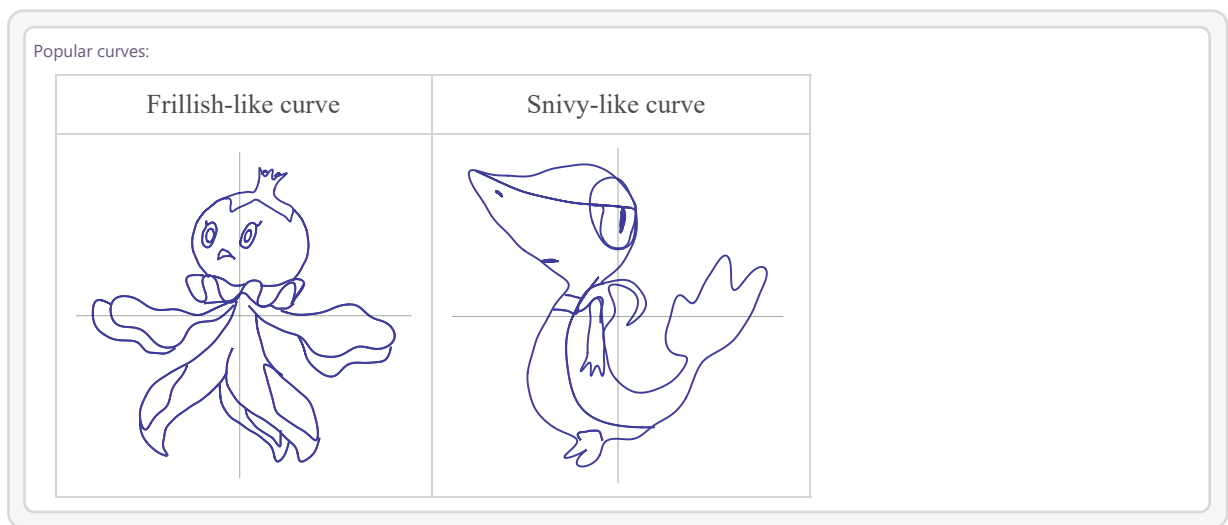


MATH:1260 Pokémath

The Mathematics of Pokémon Go[®]

Week 12 Monday, Spring 24



Plan for Today

- Module 3: To Be The Very Best
 - Computing Damage
 - PVP is turn based
 - Damage per turn, power per turn, energy per turn as lines

Class Reminders

- GW 10 in discussion Thursday
- HW 7 is due Wednesday at midnight
- Extra Credit coming up

Battle with Lines: Frillish vs Snivy

Frillish and Snivy

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

	attack	defense	HP	Fast Move	Power	Duration
Frillish	65.70903	76.574305	83	Bubble	7	3
Snivy	64.74592	76.975704	102	Vine Whip	5	2

Water
Grass

Predictions?

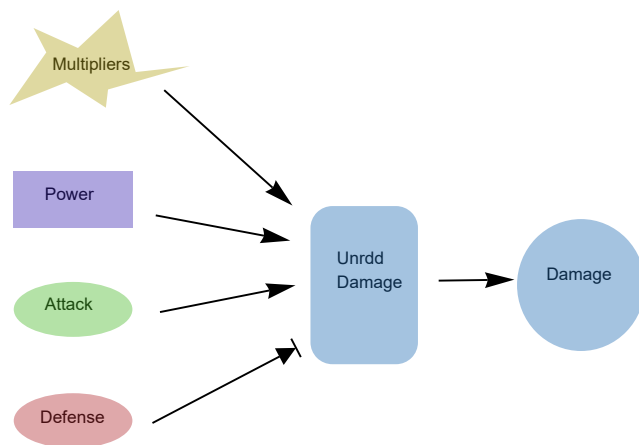


Ghost/Water



Grass

Damage Formula



Unrounded Damage =

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

Damage =

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

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_\(GO\)](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.

