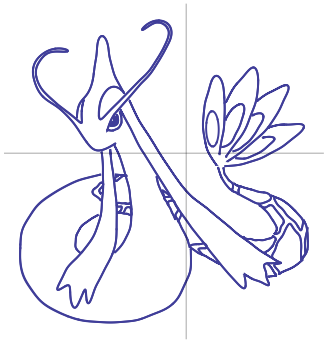
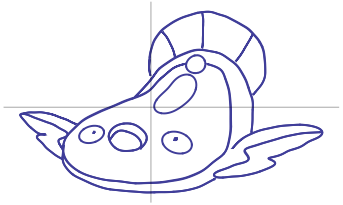
MATH:1260 Pokémath
The Mathematics of Pokémon Go®

Week 11 Wednesday, Spring 24

Popular curves:

Milotic-like curve	Stunfisk-like curve
	

Plan for Today

- Module 3: To Be The Very Best
  - Computing Damage Examples
  - PVP is turn based!

Class Reminders

- GW 9 in discussion Thursday
- HW 7 is due Wednesday
- Project 2 Stage 3 due tonight

Always default to

Gyms & Raids (different Move Stats) vs Trainer Battles (1.3 multiplier, different Move Stats)

- Gyms
- Raids
- Team Go Rocket
- Training
- Friends (vs actual human)
- Nearby Trainers (vs actual human)
- League (vs actual human)

Fast Moves and Charge Moves

Fast Moves

Does some damage

Charges up the Charge Move with Energy

Charge Moves

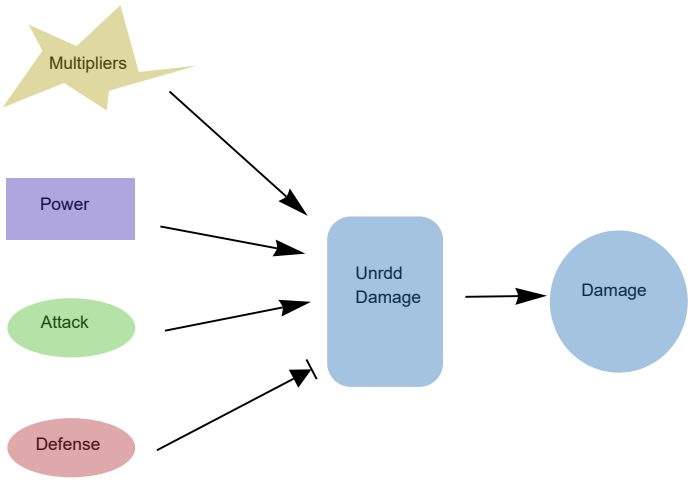
Typically do more damage

Uses up Energy

Charge Move Mini Games

Can be shielded

Damage Formula



Unrounded Damage = of the Attacker

$$\frac{1}{2} * \text{Power} * \frac{\text{Attack}}{\text{Defense}} * \text{Multiplier}$$

of the Defender

Damage =

floor function

$$\lfloor \text{Unrounded Damage} \rfloor + 1$$

Power is a property of the move that you can look up on Bulbapedia. NOTE: Moves have different power if you're in a Gym battle or a Trainer battle! https://bulbapedia.bulbagarden.net/wiki/List_of_moves_(GO)

Attack is the Attack stat of the attacking Pokemon.

Defense is the Defense stat of the defending Pokemon.

Multiplier is described below.

Multipliers

Trainer Attack Bonus (applies to all trainer battles)

This multiplier is 1.3 during a trainer battle (marked in blue above), and 1 otherwise.

STAB (Same Type Attack Bonus)

This multiplier is 1.2 if the type of the move being used matches the type of the attacking Pokemon.

Type Effectiveness Bonus

This multiplier is based on the type chart below.

If there are many multipliers, multiply them together to get the final multiplier for the formula.

