The Game Mechanics of Pokémon

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1 Introduction

Pokémon is one of the biggest video game franchises in history, having sold over 200 million games since its launch in 1996. Some of the best known games are the main RPGs in the series spanning across five generations, the most recent being Pokémon Black and White. These games have consistently shown that the Pokémon world has many complexities, even in the days of the Game Boy when cartridges could only hold 1 megabyte of data on them. This class will discuss many of the aspects of the Pokémon games, from finding them, catching them, training them, and battling with them.

2 Finding Pokémon

Anyone who has played Pokémon knows that there are many ways to find wild Pokémon, such as searching through tall grass, wandering around in caves, and surfing on the ocean. Also, some Pokémon can only be found in certain areas, and some species are rarer than others.

2.1 Encounter Rates

Every area has a table of Pokémon that can be found in that area.[1] This table also contains what levels the Pokémon appear at and the odds that any random encounter will be of a certain species. For example, here is the table of encounter rates for Kanto Route 24 in FireRed:

Species	Levels	Rate
Caterpie	7	20%
Metapod	8	1%
Weedle	7	20%
Kakuna	8	4%
Pidgey	11-13	15%
Oddish	12-14	25%
Abra	8-12	15%

Games from Generations II, IV, and V keep track of the time of day, splitting a 24-hour period into three parts: morning (4 a.m. to 10 a.m.), daytime (10 a.m. to 6 p.m.), and nighttime (6 p.m. to 4 a.m.). This allows different Pokémon to appear at different times of day. For this, there are separate tables for each part of the day, as with Sinnoh Route 203:

Species	Morning		Daytime		Nighttime	
	Level	Rate	Level	Rate	Level	Rate
Starly	4-7	35%	4-7	35%	4-7	25%
Bidoof	5-7	15%	4-7	25%	5-7	15%
Kricketot	4	10%	–		5	10%
Shinx	4-5	25%	4-5	25%	4-5	25%
Abra	4-5	15%	4-5	15%	4-5	15%
Zubat	–		–		4	10%

[1] These tables can be found on websites like Bulbapedia (`http://bulbapedia.bulbagarden.net/`).

2.2 Shiny Pokémon

Introduced in Generation II, shiny Pokémon are Pokémon that are of a different color than normal. Those who have played a Generation II game or one of their remakes have probably seen a red Gyarados in the Lake of Rage. It turns out that any species of Pokémon can be shiny. However, the odds of encountering a shiny Pokémon are rather low, approximately 1 in 8192.[2]

Interestingly, the term "shiny Pokémon" started as a nickname for these alternately-colored Pokémon due to the sparkling sound effect and animation that occurred whenever they appeared. Nintendo made this term official starting in Generation IV.

2.3 The Mystery Behind MissingNo.

MissingNo. is probably one of the most famous video game glitches of all time, notably because of its ability to duplicate the sixth item in the player's bag. The process[3] of performing this item duplication trick is as follows:

1. Place the item you want to duplicate in the sixth slot of your bag. Rare Candies and Master Balls are popular choices.
2. Talk to the old man in the northern end of Viridian City and have him show you how to catch a Pokémon.
3. Fly to Cinnabar Island, and Surf along the east coast until you encounter a MissingNo.
4. Your sixth item has now been duplicated.

This takes advantage of a programming quirk present in the games. When you enter an area, the table of wild Pokémon available is stored in a data buffer, which the game accesses for random encounters. However, when you talk to the old man, the player's name is stored in this data buffer. Normally when you enter another area, this data buffer is overwritten with valid Pokémon data. However, the programmers forgot to associate the east coast of Cinnabar Island with valid Pokémon data, so it just uses whatever was in the table beforehand. Therefore, in the process described above, the game will try to read the hexadecimal values of your name as Pokémon data, which can cause the game to see unexpected values. MissingNo. is the result of seeing an unexpected value.

But why does this process duplicate your sixth item? The reason for this involves how the game keeps track of which Pokémon you have seen. When you see a particular species Pokémon for the first time, the game sets a certain bit in memory to 1. For MissingNo., this bit happens to be the highest order bit of the memory address that contains the quantity of your sixth item. If you set this bit to 1, you increase the quantity of your sixth item by 128 (or leave it unchanged if it is already at least 128).

2.4 The Repel Trick

If you know what Pokémon are available in a certain area and at what levels they appear, then you can easily take advantage of the Repel Trick to find certain Pokémon. Repels are items that prevent you from encountering wild Pokémon that are at a lower level than the first Pokémon in your party. For example, if you have a level 20 Pokémon in the first position, you will not encounter any wild Pokémon that are level 19 or below.

