

Eurasian Oystercatcher Optimiser

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Eurasian Oystercatcher Optimiser (EOO)

- Fue desarrollada por Ahmad Salim et. al. en el año 2021 ^a.
- Es una metaheurística basado en población diseñada para resolver problemas de optimización continuos.
- Sus soluciones (individuos) iniciales se generan aleatoreamente y se van alterando bajo un conjunto de reglas de movimiento con criterios estocásticos.

^a *Eurasian oystercatcher optimiser: New meta-heuristic algorithm*, Degruyter (2022)

EOO: Ecuaciones de movimiento

- Ecuaciones de movimientos

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 \quad (1)$$

$$E = \left(\frac{iter-1}{n-1} \right) - 0,5 \quad (2)$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 \quad (3)$$

- Donde:

- T es el tiempo requerido para abrir el mejillón
 - L es un valor aleatorio entre $[3, 5]$
- E representa al energia actual del EO con:
 - $iter > 1$, representa el valor de iteración que comienza con el número de iteraciones y termina con uno
- C representa el valor calórico del mejillón

- Ecuaciones de movimientos

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1}) \quad (4)$$

$$X_i = X_{i-1} \cdot C \quad (5)$$

$$X_i = X_{i-1} + Y \quad (6)$$

- Donde:

- Y representa la energía final del EO después de cada iteración
 - r es un valor aleatorio entre $[0, 1]$
- X_i es la posición del mejillón candidato

Algorithm 1 Eurasian Oystercatcher Optimiser

Input: Population $X = \{x_1, x_2, \dots, x_N\}$
Output: Updated population $X' = \{x'_1, x'_2, \dots, x'_N\}$ and X_{best}

- 1: Initialize random fox population X
- 2: **for** $it = 1$ to $MaxIt$ **do**
- 3: calculate the fitness of each X
- 4: select X_{best}
- 5: **for** $i=0$ to N **do**
- 6: $L = \text{random}(3,5)$
- 7: $T = ((L-5)/(5-3)) * 10) - 5$
- 8: $E = (it-1)/(n-1) - 0.5$
- 9: $C = ((L-3)/(5-3)) * 2) + 0.6$
- 10: $r = \text{random}(0,1)$
- 11: $Y = T + E + L * r * (X_{best} - X_{i-1})$
- 12: $X_i = X_{i-1} * C$
- 13: $X_i = X_i + Y$
- 14: **return** updated population X' and X_{best}

EOO: Ejemplo práctico - parámetros iniciales

Considerando

$$\text{Min } z = x_1^2 + x_2^2 + x_3^2$$

Sujeto a

$$x_1, x_2, x_3 \in [-100, 100]$$

Configuración inicial de EOO:

- Tamaño de la población: 3 individuos
- Número máximo de iteraciones: 100 iteraciones

EOO: Ejemplo práctico - soluciones iniciales

Soluciones iniciales:

ind 1: [-40.8909, 9.9622, 29.5035] / fitness: 2641.7638

ind 2: [-84.6019, 90.1641, 62.8192] / fitness: 19233.2942

ind 3: [-7.0804, -53.185, 58.2809] / fitness: 6275.4378

Mejor solución:

ind 1: [-40.8909, 9.9622, 29.5035] / fitness: 2641.7638

EOO: Ejemplo práctico - iter 1 - ind 1

Ecuaciones generales de la iteración 1:

$$L = \text{random}(3, 5) = 3,9579$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{3,9579-3}{5-3} \right) \cdot 10 \right) - 5 = -10,2107$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{100-1}{3-1} \right) - 0,5 = 49$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{3,9579-3}{5-3} \right) \cdot 2 \right) + 0,6 = 1,5579$$

$$r = \text{random}(0, 1) = 0,4469$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -10,2107 + 49,0000 + 3,9579 \cdot 0,4469 \cdot (-40,8909 - -40,8909) = 38,7893$$

$$X_1 = X_0 \cdot C = -40,8909 \cdot 1,5579 = -63,7019$$

$$X_1 = X_0 + Y = -63,7019 + 38,7893 = -24,9127$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -10,2107 + 49,0000 + 3,9579 \cdot 0,4469 \cdot (9,9622 - 9,9622) = 38,7893$$

$$X_1 = X_0 \cdot C = 9,9622 \cdot 1,5579 = 15,5196$$

$$X_1 = X_0 + Y = 15,5196 + 38,7893 = 54,3088$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -10,2107 + 49,0000 + 3,9579 \cdot 0,4469 \cdot (29,5035 - 29,5035) = 38,7893$$

$$X_1 = X_0 \cdot C = 29,5035 \cdot 1,5579 = 45,9620$$

$$X_1 = X_0 + Y = 45,9620 + 38,7893 = 84,7513$$

Ecuaciones generales de la iteración 1:

