Zadatak 1

```
import sys
!{sys.executable} -m pip install pyeasyga
```

```
Requirement already satisfied: pyeasyga in
/usr/local/lib/python3.10/dist-packages (0.3.1)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-
packages (from pyeasyga) (1.16.0)
```

a)

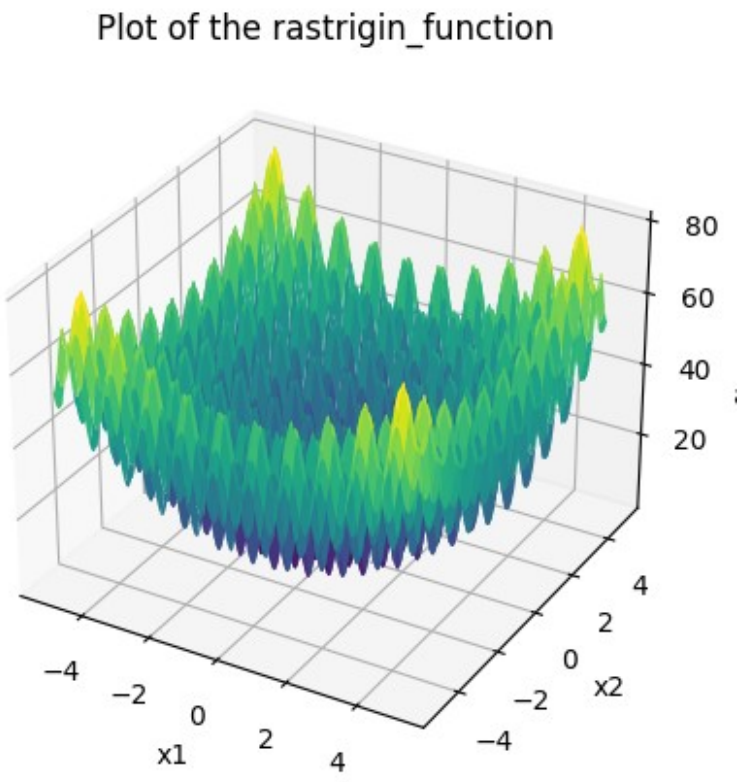
```
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
import numpy as np
import math

def rastrigin_function(x):
    x1 = x[0]
    x2 = x[1]
    return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))

x1_range = np.linspace(-5.12, 5.12, 400)
x2_range = np.linspace(-5, 5, 400)
X1, X2 = np.meshgrid(x1_range, x2_range)
Z = np.zeros_like(X1)

for i in range(X1.shape[0]):
    for j in range(X1.shape[1]):
        Z[i, j] = rastrigin_function([X1[i, j], X2[i, j]])

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.plot_surface(X1, X2, Z, cmap='viridis')
ax.set_xlabel('x1')
ax.set_ylabel('x2')
ax.set_zlabel('f(x1, x2)')
plt.title('Plot of the rastrigin_function')
plt.show()
```



Možemo primijetiti da je oblik funkcije karakterističan po mnogim lokalnim minimumima i dubokim udubljenjima. Ovaj oblik sugeriše da je funkcija multimodalna, što znači da ima više od jednog globalnog minimuma.

b) Dužina hromosoma = 26

```
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def rastrigin_function(x):
  x1 = x[0]
  x2 = x[1]
  return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))

RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = rastrigin_function,
population_size = 30,
generations = 200,
crossover_probability = 0.8,
mutation_probability = 0.02,
elitism = True,
maximise_fitness = False)
```

```
BINARY_CHROMOSOME_LENGTH = 26

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual

def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2

ga.crossover_function = crossover

def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0

ga.mutate_function = mutate

ga.tournament_size = 2

def decimal(binary):
  sum = 0
  for i in range(0, len(binary)):
        sum += binary[len(binary)-1-i]*2**(i)
  return sum

def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
```

```
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data([x_decode, y_decode])
  return fitness

ga.fitness_function = fitness

ga.run()

print("Best individual fitness and best individual binary
chromosome:")
print(ga.best_individual())

print("Best individual decoded:")
print(decode(ga.best_individual()[1]))

print("Best individual function value:")
print(rastrigin_function(decode(ga.best_individual()[1])))

print("\n--------------------------\n")

print("Last generation:")
for individual in ga.last_generation():
  print(individual)
```

```
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(0.0006250763032600304, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

--------------------------

Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
```

```
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
```

```
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
```

b) Dužina hromosoma = 6

```
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def rastrigin_function(x):
  x1 = x[0]
  x2 = x[1]
  return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))

RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = rastrigin_function,
population_size = 30,
generations = 200,
crossover_probability = 0.8,
mutation_probability = 0.02,
elitism = True,
maximise_fitness = False)

BINARY_CHROMOSOME_LENGTH = 6

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual

def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2

ga.crossover_function = crossover
```

```
def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0

ga.mutate_function = mutate

ga.tournament_size = 2

def decimal(binary):
  sum = 0
  for i in range(0, len(binary)):
    sum += binary[len(binary)-1-i]*2**(i)
  return sum

def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data([x_decode, y_decode])
  return fitness

ga.fitness_function = fitness

ga.run()

print("Best individual fitness and best individual binary
chromosome:")
```

```
print(ga.best_individual())
print("Best individual decoded:")
print(decode(ga.best_individual()[1]))

print("Best individual function value:")
print(rastrigin_function(decode(ga.best_individual()[1])))

print("\n---------------------------\n")

print("Last generation:")
for individual in ga.last_generation():
  print(individual)
```

```
Best individual fitness and best individual binary chromosome:
(19.742256935483606, [0, 1, 0, 1, 0, 1])
Best individual decoded:
(-2.1942857142857144, 2.1428571428571432)
Best individual function value:
19.742256935483606

---------------------------

Last generation:
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
```

```
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
(19.742256935483606, [0, 1, 0, 1, 0, 1])
```

Korištenjem dužine hromosoma od 26 bita, najbolja individualna fitness vrijednost je 1.99, dok je sa 6 bita najbolja fitness vrijednost 19.74. S obzirom na to da manja fitness vrijednost kod minimizacijskih problema znači bolje rješenje, može zaključiti da je algoritam s dužim hromosomom pronašao bolje rješenje.