2.4.1 Example 1 – Pokémon Mansion, Blue

Suppose you are in Pokémon Mansion in Blue version and you want to catch a Fire-type Pokémon. Here is the table of wild Pokémon for this area:

[2] In Generation II, if you breed a shiny Pokémon properly, the odds of obtaining a shiny Pokémon as offspring can be as high as 1 in 64.

[3] This trick only works in Pokémon Red and Blue.

Species	Levels	Rate
Vulpix	34	10%
Ponyta	28-34	40%
Grimer	30-32	40%
Muk	37	4%
Koffing	30	5%
Weezing	39	1%

Normally, you would have a 50% chance of encountering a Fire type. These aren't bad odds. However, they may not be ideal if you were doing a Nuzlocke run,[4] where you can only catch the first Pokémon you see in any area. However, you can easily increase these odds using Repel.

Suppose you put a level 33 Pokémon in the first position in your party. This eliminates all Grimers, all Koffings, and 5 out of 7 possible levels for Ponytas. Therefore the encounter rates for Grimer and Koffing drop to 0%, and the encounter rate for Ponyta drops to $\frac{2}{7}$ of 40%, or around 11%. After normalizing the rate percentages to add up to 100%, we get this:

Species	Levels	New "rate"	Normalized rate
Vulpix	34	10%	38%
Ponyta	33-34	11%	43%
Muk	37	4%	15%
Weezing	39	1%	4%

Your odds of encountering a Fire type are now 81%, which is much better.

2.4.2 Example 2 – Trophy Garden, Diamond/Pearl

Another example can allow you to score valuable held items. Here is the table for the Trophy Garden:

Species	Morning		Daytime		Nighttime	
	Level	Rate	Level	Rate	Level	Rate
Staravia	16-17	20%	16-17	40%	16-17	20%
Kricketune	16-17	10%	16-17	10%	16-17	30%
Roselia	16-17	30%	16-17	30%	16-17	30%
Pichu	16	30%	16	10%	16	10%
Pikachu	18	10%	18	10%	18	10%

If you use Repel with a level 18 Pokémon in front, then all wild Pokémon encounters will be Pikachus. Furthermore, if this Pokémon also has the Compoundeyes ability, then the chances of finding a Pikachu holding a Light Ball[5] increases. (This isn't a huge increase; the odds go from 5% to 7.5%. However, every little bit helps.)

3 Catching Pokémon

When you actually find a wild Pokémon, you can try to catch it. It's obviously easier to catch Pokémon with lower HP or with a status ailment. Let's look at how the mechanics of this work. We'll first talk about the mechanics of games in Generations II and beyond.

[4] A Nuzlocke run is a run through a Pokémon game with two additional rules. First, you may only catch the first Pokémon you see in any area. Second, if a Pokémon faints, it is considered dead and must be released or permanently boxed as soon as possible. Some people choose to make webcomics highlighting points of their run. The original one can be found at `http://www.nuzlocke.com/?p=4`. It's a great read.

[5] An item that doubles Pikachu's Attack and Special Attack stats when held.

3.1 Catch Rates and Modified Catch Rates

Every Pokémon species has a *catch rate* that indicates how easy it is for a Pokémon to be caught. The highest catch rate any Pokémon has is 255, which is held by common Pokémon such as Patrat or Bidoof. The lowest catch rate any Pokémon has is 3, which is held by most legendaries.

However, there are other factors that go into how likely one is to catch a Pokémon. Therefore we must compute a *modified catch rate*. We do this as follows:

1. Start with the catch rate.
2. Multiply the catch rate by $1 - \frac{2}{3} \cdot \frac{\text{current HP}}{\text{max HP}}$, where you are looking at the HP of the wild Pokémon. It's not always possible to determine the exact HP values, but it's pretty easy to estimate the ratio.
3. Multipliy the catch rate by the *ball bonus*. Each ball has a certain bonus attached to it. For example, the Poké Ball multiplies your odds by 1, the Great Ball multiplies your odds by 1.5, the Ultra Ball by 2, and so on.[6]
4. In Generation II, add 5 to the catch rate if the wild Pokémon is paralyzed, poisoned, or burned; add 10 if the wild Pokémon is asleep or frozen. In Generations III and beyond, multiply the catch rate by 1.5 if the wild Pokémon is paralyzed, poisoned, or burned; multiply by 2 if the wild Pokémon is asleep or frozen.
5. The number you got in step 4 is the modified catch rate m. If $m \geq 255$, then the Pokémon is automatically caught. Otherwise, the probability of capture is approximately $\frac{m+1}{256}$.

3.2 Shake Probabilities

What really happens is that the game calculates a *shake probability* from the modified catch rate. The game then performs four shake checks, which are done to determine how many times the Poké Ball shakes before the Pokémon breaks free or the game tells you, "Gotcha! [Wild Pokémon] was caught!"

