Contents

1 Find the shortest path with the greatest skill level between two users

1.1 Task

The task is motivated by wanting to find the shortest path from a coder to another coder in a social network graph. The path should be the shortest possible, but consist of the strongest coders possible.

Each coder has a skill level, and to make the task look like a minimisation/shortest path problem, the skill level is inverted to find a weighting for edges between two coders in the graph.

The shortest path is the one where the sum of the weights (inverted skill levels), on edges, is a minimum.

NOTE: The value 2 is arbitrarily chosen for links to coders with skill level

1.

1.2 Algorithm

Setup:

```
1. Set the start node's cost to 0
2. Set all other node's costs to some Maximum value (infinite)
3. Insert the start node onto an ordered (initially empty) list nList
4. Run the findShortest algorithm
```

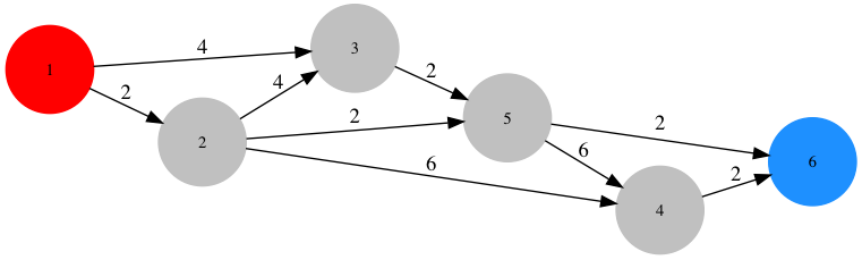
The findShortest algorithm is:

```
while targetNode hasn't been visited:
    if nList is empty - we can't find a path
    pop the first element of nList into curNode
```

```
for each node f in the friends list of curNode:
     if f has not been visited, set it's tentative cost if required:
         if f.skill != 0
            tentativeCost = curNode.cost + 1 / f.skill
         else:
             tentativeCost = curNode.cost + 2 (or chosen value.)
         if tentativeCost < f.tentativeCost:
             f.tentativeCost = curNode.cost + 2 (or chosen value.)
             insert f in order into nList
```

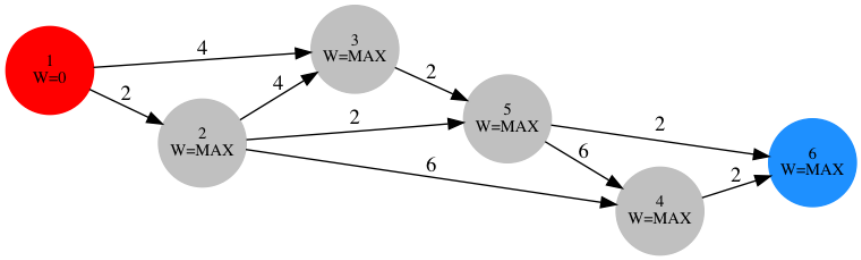
NOTE: An addition to the above algorithm, we record the path by setting a prev link from destination to source, between each f and curNode whenever we reduce f's tentativeCost.

1.3 Example



Given we want to find the shortest path with the above criteria between coder 1 and coder 6, we start at 1.

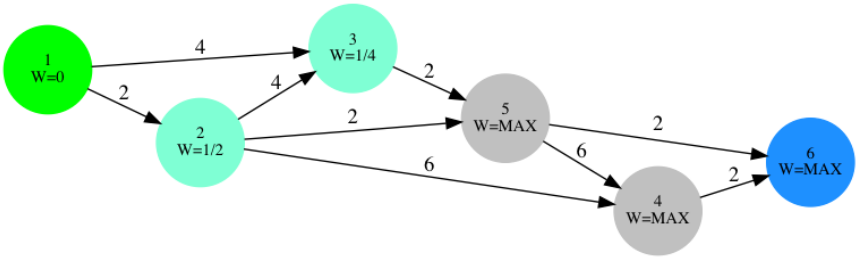
Initialise the graph with all costs = some max value, except 1, which has a cost of zero:



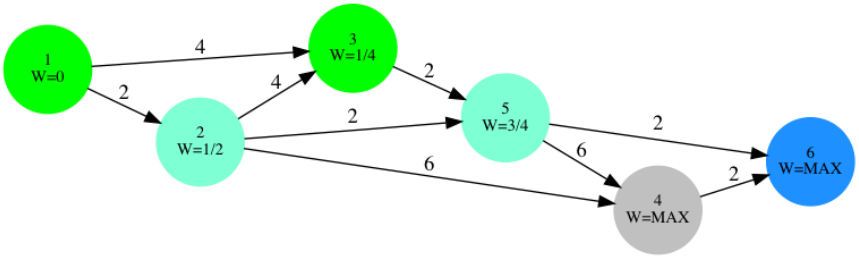
At this point, we push node 1 onto nList, mark it visited, and start with the findShortestPath Algorithm.

