



**K. J. Somaiya College of Engineering, Mumbai-77**  
(A Constituent College of Somaiya Vidyavihar University)  
**Department of Computer Engineering**

**Batch: B-3      Roll No.: 16010123133**

**Experiment No. 4**

**Grade: AA / AB / BB / BC / CC / CD / DD**

**Signature of the Staff In-charge with date**

**Title:** Study, Implementation and Analysis of Single Source Shortest Path

**Objective:** To learn the Greedy strategy of solving the problems for different types of problems

**CO to be achieved:**

CO 2      Describe various algorithm design strategies to solve different problems and analyse Complexity.

**Books/ Journals/ Websites referred:**

1. Ellis horowitz, Sarataj Sahni, S.Rajsekaran," Fundamentals of computer algorithm", University Press
2. T.H.Cormen ,C.E.Leiserson,R.L.Rivest and C.Stein," Introduction to algortihms",2nd Edition ,MIT press/McGraw Hill,2001
3. <https://www.mpi-inf.mpg.de/~mehlhorn/ftp/ShortestPathSeparator.pdf>
4. [en.wikipedia.org/wiki/Shortest\\_path\\_problem](https://en.wikipedia.org/wiki/Shortest_path_problem)
5. [www.cs.princeton.edu/~rs/AlgsDS07/15ShortestPaths.pdf](https://www.cs.princeton.edu/~rs/AlgsDS07/15ShortestPaths.pdf)

**Pre Lab/ Prior Concepts:**

Data structures, Concepts of algorithm analysis

**Historical Profile:**

Sometimes the problems have more than one solution. With the size of the problem, every time it's not feasible to solve all the alternative solutions and choose a better one. The greedy algorithms aim at choosing a greedy strategy as solutioning method and proves how the greedy solution is better one.

Though greedy algorithms do not guarantee optimal solution, they generally give a better and feasible solution.

The path finding algorithms work on graphs as input and represent various problems in the real world.



**K. J. Somaiya College of Engineering, Mumbai-77**  
(A Constituent College of Somaiya Vidyavihar University)  
**Department of Computer Engineering**

**New Concepts to be learned:** Application of algorithmic design strategy to any problem, Greedy method of problem solving Vs other methods of problem solving, optimality of the solution

**Topic: GREEDY METHOD**

**Theory:** The greedy method suggests that one can devise an algorithm that work in stages, considering one input at a time. At each stage, a decision is made regarding whether a particular input is in an optimal solution. This is done by considering the inputs in an order determined by some selection procedure. If the inclusion of the next input into the partially constructed optimal solution will result in an infeasible solution, then this input is not added to the partial solution. Otherwise, it is added. The selection procedure itself is based on some optimization measures may be plausible for a given problem. Most of these, however, will result in algorithms that generate suboptimal solutions. This version of the greedy technique is called the **subset paradigm**.

**Control Abstraction:**

```
SolType Greedy (Type s [], int n)

// a[1:n] contains the n inputs.

{SolType solution = EMPTY;
  // Initialize the solution.
  For (int i=1; i<=n; i++) {
    Type x = Select (a);

    If Feasible (solution, x)
      Solution = Union (solution, x) ;

  }
return solution;
}
```



**K. J. Somaiya College of Engineering, Mumbai-77**  
(A Constituent College of Somaiya Vidyavihar University)  
**Department of Computer Engineering**

**Algorithm:**

```
1  Algorithm ShortestPaths( $v, cost, dist, n$ )
2  //  $dist[j]$ ,  $1 \leq j \leq n$ , is set to the length of the shortest
3  // path from vertex  $v$  to vertex  $j$  in a digraph  $G$  with  $n$ 
4  // vertices.  $dist[v]$  is set to zero.  $G$  is represented by its
5  // cost adjacency matrix  $cost[1 : n, 1 : n]$ .
6  {
7      for  $i := 1$  to  $n$  do
8      { // Initialize  $S$ .
9           $S[i] := \text{false}$ ;  $dist[i] := cost[v, i]$ ;
10     }
11      $S[v] := \text{true}$ ;  $dist[v] := 0.0$ ; // Put  $v$  in  $S$ .
12     for  $num := 2$  to  $n - 1$  do
13     {
14         // Determine  $n - 1$  paths from  $v$ .
15         Choose  $u$  from among those vertices not
16         in  $S$  such that  $dist[u]$  is minimum;
17          $S[u] := \text{true}$ ; // Put  $u$  in  $S$ .
18         for (each  $w$  adjacent to  $u$  with  $S[w] = \text{false}$ ) do
19             // Update distances.
20             if ( $dist[w] > dist[u] + cost[u, w]$ ) then
21                  $dist[w] := dist[u] + cost[u, w]$ ;
22     }
23 }
```



**K. J. Somaiya College of Engineering, Mumbai-77**  
(A Constituent College of Somaiya Vidyavihar University)  
**Department of Computer Engineering**

