Bayes' theorem

is a way to calculate the probability of an event happening given that you already know something else has happened. It's essentially a tool to update your beliefs about something based on new evidence.

The formula for Bayes' theorem is:

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

Here's what each part of the formula represents:

- P(A | B): This is the **posterior probability**, the probability of event A happening given that you know event B has already happened. This is what you're trying to solve for.
- P(B | A): This is the **likelihood**, the probability of event B happening given that you know event A has already happened.
- P(A): This is the **prior probability**, the initial probability of event A happening, without considering any new evidence.
- P(B): This is the probability of event B happening regardless of event A.

Example:

Let's say you have a box with two decks of cards: one deck has only red cards (52 red cards) and the other deck has only blue cards (52 blue cards). You don't know which deck is in the box, but you assume they are equally likely (50% chance of picking either deck). You draw a red card without looking at the deck. What is the probability the deck you picked has only red cards?

- **Event A:** Picking a deck with only red cards.
- **Event B:** Drawing a red card.

We are trying to find P(A | B), the probability of picking a red deck (A) given that you drew a red card (B).

- P(B | A) = 1 (Since if you pick the red deck, you are guaranteed to draw a red card).
- P(A) = 1/2 (Assuming equal chance of picking either deck). This is our prior probability.
- P(B) = We need to consider the probability of drawing a red card from either deck. There are 104 cards total (52 red + 52 blue) and 52 red cards. So, P(B) = 52/104 = 1/2.

Now we can plug these values into the formula:

$$P(A|B) = (1 * 1/2)/(1/2) = 1/2 * 2 = 1$$