Frillish uses Bubble

Power



The Power for Bubble is 7

Attack



The Attack Stat for Frillish is 65.70903

Defense



The Defense Stat for Snivy is 76.975704

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** matches the **type of the attacking Pokemon**.

Type Effectiveness

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

		DEFENSE																	
		NORMAL	FIRE	WATER	GRASS	ELECTRIC	ICE	FIGHTING	POISON	GROUND	FLYING	PSYCHIC	BUG	ROCK	GHOST	DRAGON	DARK	STEEL	FAIRY
Type of Attacking MOVE	NORMAL													-	✖			-	
	FIRE		-	-	+		+						+	-		-		+	
	WATER		+	-						+				+		-			
	GRASS		-	+	-				-	+	-		-	+		-		-	
	ELECTRIC			+	-	-				✖	+					-			
	ICE		-	-	+		-			+	+					+		-	
	FIGHTING	+					+		-		-	-	-	+	✖		+	+	-
	POISON				+				-	-				-	-			✖	+
	GROUND		+		-	+			+		✖		-	+				+	
	FLYING				+	-		+					+	-				-	
	PSYCHIC							+	+			-					✖	-	
	BUG		-		+			-	-		-	+			-		+	-	-
	ROCK		+				+	-		-	+		+					-	
	GHOST	✖										+			+		-		
	DRAGON															+		-	✖
	DARK							-				+			+		-		-
	STEEL		-	-		-	+							+				-	+
	FAIRY		-					+	-							+	+	-	

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 $(.625) \times (.625) = .390625$

Defenders with Two Types

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

Ouch Snivy!

So each hit with Bubble reduces Snivy's HP by how much?

$$\frac{1}{2} \cdot 7 \cdot \frac{66}{77} \cdot 1.2 \cdot 1.3 \cdot .625 = 2.925$$

$$\rightarrow \lfloor 2.925 \rfloor + 1 = 3$$

How many hits with Bubble would it take to knock out Snivy?

$$\frac{102}{3} = 34 \text{ hits}$$

Turns

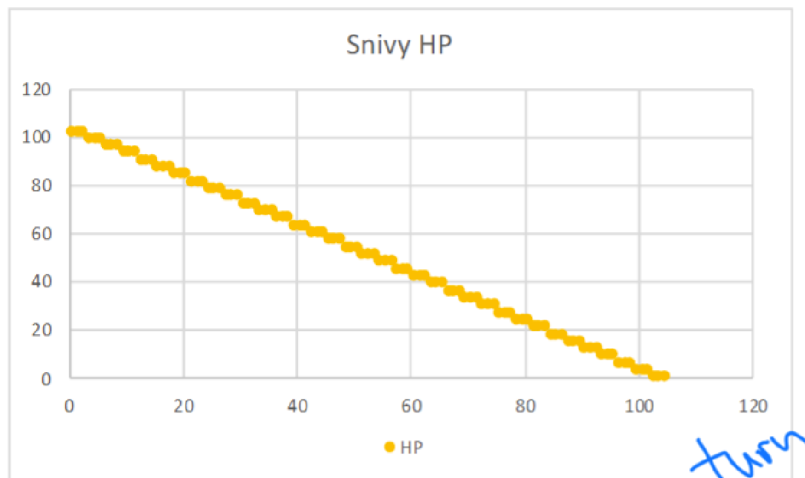
Recall: Trainer Battles are secretly turn based! Each turn is 0.5 seconds.

Each move duration is given in number of turns. Bubble takes 3 turns.

How many turns would it take to knock out Snivy with Bubble?

Rates of Change: Average Damage Per Turn

Bubble does 3 damage when it hits, but it takes 3 turns to hit. How can we communicate that with a graph?



Linear Functions Review

Slope: A number describing the relationship between x and y . Also known as $\frac{\text{"rise"}}{\text{"run"}}$

To calculate: Let's say we have points: $(x_1, y_1), (x_2, y_2)$

$$\rightarrow m = \frac{y_2 - y_1}{x_2 - x_1}$$

Point Slope Form: Let's say we have a point: (x_1, y_1) and a slope m .

