Assignment 4 (Chapter 4.7 to 5.2)

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Q1. Dijkstra's Shortest Path Algorithm

1. Dijkstra's Shortest Path Algorithm is a graph search algorithm that find the shortest path between a starting vertices in a weighted graph.

2.

(a) From a to f , b → j , a → g

S = { }

V = { a , b , c , d , e , f , g , h , i , j , z }

S	V	a	b	c	d	e	f	g	h	i	j	z
{}	{a,b,c,d,e,f,g,h,i,j,z}	0	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
{a}	{b,c,d,e,f,g,h,i,j,z}	0	3	∞	∞	5	∞	∞	4	∞	∞	∞
{a,b}	{c,d,e,f,g,h,i,j,z}	0	3	5	∞	5	10	∞	4	∞	∞	∞
{a,b,h}	{c,d,e,f,g,h,i,j,z}	0	3	5	∞	5	9	∞	4	6	∞	∞
{a,b,h,c}	{d,e,f,g,h,i,j,z}	0	3	5	8	5	7	11	4	6	∞	∞
{a,b,h,c,e}	{d,f,g,h,i,j,z}	0	3	5	8	5	7	11	4	6	∞	∞
{a,b,h,c,e,i}	{d,f,g,h,j,z}	0	3	5	8	5	7	11	4	6	10	∞
{a,b,h,c,e,i,f}	{d,g,h,j,z}	0	3	5	8	5	7	11	4	6	10	∞
{a,b,h,c,e,i,d}	{g,j,z}	0	3	5	8	5	7	11	4	6	10	10
{a,b,h,c,e,i,d,j}	{g,z}	0	3	5	8	5	7	11	4	6	10	10
{a,b,h,c,e,i,d,j,z}	{g}	0	3	5	8	5	7	11	4	6	10	10

$S = \{a, b\}$, $V = \{c, d, e, f, g, h, i, j, z\}$

$L(b) + w(b,f) < L(f)$	$L(b) + w(b,e) < L(e)$	$L(b) + w(b,c) < L(c)$
$3+7 = 10 < \infty$	$3+5 = 8 > 5$	$3+2 = 5 < \infty$
$L(f) = 10$	$L(e)$ remains	$L(c) = 5$

$S = \{a, b, h\}$, $V = \{c, d, e, f, g, i, j, z\}$

$L(h) + w(h,e) < L(e)$	$L(h) + w(h,f) < L(f)$	$L(h) + w(h,i) < L(i)$
$4+7 = 11 > 5$	$4+5 = 9 < 10$	$4+2 = 6 < \infty$
$L(e)$ remains	$L(f) = 9$	$L(i) = 6$

$S = \{a, b, h, c\}$, $V = \{d, e, f, g, i, j, z\}$

$L(c) + w(c,f) < L(f)$	$L(c) + w(c,d) < L(d)$	$L(c) + w(c,g) < L(g)$
$5+7 = 7 < 9$	$5+3 = 8 < \infty$	$5+6 = 11 < \infty$
$L(f) = 7$	$L(d) = 8$	$L(g) = 11$

$S = \{a, b, h, c, e\}$, $V = \{d, f, g, i, j, z\}$

$L(e) + w(e,f) < L(f)$	$L(e) + w(e,b) < L(b)$	$L(e) + w(e,h) < L(h)$
$5+4 = 9 > 7$	$5+5 = 10 > 3$	$5+7 = 12 > 4$
$L(f)$ remains	$L(b)$ remains	$L(h)$ remains

For a to f,
$S = \{a, b, h, c, e, f\}$
$V = \{d, g, i, j, z\}$

The loop terminate at this moment. Thus, the length of a shortest path from a to f is 7; the shortest path is from a to b to c to f.

