SIM Global Education

Data Structures and Algorithms

Assignment 3

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1 Question 1

Hash Function: $h(x) = x \; mod \; 11$
Value: $33, 13, 32, 8, 55, 37, 43, 74, 103$

The hash address:	$\boldsymbol{K}$:	33	13	32	8	55	37	43	74	103
	$\boldsymbol{H(x)}$	0	2	10	8	0	4	10	8	4

1.1 a) When Separate Chaining is used to handle collisions

0	1	2	3	4	5	6	7	8	9	10

- 0 → 33 → 55
- 2 → 13
- 4 → 37 → 4
- 8 → 8 → 74
- 10 → 32 → 43

← Hash Table using Chaining Resolution

1.2 b) When Collision are handled by linear probing

0	1	2	3	4	5	6	7	8	9	10
35	55	13	43	37	103			8	74	32

← Hash table using Linear Porbing Resolution

1.3 C) When collison are handled by double hashing

Second Hash Function: $h'(x) = (x \; mod 5) + 1$
Overall Function: $H(x) = \big(h(x) + i \; \times h'(x)\big) mod \; 11, where \; i = 0,1,2,3, \ldots$

The hash address:	$\boldsymbol{K}$:	33	13	32	8	55	37	43	74	103
	$\boldsymbol{h(x)}$	0	2	10	8	0	4	10	8	4
	$\boldsymbol{h'(x)}$					1		4	5	4

Since $h(55) = 0$, which is already occupied, collision occurs.
To solve this problem, we use the second hash function is applied.
$h'(55) = (55 \; mod 5) + 1 = 1$, 1 is the new location and its not occupied, the vaule will be place in location 1.
Similar for $h(43)$, $h(74)$, $h(103)$.

However as you can see there is is still collision between $h(43)$, $h(103)$.
In order to solve this, we will then use the overall function.

For $\boldsymbol{h(43)}$,
Let i be 0, $H(43) = (10 + 0 \times 4) mod \; 11 = 10$ (location 10 is occupied, collision)
Let i be 1, $H(43) = (10 + 1 \times 4) mod \; 11 = 3$ (location 3 is empty, no collision)

(part c will be continiued in the next page)

For $\boldsymbol{h(103)}$,

Let i be 0, $H(103) = (4 + 0 \times 4) mod\ 11 = 4$ (location 4 is occupied, collision)
Let i be 1, $H(103) = (4 + 1 \times 4) mod\ 11 = 8$ (location 8 is occupied, collision)
Let i be 2, $H(103) = (4 + 2 \times 4) mod\ 11 = 1$ (location 1 is occupied, collision)
Let i be 3, $H(103) = (4 + 3 \times 4) mod\ 11 = 5$ (location 5 is empty, no collision)

Hash table using Double-hashing Resolution

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
33	55	13	43	37	103		74	8		32

1.4 d) When Collision are handled by quadratic probing

Quadratic probing Function: $h'(x, i) = (h(x) + 0.5\ i + 0.5\ i^2\ mod\ 11,$ $where\ i = 1{,}2{,}3$

Collsion had occur for $h(55), h(43)$, $h(74)$, $h(103)$. We have to use the Quadratic probing Function to handle the collision.

For $\boldsymbol{h(55)}$,
Let i be 1, $h'(55{,}1) = 55 + (0.5 \times 1) + (0.5 \times 1^2)\ mod\ 11 = 1,$
(location 1 is empty, no collision)

For $\boldsymbol{h(43)}$,
Let i be 1, $h'(43{,}1) = 43 + (0.5 \times 1) + (0.5 \times 1^2)\ mod\ 11 = 0,$
(location 0 is occupied, collision)
Let i be 2, $h'(43{,}2) = 43 + (0.5 \times 2) + (0.5 \times 2^2)\ mod\ 11 = 1,$
(location 1 is empty, no collision)

For $\boldsymbol{h(74)}$,
Let i be 1, $h'(74{,}1) = 74 + (0.5 \times 1) + (0.5 \times 1^2)\ mod\ 11 = 9,$
(location 9 is empty, no collision)

For $\boldsymbol{h(103)}$,
Let i be 1, $h'(103{,}1) = 103 + (0.5 \times 1) + (0.5 \times 1^2)\ mod\ 11 = 5,$
(location 5 is empty, no collision)

