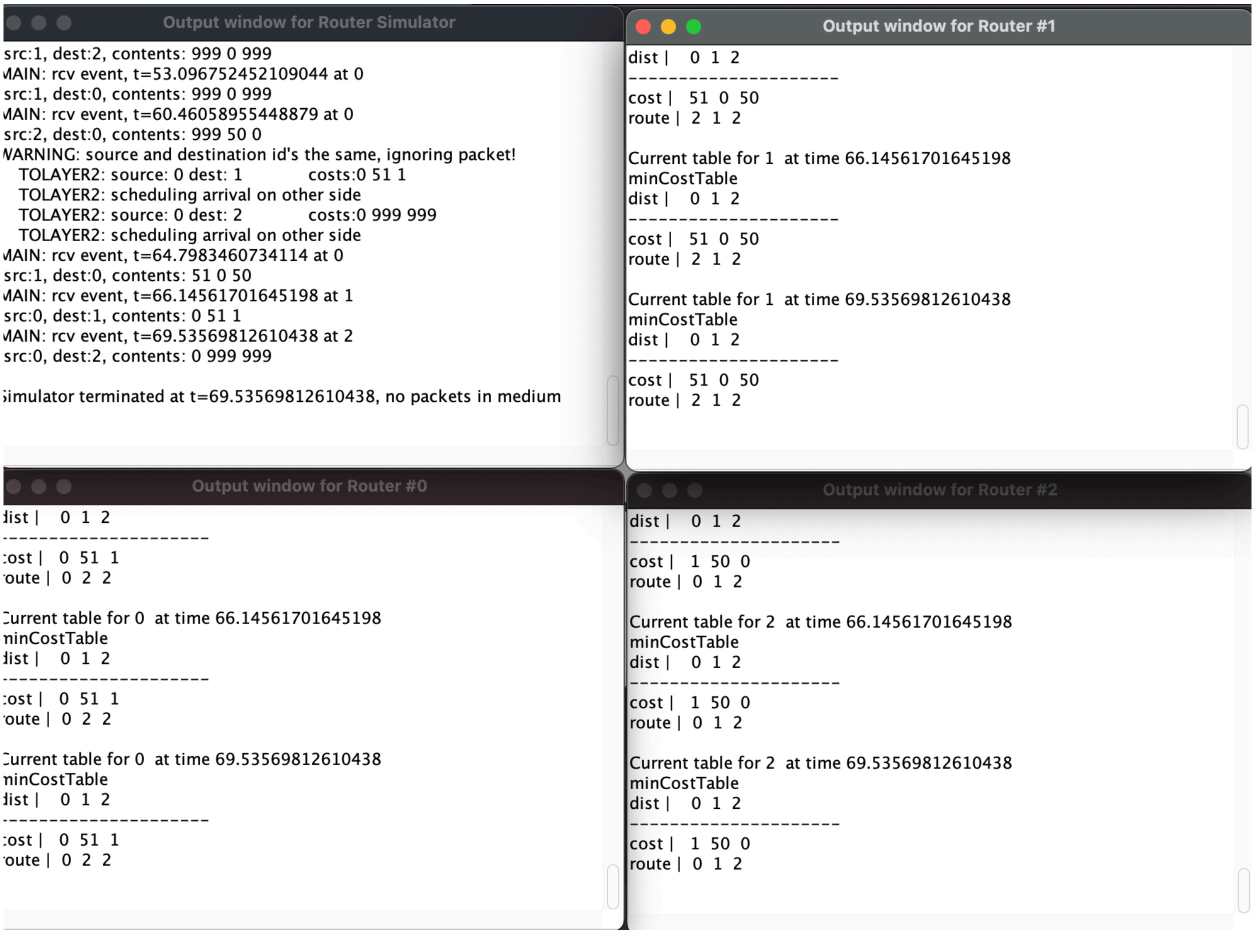
CPSC 441 A4 Report

1. Distance vector routing determines the best route to take based on distance. In order to determine the best route to take, it must take into account the cost of each path that it can take to get to a particular node and compute the distance. To calculate the best route, the Bellman-Ford algorithm is used. In the solution, it calculates the shortest distances that have at most one edge in the path. It then calculates the shortest paths with at most 2 edges and so on. The distances are summed for each path that the source vector needs to reach. The minimum cost is then taken into account for all vector routes, that the source vector can take to reach the neighbouring nodes. The algorithm must initialize all distances from the source to all vertices as infinite and distances to the source and themselves as 0. Then a distance vector must be created and record the values. To calculate the shortest distances, at each edge, we must determine if the cost at the edge is greater than the cost at the other edge plus the weight. If that is the case, then you must update the cost. This almost works like dijkstra's algorithm, but is less efficient in terms of runtime. With this solution, we also have a poisoned reverse to ensure that we don't reach the count to infinity problem.

