Genetic Algorithm
Assignment

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Semester: Fourth/2077 Batch

Q. Find the maximum solution of f(x,y,z) =x2-xy+z with the given criteria -5<x<5 , 0<y<2, -2<z<2 set following parameter in advance ,

- population size 100
- probability of crossover 0.9
- probability of mutation 0.15
- fitness function is f(x,y,z)

Solution:
https://colab.research.google.com/drive/1pnvnQDu-2HfKHz5fZQ1X6sCefgZjNL1O

Code:

```
import numpy as np


def fitness(x, y, z):
  """Calculates the fitness of an individual (x, y, z)."""
  return x**2 - x*y + z


def initialize_population(n, x_min=-5, x_max=5, y_min=0, y_max=2, z_min=-2, z_max=2):
  """Initializes a population of size n."""
  population = []
  for _ in range(n):
    x = np.random.uniform(x_min, x_max)
    y = np.random.uniform(y_min, y_max)
    z = np.random.uniform(z_min, z_max)
    population.append((x, y, z))
  return population


def roulette_wheel(population, fitness_values, tournament_size=4):
  """Selects the best individuals from the population using tournament selection."""
  selected_indices = []
  for _ in range(len(population)):
    tournament = np.random.choice(len(population), tournament_size, replace=False)
    tournament_fitness = [fitness_values[i] for i in tournament]
    selected_indices.append(tournament[tournament_fitness.index(max(tournament_fitness))])
```

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```
  return selected_indices


def crossover(parent1, parent2):
  """Performs single-point crossover between two parent individuals."""
  crossover_point = np.random.randint(1, len(parent1))
  child1 = parent1[:crossover_point] + parent2[crossover_point:]
  child2 = parent2[:crossover_point] + parent1[crossover_point:]
  return child1, child2


def mutate(individual, mutation_prob=0.15, x_min=-5, x_max=5, y_min=0, y_max=2,
z_min=-2, z_max=2):
  """Mutates an individual with a given probability."""
  mutated_individual = list(individual)
  for i in range(3):
    if np.random.rand() < mutation_prob:
      if i == 0:
        mutated_individual[i] = np.random.uniform(x_min, x_max)
      elif i == 1:
        mutated_individual[i] = np.random.uniform(y_min, y_max)
      elif i == 2:
        mutated_individual[i] = np.random.uniform(z_min, z_max)
  return tuple(mutated_individual)


def genetic_algorithm(population_size=100, num_generations=100, crossover_prob=0.9,
mutation_prob=0.10):
  """Runs the genetic algorithm."""

  # Initialize the population.
  population = initialize_population(population_size)

  # Iterate over the generations.
  for generation in range(num_generations):

    # Calculate the fitness of each individual.
    fitness_values = [fitness(*individual) for individual in population]

    # Select the best individuals to produce the next generation.
    selected_indices = roulette_wheel(population, fitness_values)

    # Produce the next generation through crossover and mutation.
    new_population = []
    for i in range(0, population_size, 2):
      if np.random.rand() < crossover_prob:
```

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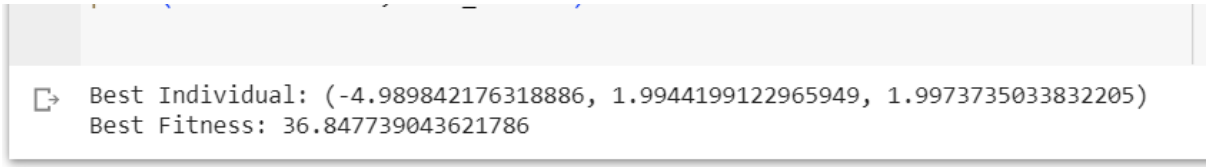
```
        child1, child2 = crossover(population[selected_indices[i]], population[selected_indices[i
+ 1]])
        new_population.extend([child1, child2])
      else:
        new_population.extend([population[selected_indices[i]], population[selected_indices[i +
1]]])

    new_population = [mutate(ind) for ind in new_population]

    # Replace the old population with the new population.
    population = new_population


  fitness_values = [fitness(*individual) for individual in population]
  # Find the maximum fitness and corresponding individual
  max_fitness = max(fitness_values)
  max_individual = population[fitness_values.index(max_fitness)]


  return max_individual, max_fitness
# Run the genetic algorithm
best_individual, best_fitness = genetic_algorithm()
print("Best Individual:", best_individual)
print("Best Fitness:", best_fitness)
```

Output:



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