Tutorial

### Addition Rule: The "Or" Rule

The **addition rule** helps you figure out the probability of *at least one* of two events happening. It's your go-to for "or" questions.

**Mutually Exclusive Events:** If two events **can't** happen at the same time (like flipping a coin and getting both heads and tails), you just add their probabilities.

**Formula:** P(A or B) = P(A) + P(B)

**Non-Mutually Exclusive Events:** If two events **can** happen together (like drawing a card that is both a King and a Heart), you add their probabilities and then subtract the chance of both happening to avoid double-counting.

**Formula:** P(A or B) = P(A) + P(B) - P(A and B)

#### Python Example: Drawing a Card

Let's find the probability of drawing a King **or** a Queen from a standard 52-card deck. These are mutually exclusive events.

### Multiplication Rule: The "And" Rule

The **multiplication rule** is for when you want to know the probability of two (or more) events happening *together*. It's your tool for "and" questions.

**Independent Events:** If one event **doesn't** affect the other (like flipping a coin twice), you just multiply their probabilities.

**Formula:** P(A and B) = P(A) \* P(B)

**Dependent Events:** If the outcome of the first event **changes** the probability of the second (like drawing two cards from a deck *without* replacing the first one), you have to adjust.

**Formula:** P(A and B) = P(A) \* P(B given A)

#### Python Example: Flipping a Coin Twice

What's the chance of getting heads **and** then getting heads again? These are independent events.

### Bayes' Theorem: The Update Rule

**Bayes' theorem** is a bit more advanced, but it's incredibly powerful. It's a way to **update your beliefs** (or probabilities) about something when you get new information. It's like being a detective: you start with a suspect (a prior belief), find a new clue (evidence), and then update how likely it is that your suspect is guilty (the posterior probability).

In simple terms, it answers the question: "Given this new piece of evidence, what is the probability that my initial hypothesis is true?"

Formula:

P(A|B) = (P(B|A) \* P(A)) / P(B)

Let's break that down:

P(A|B): The probability of your **hypothesis (A)** being true, **given the new evidence (B)**. This is what you want to find.

P(B|A): The probability of seeing that **evidence (B)**, if your **hypothesis (A)** was true.

P(A): The probability of your **hypothesis (A)** being true *before* you saw any evidence.

P(B): The probability of the **evidence (B)** occurring in general.

#### Python Example: Medical Test

Imagine a medical test for a rare disease.

The disease affects 1% of the population. P(Disease)

The test is 99% accurate if you have the disease. P(Positive Test | Disease)

The test has a 5% false positive rate (it says you have it when you don't). P(Positive Test | No Disease)

You test positive. What's the actual chance you have the disease?

Even with a positive test, there's only a ~17% chance you actually have the disease! This is because the disease is so rare to begin with. Bayes' theorem helps us see beyond the surface and make more accurate judgments.

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