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i.e., $5 \times \frac{5}{5} + 20 \times \frac{20}{20} + 40 \times \frac{35}{40}$

Weight = 5 + 20 + 35 = 60

Maximum Value:-

$30 \times \frac{5}{5} + 100 \times \frac{20}{20} + 160 \times \frac{35}{40}$

= 30 + 100 + 140 = 270 (Minimum Cost)

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ITEM	w _i	v _i
I ₁	5	30
I ₂	10	20
I ₃	20	100
I ₄	30	90
I ₅	40	160

$\frac{v_i}{w_i}$

Taking value per weight ratio i.e. p_i =

ITEM	w _i	v _i	P _i = $\frac{v_i}{w_i}$
I ₁	5	30	6
I ₂	10	20	2
I ₃	20	100	5
I ₄	30	90	3
I ₅	40	160	4

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ITEM	w _i	v _i	p _i = $\frac{v_i}{w_i}$
I ₁	5	30	6
I ₃	20	100	5
I ₅	40	160	4
I ₄	30	90	3
I ₂	10	20	2

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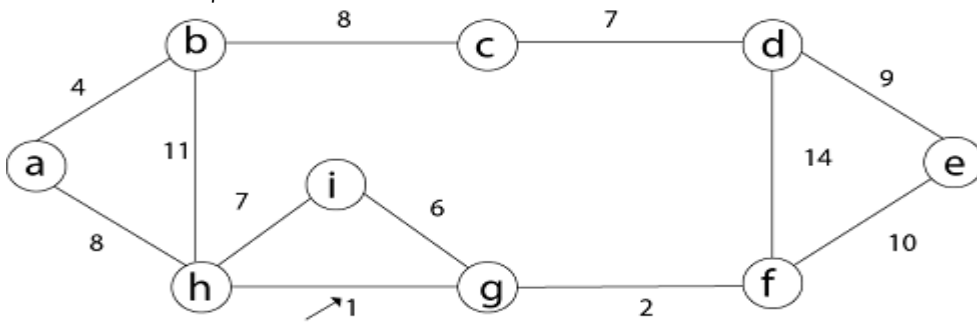
Weight	Source	Destination
1	h	g
2	g	f
4	a	b
6	i	g
7	h	i
7	c	d
8	b	c
8	a	h
9	d	e
10	e	f
11	b	h
14	d	f

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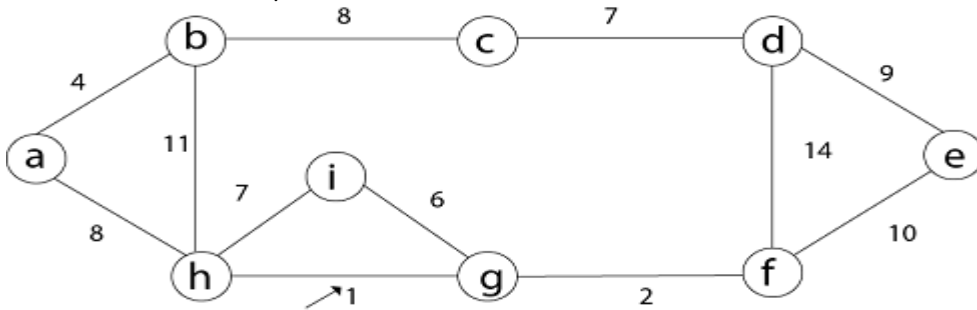
20. The following table shows the weights of the edges in a weighted undirected graph. The graph has 9 vertices labeled a through i. The weights are as follows:

9. The graph is shown below. The vertices are a, b, c, d, e, f, g, h, i. The edges and their weights are:



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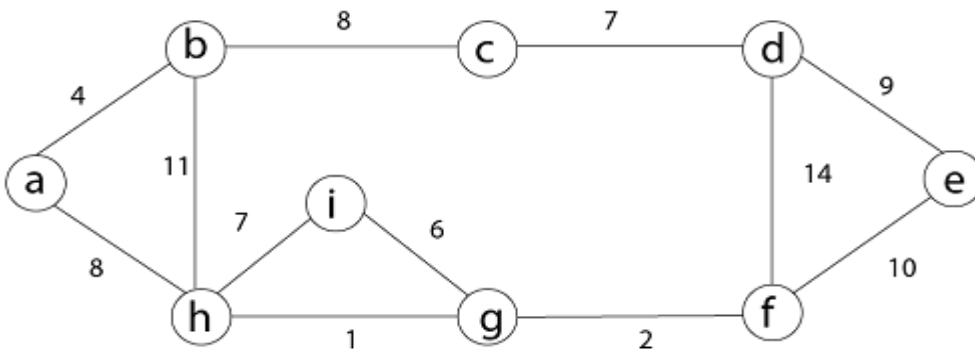
9. The graph is shown below. The vertices are a, b, c, d, e, f, g, h, i. The edges and their weights are:



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9. The graph is shown below. The vertices are a, b, c, d, e, f, g, h, i. The edges and their weights are:



