

```
In [ ]: 1 # INTERSECTIONS AND UNION RULE

1 P[A ∪ B] = P[A] + P[B] - P[A ∩ B]      # Always True

In [ ]: 1

In [ ]: 1

In [ ]: 1 # CONDITIONAL PROBABILITY

1 P[A|B] = P[A ∩ B]/P[B]      # Always True

In [ ]: 1

In [ ]: 1 # A and B are independent events if

1 P[A|B] = P[A]
2 P[B|A] = P[B]

1 P[A ∩ B] = P[A] * P[B] if A and B are independent
2 P[A ∩ B ∩ C] = P[A] * P[B] * P[C]      if A , B , C are indepenedent events

In [ ]: 1

In [ ]: 1

In [ ]: 1 # BAYES THEOREM

1 if E1 E2 E3 are mutually exhaustive events      E1 ∪ E2 ∪ E3 = S
2 E1 ∩ E2 = {}
3 E2 ∩ E3 = {}
4 E3 ∩ E1 = {}      And Mututally Exclusive events
5
6 P[E1|A] = p[A|E1] * p[E1] /      # Always True
7     P[A]
8
9 P[A] = P[A|E1]*P[E1] + P[A|E2]*P[E2] + P[A|E3]*P[E3]
10
11 P[E1|A] = (P[A|E1] * P[E1]) / (P[A|E1]*P[E1] + P[A|E2]*P[E2] + P[A|E3]*P[E3])
12     # True only for Mutually Exclusive and Exhaustive evenets
13
14
15
16

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Random Variable: A random variable is a variable that takes numerical values as a result of a random experiment or measurement ; associates a numerical value with each possible outcome.

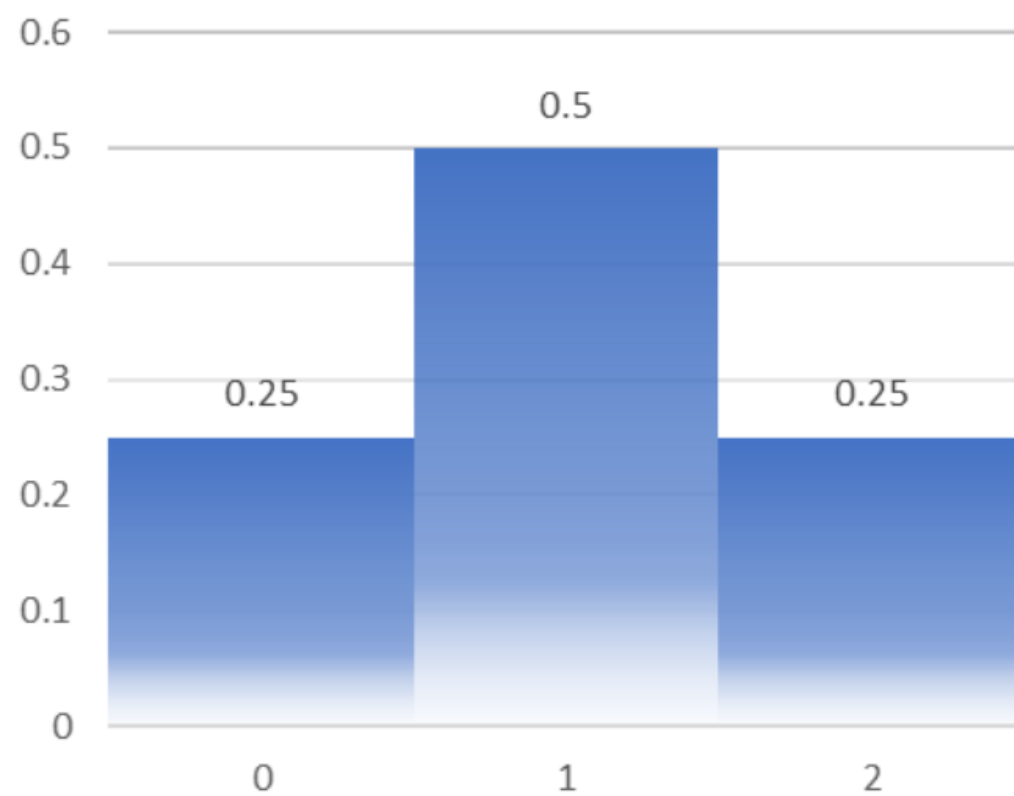
RVs must have numerical values

In []:

1