2. The solution was tested by running the three tests as per the assignment description, as well as comparing the values computed with the values that were computed by the instructor and the TA. All of which resulted in the same values. Additionally, I had also calculated some of the values by hand, tracing the costs and distances to ensure accuracy.

3.

Test case: make install3


Output window for Router Simulator
Output window for Router #1
Output window for Router #0
Output window for Router #2

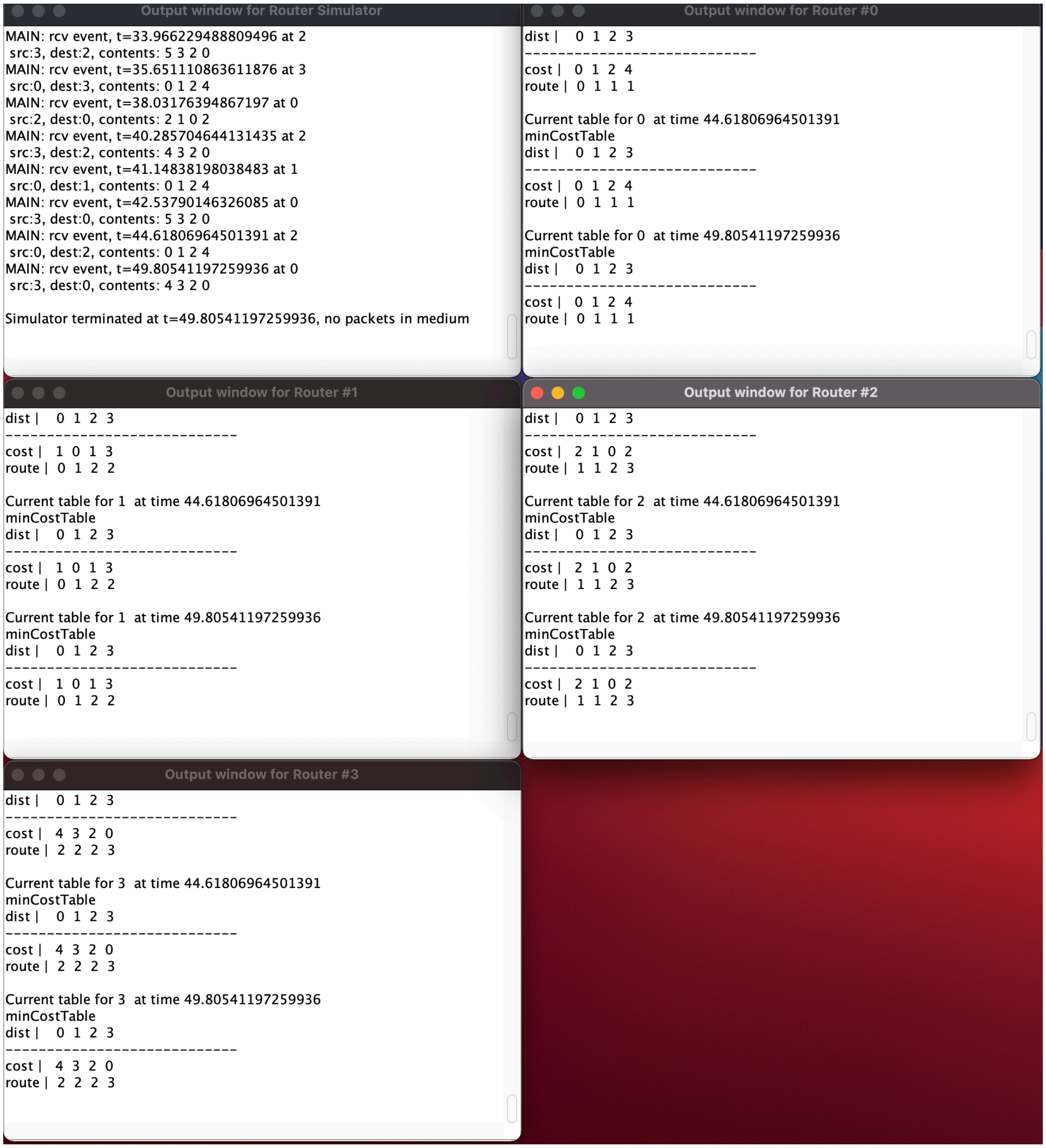
```
src:1, dest:2, contents: 999 0 999
MAIN: rcv event, t=53.096752452109044 at 0
src:1, dest:0, contents: 999 0 999
MAIN: rcv event, t=60.46058955448879 at 0
src:2, dest:0, contents: 999 50 0
WARNING: source and destination id's the same, ignoring packet!
   TOLAYER2: source: 0 dest: 1            costs:0 51 1
   TOLAYER2: scheduling arrival on other side
   TOLAYER2: source: 0 dest: 2            costs:0 999 999
   TOLAYER2: scheduling arrival on other side
MAIN: rcv event, t=64.7983460734114 at 0
src:1, dest:0, contents: 51 0 50
MAIN: rcv event, t=66.14561701645198 at 1
src:0, dest:1, contents: 0 51 1
MAIN: rcv event, t=69.53569812610438 at 2
src:0, dest:2, contents: 0 999 999

Simulator terminated at t=69.53569812610438, no packets in medium
```

```
dist |   0  1  2
---------------------
cost |   51  0  50
route |  2  1  2

Current table for 1  at time 66.14561701645198
minCostTable
dist |   0  1  2
---------------------
cost |   51  0  50
route |  2  1  2

Current table for 1  at time 69.53569812610438
minCostTable
dist |   0  1  2
---------------------
cost |   51  0  50
route |  2  1  2
```

```
dist |   0  1  2
---------------------
cost |   0  51  1
route |  0  2  2

Current table for 0  at time 66.14561701645198
minCostTable
dist |   0  1  2
---------------------
cost |   0  51  1
route |  0  2  2

Current table for 0  at time 69.53569812610438
minCostTable
dist |   0  1  2
---------------------
cost |   0  51  1
route |  0  2  2
```

```
dist |   0  1  2
---------------------
cost |   1  50  0
route |  0  1  2

Current table for 2  at time 66.14561701645198
minCostTable
dist |   0  1  2
---------------------
cost |   1  50  0
route |  0  1  2

Current table for 2  at time 69.53569812610438
minCostTable
dist |   0  1  2
---------------------
cost |   1  50  0
route |  0  1  2
```