In Generations III and beyond, if p is the probability of capture, then the probability of passing a shake check is approximately $\sqrt[4]{p}$. Generation II uses a lookup table to associate the modified catch rate m and the shake probability s:

m	s	m	s	m	s	m	s
0-1	0.250	8-10	0.445	51-60	0.695	161-160	0.918
2	0.297	11-15	0.496	61-80	0.750	181-280	0.941
3	0.332	16-20	0.527	81-100	0.789	201-220	0.965
4	0.355	21-30	0.586	101-120	0.828	221-240	0.984
5	0.375	31-40	0.629	121-140	0.863	241-254	0.992
6-7	0.406	41-50	0.664	141-160	0.891	255	1.000

However, it turns out that these values of s closely correspond to $\sqrt[4]{\frac{m+1}{256}} = \sqrt[4]{p}$.

3.3 Generation I Mechanics

Generation I mechanics are much different. The idea of catch rates still applies, but the effects of HP level, the ball used, and status ailments has changed. To determine whether or not a wild Pokémon is caught, perform the following steps in this order:

1. If you use a Master Ball, the Pokémon is automatically caught.

[6] See `http://bulbapedia.bulbagarden.net/wiki/Catch_rate#Pok.C3.A9_Ball_effectiveness_rates` for a list of all ball bonuses. Note that the Heavy Ball doesn't multiply the catch rate; rather, it adds or subtracts a bonus.

2. Pick a random integer x between 0 and A inclusive, where A is 255 if you're using a Poké Ball, 200 if you're using a Great Ball, or 150 if you're using an Ultra Ball.
3. If $x < 25$ and the Pokémon is asleep or frozen, the Pokémon is caught.
4. If $x < 12$ and the Pokémon is paralyzed, poisoned, or burned, the Pokémon is caught.
5. If x is greater than the catch rate of the wild Pokémon, the Pokémon breaks free.
6. Pick a random integer y between 0 and 255 inclusive. Calculate $z = \frac{255}{B} \cdot \frac{\text{max HP}}{\text{current HP}}$, where you are looking at the HP of the wild Pokémon, and where B is 2 for a Great Ball, 3 otherwise. If $z \geq y$, the Pokémon is caught. Otherwise it breaks free.

This method has some unusual properties:

- The effect of reducing HP diminishes on Pokémon with lower catch rates, and the effect of inflicting a status ailment diminishes on Pokémon with higher catch rates.
- Reducing the wild Pokémon's HP below half of its maximum value does not improve the chance of capture with Great Balls. For other balls, the threshold is $\frac{1}{3}$ of the maximum value.
- In some cases, Great Balls perform better than Ultra Balls. This is generally the case with Pokémon above 50% HP and no status ailment.

4 Training Pokémon

Training is one of the biggest aspects of Pokémon. As you battle, your Pokémon get stronger. However, if you choose your battles smartly, your Pokémon can become powerful in all the right places.

4.1 Experience

As you battle other Pokémon, you gain experience. When you gain enough experience, you level up and become stronger. In Generations I through IV, the formula for how much experience points a Pokémon gets from making another Pokémon faint is:

$$\text{EXP} = \frac{b \cdot L_f \cdot a \cdot t \cdot e}{7 \cdot s}$$

The variables are:

- b is equal to the base experience of the fainted Pokémon, which varies from species to species. Generally, the harder it is to make a Pokémon faint, the higher its base experience is. For example, Blissey, having a ton of HP (up to 714 HP, the most any Pokémon can have), has a b value of 608, the highest b value of all Pokémon.
- L_f is equal to the level of the fainted Pokémon.
- a is equal to 1 if the fainted Pokémon was wild, or 1.5 if it was owned by a Trainer.
- t is equal to 1 if the winning Pokémon was caught by the user, or 1.5 if it was received in a trade. In Generations IV and V, where one can trade internationally via the Nintendo Wi-Fi Connection, the trade bonus is 1.5 for domestic trades and 1.7 for international trades.
- e is equal to 1.5 if the winning Pokémon is holding a Lucky Egg, or 1 otherwise.
- s is equal to the number of Pokémon that participated in battle.

Generation V adds a new concept: stronger Pokémon gain less experience from winning against weaker Pokémon. In Generation V, the formula is:

$$\text{EXP} = \left(\frac{b \cdot L_f \cdot a}{5 \cdot s} \cdot \left(\frac{2L_f + 10}{L_w + L_f + 10} \right)^{2.5} + 1 \right) \cdot t \cdot e \cdot p$$

This introduces two new variables:

- L_w is the level of the winning Pokémon.
- p is a variable depending on Exp. Point Power, a Gen V game mechanic associated with the Entralink.

4.2 Experience Groups

When a Pokémon reaches a certain number of experience points, it levels up. The exact times when a Pokémon level up depends on which of the six experience groups it belongs to. Here are the six different experience groups, along with the formulas for how much experience is required to reach level n.

