Probability&RV Assignment-05

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AI5002−Probability−and−Random−Variables/
blob/main/Prob_ass05/rvsp_ass_5.py

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I. **QUESTION**

A bag consists of 10 balls each marked with one of the digits 0 to 9. If four balls are drawn successively with replacement from the bag, what is the probability that none is marked with the digit 0?

II. **SOLUTION**

Problem Description:

(i) An Urn consists 10 Balls each marked with any of the digits from 0 to 9.
(ii) After every Draw the Ball is replaced in the Urn.
(iii) 4 Balls needs to be Drawn from the Urn by replacing Balls after every Draw.
(iv) All Balls Drawn should be marked with non-zero digits.

Computation:

Now we should Compute Probability of Drawing 4 Balls from the Urn marked with non-zero digits with Replacement.
Here we Define Two Random Variables X and Y. X Describes whether the Ball Drawn is marked with zero or non-zero digit.and Y Describes the number of balls marked non-zero digit Drawn from the Urn.
where

$$P(X = 0)$$

is the Probability of Drawing a ball.and

$$P(X = 1)$$

is the Probability that Ball Drawn is marked with non-zero digit.
we know that

$$P(X = 0) = \frac{1}{10}$$

where Sample space consists all 10 possibilities and among them the Favourable Outcome is Drawing any ball.similarly

$$P(X = 1) = 1 - P(X = 0) = \frac{9}{10}$$

where we have Digits from 0 to 9.one ball among 10 is generally marked with 0.so now Sample Space remains same but Number of Favourable Outcomes will change to any digit except zero.therefore it becomes 9.so 9 over 10.

since balls drawn are replaced,probability of success or failure remains same in all Trials.and the Trial is Associated with two outcomes either success or failure.so the Random Variable X is a Bernoulli Random Variable.where

$$P(X = 1) = \frac{9}{10}$$

is the success Probability.and

$$P(X = 0) = 1 - P(X = 1) = \frac{1}{10}$$

is the failure probability.
Now final Probability can be obtained as below.
random variable Y can take values
Y=0
Y=1
Y=2

Y=3
Y=4.
let

$$q = P(X = 1)$$

$$1 - q = P(X = 0)$$

then

$$P(Y = 0) = \binom{4}{0}(1 - q)^4$$

$$P(Y = 1) = \binom{4}{1}(q)(1 - q)^3$$

$$P(Y = 2) = \binom{4}{2}(q)^2(1 - q)^2$$

$$P(Y = 3) = \binom{4}{3}(q)^3(1 - q)^1$$

$$P(Y = 4) = \binom{4}{4}(q)^4$$

Now we can state our Final Computed Probability that 4 balls are drawn and none of them is marked with zero-digit is

$$P(Y = 4) = \left(\frac{9}{10}\right)^4$$

Generalization

Above task can be Generalized using Binomial Distribution as

$$P_Y = \binom{n}{Y}(q)^Y(1 - q)^{n-Y}$$

where n=4.
if n=1000 then $q = \frac{999}{1000}$.

III. **CONCLUSION**

the probability that among 4 balls Drawn none is marked with the digit 0 is

$$P(Y = 4) = \left(\frac{9}{10}\right)^4$$