Team 15 - Assignment 3

ECE457A

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1a) Resolution p = 0.0001
$QF|_{x,y} = ceil(log_2(1/0.0001)) = 14$
$QI|_{x,y} = ceil(log_2(10)) = 4$
$Q_x = Q_y$ = (14 + 4) bits = 18 bits
Examples:

| x | y |
1. [00 1010 1110 1010 1010 01 0101 0101 0101 0101]
2. [00 0110 1010 1010 1010 01 0011 0101 0101 0101]
3. [00 0010 1010 1010 1010 00 0001 0101 0101 0111]
4. [01 0000 1010 1010 1010 00 0000 0101 0101 0101]

1b) Using n-point crossover:
Crossover of 1 and 2:

| | | | |
[00| 101|0 1110 1010 1010 0|1 0101 0|101 0101| 0101] ← 1
[00| 011|0 1010 1010 1010 0|1 0011 0|101 0101| 0101] ← 2
[00| 011|0 1110 1010 1010 0|1 0011 0|101 0101| 0101] ← Child 1
[00| 101|0 1010 1010 1010 0|1 0101 0|101 0101| 0101] ← Child 2

Crossover of 3 and 4:

| | | | |
[00 0|010 1010 10|10 1010 00 0001 0101 0|10|1 011|1] ← 3
[01 0|000 1010 10|10 1010 00 0000 0101 0|10|1 010|1] ← 4
[00 0|000 1010 10|10 1010 00 0001 0101 0|10|1 011|1] ← Child 3
[01 0|010 1010 10|10 1010 00 0000 0101 0|10|1 010|1] ← Child 4

1c) Using bit-flipping mutation:
[00| 011|0 1110 1010 1110 0|1 0011 0|111 0101| 0101] ← Mutated Child 1
[00| 101|0 1010 1010 1000 0|1 0101 0|101 0101| 0101] ← Mutated Child 2
[00 0|000 1010 10|10 1010 00 0001 0101 0|10|1 011|1] ← Mutated Child 3
[01 0|010 1010 10|10 1010 00 0000 0101 0|10|1 011|1] ← Mutated Child 4

1d)

a) Examples:

	{	x	,	y	}
1.	{	9.2012	,	1.1123	}
2.	{	2.8653	,	6.1789	}
3.	{	8.8843	,	8.3422	}
4.	{	0.0011	,	7.4566	}

b) A crossover operation for this example would be a whole arithmetic crossover where x’ and y’ of the child is equal to $ax_1 + (1-a)x_2$ and $by_1 + (1-b)y_2$ where x_1 and y_2 are the components of the first parent and x_2 and y_2 are the components of the second parent. a and b are variables that range between 0 and 1.

For example, the crossover of 1 and 2 would be (with a = 0.2 and b = 0.4):

	{	x	,	y	}
1.	{	9.2012	,	1.1123	}
2.	{	2.8653	,	6.1789	}
CHILD.	{	4.1325	,	4.1523	}

And the crossover of 3 and 4 would be (with a = 0.2 and b = 0.4):

	{	x	,	y	}
3.	{	8.8843	,	8.3422	}
4.	{	0.0011	,	7.4566	}
CHILD.	{	1.7778	,	7.8108	}

c) One possible mutation operator would be:

$\{ x_m = x + rand(-x, 9.9999 - x), \; y_m = y + rand(-y, 9.9999 - y) \}$

Where y_m and x_m are the mutated values of the children, and rand(-x, x), rand(-y,y) produces a uniformly random number between the values of -x and x, and -y and y. This would leave y_m and x_m in the range of [0, 10).

For example, a mutation of:

{ 4.1325 , 4.1523 }

could result in:

$x_m = 4.1325 + rand(-4.1325, 9.9999 - 4.1325)$

$x_m = 0.2253$ is one possible mutation

$y_m = 4.1523 + rand(-4.1523, 9.9999 - 4.1523)$

$y_m = 5.2720$ is one possible mutation

MUTATED CHILD. { 0.2253 , 5.2720 }

As another example take the mutation of:

{ 1.7778 , 7.8108 }

could result in:

$x_m = 1.7778 + rand(-1.7778, 9.9999 - 1.7778)$

$x_m = 7.0644$ is one possible mutation

$y_m = 7.8108 + rand(-7.8108, 9.9999 - 7.8108)$

$y_m = 5.2396$ is one possible mutation

MUTATED CHILD. { 7.0644 , 5.2396 }

Alternatively, a gaussian noise distribution could be used for mutation purposes.

2a) True. Because if the first and second parent would “survive” (interpreted here as being “reborn” or created again) because there wasn’t the first one present in the second parent, it would be False.

b) 11010yxxyyyxyxxy and yxyyx01100101101

c) Assuming that the underlined bits are the ones selected by uniform cross-over, then resulting children would be the third option:

01000101 0111000 01111010 and 10100100 10011001 01101000

d) False. The chances of disruption are regardless of distance.

e) True. G would be proportional to the population size. G would be 1, because m=n in a steady-state.

f) The calculated probabilities are as follows:

Individual	Individual 1	Individual 2	Individual 3	Individual 4	Individual 5			
Fitness	12	15	8	53	10		N	5
Ranking	3	4	1	5	2		SP	1.5
p(r)	0.75	0.875	0.5	1	0.625		Total	3.75

So the chosen individual is individual 4, since it’s probability of being chosen is 1.