What is the probability that if I flip 5 coins, 2 of them land in heads?

ans 10 ways to have 2 heads in 5 coin tosses

$$10 = \frac{5!}{2!(5!-2!)}$$

$$= \binom{5}{2}$$

Binomial coefficient

no. of ways You can have 2 heads in 5 coin tosses.

Bionomial coefficient :

In general :

$\binom{n}{k}$ counts all the combinat^ns ~~of~~ for landing k heads in n coin tosses.

Property :

$$\binom{n}{k} = \binom{n}{n-k}$$

This is why PMF of a fair coin is Symmetrical shape.

Your coin has $P(H) = p$

event : $X = x$: x heads in 5 tosses

$$p_X(x) = \binom{5}{x} p^x (1-p)^{5-x},$$

$$x = 0, 1, 2, 3, 4, 5$$

note: X follows binomial distribution

$X \sim \text{Binomial}(5, p)$

$p \leftarrow P(H)$

$5 \leftarrow$ no. of flips

Bernouli distribution ⇒ success/failure (single trial)
Binomial distribution ⇒ multiple bernouli trials

Cumulative distribution functⁿ ⇒ accumulated probability
~~Uniform distribution ⇒ Bell-shaped continous values~~
Normal distribution ⇒ Bell-shaped continous values
Uniform distribution ⇒ Equal probability over a range
Exponential distribution ⇒ Time between events
Chi-squared distribution ⇒ Skewed distribution based on degrees of freedom

For normal distribution, mean, median and mode ~~in~~ are same

mean : average calculated from a dataset to represent ~~the~~ central tend.
median : middle value in a dataset ~~~~;
mode : frequently occuring value(s)

Expected value : average outcome or value that one can anticipate from a probability distribution, given a large number of repeated trials or occurrences.

Expected value of a function : The expected value of a function of a random variable represents the average value that the function is expected to take on, considering the underlying probability distribution of the random variable.

Variance : $E(X-\mu^2)$

$$= E[x^2 - 2\mu X + \mu^2]$$
$$= E[X^2] - E[2\mu X] + E[\mu^2]$$
$$= E[x^2] - 2\mu E[X] + \mu^2$$
$$= E[x^2] - 2E[X].E[X] + E[X]^2$$
$$= E[x^2] - 2E[X]^2 + E[X]^2$$
$$= E[x^2] - E[X]^2$$

Standard deviation

variance has problem of units.

variance : $Var(X) = E[(X-\mu)^2]$

$$= E[X^2] - E[X]^2$$

Say X is measured in meters

Then $E[X]$ is measured in meters.
then $Var(X)$ is measured in m^2.
$std(X) = \sqrt{Var(X)} = m$

Standard deviation

$(\mu \pm \sigma)$ $(\mu \pm 2\sigma)$ $(\mu \pm 3\sigma)$

Normal distribution : 68-95-99.7 rule

Parameters:

μ : centre of the bell
σ : spread of the bell

$$X \sim N(\mu, \sigma^2)$$

Everything is Nicer when, mean is 0

Standardizing a distribution:

$$X \rightarrow \frac{X}{\sigma}$$

$$\begin{aligned} Var(cX) &= E[(cX)^2] - E[cX]^2 \\ &= E[c^2X^2] - (c\,E[X])^2 \\ &= c^2 E[X^2] - c^2 E[X]^2 \end{aligned}$$

$$Var\left(\frac{X}{\sigma}\right) = \frac{1}{\sigma^2} Var(X)$$

$$std\left(\frac{X}{\sigma}\right) = \frac{1}{\sigma} std(X)$$

(I) $X \longrightarrow$ $\boxed{\text{mean} = \mu,\ \text{std} = \sigma}$

$\downarrow$

$\boxed{\text{centering distribution}}$

$\downarrow$

(II) $X - \mu \longrightarrow$ $\boxed{\text{Mean} = 0,\ \text{std} = \sigma}$

$\downarrow$

$\boxed{\text{Scaling}}$

$\downarrow$

(III) $\dfrac{X - \mu}{\sigma} \longrightarrow$ $\boxed{\text{mean} = 0,\ \text{std} = 1}$

Skewness :- is a statistical measure that describes the asymmetry or departure from symmetry in the distribution of a dataset.
It helps to understand shape of data. distribution.

(I) +ve skewness = right side tail
(II) -ve skewness = left side tail
(III) zero skewness = perfectly symmetric

⇨ **Kurtosis** : is a statistical measure that describes the tailedness or peakedness of a probability distribution, indicating whether the data's distribution is heavy-tailed or light-tailed compared to normal distribution

(i) Mesokurtic (Kurtosis = 0)
(ii) Leptokurtic (+ve kurtosis)
(iii) Platykurtic (-ve kurtosis)