Test case: make install4



Output window for Router Simulator

```
MAIN: rcv event, t=33.966229488809496 at 2
 src:3, dest:2, contents: 5 3 2 0
MAIN: rcv event, t=35.651110863611876 at 3
 src:0, dest:3, contents: 0 1 2 4
MAIN: rcv event, t=38.03176394867197 at 0
 src:2, dest:0, contents: 2 1 0 2
MAIN: rcv event, t=40.285704644131435 at 2
 src:3, dest:2, contents: 4 3 2 0
MAIN: rcv event, t=41.14838198038483 at 1
 src:0, dest:1, contents: 0 1 2 4
MAIN: rcv event, t=42.53790146326085 at 0
 src:3, dest:0, contents: 5 3 2 0
MAIN: rcv event, t=44.61806964501391 at 2
 src:0, dest:2, contents: 0 1 2 4
MAIN: rcv event, t=49.80541197259936 at 0
 src:3, dest:0, contents: 4 3 2 0

Simulator terminated at t=49.80541197259936, no packets in medium
```

Output window for Router #0

```
dist |   0  1  2  3
-----------------------------
cost |   0  1  2  4
route |  0  1  1  1

Current table for 0  at time 44.61806964501391
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   0  1  2  4
route |  0  1  1  1

Current table for 0  at time 49.80541197259936
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   0  1  2  4
route |  0  1  1  1
```

Output window for Router #1

```
dist |   0  1  2  3
-----------------------------
cost |   1  0  1  3
route |  0  1  2  2

Current table for 1  at time 44.61806964501391
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   1  0  1  3
route |  0  1  2  2

Current table for 1  at time 49.80541197259936
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   1  0  1  3
route |  0  1  2  2
```

