Assignment-2

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3 ASSIGNMENT-2: GENETIC MUTATION

1) Import Libraries

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

2) Define the Fitness Function

```
[ ]: def fitness_function(individual):
         # Convert the individual's chromosome to a NumPy array
         individual_array = np.array(individual)
         # Generate a random weight matrix of the same length as the chromosome
         weight_matrix = np.random.rand(len(individual))
         # Calculate the dot product of the individual's chromosome and the weight␣
      ↪matrix
         fitness_value = np.dot(individual_array, weight_matrix)
         return fitness_value
```

3) Define Mutation Operation

```
[ ]: def mutate(individual, mutation_rate):
         # Mutate individual based on mutation_rate
         for i in range(len(individual)):
             if random.random() < mutation_rate:
                 individual[i] = 1 - individual[i]  # Flip the bit
         return individual
```

4) Define the Crossover Operation

```
[ ]: def cross_over(parent1, parent2):
         # Perform single-point crossover
         crossover_point = random.randint(1, len(parent1) - 1)
         child1 = parent1[:crossover_point] + parent2[crossover_point:]
```

```
    child2 = parent2[:crossover_point] + parent1[crossover_point:]
    return child1, child2
```

5) Select parents for reproduction using Roulette wheel selection

```
[ ]: def roulette_wheel(population, fitness_scores):
         total_fitness = sum(fitness_scores)
         roulette_value = random.uniform(0, total_fitness)
         cumulative_fitness = 0
         for i, fitness in enumerate(fitness_scores):
             cumulative_fitness += fitness
             if cumulative_fitness >= roulette_value:
                 return population[i]
```

6) Generate next generation

```
[ ]: def next_gen(population, mutation_rate):
         next_generation = []
         fitness_scores = [fitness_function(individual) for individual in population]
         for _ in range(len(population)):
             parent1 = roulette_wheel(population, fitness_scores)
             parent2 = roulette_wheel(population, fitness_scores)
             child1, child2 = cross_over(parent1, parent2)
             child1 = mutate(child1, mutation_rate)
             child2 = mutate(child2, mutation_rate)
             next_generation.extend([child1, child2])
         return next_generation
```

7) Main genetic Algorithm Function

```
[ ]: def genetic_algorithm(population_size, chromosome_length, mutation_rate,␣
      ↪generations):
         # Initialize population
         population = [[random.randint(0, 1) for _ in range(chromosome_length)] for␣
      ↪_ in range(population_size)]
         best_fitness_history = []

         # Evolution loop
         for _ in range(generations):
             # Generate next generation
             population = next_gen(population, mutation_rate)
             # Record best fitness
             best_fitness = max([fitness_function(individual) for individual in␣
      ↪population])
             best_fitness_history.append(best_fitness)

         return population, best_fitness_history
```

8) Function to visualize the evolution

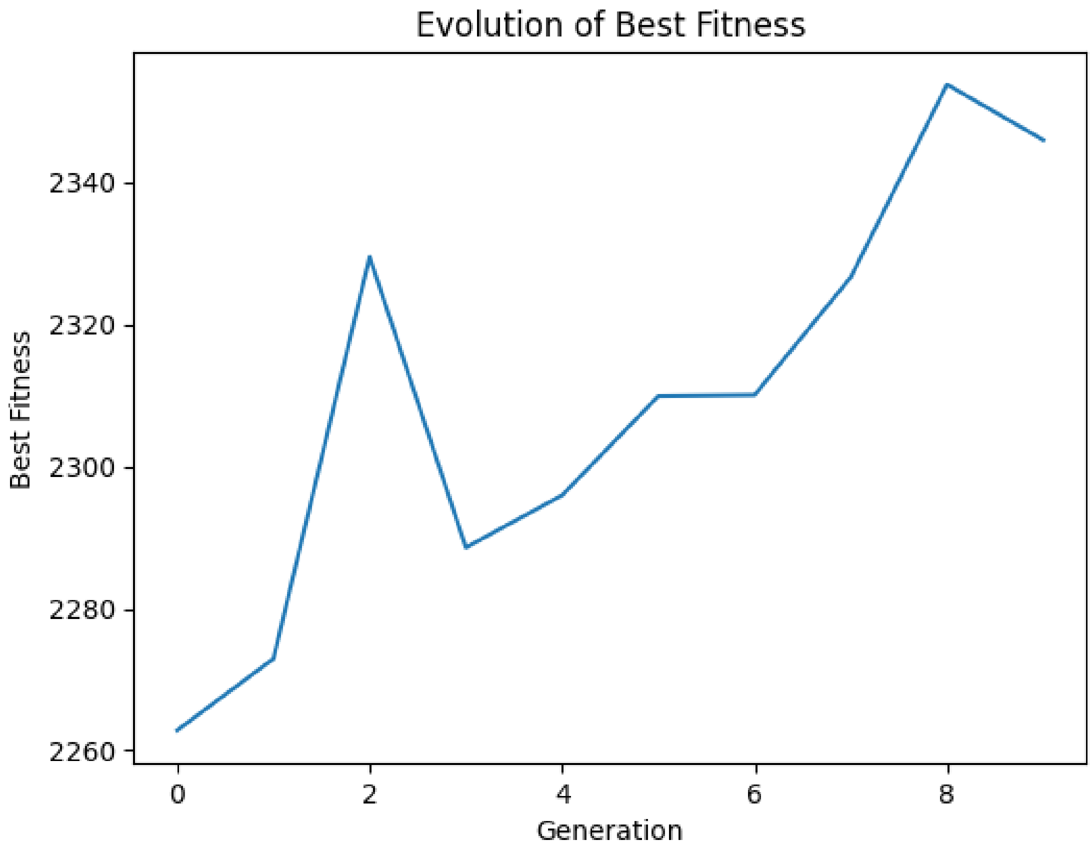
[ ]:
```python
def plot_evolution(best_fitness_history):
    plt.plot(best_fitness_history)
    plt.xlabel('Generation')
    plt.ylabel('Best Fitness')
    plt.title('Evolution of Best Fitness')
    plt.show()
```

9) User Inputs

[ ]:
```python
# User inputs
population_size = int(input("Input a population size: "))
chromosome_length = int(input("Input a chromosome length: "))
mutation_rate = float(input("Input a mutation rate: "))
generations = 10

if population_size > 10:
    print("Please enter a maximum of 10 for the Population Size for optimum␣
 ↪performance.")
else:
    # Execute Genetic Algorithm
    final_population, best_fitness_history = genetic_algorithm(population_size,␣
 ↪chromosome_length,
                                                                mutation_rate,␣
 ↪generations)

    # Plot evolution
    plot_evolution(best_fitness_history)
```



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