

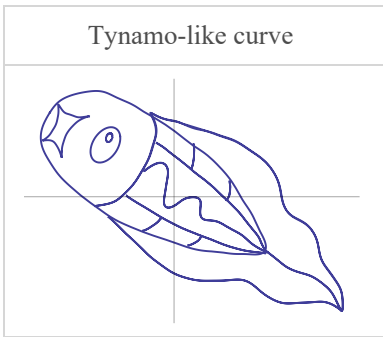
MATH:1260 Pokémath

The Mathematics of Pokémon Go[®]

Week 8 Wednesday, Spring 24

Popular curve:

Tynamo-like curve



Plan for Today

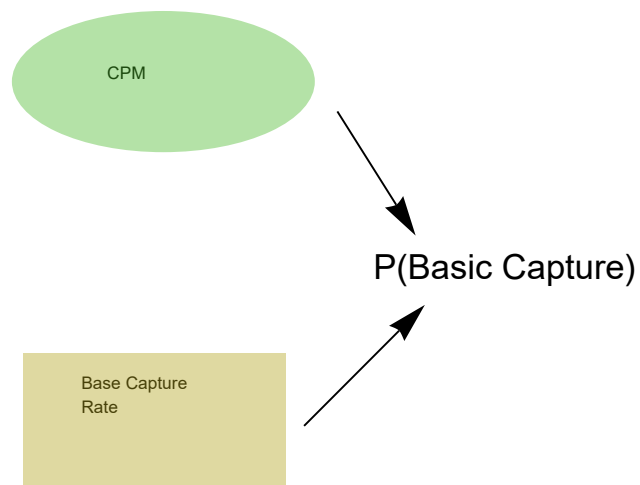
- Module 2: Gotta Catch 'Em All!®
 - Conditional probabilities
 - Probability of catch

Class Reminders

- GW7 in discussion Thursday.
- HW6 due Wednesday after break.
 - We will have a partial work day for the assignment on Monday
- Project 2 Stage 1: Proposal is ALSO due Wednesday after break.
 - Investigating Spawn Rates!
- No class next week.

Catch Rates

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



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

Tynamo!

My Tynamo is level 13. What is the P(Normal Capture)?

602		Tynamo	40%
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12	0.4627984	1300
12.5	0.472336093	1300
13	0.48168495	1600
13.5	0.4908558003	1600
14	0.49985844	1600

P depends on Level

Let's compare a level 13 Tynamo to a level 30 Tynamo

Level 13 Tynamo has a Prob of Normal Capture of about .42

Level 30 Tynamo has a CPM of .7317. This gives a Prob of Normal Capture of about .27

But those probabilities only matter if the wild Tynamo I find is level 13 or level 30. So there is a random element to the level as well...

Conditional Probability

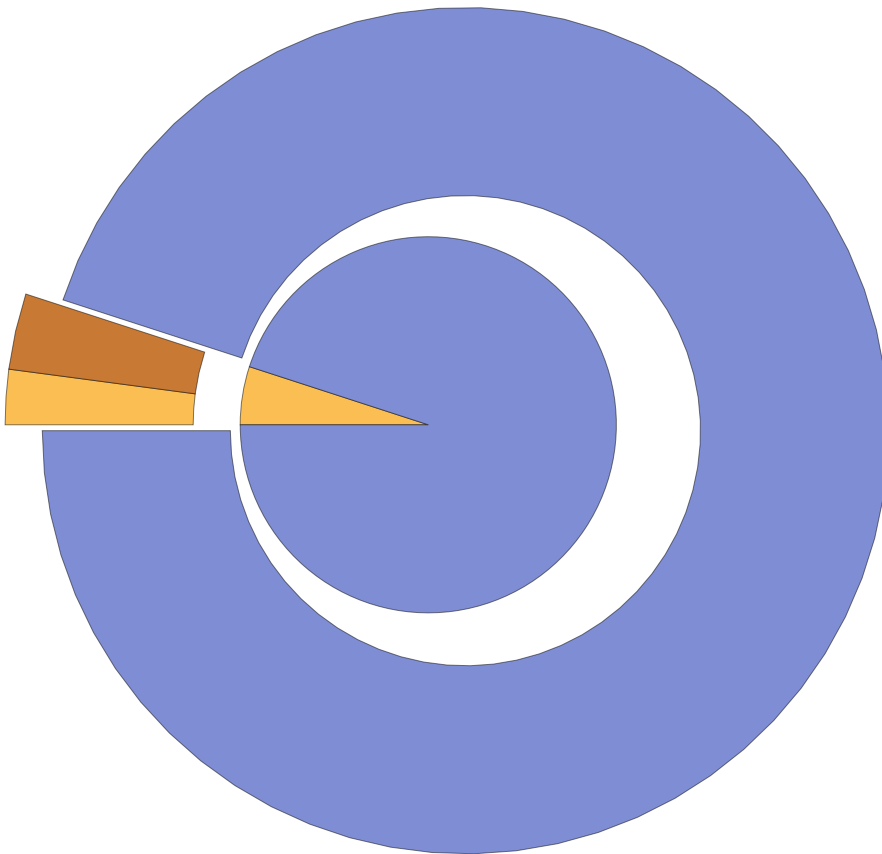
When we have a piece of information that can change the probability of an event in our random experiment, we need to think about conditional probability!

Some notation:

$P(A | B)$ represents the probability of A **given** B. That is, what is the probability of event A if we **already know** event B has happened.

Thinking about proportions

This example



General Multiplication Rule of Probability

$$P(A \cap B) = P(A | B) * P(B)$$

This is the intersection rule we couldn't do before! With conditional probability, we have the tools.

Note: A, B need not be independent! We only need the probability of A **given** B.

