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Project 3 Report

1. Experimental Bernoulli Trials

Introduction

The experiment deals with Bernoulli Trials, where three dices are rolled 1000 times. An experiment or Bernoulli trial is considered a "success" if three sixes are rolled in one roll. The trial is repeated 10,000 times and a probability mass function of number of success is plotted.

Methodology

In the experiment, a random number between 1 to 6 is generated 3 times and the sum is calculated. If the sum of the three number is 18, the trial is considered a success. The dices are rolled 1000 times and the number of success is counted. Finally, the whole experiment is repeated 10,000 times and a probability mass function of number of successes in 1000 rolls in calculated and represented in a plot.

Source code

```
"""
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Project 3 Part 1

The program plots a probability mass function of X, where X
is the number of "three sixes" received when three dices
are rolled 1000 times
"""
import numpy as np
import matplotlib.pyplot as plt


def rollDices():
    randomVariable = 0  # The variable stores the numerical
outcome of getting three sixes
    for i in range(0, 1000):
        diceFaces = np.random.randint(1, 7, 3)
        if (diceFaces.sum() == 18):
            randomVariable += 1

    return randomVariable


def makeFigure(list):
```
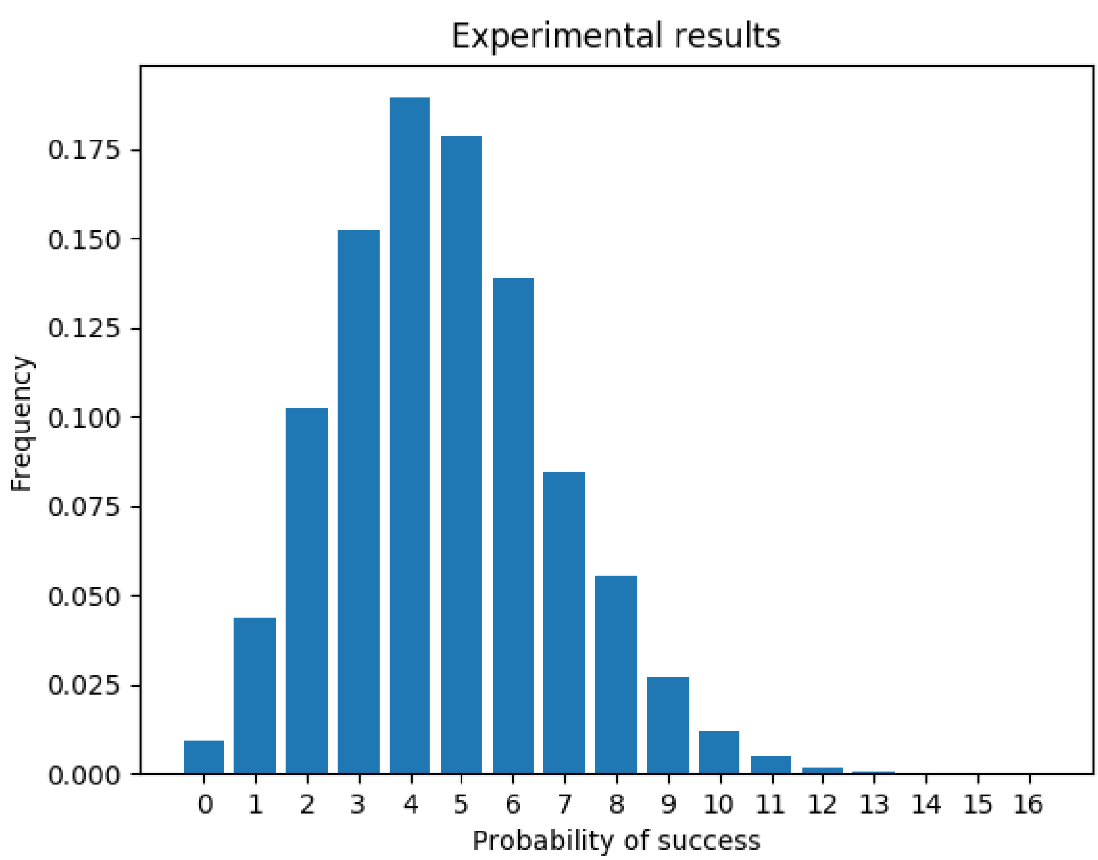

```
    b = np.arange(0,18)
    h1, bin_edges = np.histogram(list, bins = b)
    b1 = bin_edges[0:17]

    figureOne = plt.figure(1)
    p1 = h1 / 10000
    plt.xticks(b1)
    plt.bar(b1, p1)
    plt.title('Experimental results')
    plt.xlabel('Probability of success')
    plt.ylabel('Frequency')

    plt.show()


randomVariableList = []
for i in range(0, 10000):
    x = rollDices()
    randomVariableList.append(x)

makeFigure(randomVariableList)
```