c)

```
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def rastrigin_function(x):
  x1 = x[0]
  x2 = x[1]
  return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))

RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = rastrigin_function,
population_size = 30,
generations = 200,
crossover_probability = 0.8,
mutation_probability = 0.02,
elitism = True,
maximise_fitness = False)

BINARY_CHROMOSOME_LENGTH = 26

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual

def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2
```

```
ga.crossover_function = crossover

def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0
    ga.mutate_function = mutate

ga.tournament_size = 2

def decimal(binary):
  sum = 0
  for i in range(0, len(binary)):
    sum += binary[len(binary)-1-i]*2**(i)
  return sum

def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data([x_decode, y_decode])
  return fitness

ga.fitness_function = fitness
for mutation_probability in np.arange(0.01, 1.00, 0.03):
  ga.mutation_probability = mutation_probability
  ga.run()
  print(f"\nMUTATION PROBABILITY: {mutation_probability}")
```

```
  print("Best individual fitness and best individual binary
chromosome:")
  print(ga.best_individual())
  print("Best individual decoded:")
  print(decode(ga.best_individual()[1]))

  print("Best individual function value:")
  print(rastrigin_function(decode(ga.best_individual()[1])))

  print("\n---------------------------\n")

  print("Last generation:")
  for individual in ga.last_generation():
    print(individual)
```

```
MUTATION PROBABILITY: 0.01
Best individual fitness and best individual binary chromosome:
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
Best individual decoded:
(0.0006250763032600304, 0.9956049322427054)
Best individual function value:
0.9951194026084913

---------------------------

Last generation:
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
```

```
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])
(0.9951194026084913, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.04
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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```

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
```

```
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.06999999999999999
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.0006250763032591422, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

----------------------------

Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
```

```
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.0020117586331984683, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.02246772162487786 8, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.08437116281322332, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(4.501916661827359, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(25.000077515733857, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(26.254491057627973, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.09999999999999999
Best individual fitness and best individual binary chromosome:
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.9594921255036013, 0.0006104260774018044)
Best individual function value:
1.2428526212463957

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Last generation:
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

```
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.24876601850717 6, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
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```
0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(1.260530642599413, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.3171536165228162, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(12.855129428535236, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(26.24277869647752, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.13
Best individual fitness and best individual binary chromosome:
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.0006250763032591422, 2.032108411671347)
Best individual function value:
4.332354227516532

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Last generation:
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
```

```
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.332354227516532, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.16
Best individual fitness and best individual binary chromosome:
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.9594921255036013, -0.9370040288121109)
Best individual function value:
2.893930244885933

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Last generation:
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
```

```
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.893930244885933, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(2.91160826623895, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0])
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(2.9495954188519775, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.9682312401623534, [0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(15.133222400634962, [0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.19
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
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1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007428321618334621, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.0007715592356589696, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.003871962561042608, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00635205682359441, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00635205682359441, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00635205682359441, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.02143427034808454, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 1, 1])
(0.08047481511387744, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(1.262795133638484, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(11.931427446653718, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(25.000077515733857, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(34.182609389823085, [0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
0, 1, 1, 1, 1, 1, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.22
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(0.0006250763032600304, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
```

```
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007715592356589696, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0019255808570 7617, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(0.3258124829076223, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(11.612428247791541, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
```

```
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(25.000077515733857, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.25
Best individual fitness and best individual binary chromosome:
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
Best individual decoded:
(-2.000869246734221, 0.9943840800879009)
Best individual function value:
4.998651403953307

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Last generation:
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
```

```
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(4.998651403953307, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(5.0197703075484945, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 0, 1, 1, 0])
(5.025338815722844, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(5.061940729173504, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(5.063678896683371, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 0, 0])
(5.069867057925464, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 1, 1, 1, 0])
(10.353430599914972, [0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(13.344241984486795, [0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(17.50317701743475, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 0, 0, 0, 1, 1, 1, 1, 1, 0])

MUTATION PROBABILITY: 0.28
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.0006250763032591422, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

---------------------------

Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
```

```
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00192558085707617, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.0020117586331984683, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.022467721624877868, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.08047481511387744, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0])
(0.3258124829076223, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.205495051495138, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(4.701853521832302, [0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(11.61242824779157, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(15.60375662759982, [0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(16.75070792948422, [0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(26.25449105762797З, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

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MUTATION PROBABILITY: 0.31
Best individual fitness and best individual binary chromosome:
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
Best individual decoded:
(0.0006250763032600304, 0.9943840800879009)
Best individual function value:
0.9951020300660645

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Last generation:
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
```

```
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9951020300660645, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9957221487989969, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9969623481965328, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(0.9969623481965328, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(1.0009408987091817, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 0, 1, 0])
(1.0162209336612449, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 0, 1, 1, 0])
(1.0291897205860217, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(2.2577457232018467, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(14.695439878666907, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(15.536304373344635, [1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(29.9197382401181, [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1,
1, 0, 0, 1, 0, 1, 1, 1, 0])

MUTATION PROBABILITY: 0.33999999999999997
Best individual fitness and best individual binary chromosome:
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(1.0007471615187402, 0.0006104260774018044)
Best individual function value:
1.001679000053592

---------------------------

Last generation:
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

```
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.0229618298989465, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(1.0444818098990112, [1, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.0444818098990112, [1, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.0444818098990112, [1, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(6.029921016290714, [1, 0, 0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(6.179835025972174, [1, 0, 0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0])
(12.61713678833177, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(17.132135810191322, [1, 0, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(31.954268254010824, [1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.37
Best individual fitness and best individual binary chromosome:
```

```
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(0.9594921255036013, 0.0006104260774018044)
Best individual function value:
1.2428526212463957

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Last generation:
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2428526212463957, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.243444012905499, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(1.2446267616007454, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(1.2605306425994023, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.2641354510917502, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(1.3171536165228162, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.323175995857543, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
```

```
0, 0, 0, 0, 0, 1, 0, 0, 0, 0])
(1.3332014253991034, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1])
(1.3332014253991034, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1])
(1.3438129571771995, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 1, 0])
(2.1193131077629737, [1, 0, 0, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(5.744617842571024, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(12.855129428535236, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(12.855129428535236, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(13.946872202376385, [1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(18.67475408158526, [1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(40.5808872062922, [1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.4
Best individual fitness and best individual binary chromosome:
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(1.0007471615187402, 0.0006104260774018044)
Best individual function value:
1.001679000053592

---------------------------

Last generation:
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

```
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.001679000053592, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.002270391712699, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(1.0034531404079416, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(1.0034531404079416, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(1.0075923973143759, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(1.0086610369389994, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.0444818098990112, [1, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.082002374664743, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0])
(1.1268697479737746, [1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.312331424403265, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(1.312331424403265, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(2.2070226110460034, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(2.4280535050278687, [1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(6.1694293881645095, [1, 0, 0, 1, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(12.613955807342435, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(12.613955807342435, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(12.613955807342435, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(16.536729008806276, [1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(16.536729008806276, [1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(31.954268254010824, [1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.43
Best individual fitness and best individual binary chromosome:
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
```

```
Best individual decoded:
(0.9944963984861435, -0.0006104260774018044)
Best individual function value:
0.9950753488372435

----------------------------

Last generation:
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9950753488372435, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9956143624454157, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9956143624454157, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.9967729441032347, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(1.016358178682598, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 1, 1])
```

```
(1.0753987234483944, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(1.0753987234483944, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(1.3043115297517645, [1, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(2.200957973437827, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 1])
(2.230528429973372, [1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(5.619475326524643, [1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(14.957515227917492, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1])
(14.957515227917492, [1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1])
(32.04960791253709, [1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.45999999999999996
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