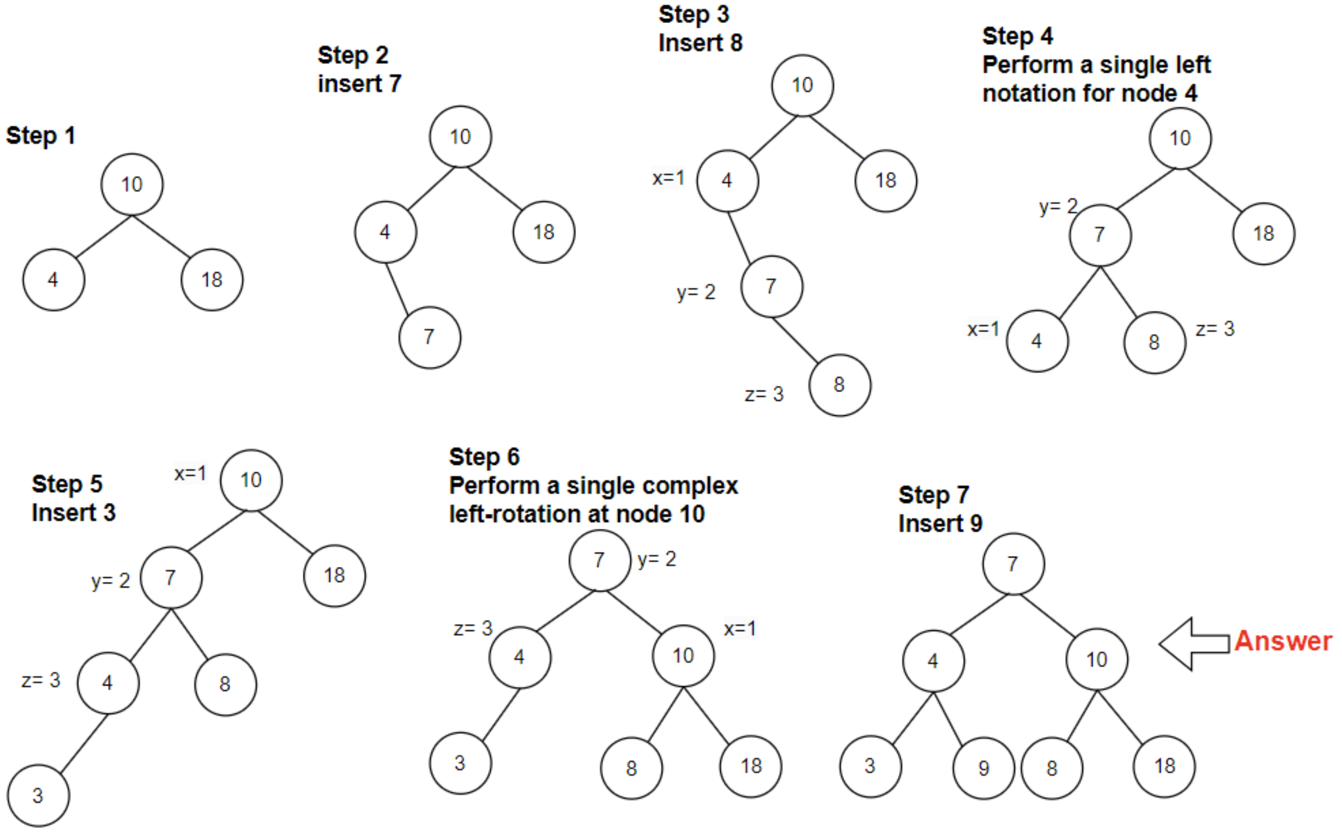
Hash table using Quadratic Probing Resolution

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
33	55	13	43	37	103			8	74	32

