확률통계론_HW03

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Conception of Program 1

- 랜덤 넘버 생성기로 생성한 1000개의 랜덤한 수를 1000 size 배열에 각각 저장
- For iteration을 이용하여 10000회 반복, 1000*10000 size 배열에 값을 저장. Lambda값과 time interval 값 계산
- Poisson Distribution를 Histogram 형식으로 작성

Code Description 1

```python
import random
import math
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import poisson

ffile = open("C:/Users/admin/PoissonDistribution.txt", 'w')

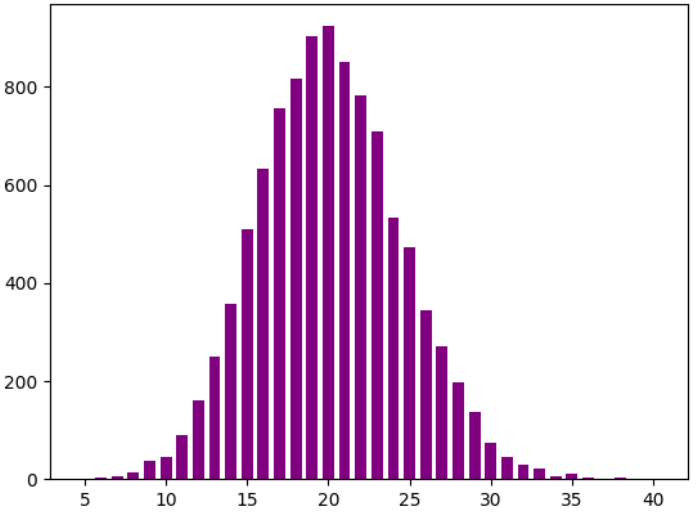
#np.random.seed(seed=10)
array = [[0 for col in range(1000)] for row in range(10000)]

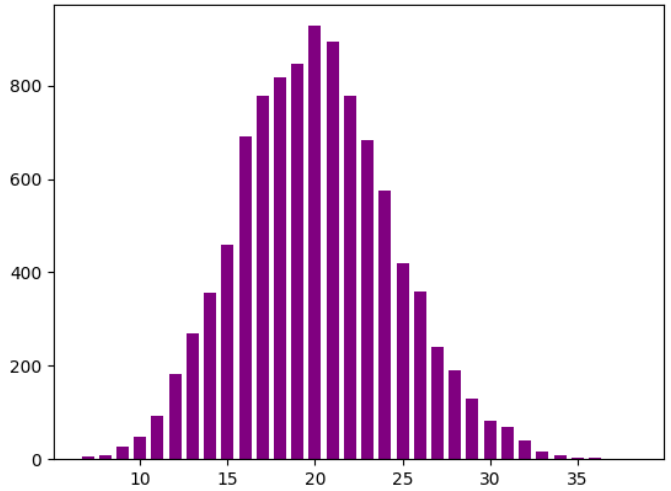
arrForPoisson = []
calcul = 0
timeInterval = 0
sumOfCalcul = np.zeros(10000)
checkTime = 0

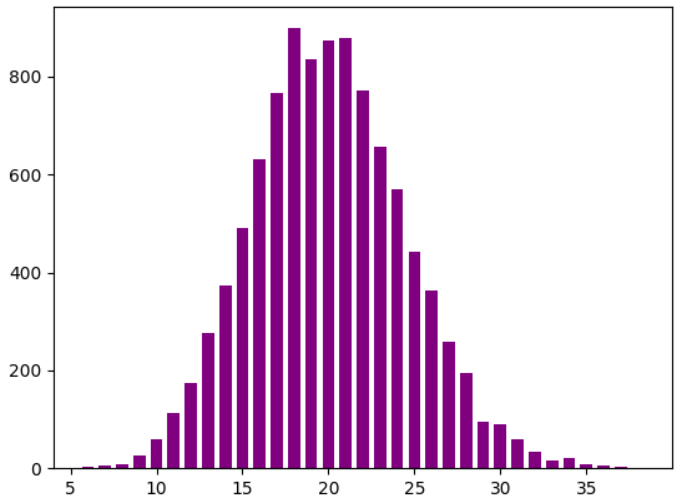

for restart in range(10000):
    for repeat in range(1000):
        array[repeat] = np.random.randint(1, 50)
        timeInterval = timeInterval + 1
        if array[repeat] == 1:
            calcul = calcul + 1
            arrForPoisson.insert(checkTime, timeInterval)
            #[checkTime] = timeInterval
            timeInterval = 0
            checkTime = checkTime + 1
    sumOfCalcul[restart] = calcul
    calcul = 0
```

- Python을 사용
- numpy와 mathplotlib를 중심으로 구현
- calcul = Trial 1당 Event 발생 횟수
- timeInterval = Time Interval
- sumOfCalcul = 10000개의 Event 발생 횟수
- checkTime = 총 Time Interval 개수(몇 번째 배열에 insert할지 판단하는데 사용

