

The Lottery Simulator

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1 Introduction

What is the lottery? A means of making a lot of money by selling numbered tickets, and then giving out prizes to the lucky ticket holders who have at least a majority of the numbers drawn at random [1]. The lottery is a common, weekly activity in many people's lives. However the interesting thing about the lottery is just how little the probability of winning the lottery is, and hence why do people continue to buy the lottery tickets? Because there's still that little chance! Throughout this assignment I will look into just how small the probability of winning is and my simulation of the current most popular lotteries. Considering the popularity I thought it would be interesting to see the mathematical side of how these numbers are chosen at random and what's the likelihood of getting the numbers you want. My main aim is focused on the random selection of numbers using my simulator as an example of just how random the lottery is and how hard it is to get near your chosen numbers.

2 The chances of winning the lottery

In the lottery, the probability of winning will be equal to the fraction of all of the possible lottery numbers which count as winning. That is,

- The probability of winning the lottery = $\frac{\text{The number of winning lottery numbers}}{\text{The total number of possible lottery numbers}}$

The number of ways of picking r items from a set of n items is denoted by

- $\binom{n}{r} = \frac{n!}{r!(n-r)!}$

This formula is exactly what is needed to find the probability of winning the lottery (Lotto). This is exactly what is needed to find the number of possible lottery numbers because in the lottery 6 numbers are chosen from a set of size 59 numbers. Since the number of ways of picking 6 numbers from a set of 59 different numbers is

- $\binom{59}{6} = 45,057,474$

So the total number of possible 6/59 tickets is equal to the above. All your numbers must match with all 6 of the winning numbers in order to win the jackpot, there is only one set of winning lottery numbers. Therefore,

- The probability of winning the jackpot in the 6/59 lottery = $\frac{1}{45,057,474}$

Well that's a very small probability! To work out the probability of winning the other prizes found in the lottery, you use the same method above where the denominator is the number of ways of picking the 6 numbers out of the set, which is equal to 45,057,474 [2]. The numerator is the number of possible winning numbers for each prize. I would continue to calculate and show these probabilities but the main aim of this assignment is to create and demonstrate my lottery simulator, which is the next chapter. But here is a table with the probability of obtaining the other prizes:

2 numbers	3 numbers	4 numbers	5 numbers	5 numbers + bonus ball	6 numbers
10/103	1/97	1/2180	1/144,415	1/7,509,579	1/45,057,474

3 Lottery simulation

There are 3 main lotteries currently being played in the UK and Europe, all run by the same company: 'The National lottery', these three lotteries are: Lotto, Euromillions, Thunderball. In my simulator I have based the coding and outcomes amongst these three games, where the Lotto chooses 6 numbers between 1 and 59, the Euromillions chooses 5 numbers between 1 and 50 and 2 lucky stars between 1 and 11, and finally the Thunderball chooses 5 numbers between 1 and 39 and 1 Thunderball between 1 and 11. I used these facts to build my simulator. I began first by creating some ground rules with the code, and creating a helper function which would create the rule where only a single draw is made at each time:

```
import random

class Lottery:
    """Simulate the lottery."""

    def __init__(self, name, rules):
        """Define the name and rules of the lottery."""
        self.name = name
        self.rules = rules

    def draw(self):
        """Simulate a single draw ."""
        output = []
        for rule in self.rules:
            output.extend(self._draw_rule(rule))
        return output
```

.....(CARRIES ON).....

The next part of my coding looks at inputting the lotteries and their details into the single drawing simulator,

```
lotteries = {1: Lottery('Euromillions',
                       [{'picks': 5, 'max': 50, 'repeats': True}, {'max': 11}, {'max': 11}]},
             2: Lottery('Lotto',
                       [{'picks': 6, 'max': 59}]},
             3: Lottery('Thunderball',
                       [{'picks': 5, 'max': 39}, {'max': 14}])}
```

As you can see I also included the 2 lucky dips in Euromillions and also the 1 thunderball in Thunderball. Where the second 'max': a parts on Euromillions and Thunderball are the extra 2 lucky dips and 1 thunderball respectively, which have their own sets to choose the numbers from. This part of the code allows the amount of numbers chosen to be random which lie within their sets.

The final part of my code to create this simulator involves turning all the rules and configurations placed into a simulator by sorting the lotteries into a format where the user can choose a lottery and then press enter to give them their numbers, here is the code for that:

```
def play():
    """This allows the user to simulate and play a single draw of the lottery."""
    print("Choose a lottery:")
    for key in sorted(lotteries):
        print("{0}: {1.name}".format(key, lotteries[key]))
    """Arranges the output so that a number represents each lottery which can be entered"""
```

.....(CONTINUING TO).....

```
print(lotteries[choice].draw())

if __name__ == "__main__":
    play()
```

4 Playing the simulator

In this chapter I will show my code running with an example of the simulator, here I am playing Euromillions, which is choice 1:

```
Choose a lottery:
1: Euromillions
2: Lotto
3: Thunderball
Enter a choice: 1
[3, 38, 2, 21, 22, 3, 8]
```

Above you can see the numbers for the Euromillions, where the first 5 numbers are the normal chosen numbers between 1 and 50, and the last 2 numbers are the lucky dips chosen between 1 and 11 (I'm not entirely sure how to split the number set so that the 5 numbers are on their own and the lucky dips are on their own also).

My favourite numbers for the Euromillions are: [4,18,25,29,48] and then lucky dip: [2,5] , after many many attempts I haven't even been able to get close, I managed to get 2 of my numbers in one draw but that's it. All of my code can be found via the following link in sage:

(Link 1): <https://cloud.sagemath.com/44104380-fa7f-40d1-baa1-44da08d276aa/raw/lottery>

5 Conclision

To conclude, the chance of winning the lottery truly is really really slim! There's a better chance of you dying on your way to buying a lottery ticket than actually winning the lottery jackpot! After completing and demonstrating my simulator with the code that accompanies it, we can see just how mathematically random the choosing of the winning lottery numbers are, with over 45 million ways of choosing the winning numbers. My simulator has allowed me to understand just how hard it is to get the right numbers on the right day with the 3 most popular lotteries all using some fairly straightforward code and some code help off youtube to do with choosing a random selection of numbers from a set of numbers.

6 References

I did not use any articles to aid me in this assignment however I did use some websites:

[1] (2016) 'About lotto', What is lotto?: <https://www.national-lottery.co.uk/games/lotto/about-lotto>

[online] date accessed (20/08/16)

[2] (2016) 'The Chances Of Winning The UK National Lottery', The jackpot: <http://lottery.merseyworld.com/Info/Chances>

[online] date accessed (20/08/16)

I used both these websites to obtain information about how the lottery works and how to begin my assignment.