Other Multipliers

There are other multipliers based on friendship, weather, and shadow Pokemon. However, for HW7, you will only need to consider Trainer Attack Bonus, STAB, and Type Effectiveness.

Type Effectiveness Chart

TYPE OF DEFENDING POKEMON

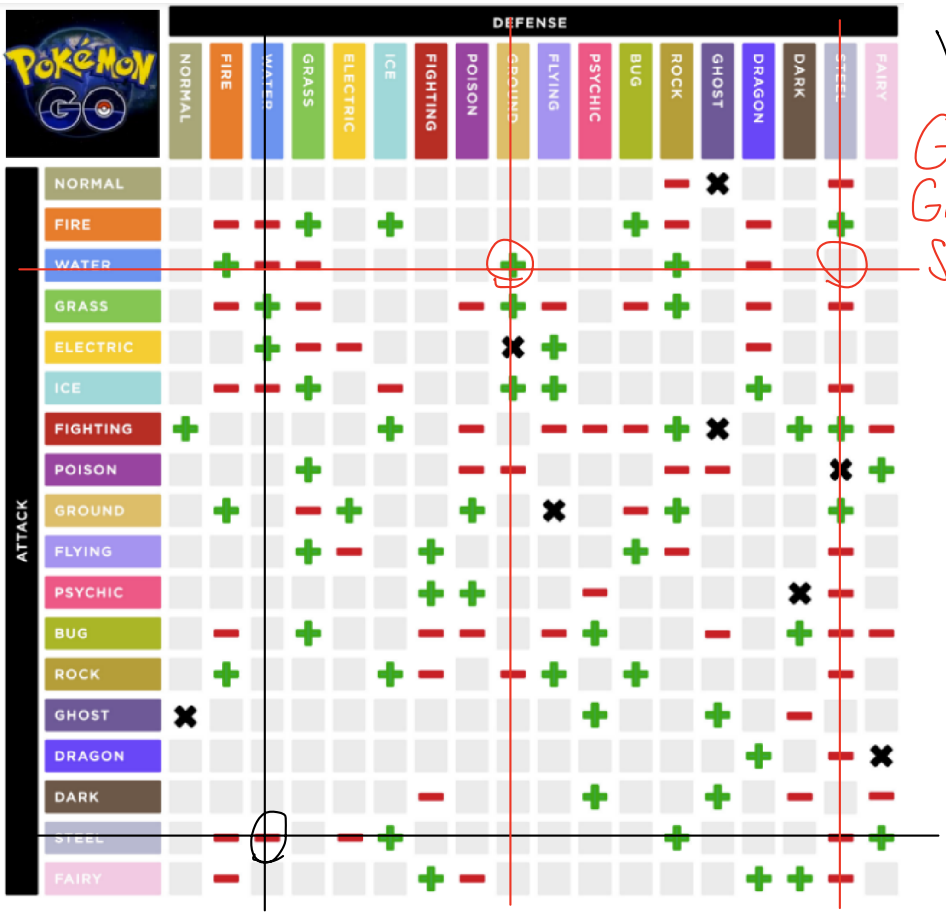
Milotic
Water

G-Stunfisk
Ground
Steel

Type of Attacking MOVE

Metal Claw
is Steel

Waterfall
is Water



Type Effectiveness Multiplier

Find the row corresponding to the type of the move used by the attacking Pokemon. Find the column corresponding to the type of the defending Pokemon.

+ Means “super effective” so the multiplier is 1.6

-- Means “not very effective” the multiplier is .625

X Means “almost immune” so the multiplier is (.625)*(.625) = .390625

Defenders with Two Types

If the defender has two types, do the process above for each type. Then multiply the two results together.

Damage Formula Examples

Pikachu vs Pidgey

Let's say Pikachu uses Quick Attack against Pidgey in a Trainer Battle.