---------------------------

Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
```

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1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007428321618334621, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.0007715592356589696, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007715592356589696, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0020117586331984683, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.022467721624877868, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.022467721624877868, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.022467721624877868, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.024241861979227508, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(0.06856162363747487, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 0, 1, 1])
(1.205495051495138, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 1])
(1.205495051495138, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 1])
(11.612428247791541, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(13.962591319582977, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1])
(14.39841301660741, [0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(16.75070792948422, [0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(25.83616619613231, [0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(26.254491057627973, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.49
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(0.0006250763032600304, -0.0006104260774018044)
Best individual function value:
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0.00015144050272652976

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Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007715592356589696, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00812619717794405, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(0.08047481511387744, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(0.08109493384680988, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(0.08419533717218997, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(0.13009814161157962, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.18561863372744014, [1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.3145243869107084, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.3170044811732673, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.3258124829076223, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(1.3801782372572866, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(3.4564225580779, [1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1])
(4.514936490633392, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1,
1, 1, 0, 1, 1, 1, 1, 1, 1, 1])
(5.0403779689013, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1])
(5.109032134134919, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(13.214365281692736, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1,
0, 1, 1, 0, 1, 1, 1, 1, 0, 1])
(13.968791935903845, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1])
(14.03966843193443, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1])
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(14.39841301660741, [1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(14.683212061682614, [1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(17.432052900841594, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(25.000077515733857, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(25.000697634466782, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(25.009377964402184, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(25.712602758319516, [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(25.836166196132332, [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])

MUTATION PROBABILITY: 0.52
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(0.0006250763032600304, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007715592356589696, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007715592356589696, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00192558085707617, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(0.0020117586331984683, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00254569959000861, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(0.006064837763510411, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(0.08047481511387744, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
```

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1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(0.31080386485239586, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.3727985224975079, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(0.4103481552821897, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(1.2687085308992962, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(1.5734475579881817, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(1.9436326093566976, [1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(4.701853521832302, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(4.827577704232251, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 0, 1, 1, 1, 1, 1, 1, 1])
(5.249989897659065, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 0, 1, 1, 1])
(5.96385071136916, [1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1])
(6.707123574703045, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 0, 1, 0, 1, 1, 1, 1, 1])
(11.059990170086976, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 1, 0, 1, 0, 1, 1, 1, 1, 1])
(12.138983858670342, [1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 0, 1, 1, 1, 1, 1, 0, 1])
(13.562488950045644, [1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(13.568402347306424, [1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(14.200687492789928, [1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(19.295927352637648, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
1, 0, 1, 1, 1, 1, 0, 1, 1, 1])
(26.864099132444544, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
1, 1, 0, 0, 1, 1, 1, 1, 1, 1])
(30.13013126154718, [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.55
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(0.0006250763032600304, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976
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Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.0026031502923054006, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.00635205682359441, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.08450085723412926, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 1, 1, 0])
(0.13009814161157962, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.3170044811732673, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(0.4103481552821897, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.205495051495138, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(1.2073553696256099, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(1.2116956678160058, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(1.2633865252976157, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(1.8564665213810478, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 0, 0, 0, 0])
(4.508117278148225, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.701853521832302, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(4.701853521832302, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(5.764560354963141, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(13.722826157509195, [1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(15.545687733921085, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(16.750707929484264, [1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

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(16.750707929484264, [1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(17.909450921648972, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 1, 0, 1, 0, 0, 0, 0, 0, 0])
(18.641544655894936, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(25.00627813205472, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(26.254491057627973, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(30.336157277102615, [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(34.22104742885054, [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 1, 1, 0, 0])

MUTATION PROBABILITY: 0.58
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007428321618334621, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.0007428321618334621, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.0007428321618334621, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.0007428321618334621, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.0007715592356589696, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
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1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007715592356589696, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0020117586331984683, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0020117586331984683, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.006684956496442851, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(0.006684956496442851, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(0.009641222375361025, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0])
(0.011226029525410297, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(0.08233513324434938, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(0.31080386485239586, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.3258124829076223, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.32640387456672926, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(1.8843593039854873, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 0, 1, 0, 1, 1, 1, 1])
(1.8843593039854873, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 0, 1, 0, 1, 1, 1, 1])
(4.566411831233562, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 0, 1, 1, 1, 1, 1, 1, 0])
(4.774825084571301, [0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(4.782176896443453, [0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(13.563080341704714, [0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(16.75129932114333, [0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0])

MUTATION PROBABILITY: 0.61
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(0.0006250763032600304, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
```

```
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.003871962561042608, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.024241861979223955, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.02737276019773205, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(0.02737276019773205, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(0.043750551470232324, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(0.06519465216959475, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.09488214481967461, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.12148334578174769, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(0.48279210230631264, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(0.8131161500334585, [1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(1.205495051495138, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(1.205495051495138, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(5.85782950915627, [1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 1, 1, 0, 0])
(10.995144603273548, [1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(13.96321143831591, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(16.02069039209792, [1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0,
0, 1, 0, 0, 0, 1, 0, 0, 1, 0])
(17.41911980732094, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 0,
1, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(17.516272623152084, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(18.275599464671757, [1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(20.649064529622613, [1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(21.439138247916603, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
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0, 1, 0, 0, 0, 0, 1, 0, 0, 0])
(24.88034572866987, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0])
(25.12748315693471, [0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(26.255111176360906, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(26.315470266126532, [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 1, 0, 0, 0])
(27.078708729527712, [1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 0, 1, 1, 0, 0, 0])