4.2.1 Erratic Group

$$\text{EXP} = \begin{cases} \frac{n^3(100-n)}{50} & n < 50 \\ \frac{n^3(150-n)}{100} & 50 \leq n < 68 \\ \frac{n^3\lfloor(1911-10n)/3\rfloor}{500} & 68 \leq n < 98 \\ \frac{n^3(160-n)}{100} & 98 \leq n \end{cases}$$

Note: $\lfloor x \rfloor$ denotes the greatest integer less than or equal to x. For example, $\lfloor 3.14 \rfloor = 3$, $\lfloor 8.999 \rfloor = 8$, and $\lfloor -13.37 \rfloor = -14$.

Pokémon in this group start out growing slowly, but end up requiring the fewest number of experience points (600,000) to reach level 100. This group was introduced in Gen III, and contains 22 Pokémon.

4.2.2 Fast Group

$$\text{EXP} = \frac{4}{5}n^3$$

This group grows consistently quickly. It was the fastest growing group in Gen I and Gen II, requiring only 800,000 EXP to reach level 100. There are 52 Pokémon in this group.

4.2.3 Medium-Fast Group

$$\text{EXP} = n^3$$

This group is the largest experience group of them all, containing 251 Pokémon. Pokémon in this group require 1,000,000 EXP to reach level 100.

4.2.4 Medium-Slow Group

$$\text{EXP} = \frac{6}{5}n^3 - 15n^2 + 100n - 140$$

Despite its name, Pokémon in this group do grow faster than those in the medium-fast group up until level 67. This group is the second-largest group, containing 175 Pokémon, including all the starters and their evolution lines. Pokémon in this group require 1,059,860 EXP to reach level 100.

Interestingly, if you evaluate this function at $n = 1$, you get -53.8, which rounds to -54. Gen I and Gen II games stored experience points as a 24-bit unsigned integer[7], so this caused an integer underflow error. Therefore if a level 1 Pokémon in this group was to gain a small amount of experience, they would instantaneously grow to level 100.

[7]This means that you can only express numbers from 0 to $2^{24} - 1 = 16777215$ inclusive. A negative number, like -5, would be represented as $2^{24} - 5$.

4.2.5 Slow Group

$$\text{EXP} = \frac{5}{4}n^3$$

The slow group was the slowest growing group in Gen I and Gen II. It contains 135 Pokémon, including many rare, legendary, and powerful Pokémon. And Magikarp, who is definitely not rare, legendary, or powerful. Pokémon in this group require 1,250,000 EXP to reach level 100.

4.2.6 Fluctuating Group

$$\text{EXP} = \begin{cases} \frac{n^3(\lfloor (n+1)/3 \rfloor + 24)}{50} & n < 15 \\ \frac{n^3(n+14)}{50} & 15 \leq n < 36 \\ \frac{n^3(\lfloor n/2 \rfloor + 32)}{50} & 36 \leq n \end{cases}$$

Pokémon in this group start by growing very quickly, but grow more slower than normal as they level up. They require 1,640,000 EXP to reach level 100. This group was introduced in Gen III, and contains 14 Pokémon.

4.3 Stats

However, EXP is not the only thing that determines how strong a Pokémon is. What mainly matters are the Pokémon's stats. A Pokémon's stats depend on several different things:

4.3.1 Base Stats

Every Pokémon has a set of base stats in six areas: HP, Attack, Defense, Special Attack, Special Defense, and Speed.[8] The higher your base stats are, the high your overall stats are. As an example, here are Pikachu's base stats:

HP	35
Attack	55
Defense	30
Special Attack	50
Special Defense	40
Speed	90

4.3.2 Effort Values

Effort values, or EVs, really define what it means to train Pokémon. Each Pokémon has six EVs, one for each stat. In Gens I and II there are only five EVs: HP, Attack, Defense, Speed, and Special. When you win a battle, in addition to experience points, you also gain EVs based on which Pokémon you made faint.

In Generations I and II, the winning Pokémon gains EVs in each stat equal to the base stats of the fainted Pokémon. For example, causing a Pikachu to faint would give the winning Pokémon 35 HP EVs, 55 Attack EVs, 30 Defense EVs, etc. The maximum number of EVs one could have in any particular stat is 65,535.

Generations III and beyond have a different EV system, each Pokémon has an EV yield, which is separate from the Pokémon's stats. However, Pokémon that are strong in a particular stat tend to yield EVs in that stat. For example, Pikachu's EV yield in the newer games is 2 Speed EVs. The maximum number of EVs one could have in any particular stat is 255, and the maximum number of EVs one could have over all stats is 510.

