DISTANCE FORMULA FOR SPECTACLES TOPOLOGY:
For the orientation of N nodes in a topology similar to the shape of a spectacle (2 full circles connected by a semi-circle in between), we distribute the N nodes evenly among these 2 circles and the semi-circle. Therefore, the first circle will have 400 nodes, the semi-circle in middle will have 200 nodes and the second circle will have 400 nodes. The formula for θ and the X and Y co-ordinate for the nodes is given by :

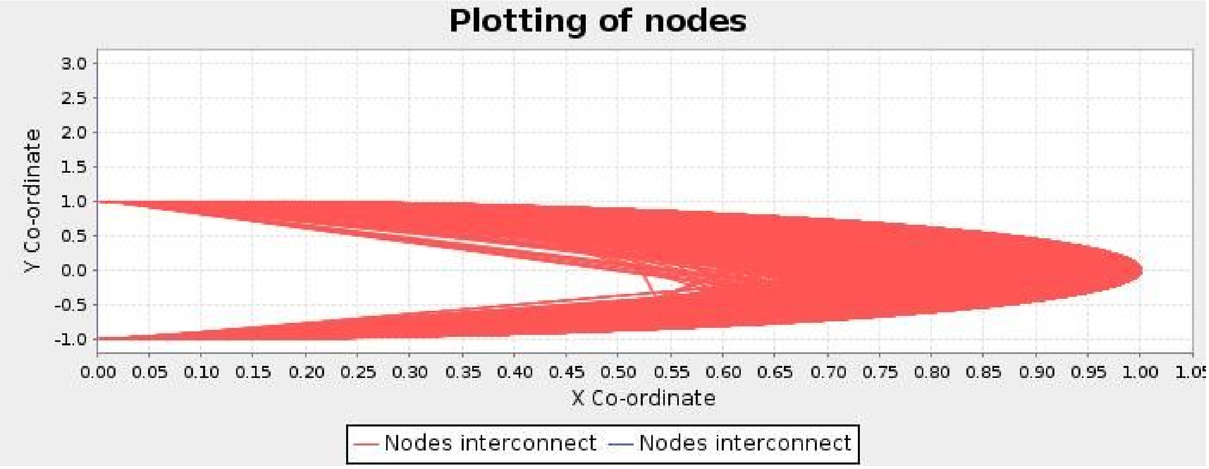
```
double e = Math.PI;
System.out.println("Topology = S");
for(int i =1; i<=400; i++){
        e = e - (Math.PI*2/400);
        nodes[i].x_co = 2 + Math.cos(e);
        nodes[i].y_co = Math.sin(e);

}
e = 0;
for(int i =401; i<=600; i++){
        e = e + (Math.PI/200);
        nodes[i].x_co = Math.cos(e);
        nodes[i].y_co = Math.sin(e);
}
e = 0;
for(int i =601; i<=1000; i++){
        e = e - (Math.PI*2/400);
        nodes[i].x_co = -2 + Math.cos(e);
        nodes[i].y_co = Math.sin(e);
}
```

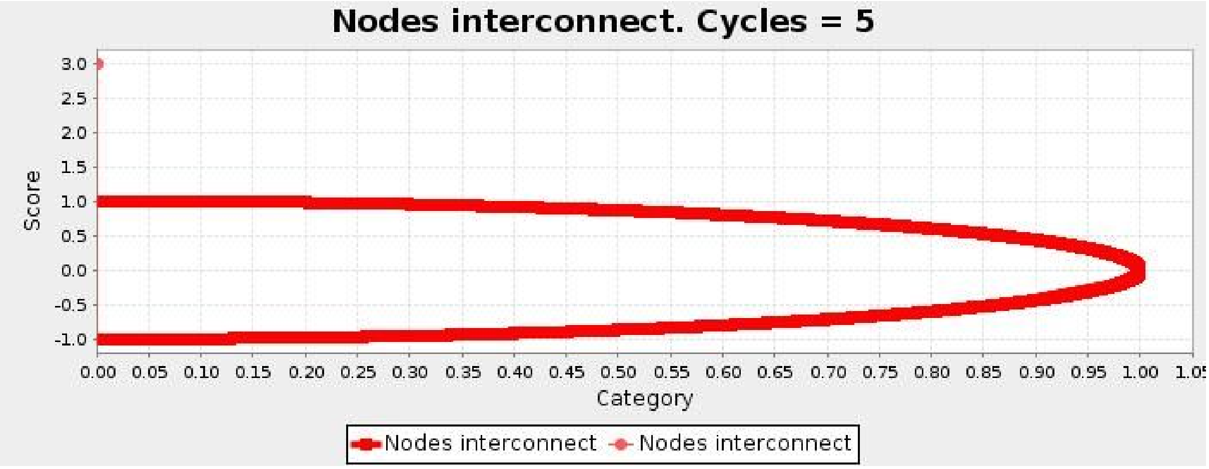
Questions -
1] What methods do you use to ensure that there are no separated nodes in the “b” and “spectacles” topology?
