4. cuckoo search

LAB-4 : Cuckoo Search (CS):

CODE:

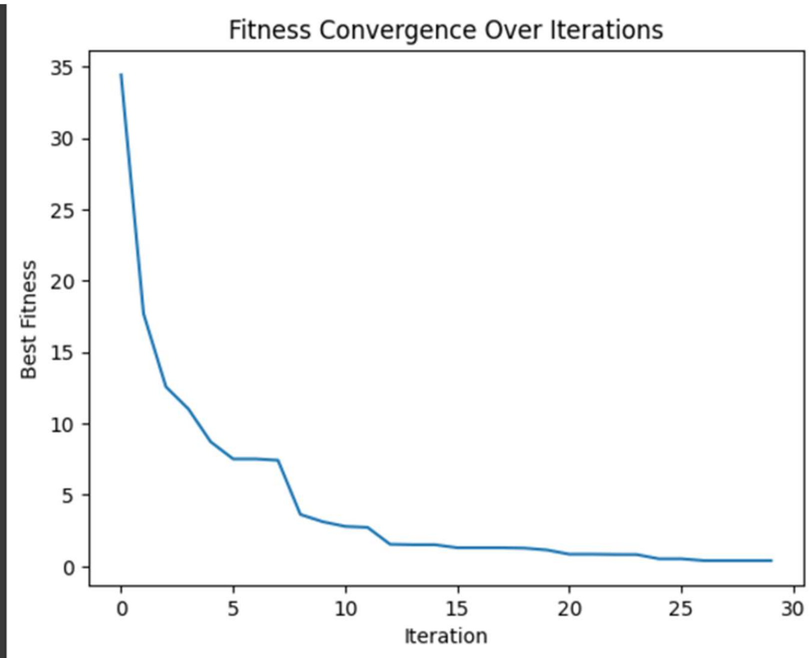
```
#cuckoo search
import numpy as np
import random
import math
import matplotlib.pyplot as plt

# Define a sample function to optimize (Sphere function in this case)
def objective_function(x):
    return np.sum(x ** 2)

# Lévy flight function
def levy_flight(Lambda):
    sigma_u = (math.gamma(1 + Lambda) * np.sin(np.pi * Lambda / 2) /
              (math.gamma((1 + Lambda) / 2) * Lambda * 2 ** ((Lambda - 1) / 2))) ** (1 / Lambda)
    sigma_v = 1
    u = np.random.normal(0, sigma_u, size=1)
    v = np.random.normal(0, sigma_v, size=1)
    step = u / (abs(v) ** (1 / Lambda))
    return step

# Cuckoo Search algorithm
def cuckoo_search(num_nests=25, num_iterations=100, discovery_rate=0.25, dim=5, lower_bound=-10, upper_bound=10):
    # Initialize nests
    nests = np.random.uniform(lower_bound, upper_bound, (num_nests, dim))
    fitness = np.array([objective_function(nest) for nest in nests])

    # Get the current best nest
```

```
best_nest_idx = np.argmin(fitness)
best_nest = nests[best_nest_idx].copy()
best_fitness = fitness[best_nest_idx]

Lambda = 1.5  # Parameter for Lévy flights
fitness_history = []  # To track fitness at each iteration

for iteration in range(num_iterations):
    # Generate new solutions via Lévy flight
    for i in range(num_nests):
        step_size = levy_flight(Lambda)
        new_solution = nests[i] + step_size * (nests[i] - best_nest)
        new_solution = np.clip(new_solution, lower_bound, upper_bound)
        new_fitness = objective_function(new_solution)

        # Replace nest if new solution is better
        if new_fitness < fitness[i]:
            nests[i] = new_solution
            fitness[i] = new_fitness

    # Discover some nests with probability 'discovery_rate'
    random_nests = np.random.choice(num_nests, int(discovery_rate * num_nests), replace=False)
    for nest_idx in random_nests:
        nests[nest_idx] = np.random.uniform(lower_bound, upper_bound, dim)
        fitness[nest_idx] = objective_function(nests[nest_idx])

    # Update the best nest
    current_best_idx = np.argmin(fitness)
    if fitness[current_best_idx] < best_fitness:
        best_fitness = fitness[current_best_idx]
        best_nest = nests[current_best_idx].copy()
```

```
        fitness_history.append(best_fitness)

        print(f"Iteration {iteration+1}/{num_iterations}, Best Fitness: {best_fitness}")


    plt.plot(fitness_history)

    plt.title('Fitness Convergence Over Iterations')

    plt.xlabel('Iteration')

    plt.ylabel('Best Fitness')

    plt.show()

    return best_nest, best_fitness


best_nest, best_fitness = cuckoo_search(num_nests=30, num_iterations=100, dim=10, lower_bound=-5, upper_bound=5)

print("Best Solution:", best_nest)

print("Best Fitness:", best_fitness)
```

OUTPUT:

```
Iteration 1/30, Best Fitness: 34.421347350368414
Iteration 2/30, Best Fitness: 17.701267864864427
Iteration 3/30, Best Fitness: 12.572246094152595
Iteration 4/30, Best Fitness: 11.025968548544025
Iteration 5/30, Best Fitness: 8.713786692960158
Iteration 6/30, Best Fitness: 7.5206125475077785
Iteration 7/30, Best Fitness: 7.5206125475077785
Iteration 8/30, Best Fitness: 7.426062303628502
Iteration 9/30, Best Fitness: 3.6305424687807872
Iteration 10/30, Best Fitness: 3.122312407680085
Iteration 11/30, Best Fitness: 2.7935374916676268
Iteration 12/30, Best Fitness: 2.7258275326189683
Iteration 13/30, Best Fitness: 1.5451154817432429
Iteration 14/30, Best Fitness: 1.5138101828809285
Iteration 15/30, Best Fitness: 1.5138101828809285
Iteration 16/30, Best Fitness: 1.300269684490209
Iteration 17/30, Best Fitness: 1.300269684490209
Iteration 18/30, Best Fitness: 1.300269684490209
Iteration 19/30, Best Fitness: 1.2738498249584989
Iteration 20/30, Best Fitness: 1.1445834652176474
Iteration 21/30, Best Fitness: 0.8487556087655604
Iteration 22/30, Best Fitness: 0.8487556087655604
Iteration 23/30, Best Fitness: 0.8289231635578032
Iteration 24/30, Best Fitness: 0.8242402471719793
Iteration 25/30, Best Fitness: 0.5258270013075049
Iteration 26/30, Best Fitness: 0.5258270013075049
Iteration 27/30, Best Fitness: 0.3996236442626478
Iteration 28/30, Best Fitness: 0.3996236442626478
Iteration 29/30, Best Fitness: 0.3996236442626478
Iteration 30/30, Best Fitness: 0.3996236442626478
```




```
Best Solution: [ 0.1187463  -0.27226584  0.30789726 -0.04631337 -0.41395998  0.0566571
 -0.05240855 -0.11176247  0.15695263 -0.00202369]
Best Fitness: 0.3996236442626478
```