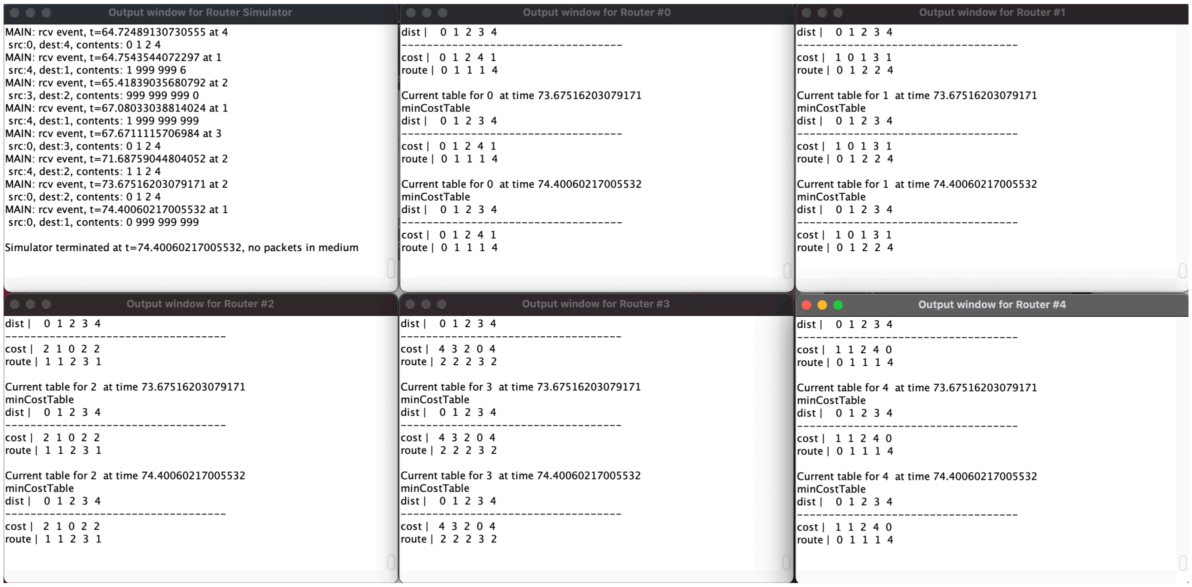
Output window for Router #2

```
dist |   0  1  2  3
-----------------------------
cost |   2  1  0  2
route |  1  1  2  3

Current table for 2  at time 44.61806964501391
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   2  1  0  2
route |  1  1  2  3

Current table for 2  at time 49.80541197259936
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   2  1  0  2
route |  1  1  2  3
```

Output window for Router #3

```
dist |   0  1  2  3
-----------------------------
cost |   4  3  2  0
route |  2  2  2  3

Current table for 3  at time 44.61806964501391
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   4  3  2  0
route |  2  2  2  3

Current table for 3  at time 49.80541197259936
minCostTable
dist |   0  1  2  3
-----------------------------
cost |   4  3  2  0
route |  2  2  2  3
```

Test case: make install5


Output window for Router Simulator
Output window for Router #0
Output window for Router #1
Output window for Router #2
Output window for Router #3
Output window for Router #4

```
MAIN: rcv event, t=64.72489130730555 at 4
 src:0, dest:4, contents: 0 1 2 4
MAIN: rcv event, t=64.7543544072297 at 1
 src:4, dest:1, contents: 1 999 999 6
MAIN: rcv event, t=65.41839035680792 at 2
 src:3, dest:2, contents: 999 999 999 0
MAIN: rcv event, t=67.08033038814024 at 1
 src:4, dest:1, contents: 1 999 999 999
MAIN: rcv event, t=67.6711115706984 at 3
 src:0, dest:3, contents: 0 1 2 4
MAIN: rcv event, t=71.68759044804052 at 2
 src:4, dest:2, contents: 1 1 2 4
MAIN: rcv event, t=73.67516203079171 at 2
 src:0, dest:2, contents: 0 1 2 4
MAIN: rcv event, t=74.40060217005532 at 1
 src:0, dest:1, contents: 0 999 999 999

Simulator terminated at t=74.40060217005532, no packets in medium
```

```
dist |   0  1  2  3  4
-----------------------------------
cost |   0  1  2  4  1
route |  0  1  1  1  4

Current table for 0  at time 73.67516203079171
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   0  1  2  4  1
route |  0  1  1  1  4

Current table for 0  at time 74.40060217005532
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   0  1  2  4  1
route |  0  1  1  1  4
```

```
dist |   0  1  2  3  4
-----------------------------------
cost |   1  0  1  3  1
route |  0  1  2  2  4

Current table for 1  at time 73.67516203079171
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   1  0  1  3  1
route |  0  1  2  2  4

Current table for 1  at time 74.40060217005532
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   1  0  1  3  1
route |  0  1  2  2  4
```