Pikachu is an Electric type Pokemon, Attack = 50, Defense = 45, HP = 55

Quick Attack is a Normal type move, Power = 5

Pidgey is a Normal/Flying type Pokemon, Attack = 40, Defense = 35, HP = 51

$$\text{Damage} = \left\lfloor \frac{1}{2} * \text{Power} * \frac{\text{Attack}}{\text{Defense}} * \text{Multiplier} \right\rfloor + 1$$

Multiplier: We are in a trainer battle (1.3), have no STAB (1), and check the table and see normal effectiveness on both of Pidgey's types (1*1). So our multiplier is 1.3 * 1 * (1*1) = 1.3

We plug in: $\left\lfloor \frac{1}{2} * 5 * \frac{50}{35} * 1.3 \right\rfloor + 1 = 5$

Vaporeon vs Flareon

Let's say Vaporeon uses Water Gun against Flareon in a Trainer Battle.

Vaporeon is a Water type Pokemon, Attack = 75, Defense = 65, HP = 100

Water Gun is a Water type move, Power = 3

Flareon is a Fire type Pokemon, Attack = 99, Defense = 54, HP = 95

$$\text{Damage} = \left\lfloor \frac{1}{2} * \text{Power} * \frac{\text{Attack}}{\text{Defense}} * \text{Multiplier} \right\rfloor + 1$$

Multiplier: We are in a trainer battle (1.3), Vaporeon gets STAB on Water Gun (1.2) and we check the table and see super effective on Flareon's type (1.6). So our multiplier is 1.3 * 1.2 * 1.6 = 2.496

We plug in: $\left\lfloor \frac{1}{2} * 3 * \frac{75}{54} * 2.496 \right\rfloor + 1 = 6$

Golurk vs Vivillion

Let's say Golurk uses Mud-Slap against Vivillion in a Trainer Battle.

Golurk is a Ground/Ghost type Pokemon, Attack = 150, Defense = 133, HP = 111

Mud-Slap is a Ground type move, Power = 11

Vivillion is a Bug/Flying type Pokemon, Attack = 121, Defense = 94, HP = 107

$$\text{Damage} = \left\lfloor \frac{1}{2} * \text{Power} * \frac{\text{Attack}}{\text{Defense}} * \text{Multiplier} \right\rfloor + 1$$

Multiplier: We are in a trainer battle (1.3), Golurk gets STAB on Mud-Slap (1.2) and we check the table and see “not very effective” and “nearly immune” on Vivillion’s type (.390625*.625). So our multiplier is 1.3 * 1.2 * .390625 * .625 = .380859375

We plug in: $\lfloor \frac{1}{2} * 11 * \frac{150}{94} * .380859375 \rfloor + 1 = 5$

Long Form Example: Milotic vs Galarian Stunfisk

Milotic

Lets use our handy CP calculator from GW 4. Put in the base stats and IVs

Milotic	Attack	Defense	HP
Base	192	219	216
IV	15	6	14

Bulbapedia

Appraisal

And then look for the CP and HP that match the Pokemon in our bag. (My Milotic has 130 HP and 1512 CP)

Lvl	CPM	Atk	Def	UnrHP	HP	UnrCP	CP
17	0.550793	114.0141	123.92836	126.6823	126	1428.571	1428
17.5	0.558831	115.6779	125.73688	128.531	128	1470.571	1470
18	0.566755	117.3182	127.51976	130.3535	130	1512.57	1512
18.5	0.574569	118.9358	129.27805	132.1509	132	1554.569	1554
19	0.582279	120.5317	131.01275	133.9241	133	1596.569	1596

Stunfisk (Galarian)

Lets use our handy CP calculator. Put in the base stats and IVs

Stunfisk	Attack	Defense	HP
Base	144	171	240
IV	13	15	15

And then look for the CP and HP that match the Pokemon in our bag. (My Stunfisk has 168 HP and 1494 CP)

lvl	cpM	Atk	Def	UnrHP	HP	UnrCP	CP
23.5	0.647581	101.6702	120.45006	165.1331	165	1433.885	1433
24	0.654436	102.7464	121.72503	166.8811	166	1464.401	1464
24.5	0.661219	103.8114	122.98678	168.6109	168	1494.917	1494
25	0.667934	104.8656	124.23572	170.3232	170	1525.434	1525
25.5	0.674582	105.9094	125.47223	172.0184	172	1555.95	1555

