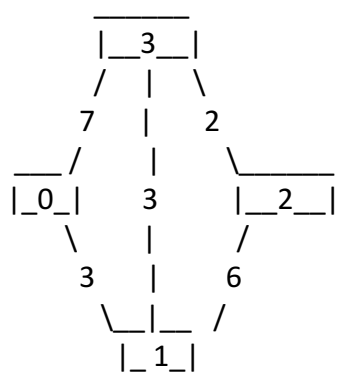
Network Example 2

Simulation for 10 exchanges WITH split-horizon heuristic of a network with 4 nodes

Input:

```
-numOfNodes 4 -maxExchanges 10 -untilStability false -manual false -splitHorizon on
-infinity 60
0 1 3
0 3 7
1 2 6
1 3 3
2 3 2
## links changes
0 1 5 -1
## show best routes
0 1 4
1 0 4
0 1 6
1 0 6
3 0 6
0 1 7
1 0 7
3 0 7
0 1 8
1 0 8
3 0 8
0 1 9
1 0 9
## trace routing tables
0 0 10
1 0 10
2 0 10
3 0 10
```

Diagram of the network



Output:

Simulator configuration:

Again, the first few lines just present the initial state of the simulator as well as all the events that have been scheduled to happen. I did not include it because I don't feel it is particularly interesting.

Exchange 0:

As before during the first exchange ever all nodes learn about their immediate neighbors. The lucky ones even learn about some of the neighbors of their neighbors.

From the output we can deduce:

1. All nodes have learned about their neighbors reflected in all routing tables having 4 entries = number of nodes in the network.
2. Some of the nodes even learn a better route to a destination from the initial. Node3 initially learns a route to node0 with cost 7 but then it learns a better route through node1 with cost 6 (blue entries). Same thing for node1 which learns in 1 round a route to node2 and a better route to node2 (yellow entries). This is because of the sequential way the simulator works. It first made node0 send its routing table to node1 and node3 thus node1 and node3 learn about node0. Some time later node1 sends its routing table to node3 which includes a better route to node0 so node3 updates its routing table to reflect that.
3. Node2 does the most progress by learning figuring out better routes for two destinations (red entries).

```
========================= Round 0 ==========================
simulate network exchange start
Node 1 logging RouteEntry{ dest: 0, cost: 3, next:0}
Node 3 logging RouteEntry{ dest: 0, cost: 7, next:0}
Node 2 logging RouteEntry{ dest: 0, cost: 9, next:1}
Node 2 logging RouteEntry{ dest: 1, cost: 6, next:1}
Node 0 logging RouteEntry{ dest: 1, cost: 3, next:1}
Node 3 logging RouteEntry{ dest: 0, cost: 6, next:1}
Node 3 logging RouteEntry{ dest: 1, cost: 3, next:1}
Node 1 logging RouteEntry{ dest: 2, cost: 6, next:2}
Node 3 logging RouteEntry{ dest: 2, cost: 2, next:2}
Node 2 logging RouteEntry{ dest: 0, cost: 8, next:3}
Node 2 logging RouteEntry{ dest: 1, cost: 5, next:3}
Node 2 logging RouteEntry{ dest: 3, cost: 2, next:3}
Node 0 logging RouteEntry{ dest: 2, cost: 9, next:3}
Node 0 logging RouteEntry{ dest: 3, cost: 7, next:3}
Node 1 logging RouteEntry{ dest: 2, cost: 5, next:3}
Node 1 logging RouteEntry{ dest: 3, cost: 3, next:3}
simulate network exchange finish

------- !!! ------- There were a changes in node routing tables ------- !!! -------
Nodes with changed routing tables:
0 1 2 3

############ ScheduledEvents after exchange 0 ############
TraceRouteTableEvent for node 0
RouteTable for node : 0
      dest cost next
         0    0 null
         1    3    1
         2    9    3
         3    7    3
```

```
TraceRouteTableEvent for node 1
RouteTable for node : 1
       dest cost next
          0    3    0
          1    0 null
          2    5    3
          3    3    3

TraceRouteTableEvent for node 2
RouteTable for node : 2
       dest cost next
          0    8    3
          1    5    3
          2    0 null
          3    2    3

TraceRouteTableEvent for node 3
RouteTable for node : 3
       dest cost next
          0    6    1
          1    3    1
          2    2    2
          3    0 null

========================= End round 0 ==========================
```

Exchange 1

From the output we can deduce:

