Monty_Hall_Problem

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1 Monty Hall Problem

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Import all libraries

```
[1]: import numpy as np
     import pandas as pd
     import random
     import matplotlib.pyplot as plt
```

Function will reveal a door without a prize

```
[2]: # non winning door revealed
     def losing_door(host, num_doors, chosen_door):
         i = 1
         while(i == host or i == chosen_door ):
             i = (i+1)%(num_doors)
         return i
```

this function will simulate the player switching doors after the first one is chosen

```
[3]: # player switches to unopened door
     def switch_function(shown_door, num_doors, chosen_door):
         i = 1
         while( i == shown_door or i == chosen_door):
             i = (i+1)%(num_doors)
         return i
```

when this function is called the game is simulated and it will keep track of how many times the players wins or loses based on the decision to switch or not

```
[4]: def Monty_Hall_Game(switch, num_tests):
         # counters to keep track of results
         win_with_switch = 0
         win_without_switch = 0
         lose_with_switch = 0
         lose_without_switch = 0

         # create doors
```

```
    doors = ['A', 'B', 'C']
    num_doors = len(doors)

    for i in range(0, num_tests):
        # assign a door with a prize
        w_door = random.randint(0, num_doors-1)

        # player chooses a door at random
        player_choice = random.randint(0,num_doors-1)
        chosen_door = player_choice

        shown_door = losing_door(w_door, num_doors, chosen_door)

        if switch == True:
            chosen_door = switch_function(shown_door, num_doors, chosen_door)

        if chosen_door == w_door and switch == False:
            win_without_switch += 1

        elif chosen_door == w_door and switch == True:
            win_with_switch += 1

        elif chosen_door != w_door and switch == False:
            lose_without_switch += 1

        elif chosen_door != w_door and switch == True:
            lose_with_switch += 1

        else:
            print(f"ERROR!")

    return win_with_switch, win_without_switch, lose_with_switch,␣
↪lose_without_switch, num_tests
```

Simulation is ran twice. Once 1,000,000 times when the player only switches doors when the oportunity is given and another 1,000,000 times without switching the chosen door

[5]:
```
# Run simulation with switching 1 million times
x = Monty_Hall_Game(True, 1_000_000)
# Run simulation without switching
y = Monty_Hall_Game(False, 1_000_000)
```

Results are printed out and percentages are calculated

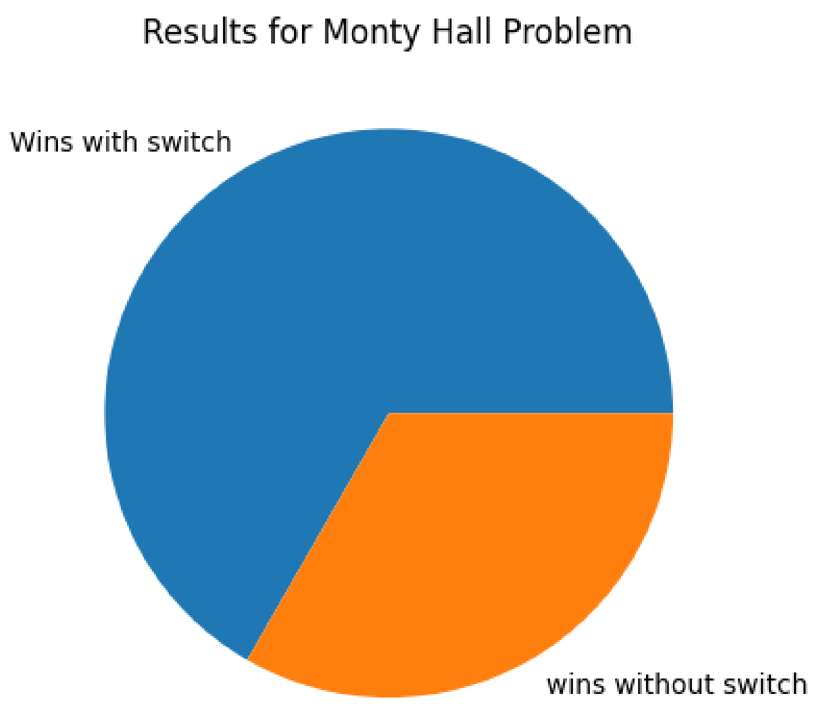
[6]:
```
# Print results and calculate percentages
print(f"Number of wins with switching: {x[0]}")
print(f"Number of loses with switching: {x[2]}")
win_with_switch_percentage = (x[0] / x[4]) * 100
```

```
lose_percentage_with_switch = (x[2] / x[4]) * 100

print(f"percentage of winning with switching: {win_with_switch_percentage:.
 ↪2f}%")
print(f"Percentage of loses with switching: {lose_percentage_with_switch:.
 ↪2f}%\n")
print(f"Number of wins without swithing: {y[1]}")
print(f"Number of loses without switching: {y[3]}")
win_percentage_without_switching = (y[1]/y[4]) * 100
lose_percentage_without_switching = (y[3] / y[4]) * 100

print(f"Percentage of winning without switching:␣
 ↪{win_percentage_without_switching:.2f}%")
print(f"Percentage of losing without switching:␣
 ↪{lose_percentage_without_switching:.2f}%\n")
```

```
Number of wins with switching: 666419
Number of loses with switching: 333581
percentage of winning with switching: 66.64%
Percentage of loses with switching: 33.36%

Number of wins without swithing: 332697
Number of loses without switching: 667303
Percentage of winning without switching: 33.27%
Percentage of losing without switching: 66.73%
```