Stunfisk uses Metal Claw

Power

The Power for Metal Claw is 5

Attack

The Attack Stat for Stunfisk is 103.8114

Defense

The Defense Stat for Milotic is 127.51976.

Ouch Milotic

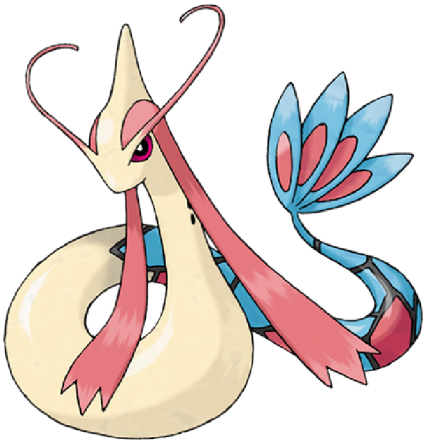
We can use the damage formula to find how much Metal Claw will reduce Milotic's HP.

$$\frac{1}{2} \cdot \text{Power} \cdot \frac{\text{Attack}}{\text{Def}} \cdot \text{Multiplier} = \frac{1}{2} \cdot 5 \cdot \frac{104}{128} \cdot 1.3 \cdot 1.2 \cdot .625$$

$$\approx 1.98 \rightarrow \lfloor 1.98 \rfloor + 1 = 2$$

How many hits with Metal Claw would it take to knock out Milotic?

$$\frac{\text{HP of Defender}}{\text{Dmg}} = \frac{150}{2} = 65 \text{ Metal Claws}$$



Turns

Trainer Battles are secretly turn based!

Each turn is 0.5 seconds.

Each move requires a certain number of turns to use, listed on bulbapedia. Metal Claw requires 2 turns to use.

How many turns would it take to knock out Milotic with Metal Claw?