MUTATION PROBABILITY: 0.64
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(0.0006250763032600304, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.001362950894765902, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.0019255808570761 7, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.0025456995900086 1, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.0026031502923054006, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.0026031502923054006, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.009641222375361025, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1])
(0.009641222375361025, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1])
(0.010043280830167589, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.012568241907210 62, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 0])
(0.029818363461515673, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.031337384764579 92, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 1])
```

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(0.03483052268179421, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.09050024465543771, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1])
(0.09050024465543771, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1])
(0.3524295472365573, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 1])
(0.419362011185445, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 1, 0, 0])
(0.5800010638326434, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 1, 1, 0, 0])
(0.7438880950460387, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 1, 1, 0, 0, 0, 1])
(4.792202325985013, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1])
(5.040969360560405, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(7.027783668050061, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0,
0, 0, 1, 0, 1, 0, 0, 1, 0, 0])
(16.750707929484264, [1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(17.432052900841594, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(17.432052900841594, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(25.634571612304313, [1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(25.713194149978623, [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(25.78796230826915, [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(28.735993207937977, [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 1])

MUTATION PROBABILITY: 0.6699999999999999
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.0006250763032591422, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.0020117586331984683, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0,
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0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.02143427034808454, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(0.09488214481967461, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.09678796421770741, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 0])
(0.10092576720183288, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 1])
(0.33312014597455075, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(0.3423670872962319, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 1])
(0.37788752459203323, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 1, 0])
(0.388318495051994, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.39332954671147746, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 1, 0, 0])
(0.41378550970315686, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 1, 0, 0])
(0.7171302709858978, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 1, 0, 0])
(3.0869202225771026, [0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(3.3851017886947403, [0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 1, 1, 1, 0])
(5.172023931293509, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 1, 0, 0])
(5.811735607143724, [0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(12.015647168964243, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(12.175057475953116, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 1, 1, 0])
(13.321370096833947, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(14.068447309283775, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(15.692368588936286, [0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(15.724877995312728, [0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 1, 0])
(15.757385936776574, [0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(16.13636501620376, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0,
0, 1, 0, 0, 1, 0, 0, 0, 0, 0])
(17.177332675188214, [0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 1])
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(23.034394940496895, [0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 1, 0, 1, 0, 0, 0, 0, 0])
(23.59847230052913, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
0, 0, 0, 0, 0, 0, 0, 1, 1, 0])
(25.4102742305133, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0])
(25.72147242145923, [0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 1])

MUTATION PROBABILITY: 0.7
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.0006250763032591422, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.0843711628132332, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.0843711628132332, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.31080386485239586, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(0.3258124829076223, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.3470953127529768, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0])
(0.8119334013382193, [0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.8326248395244669, [0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(1.262795133638484, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.262795133638484, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.3867343205951315, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 0])
(2.0385736123181317, [0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(2.0859010434244283, [0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(2.4681387446308953, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
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0, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(2.5424087587734334, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 1, 0])
(3.6767551951162893, [0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(3.7570785697274367, [0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0])
(4.501916661827359, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(4.659123960044049, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 1, 0])
(8.487782966487615, [0, 1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(10.900984166542719, [0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(13.220155588378883, [0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(13.926423552575294, [0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 1, 0, 0, 0])
(17.412028613568506, [0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 1, 0, 0, 1, 0, 1, 0, 0, 0])
(18.471935263571954, [0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 1, 0, 0, 0])
(22.273945569879174, [0, 0, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(23.973687844583953, [0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(26.0846349420652, [1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0])
(26.82790450962518, [0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 0,
0, 0, 0, 0, 1, 0, 1, 0, 0, 0])

MUTATION PROBABILITY: 0.73
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.0006250763032591422, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.009021103642428585, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1])
(0.09050024465543771, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1])
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(0.13029124378024193, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 0])
(0.13645660143775729, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 1])
(0.1776720462491319, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 1, 0, 0, 0])
(0.2540373285682236, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 0])
(0.3460493615203788, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.5031902861717548, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 1])
(1.262795133638484, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.4203799948947164, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.487715896894894, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(1.5543783508481717, [0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 1, 1, 0, 1, 0, 0])
(1.612035812991813, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(3.575908683580913, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 1, 1, 1, 0, 0, 0, 1])
(3.9149288388713934, [0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 1, 0, 0, 0])
(4.596647366144307, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0])
(5.641661794518342, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0,
0, 0, 1, 0, 0, 1, 0, 0, 0, 1])
(5.641661794518342, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0,
0, 0, 1, 0, 0, 1, 0, 0, 0, 1])
(6.510797033862584, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(12.811182215062452, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(13.280498954331925, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 1, 0, 1, 0, 1])
(16.243918086989936, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0,
1, 0, 0, 0, 0, 1, 0, 1, 0, 1])
(17.388201411427488, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(17.39106762413806, [0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 0])
(17.410966175545283, [0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1,
0, 0, 0, 0, 0, 1, 1, 0, 1, 0])
(18.29688229451711, [0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(24.612137066370913, [0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 0, 0,
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0, 0, 0, 0, 1, 1, 0, 0, 0, 0])
(26.194913424720692, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 1, 1, 0, 1, 1])
(35.90728125293003, [0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0,
0, 1, 1, 0, 0, 1, 0, 0, 0, 0])

MUTATION PROBABILITY: 0.76
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0020117586331984683, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.023294588478552924, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1])
(0.028612959595271548, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0])
(0.030473163523108582, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0])
(0.03483052268179421, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.31080386485239586, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.3301132661144095, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 0])
(0.5050811936642035, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 0, 1, 1, 0])
(0.696846950848407, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 0])
(0.7629345792568856, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 0])
(3.517099863574238, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 0, 0, 1, 1, 1, 1])
(5.965462518792766, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 0, 1, 1, 0, 1, 1, 1, 0])
(6.319564869969437, [0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(7.168194621011697, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 0, 0, 1, 1,
1, 1, 0, 1, 0, 1, 1, 1, 1, 0])
(15.547548052051555, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1,
0, 1, 1, 1, 0, 1, 1, 1, 1, 1])
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(16.00172719476258, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1,
0, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(16.75070792948422, [0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(20.179155230593565, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1,
0, 1, 1, 0, 0, 1, 1, 1, 1, 0])
(24.955974251213803, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(25.334062613196984, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(25.763602550255815, [0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(25.85335996274942, [0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0])
(29.72616482714218, [1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 0, 1, 1, 1, 1, 0])
(29.892019650626512, [0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(32.51796392062212, [0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 0, 1, 0, 1, 1, 1, 1, 0])
(35.85627743256968, [0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1,
1, 0, 1, 0, 0, 0, 1, 1, 1, 0])
(36.18639104921476, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 0])
(38.22168918364816, [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1,
0, 1, 1, 0, 0, 0, 1, 0, 1, 0])
(46.703573545054454, [1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1,
1, 0, 1, 0, 0, 0, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.79
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(0.0006250763032600304, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007428321618334621, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.00635205682359441, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.006943448482701342, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.009785359821819384, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1,
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```
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(0.01274162570074111, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 0])
(0.028381118885658196, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(0.028612959595271548, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0])
(0.11616497466503262, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 1, 1])
(0.13009814161157962, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.13009814161157962, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.23365355425836043, [1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.3114239835853283, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.32382369365843644, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.3834669573858456, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(0.3914692285810055, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 0, 1, 1])
(0.3914692285810055, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 0, 1, 1])
(0.3914692285810055, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 0, 1, 1])
(0.3934863261987971, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 1, 0])
(1.2423707216404978, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 0])
(1.395658220899886, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 0, 1, 0])
(5.109032134134919, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(13.962382951826, [1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1])
(14.683212061682614, [1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(15.342618116337533, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1])
(18.013035187287564, [1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 1,
0, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(20.037001070080983, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
1, 0, 0, 1, 1, 1, 1, 1, 1, 1])
(24.94364448003929, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 1, 1])
(26.397954800915326, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 1, 0, 0, 1, 1])
```

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(28.79314458637133, [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0])

MUTATION PROBABILITY: 0.82
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.6177287110123331, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 0])
(0.796318335610767, [0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 0])
(0.821308434688973, [0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 0])
(1.0058356740417516, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 0, 0, 0, 0])
(1.2116956678160058, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 1])
(1.3165645305750289, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 0, 1, 0])
(1.4344849524453878, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 0, 0, 1])
(1.6817391881018402, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 0, 0, 1, 1])
(1.7718475875928625, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1,
1, 1, 1, 0, 1, 1, 0, 0, 0, 1])
(1.7743276818554214, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 0, 0, 0, 1])
(4.295617042494687, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 0])
(5.378736015139246, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 0, 1, 1])
(5.8054038555631955, [0, 1, 0, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 0, 1, 1])
(6.486063236338833, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 0, 1, 0, 0, 0, 1, 0])
(12.45440353496549, [0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 1, 0])
(12.749358646394947, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0,
1, 1, 1, 1, 1, 1, 0, 0, 0, 1])
(13.187900936719434, [0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1,
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1, 1, 1, 1, 1, 0, 0, 0, 1, 1])
(13.986954060269145, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(15.675633386890281, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1,
0, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(15.832746528550071, [0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 0, 0, 1])
(15.841538820131234, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 1,
0, 1, 1, 1, 1, 0, 0, 0, 1, 1])
(15.892034028559234, [0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 0, 1])
(16.61764638972943, [0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 0, 1, 1])
(18.32169336668435, [0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 0, 1, 1])
(24.89290242227447, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 1, 1])
(26.66653805292657, [0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(27.204593668966453, [0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0,
1, 1, 1, 1, 1, 1, 0, 0, 0, 0])
(29.18095545501531, [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 1, 0])
(35.35586086111195, [0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0,
1, 1, 1, 0, 1, 1, 1, 0, 0, 1])