A: In B and spectacles topology, during the network initialization phase, the nodes are chosen in random. In the evolution phase, a random neighbor is chosen and its neighbor list is exchanged with its own. Also ensuring to replace the neighbors id in its neighbor list with its own id and sending it to the random neighbor.
Then neighbor lists are updated by taking the k nearest neighbors according to the distance function. Also no duplicate nodes are repeated.

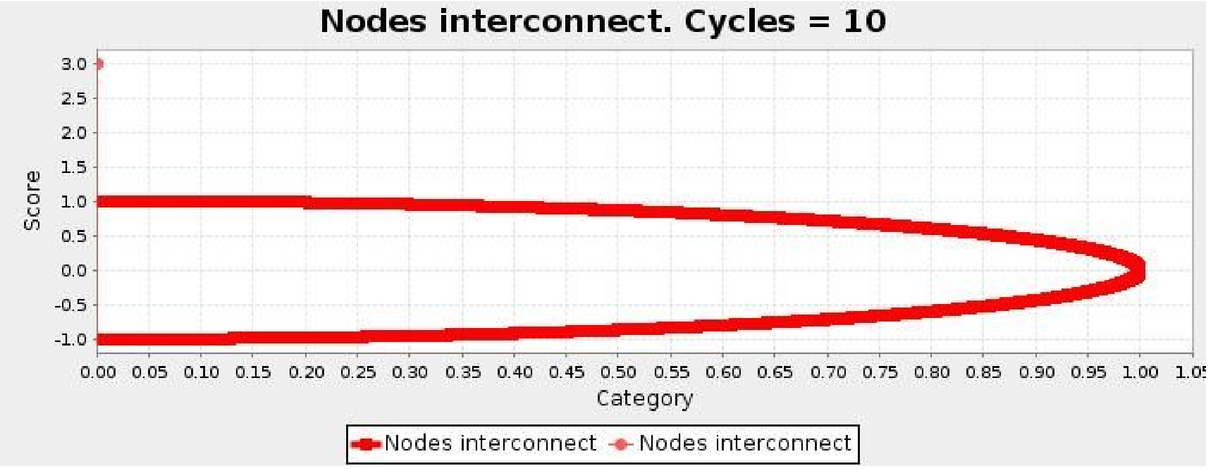
For B topology, the Nth node has 1 and N-1 node as it’s neighbors and rest all nodes are considered to be at infinite distance, no interconnect.

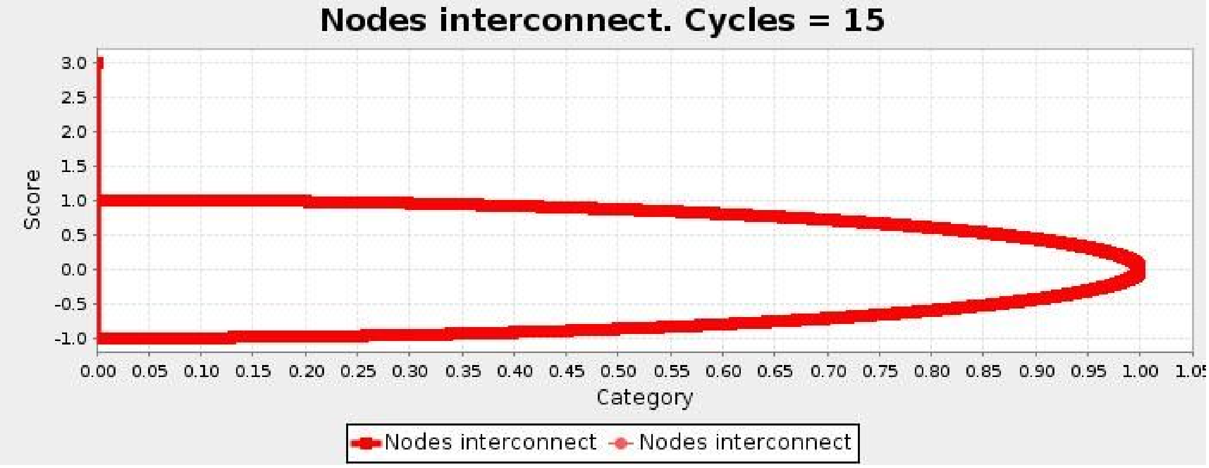
2] Can a node’s neighbor list show the same node in multiple entries?

