Graph Search Algorithms

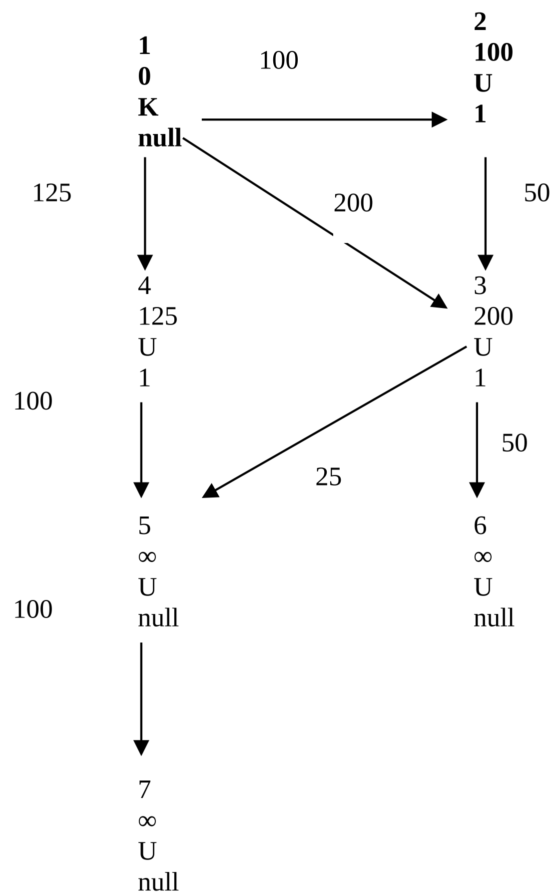
1. The following graph weighted directed graph describes the power-up sequence of devices on a space vehicle, i.e. device 1 (the Backbone Computer) must be on before devices 2,3 and 4 (Navigation, Yaw&Pitch Control and Atmosphere Control respectively) can be initiated. The weights represent the wattage required to initiate each device.

   a) For the next (first) step of Dijkstras algorithm,

   i) Explain which node will next be selected, and why.

   Node 1 as it is the least cost NewReachable node, in fact the only NewReachable node

   ii) Show the updated graph after processing the next node



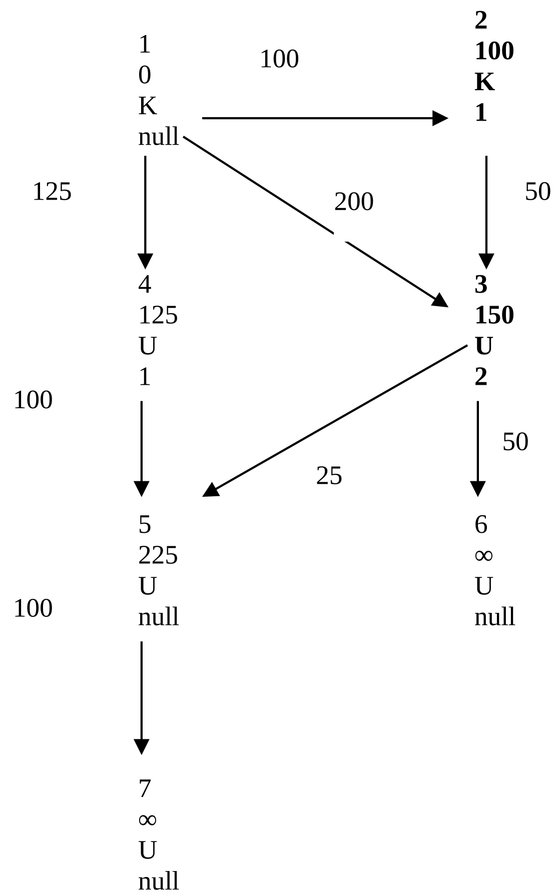
`NewReachables` **= {2,3,4}**

b) For the following (second) step of Dijkstras algorithm,

i) Explain which node will next be selected, and why.

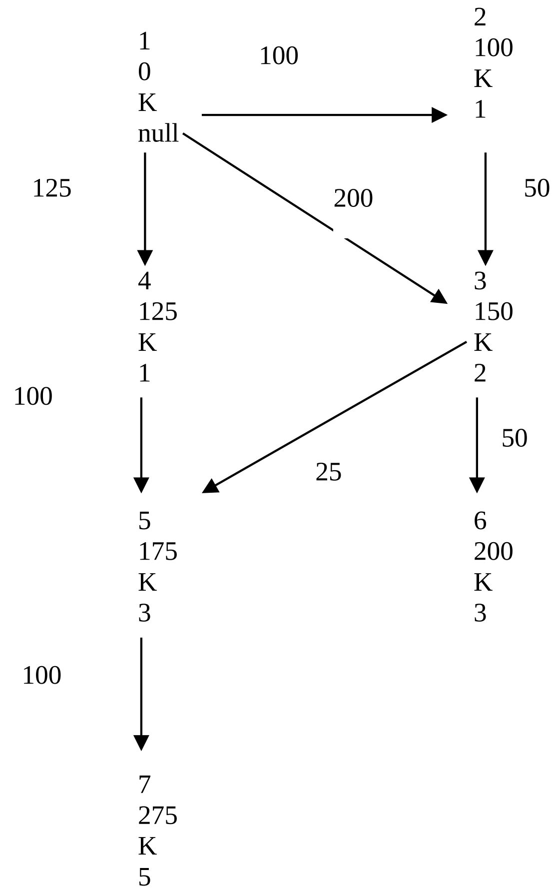
Node 2 as it is the least cost NewReachable node