Execution 1~3







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3 14 21 3 14 25 10 39 32 4 40 18 32 13 9 19 37 30 44 1 34 10 20 27 36 8 5 46 38 6 13 7 28 18 37
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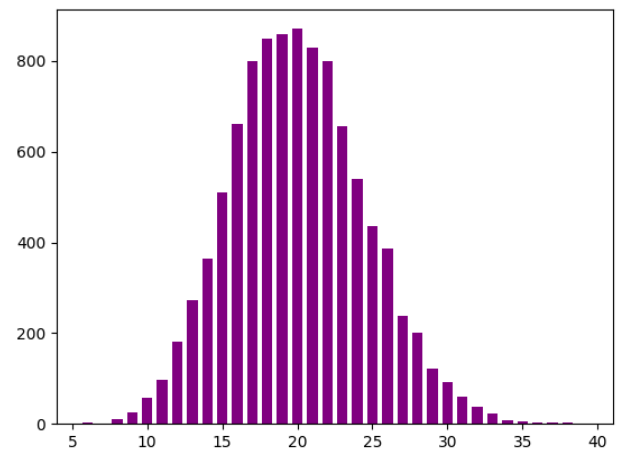
22 38 22 11 32 39 46 48 10 1 41 [illegible]

One example of random generation

Execution 4~5




```
[ 6  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
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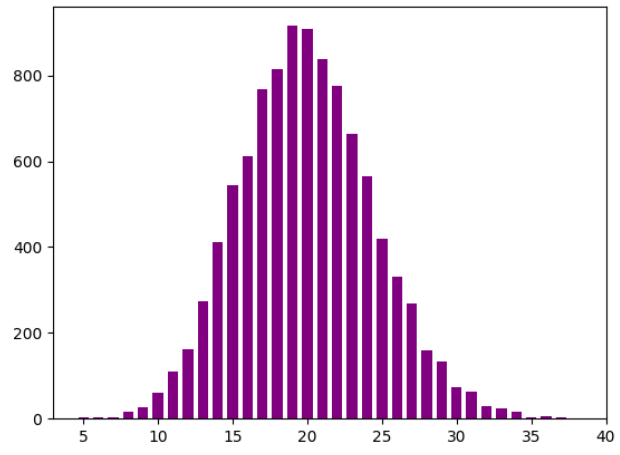


```
[ 5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
 29 30 31 32 33 34 35 36 37 38]
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 663 566 419 330 269 159 134  74  62  28  25  15   4   6   2   1]
```

Unique and Counts of Poisson Distribution

Code Description 2

```
unique, counts = np.unique(sumOfCalcul, return_counts=True)

np.asarray((unique, counts)).T

#print(unique)
#print(counts)