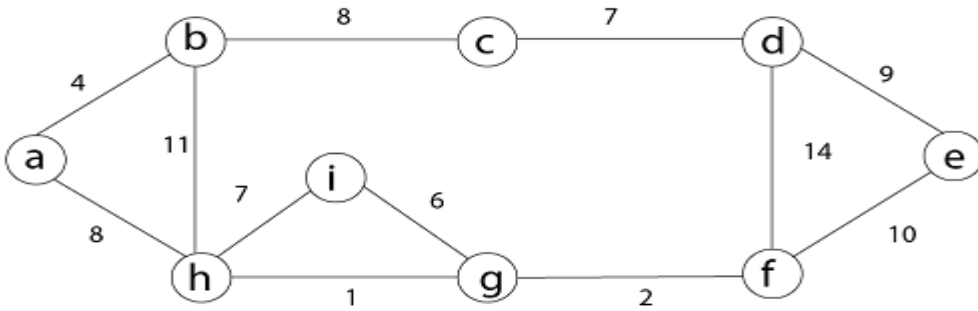
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9. The graph is shown below. The vertices are a, b, c, d, e, f, g, h, i. The edges and their weights are:

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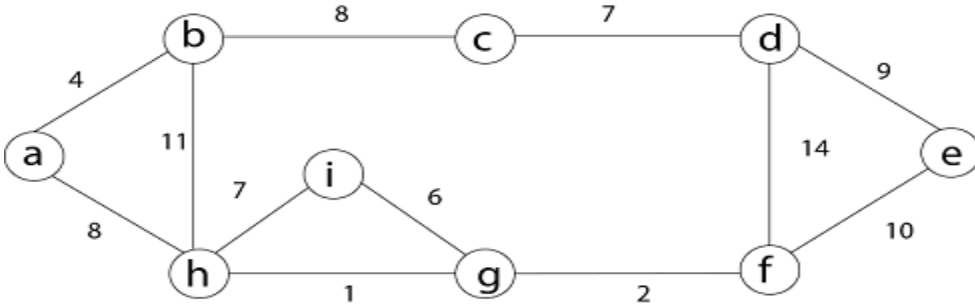


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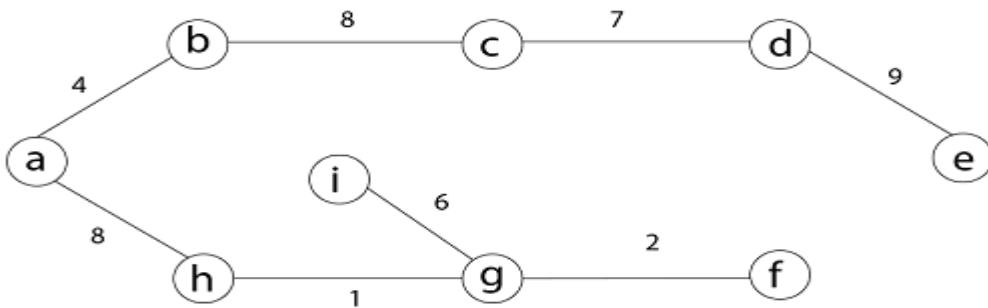
9. **9.2** **9.2.1** **9.2.2** **9.2.3** **9.2.4** **9.2.5** **9.2.6** **9.2.7** **9.2.8** **9.2.9** **9.2.10** **9.2.11** **9.2.12** **9.2.13** **9.2.14** **9.2.15** **9.2.16** **9.2.17** **9.2.18** **9.2.19** **9.2.20** **9.2.21** **9.2.22** **9.2.23** **9.2.24** **9.2.25** **9.2.26** **9.2.27** **9.2.28** **9.2.29** **9.2.30** **9.2.31** **9.2.32** **9.2.33** **9.2.34** **9.2.35** **9.2.36** **9.2.37** **9.2.38** **9.2.39** **9.2.40** **9.2.41** **9.2.42** **9.2.43** **9.2.44** **9.2.45** **9.2.46** **9.2.47** **9.2.48** **9.2.49** **9.2.50** **9.2.51** **9.2.52** **9.2.53** **9.2.54** **9.2.55** **9.2.56** **9.2.57** **9.2.58** **9.2.59** **9.2.60** **9.2.61** **9.2.62** **9.2.63** **9.2.64** **9.2.65** **9.2.66** **9.2.67** **9.2.68** **9.2.69** **9.2.70** **9.2.71** **9.2.72** **9.2.73** **9.2.74** **9.2.75** **9.2.76** **9.2.77** **9.2.78** **9.2.79** **9.2.80** **9.2.81** **9.2.82** **9.2.83** **9.2.84** **9.2.85** **9.2.86** **9.2.87** **9.2.88** **9.2.89** **9.2.90** **9.2.91** **9.2.92** **9.2.93** **9.2.94** **9.2.95** **9.2.96** **9.2.97** **9.2.98** **9.2.99** **9.2.100**



