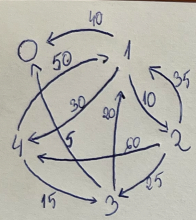


graph.txt

```
5 10
1 0 40
1 2 10
1 4 30
2 1 35
2 3 25
2 4 60
3 0 5
3 1 20
4 1 50
4 3 15
```

Lowest cost path between 2 vertices using the Bellman-Ford algorithm

Example 1: going from 4 to 2

	changed	edge(x,y)	distance	parent
initialization	True		0 1 2 3 4 ∞ ∞ ∞ ∞ 0	0 1 2 3 4 -1 -1 -1 -1 -1
iteration 1	false true true	 (4,1) (4,3)	0 1 2 3 4 ∞ 50 ∞ ∞ 0 ∞ 50 ∞ 15 0	0 1 2 3 4 -1 4 -1 -1 -1 -1 4 -1 4 -1
iteration 2	false true true true true	 (1,0) (1,2) (3,0) (3,1)	0 1 2 3 4 90 50 ∞ 15 0 90 50 60 15 0 20 50 60 15 0 20 35 60 15 0	0 1 2 3 4 1 4 1 4 -1 1 4 1 4 -1 3 4 1 4 -1 3 3 1 4 -1
iteration 3	false true	 (1,2)	0 1 2 3 4 20 35 45 15 0	0 1 2 3 4 3 3 1 4 -1
iteration 4	false	=> stop		

The minimum cost walk from start = 4 to end = 2 has the cost remembered in distance[2] = 45, and can be built backwards from the parent dictionary:

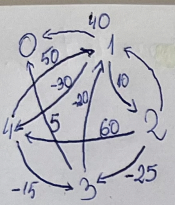
end = 2, parent[2] = 1, parent[1] = 3, parent[3] = 4 = start

walk: $4 \xrightarrow{15} 3 \xrightarrow{20} 1 \xrightarrow{10} 2$

Example 2: going from 0 to 3

	changed	edge (x,y)	distance	parent
			0 1 2 3 4	0 1 2 3 4
initialization	true		0 ∞ ∞ ∞ ∞	-1 -1 -1 -1 -1
iteration 1	false	=> stop		

Since 0 has no outbound neighbours, we can't find any edges towards 3, so the algorithm stops after the first iteration, thus the walk from 0 to 3 does not exist.
Since 0 has no outbound neighbours



graphNeg.txt

```
5 10
1 0 40
1 2 10
1 4 -30
2 1 35
2 3 -25
2 4 60
3 0 5
3 1 -20
4 1 50
4 3 -15
```

Example 3: On a modified graph, with edges that have negative values, find the path from 4 to 2

	changed	edge (x,y)	distance	parent
			0 1 2 3 4	0 1 2 3 4
initialization	true		∞ ∞ ∞ ∞ 0	-1 -1 -1 -1 -1
iteration 1	false		0 1 2 3 4	0 1 2 3 4
	true	(4,1)	∞ 50 ∞ ∞ 0	-1 4 -1 -1 -1
	true	(4,3)	∞ 50 ∞ -15 0	-1 4 -1 4 -1
iteration 2	false		0 1 2 3 4	0 1 2 3 4
	true	(1,0)	90 50 ∞ -15 0	1 4 -1 4 -1
	true	(1,2)	90 50 60 -15 0	1 4 1 4 -1
	true	(3,0)	-10 50 60 -15 0	3 4 1 4 -1
	true	(3,1)	-10 -35 60 -15 0	3 3 1 4 -1
iteration 3	false		0 1 2 3 4	0 1 2 3 4
	true	(1,2)	-10 -35 -25 -50 0	3 3 1 4 -1
	true	(1,4)	-10 -35 -25 -50 -65	3 3 1 4 1
	true	(2,3)	-10 -35 -25 -50 -65	3 3 1 2 1
	true	(3,0)	-45 -35 -25 -50 -65	3 3 1 2 1
	true	(3,1)	-45 -70 -25 -50 -65	3 3 1 2 1
	true	(4,3)	-45 -70 -25 -80 -65	3 3 1 4 1
	false		0 1 2 3 4	0 1 2 3 4
	true	(1,2)	-45 -70 -60 -80 -65	3 3 1 4 1
	true	(1,4)	-45 -70 -60 -80 -100	3 3 1 4 1
	true	(2,3)	-45 -70 -60 -85 -100	3 3 1 2 1
	true	(3,0)	-80 -70 -60 -85 -100	3 3 1 2 1
	true	(3,1)	-80 -105 -60 -85 -100	3 3 1 2 1
	true	(4,3)	-80 -105 -60 -105 -100	3 3 1 4 1
iteration 5	false	=> stop, we have gone through all the possible edges and found no path		

Thus, the graph contains negative cycles and no path can be found from 4 to 2.