Tophat: What is $P(C \cap L30)$? In words: what is the probability of catching a Tynamo and the Tynamo is level 30?

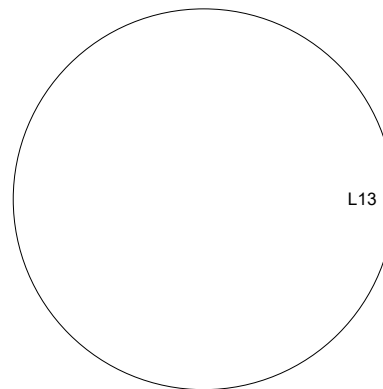
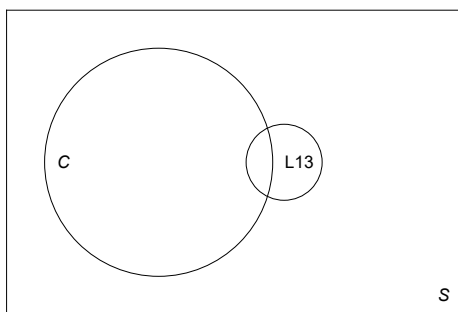
This can be written another way!

The **conditional probability** of A given B is

$$P(A | B) = \frac{P(A \cap B)}{P(B)}$$

This is the same as the previous formula, just in a different arrangement.

Another interpretation: Restrict the sample space



Formulas from last time:

Probability of a Pokemon escaping “n” times in a row:

$$P(n \text{ escapes in a row}) = (1 - P(\text{Normal Capture}))^n$$

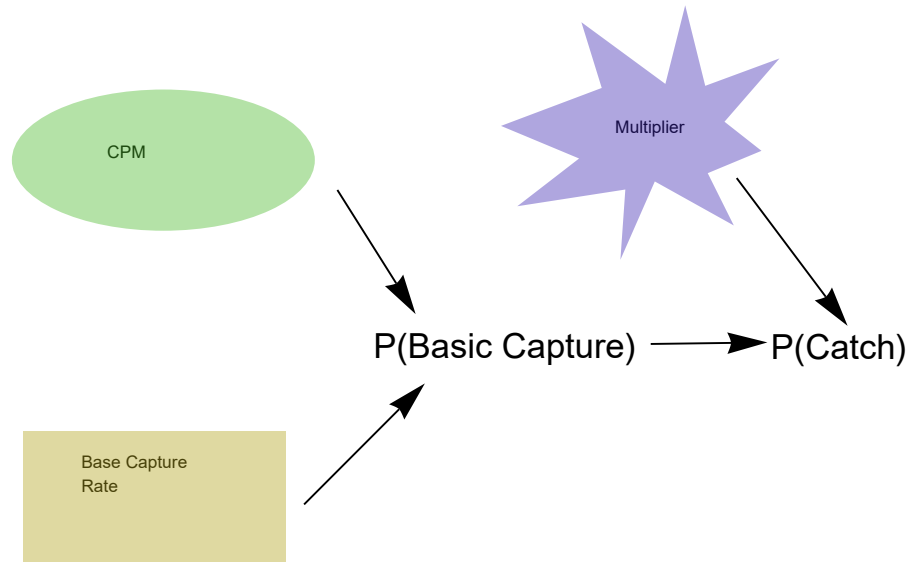
This one comes from using the product rule for independent events “n” times in a row.

Probability of capturing a Pokemon within “n” Pokeballs

$$P(\text{catch within “n” balls}) = 1 - P(n \text{ escapes in a row}) = 1 - (1 - P(\text{Normal Capture}))^n$$

This one comes from the fact that if a Pokemon did NOT escape “n” times in a row, it must have been caught at least once in “n” attempts.

Beyond Basic Capture



Here is the upgraded formula from Normal Capture to a proper **Catch Probability**.





$$P(\text{Catch}) = 1 - (1 - P(\text{Normal Capture}))^{\text{multiplier}}$$

This looks similar to the previous formula by design. However, this one was made up by the developers of Pokemon GO.

How to Compute Multiplier

Multiplier = Ball * Berry * Throw * Curveball * Encounter * Medal




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

- Ball is
 - 1 if a  Poké Ball or  Premier Ball is thrown
 - 1.5 if a  Great Ball is thrown
 - 2 if an  Ultra Ball is thrown

Example

Suppose instead that I use an ultra ball (no other “boosts” in my multiplier). What is the probability I catch Tynamo?





TH What if I throw a great ball and use a golden raspberry?

- **Berry** is
 - 1.5 if a  **Razz Berry** is used
 - 1.8 if a  **Silver Pinap Berry** is used
 - 2.5 if a  **Golden Razz Berry** is used
 - 1 if otherwise

- Throw is $2 - r$ if the Ball hits within the target ring, and 1 otherwise
 - where $r = (\text{target ring size}) / (\text{maximum ring size})$, hence $0 < r \leq 1$
 - for a Nice Throw, $1 \leq \text{Throw} < 1.3$
 - for a Great Throw, $1.3 \leq \text{Throw} < 1.7$
 - for an Excellent Throw, $1.7 \leq \text{Throw} < 2$

- `Curveball` is 1.7 if the Ball is spun before being thrown, and 1 otherwise

- `Encounter` is 2 if the Pokémon is encountered for completing [Field](#), [Special](#) or [Timed](#) Research tasks, and 1 otherwise

- `Medal` is based on the player's [type-specific Medals](#) pertaining to the wild Pokémon's type and is
 - 1 if  none
 - 1.1 if  bronze
 - 1.2 if  silver
 - 1.3 if  gold
 - 1.4 if 20px platinum
 - if the wild Pokémon has two types, `Medal` will be the average of the above for each type