

# MATH:1260 Pokémath

## The Mathematics of Pokémon Go<sup>®</sup>

Week 8 Monday, Spring 24

Popular curve:

Litten-like curve



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## Plan for Today

- Module 2: Gotta Catch 'Em All!®
    - Independent Events, “product rule” practice
    - Probability of “Normal Capture”
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## Class Reminders

- GW7 in discussion Thursday as usual.
- HW5 due Wednesday at midnight.
- Spring Break is coming!

- I hate taking points off  
so please carefully read the directions!

## Definitions (Super helpful for the Homework!)

A **random experiment** has outcomes that we can not predict.

A single repetition of a random experiment is called a **trial**.

The possible results of a trial are called **outcomes**.

The SET of all possible outcomes is called the **sample space**.

An **event** is a **subset** of the sample space that contains all **outcomes** from inside the sample space that meet some **requirement**.

## Formal Definition of (discrete) Probability

P is a function from events to the **numbers between 0 and 1** with the following properties:

- $P(S) = 1$
- The **general union rule (or general addition rule)**:
  - $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
- The **complement rule**:
  - $P(A^c) = 1 - P(A)$
- The **multiplication rule for independent events** A and B:
  - $P(A \text{ then } B) = P(A) * P(B)$
  - That is, the probability of event A and event B both occurring (**at the same time** or **one right after the other**) is  $P(A) * P(B)$ .

## Independent Events Example

Suppose I shiny check the next wild Pokemon that spawns.

Let's say I have already done my Pokemath Project 2 and I know the spawn rate of Litten is 0.2% on a sunny day.

I really want a shiny Litten because I love the shiny color of Incineroar in Smash Ultimate. We recall the shiny rate is 1/500 wild Pokemon.



What is the probability a shiny Litten is the Pokemon that spawns? Are these events independent?

$$.002 \cdot (1/500) = .000004$$

Yes

## Be Careful! Dependent Events can be Very Sneaky!

Consider the Pokémon in my bag. To make the numbers round, suppose I have 500 Pokémon® in my bag.

I have 40 that are CP less than 100.

I have 8 that are shiny.

If I **pull a random Pokemon out of my bag** (with an equal likelihood of each one being chosen) what is the probability of it being a shiny with CP less than 100? Are these events independent?

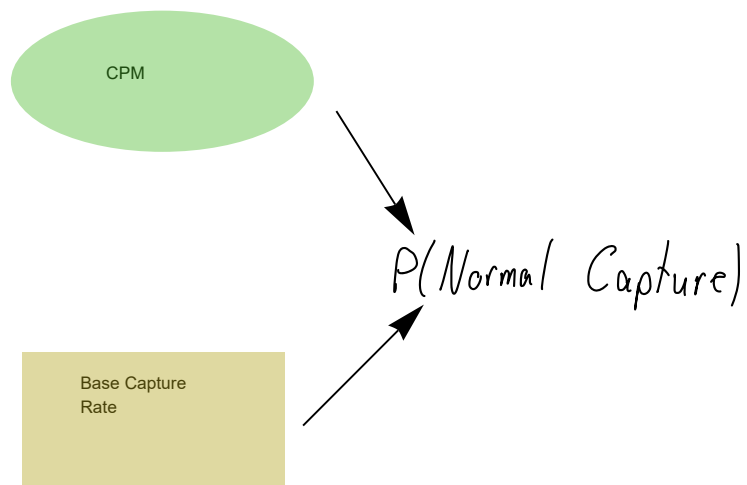
Pokemon in raids have different shiny odds and are on average have higher CP than wild Pokemon. So, weak shiny Pokemon are rarer because they cannot be found in raids.

## New Concept: Catch Rates

Some General Info

[https://bulbapedia.bulbagarden.net/wiki/Catch\\_rate\\_\(GO\)](https://bulbapedia.bulbagarden.net/wiki/Catch_rate_(GO))

**Normal Capture:** One regular ball, no curve, no nice throw, no berry, no boost.



Base capture rates

[https://bulbapedia.bulbagarden.net/wiki/List\\_of\\_Pokémon\\_by\\_catch\\_rate\\_\(GO\)](https://bulbapedia.bulbagarden.net/wiki/List_of_Pokémon_by_catch_rate_(GO))


Notation: Let's use

$P(\text{normal capture})$  for the “probability of a normal capture”

$$P(\text{normal capture}) = \frac{\text{Base Capture Rate}}{2 * \text{CPM}}$$

## Example: Magikarp!



Base Capture Rate					
129		Magikarp	70%	15%	None

This Shiny Magikarp is level 17. (How do I know this?)

Secret Power Up Cost Technique

The CPM of a Pokemon at level 17 is 0.550793. (How do I know this?)

Google it

$$P(\text{normal capture}) = \frac{.7}{2 \cdot .550793} = .6354$$



You try on Top Hat:

How about a level 30 Litten?

$$\frac{.2}{2.7317} = .137$$

## What about the probability of an escape? (Note: Escaping is different than Fleeing)

Suppose for some Pokemon, the Probability of Normal Capture = 0.15. So  $P(\text{normal capture}) = 0.15$ .

What is the probability of the Pokemon escaping (not being caught)?

$$P(\text{normal capture}^c) = 1 - P(\text{normal capture})$$

$$1 - 0.15 = 0.85$$

We are trying to catch a single Pokemon, which may require multiple Pokeballs.

The probability of two escapes in a row?

$$P(\text{normal capture}^c \text{ then normal capture}^c)$$

$$= P(\text{normal capture}^c) \cdot P(\text{normal capture}^c) = .85 \cdot .85$$

$$= .7225$$

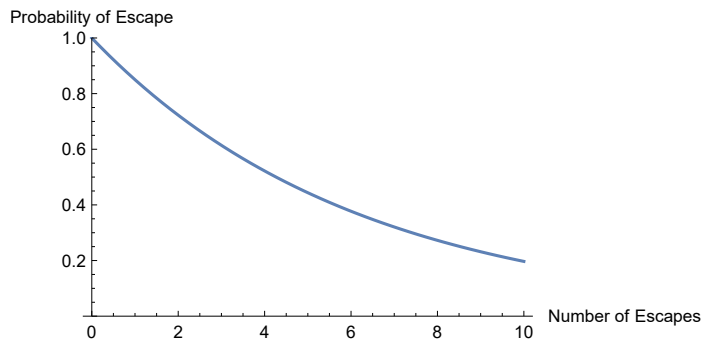
The probability of three escapes in a row?

$$= .85 \cdot .85 \cdot .85 = (.85)^3$$

$$= .578$$

## The probability of n escapes in a row?

```
Plot[(1 - .15)^n, {n, 0, 10}, PlotRange -> {0, 1},
  AxesLabel -> {"Number of Escapes", "Probability of Escape"}]
```



We have shown above that a Pokemon escaping on one throw does not affect their escape on a second throw. So escape and escape are independent.

What about catch and escape? (Remember, we are talking about catching a specific Pokemon, which may require multiple throws!)

What about catch and catch?

## The catch probability with n balls.

```
Plot[1 - (1 - .15)^n, {n, 0, 10}, PlotRange -> {0, 1},  
  AxesLabel -> {"Number of balls thrown", "Probability of Catch"}]
```

