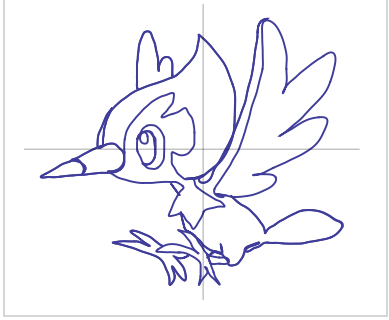
MATH:1260 Pokémath
The Mathematics of Pokémon Go®

Week 7 Wednesday, Spring 24

Popular curve:

Pikipek-like curve



Plan for Today

- Module 2: Gotta Catch 'Em All!®
  - Review sum rule and complement rule
  - Independent Events, "product rule"

Class Reminders

- GW6 in discussion Thursday.
- HW4 due tonight at midnight.
- HW5 due Wednesday March 6.

Definitions **(Super helpful on 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

0% 100%

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 General Union Rule is a shortcut for writing out the Venn Diagram

Suppose I have 279 Pokemon in my bag.

16 are rock type. set R

30 are ground type. set G

12 are rock and ground type.

If the experiment is pulling one Pokemon out of my bag at random (with an equal likelihood for each Pokemon) what is the probability that the Pokemon is ground type or rock type? How would you write this question in set theory notation?

$$P(R \cup G) = P(R) + P(G) - P(R \cap G)$$

$$= \frac{16}{279} + \frac{30}{279} - \frac{12}{274}$$

$$P(R \cup G) = \frac{34}{279}$$

The Complement Rule is a shortcut for writing out the Venn Diagram

If the experiment is still pulling one Pokemon out of my bag at random (with an equal likelihood for each Pokemon) what is the probability that the Pokemon is not ground type? How would you write this question in set theory notation?

$$P(G^c) = 1 - P(G)$$

$$= 1 - \frac{30}{279}$$

$$= \frac{279}{279} - \frac{30}{279}$$

$$P(G^c) = \frac{249}{279}$$

TopHat: We computed last week that the probability of a shiny in legendary raids to be about .05.

What is the probability of non-shiny in legendary raids?

$1 - .05 = .95$

New Concept: Independent Events

Two events are called independent if the outcome of one event does not depend on the other. Important note: The events can be from the same experiment or different experiments!

Two events are called dependent if the outcome of the first event changes the outcomes of the second event. Important note: The events can be from the same experiment or different experiments!

Independent Events:

Two coin tosses

Two die rolls (or any number of die rolls)

Catching two Pokemon (or a shiny check, appraisal, etc)

Dependent Events:

A bag contains two marbles, a black one and a white one. You pull a marble out of the bag *and do not place it back in the bag.* Then you pull another marble out of the bag. Is it possible to get two black marbles?

No! Because the events are dependent. Removing one marble from the bag has an impact on which marble you can get on your next pull.

Another example: Transferring two random Pokemon out of your bag. Once you transfer the first Pokemon, it is impossible to transfer it again, so the second Pokemon you transfer has a slightly different probability of being chosen.

Pokemon example

Suppose my wife and I do a Rockruff Raid.

The event I get a shiny is called K. Suppose P(K)=.05 $\simeq \frac{1}{20}$

The event Schuyler gets a shiny is called S. Suppose P(S)=.3 $\simeq \frac{3}{10}$

What is the probability that Schuyler and I both get Shiny Rockruff?

$$\frac{1}{20} \cdot \frac{3}{10} = \frac{3}{200}$$

Is this an intersection? **No!** This is a combination of events across *different trials* and even *different experiments*.

Definition

The multiplication rule for independent events A and B:

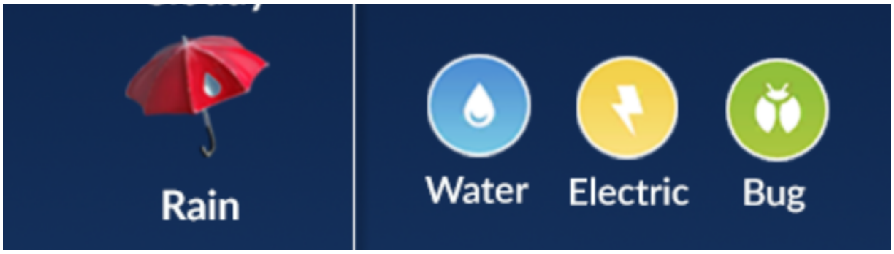
P(A then B) = P(A) * P(B)

That is, the probability of event A and event B both occurring is P(A) * P(B).

Examples

Suppose there is a 10% chance of rain today. I go out to catch a Popplio. What is the probability I catch a shiny Popplio while it's raining? Recall from a previous class, we found that the probability of a wild Pokemon being shiny Pokemon was 1/500.

$$P(\text{rain then shiny Popplio}) = P(\text{rain}) \cdot P(\text{shiny Popplio})$$
$$= 10\% \cdot \frac{1}{500}$$
$$= \frac{1}{10} \cdot \frac{1}{500}$$
$$= \frac{1}{5000}$$



Examples

The multiplication rule works between separate trials!

Let's say I am rolling a twenty-sided die. I want to roll a perfect twenty on my first trial, and also roll a perfect twenty on my second trial.

What is my sample space for a single trial? What is the event I want?

$S = \{1, 2, 3, 4 \ldots, 20\}$ $E = \{20\}$

Are the two trials independent?

Yes

What is the probability of rolling a twenty in a **single trial**? Using this, what is the probability of rolling **two twenties** in **two trials**?

single trial: $\frac{1}{20}$ two trials: $\frac{1}{20} \cdot \frac{1}{20} = \frac{1}{400}$

This problem can also be solved by changing the experiment to be roll two twenty-sided die at once. But then you must deal with having 400 different outcomes. The multiplication rule for independent events is much easier!