MUTATION PROBABILITY: 0.85
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(-0.0006250763032591422, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.00606483763510411, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(0.01256824190721062, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 0])
(0.02290666121220397, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 1])
(0.08099201340736428, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0])
(0.17705192751619947, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0])
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(0.3293606597494545, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1])
(0.41034815528217194, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.6364649072572917, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(0.9573073117164235, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 1, 1, 1, 0, 0, 0])
(1.0506479524072425, [0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 1])
(1.13722510001897, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0,
0, 0, 0, 1, 0, 1, 0, 1, 0])
(3.060793661433216, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 1, 1, 0, 1, 0, 0, 0])
(4.006717020727972, [0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 1])
(4.530139117435645, [0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 1, 1, 0, 1, 0, 1, 1])
(9.11510421675119, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0,
0, 1, 1, 0, 0, 0, 0, 0, 0])
(13.356397022480287, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 0, 0, 1, 0, 0, 0, 0, 0, 0])
(13.962591319582977, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(13.96321143831591, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0])
(14.393685777282935, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0,
0, 1, 0, 0, 0, 0, 0, 1, 1, 0])
(15.045602739669956, [0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 1, 0, 1, 0])
(15.088007146706484, [0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0])
(17.001470401586747, [0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 1, 1, 1, 1])
(18.303294405523797, [0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 1, 1])
(25.170039406316036, [0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 1, 0])
(25.302504289705105, [0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(27.711793179872974, [0, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0,
0, 0, 1, 1, 1, 1, 0, 0, 1, 0, 1])
(28.688802709336578, [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0])
(30.55793202110536, [0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(36.5770618489184, [0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 1, 0])
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MUTATION PROBABILITY: 0.88
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(0.0006250763032600304, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

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Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.0056461029153886955, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.006064837763510411, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(0.01856636302180803, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 1])
(0.04164345673472525, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(0.0499658645736325, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0])
(0.05244595883619141, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0])
(0.05760666946422788, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1])
(0.10778157055787574, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.11602931126529015, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1])
(0.33197358424488144, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 1])
(0.5027129699210953, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0])
(1.3405118903453932, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.396898420297422, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 1, 0, 1])
(1.6844095794580092, [1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 1, 1])
(6.546695099049199, [1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0])
(11.798045080327682, [1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
(12.014864322393805, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0, 1, 0, 1])
(13.562488950045644, [1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
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(15.114548078653481, [1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(16.194878945107504, [1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(18.264287305329, [1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0])
(18.26606144568335, [1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(25.00193783386432, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(25.79624057974975, [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 1])
(26.28327694458387, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 1, 0, 1, 1])
(26.28364086087734, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(28.924787650554766, [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(29.03217381464791, [1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 1])
(31.496604512499484, [1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0])

MUTATION PROBABILITY: 0.9099999999999999
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

---------------------------

Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0007428321618334621, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0])
(0.01088142177290052 4, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0])
(0.022467721624877868, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.31080386485239586, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(0.8202116728188145, [0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 0])
(1.2764584121604585, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 0])
(1.5007033695058638, [0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 1, 1,
```

```
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(1.9454067497110792, [0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(2.3025998333488573, [0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 0, 1, 0, 1, 0, 1, 0])
(2.3129215779474173, [0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(2.4231656092983194, [0, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 0])
(2.5770627599443436, [0, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 0])
(3.7380283518579205, [0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(3.8306458051466983, [0, 1, 1, 0, 1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(4.380488150189414, [0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 0])
(4.771127665182398, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1,
1, 1, 0, 1, 1, 1, 1, 0, 1, 1])
(4.9941505156527395, [0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 0, 0, 1, 1, 1, 1])
(9.877044030191083, [0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1,
1, 1, 0, 1, 1, 0, 1, 1, 1, 1])
(13.96321143831591, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(15.673773068759811, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
0, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(16.011101551370885, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1,
1, 0, 1, 1, 1, 0, 0, 0, 0, 1])
(16.185127635307712, [0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1,
1, 0, 1, 1, 1, 0, 1, 1, 1, 0])
(16.968228041404444, [0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1,
1, 0, 1, 1, 1, 0, 0, 0, 1, 0])
(20.23207147774049, [1, 0, 1, 1, 1, 0, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1])
(21.269347656781175, [0, 1, 0, 1, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1])
(21.45885600236656, [0, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(21.864152594102443, [0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 0])
(23.577975133757665, [0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 0])
(28.924787650554766, [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])

MUTATION PROBABILITY: 0.94
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
```

```
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
Best individual decoded:
(-0.0006250763032591422, -0.0006104260774018044)
Best individual function value:
0.00015144050272652976

--------------------------

Last generation:
(0.00015144050272652976, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(0.0683851924328529, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 0, 0, 0, 1])
(0.12409062745937405, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 0, 1, 1])
(1.3510569021934664, [0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 0, 1, 1, 1, 0])
(1.3740547549614313, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 0, 0])
(1.8501012533256969, [0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 0])
(2.4262969751131216, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 0, 0, 0, 1, 1])
(2.5338941106906177, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 0, 0, 0, 0, 1])
(2.5760246608979465, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 0, 0, 0, 0, 1])
(2.8424287051611046, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 0, 0, 1, 1, 0, 1, 1])
(3.9239461396586996, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 0, 0, 1, 0, 0, 1])
(5.6046721667532395, [0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1,
1, 1, 0, 1, 1, 0, 1, 1, 1, 1])
(6.410590710940195, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0,
0, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(6.988479177116261, [0, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1,
1, 1, 0, 1, 1, 1, 1, 1, 1, 1])
(8.635867516871217, [0, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1,
0, 0, 1, 0, 0, 1, 1, 1, 0, 1])
(12.34156442459506, [0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1])
(14.14030969547558, [0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1])
(14.516259611838915, [0, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(14.518033752193263, [0, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(14.829081153053567, [0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
```

```
(14.829081153053567, [0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(14.96354299010686, [0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(17.679560612718006, [0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(19.375534069695597, [0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1,
0, 1, 1, 1, 1, 1, 1, 1, 1, 1])
(20.38792532938178, [0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 0, 0, 0, 0, 0, 1])
(20.972087753473982, [0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1,
1, 0, 1, 1, 1, 1, 0, 0, 1, 0])
(31.111767964578302, [0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1])
(32.05026960982101, [0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 0, 1, 0, 0, 0, 0, 0, 0, 1])
(42.44017859384823, [0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(46.210697152999174, [0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1,
0, 1, 1, 1, 0, 0, 0, 0, 0, 1])

MUTATION PROBABILITY: 0.97
Best individual fitness and best individual binary chromosome:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
Best individual decoded:
(0.0006250763032600304, 0.0006104260774018044)
Best individual function value:
0.00015144050272652976