One way to help grow EVs is through the Pokérus, a rare symbiotic virus introduced in Gen II that infects 3 out of 65,536 Pokémon. Once infected with the virus, Pokémon gain EVs at double the normal rate. This virus goes away after a few days, but the positive effects remain. Make sure you spread the Pokérus as soon as you get it!

[8] In Generation I, Special Attack and Special Defense were combined into one stat, Special.

4.3.3 Individual Values

Individual values, or IVs, are fixed values that influence a Pokémon's stats. Like EVs, there is an IV for each stat. Unlike EVs, they cannot be changed. IVs behave like a Pokémon's genes. When you breed two Pokémon together, they pass some of their EVs down to their offspring. In Generations I and II, IVs range from 0 to 15. In Generations III and beyond, IVs range from 0 to 31.

4.3.4 Natures

Generation III introduced Natures. Every Pokémon has one of 25 different natures. Twenty of them affect stats by increasing one by 10% and decreasing another by 10%:

		Decreased stat				
		Attack	**Defense**	**Sp. Atk.**	**Sp. Def.**	**Speed**
Increased stat	**Attack**	–	Lonely	Adamant	Naughty	Brave
	Defense	Bold	–	Impish	Lax	Relaxed
	Sp. Atk.	Modest	Mild	–	Rash	Quiet
	Sp. Def.	Calm	Gentle	Careful	–	Sassy
	Speed	Timid	Hasty	Jolly	Naïve	–

The other five natures are Bashful, Docile, Hardy, Quirky, and Serious. They do not affect stats.

Interestingly, these stat modifiers also determine what flavors of Pokéblocks or Poffins Pokémon like or dislike. Each stat corresponds to a flavor: Attack corresponds to Spicy, Defense to Sour, Special Attack to Dry, Special Defense to Bitter, and Speed to Sweet. The stat that is increased determines which flavor a Pokémon likes, and the stat that is decreased determines which flavor a Pokémon dislikes. For example, a Naughty Pokémon's favorite flavor is Spicy, and its least favorite flavor is Bitter.

4.3.5 Formulas

All this information gives us formulas for determining a Pokémon's stats.

In Gens I and II, the formulas are:

$$\text{HP} = \frac{(\text{IV} + \text{base} + \frac{\sqrt{\text{EV}}}{8} + 50) \cdot \text{level}}{50} + 10$$

$$\text{Other stat} = \frac{(\text{IV} + \text{base} + \frac{\sqrt{\text{EV}}}{8}) \cdot \text{level}}{50} + 5$$

In Gens III and beyond, the formulas are:

$$\text{HP} = \frac{(\text{IV} + 2 \cdot \text{base} + \frac{\text{EV}}{4} + 100) \cdot \text{level}}{100} + 10$$

$$\text{Other stat} = \left(\frac{(\text{IV} + 2 \cdot \text{base} + \frac{\text{EV}}{4}) \cdot \text{level}}{100} + 5 \right) \cdot N$$

where N represents the nature modifier, which is either 0.9, 1, or 1.1.

5 Battling

Battles are where things get really exciting. Whenever you're in a heated battle, you're always faced with two big questions: Which Pokémon should you use, and which move will be the most effective?

5.1 Moves

Every move has three properties that determine how it behaves in battle: its base power, its base accuracy, and its priority. Moves with a higher base power are generally more powerful. Moves with a higher base accuracy are more likely to hit successfully. Moves with a higher priority tend to go before moves with a lower priority.

5.2 The Battle Structure

When in a battle, you can either choose to fight, use an item, switch to a different Pokémon, or flee from battle. Any of the latter three options always have priority. However, if both sides choose to fight, the following happens: If the two moves have different priorities, then the move with the higher priority goes first. This allows moves like Quick Attack to go first or moves like Counter to go last. If the two moves have the same priority, then the Pokémon with the higher speed stat goes first.

5.3 The Damage Formula

Here is the amount of damage most moves will do:

$$\text{damage} = \left(\frac{2 \cdot \text{level} + 10}{250} \cdot \frac{\text{attack}}{\text{defense}} \cdot \text{base} + 2\right) \cdot \text{modifier} \cdot R$$

Here, the level refers to the level of the attacking Pokémon, base refers to the base power of the move, and R is a random number between 0.85 and 1.

Attack and defense refer to the Attack and Defense stats of the attacker and defender respectively for physical moves, and the Special Attack and Special Defense stats for special moves.[9]

We will talk about modifiers later.

5.4 Stat Modification

Some moves, like Growl or Agility, cause a Pokémon's stats to change temporarily in battle. These stat changes work on a level system:

Level	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6
Multiplier	0.25	0.29	0.33	0.40	0.50	0.67	1.00	1.50	2.00	2.50	3.00	3.50	4.00

Every stat starts at level 0 at the beginning of a battle. A move like Growl, which results in a phrase like, "Turtwig's Attack fell," drops the opponent's Attack by one level. A move like Agility, which results in a phrase like, "Skarmory's Speed sharply rose," raises the user's Speed by two levels. Levels cannot drop below -6 or go above +6.