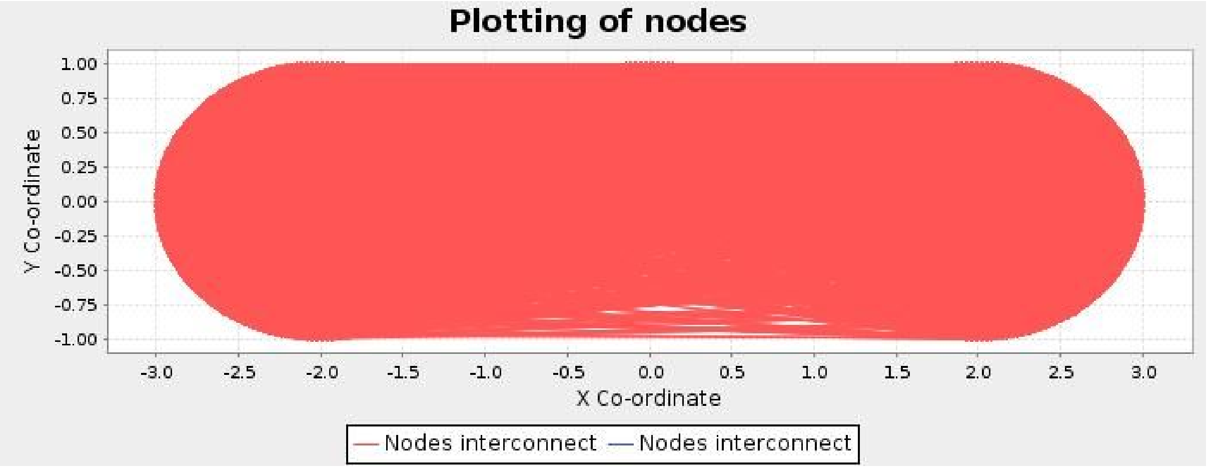
A: It is a waste of resource if more than 1 node exists in a particular location. It cannot show same node in multiple entries because the nodes are kept at a particular x y coordinate. If it happens , then the data will be routed through the same node multiple times which is a waste of energy.

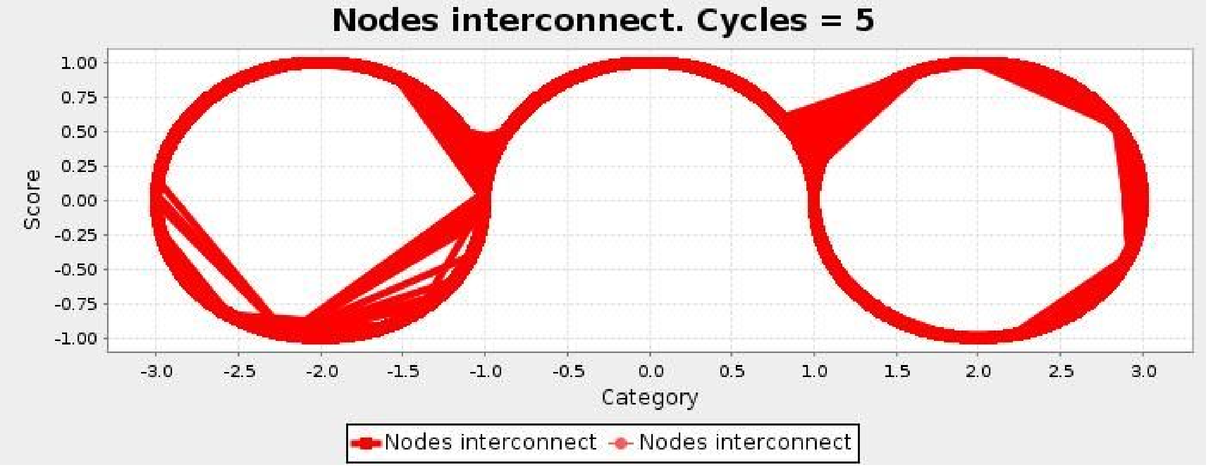


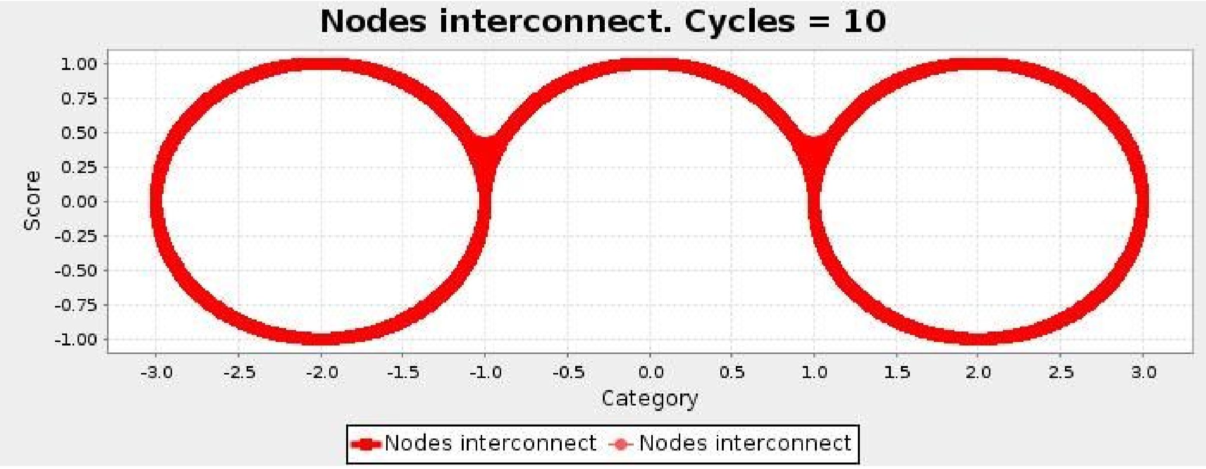


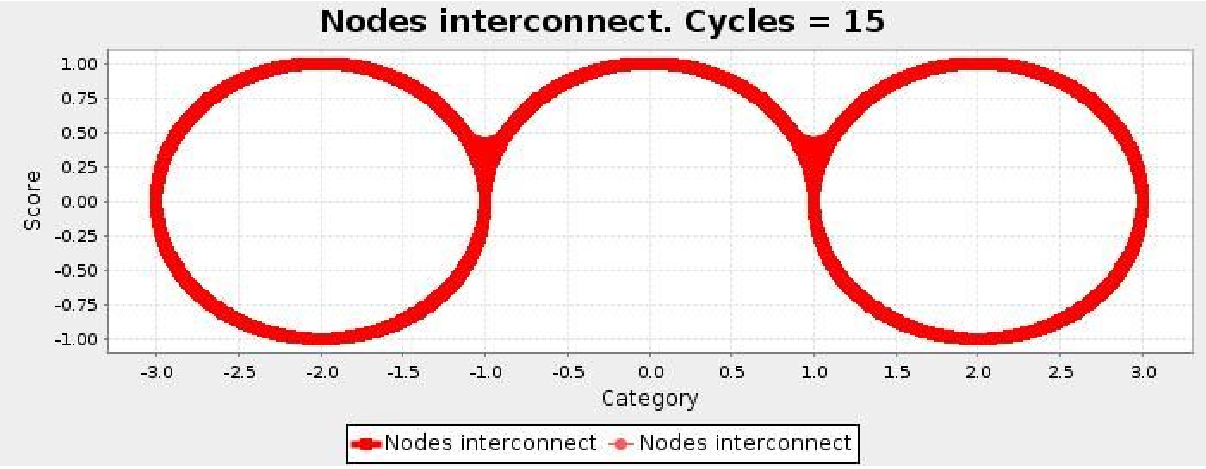



Nodes interconnect. Cycles = 15
Score
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00 1.05
Category
Nodes interconnect
Nodes interconnect


Plotting of nodes
Y Co-ordinate
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
-3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0
X Co-ordinate
Nodes interconnect
Nodes interconnect


Nodes interconnect. Cycles = 5
Score
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
-3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0
Category
Nodes interconnect
Nodes interconnect





CODE -

```
//Author : Akash R Vasishta
//UFID : 53955080
import java.util.*;
import org.jfree.ui.RefineryUtilities;
import java.io.*;
import org.jfree.chart.ChartUtilities;
import org.jfree.chart.ChartPanel;
import org.jfree.chart.JFreeChart;
import org.jfree.data.xy.XYDataset;
import org.jfree.data.xy.XYSeries;
import org.jfree.ui.ApplicationFrame;
import org.jfree.ui.RefineryUtilities;
import org.jfree.chart.plot.XYPlot;
import org.jfree.chart.ChartFactory;
import org.jfree.chart.plot.PlotOrientation;
import org.jfree.data.xy.XYSeriesCollection;