The algorithm pop's node1, and updates both of it's friends with tentative costs, $\frac{1}{4}$ for node 3, and $\frac{1}{2}$ for node 2. After the inner for loop completes, nList should contain node 3 and node 2 in that order.

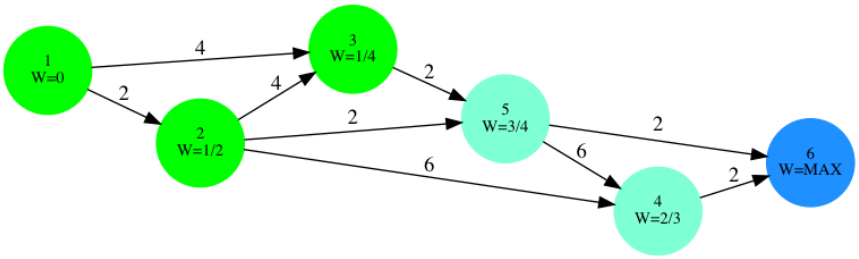
The graph is now like this:



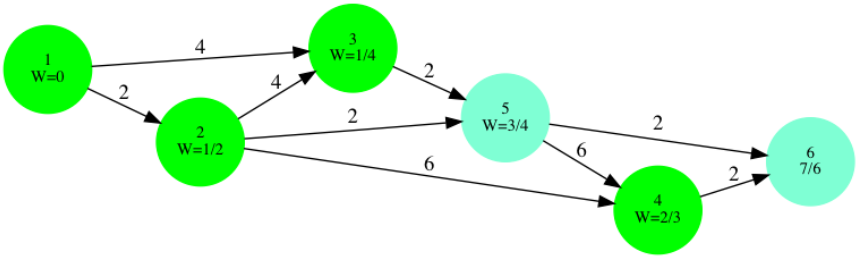
The first node in nList is now node 3 with weight $\frac{1}{4}$, so we process that node in the same way, and end up with the following graph:



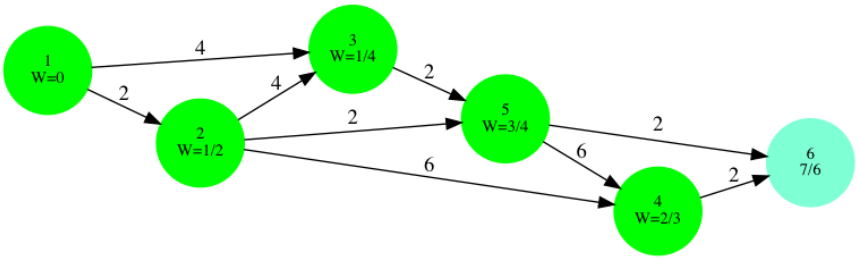
Once again, nList has the inorder list of nodes, ie. node 2 then node 5, so the next iteration processes Node 2, and we end up with the graph:



Since $\frac{2}{3} < \frac{3}{4}$, the first node in nList is now node 4, followed by node 5. We pop node4 from nList, and process it to produce:



At this point, nList contains node 5 followed by node 6, so node 5 is processed. NOTE: In this case, neither of the friends of node 5 are updated because the cost at node 5 + the weights to each of the nodes from node 5, are greater than their currently assigned costs, so the graph now looks unchanged except node 5 has changed colour to green to indicate it's been visited:



Finally, there is only one node left in nList, and we visit that node 6, which terminates the algorithm.

So our shortest path is:

```
1 -> 2 -> 4 -> 6
```

This path has a length $\frac{1}{2} + \frac{1}{6} + \frac{1}{2} = \frac{7}{6}$

1.3.1 The Json file

```
{"user" : 1 , "friends" : [2, 3], "skill" : 0}
{"user" : 2, "friends" : [3, 4, 5], "skill" : 2}
{"user" : 3, "friends" : [5], "skill" : 4}
{"user" : 4, "friends" : [6], "skill" : 6}
{"user" : 5, "friends" : [4, 6], "skill" : 2}
{"user" : 6, "friends" : [], "skill" : 2}
```