1BM22CS241

Sanjeet Prajwal Pandit

Parallel_Cellular_Algorithm

```
import numpy as np
import random

# Step 1: Define the Problem (Optimization Function)
def fitness_function(position):
    """Example fitness function: Sphere function"""
    return sum(x**2 for x in position)

# Step 2: Initialize Parameters
grid_size = (10, 10)  # Grid size (10x10 cells)
dim = 2  # Dimensionality of each cell's position
minx, maxx = -10.0, 10.0  # Search space bounds
max_iterations = 50  # Number of iterations

# Step 3: Initialize Population (Random positions)
def initialize_population(grid_size, dim, minx, maxx):
    population = np.zeros((grid_size[0], grid_size[1], dim))
    for i in range(grid_size[0]):
        for j in range(grid_size[1]):
            population[i, j] = [random.uniform(minx, maxx) for _ in
range(dim)]
    return population

# Step 4: Evaluate Fitness (Calculate fitness for each cell)
def evaluate_fitness(population):
    fitness_grid = np.zeros((grid_size[0], grid_size[1]))
    for i in range(grid_size[0]):
        for j in range(grid_size[1]):
            fitness_grid[i, j] = fitness_function(population[i, j])
    return fitness_grid

# Step 5: Update States (Update each cell based on its neighbors)
def get_neighbors(i, j):
    """Returns the coordinates of neighboring cells."""
    neighbors = []
    for di in [-1, 0, 1]:
        for dj in [-1, 0, 1]:
            if not (di == 0 and dj == 0):  # Exclude the cell itself
                ni, nj = (i + di) % grid_size[0], (j + dj) % grid_size[1]
                neighbors.append((ni, nj))
    return neighbors

def update_cell(population, fitness_grid, i, j, minx, maxx):
    """Update the state of a cell based on the average state of its
neighbors."""
    neighbors = get_neighbors(i, j)
    best_neighbor = min(neighbors, key=lambda x: fitness_grid[x[0], x[1]])

    # Update cell position to move towards the best neighbor's position
    new_position = population[best_neighbor[0], best_neighbor[1]] + \
                   np.random.uniform(-0.1, 0.1, dim)  # Small random
perturbation
```

```python
    # Ensure the new position stays within bounds
    new_position = np.clip(new_position, minx, maxx)
    return new_position

# Step 6: Iterate (Repeat for a fixed number of iterations)
population = initialize_population(grid_size, dim, minx, maxx)
for iteration in range(max_iterations):
    fitness_grid = evaluate_fitness(population)

    # Update each cell in parallel (simultaneously)
    new_population = np.zeros_like(population)
    for i in range(grid_size[0]):
        for j in range(grid_size[1]):
            new_population[i, j] = update_cell(population, fitness_grid, i,
j, minx, maxx)

    population = new_population

    # Print best fitness at each iteration
    best_fitness = np.min(fitness_grid)
    print(f"Iteration {iteration + 1}, Best Fitness: {best_fitness}")

# Step 7: Output the Best Solution
best_index = np.unravel_index(np.argmin(fitness_grid), fitness_grid.shape)
best_position = population[best_index[0], best_index[1]]
best_fitness = np.min(fitness_grid)
print("Best Position Found:", best_position)
print("Best Fitness Found:", best_fitness)
```

```
Best Position Found: [0.0006103 0.0713697]
Best Fitness Found: 0.00013118875168395672
```