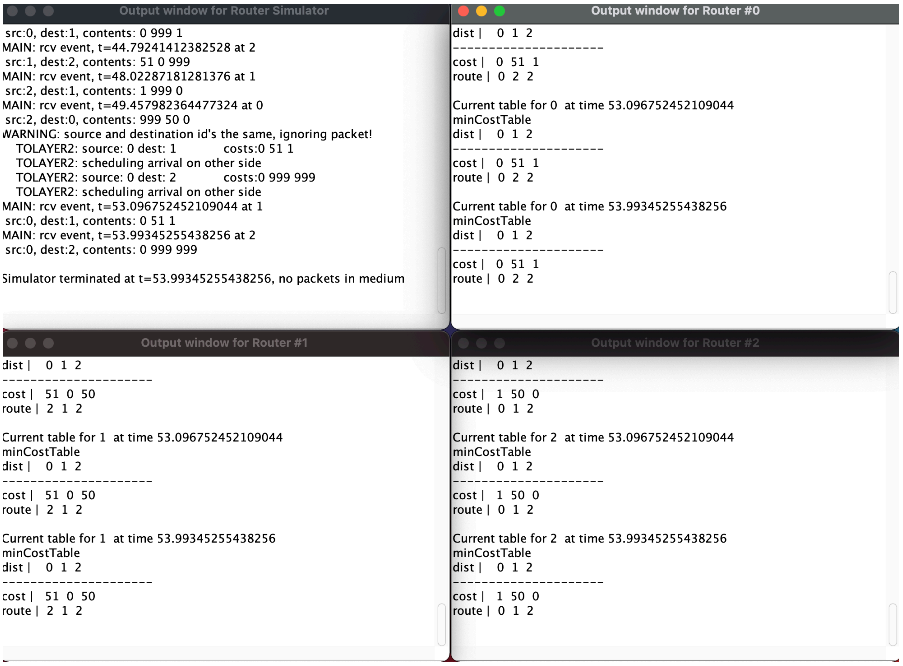
```
dist |   0  1  2  3  4
-----------------------------------
cost |   2  1  0  2  2
route |  1  1  2  3  1

Current table for 2  at time 73.67516203079171
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   2  1  0  2  2
route |  1  1  2  3  1

Current table for 2  at time 74.40060217005532
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   2  1  0  2  2
route |  1  1  2  3  1
```

```
dist |   0  1  2  3  4
-----------------------------------
cost |   4  3  2  0  4
route |  2  2  2  3  2

Current table for 3  at time 73.67516203079171
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   4  3  2  0  4
route |  2  2  2  3  2

Current table for 3  at time 74.40060217005532
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   4  3  2  0  4
route |  2  2  2  3  2
```

```
dist |   0  1  2  3  4
-----------------------------------
cost |   1  1  2  4  0
route |  0  1  1  1  4

Current table for 4  at time 73.67516203079171
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   1  1  2  4  0
route |  0  1  1  1  4

Current table for 4  at time 74.40060217005532
minCostTable
dist |   0  1  2  3  4
-----------------------------------
cost |   1  1  2  4  0
route |  0  1  1  1  4
```

4.

