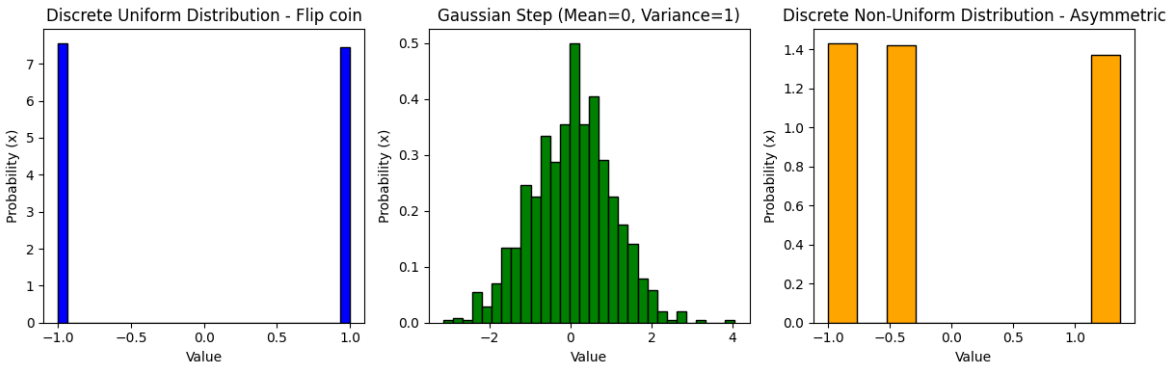
In [ ]:

5.1. Universality of random walks

5.1.a

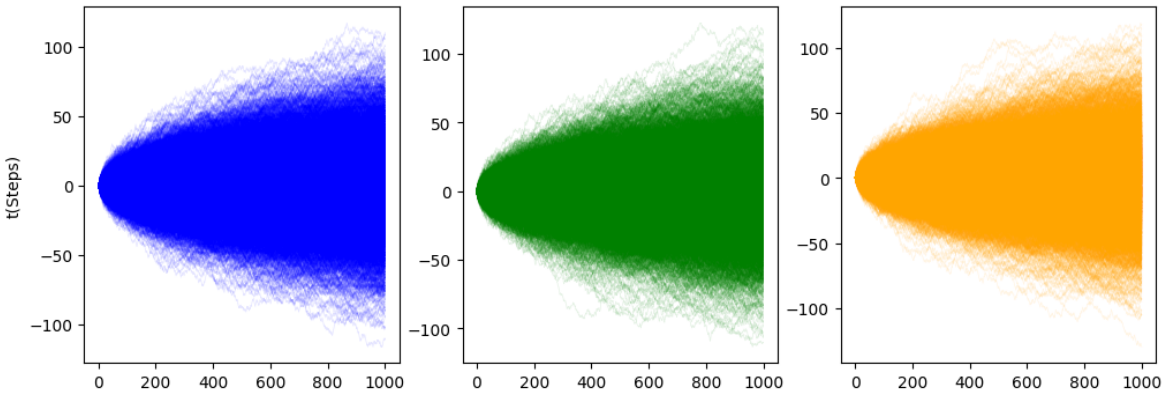
In [ ]:
```
import numpy as np
import random
from matplotlib import pyplot as plt

sample_size = 1000

discrete_uniform_distribution = np.random.choice([-1, 1], size=s
gaus_distribution = np.random.normal(0, 1, size=sample_size)
discrete_non_uniform = np.random.choice([-1,
                                         (1 - np.sqrt(3)) / 2,
                                           (1 + np.sqrt(3)) / 2

plt.figure(figsize=(12, 4))

plt.subplot(1, 3, 1)
hist, bins, _ = plt.hist(discrete_uniform_distribution,
                         bins=30, color='blue', edgecolor='blacl
plt.title('Discrete Uniform Distribution - Flip coin')
plt.xlabel('Value')
plt.ylabel('Probability (x)')

plt.subplot(1, 3, 2)
plt.hist(gaus_distribution, bins=30, color='green', edgecolor='l
plt.title('Gaussian Step (Mean=0, Variance=1)')
plt.xlabel('Value')
plt.ylabel('Probability (x)')

plt.subplot(1, 3, 3)
plt.hist(discrete_non_uniform, color='orange', edgecolor='black
plt.title('Discrete Non-Uniform Distribution - Asymmetric')
plt.xlabel('Value')
plt.ylabel('Probability (x)')

plt.tight_layout()

plt.show()
```

