Assignment- 2

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Answer1

If two ordinary dice with faces 1...6 are thrown the probability of getting any face for the first dice is $\frac{1}{6}$ and similarly the probability of getting any face for the other dice is $\frac{1}{6}$. There are 36 possible outcomes of the additive dice roll.So, the probabilty of picking up a sum of two dice faces is $\frac{1}{6}*\frac{1}{6}=\frac{1}{36}$. Th minimum possible sum is 2, and the maximum is 12.So,let us see the probabilty of all the combinations.

Sum	Combinations	Probabilty
2	[1,1]	$\frac{1}{36}$
3	[1,2],[2,1]	$\frac{2}{36}$
4	[1,3],[3,1],[2,2]	$\frac{3}{36}$
5	[1,4],[4,1],[2,3],[3,2]	$\frac{4}{36}$
6	[1,5],[5,1],[2,4],[4,2],[3,3]	$\frac{5}{36}$
7	[1,6],[6,1],[2,5],[5,2],[3,4],[4,3]	$\frac{6}{36}$
8	[2,6],[6,2],[3,5],[5,3],[4,4]	$\frac{5}{36}$
9	[6,3],[3,6],[5,4],[4,5]	$\frac{4}{36}$
10	[5,5],[6,4],[4,6]	$\frac{3}{36}$
11	[5,6],[6,5]	$\frac{2}{36}$
12	[6,6]	$\frac{1}{36}$

Table 1: Probability Distribution of Sum of two dices

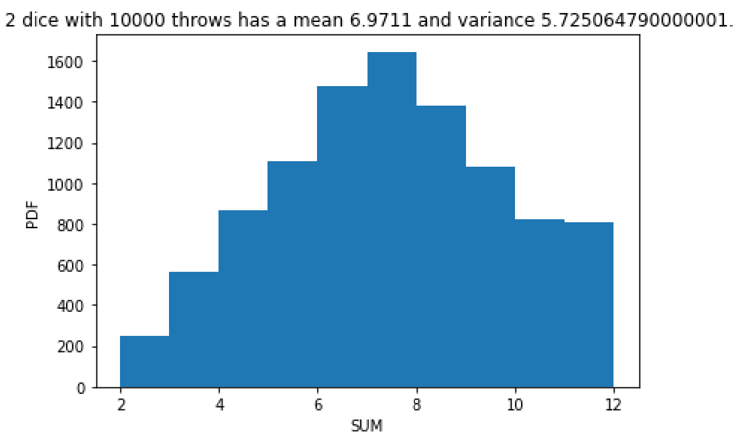


Figure 1:

Difference	Combinations	Probabilty
0	[1,1],[2,2],[3,3],[4,4],[5,5],[6,6]	$\frac{6}{36}$
1	[1,2],[2,1],[2,3],[3,2],[3,4],[4,3],,[5,4],[4,5],[5,6],[6,5]	$\frac{10}{36}$
2	[1,3],[3,1],[2,4],[4,2],[3,5],[5,3],[6,4],[4,6]	$\frac{8}{36}$
3	[1,4],[4,1],[2,5],[5,2],[6,3],[3,6]	$\frac{6}{36}$
4	[1,5],[5,1],[2,6],[6,2]	$\frac{4}{36}$
5	[1,6],[6,1]	$\frac{2}{36}$

Table 2: Probability Distribution of absolute diff of two dices

The distribution of absolute difference

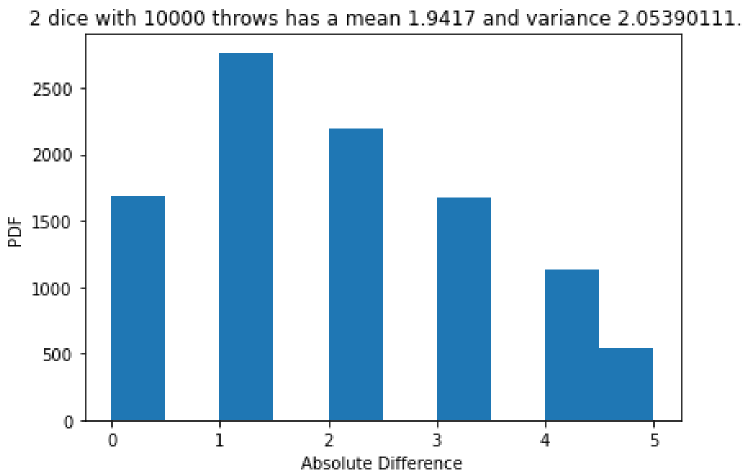


Figure 2:

ANSWER 2

The value of one die has a mean of $(1+2+3+4+5+6)/6 = 3.5$ and a variance of $35/12 = 2.9166$. For 100 throws the mean will be $100 * 3.5 = 350$ and the variance will be $100 * 2.9166.5 \approx 292$. In accordance to the Central-Limit theorem the probability distribution is approximately Gaussian with mean 350 and variance approximately 292.

