

What is Probability?

Estimate how likely something is to happen



Arsenal or Chelsea, who will win?



Rain is likely to fall



Getting a movie ticket



Stocks are likely to rise



Boy or Girl?

What is Probability?

We draw on previous experience to determine how likely something is to occur



Arsenal or
Chelsea, who
will win?
0.7



Rain is
likely to fall
40%



Getting a
movie ticket
60%

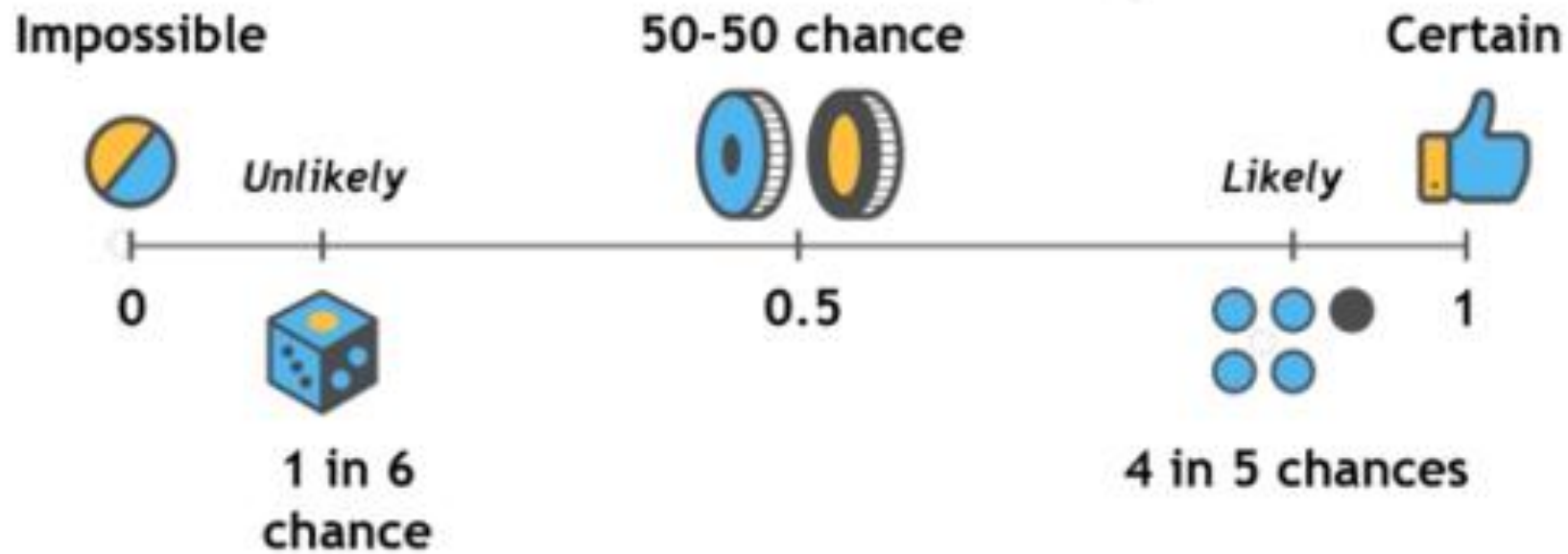


Stocks are
likely to rise
70%



Boy or
Girl?
0.5

Probability of an event



Why is Probability essential?

Probability, is the foundation and language needed for most of statistics to get certainty into decisions derived from statistics



If credit score is good there is 70 % probability of providing a loan

Components for conducting an experiment



Complement of an event

Event

*A client agrees to
invest in Mutual Funds*



Complement of an event

*A client does not invest in
Mutual Funds*



Making decisions using a tree based approach

Buying a new car



Approach Tree diagram and count of total events

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Independent Events

Person A visiting a movie theatre in India and Person B visiting the Cineplex in Australia are two independent events



Dependent Events

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The spike in sales of umbrellas in Walmart is dependent on rains and thunderstorm



Conditional Probability

The probability that an event will occur given that some other event has already happened