For other vertices,

$L(f) + w(f,c) < L(c)$
$7+2 = 9 > 5$
$L(c)$ remains

$L(f) + w(f,j) < L(j)$
$7+3 = 10 < \infty$
$L(j) = 10$

$L(f) + w(f,g) < L(g)$
$7+4 = 11 = L(g)$
$L(g) = 11$

$L(f) + w(f,i) < L(i)$
$7+4 = 11 > 6$
$L(i)$ remains

$S = \{a, b, h, c, e, i\}$, $V = \{d, f, g, h, j, z\}$

$L(i) + w(i,f) < L(f)$
$6+4 = 10 > 7$
$L(f)$ remains

$L(i) + w(i,j) < L(j)$
$6+6 = 12 > 10$
$L(j)$ remains

$S = \{a, b, h, c, e, i, d\}$, $V = \{g, j, z\}$

$L(d) + w(d,g) < L(g)$
$8+7 = 15 > 11$
$L(g)$ remains

$L(d) + w(d,z) < L(z)$
$8+2 = 10 < \infty$
$L(z) = 10$

$S = \{a, b, h, c, e, i, d, j\}$, $V = \{g, z\}$

$L(j) + w(j,g) < L(g)$
$10+4 = 14 > 11$
$L(g)$ remains

$L(j) + w(j,z) < L(z)$
$10+5 = 15 > 10$
$L(z)$ remains

$S = \{a, b, h, c, e, i, d, j, z\}$, $V = \{g\}$

$\therefore$ The loops terminate

$a \rightarrow g$
shortest path = a to b to c to g
shortest length = 11

$b \rightarrow j$
shortest path = b to c to f to j
shortest lenght = 10 − 3
= 7

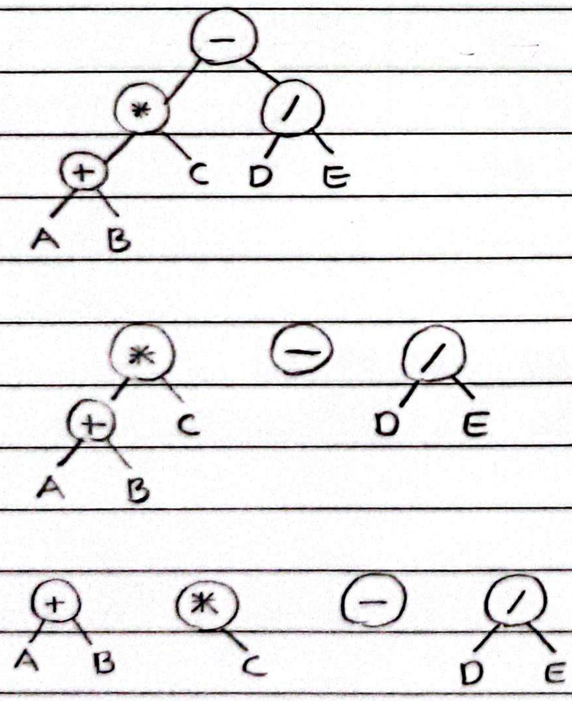
Q2. Trees

1. a and b tree are both balanced because their leaves are all at level h (height) or level h-1

Tree a:
height = 2
leaves = d (level 2), b and c (level 1)

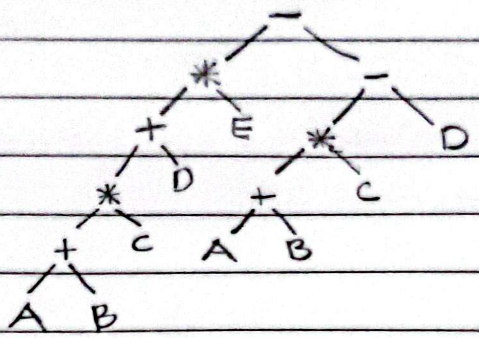
Tree b:
height = 3
leaves = g and h (level 3), f (level 2)

2.



Inorder traversal = A → + → B → * → C → - → D → / → E

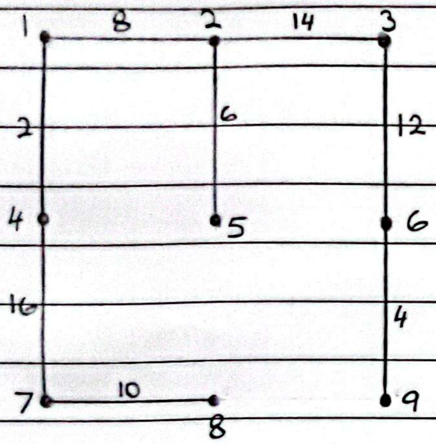
3.



Prefix Expression : − * + * + A B C D E − * + A B C D

Postfix Expression : A B + C * D + E * A B + C * D − −

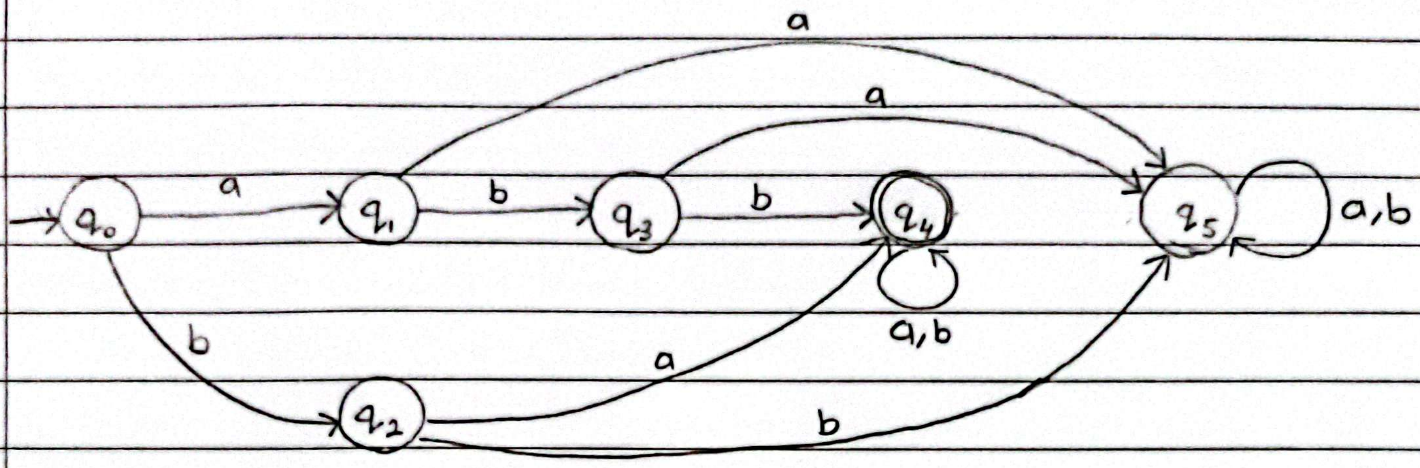
4.