```
1 Coin toss twice:
2
3     Sample Space : S = {HH,HT,TH,TT}
4
5 X : no of heads in 2 tosses:
6
7     HH 2
8     HT 1
9     TH 1
10    TT 0
11
12 0 happened 1 times    probability P[TT] = 1/4
13 1 happened 2 times    probability P[HT,TH] = 2/4
14 2 happened 1 times    probability P[HH] = 1/4
15
```

```
1 ##### Probability Mass Function
2 A probability mass function is a function that gives the probability that a discrete random variable is exactly equal to some value.
```



```
1 discrete RV
2 1. Constituting a seperate thing.
3 2. cosisting of unconnected distinct parts
4 3. Mathematics defined for a finite or countable set of values, not continuous .
5
```

```
1 that means , Random Variables must be Mutually Exclusive and Exhaustive
2 they cannot be overlaped
3
```

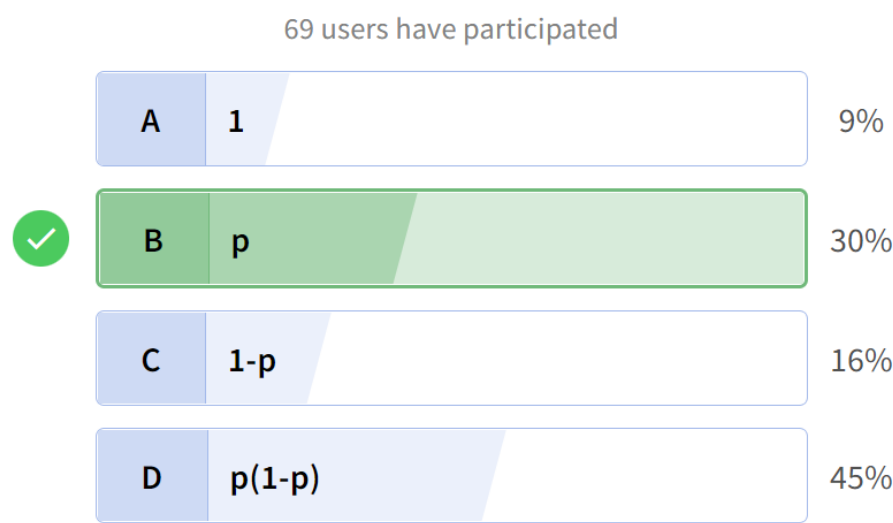
Bernoulli Random Variable :

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1 The Bernoulli distribution, is the discrete probability distribution of a random variable which takes the value 1 with probability p and the value 0 with probability q=(1-p).
```

```
1 X = 0,1
2 P[1] = p
3 P[0] = 1-p
4
5 example :
6 in dice:
7
8 S = {1,2,3,4,5,6} # all possible outcomes
9
10 if we define burnoulli RV
11
12 X = {
13     0 , (odd events)      P[0] 1/2
14     1 , (even events)     P[1] 1/2
15 }
16
17 if
```

```
18 Y = {
19     0, {1,2}          2/6    p
20     1, {3,4,5,6}      4/6    1-p
21 }
22
23
```

Let X be a Bernoulli random variable with parameter "p". What is the expectation E(X)



```
In [ ]: 1
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```
In [4]: 1 import math
```

Basic Counting Principle

```
1 ## Basic Counting Principle
2
3 4 boxes are there , and 10 balls !
4 How many ways we can put different balls into those 4 boxes . one in each box :
5
6
7 - - - -
8
9 for first box, we have 10 choices of balls
10 2nd box          9
11 3rd box          8
12 4th box          7
13
14 total ways : 10 * 9 * 8 * 7    ("Permutations ")
15
16 = 10 * 9 * 8 * 7 * ( 6 * 5 * 4 * 3 * 2 * 1)
17 /   ( 6 * 5 * 4 * 3 * 2 * 1)
18
19 = 10! / 6!
20 = 10! / (10 - 4)!
21
22 Permutation : General formula :
23
24 nPr =      n! /
25          (n-r)!
26
27
```

```
In [2]: 1 10 * 9 * 8 * 7
```

Out[2]: 5040

```
In [5]: 1 math.perm(10,4)
```

Out[5]: 5040

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```
1 if we are tossing one coin 10 times :
2
3
4
```

