# Homework 9

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## 1 Probability and simulation

### Part 1: The St. Petersburg paradox

**a)** Given the output generated by my code it returns the average for each played game so far. If we simply take the average of these values we get approximately 4. As the payoff is decided by

$$2^c$$

where c is the number of flipped coins a reasonable bet would be the closest we get to this which would be

$$2^2 = 4$$

As a result I would personally not bet any more than 2 coins even though I could potentially win an "infinite" amount of money [2].

**b)** Perhaps the most notable unrealistic assumption here would be that the casino is assumed to have infinite amounts of money [1, 2]. As the amount of money in the world is actually a finite number this assumption is rather unrealistic. In the same sense from the player's perspective; a player can not receive an infinite payout of money either.

**c)** See graph of the simulations below.

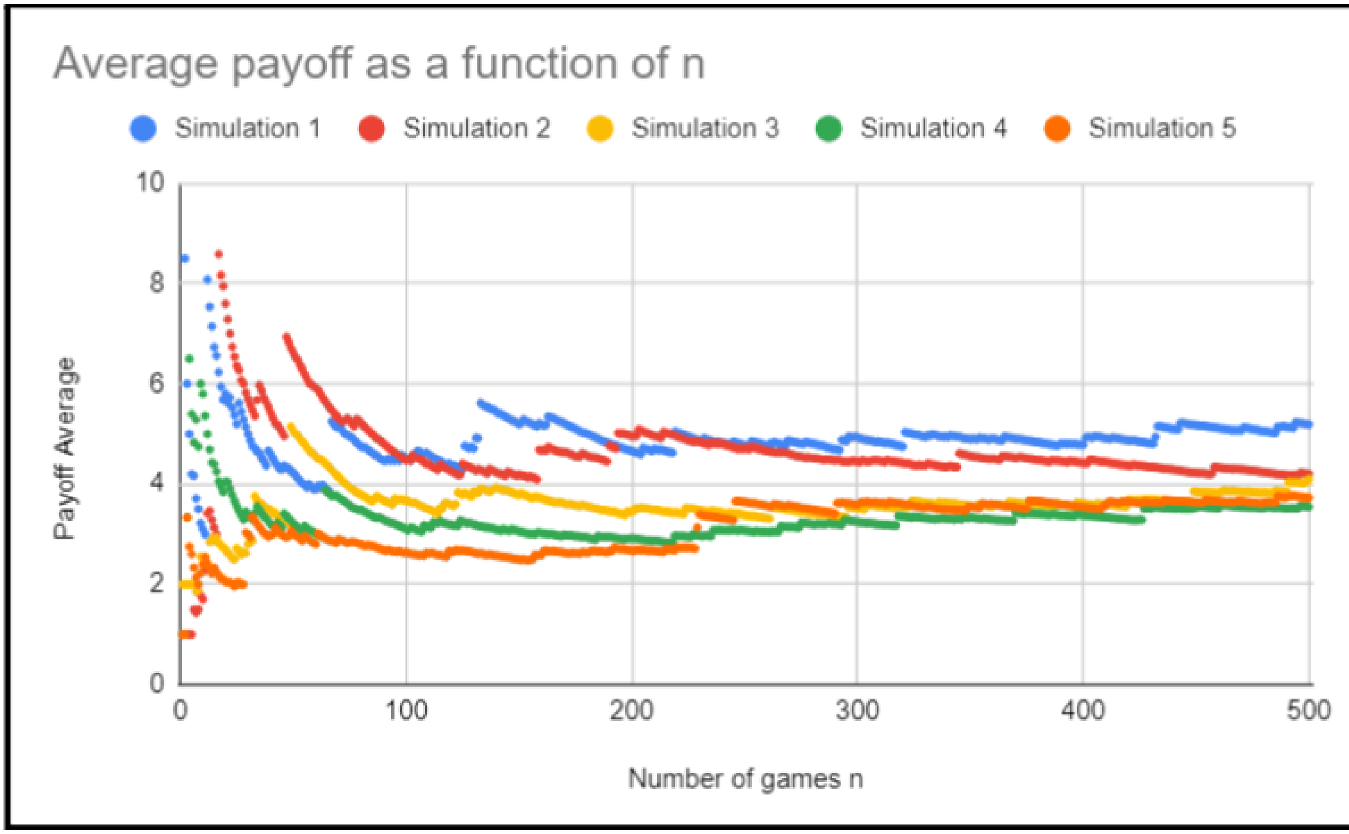


Figure 1: The results are presented within this graph

```
import random

#Maximums
payoff = 10*10^6
n = 500 #example 500, just took it to save some runtime

#Coinflip function
def coinflip():
    flippedcoins = 0
    while (True):
        toss = random.randint(0,1) #Random number between 0 and 1
        if(toss == 1 or (2**flippedcoins) >= payoff):
            if((2**flippedcoins) >= payoff):
                return payoff
            else:
                return (2**flippedcoins)
        else:
            flippedcoins += 1 #If cross, flip the coin again and add 1 to total flipped coins

totalpayoff = 0
for i in range(1,n+1):
    totalpayoff += coinflip()
    final = round(totalpayoff/i, 6) #took six decimals as the program I used to print the graph did not allow me to use more
    print(str(final).replace(".", ",")) #had to do this since the program I used to print the graph did not like dots
```

Figure 2: The code used to get the values for the graph

**d)** Judging from the graph all simulations seem to converge at about the value 4. However due to the Riemann rearrangement theorem we can conclude that if this would have been an infinite number and the series would be convergent it could in theory converge (after some rearrangements) into any finite number while not excluding positive- and negative infinity [1].