Edge	14	69	25	12	78	36	23	47	45	89	58	15	26	56	57
Weight	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30

Q3. Deterministic Finite Automata

1. Let $M = \{ \{q_0, q_1, q_2, q_3, q_4, q_5\}, \{a, b\}, q_0, f_s, \{q_4\} \}$



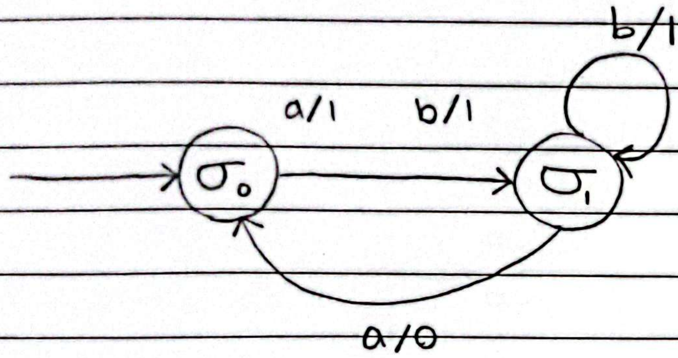
f_s	a	b
q_0	q_1	q_2
q_1	q_5	q_3
q_2	q_4	q_5
q_3	q_5	q_4
q_4	q_4	q_4
q_5	q_5	q_5

Q4. Finite State Machine

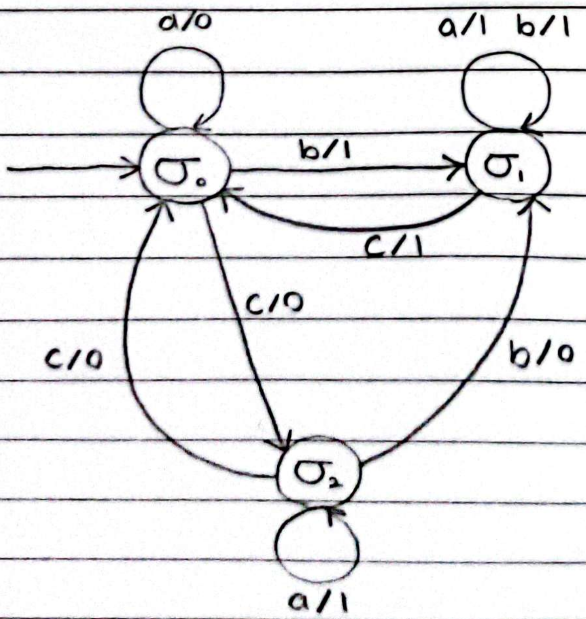
1. A finite-state machine is an abstract model of a machine with a primitive internal memory. It is written as $M = \{S, I, O, q_0, f_s, f_o\}$. Components of finite state machine are finite set of states (S), finite set of input alphabet (I), finite set of output alphabet (O), initial state ($s_0 \in S$), state transition function ($f_s : S \times I \rightarrow S$) and output function ($f_o : S \times I \rightarrow O$)

2.

(a)



(b)



3. $I = \{a, b\}$, $O = \{0, 1\}$, $S = \{\sigma_0, \sigma_1, \sigma_2, \sigma_3\}$

initial state $= \sigma_0$

	f_s		f_o	
$S \backslash I$	a	b	a	b
σ_0	σ_1	σ_2	0	0
σ_1	σ_0	σ_2	1	0
σ_2	σ_3	σ_0	0	1
σ_3	σ_1	σ_3	0	0

Output function :

$f_o(\sigma_0, a) = 0$

$f_o(\sigma_0, b) = 0$

$f_o(\sigma_1, a) = 1$

$f_o(\sigma_1, b) = 0$

$f_o(\sigma_2, a) = 0$

$f_o(\sigma_2, b) = 1$

$f_o(\sigma_3, a) = 0$

$f_o(\sigma_3, b) = 0$