Application CCSA → using Sine chaotic Map

$M = 3$

$A.P. = [0.1, 0.1, 0.1]$

$fl = [2, 2, 2]$

$t_{max} = 4$

let's assume objective $F_n = 30x - x^2$ (Maximize)

& search space of x is (0, 40)

$\therefore F(x) = 30x - x^2$ subject to : $x \geq 0$ & $x \leq 40$

A) Step I : Initialize initial positions (x) & chaotic parameters (C)

$x_0 = [5, 25, 11]$

$C_0 = [0.2, 0.2, 0.5]$

B) Step II : Evaluate the fitness function of each crow

$x_0[0] = 5 \rightarrow f(5) = 125$

$x_0[1] = 25 \rightarrow f(25) = 125$

$x_0[2] = 11 \rightarrow f(11) = 209$

C) Step III : Initialize the memory of search crows :

Let's say : $N_0 = [10, 18, 14]$

[Here, each crow has stored in memory the hiding places they think will there treasure be]

D) Step 4: To find best solution N (Run a loop for t_{MAX} times)

i) For $t = 1$

for $j = 0$

$z = 1$ (randomly)

[$\because C_0[1] = 0.2$, $AP[1] = 0.1$]

$\therefore y_1[0] = y_0[0] + C_0[0] * fl[0] * (N_0[1] - y_0[0])$

$\therefore y_1[0] = 10.2$

for $j = 1$

$z = 1$ (randomly)

[$\because C_0[1] = 0.2$, $AP[1] = 0.1$]

$\therefore y_1[1] = y_0[1] + C_0[1] * fl[1] * (N_0[1] - y_0[1])$

$\therefore y_1[1] = 22.2$

for $j = 2$

$z = 1$ (randomly)

[$\because C_0[1] = 0.2$, $AP[1] = 0.1$]

$\therefore y_1[2] = y_0[2] + C_0[2] * fl[2] * (N_0[1] - y_0[2])$

$\therefore y_1[2] = 18$

$\because y_i \; \forall i$ satisfy constraint (ie $0 \le y_i \le 40$) they are feasible

$y_1[0] = 10.2 \rightarrow f(10.2) = 201.96$

$y_1[1] = 22.2 \rightarrow f(22.2) = 173.16$

$y_1[2] = 18 \rightarrow f(18) = 216$

$\therefore Y_1 = [10.2, 22.2, 18]$

Now updating each row's memory by this behavior : $N_{t+1}[j] \begin{cases} N_t[j] & \text{otherwise} \\ Y_{t+1}[j] & \text{if } F(Y_{t+1}[j]) \text{ better than } F(N_t[j]) \end{cases}$

$\therefore N_1 = [10.2, 18, 14]$

$[\because f(N_0[0]) = 200, f(N_0[1]) = 216, f(N_0[2]) = 224,$
$f(Y_1[0]) = 201.96, f(Y_1[1]) = 173.16, f(Y_1[2]) = 216]$

$\therefore C_1 = [0.58, 0.58, 1]$ $\quad [\because C_{t+1} = \sin(\pi C_t)]$

ii) For $t=2$

for $j=0$

$z = 2$ (randomly)

$\because [C_1[2] = 1, AP[2] = 0.1]$

$\therefore Y_2[0] = Y_1[0] + C_1[0] * fl[0] * (N_1[2] - Y_1[0])$

$\therefore Y_2[0] = 14.608$

for $j=1$

$z = 2$ (randomly)

$\because [C_1[2] = 1, AP[2] = 0.1]$

$\therefore Y_2[1] = Y_1[1] + C_1[1] * fl[1] * (N_1[2] - Y_1[1])$

$\therefore Y_2[1] = 12.688$

for $j=2$

$z = 2$ (randomly)

$\because [C_1[2] = 1, AP[2] = 0.1]$

$\therefore Y_2[2] = Y_1[2] + C_1[2] * fl[2] * (N_1[2] - Y_1[2])$

$\therefore Y_2[2] = 10$

$\because y_i \ \forall i$ satisfy constraints (i.e $0 \le y_i \le 40$) they are feasible

$$y_2[0] = 14.608 \rightarrow f(14.608) = 224.84$$
$$y_2[1] = 12.688 \rightarrow f(12.688) = 219.65$$
$$y_2[2] = 10 \rightarrow f(10) = 200$$

$$y_2 = [14.608, 12.688, 10]$$

Now updating each crow's memory by this behavior : $N_{t+1}[j] \begin{cases} N_t[j] & \text{otherwise} \\ y_{t+1}[j] & \text{if } F(y_{t+1}[j]) \text{ better than } F(N_t[j]) \end{cases}$

$$\therefore N_2 = [14.608, 12.688, 14]$$

$[\because f(N_1[0]) = 201.96, f(N_1[1]) = 216, f(N_1[2]) = 224,$
$f(y_2[0]) = 224.84, f(y_2[1]) = 219.65, f(y_2[2]) = 200]$