The results are then ploted on a pie chart to show the probability of winning when switching doors compared to the probablity of keeping the same door. When a player chooses to switch the door the chance of winning is at around 66%

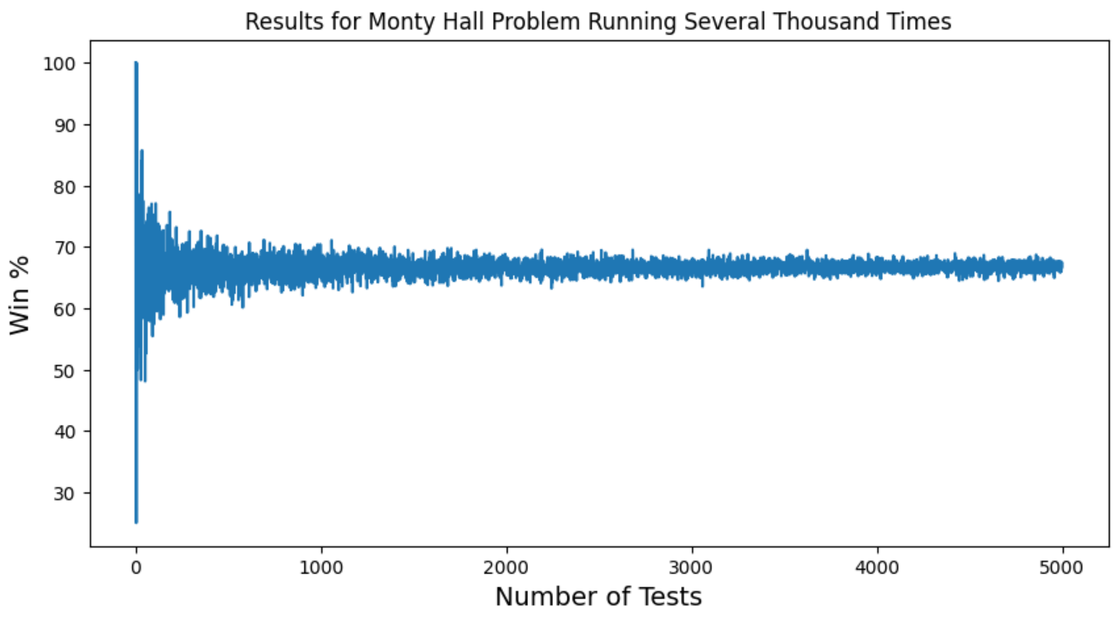
[7]:
```
# Print pie graph of wins
wins = [x[0], y[1]]
result_labels = ['Wins with switch', 'wins without switch']

plt.title('Results for Monty Hall Problem')
plt.pie(wins, labels = result_labels)
plt.show()
```



The program is ran again 5,000 times when a player choses to switch doors. The results are plotted in a line graph and shows the percentage of winning steadies at around 66% the more games are played.

```
[9]: num_tests = []
     w_percent = []
     switch = True
     for i in range(1, 5000):
         num_tests.append(i)
         z = Monty_Hall_Game(switch, i)
         res = (z[0] / z[4]) * 100
         w_percent.append(res)
```

```
[10]: # Set width and height
      plt.figure(figsize = (10, 5))
      plt.plot(num_tests, w_percent)
      plt.title('Results for Monty Hall Problem Running Several Thousand Times')
      plt.xlabel('Number of Tests',fontsize=14)
      plt.ylabel('Win %',fontsize=14)
      plt.show()
```


Results for Monty Hall Problem Running Several Thousand Times
Win %
100
90
80
70
60
50
40
30
0
1000
2000
3000
4000
5000
Number of Tests

```
[ ]:
```