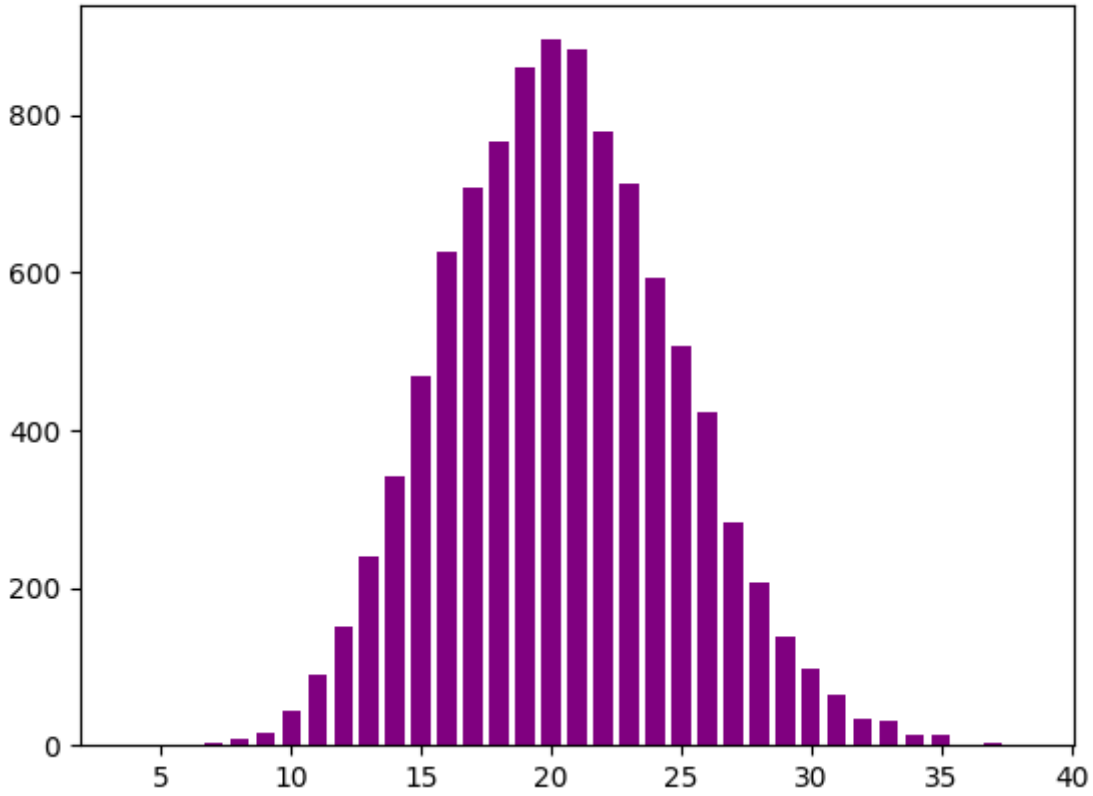
plt.bar(unique, counts, width=0.7, color="purple", align='center')
plt.show()
```

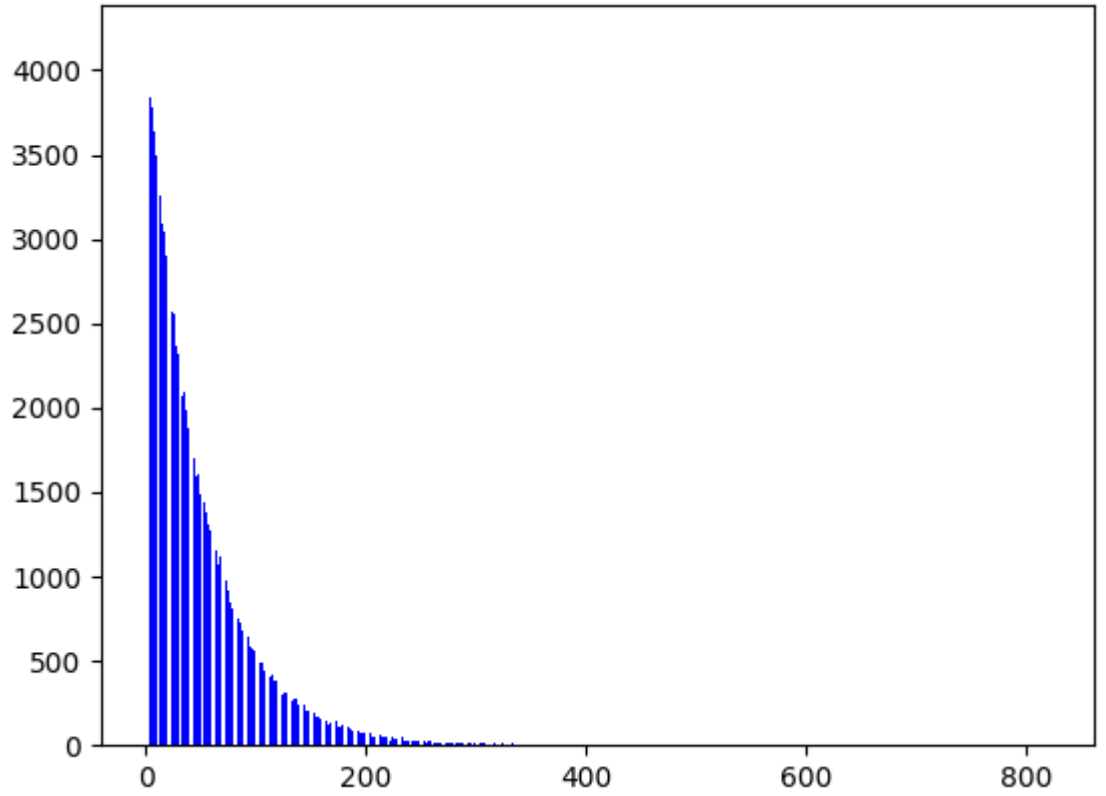
- Numpy의 unique 함수를 이용
- Event 발생 횟수를 담고있는 sumOfCalcul 배열을 unique와 counts로 분해.
- unique를 x축, counts를 y축으로 하는 Histogram 작성
- arrForPoisson 배열에는 Time Interval을 삽입

Conception of Program 2

- Time Interval은 굳이 이중 배열로 만들 필요가 없다는 것을 알게 되었음
- 빈 배열을 생성하여 Time Interval을 따로 저장
- Time Interval을 Histogram, Line Graph로 작성

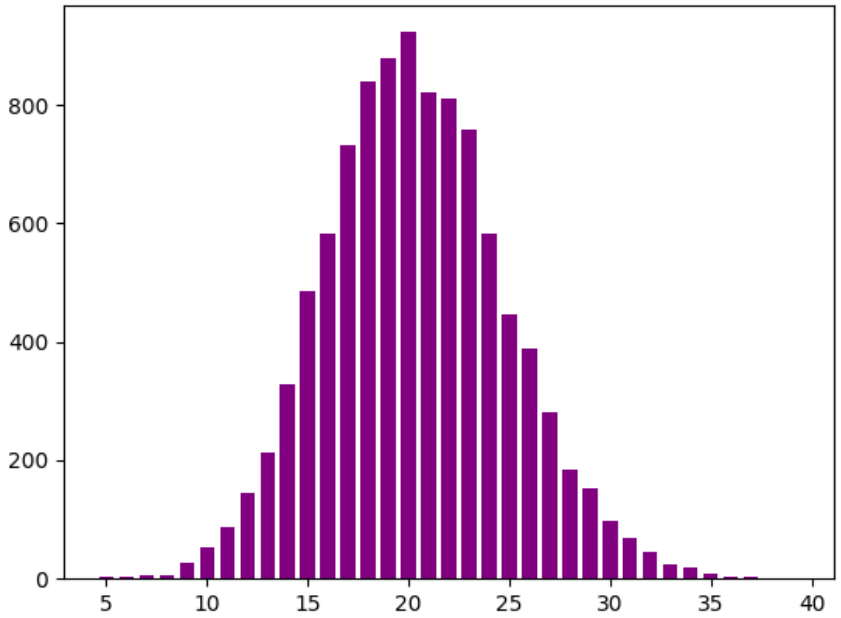
Execution 6

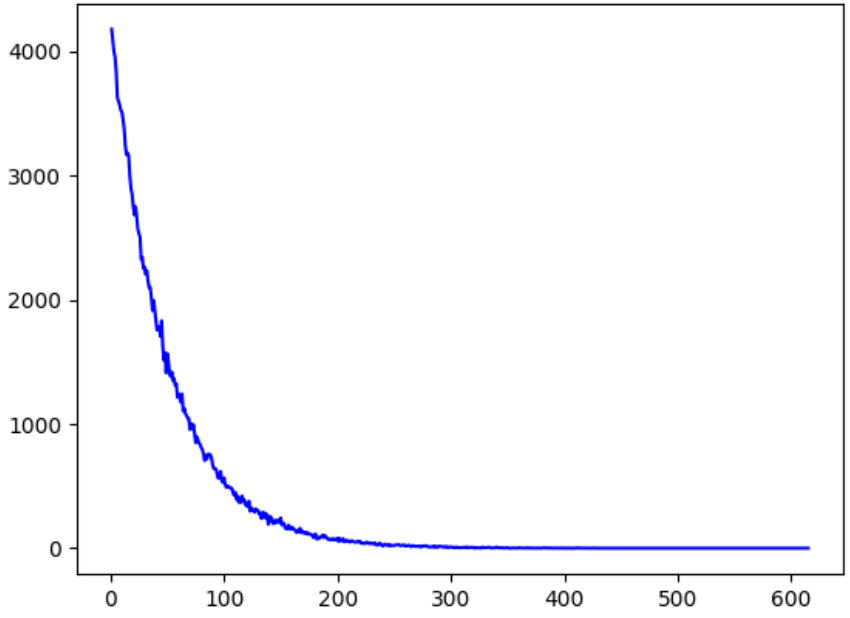




Version that made with Histogram

Execution 7





