Packet Delivery System

Submitted By:
Kamini Prakash (NUID : 001388352)
Dharti Sojitra (NUID: 001383878)

Problem Statement :

In a graph there are so many paths that can exist from a source to a destination node. Finding an optimal path is a difficult problem. We have used a swarm intelligence technique called ***Particle swarm Optimization*** to solve routing problem to get to the optimal path from graph. The shortest path problem finds the shortest path from a specific origin to a specified destination in a given network while minimizing the total cost associated with the path.

Approach:

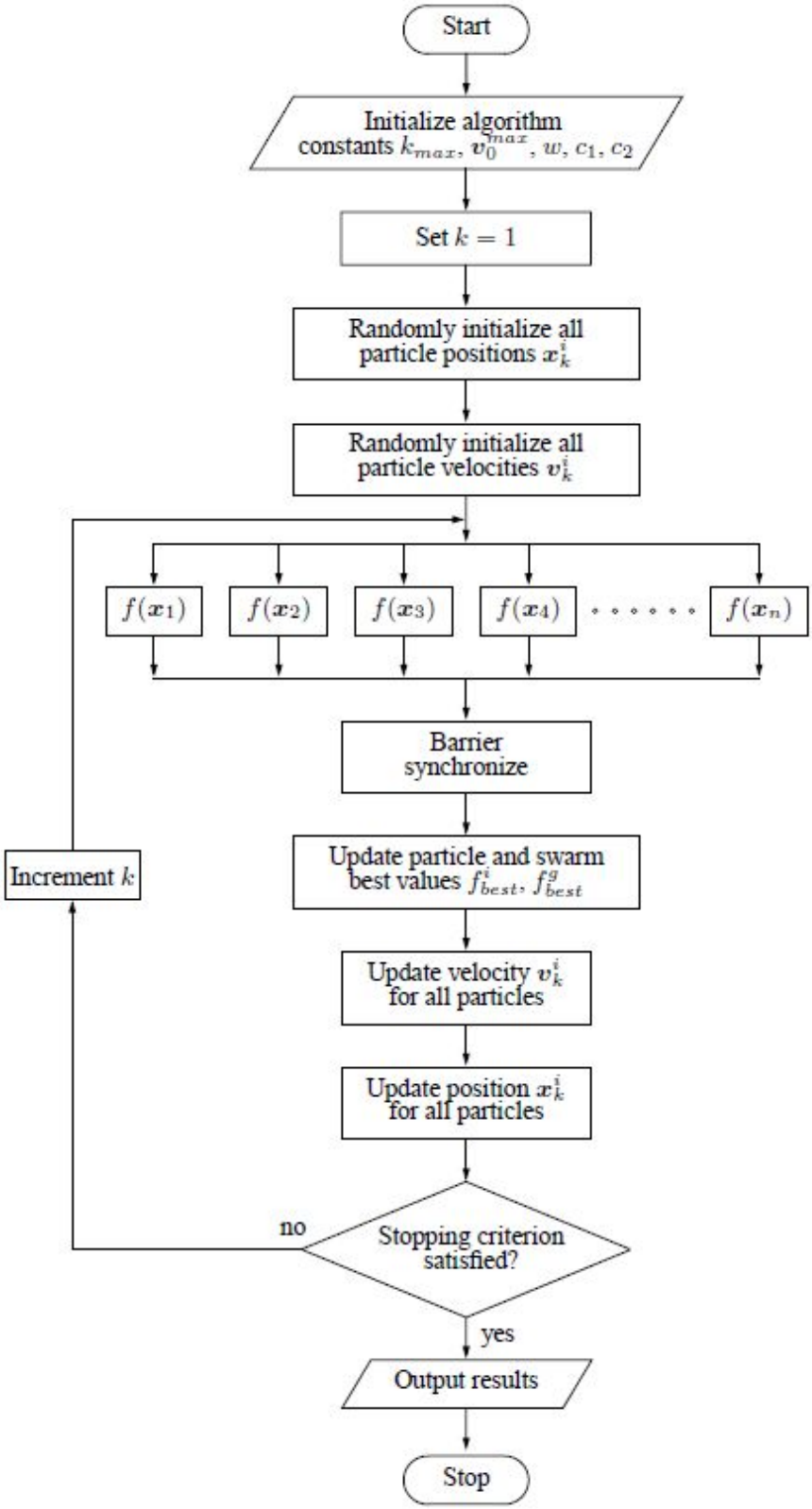
Every particle has a current position (position of particle existence in current time), personal best position (best position travel by each particle till now), global best position (best position of any particle among all particles in search space), velocity (personal velocity of each particle).

