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(1) Experiment 10

Book: Principles of Soft Computing Pg: 418

Q Consider a problem of maximizing the function $f(x) = x^2$ where x is permitted to vary between 0 & 31

Sol: Objective function $f(x) = x^2$ is to be maximized

Following is the initial selection of population at random.

String no.	Initial population (randomly selected)	x value	Fitness $f(x) = x^2$	Prob;	Expected count	Actual count
1	0 1 1 0 0	12	144	0.1247	0.499	1
2	1 1 0 0 1	25	625	0.5411	2.1645	2
3	0 0 1 0 1	5	25	0.0216	0.0865	0
4	1 0 0 1 1	19	361	0.3126	1.2502	1
Sum			1155	1	4	4
Avg.			288.75	0.25	1	1
Max			625	0.5411	2.1645	2

Step 1: Code decision variable 'x' into finite length string. Here, initial population of size 4 is chose

Step 2: Obtain decoded x values for initial population generated. Consider string 1:

$01100 = 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 + 0$

$= 12$

Ily finding decoded values for all strings.

Step 1: Calculating fitness or objective function.
$f(x) = x^2$

at $x = 12$, $f(12) = 12^2 = 144$

$f(25) = 25^2 = 625$

$f(5) = 5^2 = 25$

$f(19) = 19^2 = 361$

Step 4: Compute prob of selection.

$$\text{Prob}_i = \frac{f(x)_i}{\sum_{i=1}^{n} f(x)}$$, n is no. of populations.

$\sum f(x) = 144 + 625 + 25 + 361 = 1155$

for string 1, $P_1 = \frac{144}{1155} = 0.1247$

% prob P_1 obtained as $0.1247 \times 100 = 12.47\%$

for string 2, $P_2 = 625/1155 = 0.5411$

for string 3, $P_3 = 25/1155 = 0.0216$

for string 4, $P_4 = 361/1155 = 0.3126$

Step 5: Calculate expected count.

$$\text{Expected count} = \frac{f(x)_i}{\left[\text{Avg } f(x)\right]_i}$$

$$\left[\text{Avg } (f(x))\right]_i = \frac{\sum_{i=1}^{n} f(x)_i}{n} = \frac{1155}{4} = 288.75$$

for string 1, expected count $= \frac{\text{fitness}}{\text{avg}} = \frac{144}{288.75} = 0.4987$

for string 2, expected count $= \frac{625}{288.75} = 2.1645$

for string 3, expected count $= \frac{25}{288.75} = 0.0866$

for string 4, expected count $= \frac{361}{288.75} = 1.2501$

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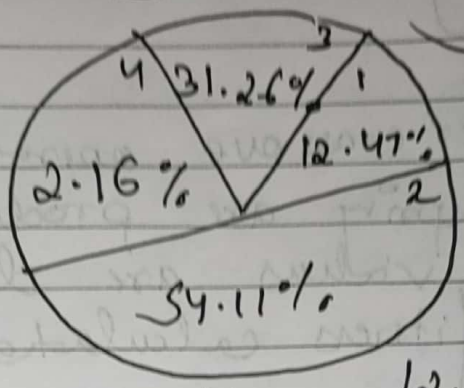
Step 6: finding actual count:
Selection using Roulette wheel:



String 1 occupies 12.47% hence, its chance is atleast "1".
With string 2, 54.11%, count is considered "2".
String 3 has least prob, so chance is poor, count is 0
string 4 with 31.26% has atleast 1 chance so actual count is 1.

Step 7: Now, write mating pool based on actual count
String 1 occurs once, string 2 occurs 2 times, string 3 occurs 0 times
4 string '4 occurs once in mating pool.

Step 8: Perform crossover operation to produce offspring
Crossover point is specified & based on that crossover is performed, single pt crossover is performed

Parent 1 0 1 1 0 0
Parent 2 1 1 0 0 1

offspring	1	0 1 1 0 1
offspring	2	1 1 0 0 0

Step 9: After crossover operation, new offspring are produced & 'x' values are decoded & fitness calculated.

Step 10: Mutation operation is performed to produce new offspring after crossover operation. Once, offspring are obtained after mutation, they are decoded to x value & fitness values are computed.

Crossover:

String No.	Mating Pool	Crossover pt.	Offspring	x value	fitness value
1	0 1 | 0 0	4	0 1 1 0 1	13	169
2	1 1 0 0 1	4	1 1 0 0 0	24	576
3	1 1 0 0 1	2	1 1 0 1 1	27	729
4	1 0 0 1 1	2	1 0 0 0 1	17	289

Mutation:

String No.	Offspring	Mutation chromosome for flipping	offspring after mutation	x value	fitness $f(x)=x^2$
1	0 1 1 0 1	1 0 0 0 0	1 1 1 0 1	29	841
2	1 1 0 0 0	0 0 0 0 0	1 1 0 0 0	24	576
3	1 1 0 1 1	0 0 0 0 0	1 1 0 1 1	27	729
4	1 0 0 0 1	0 0 1 0 0	1 0 1 0 0	20	400