Accuracy and evasiveness have a slightly different table:

Level	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6
Multiplier	0.33	0.38	0.43	0.50	0.60	0.75	1.00	1.33	1.67	2.00	2.33	2.67	3.00

To determine whether or not a move hits, multiply the base accuracy of a move by the attacker's accuracy multiplier and divide by the user's evasiveness multiplier. The resulting number is the probability than a move will hit. (If this value is greater than 1, it's guaranteed to hit.)

5.5 Modifiers

Modifiers are what can really make or break a battle. There are many different types of modifiers, some more well-known than others.

5.5.1 Type advantages

There are 17 different elemental types, each with their own strengths and weaknesses. A copy of the type advantages table can be found at the end of this handout as an appendix.

Moves can either be super effective, not very effective, or not effective at all against a particular type of Pokémon. These multiply the modifier by 2, $\frac{1}{2}$, and 0, respectively. In the case of dual-type Pokémon, these modifiers multiply together. For example, a Water-type move is doubly super effective against a dual Fire/Rock type, and therefore does 4 times as much damage.

[9] In Generations I through III, moves were classified as physical or special based on their type. Starting in Generation IV, moves are classified on a move-by-move basis. This makes some classifications more logical. For example, Bite, a Dark-type move, makes more sense to be a physical attack, even though Dark was classified as a special type.

5.5.2 Same-Type Attack Bonus

The same-type attack bonus, or STAB, is a bonus given to Pokémon who use moves that are of the same type as the user. For example, a Chikorita, a Grass type, benefits from the STAB if it uses Giga Drain, a Grass-type move. Such moves multiply the amount of damage done by 1.5.[10]

There are two common misconceptions about the STAB. Firstly, some believe that Normal types don't benefit from the STAB for using Normal-type moves. This is not true; all types benefit from the STAB. Secondly, some believe that for dual types the STAB is reduced to 1.25×. This is also not true; dual types still get a 1.5× bonus for either of their types.

5.5.3 Critical Hits

Critical Hits come at random and they have the ability to turn the tides of any battle. Overall, a Critical Hit multiplies the amount of damage done by 2 and ignores and stat modifiers that are disadvantageous to the attacker.[11]

In Generation I, the probability of a Pokémon landing a Critical Hit with a normal move is equal to its base speed stat divided by 512. For moves with a high Critical Hit ratio[12] like Slash, Karate Chop, or Razor Leaf, the probability is equal to the base speed stat divided by 64. If the base speed of the Pokémon is greater than or equal to 64, the probability is rounded down to $\frac{255}{256}$, around 99.6%.

In Generations II and beyond, there is another level system for the probability of Critical Hits:

Level	Probability
1	6.25%
2	12.5%
3	25%
4	33.3%
5	50%

All Pokémon start at Critical Hit level 1. Moves such as Focus Energy and items like Dire Hit increase the level permanently, and moves with high Critical Hit ratios temporarily increase the level.

5.5.4 Other Modifiers

There are many other possible modifiers to the damage formula.[13] They include:

- Weather. During rain, the power of Water-type moves is multiplied by 1.5, and the power of Fire-type moves is halved. In harsh sunlight the reverse is true. Weather can also modify other aspects about moves. For example, in rain, the moves Thunder and Hurricane, both of which have base accuracies of 70%, are always guaranteed to hit. Weather can also trigger certain Abilities, like Rain Dish.
- Abilities. They can modify the Critical Hit ratio, the stats of a Pokémon under certain conditions, and other things. For example, Blaze boosts the power of Fire-type moves by 50% if the user has less than $\frac{1}{3}$ HP.
- Held items. Some held items can change a Pokémon's stats. For example, BlackGlasses boosts the power of Dark-type moves by 20%.[14]
- Status ailments. For example, a burn cuts a Pokémon's Attack in half,[15] and paralysis cuts a Pokémon's Speed by a factor of 4.

[10] If the user has the Adaptability ability, the multiplier is increased from 1.5 to 2.

[11] If the user has the Sniper ability, the Critical Hit multiplier is 3. In Generation I, all stat modifiers are ignored, even if they would end up being beneficial to the attacker.

[12] There are 19 moves with a high Critical Hit ratio. Two additional moves, Frost Breath and Storm Throw, always land a Critical Hit unless the defending Pokémon has the Battle Armor or Shell Armor ability, or is under the effect of a Lucky Chant.

[13] See `http://www.smogon.com/dp/articles/damage_formula` for a comprehensive summary of the Gen IV damage formula and all of its modifiers.