In this technique every particle try to move towards the particle which is close to the solution and after some time all particle stop to particular solution which is optimal solution.

1. **vid=vid+c1r1(bid−xid)+c2r2(bidn−xid); where C1 and C2 are constants and r1 &r2 are randomly generated**
2. **To calculate next position, xid=xid+vid**

Flow of PSO Implemented :

1. Randomly generate initial swarm
2. Repeat for each particle 0 to max iteration
3. Compute the best fitness value of function
4. Update Velocity
5. Update best position
6. Update global position
7. Update position end for until termination criterion is met


Start
Initialize algorithm constants k_{max}, $\boldsymbol{v}_0^{max}$, w, c_1, c_2
Set $k = 1$
Randomly initialize all particle positions $\boldsymbol{x}_k^i$
Randomly initialize all particle velocities $\boldsymbol{v}_k^i$
$f(\boldsymbol{x}_1)$
$f(\boldsymbol{x}_2)$
$f(\boldsymbol{x}_3)$
$f(\boldsymbol{x}_4)$
$f(\boldsymbol{x}_n)$
Barrier synchronize
Update particle and swarm best values f_{best}^i, f_{best}^g
Update velocity $\boldsymbol{v}_k^i$ for all particles
Update position $\boldsymbol{x}_k^i$ for all particles
Stopping criterion satisfied?
no
yes
Increment k
Output results
Stop

We have implemented multithreading between particles for parallel implementation of the algorithm. Since some part of synchronization is required to ensure that all of the particle fitness evaluations have been completed and results reported before the velocity and position calculations can be executed.
The final global fitness is calculated which is the least from all the particles.

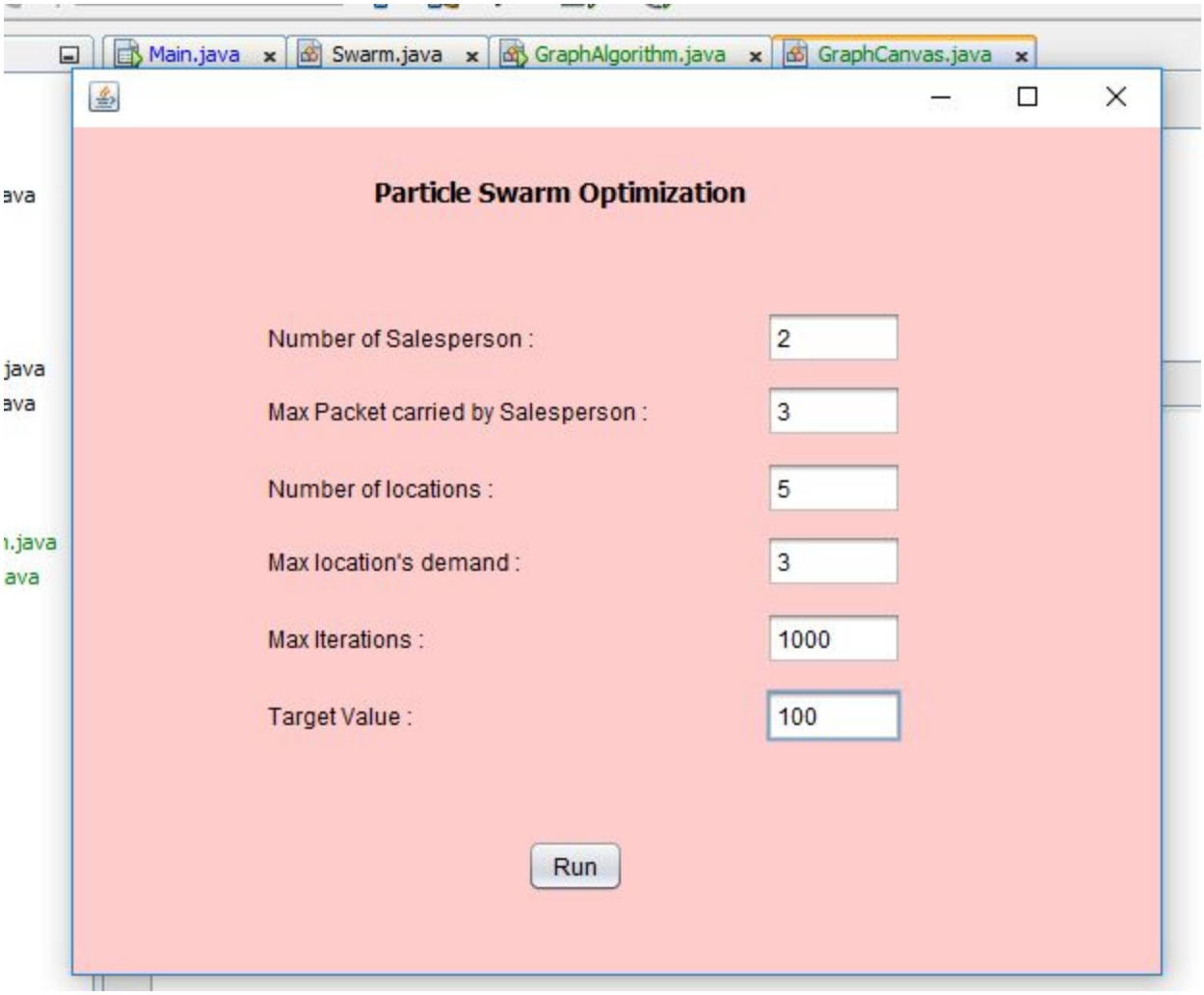
There are 3 conditions to terminate the loop,