$$L = \text{random}(3, 5) = 3,7726$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{3,7726-3}{5-3} \right) \cdot 10 \right) - 5 = -11,1371$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{100-1}{3-1} \right) - 0,5 = 49$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{3,7726-3}{5-3} \right) \cdot 2 \right) + 0,6 = 1,3726$$

$$r = \text{random}(0, 1) = 0,1875$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -11,1371 + 49,0000 + 3,7726 \cdot 0,1875 \cdot (-40,8909 - -84,6019) = 68,7861$$

$$X_1 = X_0 \cdot C = -84,6019 \cdot 1,3726 = -116,1221$$

$$X_1 = X_0 + Y = -116,1221 + 68,7861 = -47,3360$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -11,1371 + 49,0000 + 3,7726 \cdot 0,1875 \cdot (9,9622 - 90,1641) = -18,8758$$

$$X_1 = X_0 \cdot C = 90,1641 \cdot 1,3726 = 123,7566$$

$$X_1 = X_0 + Y = 123,7566 + -18,8758 = 104,8809$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -11,1371 + 49,0000 + 3,7726 \cdot 0,1875 \cdot (29,5035 - 62,8192) = 14,2937$$

$$X_1 = X_0 \cdot C = 62,8192 \cdot 1,3726 = 86,2238$$

$$X_1 = X_0 + Y = 86,2238 + 14,2937 = 100,5176$$

Ecuaciones generales de la iteración 1:

$$L = \text{random}(3, 5) = 3,4031$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{3,4031-3}{5-3} \right) \cdot 10 \right) - 5 = -12,9847$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{100-1}{3-1} \right) - 0,5 = 49$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{3,4031-3}{5-3} \right) \cdot 2 \right) + 0,6 = 1,0031$$

$$r = \text{random}(0, 1) = 0,5070$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -12,9847 + 49,0000 + 3,4031 \cdot 0,5070 \cdot (-40,8909 - -7,0804) = -22,3233$$

$$X_1 = X_0 \cdot C = -7,0804 \cdot 1,0031 = -7,1021$$

$$X_1 = X_0 + Y = -7,1021 + -22,3233 = -29,4254$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -12,9847 + 49,0000 + 3,4031 \cdot 0,5070 \cdot (9,9622 - -53,1850) = 144,9733$$

$$X_1 = X_0 \cdot C = -53,1850 \cdot 1,0031 = -53,3480$$

$$X_1 = X_0 + Y = -53,3480 + 144,9733 = 91,6253$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -12,9847 + 49,0000 + 3,4031 \cdot 0,5070 \cdot (29,5035 - 58,2809) = -13,6389$$

$$X_1 = X_0 \cdot C = 58,2809 \cdot 1,0031 = 58,4594$$

$$X_1 = X_0 + Y = 58,4594 + -13,6389 = 44,8205$$

EOO: Ejemplo práctico - validación restricciones

Restricción: $x_1, x_2, x_3 \in [-100, 100]$

Soluciones obtenidas en la iteración 1:

ind 1: [-24.9127, 54.3088, 84.7513], infactibles: 0

ind 2: [-47.336, **104.8809**, **100.5176**], **infactibles: 2**

ind 3: [-29.4254, 91.6253, 44.8205], infactibles: 0

Reparación de soluciones:

ind 1: [-24.9127, 54.3088, 84.7513] / fitness: 10752.8735

ind 2: [-47.336, 100.0, 100.0] / fitness: 22240.6965

ind 3: [-29.4254, 91.6253, 44.8205] / fitness: 11269.9249

Mejor solución:

ind 1: [-24.9127, 54.3088, 84.7513] / fitness: 10752.8735

EOO: Ejemplo práctico - iter 2 - ind 1

Ecuaciones generales de la iteración 2:

$$L = \text{random}(3, 5) = 4,6880$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{4,6880-3}{5-3} \right) \cdot 10 \right) - 5 = -6,5600$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{99-1}{3-1} \right) - 0,5 = 48,5000$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{4,6880-3}{5-3} \right) \cdot 2 \right) + 0,6 = 2,2880$$

$$r = \text{random}(0, 1) = 0,9493$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -6,5600 + 48,5000 + 4,6880 \cdot 0,9493 \cdot (-24,9127 - -24,9127) = 41,9400$$

$$X_2 = X_0 \cdot C = -24,9127 \cdot 2,2880 = -57,0000$$

$$X_2 = X_0 + Y = -57,0000 + 41,9400 = -15,0601$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -6,5600 + 48,5000 + 4,6880 \cdot 0,9493 \cdot (54,3088 - 54,3088) = 41,9400$$