```

5     total number of outcomes :  $2^{10} = 1024$ 
6
7
8     we are intereseted in 4 Heads out of 1024 outcomes :
9         choose 4 locations to place head
10
11          $10 * 9 * 8 * 7$  (permutations)
12
13     to get the combinations we have to divide the choices which are repeated in different order
14
15          $10 * 9 * 8 * 7 / 4 * 3 * 2 * 1$ 
16
17     Combinations :  $nCr = \frac{n!}{r!(n-r)!}$ 
18
19
20

```

In [6]: 1 math.comb(10,4)

Out[6]: 210

In []: 1

Binomial Random Variable :

```

1 Two pparameters :
2     > n : process consists of sequence of n trials
3     > only two exclusive outcomes are : success and failure :
4
5         P[sucess] = p
6         P[failure] = 1-p
7
8     all trials are independent, outcome of previous trials do not influence further trials.

```

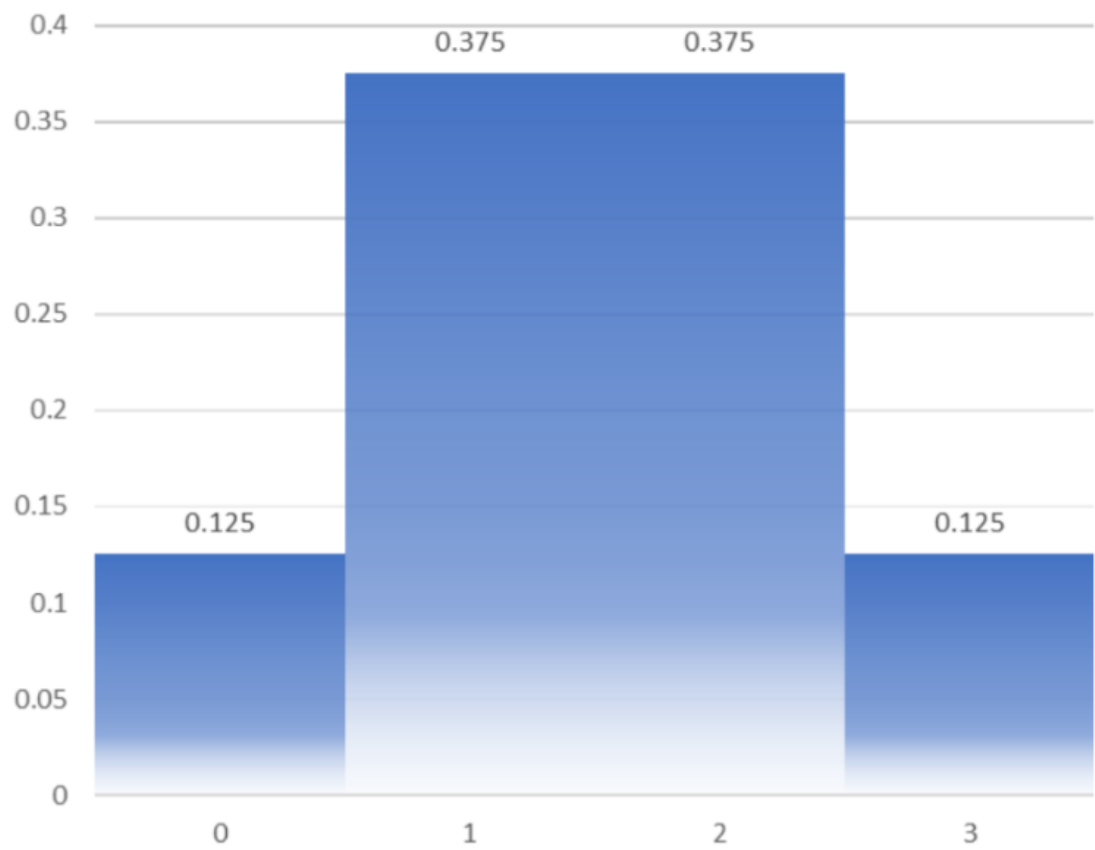
In []: 1

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1 for 3 trial coin toss :
2
3 n = 3
4
5 Probability of heads is p
6
7 S = {      # of heads      P[x]
8     HHH : 3
9     HHT : 2
10    HTH : 2
11    HTT : 1
12    THH : 2
13    THT : 1
14    TTH : 1
15    TTT : 0
16    }
17
18
19 so , the random variable will take values:  $X = \{0,1,2,3\}$ 
20
21 x  P[x]
22 0  1/8    0 : 1 times  P[x = 0] = 1 * (1-p)^3
23 1  3/8    1 : 3 times  P[x = 1] = 3 * p * ((1-p)^2)
24 2  3/8    2 : 3 times  P[x = 2] = 3 * (p^2) * (1-p)
25 3  1/8    3 : 1 times  P[x = 3] = 1 * p^3
26
27
28
29 P[x = 1]    {HTT,THT,TTH}
30
31 A    B    C        A or B or C
32
33 P[A U B U C] = P[A] + P[B] + P[C]
34               = p(1-p)^2 + p(1-p)^2 + p(1-p)^2
35               = 3 * p(1-p)^2
36
37
38 P[x = 2]    {HHT,HTH,THH}
39
40 A    B    C        A or B or C
41
42 P[A U B U C] = P[A] + P[B] + P[C]
43               = p^2 * (1-p)^1 + p^2 * (1-p)^1 + p^2 * (1-p)^1
44               = 3 * p^2 * (1-p)^1
45
46 P[x = 3]    {HHH}    (H and H and H)
47