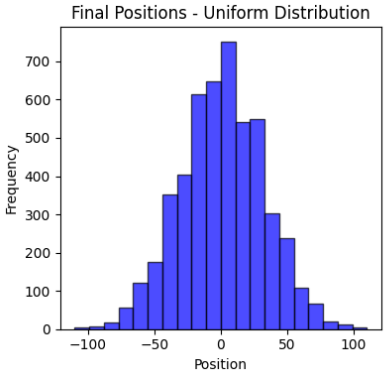


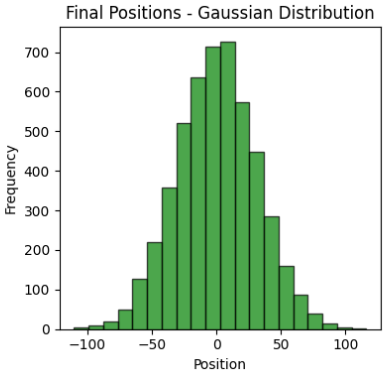
5.1.B

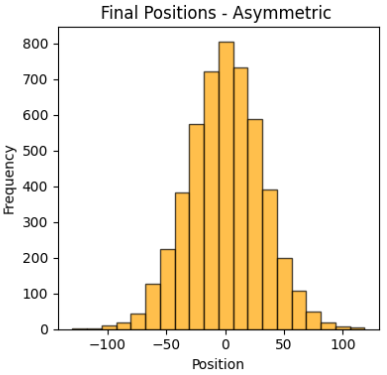
In [ ]:
```
steps = 5000
path_UD=np.zeros((steps,sample_size))
path_GD = np.zeros((steps,sample_size))
path_AS = np.zeros((steps,sample_size))



final_positions_UD = np.zeros(steps)
final_positions_GD = np.zeros(steps)
final_positions_AS = np.zeros(steps)
plt.figure(figsize=(12, 4))
for j in range(steps):
    path_UD[j] =np.random.choice([-1,1], size=sample_size)
    path_GD[j] = np.random.normal(0,1,size=sample_size)
    path_AS[j] = np.random.choice([-1,(1-np.sqrt(3))/2,
                                   (1+np.sqrt(3))/2], size=samp
    position_UD = 0
    position_list_UD =[]
    position_list_UD.append(position_UD)



    position_GD = 0
    position_list_GD =[]
    position_list_GD.append(position_GD)

    position_AS = 0
    position_list_AS =[]
    position_list_AS.append(position_GD)

    for i in range(sample_size):
        position_UD = position_UD + path_UD[j][i]
        position_list_UD.append(position_UD)

        position_GD= position_GD + path_GD[j][i]
        position_list_GD.append(position_GD)

        position_AS= position_AS + path_AS[j][i]
        position_list_AS.append(position_AS)
```

```
    final_positions_UD[j] = np.sum(path_UD[j])
    final_positions_GD[j] = np.sum(path_GD[j])
    final_positions_AS[j] = np.sum(path_AS[j])

    plt.subplot(1, 3, 1)
    plt.plot(position_list_UD, color ='blue', linewidth=0.5, alp
    plt.ylabel('t(Steps)')
    plt.subplot(1, 3, 2)
    plt.plot(position_list_GD, color ='green', linewidth=0.5, a
    plt.subplot(1, 3, 3)
    plt.plot(position_list_AS, color ='orange', linewidth=0.5, a

plt.figure(figsize=(12, 4))

plt.subplot(1, 3, 1)
plt.hist(final_positions_UD, bins=20, color='blue',
         alpha=0.7, edgecolor='black')
plt.title('Final Positions - Uniform Distribution')
plt.xlabel('Position')
plt.ylabel('Frequency')

plt.subplot(1, 3, 2)
plt.hist(final_positions_GD, bins=20, color='green',
         alpha=0.7, edgecolor='black')
plt.title('Final Positions - Gaussian Distribution')
plt.xlabel('Position')
plt.ylabel('Frequency')

plt.subplot(1, 3, 3)
plt.hist(final_positions_AS, bins=20, color='orange',
         alpha=0.7, edgecolor='black')
plt.title('Final Positions - Asymmetric ')
plt.xlabel('Position')
plt.ylabel('Frequency')

plt.tight_layout()
plt.show()
```




Final Positions - Uniform Distribution
Frequency
Position
0
100
200
300
400
500
600
700
−100
−50
0
50
100


Final Positions - Gaussian Distribution
Frequency
Position
0
100
200
300
400
500
600
700
−100
−50
0
50
100


Final Positions - Asymmetric
Frequency
Position
0
100
200
300
400
500
600
700
800
−100
−50
0
50
100