$$X_2 = X_0 \cdot C = 54,3088 \cdot 2,2880 = 124,2583$$

$$X_2 = X_0 + Y = 124,2583 + 41,9400 = 166,1983$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -6,5600 + 48,5000 + 4,6880 \cdot 0,9493 \cdot (84,7513 - 84,7513) = 41,9400$$

$$X_2 = X_0 \cdot C = 84,7513 \cdot 2,2880 = 193,9105$$

$$X_2 = X_0 + Y = 193,9105 + 41,9400 = 235,8504$$

Ecuaciones generales de la iteración 2:

$$L = \text{random}(3, 5) = 3,3565$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{3,3565-3}{5-3} \right) \cdot 10 \right) - 5 = -13,2174$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{99-1}{3-1} \right) - 0,5 = 48,5000$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{3,3565-3}{5-3} \right) \cdot 2 \right) + 0,6 = 0,9565$$

$$r = \text{random}(0, 1) = 0,9215$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -13,2174 + 48,5000 + 3,3565 \cdot 0,9215 \cdot (-24,9127 - -47,3360) = 104,6368$$

$$X_2 = X_0 \cdot C = -47,3360 \cdot 0,9565 = -45,2776$$

$$X_2 = X_0 + Y = -45,2776 + 104,6368 = 59,3592$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -13,2174 + 48,5000 + 3,3565 \cdot 0,9215 \cdot (54,3088 - 100,0000) = -106,0378$$

$$X_2 = X_0 \cdot C = 100,0000 \cdot 0,9565 = 95,6514$$

$$X_2 = X_0 + Y = 95,6514 + -106,0378 = -10,3863$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -13,2174 + 48,5000 + 3,3565 \cdot 0,9215 \cdot (84,7513 - 100,0000) = -11,8809$$

$$X_2 = X_0 \cdot C = 100,0000 \cdot 0,9565 = 95,6514$$

$$X_2 = X_0 + Y = 95,6514 + -11,8809 = 83,7706$$

Ecuaciones generales de la iteración 2:

$$L = \text{random}(3, 5) = 3,5731$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{3,5731-3}{5-3} \right) \cdot 10 \right) - 5 = -12,1346$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{99-1}{3-1} \right) - 0,5 = 48,5000$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{3,5731-3}{5-3} \right) \cdot 2 \right) + 0,6 = 1,1731$$

$$r = \text{random}(0, 1) = 0,5470$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -12,1346 + 48,5000 + 3,5731 \cdot 0,5470 \cdot (-24,9127 - -29,4254) = 45,1852$$

$$X_2 = X_0 \cdot C = -29,4254 \cdot 1,1731 = -34,5184$$

$$X_2 = X_0 + Y = -34,5184 + 45,1852 = 10,6667$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -12,1346 + 48,5000 + 3,5731 \cdot 0,5470 \cdot (54,3088 - 91,6253) = -36,5669$$

$$X_2 = X_0 \cdot C = 91,6253 \cdot 1,1731 = 107,4842$$

$$X_2 = X_0 + Y = 107,4842 + -36,5669 = 70,9172$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -12,1346 + 48,5000 + 3,5731 \cdot 0,5470 \cdot (84,7513 - 44,8205) = 114,4073$$

$$X_2 = X_0 \cdot C = 44,8205 \cdot 1,1731 = 52,5782$$

$$X_2 = X_0 + Y = 52,5782 + 114,4073 = 166,9855$$

EOO: Ejemplo práctico - validación restricciones

Restricción: $x_1, x_2, x_3 \in [-100, 100]$

Soluciones obtenidas en la iteración 1:

ind 1: [-15.0601, **166.1983**, **235.8504**], infactibles: 2

ind 2: [59.3592, -10.3863, 83.7706], infactibles: 0

ind 3: [10.6667, 70.9172, **166.9855**], infactibles: 1

Reparación de soluciones:

ind 1: [-15.0601, 100, 100] / fitness: 20226.8055

ind 2: [59.3592, -10.3863, 83.7706] / fitness: 10648.8966

ind 3: [10.6667, 70.9172, 100] / fitness: 15143.0350

Mejor solución:

ind 2: [59.3592, -10.3863, 83.7706] / fitness: 10648.8966

EOO: Ejemplo práctico - iter 100 - ind 1

Ecuaciones generales de la iteración 100:

$$L = \text{random}(3, 5) = 4,7417$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{4,7417-3}{5-3} \right) \cdot 10 \right) - 5 = -6,2916$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{1-1}{3-1} \right) - 0,5 = 0,0000$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{4,7417-3}{5-3} \right) \cdot 2 \right) + 0,6 = 2,3417$$

$$r = \text{random}(0, 1) = 0,8586$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = 6,2916 + 0,0000 + 4,7417 \cdot 0,8586 \cdot (17,4402 - 47,8724) = -130,1890$$

