Distance Vector Routing Algorithm

1. Programming Language

Python Version 2.7

2. Objective

The objective of this project is to implement the distance vector routing protocol. Our goal in project is to implement an application that can be run either at several different machines or in a single machine. Implementation also handles link cost changes.
Instead of implementing the exact distance vector routing protocol described in the textbook, we have developed a variation of the protocol. In this protocol, each host sends out the routing information to its neighbours at a certain frequency (once every 15 seconds), regardless whether the information has changed since the last announcement. This strategy improves the robustness of the protocol. For instance, a lost message will be automatically recovered by later messages. In this strategy, typically a host re-computes its distance vector and routing table right before sending out the routing information to its neighbours.

3. Distance Vector Routing

Distance-vector routing protocols use the Bellman–Ford algorithm, Ford–Fulkerson algorithm, or DUAL FSM(in the case of Cisco Systems' protocols) to calculate paths.
A distance-vector routing protocol requires that a router inform its neighbours of topology changes periodically. Compared to link-state protocols, which require a router to inform all the nodes in a network of topology changes, distance-vector routing protocols have less computational complexity and message overhead.

Routers using distance-vector protocol do not have knowledge of the entire path to a destination. Instead they use two methods:

1. Direction in which router or exit interface a packet should be forwarded.
2. Distance from its destination

Distance-vector protocols are based on calculating the direction and distance to any link in a network. "Direction" usually means the next hop address and the exit interface. "Distance" is a measure of the cost to reach a certain node. The least cost route between any two nodes is the route with minimum distance. Each node maintains a vector (table) of minimum distance to every node. The cost of reaching a destination is calculated using various route metrics.
Updates are performed periodically in a distance-vector protocol where all or part of a router's routing table is sent to all its neighbours that are configured to use the same distance-vector routing protocol. Once a router has this information it can amend its own routing table to reflect the changes and then inform its neighbours of the changes. This process has been described as ‘routing by rumour’ because routers are relying on the information they receive from other routers and cannot determine if the information is valid and true.

4. Poison Reverse

4.1 Count to infinity problem

The Bellman–Ford algorithm does not prevent routing loops from happening and suffers from the **count-to-infinity problem**. The core of the count-to-infinity problem is that if A tells B that it has a path somewhere, there is no way for B to know if the path has B as a part of it. To see the problem clearly, imagine a subnet connected like A–B–C–D–E–F, and let the metric between the routers be "number of jumps". Now suppose that A is taken offline. In the vector-update-process B notices that the route to A, which was distance 1, is down – B does not receive the vector update from A. The problem is, B also gets an update from C, and C is still not aware of the fact that A is down – so it tells B that A is only two jumps from C (C to B to A), which is false. Since B doesn't know that the path from C to A is through itself (B), it updates its table with the new value "B to A = 2 + 1". Later, B forwards the update to C and since A is reachable through B (From C's point of view), C decides to update its table to "C to A = 3 + 1". This slowly propagates through the network until it reaches infinity (in which case the algorithm corrects itself, due to the relaxation property of Bellman–Ford).

4.2 Solution

Algorithm uses Poison Reverse as a solution to above problem. If Z routes through Y to get to X, then Z tells Y its (Z's) distance to X is infinite (so Y won't route to X via Z).

5. Implementation

For details of implementation, please refer source code written in 'router.py'. It has comments throughout the source code.

6. Input Format

Routing information file should have format as below,
<Total Neighbor Routers>
<Router Name> <Link Cost> <IP Address> <Port>
.
.
<Router Name> <Link Cost> <IP Address> <Port>

7. Execution

If there are 'n' routers, then ClientApp.py in 'n' different terminals.
python ClientApp.py -n [router_name] -i [router_ip] -p [router_port] -f [router_information] -t [timeout] -w [www]

e.g.
If there are 3 routers,
python ClientApp.py -n a -i 127.0.0.1 -p 8080 -f a.dat -t 15
python ClientApp.py -n b -i 127.0.0.1 -p 8081 -f b.dat -t 15
python ClientApp.py -n c -i 127.0.0.1 -p 8082 -f c.dat -t 15

