What is the difference between Bernoulli and Binomial distributions?

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The Bernoulli and Binomial distributions are two types of probability distributions commonly used in statistics. The main difference between them is that the Bernoulli distribution is used for a single trial with two possible outcomes, while the Binomial distribution is used for multiple trials with two possible outcomes. In other words, the Bernoulli distribution is a special case of the Binomial distribution with only one trial. Additionally, the Bernoulli distribution assumes that the probability of success remains constant for each trial, while the Binomial distribution allows for varying probabilities of success. These distributions are useful in analyzing and predicting events with binary outcomes, such as success or failure, and are essential tools in many statistical analyses.

Bernoulli vs Binomial Distribution: What's the Difference?

A follows a Bernoulli distribution if it only has two possible outcomes: 0 or 1.

For example, suppose we flip a coin one time. Let the probability that it lands on heads be *p*. This means the probability that it lands on tails is 1-*p*.

Thus, we could write:

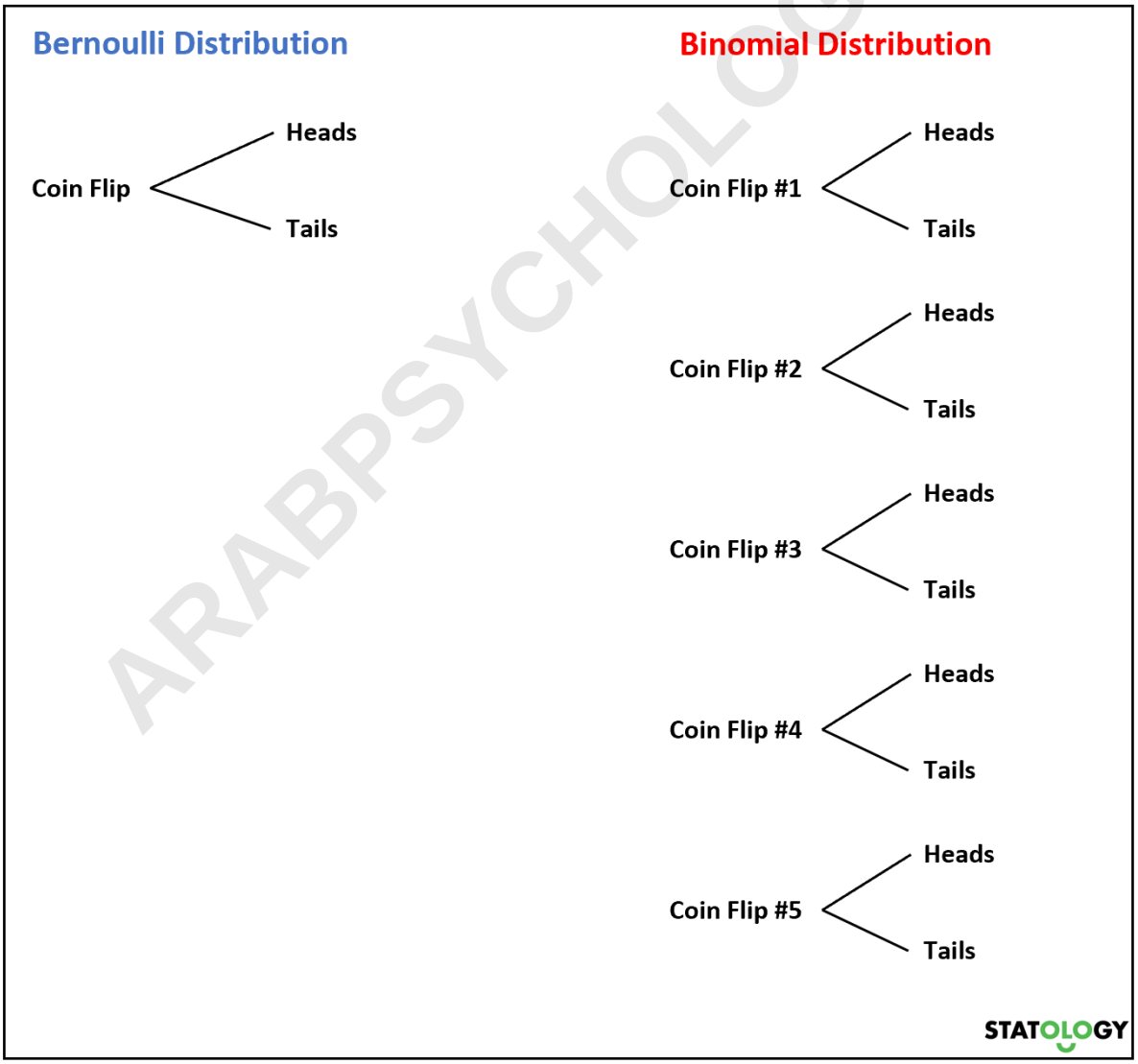
$$X = \begin{cases} 1 & \text{with probability } p \\ 0 & \text{with probability } 1-p \end{cases}$$

In this case, random variable *X* follows a Bernoulli distribution. It can only take on two possible values.

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Now, if we flip a coin multiple times then the sum of the Bernoulli random variables will follow a Binomial distribution.

For example, suppose we flip a coin 5 times and we want to know the probability of obtaining heads *k* times. We would say that the random variable *X* follows a Binomial distribution.



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If a random variable *X* follows a Binomial distribution, then the probability that *X* = *k* successes can be found by the following formula:

P(X=k) = nCk * pk * (1-p)n-k

where:

n: number of trialsk: number of successesp: probability of success on a given trialnCk: the number of ways to obtain *k* successes in *n* trials

For example, suppose we flip a coin 3 times. We can use the formula above to determine the probability of obtaining 0 heads during these 3 flips:

P(X=0) = 3C0 * .50 * (1-.5)3-0 = 1 * 1 * (.5)3 = 0.125

When *n* = 1 trial, the Binomial distribution is equivalent to the Bernoulli distribution.

Important Notes

Here are a couple important notes in regards to the Bernoulli and Binomial distribution:

For example, in a single coin flip we will either have 0 or

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1 heads. However, in a series of 5 coin flips we could have 0, 1, 2, 3, 4, or 5 heads.

2. In order for a random variable to follow a Binomial distribution, the probability of "success" in each Bernoulli trial must be equal and independent.

For example, if we define "success" as landing on heads, then the probability of success on each coin flip is equal to 0.5 and each flip is independent - the outcome of one coin flip does not affect the outcome of another.

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