R10A21126_HW05_Q4

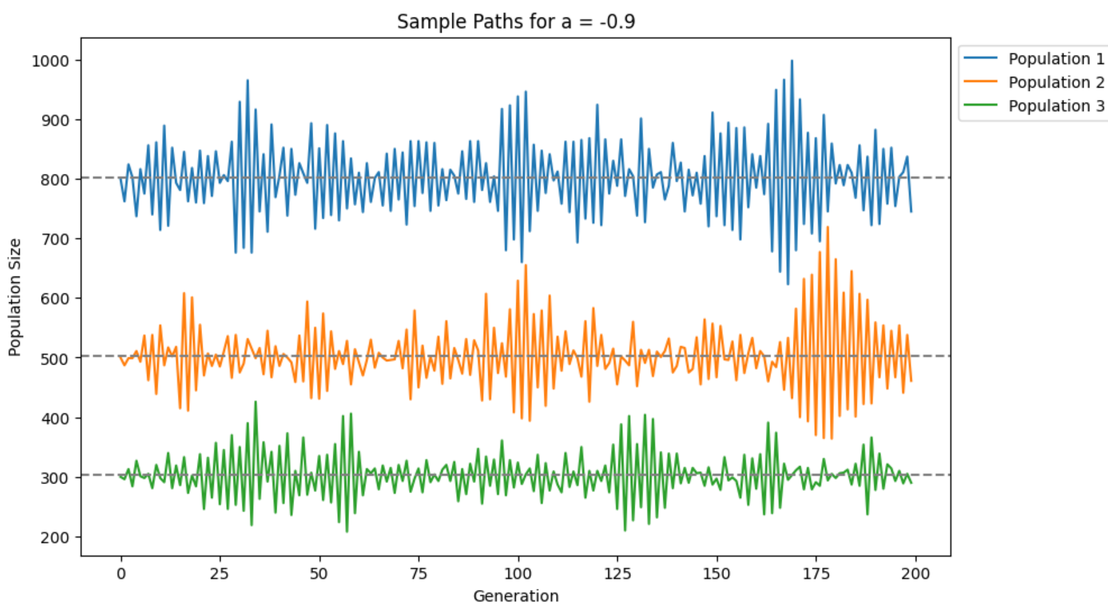
November 15, 2023

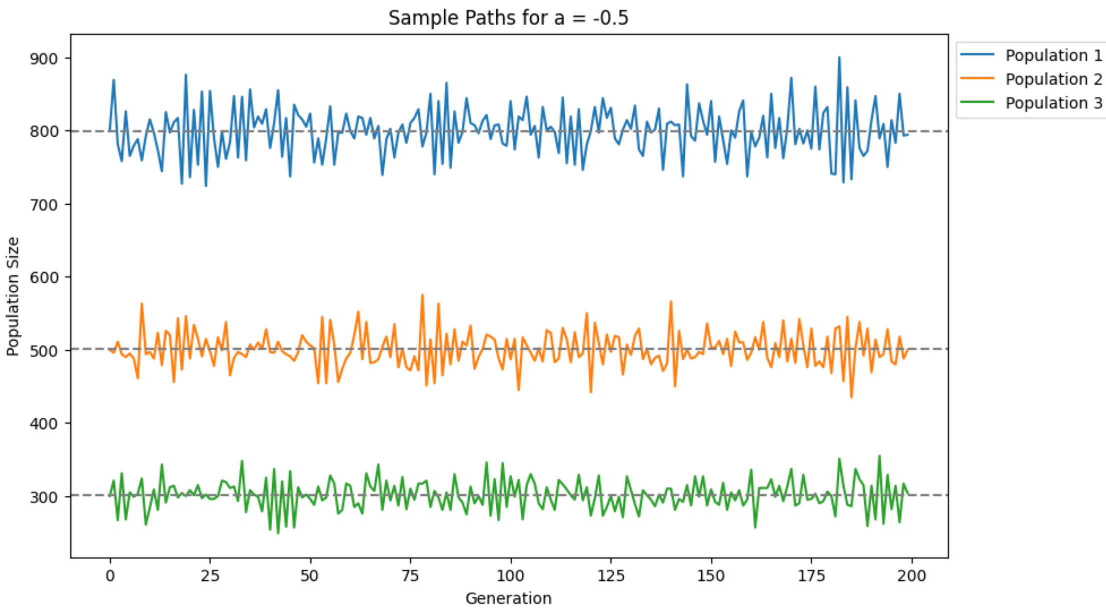
[ ]:
```python
import numpy as np
import matplotlib.pyplot as plt
```