2 Question 2

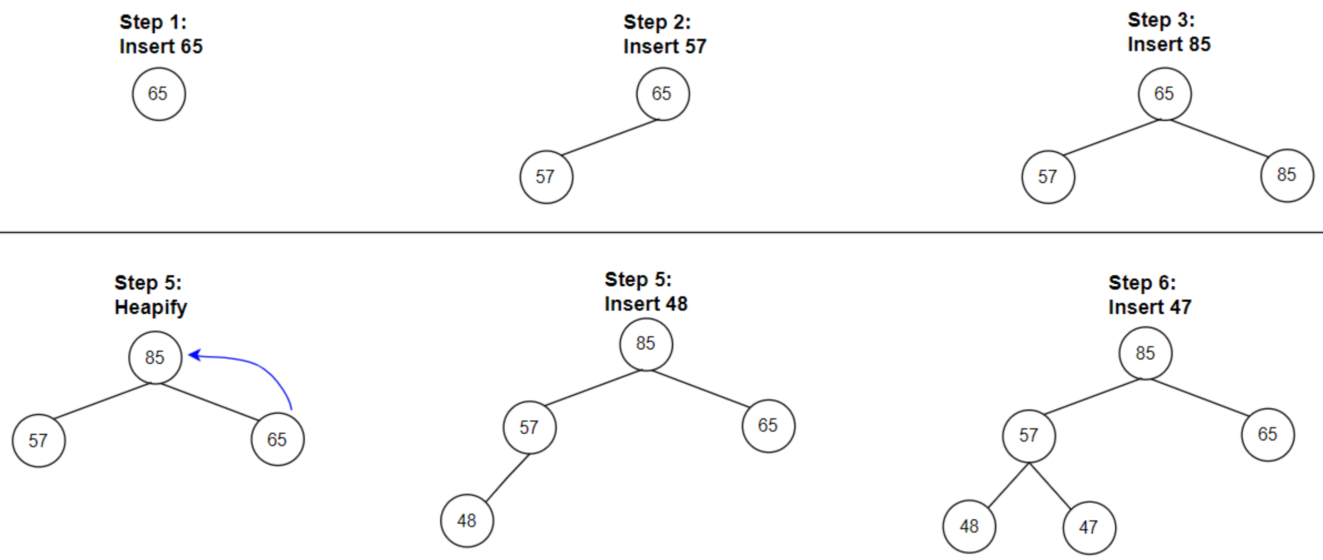
2.1 a) Insert element into partially constructed AVL

Insert value: 7, 8, 3, 9

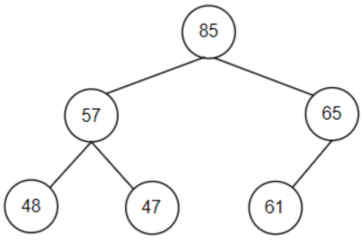


2.2 b) Make the array into a Maximum Heap

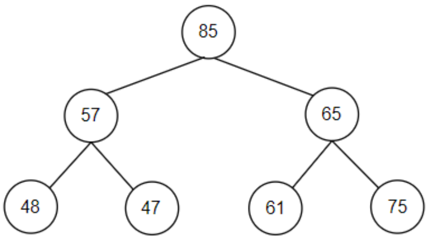
Value: 65, 57, 85, 48, 47, 61, 75, 5, 25, 85, 20, 42