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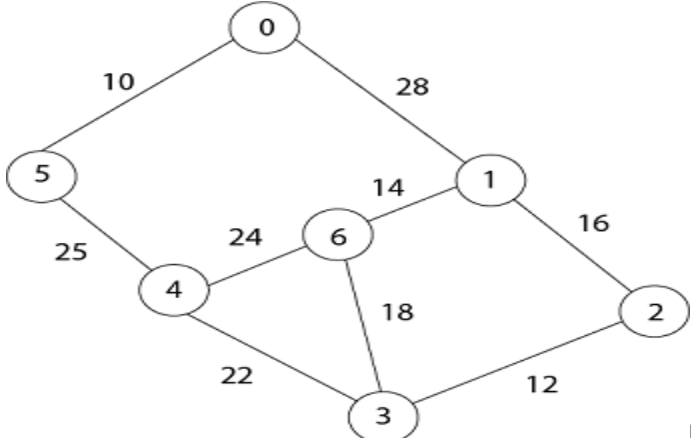
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Vertex	0	1	2	3	4	5	6
Key Value	0	28	∞	∞	25	10	∞
Parent	NIL	0	NIL	NIL	5	0	NIL



200 72 2 2 " 2 22 2222' 2\$ " 22C_D5&d20 2 222 2222 22 22 222225_2

6/ 22>2C_D5222222222

</ # " 22C_D52Z 222222\$ " 22C_D52Z 222

B/ 0 22_22 22&<222222 22_22 22&_222

_ / 0 22222 22\$ " 22C_D222 22222 22\$ " 22C_D222

d/ 0 22_22 22\$ " 22C_D2222 22_22 22\$ " 22C_D222

) 22222' 2\$ " 22 2222" 22-2\$ " 22C_D2222&<222222\$ " 22C_D2222&_2

22222222" 22222' 2222-22222222 /2

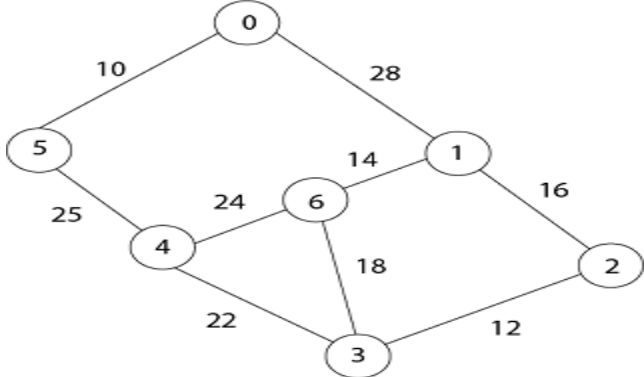
u22222 22222 22222 2222

Vertex	0	1	2	3	4	5	6
Key Value	0	28	∞	22	25	10	24
Parent	NIL	0	NIL	4	5	0	4

2222-e292222h2 (2 2222 22222222\$ " 222222\$ " 22C_D2222

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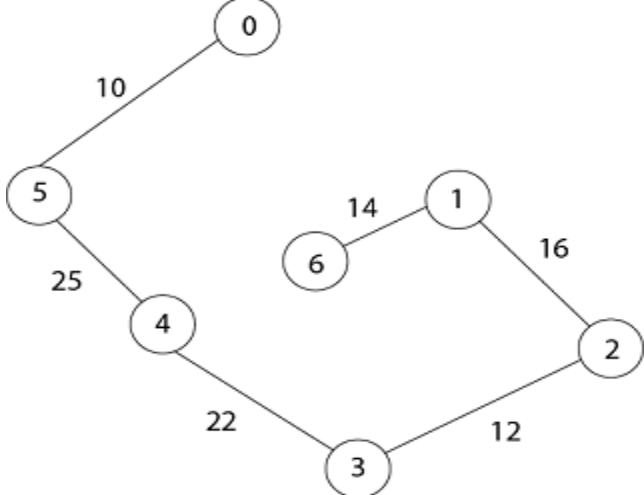
Vertex	0	1	2	3	4	5	6
Key Value	0	16	12	22	25	10	14
Parent	NIL	2	3	4	5	0	1

2 00 11111 " 2 " 3333 " 4444 " 5555 " 6666 " 7777 " 8888 " 9999 " : / ?

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Dynamic Programming	Greedy Method
1. Dynamic Programming is used to obtain the optimal solution.	1. Greedy Method is also used to get the optimal solution.
2. In Dynamic Programming, we choose at each step, but the choice may depend on the solution to sub-problems.	2. In a greedy Algorithm, we make whatever choice seems best at the moment and then solve the sub-problems arising after the choice is made.
3. Less efficient as compared to a greedy approach	3. More efficient as compared to a greedy approach
4. Example: 0/1 Knapsack	4. Example: Fractional Knapsack
5. It is guaranteed that Dynamic Programming will generate an optimal solution using Principle of Optimality.	5. In Greedy Method, there is no such guarantee of getting Optimal Solution.

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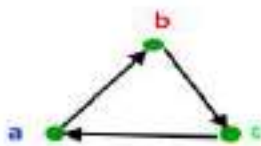
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Clockwise



Counterclockwise



Collinear

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R?

