

## Example: Step by Step operation of Dijkstra algorithm.

אלגוריתם Dijkstra – מוצא מסלולים זולים ביותר מקודקוד מקור לכל הקודקודים בגרף מכון וממושקל במשקלות אי-שליליים.

זמן הריצה -  $O(|E| + |V| \log |V|)$ .

**DIJKSTRA( $G, w, s$ )**

```

1 INITIALIZE-SINGLE-SOURCE( $G, s$ )
2  $S \leftarrow \emptyset$ 
3  $Q \leftarrow V[G]$ 
4 while  $Q \neq \emptyset$  do
5      $u \leftarrow \text{EXTRACT-MIN}(Q)$ 
6      $S \leftarrow S \cup \{u\}$ 
7     for each vertex  $v$  in  $Q$ 
           such that  $v \in \text{Adj}[u]$  do
8         RELAX( $u, v, w$ )
    
```

**RELAX( $u, v, w$ )**

```

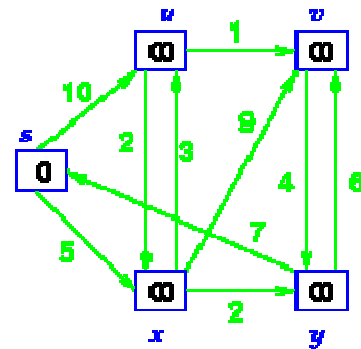
1 if  $d[v] > d[u] + w(u, v)$  then
2      $d[v] \leftarrow d[u] + w(u, v)$ 
3      $\pi[v] \leftarrow u$ 
    
```

**INITIALIZE-SINGLE-SOURCE( $G, s$ )**

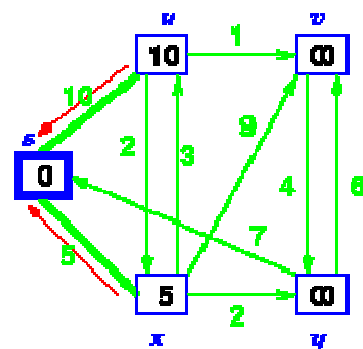
```

1 for each vertex  $v \in V[G]$  do
2      $d[v] \leftarrow \infty$ 
3      $\pi[v] \leftarrow \text{NIL}$ 
4  $d[s] \leftarrow 0$ 
    
```

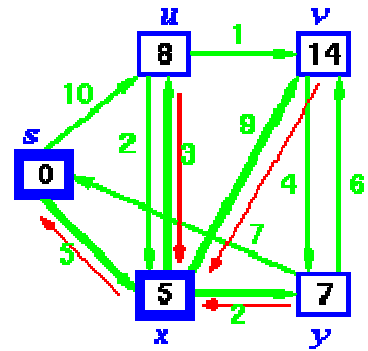
**Step 1.** Given initial graph  $G = (V, E)$ . All nodes have infinite cost except the source node,  $s$ , which has 0 cost. We initialize  $d[s]$  to 0.



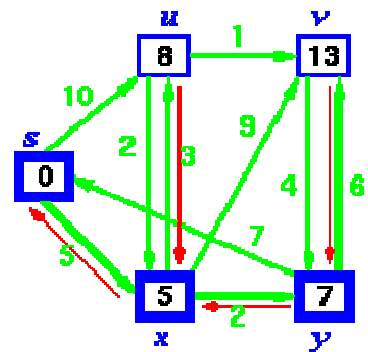
**Step 2.** We choose the node, which is closest to the source node,  $s$  (at the start, it is  $s$  itself). Add  $s$  to  $S$ . Relax all nodes adjacent to  $s$ . Update predecessor (see red arrow in diagram below) for all nodes updated.



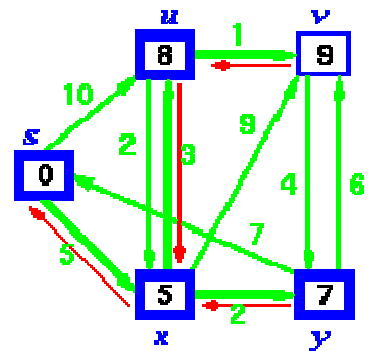
**Step 3.** Choose the closest node,  $x$ . Relax all nodes adjacent to node  $x$ . Update predecessors for nodes  $u$ ,  $v$  and  $y$  (again notice red arrows in diagram below).



**Step 4.** Now, node  $y$  is the closest node, so add it to  $S$ . Relax node  $v$  and adjust its predecessor (red arrows remember!).



**Step 5.** Now we have node  $u$  that is closest. Choose this node and adjust its neighbor node  $v$ .



**Step 6.** Finally, add node  $v$ . The predecessor list now defines the shortest path from each node to the source node,  $s$ .

