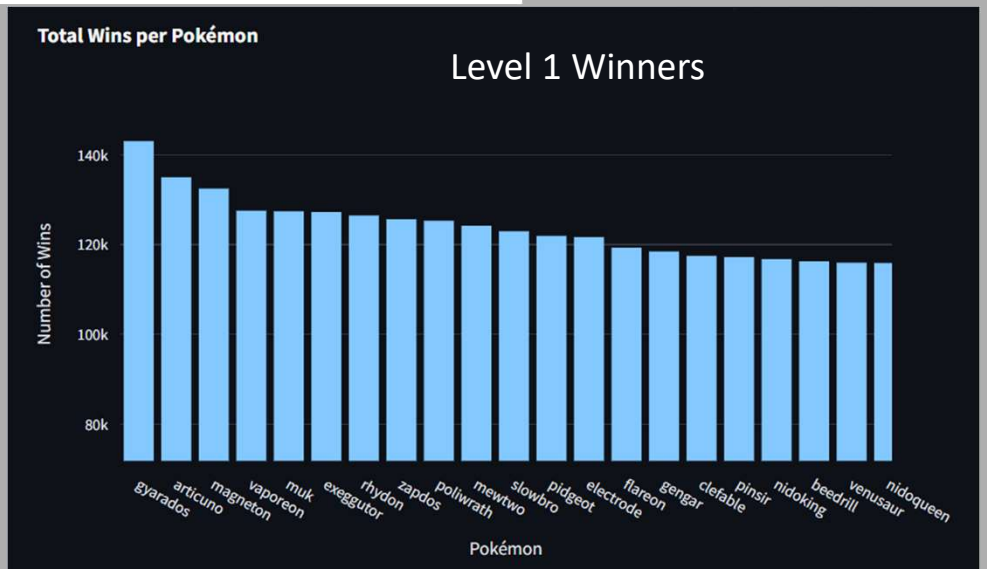


Results



Top winners

- The top six here became Team 7
- Gengar moves from rank 15 to rank 1



Experiments

Mechanics

Data

Assumptions

Results

- 11 teams were chosen for various reasons: previous winners, high hp, high win rate, type advantage, nostalgia, etc.
- Every team was run in forward and reverse against the full gauntlet of the Elite Four
- These attempts were repeated 1,000 times to find the long-term average speed of the successes

Team Number	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6
1	Gyarados	Gyarados	Gyarados	Gyarados	Gyarados	Gyarados
2	Gengar	Gengar	Gengar	Gengar	Gengar	Gengar
3	Articuno	Zapdos	Mewtwo	Blastoise	Mew	Moltres
4	Gengar	Poliwrath	Magneton	Dragonite	Charizard	Alakazam
5	Poliwrath	Himonchan	Machamp	Machamp	Primeape	Hitmonlee
6	Mewtwo	Snorlax	Muk	Vaporeon	Wigglytuff	Chansey
7	Gengar	Gyarados	Articuno	Haunter	Zapdos	Mewtwo
8	Gengar	Articuno	Mewtwo	Exeggcutor	Clefable	Vaporeon
9	Articuno	Zapdos	Moltres	Dodrio	Farfetch'd	Pidgeot
10	Gengar	Lapras	Rhydon	Venusaur	Onix	Growlithe
11	Exeggutor	Gengar	Vaporeon	Clefable	Mewtwo	Articuno