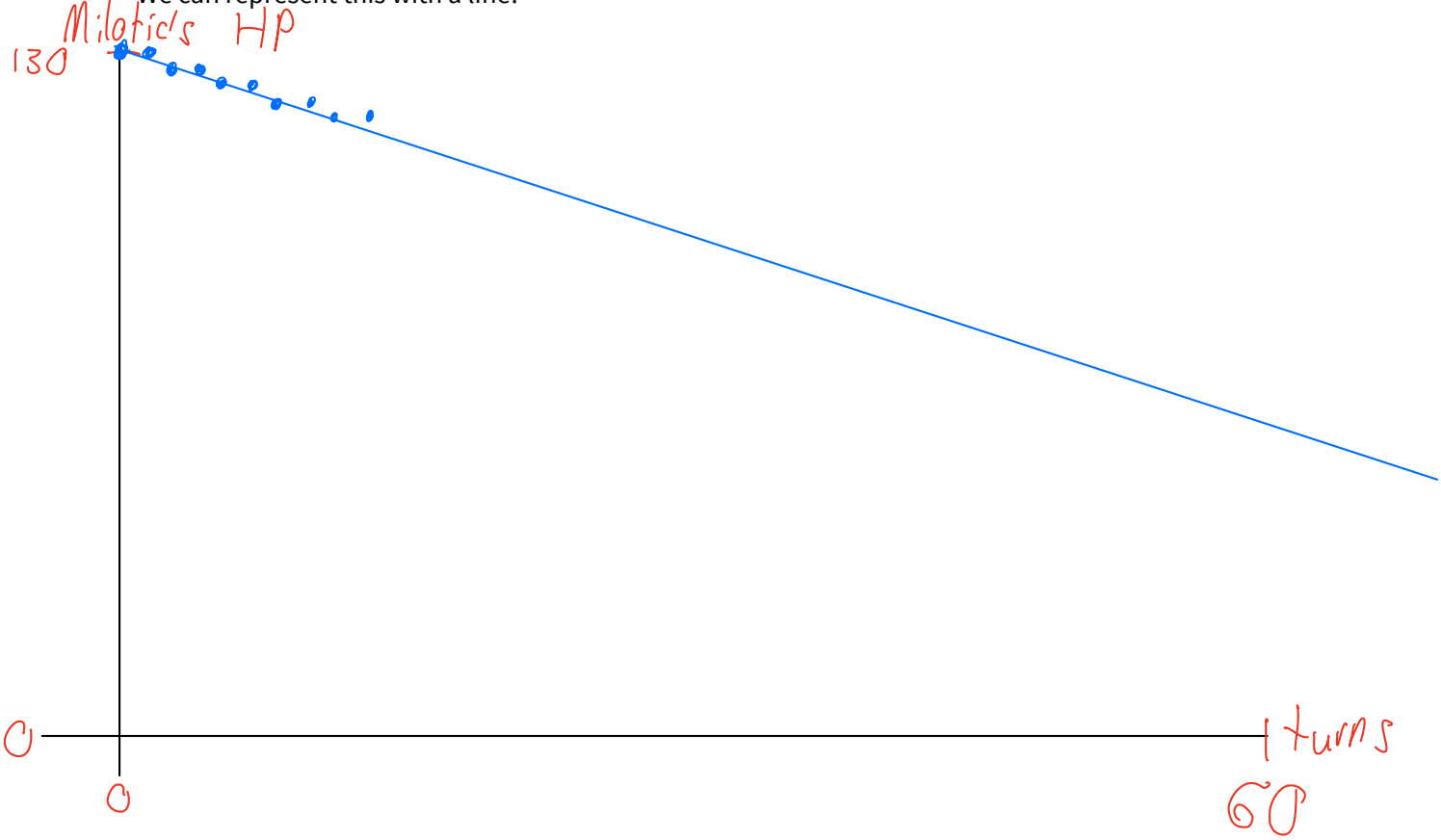
(# of moves to knock out) · (turns of move)

→ 65 Metal Claws · $2\frac{\text{turns}}{\text{Metal Claw}}$ = 130 turns

How much time (in seconds) would it take to knock out Milotic with Metal Claw?

$$130\,\text{turns} \cdot .5\frac{\text{seconds}}{\text{turn}} = 65\,\text{seconds}$$

We can represent this with a line!



Milotic uses Waterfall

Power

The Power for Waterfall is 12

Attack

The Attack Stat for Milotic is 117.3182

Defense

The Defense Stat for Stunfisk is 122.98678

Ouch Stunfisk

We can use the damage formula to find how much Waterfall will reduce Stunfisk's HP.

$\frac{1}{2} \cdot \text{Power} \cdot \frac{\text{Attack}}{\text{Def}} \cdot \text{Multiplier} = \frac{1}{2} \cdot 12 \cdot \frac{117}{123} \cdot 1.3 \cdot 1.2 \cdot 1.6$

$= 14.2 \longrightarrow \lfloor 14.2 \rfloor + 1 = 15 \text{ dmg}$

How many hits with Waterfall would it take to knock out Stunfisk?

$\frac{168}{15} = 11.2 \rightarrow 12 \text{ hits}$

Waterfall takes 3 turns.

How many turns does it take to knock out Stunfisk?

$12 \text{ hits} \cdot 3 \frac{\text{turns}}{\text{hit}} = 36 \text{ turns}$

How much time (in seconds) does it take to knock out Stunfisk?

$36 \text{ turns} \cdot .5 \frac{\text{sec}}{\text{turn}} = 18 \text{ seconds}$

Another line!