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BIONOMIAL DISTRIBUTION IN REAL LIFE

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Abstruct : In this paper I tried to explain what is binomial distribution, when it can be used. In this paper properties of binomial distribution also have been discussed. In many events, happening in daily life, binomial distribution can be employed. e.g. if a coin is tossed, possible outcomes are head or tails, if a lady give birth to a child, it may be either male of female. If a person in suffering from a serious illness, and he is operated in a hospital, then either he will survive or die. If a fair dice is tossed, then all numbers 1, 2, 3, 4, 5, 6 are likely events and if in an election if there are only two candidates ray A and B, then either A will win or B will win. So in all such events, it which there are only two outcomes named success and failure and number of trials in finite, binomial distribution can be employed.

1. Keywords : Bernauli variable, mean, binomial variable, probability density function.

2. Introductions : James Bernouli discovered binomial distribution in the year 1700, but it was first

published in 1713, eight years after his death. It is applicable in all such experiment. Which consists of a finite number of trials, probability of occurrence of an event or probability of success is constant for each trial and probability of non happening of an event i.e. of failure is also constant. If p is probability of success in a trial then probability of non failure of the event. denoted by q. is given by $q = 1 – p$.

2.1 **Definition :** Let an experiment E consists of tossing of a coin. Then possible outcomes are Head (H) or tail (T). Sample space in the set consisting of all possible outcomes of an experiment. So in this case sample space S = {H, T}.

If a coin in tossed two times (twice). then

S = {HH, HT, TH, TT}

2.2 **Definition :** Let S is the sample space associated with an experiment E. Then one dimensional random variable X is a real valued function whose domain is S and range is a subset of R. the set of real numbers.

For example Let X is a random variable associated with tossing of a coin two times where occurrence if head is success.

Then S = {HH, HT, TH, TT}
and X = {0, 1, 2}

when	HH	HT	TH	TT
X	2	1	1	0

Random variable is called discrete random variable if it can takes on a countable number of values.

2.3 **Definition :** Let X is one dimensional random variable X which takes values x_1, x_2, x_3.....x_n with each possible out come x_i, we associated a number Pi = $p(x_i)$ satisfies following properties

(i) $p(x_i)0$ $\quad i = 1, 2, 3, ...n$

(ii) $\sum_{l=1}^{n} p(x_1) = 1$

Then p is called probability mass function of the random variable X and {$p(x_1)$, $p(x_2)$ .....$p(x_n)$} is called probability distribution of the discrete random variable X.

2.4 **Binomial distribution :** A random variable X is said to follow binomial distribution if it assumes only non negative and its probability mass function is given by

$$p(x = r) = \{{}^{n}C_r\, p^r q^{n-r};\ r = 0, 1, 2, ...n;\ q = 1 - p,$$
$$0 \text{ otherwise}\}$$

n and p are parameters of the distribution. It is a discrete distribution because X is a discrete random
variable.

Clearly, $= \sum_{r=0}^{n} p(x = r) = \sum_{r=0}^{n} {}^{n}C_r\, p^r q^{n-r}$

$= n\,(C_0\, p^o q^n + {}^{n}C_1\, p^1 q^{n-1} + {}^{n}C_2\, p^2 q^{n-2} + ... + {}^{n}C_n\, q^n)$

$= (p + q)^n = (1)^n = 1$

So, the assignment of probabilities is possible.
If X is a binomial variable with parameter n and p then we write XB (n, p)
Mean of the binomial distribution in equal to np.

3. Application of Binomial distribution in Real Life :

In real life situation we faces various problems which can be easily solved by applying binomial distribution. Some of there are described below.

3.1 **Problem - I** The probability that a patient recovers from skin cancer is 0.4. If a sample of 10 patients suffering from skin cancer in a cancer hospital is taken. What is the probability that

(i) exactly three people recovers
(ii) at least 9 people recovers.

Let random variable X shown number of patients recovered from disease.

Then $p = 0.4$ $q = 1 - 0.4 = 0.6$. Since number of cases is finite and there are only two possibilities either a patient surviver or dies. So, binomial distribution is applicable.