Index	Color	Type	Origin	Stolen
1	Red	Sports	Domestic	No
2	Red	Sports	Imported	No
3	Blue	Sports	Domestic	Yes
4	Yellow	Sports	Domestic	Yes
5	Yellow	SUV	Domestic	Yes
6	Yellow	SUV	Imported	No
7	Blue	SUV	Imported	Yes
8	Red	Sports	Domestic	No
9	Red	SUV	Imported	Yes
10	Yellow	SUV	Imported	Yes
11	Red	SUV	Domestic	Yes
12	Blue	Sports	Domestic	Yes
13	Blue	SUV	Imported	Yes
14	Yellow	Sports	Domestic	No

Conditional Probability to assess crime

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What is the probability of the Red Car being stolen?



Frequency Table	Stolen	
	Yes	No
Car		
Red	2	3
Blue	4	0
Yellow	3	2

$$P(\text{Red}/(\text{Stolen} = \text{Yes})) = 2/9 = 0.222$$

Practical uses of Conditional Probability



Frequency Table

Car	Stolen	
	Yes	No
Sports	3	4
SUV	6	1

Frequency Table

Car	Stolen	
	Yes	No
Domestic	3	3
Imported	6	2

Conditional Probability-other significant applications



**Categorizing
news**



**Email Spam
detection**



**Sentiment
Analysis**



**Facial
Recognition**

Conditional Probability is the probability that the second event B occurs given that the first event A has occurred

Conditional Probability

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

Bayes Theorem:

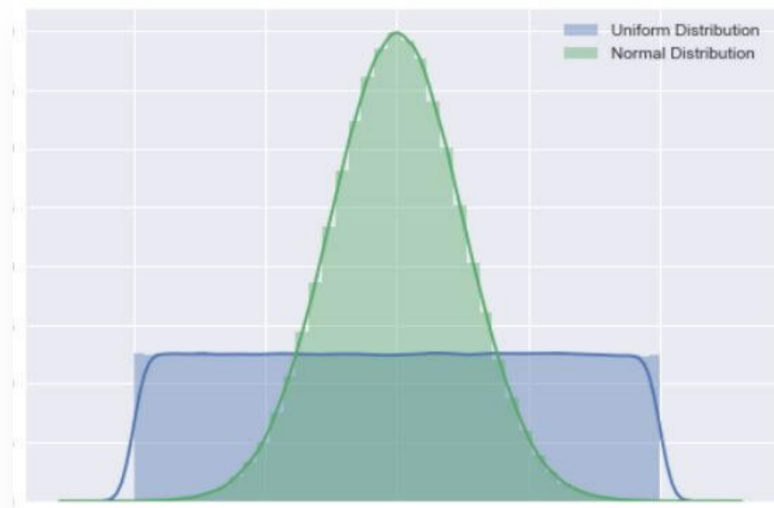
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$$\underbrace{P(A|B)}_{\text{Probability A Will Happen Given Evidence B Has Already Happened}} = \frac{\overbrace{P(B|A)}^{\text{Probability B Will Happen Given Evidence A Has Already Happened}} \cdot \overbrace{P(A)}^{\text{Probability A Will Happen}}}{\underbrace{P(B)}_{\text{Probability B Will Happen}}}$$

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Question: Find the Probability that a parents having 2 children, both of them are girl given one of them is at least a girl.

Normal Distribution is a probability distribution where probability of x is highest at centre and lowest in the ends whereas in Uniform Distribution probability of x is constant.



Normal Distribution is a probability distribution which peaks out in the middle and gradually decreases towards both ends of axis. It is also known as gaussian distribution and bell curve because of its bell like shape. Formula for normal probability distribution is as follows, where μ is mean and σ^2 is variance.

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

Uniform Distribution is a probability distribution where probability of x is constant. That is to say, all points in range are equally likely to occur consequently it looks like a rectangle. Formula for Uniform probability distribution is $f(x) = 1/(b-a)$, where range of distribution is $[a, b]$.

