

# Conditional Probability with Venn Diagrams

by Sophia



## WHAT'S COVERED

This tutorial will continue the discussion on the topic of conditional probability.

### 1. Conditional Probability with Venn Diagrams

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A Venn diagram is a useful tool to visualize conditional probability.

⇒ **EXAMPLE** What is the probability of getting an even on a roulette wheel? Like the example above, this question is not a conditional probability yet because the question is simply about the probability that the number is even. To find the answer, count up all of the even sectors.



$$P(\text{Even}) = \frac{18}{38}$$

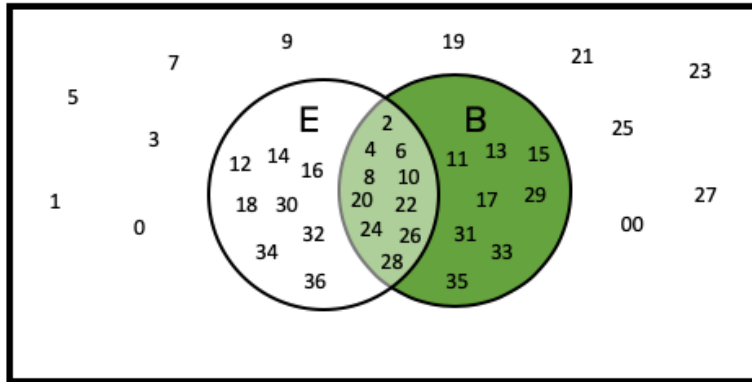


HINT

Notice that zero and double zero don't count as even. The evens on the roulette wheel are in two categories: even numbers that are in black and even numbers that are in red. 18 of the 38 numbers on the roulette wheel are even.

However, what if we want to know the probability that the sector is even, given that the sector is also black?

This is a conditional probability statement. We can create a Venn diagram to show the relationship between these two characteristics of even and black. Ignore any of the sectors that are neither black nor even, and the ones that are only even without being black. Some of the black numbers are also even.



Of the 18 numbers that are black on the roulette wheel, ten selections are both even and black. So the probability is 10 even black sectors out of 18 total black sectors.

We could also use the conditional probability formula which states we need to find the probability of a sector being both even and black, which is 10 out of 38, and divide by the probability of a sector being black, which is 18 out of 38.

$$P(E | B) = \frac{P(\text{Both Even and Black})}{P(\text{Black})} = \frac{\frac{10}{38}}{\frac{18}{38}} = \frac{10}{18}$$

In the example above, we show all the individual members of each group, but usually Venn diagrams summarize this by only indicating the total number of individuals in that group, as in the example below.





The Venn diagram represents the protein powder flavor preferences of 100 bodybuilders.

What is the probability a bodybuilder likes chocolate protein powder, given we know they like vanilla? +

Apply the conditional probability formula.  $P(\text{Chocolate} | \text{Vanilla}) = \frac{P(\text{Vanilla and Chocolate})}{P(\text{Vanilla})}$

$$P(\text{Chocolate} | \text{Vanilla}) = \frac{0.22}{0.50} = 0.44 \text{ or } 44\%$$



HINT

To calculate  $P(\text{vanilla})$ , be sure to count both the 28 who like vanilla only and the 22 who like both flavors

$$(28/100 + 22/100 = 0.50)$$



## SUMMARY

Conditional probability is the probability of some second event occurring, given that some first event has already occurred. It's calculated by dividing the joint probability of the two events by the probability of the existing event (the one that's already happening). This formula works for all events. This isn't a special formula that works only for independent events or only for mutually exclusive events.

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## TERMS TO KNOW

### Conditional Probability

The probability that one event occurs, given that another event has already occurred.



## FORMULAS TO KNOW

### Conditional Probability

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