Genetic Algorithm

Semester : _____ Subject : _____ Academic Year: 20 - 20

Q. Maximize the function $f(x) = x^2$, where x value range from 0 - 31

String no.	Initial Population	x Value	F(x) Value	Probability count	Expected count	Actual count
1	01101	13	169	0.14	0.58	1
2	11000	24	576	0.49	1.97	2
3	01000	8	64	0.06	0.22	0
4	10011	19	361	0.31	1.23	1
	Total		1170	1	4	4
	Avg		293			
	Max		576			

Probability count = $\frac{F(x)}{\text{Total}} = \frac{169}{1170}$

Expected Count = $\frac{F(x)}{\text{Avg}} = \frac{169}{293}$

Crossover & Mutation:

String 2 : 11000	String 2 : 11000
string 1 : 01101	String 4 : 10011
combinat^n 1	combined^n 2

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11000	11000
01101	10011
↑ crossover	↑ crossover
11001	11011
01100	10000

String No.	offspring	x-value	f(x)
1	01100	12	144
2	11001	25	625
3	11011	27	729
4	10000	16	256
		sum	1754 → Avg.
		Max	729

sum =

After mutation				f(x)
1	01100	11100	26	676
2	11001	11001	25	625
3	11011	11011	27	729
4	10000	10100	18	324
				2354
				588.5
				729.

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Q. Maximize the value of the function
$f(x) = -x^2 + 2x$
over the range of real number from 0 to 2 with initial population 11010, 00111, 10110, 00101 with random number 0.4, 0.15, 0.7, 0.9.

→ Select encoding technique.
→ min. value : 0 , max. value : 2
→ Encoding technique is already given
11010, 00111, 10110, 00101
→ Select initial population
* to start with, select initial population are random

Individual 1 : 11010
" 2 : 00111
" 3 : 10110
4 : 00101

→ Initial population size : 4
→ Decode individual into real number

① 11010 : 11010 → $0 + \frac{(2-0)}{(2^5-1)} \times 26 = \frac{52}{31} = 1.677$

② 00111 : 00111 → $0 + \frac{(2-0)}{(2^5-1)} \times (7) = \frac{14}{31} = 0.451$

③ 10110 : 10110 → $0 + \frac{(2-0)}{(2^5-1)} \times (22) = \frac{44}{31} = 1.419$

(4) 00101 : 00101 → $0 + \frac{(2-0)}{(2^5-1)} \times (5) = \frac{10}{31} = 0.322$

String No.	Initial Population	x-value	fitness $f(x) = -x^2 + 2x$	Prob	Cumulative count	Interval of RN
1	11010	1.677	0.541	0.21	0.21	0 to 0.21
2	00111	0.451	0.699	0.27	0.48	0.22 to 0.48
3	10110	1.419	0.824	0.32	0.8	0.49 to 0.8
4	00101	0.322	0.541	0.2	1	0.81 to 1
Sum			2.6056			
Avg.			0.6514			
Max			0.824			

$$\text{Probability} = \frac{f(x)}{\Sigma f(x)} = \frac{0.541}{2.6056}$$

Now consider given random numbers.

Random Number	Region	Chosen string
0.4	0.22 to 0.48	00111
0.15	0 to 0.21	11010
0.7	0.49 to 0.8	10110
0.9	0.81 to 1	00101

(8) crossover points : 1st & 5th digits

→ Crossover

* within each pair swap parts of the members solutions to create offspring which are a mixture of the parents

* for the first pair of strings : 00111, 11010
→ crossing these two strings at that point yeilds :

00111	→	0	011	1	→	01011
11010	→	1	101	0	→	10110

* for the second pair of strings : 10110, 00101
→

10110	→	1	011	0	→	10100
00101	→	0	010	1	→	00111

String No	New Population	x-value	Fitness f(x)	Prob
1	01011	0.709	0.915	
2	10110	1.419	0.824	
3	10100	1.29	0.915	
4	00111	0.451	0.699	

$01011 \rightarrow 0 + \frac{(2-0)}{(2^5-1)} \times (11) = \frac{22}{31} = 0.709$

$10110 \rightarrow 0 + \frac{(2-0)}{(2^5-1)} \times (22) = \frac{44}{31} = 1.419$

→ Sum = 3.3548
Avg = 0.8387
Max = 0.915

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$10100 \rightarrow 0 + \frac{(2-0)}{(2^5-1)} * (20) = \frac{40}{31} = 1.29$

$00111 \rightarrow 0 + \frac{(2-0)}{(2^5-1)} \times (7) = \frac{14}{31} = 0.451$

Previous Max. value was 0.824, after 1st generation it is 0.915.