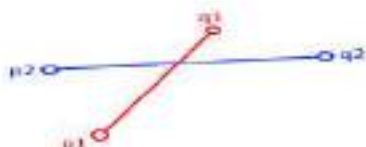
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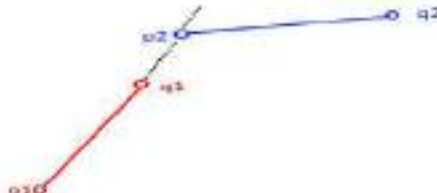
Example: Orientations of (p1,q1,p2) and (p1,q1,q2) are different. Orientations of (p2,q2,p1) and (p2,q2,q1) also different.



Example: Orientations of (p1,q1,p2) and (p1,q1,q2) are different. Orientations of (p2,q2,p1) and (p2,q2,q1) also different.



Example: Orientations of (p1,q1,p2) and (p1,q1,q2) are different. Orientations of (p2,q2,p1) and (p2,q2,q1) are same.



Example: Orientations of (p1,q1,p2) and (p1,q1,q2) are different. Orientations of (p2,q2,p1) and (p2,q2,q1) are same.

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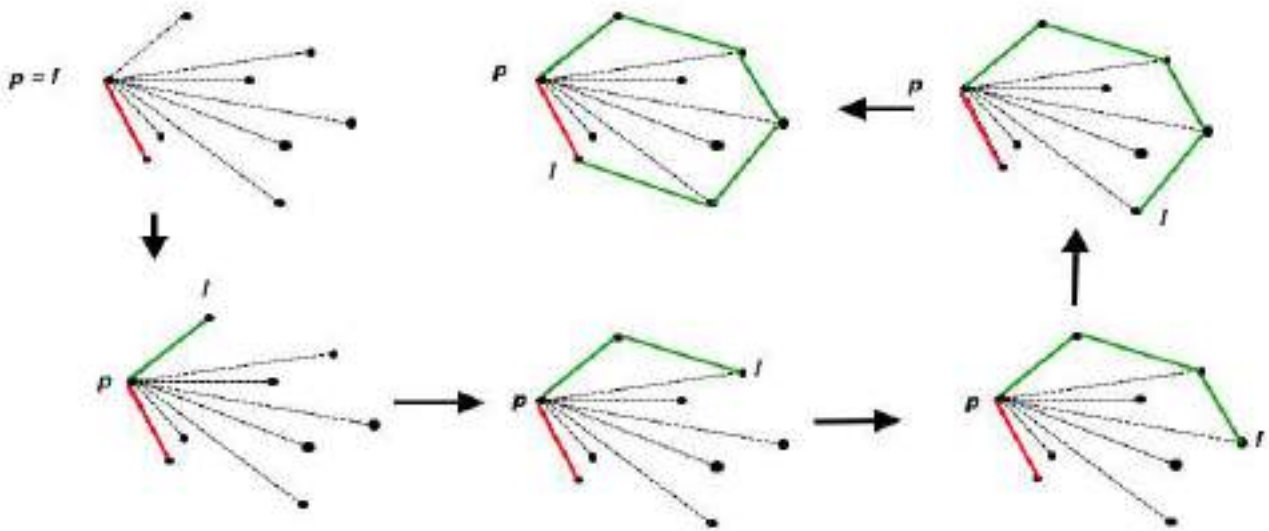
6 $\text{Jarvis_March}(P)$ - Jarvis_March algorithm

\leftarrow P is a set of points in the plane

; // p is the current point, q is the next point

; // p is the current point, q is the next point

; // p is the current point, q is the next point



The execution of Jarvis's March

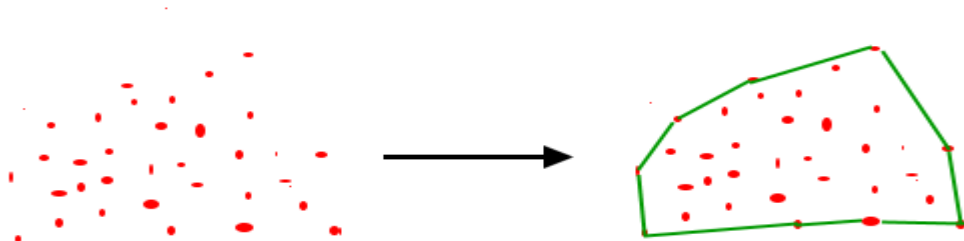
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: $\text{Jarvis_March}(P)$ is a set of points in the plane

2

6 $\text{Jarvis_March}(P)$ - Jarvis_March algorithm

2 \leftarrow P is a set of points in the plane



2

2 \leftarrow P is a set of points in the plane

2 \leftarrow P is a set of points in the plane

2

5 $\text{Jarvis_March}(P)$ - Jarvis_March algorithm

1 $\text{Jarvis_March}(P)$ - Jarvis_March algorithm

2 \leftarrow P is a set of points in the plane

2 \leftarrow P is a set of points in the plane

7 $\text{Jarvis_March}(P)$ - Jarvis_March algorithm

2 \leftarrow P is a set of points in the plane

2 \leftarrow P is a set of points in the plane

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2. **Suffix Tree Construction**

2.1. "Suffix Tree Construction" is a data structure that stores all the suffixes of a string in a compact way. It is a directed acyclic graph (DAG) where the root node is the starting point and the edges are labeled with characters. The leaf nodes represent the suffixes of the string.

