Abstract:

An Algorithm for solving the Steiner problem on an finite undirected graph is presented. This Algorithm computes the set of edges of minimum length needed to connect a specified set of 't' nodes. If entire graph contain 'n' node Algorithm takes

$$n^3/2 + 3^t n^2$$

" $n^3/2$ " time is for finding All pair shortest path and it can be discarded if there is shortest path matrix.

Our Algorithm exploits optimal substructure property. It will start from set of terminal taking each element from it forming a tree recursion until size equals 2 and built up remaining subset from that subset.

By using DP Approach we can avoid recalculation of repeated subproblem.

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Algorithm:

~~Steiner~~

Steiner-Tree (G, T)

{ T be set of terminals.

// base condition

for each $t \in T$ do

for each $v \in V$ do

ST[t][v] = dist(t, v);

|T|-2 for (m = 2 to m ≤ |T|) do.

$\binom{|T|}{m}$ { Let x be subset of size m.

|V| for each $v \in V$ do

{ ST[x][v] = ∞ ;

|V| for each $u \in V$ do.

$2^m - 1$ { for each nm disjoint non empty subset combination of x do (x' and x'', $x' \cap x'' = \phi$

{

Sum = min (sum, ST[x'][u] + ST[x''][u]

}

ST[x][v] = min(ST[x][v], sum + dist[v][u])

}

if(|x| = = |T|)

return.

}

}.

}.

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Algorithm:

```
~~Steen~~
Steiner-Tree (G, T)
  {   T be set of terminals.
      // base condition
        for each t ∈ T do
              for each v ∈ V do
                   ST[t][v] = dist(t, v);

|T|-2      for (m = 2 to m ≤ |T|) do.
(|T| m)      {  Let X be subset of size m.
|V|            for each v ∈ V do
                 {   ST[X][v] = ∞ ;
|V|             for each u ∈ V do.
2^m-1             { for each nm disjoint non empty subset
                    combination of X do (X' and X'', X' ∩ X'' = φ)
                    {
                      Sum = min ( sum, ST[X'][u] + ST[X''][u])
                    }
                  ST[X][v] = min(ST[X][v], sum + dist[v][u])
                }
                if(|X| == |T|)
                     return.

                }
            }.
  }.
```

Running time :-

$$\sum_{m=2}^{|T|-1} \binom{|T|}{m}(2^m - 1)|V|^2 = 3^{|T|}|V|^2$$

α Running time $= 3^{|T|}|V|^2$ where $|T|$ $\in$ no of terminal.

Optimal decomposition property:

Let S be any steiner tree connecting Y, where $Y \subseteq N$ is a subset of nodes of Graph $G = (N, A)$, and Let q be any node of Y. If contain atleast 3 members then there exist a $p \in N$ and subset D of Y ST

D is proper subset of $Y - \{q\}$ and D nonempty.

S contain 3 disjoint set S_1 S_2 S_3.

S_1 connect $\{p, q\}$ S_2 connect $\{p\} \cup D$.

S_3 connect $\{p\} \cup (Y - D - \{q\})$.

furthermore S_1 S_2 S_3 are all steiner path connecting Respective set.

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Running time :-

$$\sum_{m=2}^{|T|-1} \binom{|T|}{m}(2^m - 1)|V|^2 = 3^{|T|}|V|^2$$

α Running time = $3^{|T|}|V|^2$ where $|T|$ = no of terminal.

Optimal decomposition property:

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Recursive Algorithm:

```
ST ( G, T ).
{
    if (|T| = = 2)
    { let t1 and t4 be two elements.
        for each v ∈ G.V do
            return min ( d(v, t') + d(v, t''))
    }
    else
    { for each t ∈ T do
          for each v ∈ G.V do
          {
              return min ( ST(G, T-to) + d(v, to))
          }
    }.
}.
```

Running time of Recursive Solution = $|T|^{|T|} \times n$.

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