So, $p\ (x = r) = {}^{10}C_r\,(0.4)^r\ (0.6)^{10-r}$

When, $r = 3$, we get

$p\ (x = 3) = {}^{10}C_3\,(0.4)^3\ (0.6)^7$

$$= \frac{\lfloor 10}{\lfloor 7 \lfloor 3} \times 0.064 \times 0.0279936$$

$$= \frac{10 \times 9 \times 8}{6} \times 0.064 \times 0.0279936$$

0.21499

So, probability that exactly three people recoveres is 0.21

(ii) Probability that at least 7 patient recovers is given by

$p\ (X7) = p\ (X = 7) + p\ (X = 8) + p\ (X = 9) + p\ (X = 10)$

$= {}^{10}C_7\,(0.4)^7\,(0.6)^3 + {}^{10}C_8\,(0.4)^8\ (0.6)^2 + {}^{10}C_9\,(0.4)^9\ (0.6)^1 + {}^{10}C_{10}\,(0.4)^{10}$

$$= \frac{\lfloor 10}{\lfloor 7 \lfloor 3}\ (0.4)^7\ (0.6)^3 + \frac{\lfloor 10}{\lfloor 8 \lfloor 12}\ (0.4)^8\ (0.6)^2 + \frac{\lfloor 10}{\lfloor 9 \lfloor 11}\ (0.4)^9\ (0.6)^1 + 1 \times (0.4)^{10}$$

$$= \frac{10 \times 9 \times 8}{6} \times (0.0016384)\ (0.216) + \times\ 0.00065536 \times 0.36 + 10 \times 0.000262144 \times 0.6$$

$+ 0.0001048576$

$= 0.042467328 + 0.010616832 + 0.001572864 + 0.0001048576$

$= 0.054760.055$

3.2 **Problem - 2 :** In a metropolitan city, it is observed that out of 4 senior citizen one is suffering from

diabeties. If a random sample of 10 senior citizens is taken what is the probability that at most two will be suffering from diabeties.

Since, there are only two outcomes that either a person is having diabeties or not and number of cases are limited.

(Finite 1, se we can apply binomial distribution.

Let X is a random variable showing that a person is diabeties.

here $p = \frac{1}{4}$ $q = 1 - \frac{1}{4} = \frac{3}{4} = 0.75$

So, X□ B $(10, \frac{1}{4})$

p (X = 0) $= {}^{10}C_0 (0.25)^o (1 - 0.25)^{10}$

$= 1 \times 1 \times (0.75)^{10}$ 0.0563

p (X = 1) $= {}^{10}C_0 (0.25)^o (1 - 0.25)^{10}$

p (X = 21) $= {}^{10}C_2 (0.25)^2 (0.75)^8$

$= \frac{\lfloor 10}{\lfloor 2 \lfloor 8} (0.25)^2 (0.75)^8$

$= 0.2816$

So, p (X $\leq$ 2) = 0.0563 + 0.1877 + 0.2816

0.5256

3.3 **Problem - 3 :** In a certain town, 20% of the population is literate. 200 investigations take a sample of ten

individuals to see whether they are literate. How many investigators will be expected to report that three people are literate in the sample.

Let probability of a person selected to be literate is p.

The $p = \frac{200}{100} = 0.2 = \frac{1}{5}$

So, $q = 1 - \frac{1}{5} = \frac{4}{5}$

So, $P(r) = {}^{10}C_r \left(\frac{1}{5}\right)^r \left(\frac{4}{5}\right)^{10-3}$

$= p(3) = {}^{10}C_3 \left(\frac{1}{5}\right)^3 \left(\frac{4}{5}\right)^{10-3}$

$= \frac{\lfloor 10}{\lfloor 7 \lfloor 3} \times \frac{1}{5 \times 5 \times 5} \times \left(\frac{4}{5}\right)^7$

$= \frac{1966080}{1953125 \times 5}$

$\cong 0.2013$

So, expected number = 0.2013 × 200 = 40.26 41

3.4 **Problem :** In a competitive exam that contains 10 multiple choice question with five possible choices for each question. Out of which only 1 is correct. To pass the exam, a student has to give at least 6 correct answer.

What is the probability that a student will fail.

Let X represents the number of questions the student answers correctly.