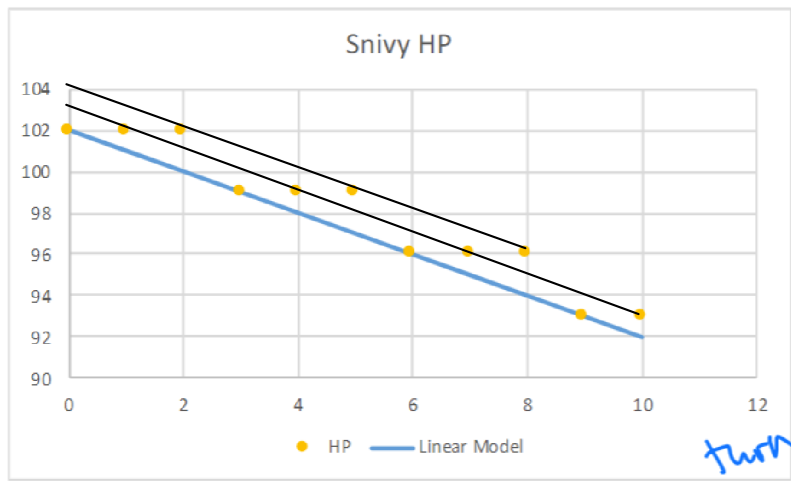
The equation of a line with that slope passing through our point is: $y - y_1 = m(x - x_1)$

Slope Intercept Form:

$y = mx + b$ where m is our slope and b is the point $(0, b)$ where the line touches the y -axis.

Rates of Change: Average Damage Per Turn

Zoom in a little. The dots don't make a line, but we can approximate...



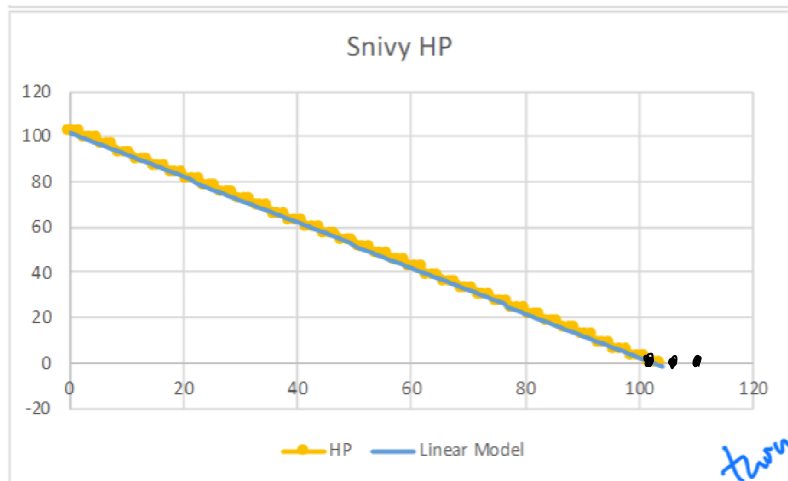
What is the slope of this line? What are the units?

$$\frac{3 \text{ damage}}{3 \text{ turns}} \rightarrow \frac{3}{3} = 1 \frac{\text{dmg}}{\text{turn}} = -1 \frac{\text{HP}}{\text{turn}} = m$$

How does the slope of this line relate to damage per turn?

The slope is the average rate of change of HP.

A Linear Model



What is the slope for our linear model?

$$-1 = m$$

What is the "y- intercept"?

$$b = 102 \quad \text{Snivy's HP at the start}$$






TopHat: What is the linear model (in slope intercept form) for Snivy HP?

$$y = mx + b$$

$$y = -1x + 102$$

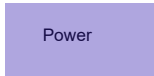
Power per turn

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

Move	Type	PWR	ENG	TURNS	DPT	EPT	DPT * EPT
Acid		6	5	2	3.00	2.50	7.50
Air Slash		9	9	3	3.00	3.00	9.00
Astonish		5	9	3	1.67	3.00	5.00
Bite		4	2	1	4.00	2.00	8.00
Bubble		7	11	3	2.33	3.67	8.56

Snivy hits back with Vine Whip!