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Bernoulli Distribution

- Also called the **binary distribution**.
- This is the kind of distribution that is present when flipping a coin. What this means is that for whatever your experiment or event may be, there are only two possible outcomes — Heads or tails, success or failure, 0 or 1, etc.
- The probability of obtaining heads or tails for one flip would be 50% each.
- Let's say, kicking an extra point in football has a 75% success rate, and you represent 1 as a successful try, then the probability of 1 would be 75% and the probability of 0 would be 25%.

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

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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:

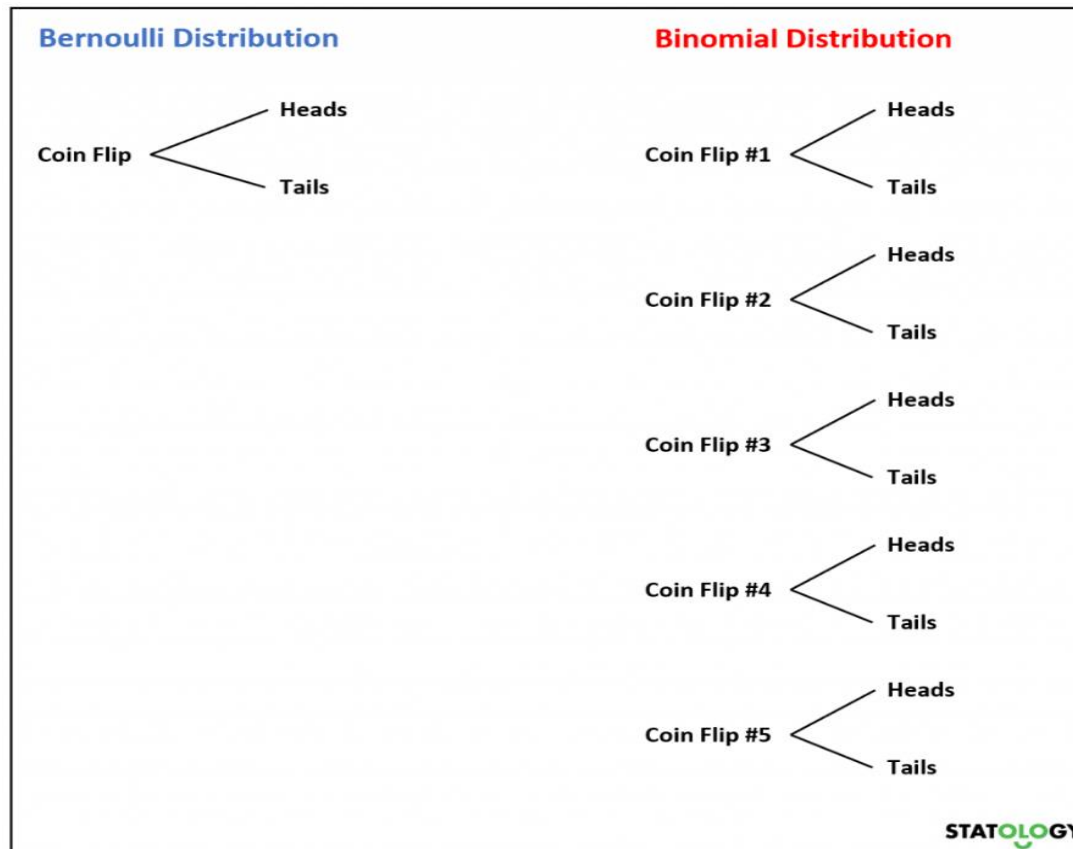
$$X = \begin{cases} 1 & \text{with probability } p \\ 0 & \text{with probability } 1 - p \end{cases}$$

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

Bernoulli Distribution

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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.



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

$$P(X=k) = {}_nC_k * p^k * (1-p)^{n-k}$$

where:

- **n**: number of trials
- **k**: number of successes
- **p**: probability of success on a given trial
- **${}_nC_k$** : 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:

$$P(X=0) = {}_3C_0 * .50 * (1-.5)^{3-0} = 1 * 1 * (.5)^3 = 0.125$$

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

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