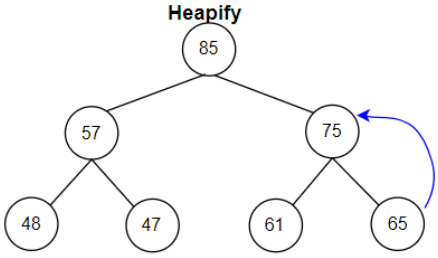
Step 7:
Insert 61



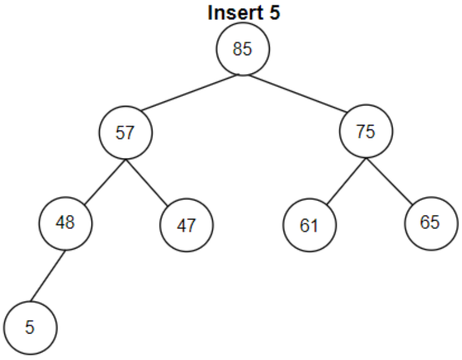
Step 8:
Insert 75



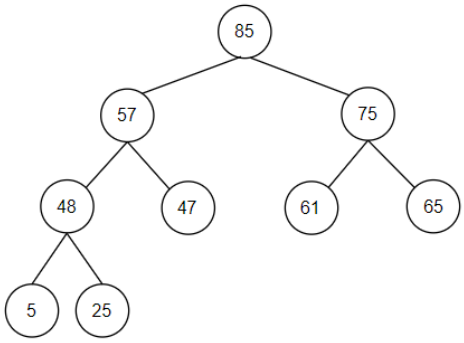
Step 9:
Heapify



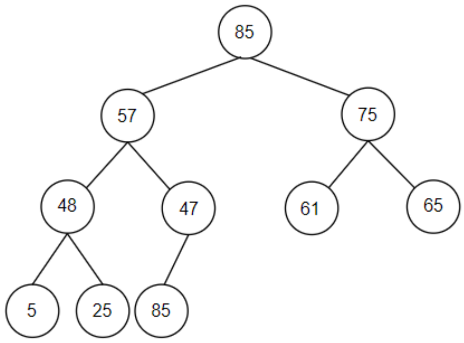
Step 10:
Insert 5



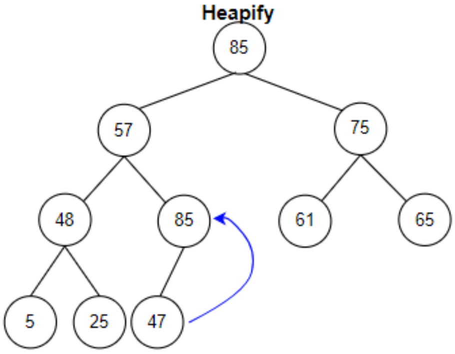
Step 11:
Insert 25



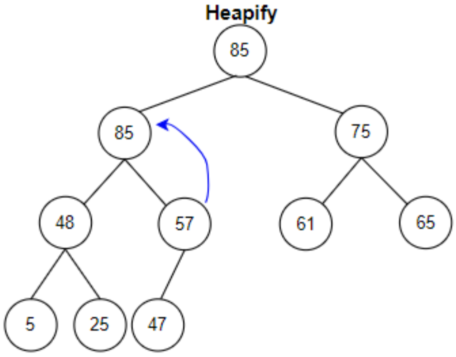