1. During this exchange node0 found out better routes to both node2 and node3.
2. Non of the other nodes found out better routes. This is expected since in exchange 0 node1, node2 and node3 not only acknowledged the presence of the other nodes on the network but also managed to find out the best routes to them.

```
======================== Round 1 ==========================
simulate network exchange start
Node 0 logging RouteEntry{ dest: 2, cost: 8, next:1}
Node 0 logging RouteEntry{ dest: 3, cost: 6, next:1}
simulate network exchange finish

------- !!! ------- There were a changes in node routing tables ------- !!! -------
Nodes with changed routing tables:
0

########### ScheduledEvents after exchange 1 ###########
TraceRouteTableEvent for node 0
RouteTable for node : 0
       dest cost next
          0    0 null
          1    3    1
          2    8    1
          3    6    1

TraceRouteTableEvent for node 1
RouteTable for node : 1
       dest cost next
          0    3    0
          1    0 null
          2    5    3
          3    3    3

TraceRouteTableEvent for node 2
RouteTable for node : 2
       dest cost next
          0    8    3
          1    5    3
          2    0 null
          3    2    3

TraceRouteTableEvent for node 3
RouteTable for node : 3
       dest cost next
          0    6    1
          1    3    1
          2    2    2
          3    0 null

======================== End round 1 ==========================
```

Exchange 2,3,4,5

Nothing interesting happens during those exchanges.

From the output we can deduce that:

1. Network is stable since round 2
2. Nothing happens in the network
3. At round 4 we see the current best route from node0 to node1.
4. At round 5 link between route node0 and node1 fails.

```
======================== Round 2,3,4,5 ========================
simulate network exchange start
simulate network exchange finish

------- !!! ------- Network stable for this round ------- !!! ------

########### ScheduledEvents after exchange 4 ###########
ShowBestRouteEvent from 0 to 1
       0 - > 1

ShowBestRouteEvent from 1 to 0
       1 - > 0

########### ScheduledEvents after exchange 5 ###########
LinkCostChangeEvent
       link between 0 and 1 from 3 to -1

TraceRouteTableEvent for node 0
RouteTable for node : 0
       dest cost next
          0    0 null
          1    3    1
          2    8    1
          3    6    1

TraceRouteTableEvent for node 1
RouteTable for node : 1
       dest cost next
          0    3    0
          1    0 null
          2    5    3
          3    3    3

TraceRouteTableEvent for node 2
RouteTable for node : 2
       dest cost next
          0    8    3
          1    5    3
          2    0 null
          3    2    3

TraceRouteTableEvent for node 3
RouteTable for node : 3
       dest cost next
          0    6    1
          1    3    1
          2    2    2
          3    0 null

======================== End round 2,3,4,5 ========================
```

Exchange 6

In the previous exchange the link between node0 and node1 has failed.

From the output we can deduce:

1. Node0 and node1 notice the failed link and recover by removing all the entries in the table learned from the node on the other end of the failed link. They later fill in the missing routes.
2. Node1 shows signs of the count-to-infinity problem. A cycle is formed between node1, node2 and node3 about a path to node0. Because node1 has noticed the link failure it has deleted entries learned from node0 as well as through node0. When it later receives node2's routing table it "registers" a route to an unknown node0 so it just accepts it and thus closes the cycle between node1, node2 and node3 which now depend on each other.

```
======================== Round 6 ==========================
simulate network exchange start
Node 0 remove neighbour 1
Node 0 will remove entry because it came from neightbor 1 : RouteEntry{ dest: 3,
cost: 6, next:1}
Node 0 will remove entry because it came from neightbor 1 : RouteEntry{ dest: 2,
cost: 8, next:1}
Node 1 remove neighbour 0
Node 1 logging RouteEntry{ dest: 0, cost: 14, next:2}
Node 0 logging RouteEntry{ dest: 1, cost: 10, next:3}
Node 0 logging RouteEntry{ dest: 2, cost: 9, next:3}
Node 0 logging RouteEntry{ dest: 3, cost: 7, next:3}
simulate network exchange finish

------- !!! ------- There were a changes in node routing tables ------- !!! -------
Nodes with changed routing tables:
0 1
########### ScheduledEvents after exchange 6 ###########
ShowBestRouteEvent from 0 to 1
       0 - > 3 -> 1
ShowBestRouteEvent from 1 to 0
There is a cycle in the routes meaning the end node (0) has become unreachable!
       1 - > 2 -> 3 -> 1
ShowBestRouteEvent from 3 to 0
There is a cycle in the routes meaning the end node (0) has become unreachable!
       3 - > 1 -> 2 -> 3
TraceRouteTableEvent for node 0
RouteTable for node : 0
       dest cost next
          0    0 null
          1   10    3
          2    9    3
          3    7    3
TraceRouteTableEvent for node 1
RouteTable for node : 1
       dest cost next
          0   14    2
          1    0 null
          2    5    3
          3    3    3
TraceRouteTableEvent for node 2
RouteTable for node : 2
       dest cost next
          0    8    3
          1    5    3
          2    0 null
          3    2    3
```

```
TraceRouteTableEvent for node 3
RouteTable for node : 3
       dest cost next
          0    6    1
          1    3    1
          2    2    2
          3    0 null
======================== End round 6 ==========================
```

Exchange 7

This is very interesting exchange.