---------------------------

Last generation:
(0.00015144050272652976, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(0.0019255808570761 7, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0])
(0.043750551470232324, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0])
(0.17735200087384584, [1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 1, 1])
(0.371067247312741, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 1, 1])
(0.6077349279107693, [1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1])
(0.84002571052077, [1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 0, 0,
0, 0, 0, 0, 1, 1, 0, 0, 0])
(1.4023437245729475, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 1, 0])
(1.5968012941725043, [1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0,
```

```
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(1.6126384351233796, [1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 1, 0])
(1.8363936889074672, [1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 1, 1, 1, 0, 0, 0])
(1.8918489235355267, [1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 0])
(2.2524304986502024, [1, 0, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 1, 0, 0])
(2.9741754572292294, [1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 1, 1])
(5.533617098693686, [1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 1, 0, 0])
(5.716732368019773, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 1, 0, 0, 1, 0])
(5.792035451386418, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0,
0, 0, 1, 0, 0, 1, 0, 0, 1, 1])
(9.944858495972841, [1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 1, 1])
(13.61147337645716, [1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 1, 0, 0])
(14.17982448573904, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 1, 1])
(14.39841301660741, [1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(14.45519440078833, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1,
0, 0, 0, 0, 1, 0, 0, 1, 0, 0])
(15.28918453182931, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0,
0, 1, 0, 0, 0, 1, 0, 0, 1, 1])
(16.45022568098488, [1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(17.27137610445105, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 1, 1])
(22.948248117499713, [1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0,
0, 0, 1, 0, 0, 0, 0, 0, 1, 1])
(26.392528032589627, [1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0,
0, 0, 1, 0, 0, 1, 0, 0, 1, 1])
(29.593793093448205, [0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 0, 1, 1, 0])
(29.931094812241533, [1, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
(31.591956652475293, [0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0,
0, 0, 1, 0, 0, 0, 1, 0, 0, 0])
```

Kako raste mutation probability, povećavaju se odstupanja jediniku u zadnjoj generaciji. Najmanja nađena vrijednost funkcije opada te je algoritam precizniji.

d)

```
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def rastrigin_function(x):
  x1 = x[0]
  x2 = x[1]
  return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))

RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = rastrigin_function,
population_size = 10,
generations = 200,
crossover_probability = 0.8,
mutation_probability = 0.02,
elitism = True,
maximise_fitness = False)

BINARY_CHROMOSOME_LENGTH = 26

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual

def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2

ga.crossover_function = crossover

def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0
    ga.mutate_function = mutate

ga.tournament_size = 2
```

```
def decimal(binary):
  sum = 0
  for i in range(0, len(binary)):
    sum += binary[len(binary)-1-i]*2**(i)
  return sum


def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data([x_decode, y_decode])
  return fitness

ga.fitness_function = fitness
print(f"Velicina populacije: {ga.population_size}\n")
for generations in np.arange(1, 51, 5):
  ga.generations = generations
  ga.run()
  print(f"\nGenerations: {generations}")
  print("Best individual fitness and best individual binary
chromosome:")
  print(ga.best_individual())
  print("Best individual decoded:")
  print(decode(ga.best_individual()[1]))

  print("Best individual function value:")
  print(rastrigin_function(decode(ga.best_individual()[1])))
```

```
  print("\n--------------------------\n")

  print("Last generation:")
  for individual in ga.last_generation():
    print(individual)
```

```
Velicina populacije: 10


Generations: 1
Best individual fitness and best individual binary chromosome:
(16.95099975148792, [1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1,
0, 0, 1, 1, 0, 0, 1, 0, 0, 1])
Best individual decoded:
(3.989862043706508, -1.0041508973263338)
Best individual function value:
16.95099975148792

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Last generation:
(16.95099975148792, [1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1,
0, 0, 1, 1, 0, 0, 1, 0, 0, 1])
(36.69660975497, [0, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 0, 0, 1,
1, 0, 1, 1, 1, 0, 1, 1, 1])
(38.294689086717064, [0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1,
1, 0, 1, 1, 0, 1, 1, 0, 0, 0])
(38.80801674526662, [1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1,
1, 1, 1, 0, 0, 0, 0, 1, 0, 0])
(38.98968098422507, [0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1,
0, 1, 1, 1, 0, 0, 1, 1, 1, 0])
(43.95054421467424, [0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1,
0, 0, 1, 1, 0, 1, 1, 0, 1, 1])
(46.52348148563729, [0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1,
1, 0, 0, 1, 1, 0, 0, 0, 1, 1])
(61.149991259761805, [1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 1, 0, 0, 0])
(64.0522165498754, [0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1,
0, 0, 0, 0, 1, 1, 0, 1, 1])
(78.26026144400802, [1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1,
1, 0, 0, 1, 0, 1, 1, 0, 0, 1])

Generations: 6
Best individual fitness and best individual binary chromosome:
(2.0061653929951753, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 1, 0])
Best individual decoded:
(0.9869954828470275, 0.9992674887071171)
Best individual function value:
2.0061653929951753
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Last generation:
(2.0061653929951753, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 1, 0])
(2.0061653929951753, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 1, 0])
(2.5277871421161606, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 1, 0])
(2.5277871421161606, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 1, 0])
(2.5277871421161606, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 1, 0])
(6.195144743522757, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0,
1, 0, 1, 0, 1, 1, 0, 0, 1, 0])
(6.2017947571718945, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0,
1, 0, 1, 0, 1, 1, 0, 0, 1, 0])
(6.749870478714495, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0,
1, 1, 1, 0, 1, 1, 0, 0, 1, 0])
(6.749870478714495, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0,
1, 1, 1, 0, 1, 1, 0, 0, 1, 0])
(22.072887172516566, [0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0,
1, 0, 1, 0, 1, 1, 0, 0, 0, 1])

Generations: 11
Best individual fitness and best individual binary chromosome:
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
Best individual decoded:
(-2.0196215358320107, -0.004272982541814407)
Best individual function value:
4.158393915006819

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Last generation:
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
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1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])
(4.158393915006819, [0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 0])

Generations: 16
Best individual fitness and best individual binary chromosome:
(13.241977881953389, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 0, 1, 0])
Best individual decoded:
(-2.9859895006714687, -1.9503113172994748)
Best individual function value:
13.241977881953389

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Last generation:
(13.241977881953389, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 0, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.321663851498418, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 0, 0, 1, 1, 0])
(13.728490255264415, [0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0,
0, 1, 1, 1, 0, 1, 0, 1, 1, 0])

Generations: 21
Best individual fitness and best individual binary chromosome:
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
Best individual decoded:
(1.9908680258820661, 0.10804541570015846)
Best individual function value:
6.208854353038301
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Last generation:
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])
(6.208854353038301, [1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 0])

Generations: 26
Best individual fitness and best individual binary chromosome:
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
Best individual decoded:
(0.8582297643755341, -0.0433402514955441)
Best individual function value:
4.818782585516757

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Last generation:
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
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(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])
(4.818782585516757, [1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 0, 0])

Generations: 31
Best individual fitness and best individual binary chromosome:
(3.3398952603902394, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 1, 1])
Best individual decoded:
(-1.0995092174337682, -0.03479428641191529)
Best individual function value:
3.3398952603902394