7.1 Normal scenario

Router ‘a’:

```
Chetans-MacBook-Pro:DistanceVectorRouting chetan$ python ClientApp.py -n a -p 8080 -f a.dat
2017-04-23 22:37:39,693 DISTANCE VECTOR ROUTING [INFO] Running Distance Vector Routing at router: a
2017-04-23 22:37:39,693 DISTANCE VECTOR ROUTING [INFO] Creating UDP socket 127.0.0.1:8080
2017-04-23 22:37:39,693 DISTANCE VECTOR ROUTING [INFO] Loading router information from: a.dat
2017-04-23 22:37:39,719 DISTANCE VECTOR ROUTING [INFO] Creating a thread to run Distance Vector Routing algorithm
2017-04-23 22:37:39,719 DISTANCE VECTOR ROUTING [INFO] Creating a thread to monitor links with neighbour routers
2017-04-23 22:37:39,719 DISTANCE VECTOR ROUTING [INFO] Starting thread execution
2017-04-23 22:37:39,720 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:37:39,720 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <1>
2017-04-23 22:37:39,720 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-a: Cost [0.000000], Next Hop Router [a]
2017-04-23 22:37:39,720 DISTANCE VECTOR ROUTING [INFO] [RouterLinkMonitor] Started monitoring links for a router: a
2017-04-23 22:37:39,721 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-c: Cost [7.000000], Next Hop Router [c]
2017-04-23 22:37:39,721 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-b: Cost [2.000000], Next Hop Router [b]
2017-04-23 22:37:41,323 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:37:41,323 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:37:45,932 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:37:45,933 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:00,935 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <2>
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-a: Cost [0.000000], Next Hop Router [a]
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-c: Cost [3.000000], Next Hop Router [b]
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-b: Cost [2.000000], Next Hop Router [b]
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:38:00,937 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:00,937 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:00,937 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:15,938 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:15,938 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <3>
2017-04-23 22:38:15,939 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-a: Cost [0.000000], Next Hop Router [a]
2017-04-23 22:38:15,939 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-c: Cost [3.000000], Next Hop Router [b]
2017-04-23 22:38:15,939 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-b: Cost [2.000000], Next Hop Router [b]
2017-04-23 22:38:15,939 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:15,940 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:15,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:38:15,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
```

Router ‘b’:

```
Chetans-MacBook-Pro:DistanceVectorRouting chetan$ python ClientApp.py -n b -p 8081 -f b.dat
2017-04-23 22:37:41,298 DISTANCE VECTOR ROUTING [INFO] Running Distance Vector Routing at router: b
2017-04-23 22:37:41,298 DISTANCE VECTOR ROUTING [INFO] Creating UDP socket 127.0.0.1:8081
2017-04-23 22:37:41,298 DISTANCE VECTOR ROUTING [INFO] Loading router information from: b.dat
2017-04-23 22:37:41,319 DISTANCE VECTOR ROUTING [INFO] Creating a thread to run Distance Vector Routing algorithm
2017-04-23 22:37:41,320 DISTANCE VECTOR ROUTING [INFO] Creating a thread to monitor links with neighbour routers
2017-04-23 22:37:41,320 DISTANCE VECTOR ROUTING [INFO] Starting thread execution
2017-04-23 22:37:41,320 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:37:41,321 DISTANCE VECTOR ROUTING [INFO] [RouterLinkMonitor] Started monitoring links for a router: b
2017-04-23 22:37:41,321 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <1>
2017-04-23 22:37:41,322 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-a: Cost [2.000000], Next Hop Router [a]
2017-04-23 22:37:41,322 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-c: Cost [1.000000], Next Hop Router [c]
2017-04-23 22:37:41,322 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-b: Cost [0.000000], Next Hop Router [b]
2017-04-23 22:37:45,933 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:37:45,933 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:00,935 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <2>
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-a: Cost [2.000000], Next Hop Router [a]
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-c: Cost [1.000000], Next Hop Router [c]
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-b: Cost [0.000000], Next Hop Router [b]
2017-04-23 22:38:00,937 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
```

Router ‘c’:

```
Chetans-MacBook-Pro:DistanceVectorRouting chetan$ python ClientApp.py -n c -p 8082 -f c.dat
2017-04-23 22:37:45,897 DISTANCE VECTOR ROUTING [INFO] Running Distance Vector Routing at router: c
2017-04-23 22:37:45,897 DISTANCE VECTOR ROUTING [INFO] Creating UDP socket 127.0.0.1:8082
2017-04-23 22:37:45,897 DISTANCE VECTOR ROUTING [INFO] Loading router information from: c.dat
2017-04-23 22:37:45,927 DISTANCE VECTOR ROUTING [INFO] Creating a thread to run Distance Vector Routing algorithm
2017-04-23 22:37:45,927 DISTANCE VECTOR ROUTING [INFO] Creating a thread to monitor links with neighbour routers
2017-04-23 22:37:45,928 DISTANCE VECTOR ROUTING [INFO] Starting thread execution
2017-04-23 22:37:45,928 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:37:45,928 DISTANCE VECTOR ROUTING [INFO] [RouterLinkMonitor] Started monitoring links for a router: c
2017-04-23 22:37:45,929 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <1>
2017-04-23 22:37:45,930 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-a: Cost [7.000000], Next Hop Router [a]
2017-04-23 22:37:45,930 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-c: Cost [0.000000], Next Hop Router [c]
2017-04-23 22:37:45,931 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-b: Cost [1.000000], Next Hop Router [b]
2017-04-23 22:38:00,935 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
```

```
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <2>
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-a: Cost [7.000000], Next Hop Router [a]
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-c: Cost [0.000000], Next Hop Router [c]
2017-04-23 22:38:00,936 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-b: Cost [1.000000], Next Hop Router [b]
2017-04-23 22:38:00,938 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:38:00,938 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:00,938 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:00,938 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:15,939 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:15,940 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <3>
2017-04-23 22:38:15,940 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-a: Cost [3.000000], Next Hop Router [b]
2017-04-23 22:38:15,940 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-c: Cost [0.000000], Next Hop Router [c]
2017-04-23 22:38:15,940 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-b: Cost [1.000000], Next Hop Router [b]
2017-04-23 22:38:15,940 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:38:15,940 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:15,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:15,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
```

7.2 Link cost change scenario

Note: One can directly change link costs in routing information file to simulate link cost change scenario. Implementation automatically handles such link cost changes and update distance vectors at every router.