1. User entered maximum Iterations reached
2. User entered target value reached
3. If we get same gbest value for 3 consecutive iterations

Description:

1. The aim is to find an optimal route which the salesperson would follow in order to minimize the delivery time and cost.
2. Every store has some demands which is randomly generated.
3. Every salesperson has a capacity of carrying the number of packets to deliver, which is also randomly generated.
4. Every salesperson starts and ends it's route at the depot.
5. Every salesperson has to serve every location in the system
6. If the capacity of salesperson is less than the demand of the location, the salesperson has to go to its initial position to renew it's capacity.

Example :



As per the example,

1. we have an input of maximum packet delivered by the salesperson, the actual salesman capacity is generated randomly between 0 and the entered value.

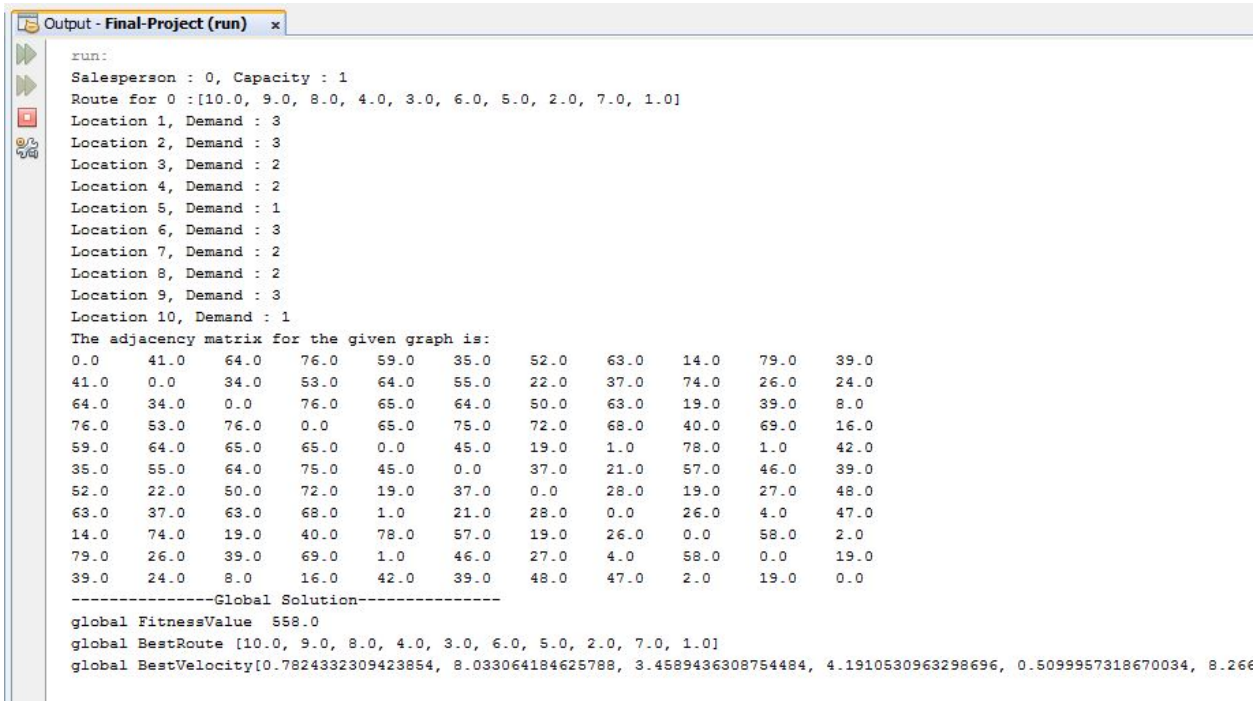
2. User will have to enter the maximum locations demand, and for each location, the demand will be generated randomly between 0 and the entered value.