```

```
48 P[H] = p
49
50 P[HHH] = p^3
51
52 P[x = 0]
53 TTT (T and T and T)
54 (1-p)^3
55
56
57
58
59
```



```
1 x P[x]
2 0 1/8
3 1 3/8
4 2 3/8
5 3 1/8
```

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In [ ]: 1
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In [ ]: 1
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```
1 x : no of heads in n trials(n tosses)
2 p : probability of heads
3
4 P[x = k] = nCk * (p^k) * (1-p)^(n-k)
5 probability of total number
6 number of heads of outcomes
7 in n trials with k heads
```

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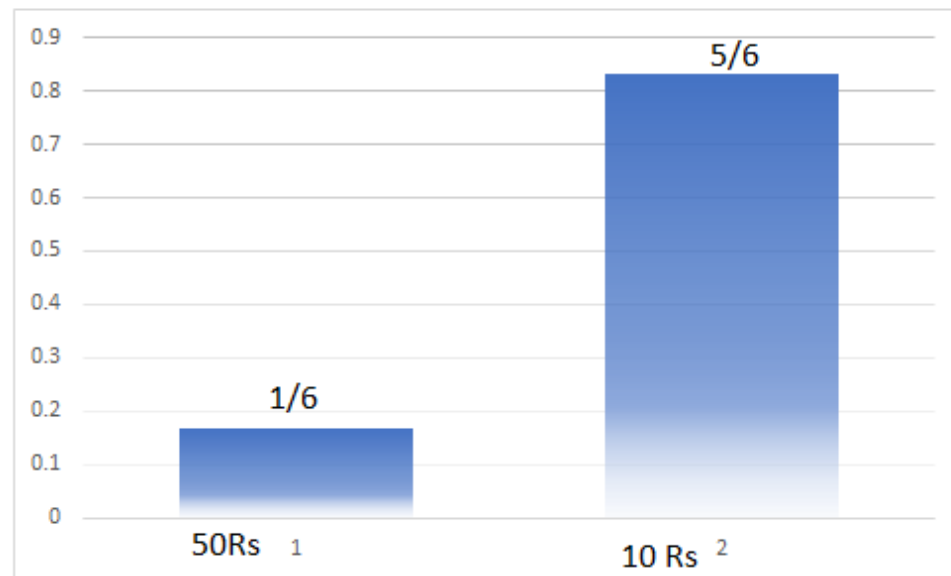
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In [ ]: 1
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Expected value :

weighted average

Example :

```
In [ ]: 1 # roll a dice: {1,2,3,4,5,6}
2 # everytime 6 comes up , u get 50rs
3 # else : 10 rs
4
5 RV :
6 10 : {1,2,3,4,5} 5/6
7 50 : {6} 1/6
8
9
```



```
In [ ]: 1
2 # We toss 1000 times :
3
4 # How much money do we expect to get :
5
6
7
```