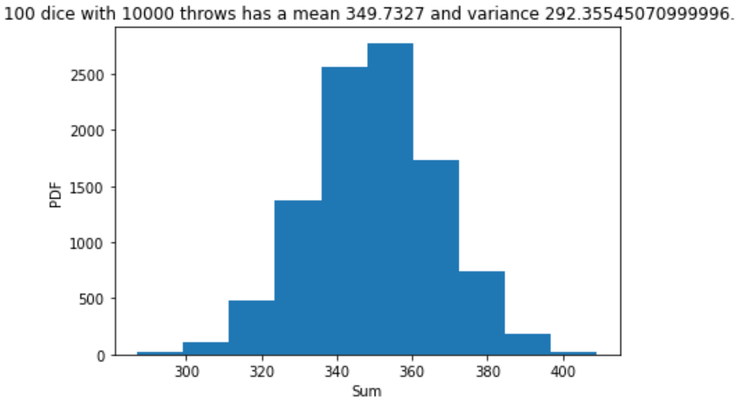


Figure 3:

Answer 3

In this question we need to chose two cubical dice with the numbers 0,1,2,3,4,5,6 such that on throwing the dices we have a uniform probability distribution i.e the probability of the sum of dices are equal. We need a uniform distribution from 1-12 which limits the condition of the sum of dices to be 0. So we cant have [0,0].So, one of the dices have 0 and the other wont have zero but 1 for sure. The second thing we notice is the max sum is 12 so we have only one condition [6,6]. This means both dice has 6. So, the unique solution will be a dice 1,2,3,4,5,6 and the other will be 6,6,6,0,0,0 the distribution we will have is:

Sum	Combinations	Probabilty
1	[0,1]	$\frac{3}{36}$
2	[0,2]	$\frac{3}{36}$
3	[0,3]	$\frac{3}{36}$
4	[0,4]	$\frac{3}{36}$
5	[0,5]	$\frac{3}{36}$
6	[0,6]	$\frac{3}{36}$
7	[6,1]	$\frac{3}{36}$
8	[6,2]	$\frac{3}{36}$
9	[6,3]	$\frac{3}{36}$
10	[6,4]	$\frac{3}{36}$
11	[6,5]	$\frac{3}{36}$
12	[6,6]	$\frac{3}{36}$

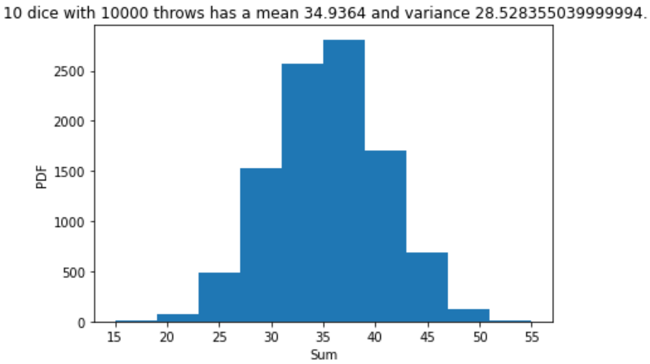
Table 3: Probability Distribution of absolute diff of two dices