import org.jfree.chart.renderer.xy.XYLineAndShapeRenderer;
```

```
//TMAN class which implements the TMAN's algorithm.
public class TMAN {
             static int N;
             static int k;
             static Node nodes[];
             static int cycles = 40;
             static char topology;
             public static double[] dis = new double[cycles];

   public static void main(String[] args) {
            N=Integer.parseInt(args[0]);
            k=Integer.parseInt(args[1]);
            topology = args[2].charAt(0);
            System.out.println(topology);
            nodes = new Node[N+1];
//          nodes.received_list = new int[k];
//          Map<String, String> node = new HashMap<String, String>();/
//          node.put("dog", "type of animal");
//          System.out.println(node.get("dog"));
            networkInitialization();
//          System.out.println("The generated nodes are - " + nodes[0].node_id);
    System.out.println("The nodes are - " );
    System.out.print("node_id - x_co - y_co - theta");
            for(int i = 1; i<=N; i++){
                        System.out.println("\n"+nodes[i].node_id + "  " + nodes[i].x_co + "  " +
nodes[i].y_co + "  " + nodes[i].theta);
                        System.out.print("    neighbors = ");
                        for(int j = 0; j < k; j++){
                                    System.out.print(nodes[i].neighbors[j] + " ");
                        }
            }

            networkEvolution();

   }
//The Network initialization phase. Every node randomly selects k neighbors and places
them into its neighbor list.
