

```

1 import numpy as np
2 from evolution import selection, fitness
3 from functions import *
4
5 class EvoPhase:
6     #Initiate parameters
7     def __init__(self, population_tot, crossover_rate, mutation_rate, generations, N, d, target):
8         self.population_tot = population_tot
9         self.crossover_rate = crossover_rate
10        self.mutation_rate = mutation_rate
11        self.generations = generations
12        self.N = N
13        self.target = target
14
15        # Spacing between antennas
16        self.pop_dis = np.ndarray(shape=(self.population_tot, self.N-1))
17
18        # Phase Shift of the signal of each antenna element
19        self.pop_pha = np.random.uniform(size = (self.population_tot, self.N), low = 0, high = 2*np.pi) # randians
20
21        # Amplitude of the signal of each antenna element.
22        self.pop_amp = np.ndarray(shape=(self.population_tot, self.N))
23        # Uniform amplitude
24        amp = np.array([1, 1, 1, 1, 1, 1])
25
26        # Population with same spacing and amplitude -> Only optimizing phase
27        for i in range(self.population_tot):
28            self.pop_dis[i, :] = d
29            self.pop_amp[i, :] = amp
30
31        # Fitness scores
32        self.pop_fit = np.zeros(self.population_tot, dtype = np.float)
33
34        self.evolve()
35
36    def results(self):
37        # Return the best solution
38        q = np.argmin(self.pop_fit)
39        return self.pop_pha[q]
40
41    def evolve(self):
42        # probabilities for crossover. To avoid calculating random numbers every iteration.
43        crossovers = np.random.uniform(size=(self.generations), low = 0, high=1)
44        mutations = np.random.uniform(size=(self.generations), low = 0, high=1)
45
46        for i in range(self.generations):
47            tot = 0
48            # Calculate the fitness score of each solution
49            for dna in range(self.population_tot):
50                score = fitness(self.pop_dis[dna], self.pop_pha[dna], self.pop_amp[dna], self.target)
51                self.pop_fit[dna] = score;
52                tot += score
53            # Index of fittest solution
54            index = np.argmin(self.pop_fit)
55            # Copy fittest solution over to next generation (first and last index of array)
56            self.pop_pha[0] = self.pop_pha[index]
57            self.pop_pha[-1] = self.pop_pha[index]
58
59            # Stop simulating when the generation matches the maximum no of generations.
60            if i == self.generations-1:
61                print('DONE')
62                break
63
64            # Iterations per generations
65            for _ in range(1):
66                if crossovers[i] < self.crossover_rate:
67                    # crossover occurs (Two parent solutions)
68                    s_1 = selection(self.pop_fit)
69                    s_2 = selection(self.pop_fit)
70                    # Offspring
71                    self.pop_pha[s_1] = np.divide(self.pop_pha[s_1] + self.pop_pha[s_2],2)
72
73                if mutations[i] < self.mutation_rate:
74                    # mutation occurs
75                    s_1 = selection(self.pop_fit)
76                    self.pop_pha[s_1][np.random.randint(low=0, high=self.N)] = np.random.uniform(low = 0, high=2*np.pi)
77

```