Poisoned Reverse On


Output window for Router Simulator
Output window for Router #0
Output window for Router #1
Output window for Router #2

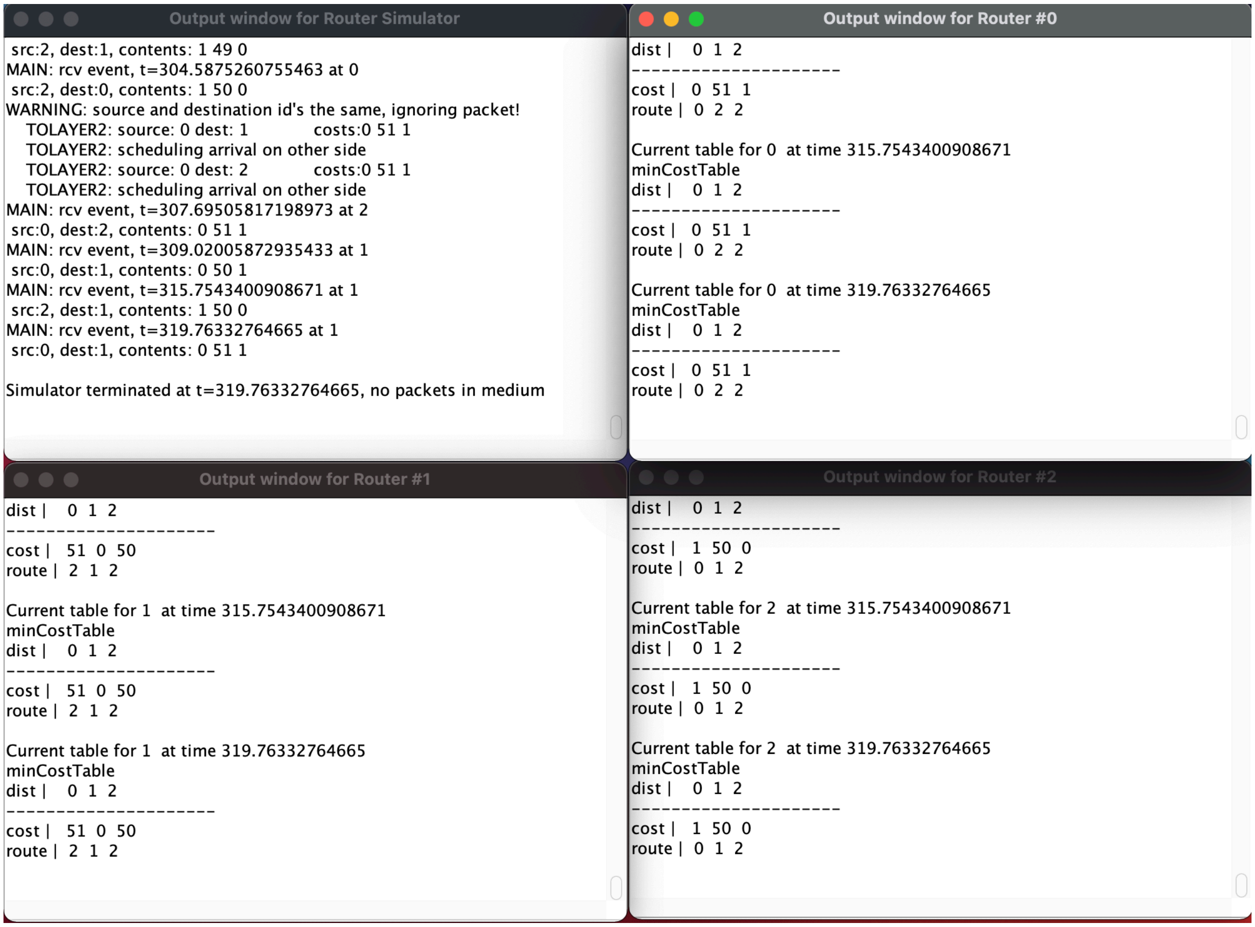
```
 src:0, dest:1, contents: 0 999 1
MAIN: rcv event, t=44.79241412382528 at 2
 src:1, dest:2, contents: 51 0 999
MAIN: rcv event, t=48.02287181281376 at 1
 src:2, dest:1, contents: 1 999 0
MAIN: rcv event, t=49.457982364477324 at 0
 src:2, dest:0, contents: 999 50 0
WARNING: source and destination id's the same, ignoring packet!
   TOLAYER2: source: 0 dest: 1           costs:0 51 1
   TOLAYER2: scheduling arrival on other side
   TOLAYER2: source: 0 dest: 2           costs:0 999 999
   TOLAYER2: scheduling arrival on other side
MAIN: rcv event, t=53.096752452109044 at 1
 src:0, dest:1, contents: 0 51 1
MAIN: rcv event, t=53.99345255438256 at 2
 src:0, dest:2, contents: 0 999 999

Simulator terminated at t=53.99345255438256, no packets in medium
```

```
dist |   0  1  2
---------------------
cost |   0  51  1
route |  0  2  2

Current table for 0  at time 53.096752452109044
minCostTable
dist |   0  1  2
---------------------
cost |   0  51  1
route |  0  2  2

Current table for 0  at time 53.99345255438256
minCostTable
dist |   0  1  2
---------------------
cost |   0  51  1
route |  0  2  2
```

```
dist |   0  1  2
---------------------
cost |   51  0  50
route |  2  1  2

Current table for 1  at time 53.096752452109044
minCostTable
dist |   0  1  2
---------------------
cost |   51  0  50
route |  2  1  2

Current table for 1  at time 53.99345255438256
minCostTable
dist |   0  1  2
---------------------
cost |   51  0  50
route |  2  1  2
```

```
dist |   0  1  2
---------------------
cost |   1  50  0
route |  0  1  2

Current table for 2  at time 53.096752452109044
minCostTable
dist |   0  1  2
---------------------
cost |   1  50  0
route |  0  1  2

Current table for 2  at time 53.99345255438256
minCostTable
dist |   0  1  2
---------------------
cost |   1  50  0
route |  0  1  2
```

