USN : 1BM22CS235

LAB-5 : Grey Wolf Optmizer (GWO):

CODE:

```
import numpy as np import matplotlib.pyplot as plt


# Step 1: Define the Problem (a mathematcal functon to

optmize)
def objectve_functon(x):
   return np.sum(x**2) # Example: Sphere functon (minimize sum of

   squares)
# Step 2: Initalize Parameters
num_wolves = 5 # Number of wolves in the pack
num_dimensions = 2 # Number of dimensions (for the optmizaton

problem)
num_iteratons = 30 # Number of iteratons
lb = -10 # Lower bound of search space
ub = 10 # Upper bound of search space
# Step 3: Initalize Populaton (Generate inital positons randomly)
wolves = np.random.uniform(lb, ub, (num_wolves,
num_dimensions))

# Initalize alpha, beta, delta wolves
alpha_pos =
np.zeros(num_dimensions)
beta_pos =

np.zeros(num_dimensions)
delta_pos =
np.zeros(num_dimensions)
alpha_score = float('inf') # Best (alpha) score
beta_score = float('inf') # Second best (beta) score
delta_score = float('inf') # Third best (delta) score
# To store the alpha score over iteratons for

graphing
```

```
alpha_score_history = []

# Step 4: Evaluate Fitness and assign Alpha, Beta, Delta wolves
def evaluate_fitness():
  global alpha_pos, beta_pos, delta_pos, alpha_score, beta_score, delta_score

  for wolf in wolves:
    fitness = objectve_functon(wolf)

    # Update Alpha, Beta, Delta wolves based on fitness
    if fitness < alpha_score:
      delta_score = beta_score
      delta_pos = beta_pos.copy()

      beta_score = alpha_score
      beta_pos = alpha_pos.copy()

      alpha_score = fitness
      alpha_pos = wolf.copy()
    elif fitness < beta_score:
      delta_score = beta_score
      delta_pos = beta_pos.copy()

    beta_score = fitness
    beta_pos = wolf.copy()
    elif fitness < delta_score:
    delta_score = fitness
    delta_pos = wolf.copy()

# Step 5: Update Positons
def update_positons(iteraton):
```

```
 a = 2 - iteraton * (2 / num_iteratons) # a decreases linearly from 2 to

0
   for i in range(num_wolves):
      for j in range(num_dimensions):
         r1 = np.random.random()
         r2 = np.random.random()


         # Positon update based on alpha
         A1 = 2 * a * r1 - a
         C1 = 2 * r2
         D_alpha = abs(C1 * alpha_pos[j] -
         wolves[i, j])
         X1 = alpha_pos[j] - A1 * D_alpha

         # Positon update based on beta
         r1 = np.random.random()
         r2 = np.random.random()
         A2 = 2 * a * r1 - a
         C2 = 2 * r2
         D_beta = abs(C2 * beta_pos[j] - wolves[i,
         j])
         X2 = beta_pos[j] - A2 * D_beta

         # Positon update based on delta
         r1 = np.random.random()
         r2 = np.random.random()
         A3 = 2 * a * r1 - a
         C3 = 2 * r2
         D_delta = abs(C3 * delta_pos[j] - wolves[i,
         j])
         X3 = delta_pos[j] - A3 * D_delta

         # Update wolf positon
         wolves[i, j] = (X1 + X2 + X3)
         / 3
```

