PROBABILITY THEORY

TOC

# What is the Probability Theory.

It is the mathematical tool we use to measure the **likelihood** of the **different results** of an **experiment**. For example, if we want to measure the probability of getting each number when throwing a die, we would use the **probability theory**.

For that we denote Ω to be the set of possible outcomes. We can represent this set as a box that will contain all the possible outcomes, for that, the possibility of Ω will be 1. (note that the probabilities are between 0 and 1 for then 1 is the same as 100%)

This set can be divided into different subsets, also called events, each one of them with a **probability measure** between **0 and 1**. In the case of having a subset with probability of 1, this will be the same as Ω.

Subsets can also be combined in the following ways:

* A U B (Union): Either A or B or both happen.
* A ∩ B (Intersection): Both A and B happen.
* A \ B (Difference): A happens but B does not
* A’ or Aᶜ (Complement): The opposite of A. That is the possibility of A not happening.

Properties of events in Ω:

1. P(A) belongs to [0,1]
2. P(Ω) equals 1 and P(Ø[[1]](#footnote-1)) equals 0.
3. If A ⃀ B, then P(A) ⃀ P(B)[[2]](#footnote-2)
4. If A ∩ B = Ø 1, the P(A U B) = P(A) + P(B) [[3]](#footnote-3)
5. P(A\B) = P(A) – P(A ∩ B)

Image of the probability Space


Image 1. Ω Is the sample space and Ø anything outside it

A grey and orange circle with black letters

Description automatically generated

Image 2. The circles containing each letter denotes the probability of either A or B happening.

For that, every time A happens, B has to happen since A ⃀ in B.

A grey box with orange circles and black text

Description automatically generatedA diagram of a venn diagram

Description automatically generated

Image 3 (Left) and Image 4 (Right). In image A we can se that they are not intersecting, thus P(A) U P(B) = P(A) + P(B).

In the other hand, for image 4 we cannot do so since the red region would be added twice.

For that we use P(A) U P(B) = P(A) + P(B) – P(A∩B).

1. Ø is defined to be the empty set. That is the probability of Ø is the same as the probability Ω not happening for that, is 0. [↑](#footnote-ref-1)
2. The symbol ⃀ denotes that A is contained in B. For that reason if A happens, B MUST also happen since A is inside the probability B. Check image 2. [↑](#footnote-ref-2)
3. If there is no intersection between A and B, they are both different events, so since they have not repeated values their probabilities can be added. Check images 3 and 4. [↑](#footnote-ref-3)