```
In [8]: 1 1000*((5/6*10)+(1/6*50))
```

Out[8]: 16666.666666666664

```
In [ ]: 1
```

```
In [ ]: 1 for example : if we get 320 times {6} out of 1000
2             and 680 times {1,2,3,4,5,}
3
4     ( (320 * 50Rs) + (680 * 10Rs))/1000
5         k1           k2
6
7     total expected amount(average) to get per toss : K = (k1 + k2)
8                                                         ((k1*50) + (k2*10))/k
9     ((k1*50) + (k2*10))/ k1 + k2
10
11     (1/6 * 50) + (5/6 * 10)      this is per toss
12 ((1/6 * 50) + (5/6 * 10)) * 1000 toss
13
14
15
```

```
1 Expected value (Mean of a random vvariable )
2
3 E(X) = Σ(x*P(x))
4       = 50*(1/6) + 10*(5/6)
5       = 16.666 Rs
6
7 for 1000 times 16666.67 Rs
8
```

```
In [11]: 1 (50*(1/6) + 10*(5/6))*1000
```

Out[11]: 16666.666666666664

PROJECTED PROFITS $E(X)$

Below is the probability distribution for Terrific Taco's projected profits (in \$million).

$$x = -1, 0, .5, 1, 1.5, 2$$

x	$P(x)$
-1	.08
0	.22
.5	.24
1	.31
1.5	.10
2	.05
Σ	1

What is the $E(x)$ or μ profit (\$million) for Terrific Taco Company?

x	$P(x)$	$xP(x)$
-1	.08	$-1 \times .08 = -.08$
0	.22	$0 \times .22 = 0$
.5	.24	$.5 \times .24 = .12$
1	.31	$1 \times .31 = .31$
1.5	.10	$1.5 \times .10 = .15$
2	.05	$2 \times .05 = .10$
Σ	1	.675 or \$675,000

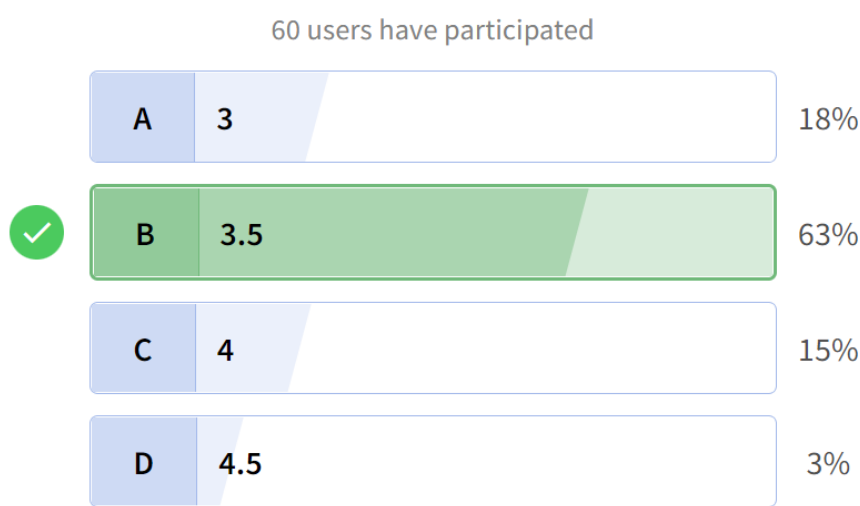
The expected value is simply the **mean of a random variable**; the average expected outcome. *It does not have to be a value the discrete random variable can assume.*

$$E(X) = \mu = \Sigma xP(x)$$

- $E(X)$ is the expected value or mean of the outcomes x
- μ is the mean
- $\Sigma xP(x)$ is the **sum** of each **random variable value** x multiplied by its **own probability** $P(x)$

A WEIGHTED AVERAGE

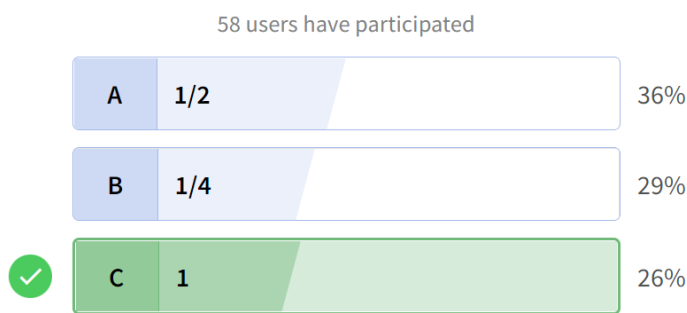
Let X be a RV taking values {1, 2, 3, 4, 5, 6} for a dice thrown. What is the expectation E(X)?