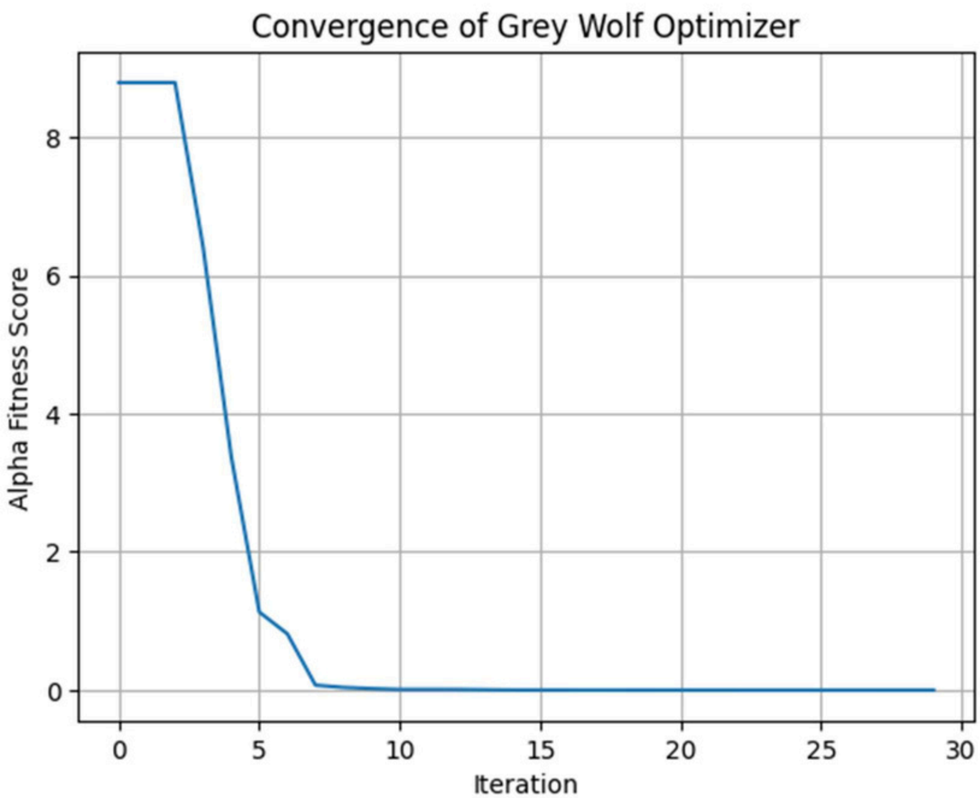
```
        # Apply boundary constraints
        wolves[i, j] = np.clip(wolves[i, j], lb, ub)

# Step 6: Iterate (repeat evaluaton and positon
updatng)
for iteraton in range(num_iteratons):
    evaluate_fitness() # Evaluate fitness of each wolf
    update_positons(iteraton) # Update positons based on alpha, beta,
    delta
    # Record the alpha score for this
    iteraton
    alpha_score_history.append(alpha_sco
    re)
    # Optonal: Print current best score
    print(f"Iteraton {iteraton+1}/{num_iteratons}, Alpha Score:
    {alpha_score}")

# Step 7: Output the Best Soluton
print("Best Soluton:", alpha_pos)
print("Best Soluton Fitness:",
alpha_score)
# Plotng the convergence graph
plt.plot(alpha_score_history)
plt.ttle('Convergence of Grey Wolf
Optmizer')
plt.xlabel('Iteraton')
plt.ylabel('Alpha Fitness Score')
plt.grid(True)
plt.show()
```

OUTPUT:

```
Iteration 1/30, Alpha Score: 8.789922247101906
Iteration 2/30, Alpha Score: 8.789922247101906
Iteration 3/30, Alpha Score: 8.789922247101906
Iteration 4/30, Alpha Score: 6.409956649485766
Iteration 5/30, Alpha Score: 3.383929841190778
Iteration 6/30, Alpha Score: 1.1292299489236237
Iteration 7/30, Alpha Score: 0.8136628488047792
Iteration 8/30, Alpha Score: 0.07110881373527288
Iteration 9/30, Alpha Score: 0.03823180120070083
Iteration 10/30, Alpha Score: 0.021111314445105462
Iteration 11/30, Alpha Score: 0.00874782100259989
Iteration 12/30, Alpha Score: 0.00874782100259989
Iteration 13/30, Alpha Score: 0.00874782100259989
Iteration 14/30, Alpha Score: 0.005066807028932165
Iteration 15/30, Alpha Score: 0.0011746187200998674
Iteration 16/30, Alpha Score: 0.0011746187200998674
Iteration 17/30, Alpha Score: 0.0008078646351838173
Iteration 18/30, Alpha Score: 0.0008078646351838173
Iteration 19/30, Alpha Score: 0.0006302256737926024
Iteration 20/30, Alpha Score: 0.0005272190797352655
Iteration 21/30, Alpha Score: 0.00035614966782860404
Iteration 22/30, Alpha Score: 0.0003270119398391142
Iteration 23/30, Alpha Score: 0.00022723766847392013
Iteration 24/30, Alpha Score: 0.00022152382849585967
Iteration 25/30, Alpha Score: 0.00022152382849585967
Iteration 26/30, Alpha Score: 0.00020102313789207912
Iteration 27/30, Alpha Score: 0.0001974565833678501
Iteration 28/30, Alpha Score: 0.0001547675581999543
Iteration 29/30, Alpha Score: 0.00014751518222697009
Iteration 30/30, Alpha Score: 0.00014751518222697009
Best Solution: [ 0.00643925 -0.01029812]
Best Solution Fitness: 0.00014751518222697009
```


Convergence of Grey Wolf Optimizer
Alpha Fitness Score
Iteration
0
2
4
6
8
0
5
10
15
20
25
30