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2013 1913 1994 1918 1828 1756 1782 1774 1705 1830 1630 1513 1573 1410 1566 1502 1406 1381 1419 1348 1366 1310 1323 1214 1226 1240 1176 1242 1104 1126 1084 1067 1047 1044 956
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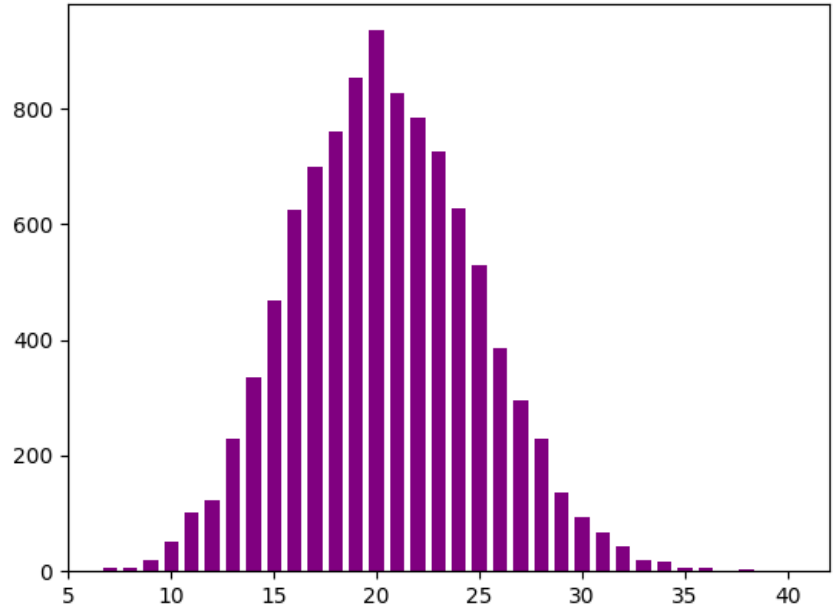
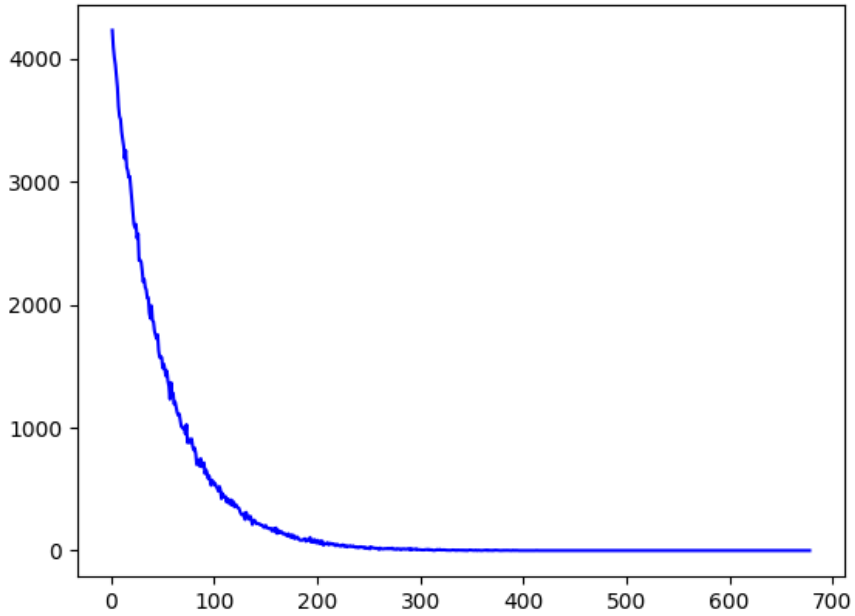
1 2 1 1 1 1 1 1 1

Counts of Time Interval

Execution 8





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2057 1934 1891 1992 1874 1862 1784 1755 1724 1757 1626 1572 1581 1570 1485 1518 1477 1421 1461 1380 1337 1232 1368 1265 1281 1193 1209 1164 1124 1101 1112 1059 1009 1008 990
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1 1 1 1 1 2 2 2 1 1 1 3 1 1 1 1 2 2 1 1 2 1 1 1 2 1 1 2 1 1 1 1 1 1 1
1 1 1 1

Code Description 3