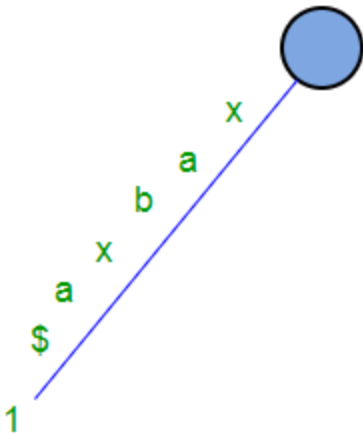
2.2. **Example**

- The root node is labeled with the character 'a'.
- The root node has three children: 'a', 'b', and 'x'.
- The 'a' child has two children: 'a' and 'b'.
- The 'b' child has one child: 'x'.
- The 'x' child has one child: '\$'.
- The leaf nodes are labeled with the suffixes: 'a', 'ba', 'xa', 'bxa', and 'axa'.

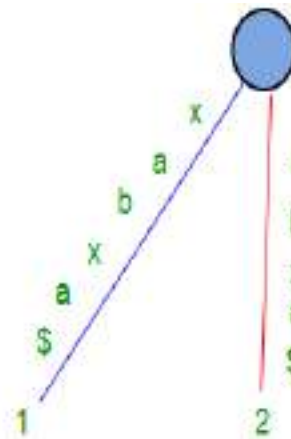
2

2.3. **Construction**

2.3.1. The construction of a suffix tree involves inserting all the suffixes of the string into the tree. This is done by traversing the tree and adding new nodes and edges as needed.



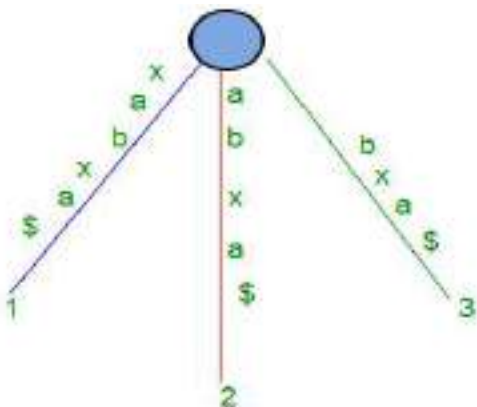
Tree with suffix N1, S[1....6] Figure 4



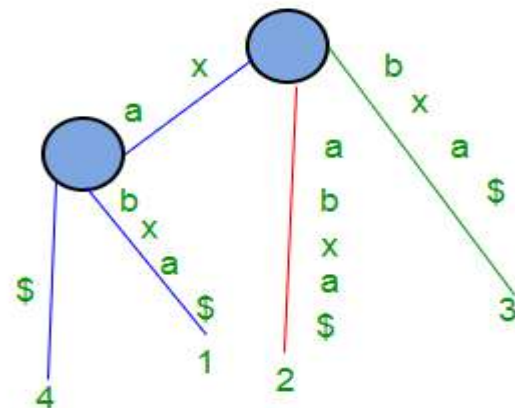
Tree with suffix N1, S[1...6] and N2, S[2...6] Figure 5

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2



Tree with suffixes N1, N2 and N3 Figure 6



Tree with suffix N1, N2, N3 and N4 Figure 7

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2.4. **Applications**

2.4.1. Suffix trees are used in many applications, including string matching, text compression, and bioinformatics. They are particularly useful for finding all occurrences of a pattern in a text.

2

+වැ' ව්‍යාපාරකරණයක් වන "ව්‍යාපාර" ඒ ව්‍යාපාර" ව්‍යාපාරකරණයක් වන ක්‍රමයක් ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව

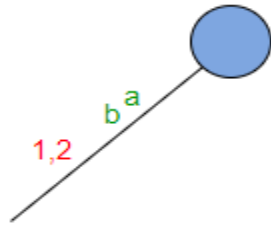


Figure 21 : Phase 2, Extension1-Rule1 applied extended the leaf edge from (1,1) to (1,2)

- +වැ' ව්‍යාපාරකරණයක් වන "ව්‍යාපාර" ඒ ව්‍යාපාර" ව්‍යාපාරකරණයක් වන ක්‍රමයක් ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව

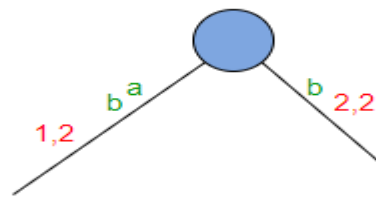


Figure 22 : Phase 2, Extension2-Rule2 applied Created a leaf edge(2,2) Phase 2 completes here

ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව
 ව්‍යාපාර" ක්‍රමයක් "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව

- ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව
 (ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව
 +වැ' ව්‍යාපාරකරණයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව
 ව්‍යාපාර" ක්‍රමයක් "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව
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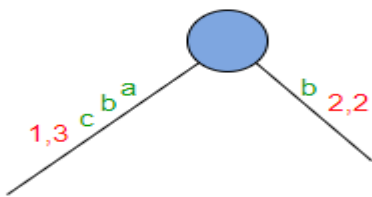


Figure 23 : Phase 3, Extension1-Rule1 applied Extended the leaf edge from (1,2) to (1,3)

- +වැ' ව්‍යාපාරකරණයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව
 ව්‍යාපාර" ක්‍රමයක් "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව ව්‍යාපාර" ක්‍රමයක් /ව
 +වැ' ව්‍යාපාරකරණයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් වන "ව්‍යාපාර" ක්‍රමයක් /ව

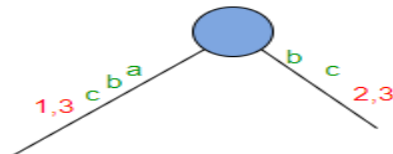


Figure 24 : Phase 3, Extension2-Rule1 applied Extended the leaf edge from (2,2) to (2,3)

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So, S=2 is a Valid Shift



S = 3
 →



S = 4
 →



S = 5
 →



2

2



S = 6
 →



2

So, S=6 is a Valid Shift



S = 7
 →



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2

2

* 2-22222, 2222 222 22222 22 22-222222??

* 22222222 "222" 222222 22

%22222222 1222222- 22222

? 2 2222 12222??

? 2 2222 12- 22??

? * 22 2222222222%22222 /22222 2222222222

? 22 22222 2222 "2 12 2222 2222 2222

? 2 2 2222?

? 2 2 22

? 2 2 * 2 222222222222%2- 2222222222??

? 2 2 * 222222222222?? 2222222222

? 2 2 ! 2222 2222?? 2222

? 2 2 2222 2- 2222/222222 2222 2222

? 2 2 2 2222#?

? 2 2 2222?

2

? 2 2222222222 2222

2

2

T = 3 1 4 1 5 9 2 6 5 3 5

P = 2 6

S = 0

3 1 4 1 5 9 2 6 5 3 5

31 mod 11 = 9 not equal to 4

S = 1

3 1 4 1 5 9 2 6 5 3 5

14 mod 11 = 3 not equal to 4

S = 2

3 1 4 1 5 9 2 6 5 3 5

41 mod 11 = 8 not equal to 4

S = 3

3 1 4 1 5 9 2 6 5 3 5

2

2

15 mod 11 = 4 equal to 4 SPURIOUS HIT

S = 4

3 1 4 1 5 9 2 6 5 3 5

59 mod 11 = 4 equal to 4 SPURIOUS HIT

S = 5

3 1 4 1 5 9 2 6 5 3 5

92 mod 11 = 4 equal to 4 SPURIOUS HIT

S = 6

3 1 4 1 5 9 2 6 5 3 5

26 mod 11 = 4 EXACT MATCH

S = 7

3 1 4 1 5 9 2 6 5 3 5

2

S = 7

3 1 4 1 5 9 2 6 5 3 5

65 mod 11 = 10 not equal to 4

S = 8

3 1 4 1 5 9 2 6 5 3 5

53 mod 11 = 9 not equal to 4

S = 9

3 1 4 1 5 9 2 6 5 3 5

35 mod 11 = 2 not equal to 4

The Pattern occurs with shift 6.

2

2

2

Step 1: $q = 2, k = 0$

$$\Pi [2] = 0$$

q	1	2	3	4	5	6	7
p	a	b	a	b	a	c	a
π	0	0					

Step 2: $q = 3, k = 0$

$$\Pi [3] = 1$$

q	1	2	3	4	5	6	7
p	a	b	a	b	a	c	a
π	0	0	1				

Step3: $q = 4, k = 1$

$$\Pi [4] = 2$$

q	1	2	3	4	5	6	7
p	a	b	a	b	a	c	A
π	0	0	1	2			

Step4: $q = 5, k = 2$

$$\Pi [5] = 3$$

q	1	2	3	4	5	6	7
p	a	b	a	b	a	c	a
π	0	0	1	2	3		

Step5: $q = 6, k = 3$

$$\Pi [6] = 0$$

q	1	2	3	4	5	6	7
p	a	b	a	b	a	c	a
π	0	0	1	2	3	0	

Step6: $q = 7, k = 1$

$$\Pi [7] = 1$$

q	1	2	3	4	5	6	7
p	a	b	a	b	a	c	a
π	0	0	1	2	3	0	1

2

2-2' 2?? 2??2??2?? "2???" ??' -??2??2??2??2?? 2??2??2??2??2?? 2?' 2' H

q	1	2	3	4	5	6	7
p	a	b	A	b	a	c	a
π	0	0	1	2	3	0	1

2

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2?" 2? 2? 2??2?? 2? 2? 2?? " 2?2? 2?2?2?2?" 2??2??2??2??2? -??2??2??2?? 2? 2??2??2??2??2?? 2??2??-??2??/??2??0 2??2?