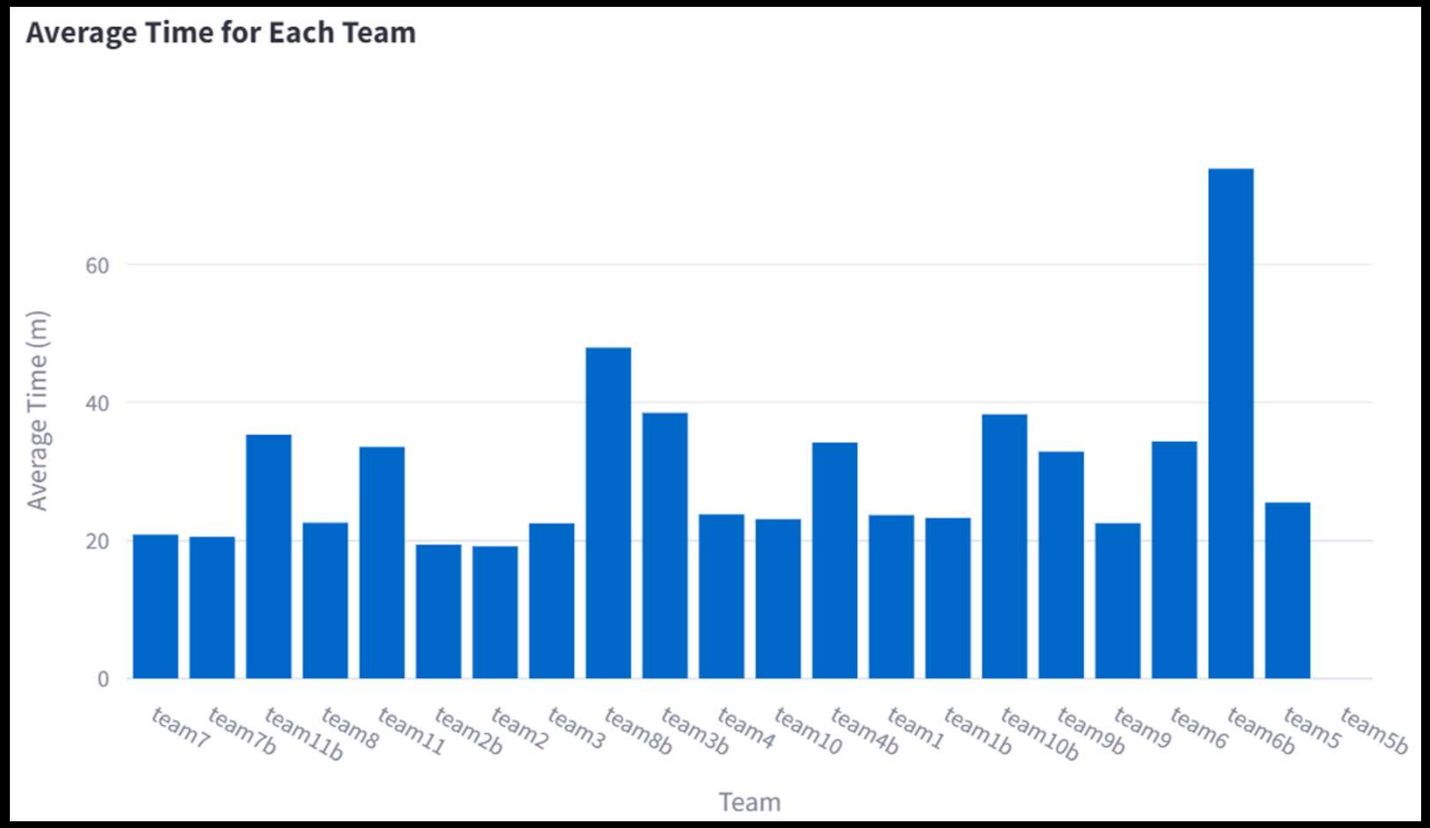
Experiments

Mechanics

Data

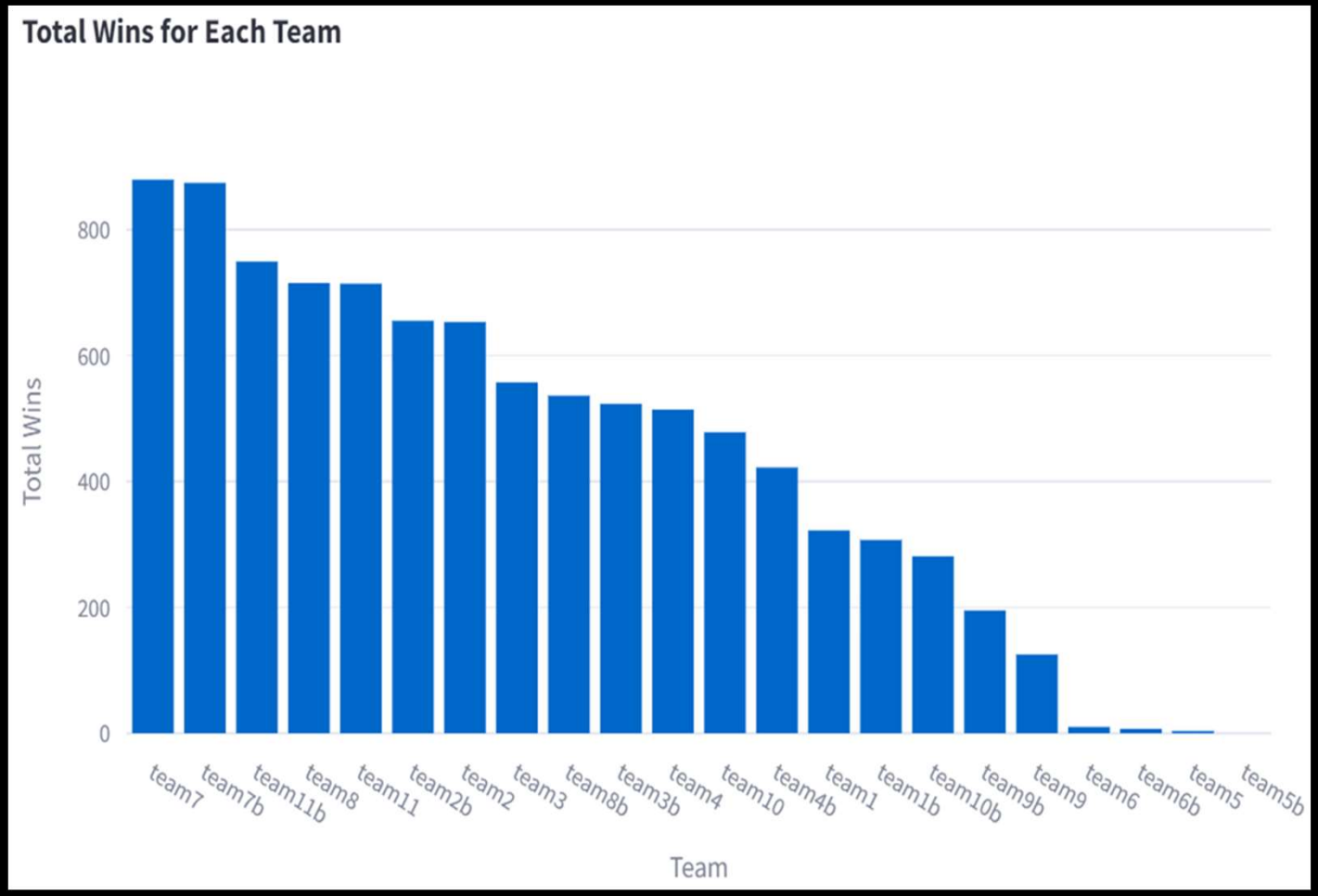
Assumptions

- Of the 11 teams we tested, the fastest team was a little unclear at first
- Multiple teams could win in under 25 minutes, when they won
- Others couldn't win at all, regardless of time



Results
Experiments
Mechanics
Data

- It became much clearer when we involved the win rate as well



Results

Experiments

Mechanics

Data

- The fastest team with the highest win rate was team 7
  - Under 21 minutes (<210 actions)
  - Averaging less than 11 attacks per opponent Pokémon
  - 87.9% win rate
- Gengar, Gyarados, Articuno, Haunter, Zapdos, and Mewtwo should run point on our invasion force against the Elite Four

Losses to Elite Four Members:

	Agatha	Bruno
Defeats	120	1

Further Research

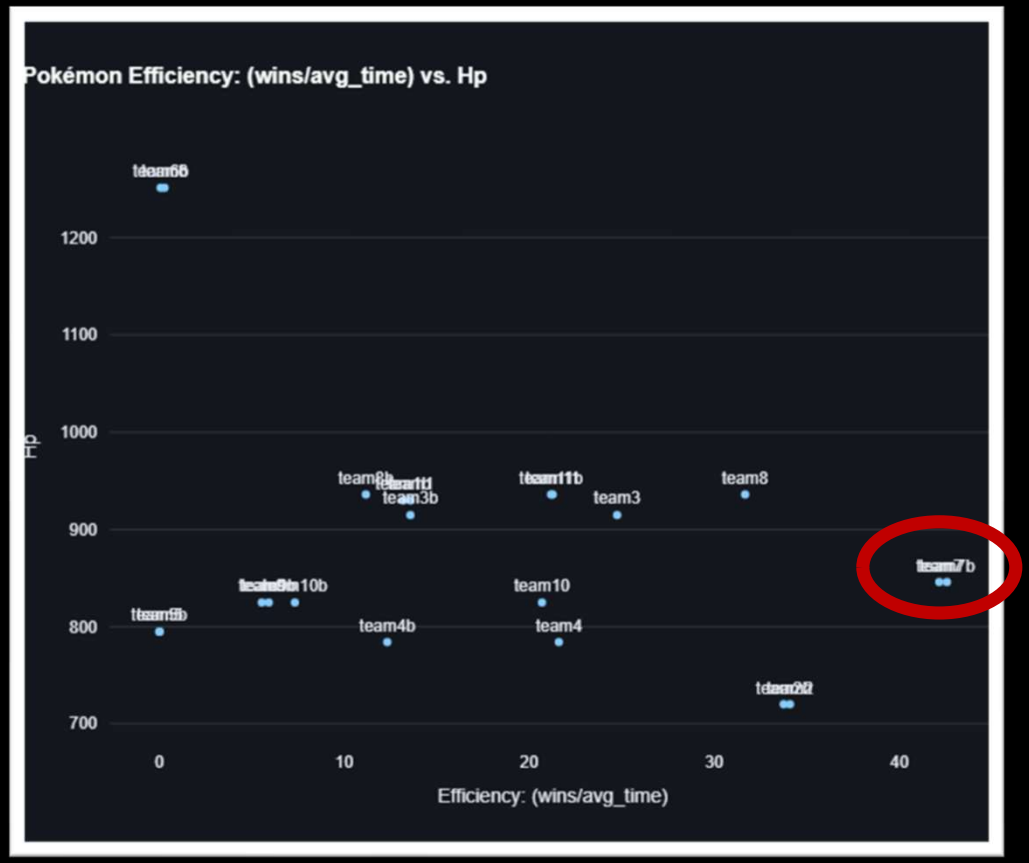
Results

Experiments

Mechanics

Data

Pokémon Total Team Health vs Efficiency (wins/average time)