$\therefore C_2 = [0.96, 0.96, 0]$ $\quad [\because C_{t+1} = \sin(\pi(t))]$

iii) For $t = 3$

for $j = 0$

$z = 2$ (randomly)

$\because [C_2[2] = 0, AP[2] = 0.1]$

$\therefore y_3[0] = 21$ (randomly)

[Here crow 2 got to know crow 0 is following it, this way he misrouted crow 0 from treasure]

For $j = 1$

$z = 2$ (randomly)

$[\because G_2[2] = 0, \ AP[2] = 0.1]$

$\therefore Y_3[1] = 11$ (randomly)

For $j = 2$

$z = 2$ (randomly)

$[\because G_2[2] = 0, \ AP[2] = 0.1]$

$\therefore Y_3[2] = 10$ (randomly)

$\because Y_i \ \forall \ i$ satisfies constraint (i.e $0 \le Y_i \le 40$) are feasible

$\therefore Y_3[0] = 21 \rightarrow f(21) = 189$

$Y_3[1] = 11 \rightarrow f(11) = 209$

$Y_3[2] = 10 \rightarrow f(10) = 200$

$Y_3 = [21, 11, 10]$

$\therefore$ Now updating crow's memory : $N_{t+1}[j] \begin{cases} N_t[j] & \text{otherwise} \\ Y_{t+1}[j] & \text{if } F(Y_{t+1}[j]) \text{ better than } F(N_t[j]) \end{cases}$

by this behaviour

$\therefore N_3 = [14.608, 12.688, 14]$

$[\because f(N_2[0]) = 224.84, \ f(N_2[1]) = 219.65, \ f(N_2[2]) = 224,$
$f(Y_3[0]) = 189, \ f(Y_3[1]) = 209, \ f(Y_3[2]) = 200]$

$\therefore C_3 = [0.125, 0.125, 0]$ $[\because C_{t+1} = \sin(\pi C_t)]$

iv) For $t = 4$

for $j = 0$:

$z = 1$ (randomly)

[$\because C_3[1] = 0.125$, $AP[1] = 0.1$]

$\therefore Y_4[0] = Y_3[0] + C_3[0] * fl[0] * (N_3[1] - Y_3[0])$

$\therefore Y_4[0] = 21 + (0.125 * 2 * (12.688 - 21))$

$\therefore Y_4[0] = 18.922$

for $j = 1$:

$z = 0$ (randomly)

[$\because C_3[0] = 0.125$, $AP[0] = 0.1$]

$\therefore Y_4[1] = Y_3[1] + C_3[1] * fl[1] * (N_3[0] - Y_3[1])$

$\therefore Y_4[1] = 11.902$

for $j = 2$

$z = 1$ (randomly)

[$\because C_3[2] = 0$, $AP[2] = 0.1$]

$\therefore Y_4[2] = 20$ (randomly)

$\because Y_i \ \forall i$ satisfies constraint $(0 \le Y_i \le 40)$ are feasible

$\therefore Y_4[0] = 18.922 \rightarrow f(18.922) = 209.61$

$Y_4[1] = 11.902 \rightarrow f(11.902) = 215.40$

$Y_4[2] = 20 \rightarrow f(20) = 200$

$Y_4 = [18.922, 11.902, 20]$

Now updating each row's memory by this behavior : $N_{t+1}[j] \begin{cases} N_t[j] & \text{otherwise} \\ Y_{t+1}[j] & \text{if } F(Y_{t+1}[j]) \text{ better than } F(N_t[j]) \end{cases}$

$$\therefore N_4 = [14.608, 12.688, 14]$$

$[\because f(N_3[0]) = 224.84, f(N_3[1]) = 219.65, f(N_3[2]) = 224$
$f(Y_4[0]) = 209.61, f(Y_4[1]) = 215.40, f(Y_4[2]) = 200]$

$\therefore$ Optimum values of N for each row is : $[14.608, 12.688, 14]$