ii) Show the updated graph and `NewReachables` set after processing the next node



`NewReachables` = {3,4}

c) After Dijkstra's shortest path algorithm completes
i) Show the graph



a) The batteries in the vehicle have limited power and for a course correction maneuver mission control asks:
i) What sequence should the devices be started to initiate device 3 (Yaw&Pitch Control) with minimal power usage?

Sequence: 1,2,3

ii) What sequence should the devices be started to initiate device 7 (the Side Thrusters) with minimal power usage? For each vertex `v`$_i$ on the path, show `v`$_i$`.path`.

Sequence: 1,2,3,5,7

v1.path = null **v5.path = 3**
v2.path = 1 **v7.path = 5**
v3.path = 2

b) After the manoever all devices except device 1 (the Backbone Computer) are turned off for 2 days to conserve power, by which time the maximum power output from the batteries is 200W. Mission control now asks the following questions

i) Can device 5 (Roll Control) be initiated? If so using what sequence, and what is the total power consumed?

Yes, sequence: 1,2,3,5 power consumed: 175 Watts

ii) Can device 7 (Side Thrusters) be initiated? If so using what sequence, and what is the total power consumed?

No

iii) Can devices 5 and 6 (Roll Control and Cabin Heater) be initiated simultaneously? If so using what sequence, and what is the total power consumed?

No

iv) What are the *largest* sequences of devices that can be initiated with the power available?

{1,2,3,6} or {1,2,3,5} or {1,4}

c) Did the vehicle land safely ;-) ???

Yes: it is loosely based on the aborted Apollo 13 mission.

2.

i) Adapt the pseudocode for Dijkstra's shortest path algorithm to find the longest path from a source node to every destination node.

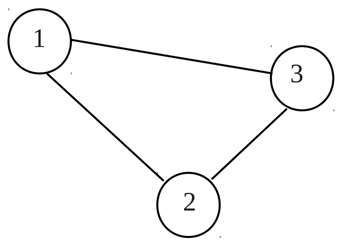
```
dikstraLongestPath(Vertex s)
{
 for each vertex v {
  v.dist = -INFINITY
  v.known = false
 }
 s.dist = 0
 newReachableVertices = {s}
 while newReachableVertices is not empty {
  delete from newReachableVertices the v with greatest dist
  v.known = true
  for each vertex w adjacent to v
   if (!w.known) {
    add w to newReachableVertices
    if (v.dist + getWeight(v,w) > w.dist) {
     w.dist = v.dist + getWeight(v,w)
     w.path = v
    }
   }
 }
}
```

ii) Perform a walkthrough of your algorithm to check it works correctly.
Omitted: depends on your algorithm and the graph you select.

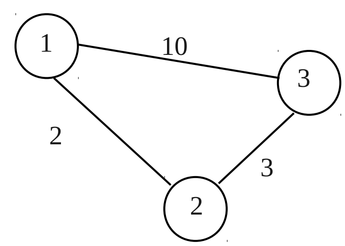
3.

(i) **Node Visited**	**Stack**	(ii) **Node Visited**	**Queue**
0	(1 6 7)	0	(1 6 7)
1	(2 3 6 7)	1	(6 7 2 3)
2	(3 6 7)	6	(7 2 3)
3	(4 5 6 7)	7	(2 3 8 9)
4	(5 6 7)	2	(3 8 9)
5	(6 7)	3	(8 9 4 5)
6	(7)	8	(9 4 5)
7	(8 9)	9	(4 5)
8	(9)	4	(5)
9	end	5	end

4. Consider the following graphs:
1. (a)



(b)



(a) is a non-weighted or uniform weight graph, and the shortest path entails visiting the least number of nodes. For example the shortest path from node 1 to 3 is via the edge between those two nodes
(b) is a weighted graph, and the shortest path is the one with the least total weight. For example the shortest path between nodes 1 and 3 is now via node 2, with total weight 5.

5. No set answer, but discuss when direction, cycles, weights and labels are important.