//The nodes are placed at a location given by the overlay network topology.
            public static void networkInitialization(){
                        Random random = new Random();
                        int next;
                        double theta;
                        System.out.println("Initializing the network");
                        nodes[0] = new Node();
                        System.out.println(" nodes.length = " + nodes.length);
                        for(int i = 1; i<N+1; i++){
```

```
            nodes[i] = new Node();
            nodes[i].neighbors = new int[k];
            HashSet<Integer> used = new HashSet<Integer>();
//Nodeid
            nodes[i].node_id = i;
//      System.out.println(nodes[i].node_id);
//Generating 'k' random neighbors list
            for(int j = 0; j<k; j++){
                next = random.nextInt(N-1) + 1;
            while (used.contains(next) || next == i) { //while we have already used
the number
            next = random.nextInt(N-1) + 1; //generate a new one because it's
already used
//                  System.out.println("@" + next);
            }
            if(i == N && topology == 'B'){
                used.add(next);
                if(j==0)
                    nodes[i].neighbors[j] = 1;
                else if (j==1)
                    nodes[i].neighbors[j] = 999;
                else
                        nodes[i].neighbors[j] = next;

            } else{
                    used.add(next);
                    nodes[i].neighbors[j] = next;

            }
            }
//Calculating XCo and YCo
            if(topology == 'B'){
                theta = (Math.PI/2)-((i-1)*Math.PI/(N-2));
                if (i == 1000) {
                    nodes[i].x_co = 0;
                    nodes[i].y_co = 3;
                } else {
                    nodes[i].x_co = Math.cos(theta);
                    nodes[i].y_co = Math.sin(-theta);
                }
                nodes[i].theta = theta;
//      System.out.println(nodes[0].x_co);
            }
            else{
                System.out.println("Topology = S");
            }
        }

        if (topology == 'S'){
                double e = Math.PI;
                System.out.println("Topology = S");
                for(int i =1; i<=400; i++){
//                  e = (Math.PI/2)-((i-1)*(Math.PI/(10-2)));
//                  System.out.println("e =" + (random.nextInt(10) + 1));
                    e = e - (Math.PI*2/400);
//                  System.out.println(i +" "+(2+Math.cos(e)) + " " +
Math.sin(e));
                    nodes[i].x_co = 2 + Math.cos(e);
                    nodes[i].y_co = Math.sin(e);

                }
                e = 0;
                for(int i =401; i<=600; i++){
//                  e = (Math.PI/2)-((i-1)*(Math.PI/(10-2)));
//                  System.out.println("e =" + (random.nextInt(10) + 1));
                    e = e + (Math.PI/200);
//                  System.out.println("\n" + i +" "+(Math.cos(e)) + " " +
Math.sin(e));
                    nodes[i].x_co = Math.cos(e);
                    nodes[i].y_co = Math.sin(e);
                }
                e = 0;
                for(int i =601; i<=1000; i++){
//                  e = (Math.PI/2)-((i-1)*(Math.PI/(10-2)));
//                  System.out.println("e =" + (random.nextInt(10) + 1));
                    e = e - (Math.PI*2/400);
//                  System.out.println(i +" "+(-2 + Math.cos(e)) + " " +
Math.sin(e));
                    nodes[i].x_co = -2 + Math.cos(e);
                    nodes[i].y_co = Math.sin(e);
                }

        }
//      nodes[1000] = new Node()
/*  for(int i = 0; i<N; i++){
        System.out.println(nodes[i].node_id);
    }
*/
    }
//Network Evolution phase.
//In every cycle of the iterative algorithm, every node randomly selects one of its neighbors,
//and then sends a list consisting of the identifiers of its neighbors and of itself to that
neighbor. The selected
//neighbor also sends its neighbors list back to the node which initiated the action. Upon
receiving the new
//neighbor list, the nodes select the nearest k nodes from both the new and old lists as their
neighbors and
//discards all the others.