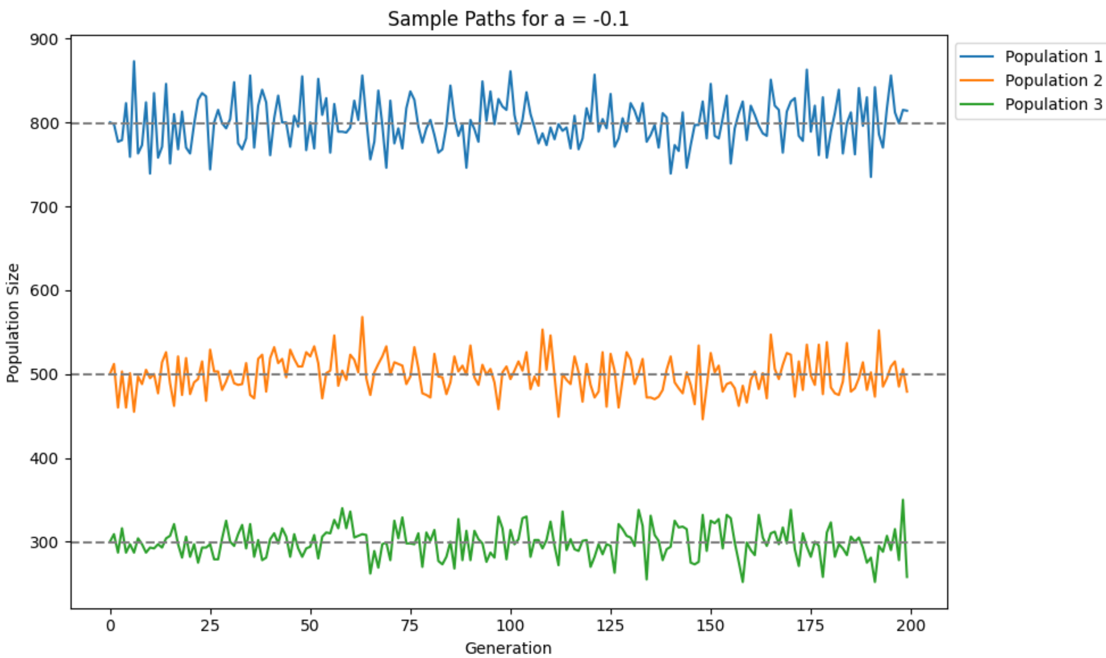
[ ]:
```python
# Function to calculate lamda for Poisson distribution
def calculate_lamda(yij_prev, mu, alpha):
    return (mu /yij_prev ) ** (1-alpha)

# Function to generate sample paths
def generate_sample_paths(num_generations, initial_values, mu, alpha, d):
    num_populations = len(initial_values)
    sample_paths = np.zeros((num_populations, num_generations))
    sample_paths[:, 0] = initial_values

    for j in range(1, num_generations):
        for i in range(num_populations):

            yij_prev = sample_paths[i, j-1]
            # print(yij_prev)

            Zk = np.random.poisson(calculate_lamda(max(yij_prev, d), mu[i],␣
↪alpha), size = round(yij_prev))

            yij =  np.sum(Zk)
            sample_paths[i, j] = yij

    return sample_paths


def simulate_and_plot(num_generations, initial_values, mu, alpha, d):

    # Generate sample paths
    sample_paths = generate_sample_paths(num_generations,initial_values, mu,␣
↪alpha, d)

    # Plotting
    plt.figure(figsize=(10, 6))
    for i in range(len(initial_values)):
```

```
        plt.plot(sample_paths[i, :], label=f'Population {i + 1}')
        plt.axhline(y=np.average(sample_paths[i, :]), color='grey',␣
↪linestyle='--')

    plt.title(f'Sample Paths for a = {alpha}')
    plt.xlabel('Generation')
    plt.ylabel('Population Size')
    plt.legend(bbox_to_anchor=(1, 1))
```

[ ]:
```
# Parameters
num_generations = 200  # Number of generations

# Set initial values of population
initial_values = np.array([800, 500, 300])
mu = initial_values

d = 0.1

# Parameter alpha
alpha_values = [-0.9,-0.5,-0.1]



for alpha in alpha_values:
    simulate_and_plot(num_generations, initial_values, mu, alpha, d)

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




Sample Paths for a = -0.5
Population 1
Population 2
Population 3
Population Size
Generation
900
800
700
600
500
400
300
0
25
50
75
100
125
150
175
200


Sample Paths for a = -0.1
Population 1
Population 2
Population 3
Population Size
Generation
900
800
700
600
500
400
300
0
25
50
75
100
125
150
175
200