- Not a strong positive correlation between Health and Efficiency

Further Research

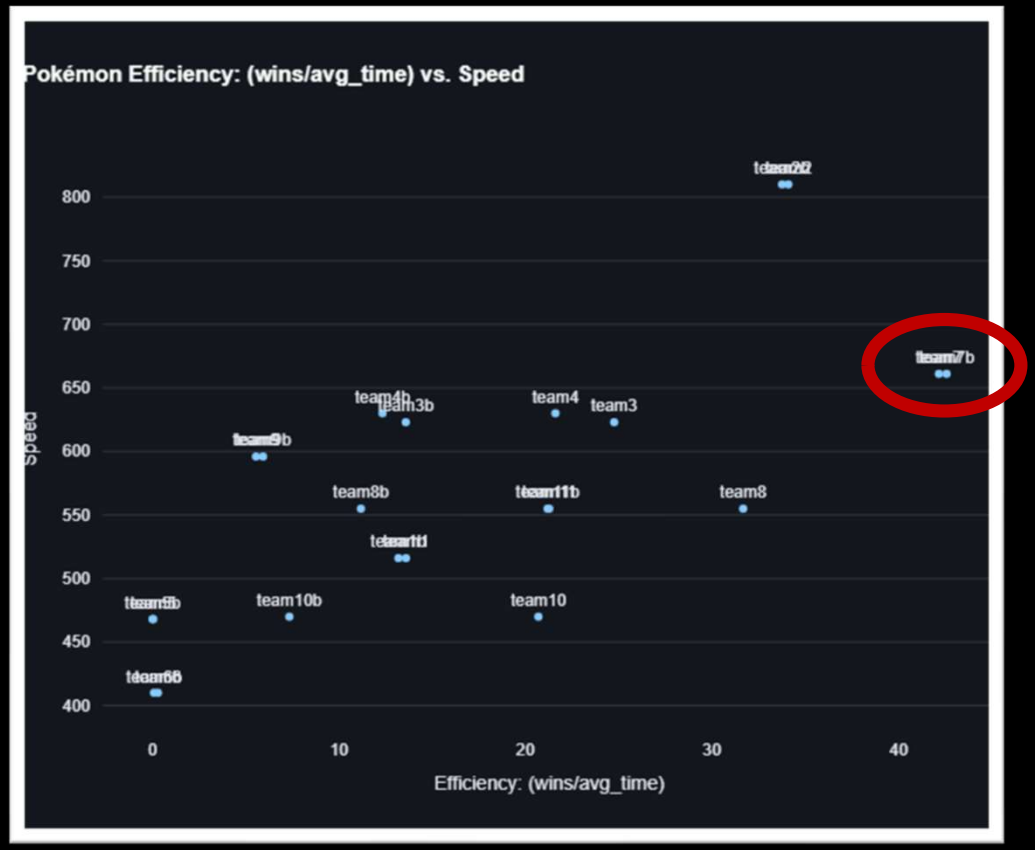
Results

Experiments

Mechanics

Data

Pokémon Total Team Speed vs Efficiency (wins/average time)



- Noticeable strong positive correlation between Speed and Efficiency

Further Research

Results

Experiments

Mechanics

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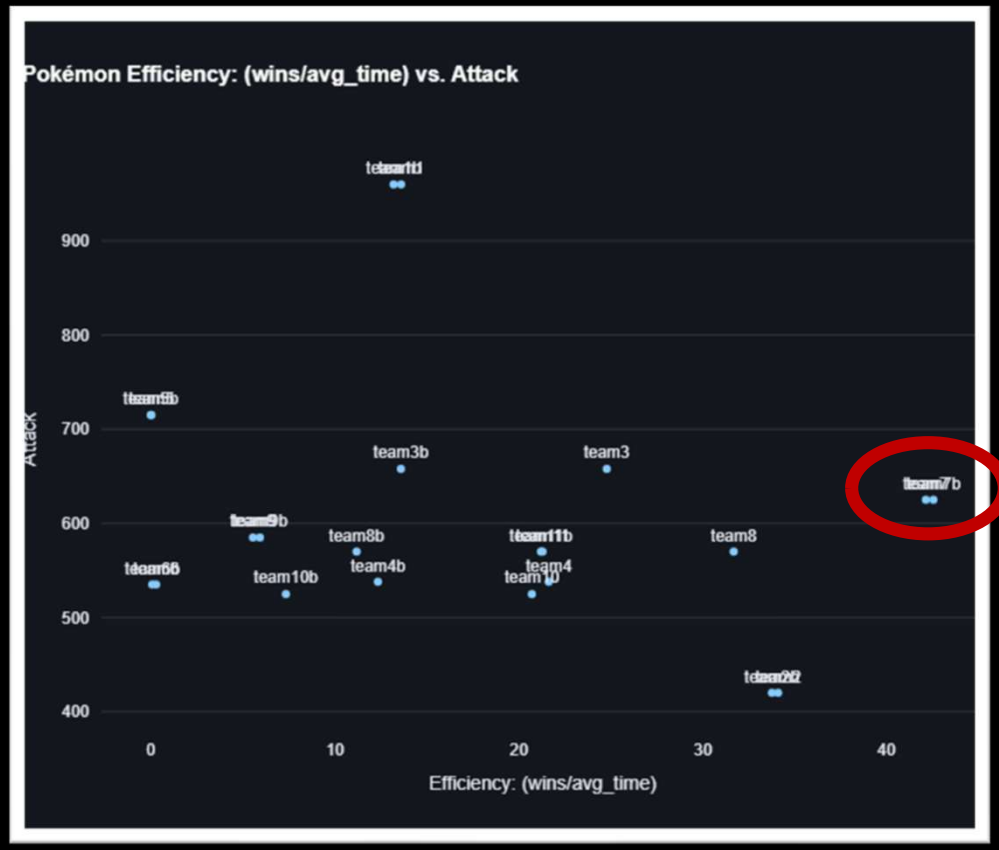
Pokémon Total Team Attack vs Efficiency (wins/average time)



