National University of Computer and Emerging Sciences, Lahore Campus

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Note: Solve everything on the question paper.

Q1. a. Suppose there are 10 chromosomes with fitness as shown in table. What will be there selection probability according to proportionate and linear rank selection method: (20)

Chromosome No.	Fitness	Proportionate $\frac{F}{\Sigma F}$	Linear Rank (N)
A	50	0.05	0.18
B	25	0.025	0.16
C	25	0.025	0.14
D	100	0.1	0.12
E	75	0.075	0.10
F	125	0.125	0.09
G	250	0.25	0.072
H	110	0.11	0.054 0.036
I	140	0.14	0.018
J	100	0.1	
	1000	1	

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Sort N_f $(P-r+1)$		N $=N_f/\Sigma N_f$
10	0.5	0.18
9	2.7	0.16
8	3.125	0.14
7	14.2	0.12
6	12.5	0.10
5	25	0.09
4	62.5	0.072
3	36.6	0.054
2	70	0.036
1	100	0.018
55		1

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b. Given the following parents, P_1 and P_2, and the template T for selecting the genes. (20)

	A	B	C	D	E	F	G	H	I	J
	E	F	J	H	B	C	I	A	D	G
	1	0	1	1	0	0	0	1	0	1

a) Show how the following crossover operators work. Assuming 1 → P1 & 0 → P2

- uniform crossover

AFCDBCIHDJ

ACDHJ
EJHAG

- one-point crossover   if we randomly choose 5 then

Child1 → ABCDECIADG

child2 → EFJHBFGHIJ

Use this problem description for parts b and c. Assume we have the following function

$$f(x) = x^3 - 60 * x^2 + 900 * x + 100$$

where x is constrained to 0...31. We wish to maximize f (x) (the optimal is x=10)
Using a binary representation we can represent x using five binary digits.
b) Given the following four chromosomes give the values for x and f(x).

Chromosome	Binary String	x	fx
P_1	11100	28	212
P_2	01111	15	3475
P_3	10111	23	1227
P_4	00100	4	2804

$f(28) = (28)^3 - 60(28)^2 + 900 \times 28 + 100 = 212$

$f(15) = (15)^3 - 60(15)^2 + 900 \times 15 + 100 = 3475$

$f(23) = (23)^3 - 60(23)^2 + 900 \times 23 + 100 = 1227$

$f(4) = (4)^3 - 60(4)^2 + 900 \times 4 + 100 = 2804$

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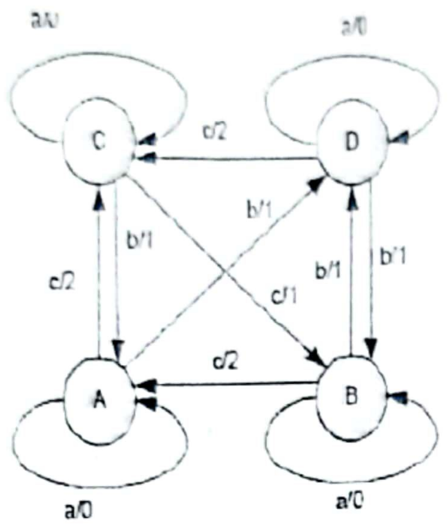
...e have a finite state machine defined by the following graph: (20)



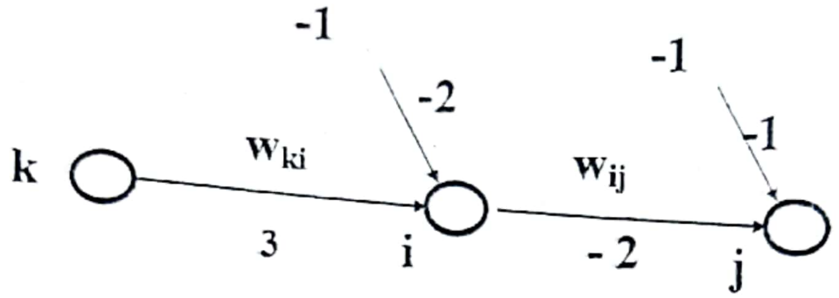
Let the chromosomes for this problem be such that it represents four state-nodes. Each node is represented by 12 bits. The first two bits represent the next state [A = 00, B = 01, C = 10, D = 11] for the case when input = 0, the next two bits represent the output symbol [a = 00, b = 01, c = 10] for this input. The next four bits represent the next state and output symbol for the case when input = 1, and the following four bits represent the next state and output symbol for the case when input = 2. The chromosome has 48 bits, with the first 12 bits reserved for state A, the second 12 bits reserved for state B, the third 12 bits for state C, and the last 12 bits for state D. Assume that the initial state at start up is A. The fitness of each chromosome is measured as the chromosome's ability to correctly predict the next output symbol, given the previous input

Find and correct the mistake in the FSM. After correction, what would be the fitness of the chromosome given below, if it is tested on the following sequence of input?

Input: 1 1 1 0 1

Chromosome: 0110 1001 0110 1000 0100 0100 0110 1001 0110 0110 1001 0110

Q2. For the following network, find the new weight wki (new) by the delta rule. Activation Functions o: neurons "i" and "j" are linear, i.e. y = activation. The learning rate is 0.1. The training pair is [2; 3]; i.e. in and output = 3. The current weights are shown on the links. There is only one input "k" and only one outpu The hidden layer has one neuron "i". The node "k" is not a neuron and just passes on the input without any processing or modification. Assume bias (j) has been updated but w (ij) needs to be updated. (40)



Given Data:

According to the generalized delta rule, the hidden weight change is governed by:

Δwki = wki(new) – wki(old)

Δwki = -c[-2Σj {(yj(desired) – yj(actual)) f'(act)j wij }f'(act)i xk]

For the above problem, there is only one output neuron (i.e. "j" = 1). Hence the Equation becomes

wki(new) = wki(old) -c[-2Σj {(yj(desired) – yj(actual)) f'(act)j wij }f'(act)i xk]

Desired
~~Actual~~ output = 3

Desired $Y_i = 2 \times 3 + (-1)(-2) = 6 + 2 = 8$

A $Y_j = 8 \times (-2) + (-1)(-1) = -16 + 1 = -15$

w_{ki} (New) = $3 + [(-0.1)(-2 \times (3+15) \times 1 \times (-2)] \times 1 \times 2$

$= 3 + (-14.4)$

$w_{ki} = 3 - 14.4 = 11.4$

$\boxed{w_{ki} = -11.4}$

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