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LAB-5 : Grey Wolf Op mizer (GWO):

CODE:

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


# Step 1: Define the Problem (a mathema cal func on to op mize) def
objec ve_func on(x):

    return np.sum(x**2)  # Example: Sphere func on (minimize sum of squares)


# Step 2: Ini alize Parameters num_wolves = 5  # Number of wolves in the
pack num_dimensions = 2  # Number of dimensions (for the op miza on
problem) num_itera ons = 30  # Number of itera ons lb = -10  # Lower bound
of search space ub = 10  # Upper bound of search space


# Step 3: Ini alize Popula on (Generate ini al posi ons randomly) wolves
= np.random.uniform(lb, ub, (num_wolves, num_dimensions))


# Ini alize 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 itera ons 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 = objec ve_func on(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 Posi ons def
update_posi ons(itera on):     a =
2 - itera on * (2 / num_itera ons)
# 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()


            # Posi on 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

            # Posi on 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

            # Posi on 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 posi on
wolves[i, j] = (X1 + X2 + X3) / 3
# Apply boundary constraints
wolves[i, j] = np.clip(wolves[i, j], lb,
ub)


# Step 6: Iterate (repeat evalua on and posi on upda ng) for
itera on in range(num_itera ons):

   evaluate_fitness()  # Evaluate fitness of each wolf     update_posi ons(itera
on)  # Update posi ons based on alpha, beta, delta


   # Record the alpha score for this itera on
alpha_score_history.append(alpha_score)


   # Op onal: Print current best score     print(f"Itera on {itera
on+1}/{num_itera ons}, Alpha Score: {alpha_score}")


# Step 7: Output the Best Solu on
print("Best Solu on:", alpha_pos) print("Best
Solu on Fitness:", alpha_score)


#     Plo     ng     the     convergence     graph
plt.plot(alpha_score_history)                      plt.
```

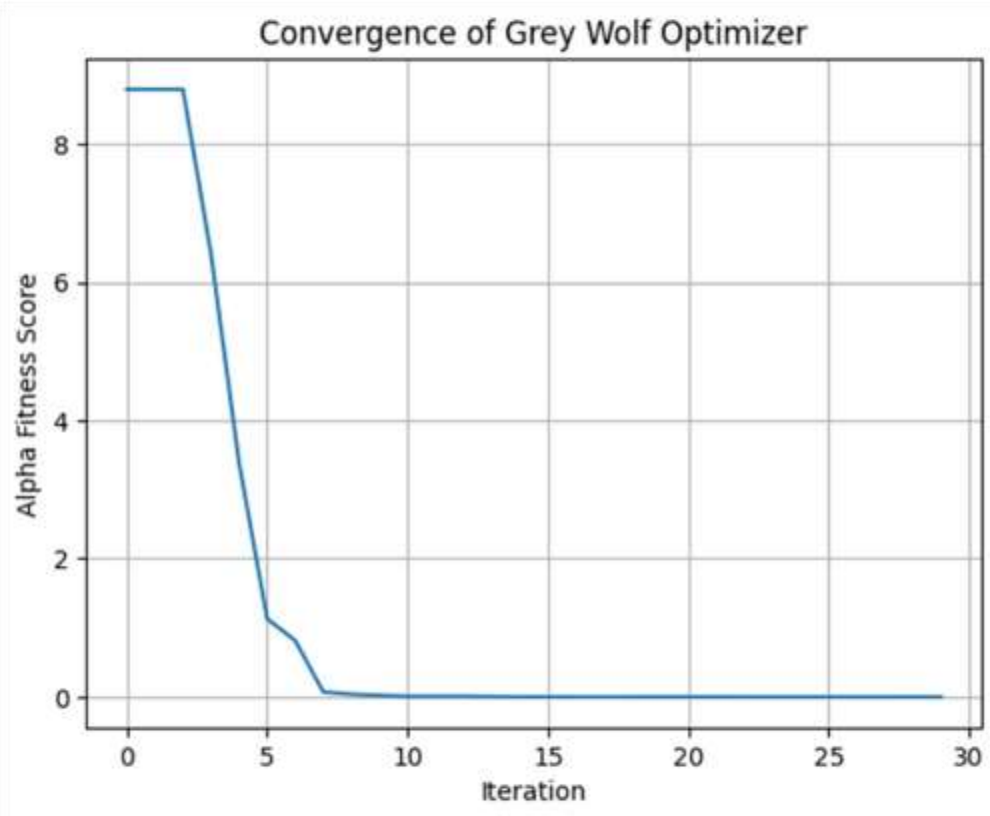
```
Iteration 1/30, Alpha Score: 8.789922247101906
Iteration 2/30, Alpha Score: 8.789922247101906
Iteration 3/30, Alpha Score: 8.789922247101906
Iteration 4/30, Alpha Score: 6.409956649485766
Iteration 5/30, Alpha Score: 3.383929841190778
Iteration 6/30, Alpha Score: 1.1292299489236237
Iteration 7/30, 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
```

tle('Convergence of Grey Wolf Op mizer')

plt.xlabel('Itera on') plt.ylabel('Alpha Fitness

Score') plt.grid(True) plt.show()

OUTPUT:



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