[14] 10% in Generations II and III.

[15] If the Pokémon has the Guts ability, its Attack is raised by 50% instead.

- Double battles. Some moves, like Surf and Explosion, hit multiple Pokémon. These moves are reduced to 75% of their normal power in double battles and triple battles.

6 Applications

Using this information, it's easier to train and battle more wisely. Consider the following case studies:

6.1 Training Pokémon Evenly?

Many people like to train their Pokémon evenly, but this may not always be necessary. Pokémon with naturally higher base stats may not need as much training as others. Take Arcanine, for example:

	Arcanine's stats	**Average stats (fully evolved)**
HP	90	80
Attack	110	90
Defense	80	83
Special Attack	100	83
Special Defense	80	83
Speed	95	78

Arcanine has only slightly below average Defense and Special Defense, which can easily be made up with some EV training. However, its Attack and Special Attack stats are pretty well above average. Therefore one may not need to train an Arcanine as much to do the same amount of damage as an average fully evolved Pokémon. This becomes convenient because Arcanine is in the slow experience group.

6.2 Move Selection

Suppose you have a Linoone, a Normal type, and you can either teach it Surf or Strength. Which one would you choose?

Surf and Strength both have a base accuracy of 100%, but Surf's base power is 95 while Strength's base power is only 80. However, this does not necessarily mean that Surf is the stronger move. Linoone's Attack base stat, 70, is higher then its Special Attack base stat, 50. In addition, Linoone receives a STAB for using Strength, a Normal-type move. Therefore Strength would end up doing more damage overall.

However, teaching Linoone Surf has some notable advantages. A Water-type move helps cover the types that Normal-type moves are weak against: Rock, Ghost, and Steel. Normally, Normal-type moves are not very effective against Rock and Steel, and do not affect Ghost-type Pokémon. However, a Water-type move is super effective against Rock types and damages Ghost and Steel types normally. This makes Surf a good addition to round out Linoone's moveset. Besides, Linoone learns other Normal-type moves with comparable base powers, like Slash (base power 70, but high Critical Hit ratio).

6.3 Battling Effectively[16]

A move's total effectiveness does not necessarily correspond to its total power. Consider an example where your Lucario, a Fighting/Steel type, is battling a Gliscor, a Ground/Flying type. Suppose you are between two moves: Crunch, a physical Dark-type move with base power 80 and 100% accuracy, or Close Combat, a physical Fighting-type move with base power 120 and 100% accuracy. Crunch does not receive any modifiers, so its power is 80. Close Combat, despite being not very effective against Gliscor (Flying-type Pokémon resist Fighting-type moves), receives a STAB and therefore have an effective power of $120 \times 1.5 \div 2 = 90$. Therefore Close Combat will do more damage despite being at a type disadvantage.

Of course, Lucario is weak to Ground-type moves, so the optimal choice here would probably be to switch out. But that's beside the point. The point here is that it's not just modifiers that determine how you should battle; it also depends on the moves you choose.

[16]Thanks to leafbarrett of the Nuzlocke Forums for this example!

6.4 Ridiculously Huge Multipliers

When done right, multipliers can add up to do massive damage. Pokémon Stadium 2 gives an example of a Pikachu able to get a 24× multiplier against a Gyarados with an Electric attack (1.5× for the STAB, 4× type effectiveness, 2× if holding a Light Ball, and 2× for a Critical Hit). However, we can go much higher.

If you have a Chansey using Rollout on a Moltres, you can get huge multipilers. Rollout doubles in power for every consecutive use, up to 16×. Also, if you use Defense Curl beforehand, Rollout's power doubles. Other multipliers include being type effectiveness (4×), assisted by Helping Hand (1.5×), Cherrim's Flower Gift ability[17] (1.5×), a Choice Band (1.5×), doing Skill Swap against a Pokémon with the Pure Power ability[18] (2×), a Critical Hit (2×). Combine this with raising Chansey's Attack to stage +6 (4×), and lowering Moltres' Defense to stage -6 (4×). This yields a whopping 27,648× multiplier! With all of these, a level 1 Chansey, despite having the lowest Attack stat of all Pokémon, can OHKO[19] a fully EV trained level 100 Moltres!

6.5 F.E.A.R.

You can also do insane amounts of damage is by choosing the right moves at the right time. F.E.A.R., which stands for **F**ocus Sash, **E**ndeavor, Quick **A**ttack, **R**attata,[20] depends on this idea. Here's how you do it:

Start by sending out a "weak" Pokémon (often Rattata) that is holding a Focus Sash and also knows the moves Endeavor and Quick Attack. Let it take a hit; the Focus Sash will prevent it from fainting and leave it with 1 HP. Then use Endeavor, which will reduce your opponent down to 1 HP as well. On your next turn, use Quick Attack and knock it out. Now that's what I call a top percentage Rattata!