Step 12:
Insert 85



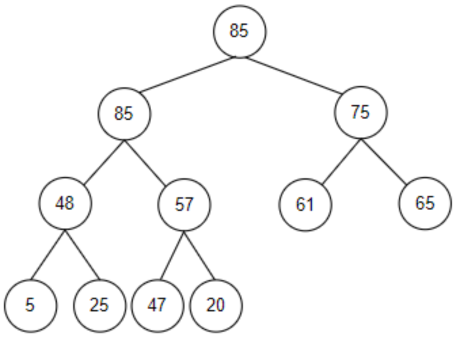
Step 13:
Heapify



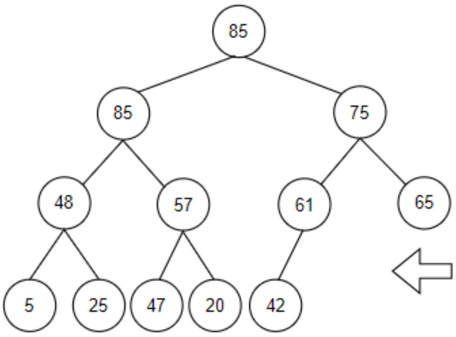
Step 14:
Heapify



Step 15:
Insert 20



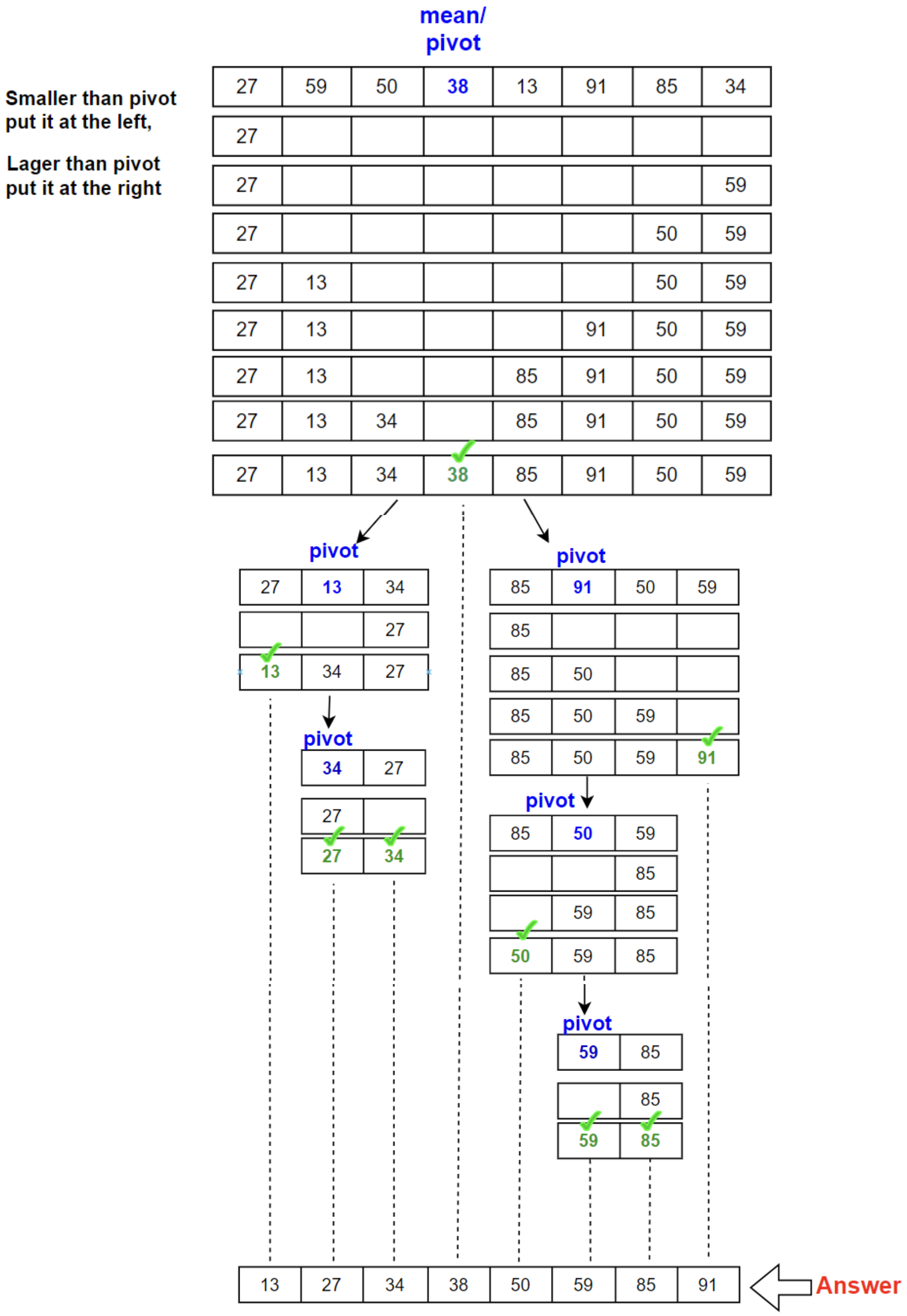
Step 16:
Insert 42



Answer

3 Question 3

- Quicksort with middle-of tree (mean) pivot
- Sorting the array in a accending order.