PMF Plot



2. Calculations using the Binomial Distribution

Introduction

The objective of this experiment is similar to the first one. A probability mass function needs to be calculated for number of successes in 1000 Bernoulli trials. However, the theoretical formula for Binomial distribution is used calculate the probability of getting x amount of success while 1000 rolls are made.

Methodology

Firstly, the probability of getting three sixes in roll of three dices is calculated and assigned as ‘p’. Then, the formula for binomial distribution is used to calculate the probability for various value of ‘x’. The value of ‘x’ is increased up to 16 as any value more than that will result in very small probability. Each probability is assigned to each value of ‘x’ and the probability mass function is plotted.

Source Code

```
"""
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Project 3 Part 2

The program plots a probability mass function of X, where X
is the number of "three sixes" received when three dices
are rolled 1000 times. Poisson distribution formula is used
to calculate the probability for various x.
"""
import numpy as np
import matplotlib.pyplot as plt
import math as math

def nCr(n,r):
    return
math.factorial(n)/(math.factorial(r)*math.factorial(n-r))

def binomialDistList():
    probabilityOfSuccess = 0.005 #Probability of getting
three sixes in one roll of three dice
    probabilityList =[]
    for randomVariable in range(0, 17):

probabilityList.append(nCr(1000,randomVariable)*(math.pow(p
robabilityOfSuccess,randomVariable))*
```
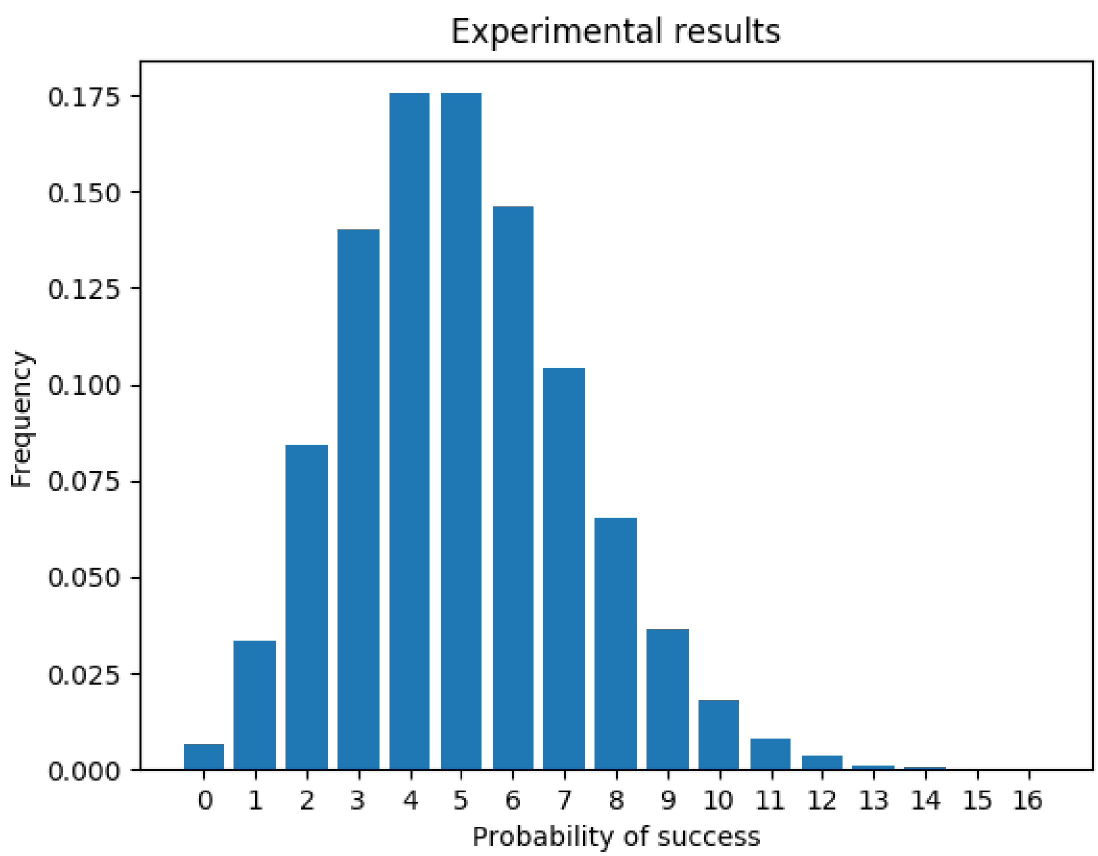

```
                                        (math.pow(1-
probabilityOfSuccess,1000-randomVariable)))

    return probabilityList

def makeFigure(list):
    b = np.arange(0,17)

    figureOne = plt.figure(1)

    plt.xticks(b)

    plt.bar(b, list)
    plt.title('Experimental results')
    plt.xlabel('Probability of success')
    plt.ylabel('Frequency')

    plt.show()

list = binomialDistList()
makeFigure(list)
```