Of course, this method has two main weak points. First, it can only be used once unless you call back your Pokémon and heal it. Second, it can be counteracted by a Pokémon who knows a move with higher priority, like Extremespeed. However, this strategy can easily catch an unknowning trainer off guard.

6.6 Magikarp Sweeping

But if you really want to do some major trolling, with a little luck you can pull off Magikarp sweeping. For this you will need a Magikarp holding a Focus Sash with good Attack and Speed EVs and IVs. You will also need another Pokémon that knows a move that will immobilize the opponent (Hypnosis, e.g.), moves or items that enhance Attack, Speed, and the Critical Hit ratio, and Baton Pass.[21]

Start by sending out your Magikarp. Let it take a hit; as in F.E.A.R., the Magikarp will be left with 1 HP thanks to the Focus Sash. Then switch out to your other Pokémon. While keeping your opponent immobilized, boost your Attack stat and Critical Hit ratio all the way up, boost your Speed stat a few levels. Baton Pass back to Magikarp. Then use Flail, which will have base power 200 when the user has a sliver of HP left. You'll do massive damage!

Let's work out an example. A fully trained level 100 Magikarp with a helpful nature has an Attack stat of 130. Suppose you're up against Arceus, who has a maximum Defense stat of 372 when fully trained and with a helpful nature. If you use Flail with your Attack stage at +6 and you land a Critical Hit, here's how much damage you will do:

$$\text{damage} = \left(\frac{2 \cdot 100 + 10}{250} \cdot \frac{130 \cdot 4}{372} \cdot 200 + 2\right) \cdot 2 \cdot R \approx 473R$$

So you'll do anywhere between around 402 and 473 damage. Arceus has at most 444 HP at level 100, so with a little bit of luck, a Magikarp will OHKO Arceus. You read that right; *a Magikarp can OHKO Arceus.*

Now that you know some of the secrets behind how the world of Pokémon works, your strategies may change to reflect your new knowledge, giving yourself previously unsen advantages. Now go out there and be the best Pokémon Master you can be, like no one ever was!

[17] Multiplies an ally's Attack stat by 1.5 in harsh sunlight.
[18] Pure Power doubles the user's Attack stat. Skill Swap exchanges abilities with another Pokémon.
[19] One-hit KO
[20] Alternatively, **F**...ing **E**vil **A**nnoying **R**odent.
[21] Baton Pass allows you to switch Pokémon while keeping any applied stat enhancements.

A Type Effectiveness Chart: Gen I

Attacking type \ Defending type	Normal	Fire	Water	Electric	Grass	Ice	Fighting	Poison	Ground	Flying	Psychic	Bug	Rock	Ghost	Dragon
Normal													1/2	0	
Fire		1/2	1/2		2	2						2	1/2		1/2
Water		2	1/2		1/2				2				2		1/2
Electric			2	1/2	1/2				0	2					1/2
Grass		1/2	2		1/2			1/2	2	1/2		1/2	2		1/2
Ice			1/2		2	1/2			2	2					2
Fighting	2					2		1/2		1/2	1/2	1/2	2	0	
Poison					2			1/2	1/2			2	1/2	1/2	
Ground		2		2	1/2			2		0		1/2	2		
Flying				1/2	2		2					2	1/2		
Psychic							2	2			1/2				
Bug		1/2			2		1/2	2		1/2	2				
Rock		2				2	1/2		1/2	2		2			
Ghost	0										0			2	
Dragon															2

B Type Effectiveness Chart: Gen II and Beyond

Attacking type \ Defending type	Normal	Fire	Water	Electric	Grass	Ice	Fighting	Poison	Ground	Flying	Psychic	Bug	Rock	Ghost	Dragon	Dark	Steel
Normal													1/2	0			1/2
Fire		1/2	1/2		2	2						2	1/2		1/2		2
Water		2	1/2		1/2				2				2		1/2		
Electric			2	1/2	1/2				0	2					1/2		
Grass		1/2	2		1/2			1/2	2	1/2		1/2	2		1/2		1/2
Ice		1/2	1/2		2	1/2			2	2					2		1/2
Fighting	2					2		1/2		1/2	1/2	1/2	2	0		2	2
Poison					2			1/2	1/2				1/2	1/2			0
Ground		2		2	1/2			2		0		1/2	2				2
Flying				1/2	2		2					2	1/2				1/2
Psychic							2	2			1/2					0	1/2
Bug		1/2			2		1/2	1/2		1/2	2			1/2		2	1/2
Rock		2				2	1/2		1/2	2		2					1/2
Ghost	0										2			2		1/2	1/2
Dragon															2		1/2
Dark							1/2				2			2		1/2	1/2
Steel		1/2	1/2	1/2		2							2				1/2