## Part 2: The Hospital

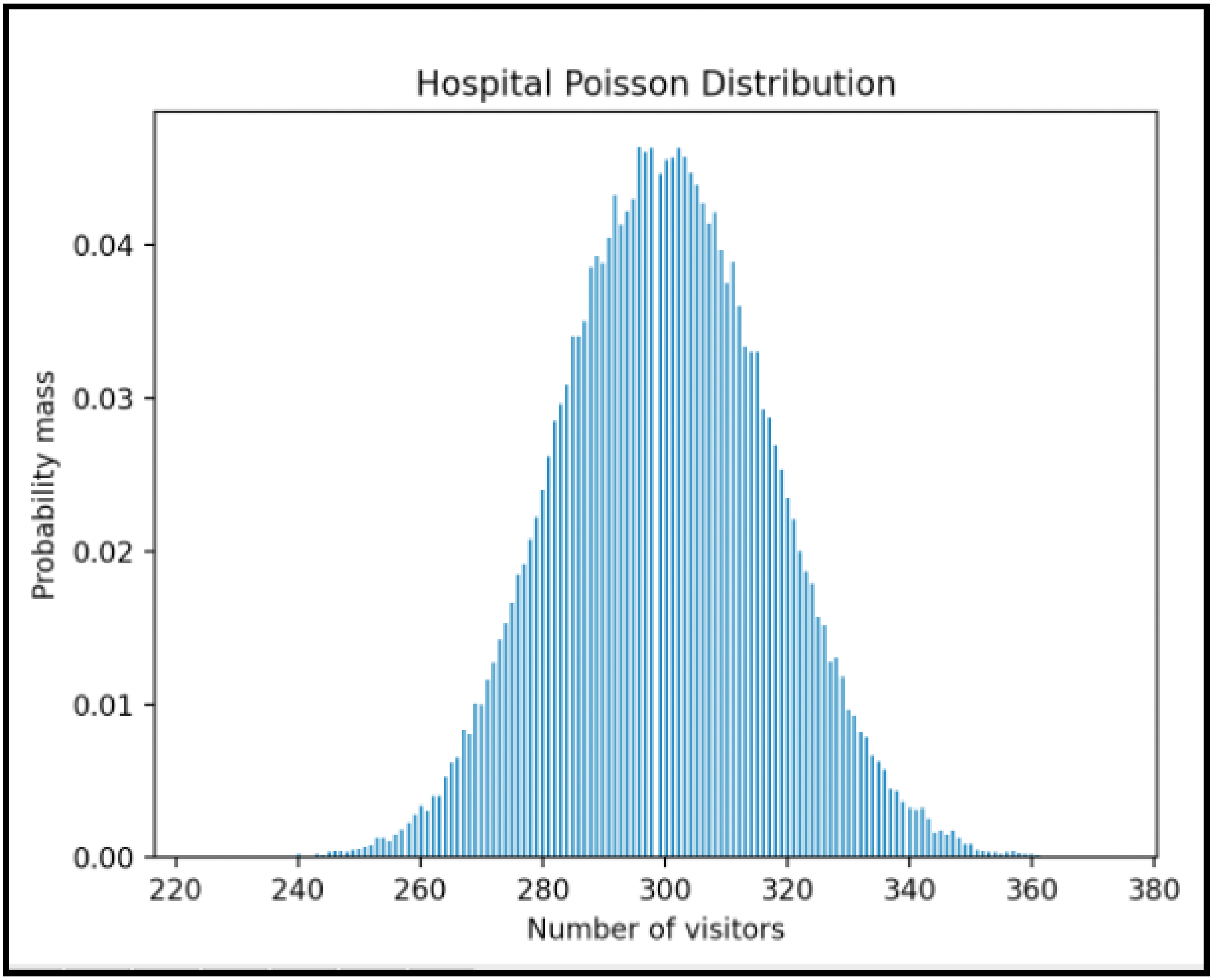


Figure 3: The graph of the poisson distribution of the hospital visitors, created using Numpy and Matplotlib

```python
import numpy as np
import matplotlib.pyplot as plt
from numpy import random

#Lambda = 300 and a day in seconds=24*60*60
s = np.random.poisson(lam = 300, size= 24*60*60)

#Histogram settings
plt.hist(s, density=True, bins=300)
plt.title("Hospital Poisson Distribution")
plt.xlabel("Number of visitors")
plt.ylabel("Probability mass")
plt.show()
```

Figure 4: The code used to get the values for the histogram and plot it

**Analysis:** According to the above distribution 369 visitors is considered very rare for the hopsital however it has happened before (at least approximately speaking). As it is so exceedingly uncommon though it should not be taken lightly; it could pose a red flag for a potential epidemic if the next following days also have a similar amount of visitors. Judging by the histogram the most common amount of visitors seem to be around 280 to 330 per day but one anomaly is probably not enough to conclude any potential epidemics or similar; if repeated though there might be a problem on the horizon.

# References


[1] Peterson, Martin, ”The St. Petersburg Paradox”, The Stanford Encyclopedia of Philosophy (Fall 2020 Edition), Edward N. Zalta (ed.), URL = ¡https://plato.stanford.edu/archives/fall2020/entries/paradox-stpetersburg/¿.

[2] Daniel Bernoulli, Specimen Theoriae Novae de Mensura Sortis, Commentarii Academiae Scientiarum Imperialis Petropolitanae, Tomus V, 1738, pp.175-192. Translated as Exposition of a new theory of the measurement of risk, Louise Sommer, transl., Econometrica, 22, 23-36 (1954).