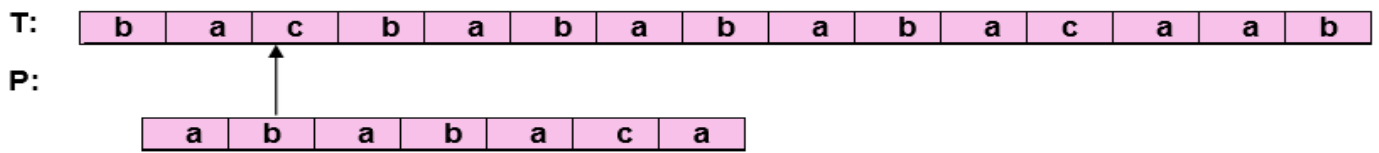
2?' 2??2??2?? " 2??2 2??2' 2? " 2??2??2??2?? 2??2? " 2??-2? 2??2??2??2?? H

2

2

Step 3: $i = 3, q = 1$

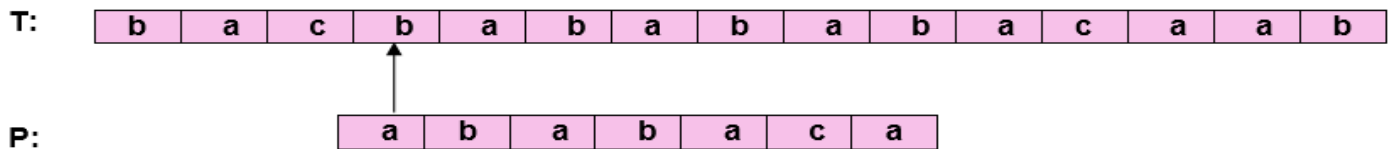
Comparing P [2] with T [3] P [2] doesn't match with T [3]



Backtracking on p, Comparing P [1] and T [3]

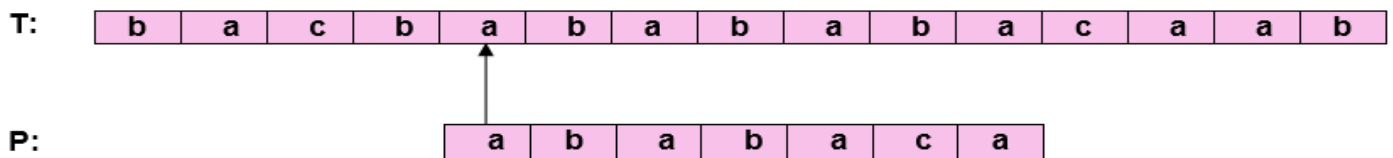
Step4: $i = 4, q = 0$

Comparing P [1] with T [4] P [1] doesn't match with T [4]



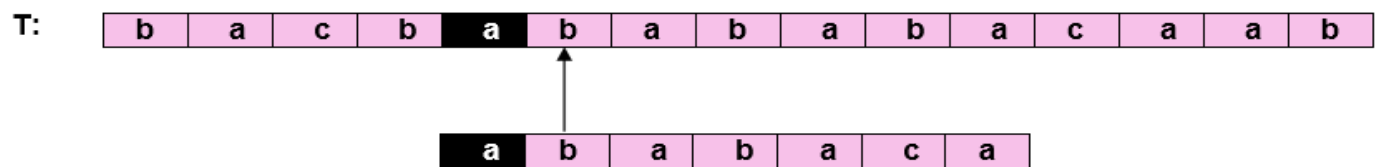
Step5: $i = 5, q = 0$

Comparing P [1] with T [5] P [1] match with T [5]



Step6: $i = 6, q = 1$

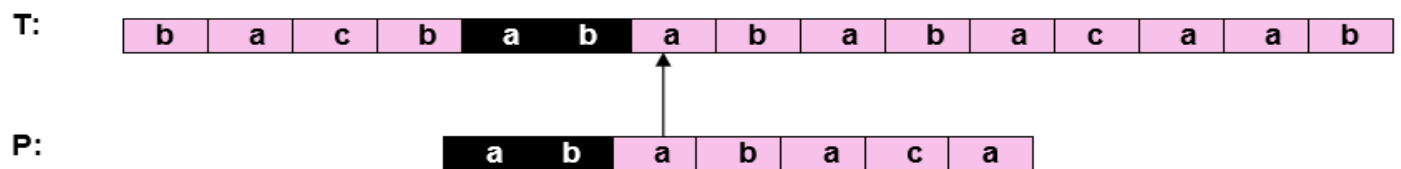
Comparing P [2] with T [6] P [2] matches with T [6]



P:

Step7: $i = 7, q = 2$

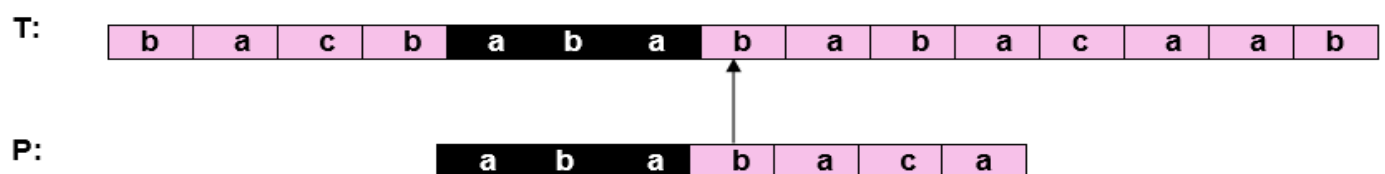
Comparing P [3] with T [7] P [3] matches with T [7]