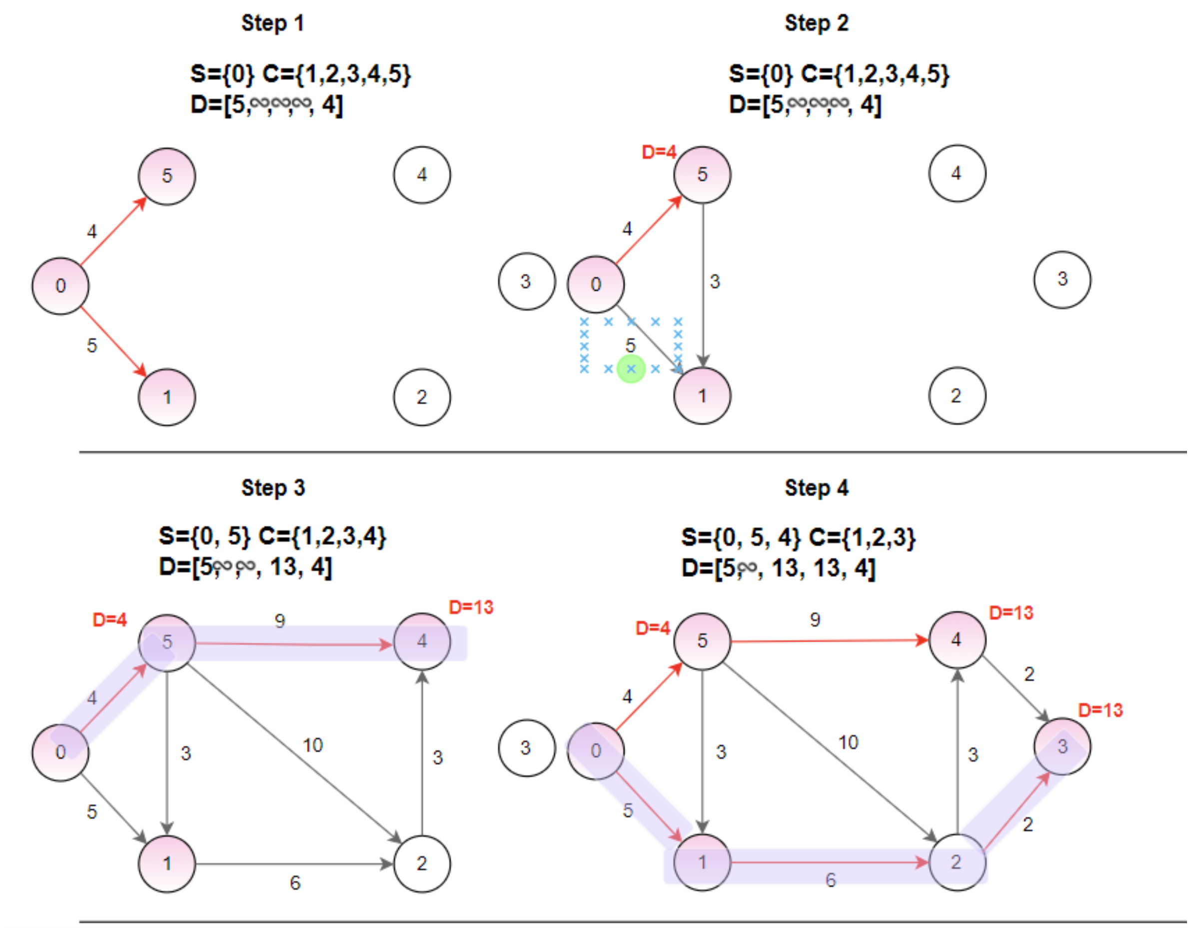
4 Question 4

4.1 Adjacency Matrix

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

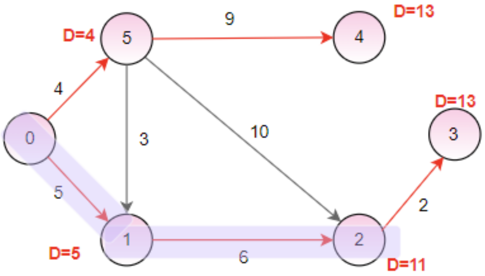
4.2 Show all paths from 0 to all other network nodes.

Method 1(both answer are the same)



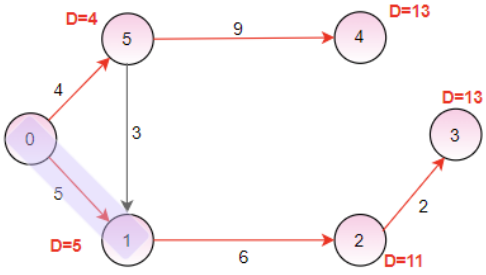
Step 5

S={0, 5, 4, 3} C={1,2}
D=[5, 11, 13, 13, 4]



Step 6

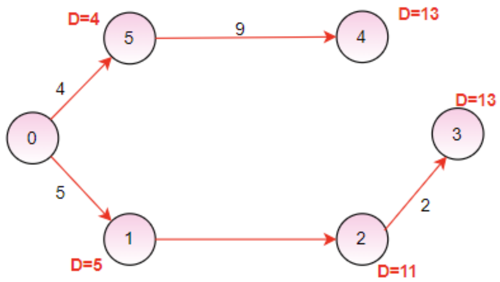
S={0, 5, 4, 3, 2} C={1}
D=[5, 11, 13, 13, 4]



Step 6

S={0, 5, 4, 3, 2, 1} C={ }
D=[5, 11, 13, 13, 4]