```
unique2, counts2 = np.unique(arrForPoisson, return_counts=True)

np.asarray((unique2, counts2)).T

#print(unique2)
#print(counts2)

numToFind = 0

for printRepeat in range(len(counts2)):
    print(counts2[printRepeat])
    printarray = str(counts2[printRepeat])
    ffile.write(printarray)
    ffile.write(" ")
    numToFind = numToFind + 1
    if numToFind == 35 :
        ffile.write("\n")
        numToFind = 0

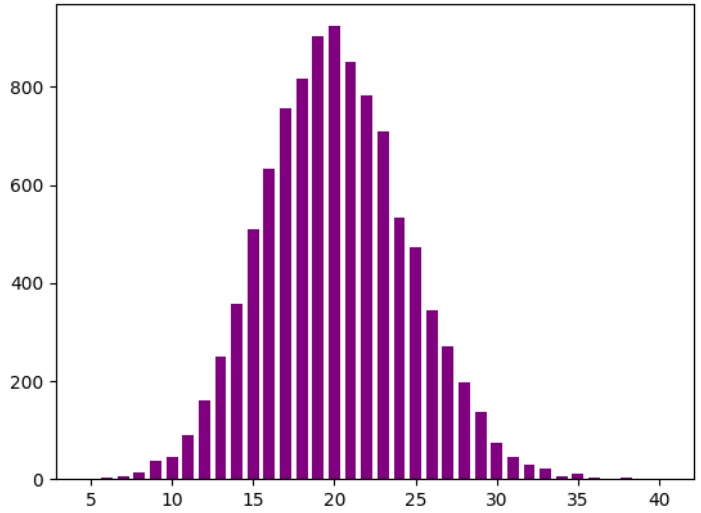
ffile.close
plt.plot(unique2, counts2, color="blue")
plt.show()
```

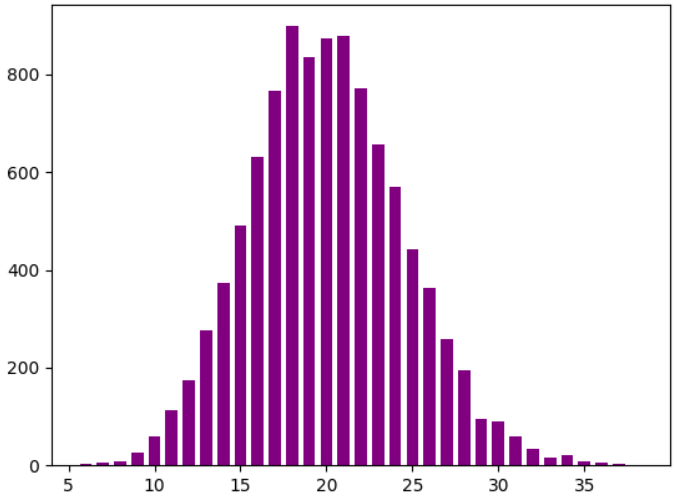
- Numpy의 unique 함수를 이용
- Time Interval을 갖고 있는 arrForPoisson 배열을 unique와 counts 로 분해.
- unique를 x축, counts를 y축으로 하는 Line Graph 작성

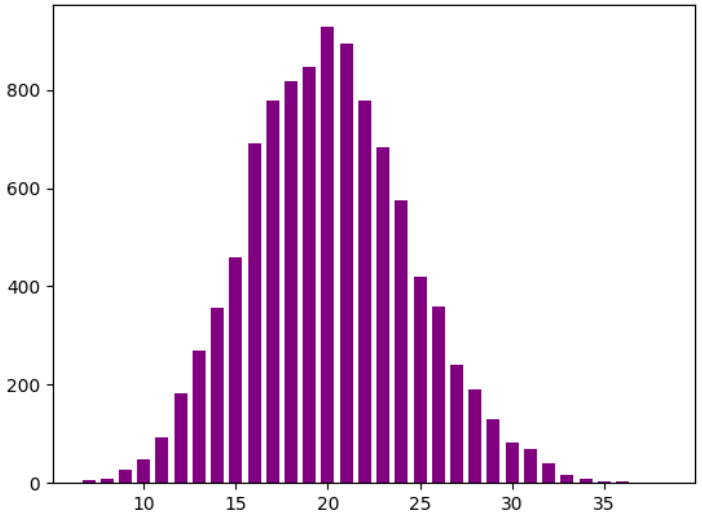
Explanation

