TECNOLÓGICO DE MONTERREY

COMPUTATIONAL INTELLIGENCE

Activity Extra Point

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1. The eight queens puzzle

- Propose one suitable chromosome representation and briefly justify your answer. By using the chromo-some representation you propose, indicate how the chessboard depicted in Fig. 1 would be represented in the genetic algorithm.

  A simple, but useful representation would be one of a list of integers from 1 to 8, without allowing repetition. In this form, the problem would be even easier to solve as multiple invalid states would be trimmed from the start. And well, the representation of the board shown would be [5,3,1,7,2,8,6,4]

- Propose one suitable selection strategy and briefly justify your answer. A tournament selection with an m of 4 would probably select very good representations fast as there is not that many options for the list

- Propose one suitable crossover operator and briefly justify your answer.

  Using a number between 2 and 6, using it as an index for the first parent, in which numbers to the left of the index would change positions with the equivalents in the second parent. AS

- Propose one suitable mutation operator and briefly justify your answer.

  A mutation operator feasible for this representation would change the positions of a pair of items at a selected index. This assures us that it is only a small change but that it gives a noticeable different individual.

Schemata analysis

	Population	f
A_1	10011001	4
A_2	01101010	4
A_3	01010111	5
A_4	01000010	2

Avg = 3.25

	Schema	Contained in	count	fitness	f(h)
H1	*******1	A_1, A_3	2	4, 5	4.5
H2	*1*****0	A_3, A_4	2	4, 2	3
H3	0*0****0	A_4	1	2	2
H4	0*******	A_2, A_3, A_4	3	4,5,2	3.666

Reproduction

$$m(H_1,t)\frac{f(H_1)}{f} = 2 * \frac{4.5}{3.75} = 2.4$$
$$m(H_2,t)\frac{f(H_2)}{f} = 2 * \frac{3}{3.75} = 1.6$$
$$m(H_3,t)\frac{f(H_3)}{f} = 1 * \frac{2}{3.75} = 0.53$$
$$m(H_4,t)\frac{f(H_4)}{f} = 3 * \frac{43.6}{3.75} = 2.92$$

Crossover

Template $\rightarrow$ 01101100

H_1 = *******1

$$\begin{aligned} Ps &= 1 - (Pc * Pd) \\ &= 1 - 0.8 * 0 = 1 \end{aligned}$$

$H2$ = *1*****0

$$\begin{aligned} Ps &= 1 - (Pc * Pd) \\ &= 1 - 0.8 * 1 = 0.2 \end{aligned}$$

$H3$ = 0*0****0

$$\begin{aligned} Ps &= 1 - (Pc * Pd) \\ &= 1 - 0.8 * 1 = 0.2 \end{aligned}$$

$H4$ = 0*******

$$\begin{aligned} Ps &= 1 - (Pc * Pd) \\ &= 1 - 0.8 * 0 = 1 \end{aligned}$$

Mutation

$Pm = 0.001$

H_1 = *******1
$O(H_1) = 1$

$$(1 - 0.001)^1 = 0.999$$

H_2 = *1*****0
$O(H_2) = 2$

$$(1 - 0.001)^2 = 0.998$$

H_3 = 0*0****0
$O(H_3) = 3$

$$(1 - 0.001)^3 = 0.997$$

H_4 = 0*******
$O(H_4) = 1$

$$(1 - 0.001)^2 = 0.999$$

Expected number of chromosomes

$$\begin{aligned} m(H_1, t+1) &= 2.4 * 1 * 0.999 = 2.3975999999999997 \\ m(H_2, t+1) &= 1.6 * 0.2 * 0.998 = 0.3193600000000001 \\ m(H_3, t+1) &= 0.53 * 0.2 * 0.997 = 0.10568200000000001 \\ m(H_4, t+1) &= 2.92 * 1 * 0.999 = 2.91708 \end{aligned}$$

3. Steady-state genetic algorithm

	Population	f
A_1	83251	240
A_2	42262	192
A_3	73455	2100
A_4	92113	54
A_5	12354	120

Remove A_4 and A_5

Crossover point $= 1 + mod(7 + 3 + 4 + 5 + 5 + 8 + 3 + 2 + 5 + 1, 4) = 4$

Children are 73451 and 83255

	Population	f
A_1	83251	240
A_2	42262	192
A_3	73455	2100
A_4	73451	420
A_5	83255	1200

Remove A_1 and A_2

Crossover point $= 1 + mod(7+3+4+5+5+8+3+2+5+5, 4) = 4$

Children are 73455 and 83255

	Population	f
A_1	73455	2100
A_2	83255	1200
A_3	73455	2100
A_4	73451	420
A_5	83255	1200

Remove A_4 and A_5 Crossover point $= 1 + mod(7+3+4+5+5+7+3+4+5+5, 4) = 1$ Children are 73455 and 73455

4. Analyze the cases

- Case 1 $\rightarrow$ We should reduce the mutation rate
- Case 2 $\rightarrow$ We should increase the population size
- Case 3 $\rightarrow$ This is the expected behavior