$$X_{100} = X_0 \cdot C = 47,8724 \cdot 2,3417 = 112,1016$$

$$X_{100} = X_0 + Y = 112,1016 + -130,1890 = -18,0873$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -6,2916 + 0,0000 + 4,7417 \cdot 0,8586 \cdot (17,4402 - 47,8724) = -130,1890$$

$$X_{100} = X_0 \cdot C = 47,8724 \cdot 2,3417 = 112,1016$$

$$X_{100} = X_0 + Y = 112,1016 + -130,1890 = -18,0873$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -6,2916 + 0,0000 + 4,7417 \cdot 0,8586 \cdot (17,4402 - 47,8724) = -130,1890$$

$$X_{100} = X_0 \cdot C = 47,8724 \cdot 2,3417 = 112,1016$$

$$X_{100} = X_0 + Y = 112,1016 + -130,1890 = -18,0873$$

Ecuaciones generales de la iteración 100:

$$L = \text{random}(3, 5) = 4,9710$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{4,9710-3}{5-3} \right) \cdot 10 \right) - 5 = -5,1451$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{1-1}{3-1} \right) - 0,5 = 0,0000$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{4,9710-3}{5-3} \right) \cdot 2 \right) + 0,6 = 2,5710$$

$$r = \text{random}(0, 1) = 0,6048$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -5,1451 + 0,0000 + 4,9710 \cdot 0,6048 \cdot (17,4402 - 20,5930) = -14,6245$$

$$X_1 = X_0 \cdot C = 20,5930 \cdot 2,5710 = 52,9441$$

$$X_1 = X_0 + Y = 52,9441 + -14,6245 = 38,3196$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -5,1451 + 0,0000 + 4,9710 \cdot 0,6048 \cdot (17,4402 - 20,5930) = -14,6245$$

$$X_1 = X_0 \cdot C = 20,5930 \cdot 2,5710 = 52,9441$$

$$X_1 = X_0 + Y = 52,9441 + -14,6245 = 38,3196$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -5,1451 + 0,0000 + 4,9710 \cdot 0,6048 \cdot (17,4402 - 20,5930) = -14,6245$$

$$X_{100} = X_0 \cdot C = 20,5930 \cdot 2,5710 = 52,9441$$

$$X_{100} = X_0 + Y = 52,9441 + -14,6245 = 38,3196$$

Ecuaciones generales de la iteración 100:

$$L = \text{random}(3, 5) = 3,1168$$

$$T = \left(\left(\frac{L-3}{5-3} \right) \cdot 10 \right) - 5 = \left(\left(\frac{3,1168-3}{5-3} \right) \cdot 10 \right) - 5 = -14,4158$$

$$E = \left(\frac{\text{iter}-1}{n-1} \right) - 0,5 = \left(\frac{1-1}{3-1} \right) - 0,5 = 2pt0,0000$$

$$C = \left(\left(\frac{L-3}{5-3} \right) \cdot 2 \right) + 0,6 = \left(\left(\frac{3,1168-3}{5-3} \right) \cdot 2 \right) + 0,6 = 0,7168$$

$$r = \text{random}(0, 1) = 0,5148$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -14,4158 + 0,0000 + 3,1168 \cdot 0,5148 \cdot (17,4402 - 17,4402) = -14,4158$$

$$X_{100} = X_0 \cdot C = 17,4402 \cdot 0,7168 = 12,5020$$

$$X_{100} = X_0 + Y = 12,5020 + -14,4158 = -1,9137$$

Ecuación general EOO:

$$Y = T + E + L \cdot r \cdot (X_{best} - X_{i-1})$$

$$X_i = X_{i-1} \cdot C$$

$$X_i = X_{i-1} + Y$$

$$Y = -14,4158 + 0,0000 + 3,1168 \cdot 0,5148 \cdot (17,4402 - 17,4402) = -14,4158$$

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$$X_{100} = X_0 + Y = 12,5020 + -14,4158 = -1,9137$$

EOO: Ejemplo práctico - validación restricciones

Restricción: $x_1, x_2, x_3 \in [-100, 100]$

Soluciones obtenidas en la iteración 2:

ind 1: [-18.0873, -18.0873, -18.0873], infactibles: 0

ind 2: [38.3196, 38.3196, 38.3196], infactibles: 0

ind 3: [-1.9137, -1.9137, -1.9137], infactibles: 0

Reparación de soluciones:

ind 1: [-18.0873, -18.0873, -18.0873] / fitness: 981.4566

ind 2: [38.3196, 38.3196, 38.3196] / fitness: 4405.1819

ind 3: [-1.9137, -1.9137, -1.9137] / fitness: 10.9872

Mejor solución:

ind 3: [-1.9137, -1.9137, -1.9137] / fitness: 10.9872