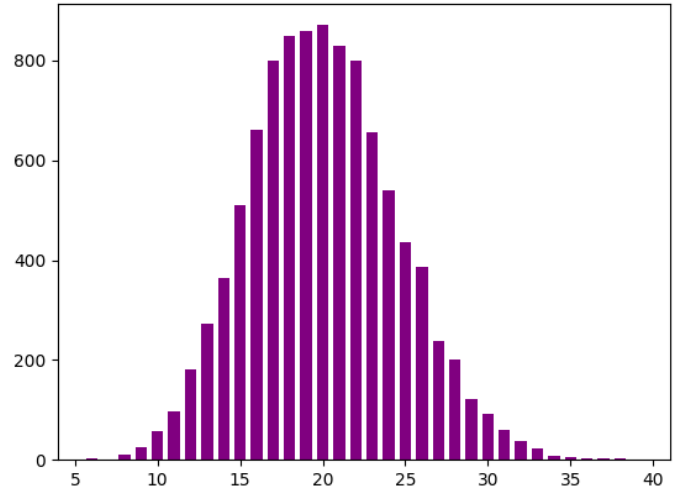
- Random Generator을 이용하여 1~50까지의 변수 생성
- 1이 나오는 경우를 체크
- Repeat It for 10000 Experiment
- $\lambda = 50$
- 기댓값 = 20
- $f(t) = \lambda e^{-\lambda t}$
- Express Poisson Distribution with PDF

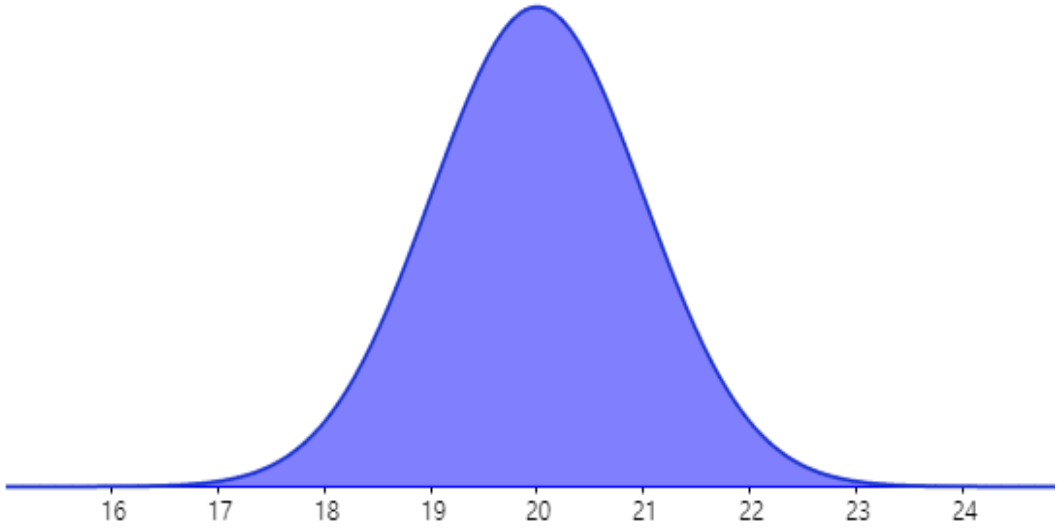
Compare Histogram1





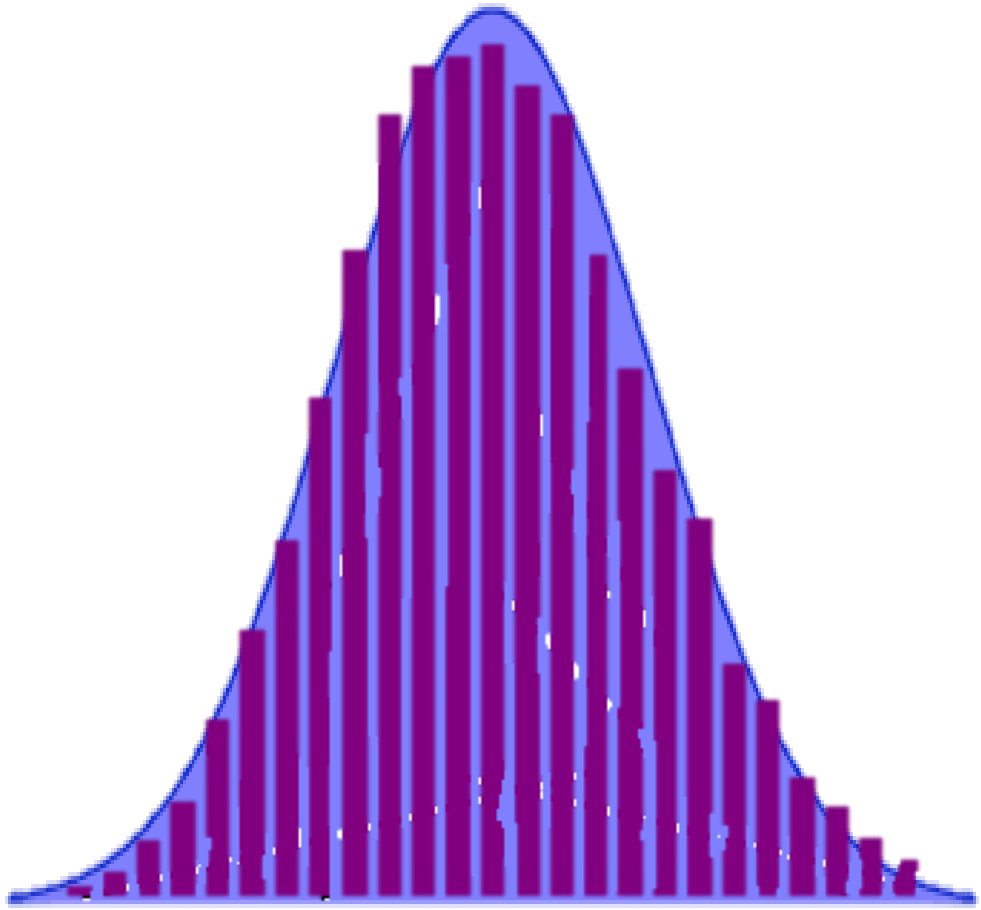






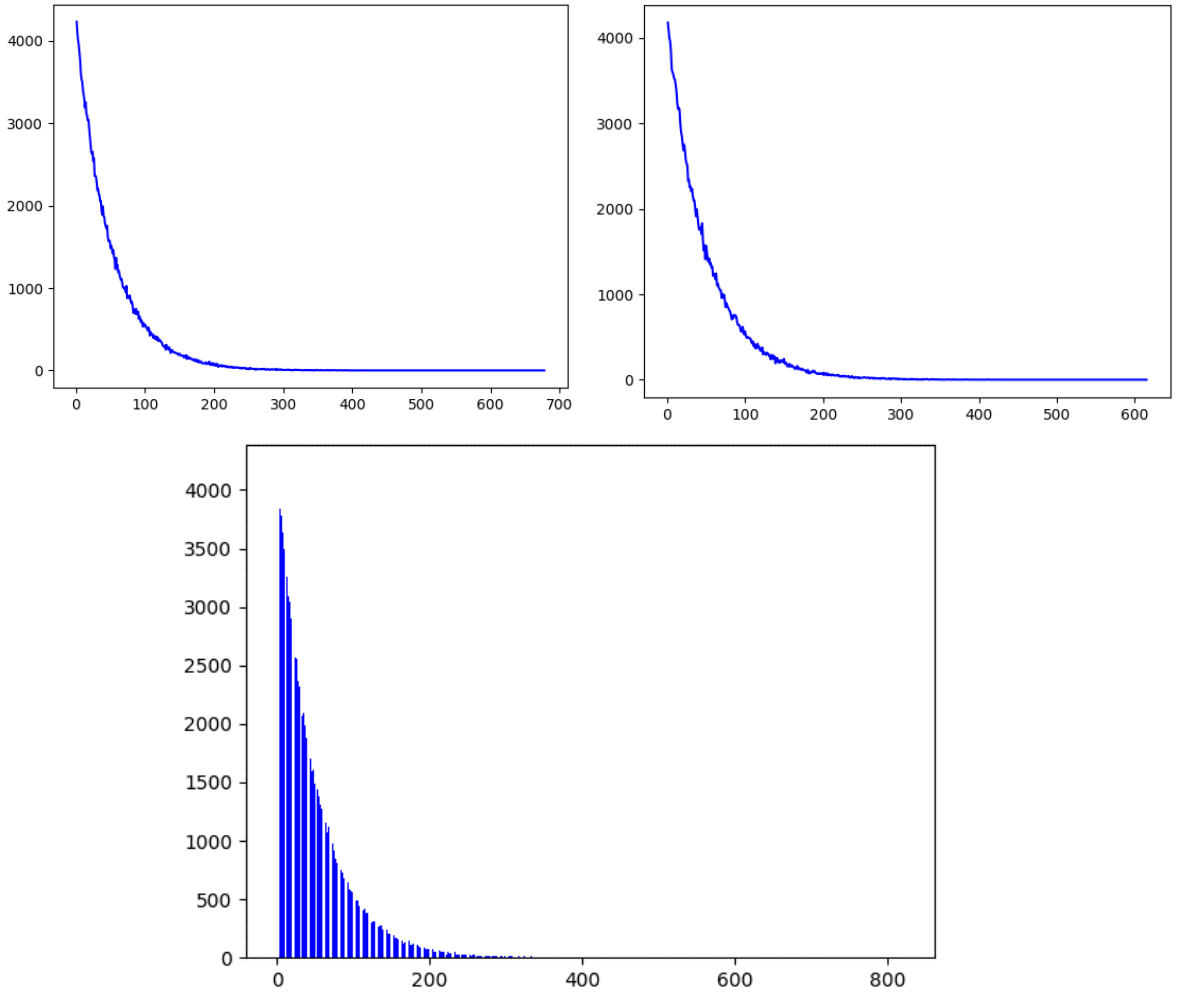
Source: GeoGebra

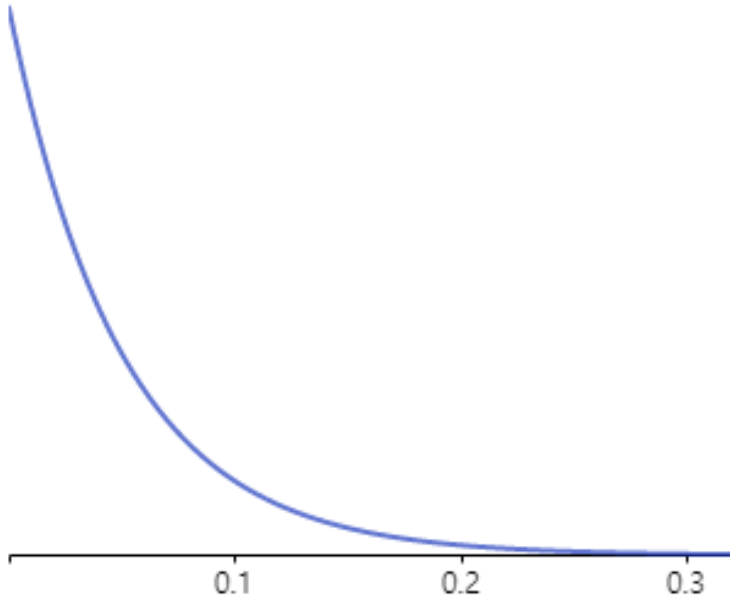
Compare Histogram2



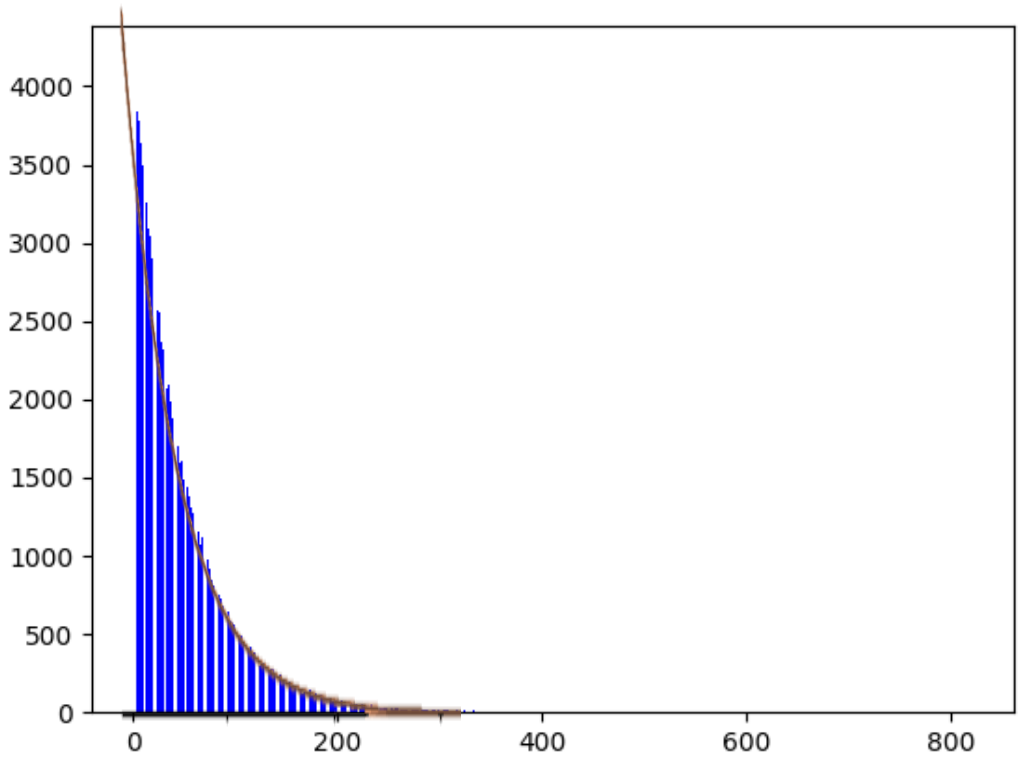
- Poisson Distribution(Ex 4)을 Normalization한 Histogram과 Compare Histogram을 PDF 형태로 작성하여 비교
- Normalization한 Histogram과 Compare Histogram 사이 상당한 유사도를 보임

Compare Histogram3





Compare Histogram4



- Time interval Histogram Lambda값의 지수 함수와 비교