<u>PMF Plot</u>



3. Approximation of Binomial by Poisson Distribution

<u>Introduction</u>

The experiment is similar to the first two experiments where the number of getting three sixes in a roll in 1000 rolls has to be calculated and the probability mass function has to be plotted. However, the formula for poisson distribution will be used to calculate the probability of getting ‘x’ number of successes in 1000 rolls. The formula is suitable as the value of n is large (n=1000) and the probability of getting three sixes is small (p=0.005).

<u>Methodology</u>

Firstly, the probability of getting three sixes in roll of three dices is calculated and assigned as ‘p’. Secondly, λ is calculated. Then, the formula for poisson distribution is used to calculate the probability for various value of ‘x’. The value of ‘x’ is increased up to 16 as any value more than that will result in very small probability. Each probability is assigned to each value of ‘x’ and the probability mass function is plotted.

<u>Source code</u>

```
"""
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Project 3 Part 3
The program plots a probability mass function of X, where X
is the number of "three sixes" received when three dices
are rolled 1000 times. The probability is calculated using
the Poisson Distribution
"""
import numpy as np
import matplotlib.pyplot as plt
import math as math

def poissonDistList():
    probabilityOfSuccess = 0.005  # Probability of getting
three sixes in one roll of three dice
    n = 1000 #Number of trials
    probabilityList = []
    for randomVariable in range(0, 17):

probabilityList.append(math.pow(n,randomVariable)*math.pow(
probabilityOfSuccess,randomVariable)*
```

```
                                math.exp(-
n*probabilityOfSuccess)/math.factorial(randomVariable))

    return probabilityList

def makeFigure(list):
    b = np.arange(0,17)
    figureOne = plt.figure(1)

    plt.xticks(b)

    plt.bar(b, list)
    plt.title('Experimental results')
    plt.xlabel('Probability of success')
    plt.ylabel('Frequency')

    plt.show()

list = poissonDistList()
makeFigure(list)
```

PMF Plot