- Little correlation between Attack and Efficiency

Further Research

Results

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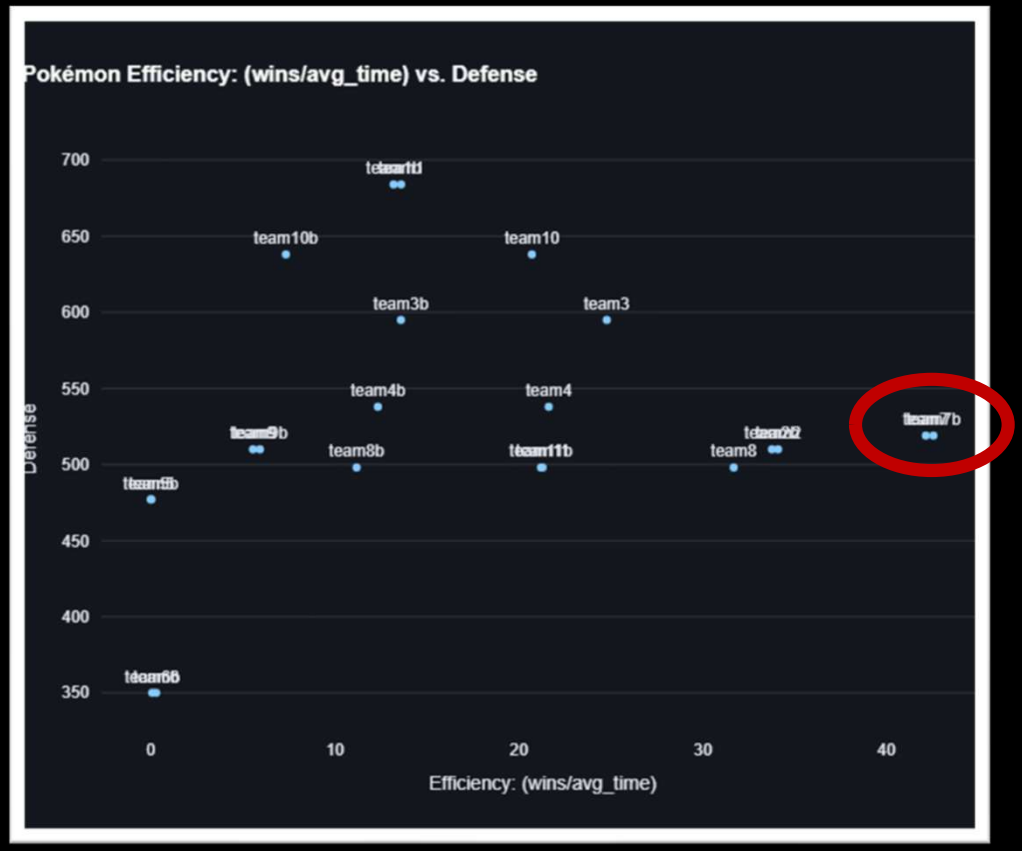
Mechanics

Data

Pokémon Total Team Defense vs Efficiency (wins/average time)