    public static void networkEvolution(){
        int neighbor_id;
        int[] neighborList = new int[k];
        String fileName;
//      int[] receivedNList = new int[k];
//      ArrayList<Integer> mergedList = new ArrayList<Integer>();
        int r;
        double d;
        System.out.println("\n****************************************************\nIn the
networkEvolution phase\n*******************************************************");
        for(int j=0; j<cycles; j++){
//          dis = 0;

System.out.println("\n#############################################\ncycle = " + j +
"\n############################################\n");
            for(int i = 1; i < N+1; i++){
//              System.out.println("\nNode = " + i);
                neighbor_id = selectPeer(i);
                neighborList = nodes[i].neighbors.clone();
/*              System.out.print("Neighbor List = [");
                for(int h=0; h<k; h++){
                    System.out.print(" " + neighborList[h]);
                }
                System.out.println(" ]");
                System.out.print("Random Neighbor = " + neighbor_id);
*/
                Arrays.sort(neighborList);
//              System.out.print(" Sorted. To be ex NL = [");
//              for(int h=0; h<k; h++){
//                  System.out.print(" " + neighborList[h]);
//              }
//              System.out.println(" ]");

                r = Arrays.binarySearch(neighborList, neighbor_id);
//              System.out.println(" index = " + r);
//              r = neighborList.indexOf(neighbor_id);
                neighborList[r] = i;
//              System.out.print("To be ex NL = [");
//              for(int h=0; h<k; h++){
```

```
//                  System.out.print(" " + neighborList[h]);
//              }
//              System.out.println(" ]");
//              neighborList = ArrayUtils.removeElement(neighborList,
neighbor_id);
//For received_list hashmap, uncomment below line
//              nodes[neighbor_id].received_list.put(i, neighborList);
                nodes[neighbor_id].received_list = neighborList.clone();
//f             receivedNList = nodes[neighbor_id].neighbors.clone();
//For received_list hashmap, uncomment below line
//              nodes[i].received_list.put(neighbor_id, receivedNList);
                nodes[i].received_list = nodes[neighbor_id].neighbors.clone();
/*              System.out.print("\nReceived NeighborList = [");
                for(int h=0; h<k; h++){
                    System.out.print(" " + nodes[i].received_list[h]);
                }
                System.out.println(" ]");
*/
                updateNL(i);
                updateNL(neighbor_id);
//              System.out.print("Final my Neighbors = [");
                for(int h=0; h<k; h++){
//                  System.out.print(" " + nodes[i].neighbors[h]);
                    d = distance(i, nodes[i].neighbors[h]);
                    if(d != 10000)
                        dis[j] = dis[j] + d;
                }
/*              System.out.println(" ]");
                System.out.print("Final neighbors Neighbors = [");
                for(int h=0; h<k; h++){
                    System.out.print(" " + nodes[neighbor_id].neighbors[h]);
                }
                System.out.println(" ]");
*/
            }
            if(j == 0){
      JFreeChart xylineChart = ChartFactory.createXYLineChart(
      "Plotting of nodes ",
     "X Co-ordinate" ,
    "Y Co-ordinate" ,
    createDataset() ,
    PlotOrientation.VERTICAL ,
    true , true , false);

                XYLineChart_AWT chart1 = new
XYLineChart_AWT("Topology","Nodes interconnect. Cycles = 1");
```

```
            chart1.pack( );
            RefineryUtilities.centerFrameOnScreen( chart1 );
            chart1.setVisible( true );

            try{
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".txt";
                PrintWriter writer = new PrintWriter(fileName, "UTF-8");
                for(int m=1;m<=N;m++){
                    writer.print("Node " + String.valueOf(m) + " neighbors =
");

                    for(int n=0;n<k;n++){
                        writer.print(" " +
String.valueOf(nodes[m].neighbors[n]));
                    }
                writer.println("");
                }
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".jpg";
                ChartUtilities.saveChartAsJPEG(new File(fileName),
xylineChart, 700, 270);
                writer.close();
            } catch (IOException e) {
                e.printStackTrace();
                }

            } else if(j == 4){
                XYLineChart_AWT chart2 = new
XYLineChart_AWT("Topology","Nodes interconnect. Cycles = 5");
            chart2.pack( );
            RefineryUtilities.centerFrameOnScreen( chart2 );
            chart2.setVisible( true );
            try{
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".txt";
                PrintWriter writer = new PrintWriter(fileName, "UTF-8");
                for(int m=1;m<=N;m++){
                    writer.print("Node " + String.valueOf(m) + " neighbors =
");

                    for(int n=0;n<k;n++){
                        writer.print(" " +
String.valueOf(nodes[m].neighbors[n]));
                    }
                writer.println("");
                }
```

```
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".jpg";
                ChartUtilities.saveChartAsJPEG(new File(fileName),
chart2.xylineChart, 700, 270);
                writer.close();
            } catch (IOException e) {
                e.printStackTrace();
                }

            } else if(j == 9){
                XYLineChart_AWT chart3 = new