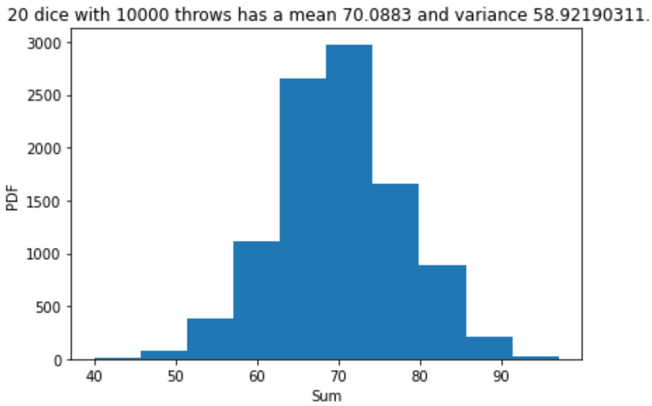
Answer 4

It is not possible to label hundred dices by just six numbers to give unique combinations. So, we can consider other integers. One such possibility would be to use labeling that is completely different from one another and also their combinations. The possible solution can be , as mentioned in book 3 is, $label = (0, 1, 2, 3, 4, 5) * 6^r$

Answer 5

The distribution looks like a Gaussian when the Number of dice is $= 2, 3, 4, 10, 20$. Here, I have shown for Number of dice = 10 and 20

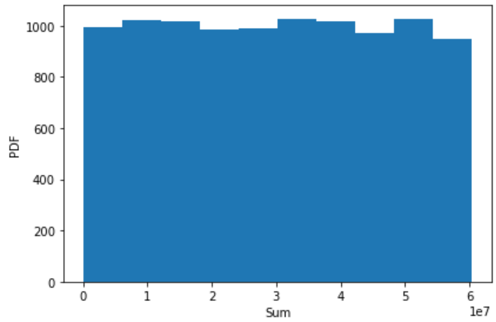




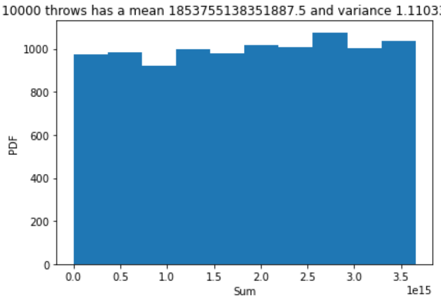
Answer 6

The distribution does not looks like a Gaussian when the Number of dice is $= 2, 3, 4, 10, 20$. Here, I have shown for Number of dice $= 10$ and 20.
.The reason might be that the variance is very large and increases exponentially on increasing the number of dices so it doesn't converge.

10 dice with 10000 throws has a mean 30069333.3999 and variance 302262425571547.9.



20 dice with 10000 throws has a mean 1853755138351887.5 and variance 1.1103392129189871e+30.



Answer 4 Python Code for the simulation of the problem

```
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
Created on Thu Oct 27 15:48:03 2022

@author: draco
"""

import numpy as np
import matplotlib.pyplot as plt
import random
from scipy.stats import norm



print("call dicethrow with !st variable input as the number of throws, second as no. of dice and the mode.The default mode is sum. In case of abs diff the number mode =! sum and to be noted that it only works when the number of dice is two \n" )
def dicethrow(no_throws,no_dice,mode ='add'):

    dice_sum_outcome = []# the elements in number of sum should be the sum of the dices.

    for i in range (1,no_throws+1):

        dice_face = []

        for j in range(1,no_dice+1):

            dice = random.randint(1,6)

            dice_face.append(dice)

        if mode == 'add':
            out_add = sum(dice_face)



        else:
                ######## only in case of two dice ########

            out_add = abs(dice_face[0]-dice_face[1])
        dice_sum_outcome.append(out_add)
    return dice_sum_outcome
```

```


def diceinteg(no_throws, no_dice):
    Dice=np.zeros((6 , no_dice))
    for r in range (no_dice) :
        Dice [:,r]=np.array ( [ 0 , 1 , 2 , 3 , 4 , 5 ] )*6**r

    output_sum = np.zeros(no_throws)
    for i in range (no_throws):

        for j in range(no_dice):
            dice_output = random.choice(Dice[:,j])
            output_sum[i] += dice_output

    dice_sum_outcome = output_sum
    return (dice_sum_outcome)

no_dice=2
no_throws=10000
dice_sum_output =  dicethrow(no_throws,no_dice)
#dice_sum_output = diceinteg(no_throws,no_dice)


mu = np.mean(dice_sum_output)
sigma = np.var(dice_sum_output)
print(mu,sigma)

########## Plot ########

plt.hist(dice_sum_output)
plt.ylabel("PDF")
plt . xlabel("SUM")
plt.tight_layout()
plt.title(" %s dice with %s throws has a mean %s and variance %s."
    %(no_dice,no_throws,mu,sigma))
plt.show()
```