- Weak positive correlation between Health and Efficiency

Further Research

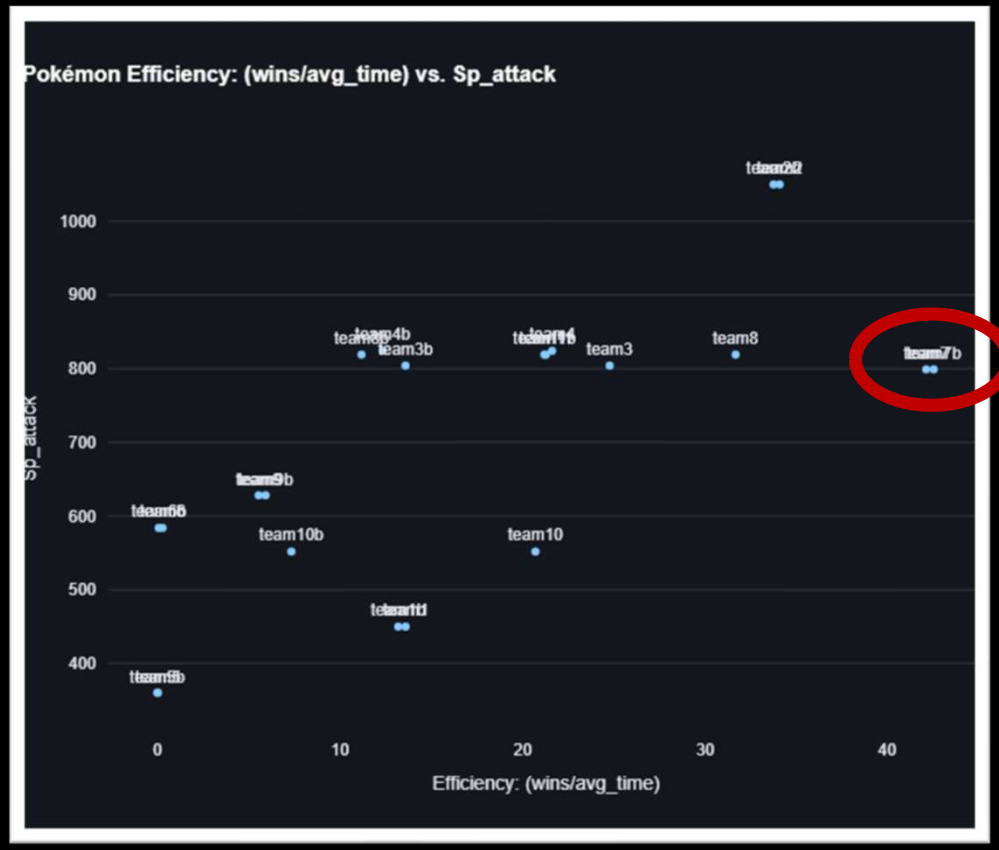
Results

Experiments

Mechanics

Data

Pokémon Total Team Special Attack vs Efficiency (wins/average time)



- Noticeable strong positive correlation between Special Attack and Efficiency

Further Research

Results

Experiments

Mechanics

Data

Further Research

Results

Experiments

Mechanics

Data

Pokémon Total Team Special Defense vs Efficiency (wins/average time)

- Weak positive correlation between Special Defense and Efficiency

Further Research

Conclusions:

- Invest in teams with high speed and special attack stats
- Most teams' orders do not result in significant performance change
- Some models are best performed with Python instead of Simio

- Gengar, Gyarados, Articuno, Haunter, Zapdos, and Mewtwo should run point on our invasion force against the Elite Four
  - Under 21 minutes (<210 actions)
  - 87.9% win rate
  - Highest individual win rates

Team Members:


gengar
Pokedex#: 94


gyarados
Pokedex#: 130


articuno
Pokedex#: 144


haunter
Pokedex#: 93


zapdos
Pokedex#: 145


mewtwo
Pokedex#: 150

Results

Experiments

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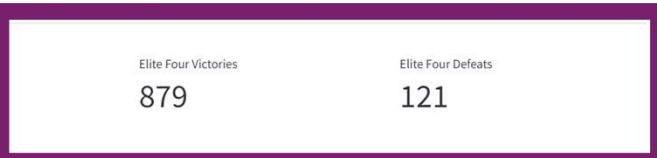
- Find a team that beats Agatha even more consistently
- Repeat experiment at Level 100
- Add move limits (PP)
- Allow item usage
- Allow for move selection input
  - Compare available moves for each Pokémon
  - Do moves affect outcome more than stats?
- Train an AI for each Pokémon to handle the move inputs
- Test all 11,853,911,588,401 possible combinations