Answer



The paths:
0 to 1: 0,1
0 to 2: 0,1,2
0 to 3: 0,1,2,3
0 to 4: 0,5,4
0 to 5: 0,5

Method 2 (both answer are the same)

Step 1

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

P =	D =
0	5
0	∞
0	∞
0	∞
0	4

V= 5
C= { 1,2,3,4}
S ={0}

Step 2

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

P =	D =
0	5
5	14
0	∞
5	13
0	4

V= 5
C= { 1,2,3,4}
S ={0}

Step 3

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

P =	D =
0	5
1	11
0	∞
5	13
0	4

V= 1
C= {2,3,4}
S ={0,5}

Step 4

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

P =	D =
0	5
1	11
2	13
5	13
0	4

V= 2
C= {3,4}
S ={0,1,5}

Step 5

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

P =	D =
0	5
1	11
2	13
5	13
0	4

V= 4
C= { 3}
S ={0,1,2,5}

Step 6

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

P =	D =
0	5
1	11
2	13
5	13
0	4

V= 3
C= { }
S ={0,1,2,4,5}

Step 7

A	0	1	2	3	4	5
0	∞	∞	∞	∞	∞	∞
1	5	∞	∞	∞	∞	3
2	∞	6	∞	∞	∞	10
3	∞	∞	2	∞	2	∞
4	∞	∞	3	∞	∞	9
5	4	∞	∞	∞	∞	∞

P =	D =
0	5
1	11
2	13
5	13
0	4

V=
C= { }
S ={0,1,2,3,4,5}

The paths:
0 to 1: 0,1
0 to 2: 0,1,2
0 to 3: 0,1,2,3
0 to 4: 0,5,4
0 to 5: 0,5

5 Question 5

5.1 Is the heuristic in the problem admissible?

For every node n, $\forall(s,s')$:$h(s) - h(s') \leq C(s,s')$.

States	$h(s) - h(s')$	$c(s, s')$	$h(s) - h(s') \leq c(s, s')$
S-C	30 – 27 = 3	C(S,C)= 3	True
S-B	30 – 17 = 13	C(S,B)= 14	True
S-G	30 – 0 = 30	C(S,G)= 33	True
C-D	27- 18 = 9	C(C, D)= 9	True
B-E	17 – 18 = 7	C(B, E)= 8	True
B-F	17 – 10 = 14	C(B, F)= 15	True
D-F	18 – 3 = 15	C(D, F)= 16	True
D-E	18 – 3 = 8	C(D, E)= 8	True
E-F	10 – 3 = 7	C(E, F)= 7	True
F-G	3 – 0 = 3	C(F, G)= 4	True

Answer: Yes, the heuristic specified in the problem is admissible.

5.2 Find the shortest path using A*Search

$$s, f(s) = g(\varnothing) + \mathrm{h}(s)$$
$$f(s) = 0 + 30 + 30$$

S-C
$$f(C) = g(SC) + h(C)$$
$$= (0 + 3) + 27 = 30$$

S-B
$$f(B) = g(SB) + h(B)$$
$$= (0 + 14) + 17 = 30$$

S-G
$$f(G) = g(SG) + h(G)$$
$$= (0 + 33) + 0 = 33$$

S-G cannot poceed,
as its bigger than SCDEF-G

SC-D
$$f(D) = g(SCD) + h(D)$$
$$= (3 + 9) + 18 = 30$$

SB-F
$$f(F) = g(SBF) + h(F)$$
$$= (14 + 15) + 3 = 32$$

SB-F cannot poceed,
as its bigger than SCD-F

SB-E
$$f(E) = g(SBE) + h(E)$$
$$= (14 + 8) + 10 = 32$$

SB-E cannot poceed,
as its bigger than SCD-E

SCD-F
$$f(F) = g(SCDF) + h(F)$$
$$= (12 + 16) + 3 = 31$$

SCD-F cannot poceed,
as its bigger than SCDE-F

SCD-E
$$f(E) = g(SCDE) + h(E)$$
$$= (12 + 8) + 10 = 30$$

SCDE-F
$$f(F) = g(SCDEF) + h(F)$$
$$= (20 + 7) + 3 = 30$$

SCDEF-G
$$f(G) = g(SCDEFG) + h(G)$$
$$= (27 + 4) + 0 = 31$$

Answer

Answer: There is no need to continue as the goal is G. The shortest route is SCDEFG at cost 31.