Then $X \sqcup B \left(10, \frac{1}{5}\right)$

i.e. here $n = 10$

$p = \frac{1}{5} = 0.20$, $q = 1 - \frac{1}{5} = 0.80$

So, p (X = 0), $= (0.80)^{10} = 0.1073741824 = 0.1074$

$p\ (X = 1) = \frac{\lfloor 10}{\lfloor 1 \lfloor 9} \ (0.20)^{1}\ (0.80)^{9}$

$= 0.268435456 \cong\ 0.2684$

$p\ (X = 2) = \frac{\lfloor 10}{\lfloor 2 \lfloor 8} \ (0.20)^{2}\ (0.80)^{8}$

$= 0.30198$

$p\ (X = 3) = {}^{10}C_{3} = (0.20)^{3}\ (0.80)^{7}$

$= \frac{\lfloor 10}{\lfloor 3 \lfloor 7} \times (0.20)^{3} \times (0.80)^{7}$

$\cong 0.2013$

$p\ (X = 4) = {}^{10}C_{4} \times (0.20)^{4}\ (0.80)^{6}$

$= \frac{\lfloor 10}{\lfloor 4 \lfloor 6} \times (0.20)^{4} \times (0.80)^{6}$

$= 0.08808$

$p\ (X = 5) = {}^{10}C_{5} \times (0.20)^{5}\ (0.80)^{5}$

$= \frac{\lfloor 10}{\lfloor 5 \lfloor 5} \times (0.20)^{5}\ (0.80)^{5}$

$= 0.0264$

So, $p\ (X \leq 5) = 0.01074 + 0.2684 + 0.30198 + 0.2013 + 0.08808 + 0.0264$

$= 0.9935$

3.5 **Problem 5 :** In a maternity ward of a reputed hospital. 10 babies were born on a particular day. What is the probability that at most three girls were born.

Here, $p = \frac{1}{2} = 0.5$, $q = 1\text{-}0.5 = 0.5$

$n = 10$

and $n = 10$

X□ B (10, 0.5)

$p\ (X = 0), = {}^{10}C_{0}\, p^{0}\ q^{10-0}$

$= 1 \times 1 \times (0.5)^{10} = 0.0009765625$

$p\ (X = 1) = {}^{10}C_{1}\ (0.5)^{1}\ (0.5)^{9}$

$= 10 \times (0.5)^{10} = 0.009765625$

$p\ (X = 2) = {}^{10}C_{2}\ (0.5)^{2}\ (0.5)^{8}$

$= {}^{10}C_{2}\ (0.3)^{10} = \frac{10 \times 9}{2}\ (0.5)^{10} = 0.0439453125$

$p\ (X = 3) = {}^{10}C_{3} = (0.5)^{3}\ (0.5)^{7} = {}^{10}C_{3} = (0.5)^{10}$

$= \frac{\lfloor 10}{\lfloor 7 \lfloor 3} = (0.5)^{10} = \frac{10 \times 9 \times 8}{6} = (0.5)^{10}$

$= 120 \times (0.5)^{10} = 0.1171875$

So, $p\ (X \leq 3)\ 0.0009765625 + 0.009765625 + 0.0439453125 + 0.1171875$

$\cong 0.1719$

3.6 **Problem : 6** Let a fair dice is thrown six times. The occurrence of coming of 4 or 6 is considered as

success. Let X is the random variable representing occurrence of 4 or 6 in a throw.

Now we calculate the probablity that there are atmost 3 successes.

$p = \frac{2}{6}$ because there are total six out comes

viz {1, 2, 3, 4, 5, 6} in a throw and favourable out come {4, 6}

$p = 0.33$

$q = 1 - p$

$\cong 1 - 0.33 \cong 0.67$

So X is a binomial variable with parameter 6 and 0.33

so X□ B (6, 0.33)

Now $P(0) = {}^{6}C_{0}(0.33)^{0}(0.67)^{6}$

$= 6 \times (0.67)^{6}$

$= 0.0905$

$p(X = 1) = {}^{6}C_{1} = (0.33)^{1}(0.67)^{5} = 0.2673$

$p(X = 2) = {}^{6}C_{2} = (0.33)^{2}(0.67)^{4} = 0.3291$

$p(X = 3) = {}^{6}C_{3} = (0.33)^{3}(0.67)^{3} = 0.2162$

Required probability

$$p(X \leq 3) = \sum_{x=0}^{3} p(X)$$

$= p(0) + p(1) + p(2)\, p(3)$

$= 0.0905 + 0.2673 + 0.3291 + 0.2162$

$\cong 0.9050$

4. Conclusion :

In this paper I tried to explain basics of binomial distribution. My present paper threw light on distribution functions of random variables. Probability mass functions and other aspects of binomial distribution.

It als comprised us various applications of binomial distribution in real life. Various problems coming in daily life can be solved by applications of binomial distributions provided number of trials are finite, outcomes of each trial are independent, success of an event is same in all trials. My paper also gave a brief history of binomial distributions..

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