From the output we can deduce that:

1. We can very clearly see the counting-to-infinity happening between nodes 1, 2 and 3 which all feed the others wrong info about a route to node0. Even though split-horizon is turned on it will not help in this situation because it can only prevent two nodes from feed each other information.
2. Node3 does not register that node0 can be reached through the direct link connecting them with cost 7. This is again because of the sequential way the simulator works. What has happened is that node0 has advertised its routing table to node3 before node3 has had the chance to know about the link fail. This means that node3 still holds a route entry for node0 through node1 for cost 6 and thus it disregards node0's route.

```
======================== Round 7 ==========================
simulate network exchange start
Node 3 logging RouteEntry{ dest: 0, cost: 17, next:1}
Node 2 logging RouteEntry{ dest: 0, cost: 19, next:3}
simulate network exchange finish

------- !!! ------- There were a changes in node routing tables ------- !!! -------
Nodes with changed routing tables:
2 3

########### ScheduledEvents after exchange 7 ###########
ShowBestRouteEvent from 0 to 1
       0 - > 3 -> 1

ShowBestRouteEvent from 1 to 0
There is a cycle in the routes meaning the end node (0) has become unreachable!
       1 - > 2 -> 3 -> 1

ShowBestRouteEvent from 3 to 0
There is a cycle in the routes meaning the end node (0) has become unreachable!
       3 - > 1 -> 2 -> 3

TraceRouteTableEvent for node 0
RouteTable for node : 0
       dest cost next
          0    0 null
          1   10    3
          2    9    3
          3    7    3

TraceRouteTableEvent for node 1
RouteTable for node : 1
       dest cost next
          0   14    2
          1    0 null
          2    5    3
          3    3    3

TraceRouteTableEvent for node 2
RouteTable for node : 2
       dest cost next
          0   19    3
          1    5    3
          2    0 null
          3    2    3
```

```
TraceRouteTableEvent for node 3
RouteTable for node : 3
       dest cost next
          0   17    1
          1    3    1
          2    2    2
          3    0 null

======================== End round 7 ========================
```

Exchange 8

Network recovers.

From the output we can deduce:

1. Node3 figures out that the best route to node0 because this time the advertised route has a lower cost than the known route.
2. Node3 shares the new info with the other nodes which also promptly update their routes to node0.
3. Network recovers fully

```
======================== Round 8 ========================
simulate network exchange start
Node 3 logging RouteEntry{ dest: 0, cost: 7, next:0}
Node 1 logging RouteEntry{ dest: 0, cost: 25, next:2}
Node 2 logging RouteEntry{ dest: 0, cost: 9, next:3}
Node 1 logging RouteEntry{ dest: 0, cost: 10, next:3}
simulate network exchange finish

------- !!! ------- There were a changes in node routing tables ------- !!! -------
Nodes with changed routing tables:
1 2 3

########### ScheduledEvents after exchange 8 ###########
ShowBestRouteEvent from 0 to 1
       0 - > 3 -> 1

ShowBestRouteEvent from 1 to 0
       1 - > 3 -> 0

ShowBestRouteEvent from 3 to 0
       3 - > 0

TraceRouteTableEvent for node 0
RouteTable for node : 0
       dest cost next
          0    0 null
          1   10    3
          2    9    3
          3    7    3

TraceRouteTableEvent for node 1
RouteTable for node : 1
       dest cost next
          0   10    3
          1    0 null
          2    5    3
          3    3    3

TraceRouteTableEvent for node 2
RouteTable for node : 2
       dest cost next
          0    9    3
```

```
          1    5    3
          2    0 null
          3    2    3

TraceRouteTableEvent for node 3
RouteTable for node : 3
       dest cost next
          0    7    0
          1    3    1
          2    2    2
          3    0 null

======================== End round 8 ==========================
```

Exchange 9

Nothing exciting.

From the output we can deduce:

1. Network is stable

```
======================== Round 9 ==========================
simulate network exchange start
simulate network exchange finish

------- !!! ------- Network stable for this round ------- !!! ------

########### ScheduledEvents after exchange 9 ###########
ShowBestRouteEvent from 0 to 1
       0 – > 3 –> 1

TraceRouteTableEvent for node 0
RouteTable for node : 0
       dest cost next
          0    0 null
          1   10    3
          2    9    3
          3    7    3

TraceRouteTableEvent for node 1
RouteTable for node : 1
       dest cost next
          0   10    3
          1    0 null
          2    5    3
          3    3    3

TraceRouteTableEvent for node 2
RouteTable for node : 2
       dest cost next
          0    9    3
          1    5    3
          2    0 null
          3    2    3

TraceRouteTableEvent for node 3
RouteTable for node : 3
       dest cost next
          0    7    0
          1    3    1
          2    2    2
          3    0 null

======================== End round 9 ==========================
```