- Time Interval Histogram과 Lambda값의 지수 함수와의 형태가 매우 유사함을 알 수 있음

Analysis of the Simulation

- 총 10000000번의 시행에서 Event가 발생한 사건은 [204168, 204073, 203710, 203808, 203835 …]로 Event가 발생한 확률은 기댓값인 1/λ 보다 조금 크게 나타났다.
- Time Interval은 0~4까지 4000회 이상, ~91까지 1000회 이상, ~298까지 100회 이상 나타났으며, 667이라는 특수한 Time Interval이 나타나기도 했다.
- Event Occurrence가 20인 경우의 Normalization은 평균적으로 0.09였다.
- Time Interval을 1로 설정한 경우, 확률 밀도는 4.1*10^-8

Your Conclusions

- Modeled Poisson Distribution Histogram과 Compare Histogram은 상당히 유사한 모습을 보인다.
- Modeled Poisson Distribution Histogram은 정규 분포 형상을 띄고있다
- Compare Histogram과 다르게 λ값이 최고점이 되지 않는 경우가 있다
- 10000번의 실행을 거치면 1번 정도는 특수한 특잇값이 나오는 경우가 있다.
- Time Interval이 0일 확률은 (1/50)^2가 아닐까 생각했지만, 실제로는 더 복잡한 계산이 필요하다는 것을 알 수 있었다.

Full Code