P:

Step8: $i = 8, q = 3$

Comparing P [4] with T [8] P [4] matches with T [8]



P:

2

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Step9: $i = 9, q = 4$

Comparing P [5] with T [9]

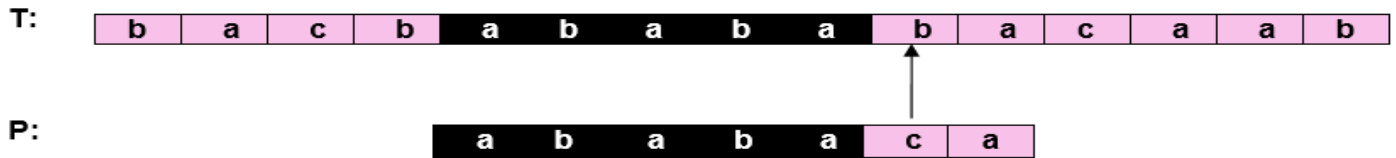
P [5] matches with T [9]



Step10: $i = 10, q = 5$

Comparing P [6] with T [10]

P [6] doesn't match with T [10]



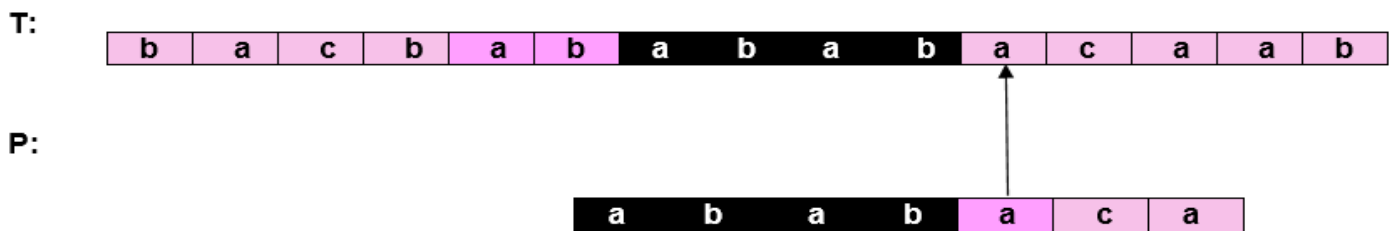
Backtracking on p, Comparing P [4] with T [10] because after mismatch $q = \pi [5] = 3$

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Step11: $i = 11, q = 4$

Comparing P [5] with T [11]

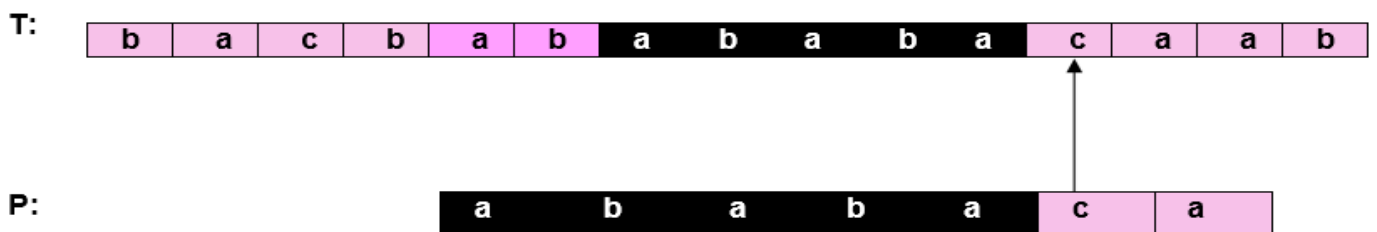
P [5] match with T [11]



Step12: $i = 12, q = 5$

Comparing P [6] with T [12]

P [6] matches with T [12]

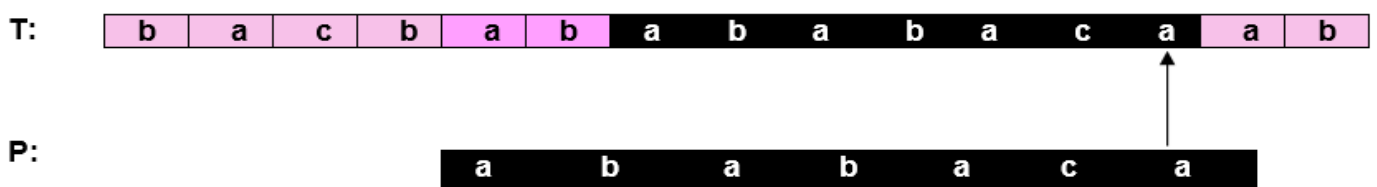


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Step13: $i = 3, q = 6$

Comparing P [7] with T [13]

P [7] matches with T [13]



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