```
In [12]: 1 (1*(1/6))+(2*(1/6))+(3*(1/6))+(4*(1/6))+(5*(1/6))+(6*(1/6))
        2 # E(X) = Σ(x*P(x))
```

Out[12]: 3.5

Let "X" denote random variable which is the number of heads in two coin tosses for a fair coin. Find the expectation: E(X)

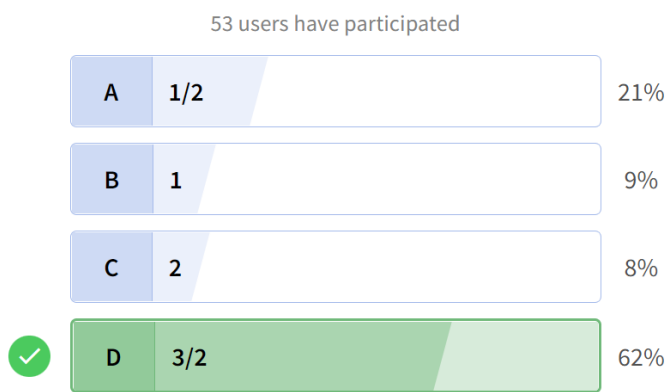


```
1 two coin toss :
2
3 X : no of heads
4 {
5     HH  2
6     HT  1
7     TH  1
8     TT  0
9 }
10
11 RV
12
13 x      P(x)
14 0 : 1  1/4
15 1 : 2  2/4
16 2 : 1  1/4
17
18 E(X) = Σ(x*P(x))
```

```
In [13]: 1 (0*(1/4))+(1*(2/4))+(2*(1/4))
```

Out[13]: 1.0

Let "X" denote random variable which is the number of heads in two coin tosses for coin whose probability of heads is 3/4. Find the expectation: E(X)



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```

5
6     E(X) = Σ(x*P(x))
7     E(X) = (0 * P[x=0]) + (1 * P[x=1]) + (2 * P[x=2])
8
9         (0 * ((1/4)^2)) + (1 * (2*(1/4)*(3/4))) + (2 * ((3/4)^2))
10
11

```

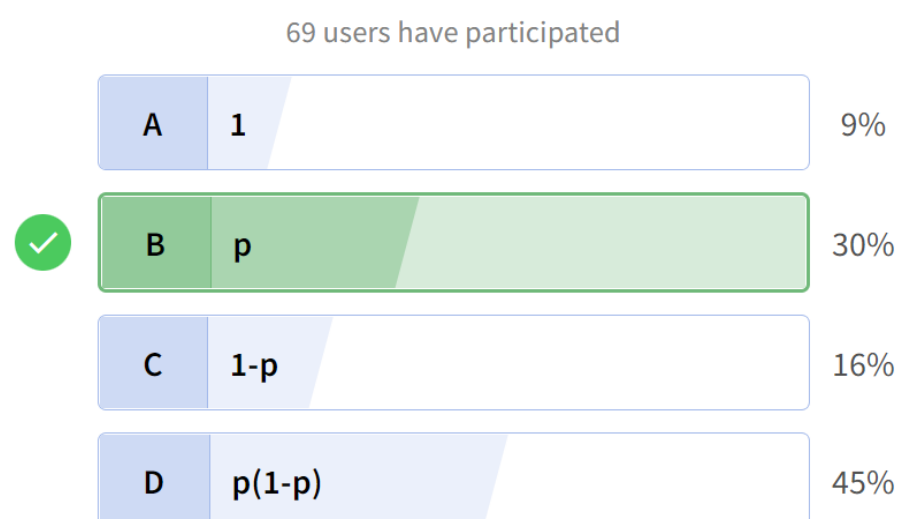
```
In [21]: 1 (0 * ((1/4)**2)) + (1 * 2*(1/4)*(3/4)) + (2 * ((3/4)**2))
```

Out[21]: 1.5

```
In [22]: 1 3/2
```

Out[22]: 1.5

Let X be a Bernoulli random variable with parameter "p". What is the expectation E(X)



```
In [ ]: 1
```

```
In [ ]: 1
```

```
In [ ]: 1
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In [ ]: 1
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In [ ]: 1
```

Q6. Exactly 3 baskets

✓ Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

A basketball player takes 5 independent free throws with a probability of 0.6 of getting a basket on each shot. Find the probability that he gets exactly 3 baskets.