**Example Graph:**

Date / /

HSBC Mutual Fund

1<sup>st</sup> assign start node

start node = A

Graph:

```

graph LR
    A((A)) -- 4 --> B((B))
    A -- 5 --> C((C))
    A -- 2 --> C
    B -- 10 --> D((D))
    C -- 3 --> E((E))
    D -- 4 --> E
    D -- 11 --> F((F))
  
```

Source	Destination				
<del>A</del>	<del>B</del>	<del>C</del>	<del>D</del>	<del>E</del>	<del>F</del>
<del>A</del>	<del><math>\infty</math></del>	<del><math>\infty</math></del>	<del><math>\infty</math></del>	<del><math>\infty</math></del>	<del><math>\infty</math></del>
<del>A, B</del>	<del>4</del>	<del>(2)</del>	<del><math>\infty</math></del>	<del><math>\infty</math></del>	<del><math>\infty</math></del>
<del>A, C</del>	<del>4</del>	<del>(2)</del>	<del><math>\infty</math></del>	<del>(3)</del>	<del><math>\infty</math></del>
<del>A, C, D</del>	<del>4</del>	<del>(2)</del>	<del>(3)</del>	<del>(3)</del>	<del><math>\infty</math></del>

  

Source	Destination				
A	B	C	D	E	F
A	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$
A, C	4	(2)	$\infty$	$\infty$	$\infty$
A, C, B	(4)	(2)	$\infty$	5	$\infty$
A, C, B, E	(4)	(2)	14	(5)	$\infty$
A, C, B, E, D	(4)	(2)	(14)	(5)	20
A, C, B, E, D, F	(4)	(2)	(14)	(5)	(20)



**K. J. Somaiya College of Engineering, Mumbai-77**  
(A Constituent College of Somaiya Vidyavihar University)  
**Department of Computer Engineering**

**Solution:**

**CODE:**

```
#include <iostream>
#include <limits>

using namespace std;

const int INF = numeric_limits<int>::max();
const int MAX = 6;

void dijkstra(int v, int cost[MAX][MAX], int dist[MAX], int n) {
    bool S[MAX] = {false};

    for (int i = 0; i < n; i++) {
        if (cost[v][i] == 0 && i != v)
            dist[i] = INF;
        else
            dist[i] = cost[v][i];
    }

    S[v] = true;
    dist[v] = 0;

    for (int num = 1; num < n; num++) {
        int u = -1, minDist = INF;

        for (int i = 0; i < n; i++) {
            if (!S[i] && dist[i] < minDist) {
                minDist = dist[i];
                u = i;
            }
        }

        if (u == -1) break;
        S[u] = true;

        for (int w = 0; w < n; w++) {
            if (!S[w] && cost[u][w] != 0 && dist[u] + cost[u][w] < dist[w]) {
                dist[w] = dist[u] + cost[u][w];
            }
        }
    }
}
```



**K. J. Somaiya College of Engineering, Mumbai-77**  
(A Constituent College of Somaiya Vidyavihar University)  
**Department of Computer Engineering**

```
int main() {
    int cost[MAX][MAX] = {
        {0, 7, 9, 0, 0, 14},
        {7, 0, 10, 15, 0, 0},
        {9, 10, 0, 11, 0, 2},
        {0, 15, 11, 0, 6, 0},
        {0, 0, 0, 6, 6, 9},
        {14, 0, 2, 0, 9, 0}
    };

    int dist[MAX];
    int source = 0;

    dijkstra(source, cost, dist, MAX);

    cout << "Shortest distances from vertex " << source + 1 << ":\n";
    for (int i = 0; i < MAX; i++) {
        if (dist[i] == INF)
            cout << "To vertex " << i + 1 << ": No Path\n";
        else
            cout << "To vertex " << i + 1 << ": " << dist[i] << endl;
    }

    return 0;
}
```

**OUTPUT:**

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● PS C:\Users\tanis> & 'c:\Users\tanis\.vscode\extensions\ms-vscode.cpptools-1.23.6-win32-x64\def
rosoft-MIEngine-In-rqzx4bii.sa4' '--stdout=Microsoft-MIEngine-Out-szzfenlu.tyw' '--stderr=Microso
ngine-Pid-tcotipyz.3ni' '--dbgExe=C:\msys64\ucrt64\bin\gdb.exe' '--interpreter=mi'
Shortest distances from vertex 1:
To vertex 1: 0
To vertex 2: 7
To vertex 3: 9
To vertex 4: 20
To vertex 5: 20
To vertex 6: 11
```



**K. J. Somaiya College of Engineering, Mumbai-77**  
(A Constituent College of Somaiya Vidyavihar University)  
**Department of Computer Engineering**

**Time Complexity for single source shortest path:**

Time Complexity for single source shortest path: When using an adjacency matrix, Dijkstra's Algorithm runs in  $O(n^2)$  time.

**Conclusion:**

Implementation and Analysis of Single Source Shortest Path