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Last generation:
(3.3398952603902394, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 1, 1])
(3.3398952603902394, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 1, 1])
(3.3398952603902394, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 1, 1])
(3.3744919242673745, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(3.3744919242673745, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(3.3744919242673745, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(3.3744919242673745, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(3.3744919242673745, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(3.3744919242673745, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])
(3.3744919242673745, [0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 0, 0, 0, 0, 1])

Generations: 36
Best individual fitness and best individual binary chromosome:
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
Best individual decoded:
(0.9894957880600668, -0.9345623245025028)
Best individual function value:
2.7076906726962093

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Last generation:
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7076906726962093, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7143406863453485, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7143406863453485, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])
(2.7143406863453485, [1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0])

Generations: 41
Best individual fitness and best individual binary chromosome:
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
Best individual decoded:
(1.040752044927359, -0.0030521303870099104)
Best individual function value:
1.4110405490745137

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Last generation:
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
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1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])
(1.4110405490745137, [1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1])

Generations: 46
Best individual fitness and best individual binary chromosome:
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
Best individual decoded:
(-0.9544915150775246, -1.0029300451715297)
Best individual function value:
2.3246429629862

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Last generation:
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
(2.3246429629862, [0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0,
0, 1, 1, 0, 0, 1, 0, 1, 0])
```

Ne postoji neko konzistentno pravilo ako se povećava broj generacija na malu veličinu populacije.

e)

```python
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def rastrigin_function(x):
```

```
  x1 = x[0]
  x2 = x[1]
  return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))


RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = rastrigin_function,
population_size = 5,
generations = 200,
crossover_probability = 0.8,
mutation_probability = 0.02,
elitism = False,
maximise_fitness = False)


BINARY_CHROMOSOME_LENGTH = 26

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual

def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2

ga.crossover_function = crossover

def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0

ga.mutate_function = mutate

ga.tournament_size = 2

def decimal(binary):
  sum = 0
```

```
  for i in range(0, len(binary)):
    sum += binary[len(binary)-1-i]*2**(i)
  return sum

def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data([x_decode, y_decode])
  return fitness

ga.fitness_function = fitness


ga.run()

print("Best individual fitness and best individual binary
chromosome:")
print(ga.best_individual())

print("Best individual decoded:")
print(decode(ga.best_individual()[1]))

print("Best individual function value:")
print(rastrigin_function(decode(ga.best_individual()[1])))

print("\n--------------------------\n")

print("Last generation:")
```

```
for individual in ga.last_generation():
  print(individual)

Best individual fitness and best individual binary chromosome:
(10.946767700333616, [1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
Best individual decoded:
(3.055998046636552, 0.9943840800879009)
Best individual function value:
10.946767700333616

---------------------------

Last generation:
(10.946767700333616, [1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(10.946767700333616, [1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(10.946767700333616, [1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(10.946767700333616, [1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
(10.946767700333616, [1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0,
1, 1, 0, 0, 1, 0, 1, 1, 1, 0])
```

U odnosu na zadatak pod a) postignuto je bolje rješenje, s obzirom na vrijednosti pronadjenih minimalnih vrijednosti funkcije (1.20 < 1.99).

f) Rulet točak selekcija

```
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def rastrigin_function(x):
  x1 = x[0]
  x2 = x[1]
  return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))

RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = rastrigin_function,
population_size = 30,
generations = 200,
crossover_probability = 0.8,
mutation_probability = 0.02,
elitism = True,
maximise_fitness = False)
```

```
BINARY_CHROMOSOME_LENGTH = 26

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual

def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2

ga.crossover_function = crossover

def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0

ga.mutate_function = mutate

def roulette_wheel_selection(population):
  total_fitness = sum(individual.fitness for individual in population)
  selection_probs = [individual.fitness / total_fitness for individual
in population]

  chosen = random.choices(population, weights=selection_probs,
k=len(population))
  return chosen

ga.selection = roulette_wheel_selection

def decimal(binary):
  sum = 0
  for i in range(0, len(binary)):
    sum += binary[len(binary)-1-i]*2**(i)
  return sum


def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
```

```
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data([x_decode, y_decode])
  return fitness

ga.fitness_function = fitness

ga.run()

print("Best individual fitness and best individual binary
chromosome:")
print(ga.best_individual())

print("Best individual decoded:")
print(decode(ga.best_individual()[1]))
print("Best individual function value:")
print(rastrigin_function(decode(ga.best_individual()[1])))

print("\n--------------------------\n")

print("Last generation:")
for individual in ga.last_generation():
  print(individual)
```

```
Best individual fitness and best individual binary chromosome:
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
Best individual decoded:
(-2.000869246734221, 0.996825784397509)
Best individual function value:
```

```
4.999277320679848

---------------------------

Last generation:
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
```

```
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
(4.999277320679848, [0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 0, 1, 1, 0, 0, 0, 0])
```

Bolji rezultat kako kad se koristi turnir selekcija(1.00 < 1.99)

f) Selekcija na bazi ranga

```
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def rastrigin_function(x):
  x1 = x[0]
  x2 = x[1]
  return 20 + x1**2 + x2**2 - 10*(np.cos(2*math.pi*x1) +
np.cos(2*math.pi*x2))

RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = rastrigin_function,
population_size = 30,
generations = 200,
crossover_probability = 0.8,
mutation_probability = 0.02,
elitism = True,
maximise_fitness = False)


BINARY_CHROMOSOME_LENGTH = 26

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual
```

```
def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2

ga.crossover_function = crossover

def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0

ga.mutate_function = mutate

def rank_based_selection(population):
    population.sort(key=lambda x: x.fitness, reverse=True)
    total_ranks = sum(range(1, len(population) + 1))
    selection_probs = [rank / total_ranks for rank in range(1,
len(population) + 1)]

    chosen = random.choices(population, weights=selection_probs,
k=len(population))
    return chosen

ga.selection = rank_based_selection

def decimal(binary):
  sum = 0
  for i in range(0, len(binary)):
    sum += binary[len(binary)-1-i]*2**(i)
  return sum

def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
```

```
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data([x_decode, y_decode])
  return fitness

ga.fitness_function = fitness

ga.run()

print("Best individual fitness and best individual binary
chromosome:")
print(ga.best_individual())

print("Best individual decoded:")
print(decode(ga.best_individual()[1]))
print("Best individual function value:")
print(rastrigin_function(decode(ga.best_individual()[1])))

print("\n---------------------------\n")

print("Last generation:")
for individual in ga.last_generation():
  print(individual)
```

```
Best individual fitness and best individual binary chromosome:
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
Best individual decoded:
(0.0006250763032600304, -1.9930411427176167)
Best individual function value:
3.981847838522256

---------------------------

Last generation:
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
```

```
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
```

```
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(3.981847838522256, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
(4.23334153022887, [1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 1, 1, 1, 1, 1, 1])
(20.73240432750379, [1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 1, 1, 1, 1, 1])
```

Gori rezultat (2.64 >2.08)

Zadatak 2

a)

```
def create_individual(data):
    individual = data[:]
    random.shuffle(individual)
    return individual

ga.create_individual = create_individual
```

Definicija mehanizma kodiranja: Kodiranje individua populacije vrši se nasumičnom raspodjelom elemenata liste koja se dobije stvaranjem duboke kopije i koja se zatim proslijedi. Ovo osigurava različitost individua i spriječava pojavu duplikata.

b)

