بسم الله الرحمن الرحيم

EE6227 Homework 1 31 August 2023

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1. a. Fitness Calculation

My Student ID number is G2104045K, and the last two digits is 45.

So, $X_4 X_3 X_2 X_1 \equiv 45 \mod 16$

$X_4 X_3 X_2 X_1 \equiv 13 \mod 16$

In binary, 13 is represented as 1101, So, $X_4 X_3 X_2 X_1 = 1101$

Then

$B1 = 1011\ 1101\ 0001$

$B2 = 0101\ 1101\ 1101$

Thus, $f(B1) = 6$

$f(B2) = 8$

b. Commentary on the Fitness Function

Pros:

1. Simplicity : It's easy to calculate
2. Reflects the objective : It captures the objective of maximizing the alternation with accuracy

Cons:

1. Depend on the context : If there are long 1 or 0 strings, the score does not significantly penalize these strings, which may not reflect a "good" solution in each context.

Overall, the suitability of the fitness function depends on the specific problem context. If the only purpose is to maximize the alternating sequences regardless of the length of the string, then it is appropriate. If we intend to find strings densely packed with alternation or consider other nuances, the function may need adjustments or additional terms.

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2iii with $f(x) = 120x + (1-x)\,g(x)$

$$g(x) = 50 + 30\,e^{-100x}$$

$$f^*(x) = \frac{f(x) - f_{min}}{f_{max} - f_{min}} = \frac{f(x) - 80}{40}$$

the filled table is as follows:

X	g(x)	f(x)	f*(x)
0.00	80	80	0.000
0.05	50.202	53.69	-0.658
0.10	50.001	57.00	-0.575
0.15	50.000	60.50	-0.487
0.20	50.000	64.00	-0.400
0.25	50.000	67.50	-0.312
0.30	50.000	71.00	-0.225
0.35	50.000	74.50	-0.138
0.40	50.000	78.00	-0.050
0.45	50.000	81.50	0.038
0.50	50.000	85.00	0.125
0.55	50.000	88.50	0.213
0.60	50.000	92.00	0.300
0.65	50.000	95.50	0.388
0.70	50.000	99.00	0.475
0.75	50.000	102.50	0.563
0.80	50.000	106.00	0.650
0.85	50.000	109.50	0.738
0.90	50.000	113.00	0.825
0.95	50.000	116.50	0.913
1.00	50.000	120.00	1.000

from those values, I see that the g(x) needs to be readjusted.

So, I readjust the formula to be

$$g(x) = 50 + 30\,e^{-4.25x}$$

and these are the

reddjusted & filled table →

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2 i, ii, iii with $f(x) = 120x + (1-x)g(x)$

$$g(x) = 50 + 30e^{-4.25x}$$

$$f^*(x) = \frac{f(x) - f_{min}}{f_{max} - f_{min}} = \frac{f(x) - 80}{40}$$

The filled table is as follows:

x	$g(x)$	$f(x)$	$f^*(x)$
0.00	80	80.00	0.000
0.05	74	76.54	−0.086
0.10	70	74.65	−0.134
0.15	66	73.98	−0.151
0.20	63	74.26	−0.144
0.25	60	75.28	−0.118
0.30	58	76.87	−0.078
0.35	57	78.91	−0.027
0.40	55	81.29	0.032
0.45	54	83.94	0.098
0.50	54	86.79	0.170
0.55	53	89.80	0.245
0.60	52	92.94	0.323
0.65	52	96.16	0.404
0.70	52	99.46	0.486
0.75	51	102.81	0.570
0.80	51	106.20	0.655
0.85	51	109.62	0.741
0.90	51	113.07	0.827
0.95	51	116.53	0.913
1.00	50	120.00	1.000

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2 iii. From an optimization perspective :

Finding the optimum value of x for which f(x) is minimized is a challenging problem. This is primarily because f(x) is non-linear due to the exponential function embedded with g(x).
This means that the curve is neither purely convex nor concave throughout, which can make analytical optimization methods less straight forward.

Further, the exact behaviour and turning points of the function will depend on the specifics of the exponential term.

Depending on the range of x we're looking at, the function might display multiple local minima and maxima, or none at all.

However, for a given range of x, numerical methods or optimization algorithms, like gradient descent, can be employed to approximate the optimum value of x. Given that the function is smooth, iterative techniques should converge to an optimum point (though it may be a local and not global optimum, depending on the function's behaviour).