# Interesting Facts about Probability

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Probability is a mathematical discipline that measures the chances of an event happening by assigning a value between 0 and 1. A value closer to 1 signifies a higher likelihood of the event occurring. It is essentially the ratio of the number of favorable outcomes to the total number of possible outcomes.

> ***The formula for Probability is : P(Event) = favorable outcomes/total number of outcomes***

## Some Amazing Facts About Probability:

- Girolamo Cardano, an Italian mathematician, physician, and avid gambler is credited as one of the earliest contributors to probability theory.
- Blaise Pascal and Pierre de Fermat are considered the father of probability.
- The probability of a sure event is 1 while the probability of an impossible event is 0.
- Probability can never be negative and always range between 0 and 1.
- For the probability of at least two people in a room having the same birthday to be 100%, there must be 367 people. This is because there are 366 possible birthdays, including February 29 (in a leap year)

- To make the probability at least 50% that two people in a room share the same birthday, only 23 people are needed. This surprising result is also called the **birthday paradox**.

- **Monty Hall Problem** involves a game show scenario, a contestant picks one of three doors, behind one of which is a prize. Knowing what's behind each door, the host opens another door to reveal no prize. The contestant is then allowed to switch their choice to the other unopened door. Mathematically, switching doors increases the probability of winning to 2/3, while staying with the original choice keeps the probability at 1/3.

- **The Gambler's Fallacy,** also known as the Monte Carlo fallacy, this is the mistaken belief that past random events can influence the likelihood of future random events.
    - For example, believing that after several coin tosses resulting in heads, tails are 'due' next. In reality, each coin toss is independent, and the probability remains **50/50**.

- **Law of Truly Large Numbers, t**his principle states that with a large enough number of trials, any unlikely event is likely to occur.

- **Bertrand's Box Paradox**: This paradox involves three boxes: one with two gold coins, one with two silver coins, and one with one gold and one silver coin.
    - If we randomly pick a box and then a coin, and it turns out to be gold, the probability that the other coin in the box is also gold is 2/3, not 1/2.

- **Stefan Mandel**, a Romanian-Australian economist, applied probability theory to win 14 lotteries by calculating all possible combinations and

- If 100 passengers board a plane with 100 seats, and the first passenger chooses a seat randomly, while subsequent passengers take their assigned seat if available or choose randomly otherwise, the probability that the last passenger sits in their assigned seat is always 50%. This result is independent of the number of passengers.

- The probability of having two boys in a family of two children varies based on specific conditions:
    - If at least one child is a boy, the probability is **1/3**.
    - If at least one child is a boy born on Tuesday, the probability increases to **13/27**, factoring in the day of the week.
    - If at least one child is a boy named Bob, the probability approaches **1/2**, depending on the uniqueness of the name.
    - If you meet a boy who is one of the two children, the probability of both being boys is exactly **1/2**, as either child is equally likely to be the one encountered.

- A standard 52-card deck can be arranged in **52!** (52 factorial) ways, which is approximately $8.07 \times 10^{67}$. This means there are more possible card arrangements than there are atoms on Earth!

- The number of unique chess games is estimated to be around $10^{120}$, known as the **Shannon Number**.

### Ratio of Boys and Girls in a Country where people want only boys:

- In a country where families keep having children until a boy is born, the expected ratio of boys to girls remains **1:1**, as each child has an equal probability of being a boy or girl, and the process resets for every family.

*Let p be the probability that a child is girl and (1-p) be probability that a child is boy.*

*NG can be written as sum of following infinite series.*

$NG = 0*(1-p) + 1*p*(1-p) + 2*p*p*(1-p) + 3*p*p*p*(1-p) + 4*p*p*p*p*(1-p) +.....$

*Putting p = 1/2 and (1-p) = 1/2 in above formula.*

$NG = 0*(1/2) + 1*(1/2)^2 + 2*(1/2)^3 + 3*(1/2)^4 + 4*(1/2)^5 + ...$
$1/2*NG = 0*(1/2)^2 + 1*(1/2)^3 + 2*(1/2)^4 + 3*(1/2)^5 + 4*(1/2)^6 + ...$

$NG - NG/2 = 1*(1/2)^2 + 1*(1/2)^3 + 1*(1/2)^4 + 1*(1/2)^5 + 1*(1/2)^6 + ...$

*Using sum formula of infinite geometrical progression with ratio less than 1*
$NG/2 = (1/4)/(1-1/2) = 1/2$

$NG = 1$

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