Choose the correct answer from below:



0.536



0.3456

```
In [24]: 1 math.comb(5,3)
```

Out[24]: 10

```
In [25]: 1 0.6**3
```

Out[25]: 0.21599999999999997

```
In [26]: 1 (1-0.6)**2
```

Out[26]: 0.16000000000000003

```
In [27]: 1 10*0.21599999999999997*0.16000000000000003
        2
```

Out[27]: 0.3456

```
In [ ]: 1
```

Q5. Find npq

 Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

For a binomial distribution, the mean is 3 and the standard deviation is $3/2$. The values of n (number of trials), p (probability of success), and q (probability of failure) are:

```
1 mean = 3 = np
2 std = 3/2
3
4 std = sq(npq)
5 3/2 = sq(3 * q)
6 q = 3/4
7 p = 1-q = 1/4
8 n = mean/p = 3 / (1/4) = 12
```

```
In [ ]: 1
```

```
In [ ]: 1
```

Choose the correct answer from below:



$n=12, p=3/4, q=1/4$



$n=12, p=1/4, q=3/4$

Q7. Defective Bulbs

 Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

In a factory, the probability of producing a defective bulb is 0.25. A sample of 40 bulbs is collected. What is the probability that exactly 10 bulbs are defective?

Choose the correct answer from below:



0.10



0.12



0.11



0.14

```
In [98]: 1 (math.comb(40,10)) * (0.25**10) * ((1-0.25)**(40-10))
```

Out[98]: 0.14436434635625678

```
In [ ]: 1
```

Q7. Mean of the tosses

Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

If you toss a coin 10 times, which let's say represents a binomial distribution here. What's the mean and variance value of the number of heads?

Choose the correct answer from below:



10, 5



5, 2



5, 2.5



2.5, 5

```
1 n * p = (10 * (1/2))
2 n*p*q = variance = 10*(1/2)*(1/2)
```

```
In [101]: 1 (10 * (1/2)), (10*(1/2)*(1/2))
```

```
Out[101]: (5.0, 2.5)
```

```
In [ ]: 1
```

Q8. Archer

Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

An Archer can shoot an arrow into the bull's eye with a probability of 0.72. What is the probability that the archer misses shooting the bull's eye and also calculate its variance?

Choose the correct answer from below:



0.72, 0.30



0.72, 0.20



0.28, 0.20

```
In [31]: 1 (1-0.72), (0.72*(1-0.72))
```

```
Out[31]: (0.28, 0.2016)
```

```
In [ ]: 1
```

Q10. Final exam-avg score

Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

A teacher is teaching two Statistics classes. On the final exam, the 25 students in the first class averaged 90 while the 15 students in the second class averaged only 87. If the teacher combines the classes, what will the average final exam score be?

Choose the correct answer from below:

☐

87

☐

87.5

☐

88

☒

88.8

```
In [ ]: 1 students    grades
        2 25         90      25*90 = 2250
        3 15         87      15*87 = 1305
        4 total Students : 40      total : 3555
        5
        6     expected final average : 3555/40 = 88.8
        7
        8
```

```
In [52]: 1 3555/40
```

```
Out[52]: 88.875
```

```
In [ ]: 1
```

Q11. Right measure

Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

Given a sample of values [25, 25, 40, 45, 30, 41, 50, 30, 30, 1000] which measure of central tendency would you choose to represent the sample more correctly?

Choose the right combination of measure of central tendency and the value.

Choose the correct answer from below:

☒

Median, 35

☐

Mean, 131

☐

Mode, 30

```
In [54]: 1 x = np.array([25, 25, 40, 45, 30, 41, 50, 30, 30, 1000])
```

```
In [57]: 1 np.median(x)
```

```
Out[57]: 35.0
```

```
In [ ]: 1
```

```
In [ ]: 1
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In [ ]: 1
```

Q13. New average

Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

The average of a set of 15 observations is recorded, but later it is found that for one observation, the digit in the tens place was wrongly recorded as 8 instead of 3. After correcting the observation, the average is