```python
import random
import math
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import poisson

ffile = open("C:/Users/admin/PoissonDistribution.txt", 'w')

#np.random.seed(seed=10)
array = [[0 for col in range(1000)] for row in range(10000)]

arrForPoisson = []
calcul = 0
timeInterval = 0
sumOfCalcul = np.zeros(10000)
checkTime = 0


for restart in range(10000):
    for repeat in range(1000):
        array[repeat] = np.random.randint(1, 50)
        timeInterval = timeInterval + 1
        if array[repeat] == 1:
            calcul = calcul + 1
            arrForPoisson.insert(checkTime, timeInterval)
            #[checkTime] = timeInterval
            timeInterval = 0
            checkTime = checkTime + 1
    sumOfCalcul[restart] = calcul
    calcul = 0


unique, counts = np.unique(sumOfCalcul, return_counts=True)

np.asarray((unique, counts)).T

#print(unique)
#print(counts)



print(counts)

plt.bar(unique, counts, width=0.7, color="purple", align='center')
plt.show()



unique2, counts2 = np.unique(arrForPoisson, return_counts=True)

np.asarray((unique2, counts2)).T

print(unique2)
print(counts2)

numToFind = 0

for printRepeat in range(len(counts2)):
    print(counts2[printRepeat])
    printarray = str(counts2[printRepeat])
    ffile.write(printarray)
    ffile.write(" ")
    numToFind = numToFind + 1
    if numToFind == 35:
        ffile.write("\n")
        numToFind = 0

ffile.close
print(sum(counts2))

plt.plot(unique2, counts2, color="blue")
plt.show()
```

Thank You

Use Python, Geogebra

random, math, numpy, matplotlib