Power



The Power for Vine Whip is 5

Attack



The Attack Stat for Snivy is 64.74592

Defense



The Defense Stat for Frillish is 76.574305

Ouch Frillish

So each hit with Vine Whip reduces Frillish's HP by how much?

$$\frac{1}{2} \cdot 5 \cdot \frac{65}{27} \cdot 1.2 \cdot 1.3 \cdot 1.6 = 5.27 \rightarrow \lfloor 5.27 \rfloor + 1 = 6 \text{ damage}$$

How many hits with Vine Whip would it take to knock out Frillish?

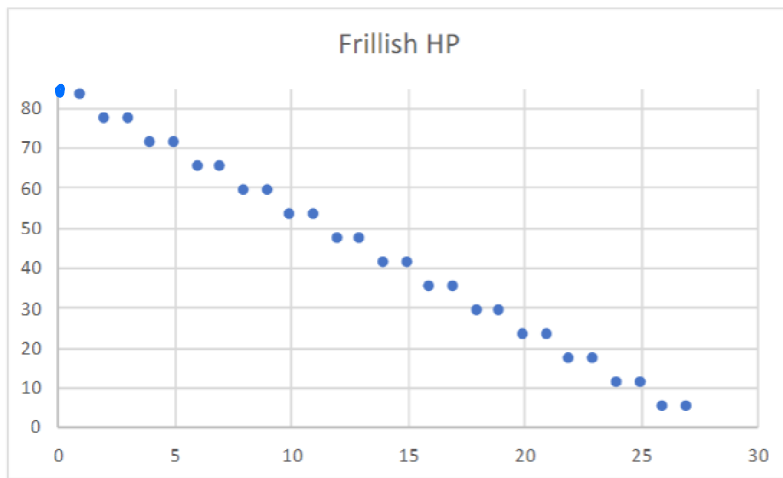
$$\frac{83}{6} = 13.83 \rightarrow 14 \text{ hits}$$

Vine Whip has a duration of 2 turns.

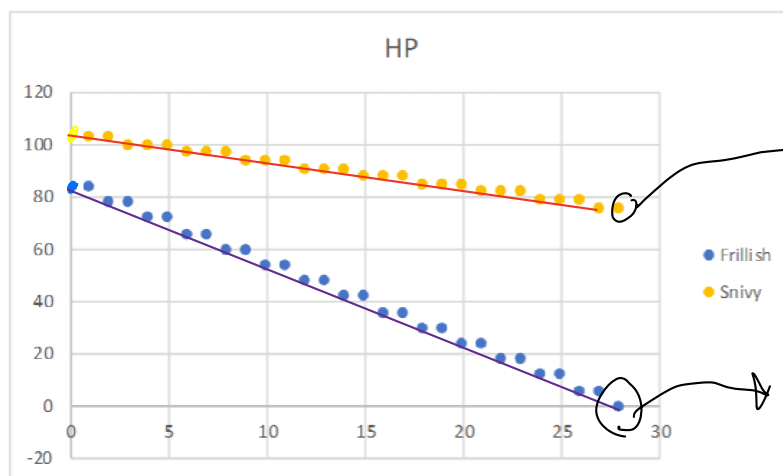
How many turns does it take to knock out Frillish?

$$14 \cdot 2 = 28 \text{ turns}$$

Graph both lines at once to see the battle in one picture!



turns



Snivy at ~82 HP

Frillich at 0 HP

Snivy wins!

Snivy Wins!

Snivy knocks out Frillish. How much HP does Snivy have left?