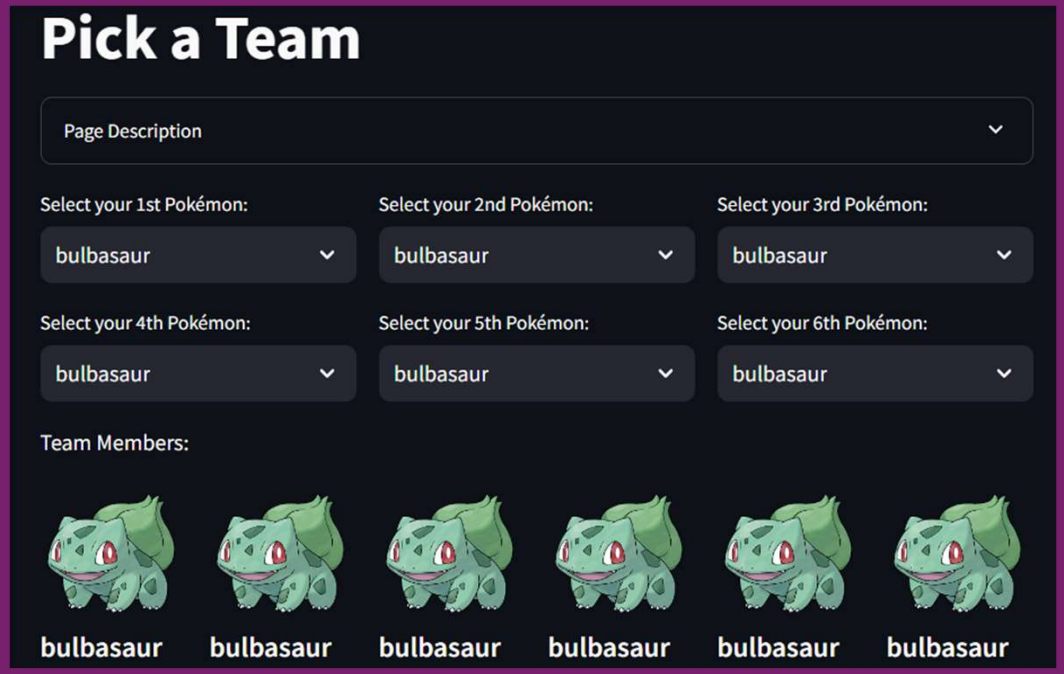
Further Research

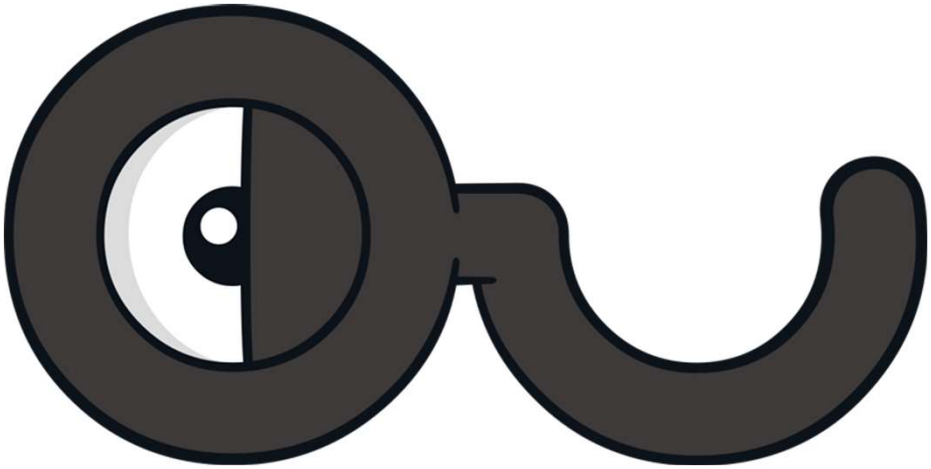
Results

Experiments

Mechanics

Streamlit App





Questions

Further Research

Results

Experiments

Mechanics

Appendix Slides

Generation I

$$Damage = \left(\frac{\left(\frac{2 \times Level \times Critical}{5} + 2 \right) \times Power \times A/D}{50} + 2 \right) \times STAB \times Type1 \times Type2 \times random$$

Generations I and II

$$\mathrm{HP} = \left\lfloor \frac{\left((\mathrm{Base} + \mathrm{DV}) \times 2 + \left\lfloor \frac{\lceil \sqrt{\mathrm{STATEXP}} \rceil}{4} \right\rfloor \right) \times \mathrm{Level}}{100} \right\rfloor + \mathrm{Level} + 10$$

$$\mathrm{OtherStat} = \left\lfloor \frac{\left((\mathrm{Base} + \mathrm{DV}) \times 2 + \left\lfloor \frac{\lceil \sqrt{\mathrm{STATEXP}} \rceil}{4} \right\rfloor \right) \times \mathrm{Level}}{100} \right\rfloor + 5$$

For leveling up the Pokémon, we set DV and STATEXP t = 0. These are values dependent on the Pokémon and how many prior battles it has undergone.