Poisoned Reverse Off


Output window for Router Simulator
Output window for Router #0
Output window for Router #1
Output window for Router #2

```
 src:2, dest:1, contents: 1 49 0
MAIN: rcv event, t=304.5875260755463 at 0
 src:2, dest:0, contents: 1 50 0
WARNING: source and destination id's the same, ignoring packet!
    TOLAYER2: source: 0 dest: 1           costs:0 51 1
    TOLAYER2: scheduling arrival on other side
    TOLAYER2: source: 0 dest: 2           costs:0 51 1
    TOLAYER2: scheduling arrival on other side
MAIN: rcv event, t=307.69505817198973 at 2
 src:0, dest:2, contents: 0 51 1
MAIN: rcv event, t=309.02005872935433 at 1
 src:0, dest:1, contents: 0 50 1
MAIN: rcv event, t=315.7543400908671 at 1
 src:2, dest:1, contents: 1 50 0
MAIN: rcv event, t=319.76332764665 at 1
 src:0, dest:1, contents: 0 51 1

Simulator terminated at t=319.76332764665, no packets in medium
```

```
dist |    0  1  2
----------------------
cost |   0  51  1
route |  0  2  2

Current table for 0  at time 315.7543400908671
minCostTable
dist |    0  1  2
----------------------
cost |   0  51  1
route |  0  2  2

Current table for 0  at time 319.76332764665
minCostTable
dist |    0  1  2
----------------------
cost |   0  51  1
route |  0  2  2
```

```
dist |    0  1  2
----------------------
cost |   51  0  50
route |  2  1  2

Current table for 1  at time 315.7543400908671
minCostTable
dist |    0  1  2
----------------------
cost |   51  0  50
route |  2  1  2

Current table for 1  at time 319.76332764665
minCostTable
dist |    0  1  2
----------------------
cost |   51  0  50
route |  2  1  2
```

```
dist |    0  1  2
----------------------
cost |   1  50  0
route |  0  1  2

Current table for 2  at time 315.7543400908671
minCostTable
dist |    0  1  2
----------------------
cost |   1  50  0
route |  0  1  2

Current table for 2  at time 319.76332764665
minCostTable
dist |    0  1  2
----------------------
cost |   1  50  0
route |  0  1  2
```

From the test case above, we can see that poisoned reverse is necessary because the Bellman-Ford algorithm does not have a solution to get rid of routing loops. In the figure with the poisoned reverse toggled off, we can see a much higher time. This is due to the fact the program increments the cost by two for each iteration, resulting in a much longer time.

5. Poisoned reverse can communicate with the other nodes, indicating that it has reached a case in which it continuously loops back upon itself creating a count to infinity problem. When it reaches this, the node that that is affected will no longer route to the node in which the loop was created. This gets rid of the routing loop when an update is successfully transmitted. However, poison reverse is not capable of getting rid of loops greater than two.