Choose the correct answer from below:

reduced by $1/3$ increased by $10/3$ reduced by $10/3$

```
In [66]: 1 np.mean(np.array([100,180,20,100,100,100,100,100,100,100,100,100,100,100,100]))
```

```
Out[66]: 100.0
```

```
In [ ]: 1 100
```

```
In [67]: 1 np.mean(np.array([100,130,20,100,100,100,100,100,100,100,100,100,100,100,100]))
```

```
Out[67]: 96.66666666666667
```

```
In [68]: 1 96.66/100
```

```
Out[68]: 0.9666
```

```
In [70]: 1 (96/2)/2
```

```
Out[70]: 24.0
```

```
In [71]: 1 10/3
```

```
Out[71]: 3.3333333333333335
```

```
In [74]: 1 96.666+3.333
```

```
Out[74]: 99.999
```

```
In [ ]: 1
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In [ ]: 1
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Q15. Mean-Median impact

Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

For the given data below, If a data point beyond the $Q3+1.5$ IQR is removed, then what can you say about the mean and median.

```
data=[10,23,24,24,28,29,20,32,33,25,38,29,25,41,50,25,31,60,70]
```

Choose the correct answer from below:



Mean and median both will have equal impact.



Mean will have significant impact compared to median.



Median will have significant impact compared to mean.

```
In [75]: 1 x = np.array([10,23,24,24,28,29,20,32,33,25,38,29,25,41,50,25,31,60,70])
```

```
In [76]: 1 x
```

```
Out[76]: array([10, 23, 24, 24, 28, 29, 20, 32, 33, 25, 38, 29, 25, 41, 50, 25, 31, 60, 70])
```

```
In [85]: 1 np.quantile(x,0.75),np.quantile(x,0.25)
```

```
Out[85]: (35.5, 24.5)
```

```

In [82]: 1 np.sort(x)
Out[82]: array([10, 20, 23, 24, 24, 25, 25, 25, 28, 29, 29, 31, 32, 33, 38, 41, 50,
              60, 70])

In [83]: 1 len(x)
Out[83]: 19

In [86]: 1 35.5-24.5
Out[86]: 11.0

In [87]: 1 35.5+(1.5*11)
Out[87]: 52.0

In [89]: 1 y = np.array([10, 20, 23, 24, 24, 25, 25, 25, 28, 29, 29, 31, 32, 33, 38, 41,])

In [90]: 1 np.mean(y),np.mean(x)
Out[90]: (27.3125, 32.473684210526315)

In [91]: 1 np.median(y),np.median(x)
Out[91]: (26.5, 29.0)

In [ ]: 1
In [ ]: 1

```

Q16. Weighted mean

 Solved



Stuck somewhere?

Ask for help from a TA and get it resolved.

[Get help from TA.](#)

Suppose a firm conducts a survey of 1000 households to determine the average number of children living in each household. The data showed a large number of households have two or three children and a smaller number with one or four children. Every household in the sample has at least one child and no household with more than 4 children. Find the average number of children living per household.

No. of children per household	Number of households
1	70
2	385
3	523
4	22

Choose the correct answer from below:



2.49



2.63



3.50



4.23

```

In [97]: 1 70+385+523+22
Out[97]: 1000

In [ ]: 1


In [95]: 1 (1*(70/1000))+(2*(385/1000))+(3*(523/1000))+(4*(22/1000))
Out[95]: 2.497


In [ ]: 1


In [ ]: 1 If a normal distribution with  $\mu = 200$  have  $P(X > 225) = 0.1587$ , then  $P(X < 175)$  equal to:


```

Q5. PnC 05



 Solved





Stuck somewhere?

Ask for help from a TA and get it resolved.

Get help from TA.

In how many ways can we arrange the word **FUZZTONE** so that all the vowels come together?

Choose the correct answer from below:

- ☐ 1440
- ☐ 6
- ☒ 2160
- ☐ 4320

```
1
2          FUZZTONE
3          FZZTN(UOE)
4 (n-r)!
5 n!
6
7 There are 3 vowels (U,E,O) which can be arranged in 3! ways.
8 Let the vowels be in one group.
9 Now, we have (8-3=)5 characters + 1 group = 6
10 This can be arranged in 6! ways.
11 But the alphabet Z is twice so we need to divide by 2!.
12 This give us
13
14 6!/2!
15
16 Total ways to arrange the letters = 3!× 6!/2!
17                               =2160
18 Hence, the value of FUZZTONE after applying permutation is 2160.
```