XYLineChart_AWT("Topology","Nodes interconnect. Cycles = 10");
            chart3.pack( );
            RefineryUtilities.centerFrameOnScreen( chart3 );
            chart3.setVisible( true );
            try{
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".txt";
                PrintWriter writer = new PrintWriter(fileName, "UTF-8");
                for(int m=1;m<=N;m++){
                    writer.print("Node " + String.valueOf(m) + " neighbors =
");

                    for(int n=0;n<k;n++){
                        writer.print(" " +
String.valueOf(nodes[m].neighbors[n]));
                    }
                writer.println("");
                }
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".jpg";
                ChartUtilities.saveChartAsJPEG(new File(fileName),
chart3.xylineChart, 700, 270);
                writer.close();
            } catch (IOException e) {
                e.printStackTrace();
                }

            } else if(j == 14){
                XYLineChart_AWT chart4 = new
XYLineChart_AWT("Topology","Nodes interconnect. Cycles = 15");
            chart4.pack( );
            RefineryUtilities.centerFrameOnScreen( chart4 );
            chart4.setVisible( true );
            try{
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".txt";
```

```
                PrintWriter writer = new PrintWriter(fileName, "UTF-8");
                for(int m=1;m<=N;m++){
                    writer.print("Node " + String.valueOf(m) + " neighbors =
");
                    for(int n=0;n<k;n++){
                        writer.print(" " +
String.valueOf(nodes[m].neighbors[n]));
                    }
                writer.println("");
                }
                    fileName = topology + "_N" + String.valueOf(N) + "_k" +
String.valueOf(k) + "_"+ String.valueOf(j+1) + ".jpg";
                ChartUtilities.saveChartAsJPEG(new File(fileName),
chart4.xylineChart, 700, 270);
                writer.close();
            } catch (IOException e) {
                e.printStackTrace();
                }

            }



        }
        System.out.println("The aggregate distance of all nodes for all cycle = {");
        for(int h=0; h<cycles; h++)
            System.out.print(", " + dis[h]);
        System.out.println(" }");

        LineChart_AWT chart = new LineChart_AWT(
           "Distance vs Cycles" ,
        "Sum of distances vs cycles");

        chart.pack( );
        RefineryUtilities.centerFrameOnScreen( chart );
        chart.setVisible( true );



    }
//Function to randomly select a node from its neighbor list
    public static int selectPeer(int i){
        int neighbor_id;
        int neid_index;
        Random random = new Random();
        neid_index = random.nextInt(k);
        neighbor_id = nodes[i].neighbors[neid_index];
        return neighbor_id;
    }

//Function to update the nodes neighbor list with the k nearest elements. The final nieghbor list consists of k nearest elements
//from its own neighbor list and the received neighbor list combined.
    public static void updateNL(int id){
        Set<Integer> mergedSet = new HashSet<>();
    List<Integer> aList = new ArrayList<Integer>();
    int n[] = new int[k];
    int j = 0;
    int u=0;
        for (int index = 0; index < nodes[id].neighbors.length; index++)
        {
        aList.add(nodes[id].neighbors[index]);
        }
        if(nodes[id].received_list.length != 0){
        List<Integer> bList = new ArrayList<Integer>();
            for (int index = 0; index < nodes[id].received_list.length; index++)
            {
            bList.add(nodes[id].received_list[index]);
            }
            mergedSet.addAll(bList);
        }
        mergedSet.addAll(aList);
        aList.clear();
        n =  distanceFunc(id, mergedSet);
        nodes[id].neighbors = n.clone();
//      for(j=0; j<k; j++){
//          nodes[id].neighbors[j] = n[];
//      }
//      Iterator<Integer> it = mergedSet.iterator();
//  while(it.hasNext()){
//  System.out.println(it.next());
//  }
    }

//Distance function
//Description : Selects the k nearest elements from the mergedSet based on the distance between the nodes.
//Parameters : id1 - Node id.
//               mergedSet - Combined set of id1 neighborlist and id1 received list.
//Returns : id1's neighbor list
    public static int[] distanceFunc(int id1, Set<Integer> mergedSet){
    List<Integer> newNeighborList = new ArrayList<Integer>();
        int id2;
        double d[] = new double[mergedSet.size()];
        int sortedArray[] = new int[mergedSet.size()];
        int i = 0;
        int u =0;
        int neighborArray[] = new int[k];
        Iterator<Integer> it = mergedSet.iterator();
//      System.out.print("mergedSet = ");
    while(it.hasNext()){
//  System.out.println(it.next());
        id2 = it.next();
        d[i] = distance(id1, id2);
        i++;
//      System.out.print(" " + id2);
    }
//  System.out.println("");
    sortedArray = sort(d, mergedSet);
//      System.out.print("Sorted based on distance merged Array = ");
//  for(i=0; i<sortedArray.length; i++){
//      System.out.print(" " + sortedArray[i]);
//  }
//  System.out.println("");
    for(i=0; i<k; i++){
        while(sortedArray[u] == id1)
                u++;
//          if(id1 == nodes[N].node_id)
//              if(sortedArray[u] == nodes[N-1].node_id)
//                      neighborArray[i++] = nodes[1].node_id;
        neighborArray[i] = sortedArray[u++];
    }
    return neighborArray;
    }
//Distance
//Description: Returns the distance between 2 nodes based on its x y coordinates.
//For the Nth node, it returns a minimum distance for 1st and N-1th node and maximum
distance for all other nodes.