Router 'a':

```
2017-04-23 22:38:27,875 DISTANCE VECTOR ROUTING [INFO] [RouterLinkMonitor] Router information is updated
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <4>
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-a: Cost [0.000000], Next Hop Router [a]
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-c: Cost [3.000000], Next Hop Router [b]
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-b: Cost [2.000000], Next Hop Router [b]
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:30,943 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <5>
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-a: Cost [0.000000], Next Hop Router [a]
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-c: Cost [7.000000], Next Hop Router [c]
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-b: Cost [8.000000], Next Hop Router [c]
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:45,950 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:45,950 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <6>
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-a: Cost [0.000000], Next Hop Router [a]
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-c: Cost [7.000000], Next Hop Router [c]
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path a-b: Cost [8.000000], Next Hop Router [c]
```

Router 'b':

```
2017-04-23 22:38:28,996 DISTANCE VECTOR ROUTING [INFO] [RouterLinkMonitor] Router information is updated
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <4>
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-a: Cost [2.000000], Next Hop Router [a]
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-c: Cost [1.000000], Next Hop Router [c]
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-b: Cost [0.000000], Next Hop Router [b]
2017-04-23 22:38:30,943 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:38:30,943 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:30,943 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:38:30,943 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <5>
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-a: Cost [50.000000], Next Hop Router [a]
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-c: Cost [1.000000], Next Hop Router [c]
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-b: Cost [0.000000], Next Hop Router [b]
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:38:45,950 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:45,950 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:38:45,950 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <6>
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-a: Cost [4.000000], Next Hop Router [c]
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-c: Cost [1.000000], Next Hop Router [c]
```

```
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-b: Cost [0.000000], Next Hop Router [b]
2017-04-23 22:39:00,952 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:39:00,952 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:00,952 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:39:00,953 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:15,958 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:39:15,958 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <7>
2017-04-23 22:39:15,958 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-a: Cost [8.000000], Next Hop Router [c]
2017-04-23 22:39:15,958 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-c: Cost [1.000000], Next Hop Router [c]
2017-04-23 22:39:15,959 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-b: Cost [0.000000], Next Hop Router [b]
2017-04-23 22:39:15,959 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:39:15,959 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:15,960 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:39:15,960 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:30,963 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:39:30,964 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <8>
2017-04-23 22:39:30,964 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-a: Cost [8.000000], Next Hop Router [c]
2017-04-23 22:39:30,964 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-c: Cost [1.000000], Next Hop Router [c]
2017-04-23 22:39:30,964 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path b-b: Cost [0.000000], Next Hop Router [b]
2017-04-23 22:39:30,965 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8082
2017-04-23 22:39:30,965 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:30,965 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:39:30,966 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
```

Router ‘c’:

```
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <4>
2017-04-23 22:38:30,941 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-a: Cost [3.000000], Next Hop Router [b]
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-c: Cost [0.000000], Next Hop Router [c]
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-b: Cost [1.000000], Next Hop Router [b]
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:38:30,942 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:30,943 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:30,943 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <5>
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-a: Cost [3.000000], Next Hop Router [b]
2017-04-23 22:38:45,948 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-c: Cost [0.000000], Next Hop Router [c]
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-b: Cost [1.000000], Next Hop Router [b]
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:38:45,949 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:38:45,950 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:38:45,950 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <6>
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-a: Cost [7.000000], Next Hop Router [a]
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-c: Cost [0.000000], Next Hop Router [c]
2017-04-23 22:39:00,951 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-b: Cost [1.000000], Next Hop Router [b]
2017-04-23 22:39:00,952 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8080
2017-04-23 22:39:00,952 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:00,952 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Received packet from: 127.0.0.1:8081
2017-04-23 22:39:00,953 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Updating routing table
2017-04-23 22:39:15,958 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sending distance vector to neighbour routers
2017-04-23 22:39:15,958 DISTANCE VECTOR ROUTING [INFO] [DistanceVectorRouting] Sequence Number: <7>
2017-04-23 22:39:15,958 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-a: Cost [7.000000], Next Hop Router [a]
2017-04-23 22:39:15,959 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-c: Cost [0.000000], Next Hop Router [c]
2017-04-23 22:39:15,959 DISTANCE VECTOR ROUTING [DEBUG] [DistanceVectorRouting] Shortest Path c-b: Cost [1.000000], Next Hop Router [b]
```

8. Reference

https://en.wikipedia.org/wiki/Distance-vector_routing_protocol