# Binomial Distribution

## condition

1. Binomial distribution has two discrete outcomes (head or tail), Pass or fail, Succes

2. Trail should be made up of independent trail.

3. fixed no. of trail

4. The objective is to find the probability of getting $K$ successes out of $n$ trail ($K \leq n$)

5. The prob of success is "p", and prob of failure is $(1-p)$

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6. The Prob p is constant and does not change between trail

any one of them true

Please note, given above listed condition does not match, it is consider non-binomial dist Prob.

General Formula

PMF of Binomial dist

$$\boxed{\left(PMF(x) = P(X) = x\right) = \left({}^{n}C_{x}\right) * p^{x} * (1-p)^{n-x}}$$

where,

$x$ = Total no. of "successes"
$n$ = number of trail
$p$ = prob of success
$1-p$ = " " Failure

$$\binom{n}{x} * p^{x} * (1-p)^{n-x}$$

$$\binom{10}{6} * (0.5)^{6} * (0.5)^{4}$$

$$\frac{10!}{6!\,4!} * (0.5)^{6+4}$$

* A fair coin is flipped 10 times, what is the probability of getting exactly 6 heads?

→ $n = 10$
→ $x = 6$
→ $p = 0.5$ (success)

Failure $= 1-p$
$= 1 - 0.5$
Failure $= 0.5$

$${}^{n}C_{r} = \frac{n!}{r!\,(n-r)!}$$

$$x^2 * x^3$$
$$x^{2+3}$$

$$\frac{10!}{6!\ 4!} * (0.5)^{10} = \frac{10 \times \cancelto{3}{9} \times \cancel{8} \times 7 \times \cancel{6!}}{\cancel{6!} \times \cancel{4} \times \cancel{3} \times \cancel{2} \times 1} * (0.5)^{10}$$

$$= 10 \times \underline{3 \times 7} \times (0.5)^{10}$$

$$= 210 \times (0.5)^{10} \approx 0.2050$$

Hence, the prob of getting exactly 6 heads is $\underline{20\%}$.

Q: 60% of people who purchase a sports car are men, if 10 sports car owners are selected randomly then what is the Prob that exactly 7 are men?

$n = 10$

$x = 7$

$p = 0.6$

$1-p = 0.4$

$$\binom{n}{x} * (p)^{x} * (1-p)^{n-x} = \binom{10}{7} * (0.6)^{7} * (0.4)^{3}$$

$$= \frac{10!}{7!\,3!} * (0.6)^{7} * (0.4)^{3}$$

$$= \frac{10 \times \cancel{9}^{3} \times \cancel{8}^{4} \times \cancel{7!}}{\cancel{7!} \times \cancel{3} \times \cancel{2}} * (0.6)^{7} * (0.4)^{3} = 21.49\ \%$$

## Sampling

Q: Amazon — 10% of their customer return the purchased items. On the particular days, 20 customers purchased items from Amazon.

(a) The Prob that exactly five customer will return item?

(b) " " " maximum of five customer will return the Prod.

(c) " " " more than 5 customer will return the Pro

(d) The avg no. of customer likely to return items

(e) The variance & the std of the no. of return.

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Prob of Success $(p) = 0.1$

" " failure $(1-p) = 0.9$

$n = 20$

$x = 5$

CDF

$$P(X \leq x) = \sum_{k=0}^{n} \binom{n}{k} (p)^k * (1-p)^{n-k}$$

$$\boxed{P(X) \leq x}$$

Q(1) $\binom{20}{5} (0.1)^5 * (0.9)^{15} =$

Q2 : $\binom{20}{0}(0.1)^0 * (0.9)^{20} + \binom{20}{1} * (0.1)^1 * (0.9)^{19} + \binom{20}{2} (0.1)^2 * (0.9)^{18}$
$+ \binom{20}{3} * (0.1)^3 * (0.9)^{17} + \binom{20}{4} * (0.1)^4 * (0.9)^{16} + \binom{20}{5} (0.1)^5 * (0.9)^{15}$

CDF

$= 0.9887$

**Q3:** $1 - 0.9887 = 0.0113$

**Q4:** Avg no. in Binomial dist $= \boxed{n \times p}$

$20 * 0.1 = \underline{2}$

**Q5:-** variance $= n \times p \times (1-p) = \dfrac{2\cancel{0} \times 0\cancel{1} * 0\cancel{9}}{100}$

$= 1.8$

Std $= \sqrt{\text{var}} = \sqrt{1.8}$

$\log_e \log 2$

Poisson Distribution → discrete prob dist

→ it express the prob of a given no. of event occurring in a fixed interval of time or some other continuous unit

$$\boxed{P(x:\lambda) = \frac{\lambda^{x} * e^{-\lambda}}{x!}}$$

$e$ = A constant equal to approx 2.718

$\lambda$ = mean no. of success

$x$ = Actual no. of "

Q:- The avg no. of houses sold by a company is 2 houses per day. What is the prob that exactly 3 houses will be sold tomorrow?

$\lambda = 2$
$x = 3$
$e = 2.718$

$$P(x;\lambda) = \frac{\lambda^x \cdot e^{-\lambda}}{x!} = \frac{2^3 * (2.718)^{-2}}{3!}$$

$$= \frac{8}{6} * \frac{1}{(2.718)^2} = 0.18$$

$x^{-1} = \frac{1}{x}$

$x^{-2} = \frac{1}{x^2}$

Q :- Make my trip → no. of cancellations on a day is exactly 20 and the prob that the max^m no. of cancellation is 25.

① $\lambda = 20, \; x = 20 \rightarrow \dfrac{\lambda^x \cdot e^{-\lambda}}{x!}$

② $\lambda = 20, \; x \leq 25$

$$\boxed{\sum_{x=0}^{25} \frac{\lambda^x \cdot e^{-\lambda}}{x!}}$$

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Q: the avg no. of houses sold by a company is 2 house per day, what is the probability that lower than 3 house will be sold tomorrow?

$\lambda = 2, \ x < 3$ poisson.cdf(2, 2) =

Q:- 16 houses per day, no house "4 PM to 5 PM" tomorrow

$\lambda = 16$, Hour $= \frac{\text{Day}}{24}$, $x = 0$

Hour $= \frac{\cancel{16}\,2}{\cancel{24}\,3} = \frac{2}{3} = 0.666$