//Parameters: id1 - Node id
//           id2 - Node id
//Returns : Distance
    public static double distance(int id1, int id2){
        double d;
        if(id2 == nodes[N].node_id && topology == 'B'){
//      if(id1 == id2){
            if(id1 == nodes[1].node_id || id1 == nodes[N-1].node_id){
//
System.out.println("^^^^^^^^^^^^^^^^^^Here^^^^^^^^^^^^^^^^^");
                return 0.000001;
            } else{
```

```
//                                      System.out.println("--------------------Here----------------");
                                        return 10000;
                                }
                        }
                        else if(id1 == nodes[N].node_id && topology == 'B'){
//                      if(id1 == id2){
                                if(id2 == nodes[1].node_id || id2 == nodes[N-1].node_id){
//
System.out.println("^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^Here^^^^^^^^
^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^");
//                                      System.exit(0);
                                        return 0.000001;
                                } else{
//                                      System.out.println("--------------------Here----------------");
                                        return 10000;
                                }
                        }

                        else{
//
System.out.println("$$$$$$$$$$$$$$$$$$$$Here$$$$$$$$$$$$$$$$$$$$$$$$$$$$");
                                d = Math.hypot(nodes[id1].x_co - nodes[id2].x_co, nodes[id1].y_co -
nodes[id2].y_co);
                                return d;
                        }
                }

//Sort
//Discription : Given an array of distances and a mergedSet. Sort function will sort the
mergedSet based on the
//distance array arranged in an ascending order.
//Parameters : arr[] - The distance array.
//                              mergedSet - The set that needs to be sorted based on distance
array
//Returns : Sorted mergedSet
    public static int[] sort(double arr[], Set<Integer> mergedSet)
    {
        int n = arr.length;
                        Iterator<Integer> it = mergedSet.iterator();
                        int sortedArray[] = new int[mergedSet.size()];
                        for(int g=0; g<mergedSet.size();g++){
                                sortedArray[g] = it.next();
                        }
                        Iterator<Integer> it1 = mergedSet.iterator();
        // One by one move boundary of unsorted subarray
        for (int i = 0; i < n-1; i++)
        {
                // Find the minimum element in unsorted array
                int min_idx = i;
                for (int j = i+1; j < n; j++)
                    if (arr[j] < arr[min_idx])
                        min_idx = j;

                // Swap the found minimum element with the first
                // element
                double temp = arr[min_idx];
                arr[min_idx] = arr[i];
                arr[i] = temp;
                int temp1 = sortedArray[min_idx];
                sortedArray[min_idx] = sortedArray[i];
                sortedArray[i] = temp1;

        }

        return sortedArray;
    }


   public static XYDataset createDataset( ) {
      final XYSeries firefox = new XYSeries( "Nodes interconnect", false, true );
      final XYSeries chrome = new XYSeries( "Nodes interconnect", false, true );
      int ne;
      for(int i =1; i<=N; i++){
         for(int j =0; j<k; j++){
                ne = nodes[i].neighbors[j];
                if(i==N && topology == 'B'){
                   System.out.println("done");
//               System.exit(0);
                   if (j==0){
                   chrome.add( nodes[i].x_co , nodes[i].y_co);
                   chrome.add( nodes[ne].x_co , nodes[ne].y_co);
                   } else if(j==1){
                   chrome.add( nodes[i].x_co , nodes[i].y_co);
                   chrome.add( nodes[ne].x_co , nodes[ne].y_co);
                   break;
                   }
                } else {
                   firefox.add( nodes[i].x_co , nodes[i].y_co);
                   firefox.add( nodes[ne].x_co , nodes[ne].y_co);
                }
      }
    }

    final XYSeriesCollection dataset = new XYSeriesCollection( );
    dataset.addSeries( firefox );
    dataset.addSeries( chrome );
//     dataset.addSeries( iexplorer );
    return dataset;
  }

}

//Class : Node
class Node{
         int node_id;
         double x_co;
         double y_co;
         double theta;
//       int k = 30;
         int neighbors[];
         int received_list[];

//       Map<Integer, int[]> received_list = new HashMap<Integer, int[]>();
        int N;
        public  int getNodeId(){
                return node_id;
        }
        public  double getXCo(){
                return x_co;
        }

        public  double getYCo(){
                return y_co;
        }

        public  double getTheta(){
                return theta;
        }

        public  int[] getNeighbors(){
                return neighbors;
        }

        public  int[] getReceivedList(){
                return received_list;
        }
```

```
	public void setNodeId(int node_id){
		this.node_id = node_id;
	}

	public void setXCo(int x_co){
		this.x_co = x_co;
	}

	public void setYCo(int y_co){
		this.y_co = y_co;
	}

	public void setTheta(double theta){
		this.theta = theta;
	}

	public void setNeighbors(int neighbors[]){
		this.neighbors = neighbors;
	}



}
```