```
def selection(population):
    return random.choice(population)

ga.selection_function = selection
```

Definicija mehanizma selekcije: Selekcija se vrši nasumičnim odabirom iz populacije. Ovaj pristup omogućava raznolikost u selekciji roditelja za ukrštanje, ali može rezultirati manjim izborom boljih rješenja.

c)

```
def fitness (individual, data):
    collisions = 0
    for item in individual:
        item_index = individual.index(item)
        for elem in individual:
            elem_index = individual.index(elem)
            if item_index != elem_index:
                if item - (elem_index - item_index) == elem \
```

```
                    or (elem_index - item_index) + item == elem:
                    collisions += 1
    return collisions

ga.fitness_function = fitness
```

Definicija fitness funkcije: Fitness funkcija provjerava broj kolizija između kraljica, odnosno da li se kraljice napadaju. Cilj genetičkog algoritma je minimizirati ovaj broj kolizija, odnosno svesti ga na nulu.

d)

```
def crossover(parent_1, parent_2):
    crossover_index = random.randrange(1, len(parent_1))
    child_1a = parent_1[:crossover_index]
    child_1b = [i for i in parent_2 if i not in child_1a]
    child_1 = child_1a + child_1b

    child_2a = parent_2[crossover_index:]
    child_2b = [i for i in parent_1 if i not in child_2a]
    child_2 = child_2a + child_2b

    return child_1, child_2

ga.crossover_function = crossover
```

Definicija operatora ukrštanja: Operator ukrštanja određuje nasumični crossover index. Prvo dijete se formira koristeći segment od početka do crossover indexa od roditelja 1, te preostali dio segmenta od roditelja 2 koji nema iste elemente koji su već dobiveni od segmenta roditelja 1. Slično, drugo dijete se formira koristeći segment od crossover indexa do kraja od roditelja 2, te preostali dio segmenta od roditelja 1 koji nema iste elemente koji su već dobiveni od segmenta roditelja 2.

e)

```
def mutate(individual):
    mutate_index1 = random.randrange(len(individual))
    mutate_index2 = random.randrange(len(individual))
    individual[mutate_index1], individual[mutate_index2] =
individual[mutate_index2], individual[mutate_index1]

ga.mutate_function = mutate
```

Definicija operatora mutacije: Operator mutacije nasumično odabire dva indeksa liste koja predstavljaju binarnu reprezentaciju individue populacije i zamjenjuje vrijednosti na tim indeksima.

f)

```
# setup seed data
seed_data = [0, 1, 2, 3, 4, 5, 6, 7]

# initialise the GA
ga = pyeasyga.GeneticAlgorithm(seed_data,
                               population_size=200,
                               generations=100,
                               crossover_probability=0.8,
                               mutation_probability=0.2,
                               elitism=True,
                               maximise_fitness=False)
```

Izmjene za rješavanje generalizovanog problema N kraljica: Da bismo riješili generalizovani problem N kraljica, trebamo promijeniti veličinu populacije, broj generacija, vjerovatnoću ukrštanja i vjerovatnoću mutacije u skladu sa specifičnostima problema. Također bi trebali prilagoditi fitness funkciju i mehanizam ukrštanja i mutacije da bi radili sa proizvoljnim brojem kraljica. Osim toga, seed_data lista bi se unosila ručno sa proizvoljnim N brojem elemenata, gdje bi svaki element predstavljao početnu poziciju jedne kraljice na šahovskoj ploči.

LEVY FUNCTION N. 13

```
from pyeasyga.pyeasyga import GeneticAlgorithm
import random
import numpy as np
import math

def levy_function(x, y):
    return (np.sin(3 * np.pi * x) ** 2 +
            (x - 1) ** 2 * (1 + np.sin(3 * np.pi * y) ** 2) +
            (y - 1) ** 2 * (1 + np.sin(2 * np.pi * y) ** 2))

RANGE = np.array([[-5.12,5.12], [-5,5]])

ga = GeneticAlgorithm(seed_data = levy_function,
                      population_size = 30, #uvecali populaciju
                      generations = 200, #uvecali generaciju
                      crossover_probability = 0.8,
                      mutation_probability = 0.02,
                      elitism = True,
                      maximise_fitness = False)

BINARY_CHROMOSOME_LENGTH = 26

def create_individual(data):
  return [random.randint(0, 1) for _ in
range(BINARY_CHROMOSOME_LENGTH)]

ga.create_individual = create_individual
```

```
def crossover(parent_1, parent_2):
  crossover_index1 = random.randrange(1, len(parent_1)-1)
  crossover_index2 = random.randrange(crossover_index1+1,
len(parent_1))
  child_1 = parent_1[:crossover_index1] + parent_2[crossover_index1:
  crossover_index2] + parent_1[crossover_index2:]
  child_2 = parent_2[:crossover_index1] + parent_1[crossover_index1:
  crossover_index2] + parent_2[crossover_index2:]
  return child_1, child_2

ga.crossover_function = crossover

def mutate(individual):
  mutate_index = random.randrange(len(individual))
  if individual[mutate_index] == 0:
    individual[mutate_index] = 1
  else:
    individual[mutate_index] = 0

ga.mutate_function = mutate

ga.tournament_size = 2

def decimal(binary):
  sum = 0
  for i in range(0, len(binary)):
    sum += binary[len(binary)-1-i]*2**(i)
  return sum

def decode(individual):
  x_binary = individual[:BINARY_CHROMOSOME_LENGTH // 2]
  y_binary = individual[BINARY_CHROMOSOME_LENGTH // 2:]
  x_range = RANGE[0]
  y_range = RANGE[1]
  x_min = x_range[0]
  x_max = x_range[1]
  y_min = y_range[0]
  y_max = y_range[1]
  x_decode = x_min + ((x_max -
x_min)*decimal(x_binary))/(2**(len(x_binary)) - 1)
  y_decode = y_min + ((y_max -
y_min)*decimal(y_binary))/(2**(len(y_binary)) - 1)
  return x_decode, y_decode

def is_in_range(x, range_x):
  return x >= range_x[0] and x<= range_x[1]

def fitness (individual, data):
  x_decode, y_decode = decode(individual)
```

```
  while not (is_in_range(x_decode, RANGE[0]) and is_in_range(y_decode,
RANGE[1])):
    individual = create_individual(data)
    x_decode, y_decode = decode(individual)
  fitness = data(x_decode, y_decode)
  return fitness

ga.fitness_function = fitness

ga.run()

print("Best individual fitness and best individual binary
chromosome:")
print(ga.best_individual())
print("Best individual decoded:")
print(decode(ga.best_individual()[1]))

print("Best individual function value:")
print(levy_function(*decode(ga.best_individual()[1])))

print("\n---------------------------\n")

print("Last generation:")
for individual in ga.last_generation():
  print(individual)
```

```
Best individual fitness and best individual binary chromosome:
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
Best individual decoded:
(1.0007471615187402, 0.9760712977658406)
Best individual function value:
0.0006356013356224202

---------------------------

Last generation:
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
```

```
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
(0.0006356013356224202, [1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1])
```