3. User can pass the maximum number of iterations and target value

Applications:

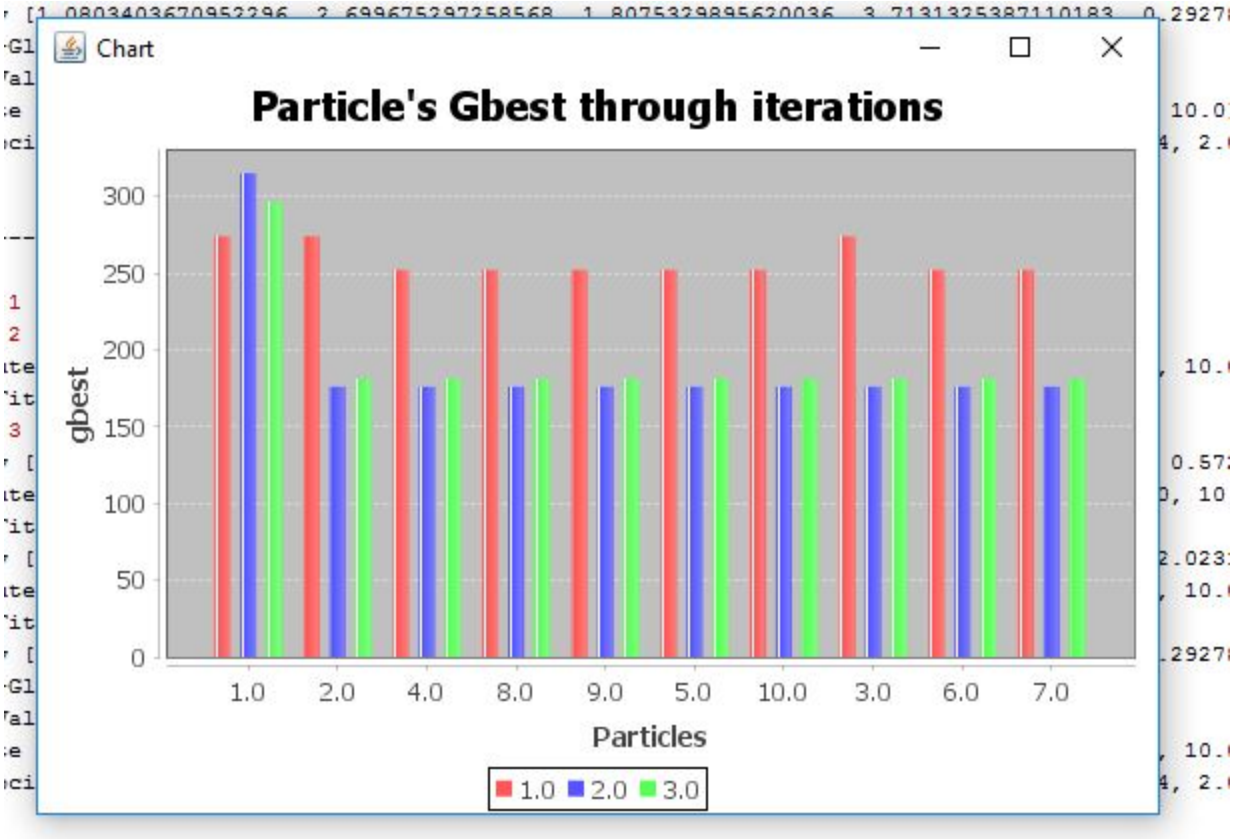
1. **vehicle routing in transportation systems**
2. **traffic routing in communication networks**
3. **path planning in robotic systems**

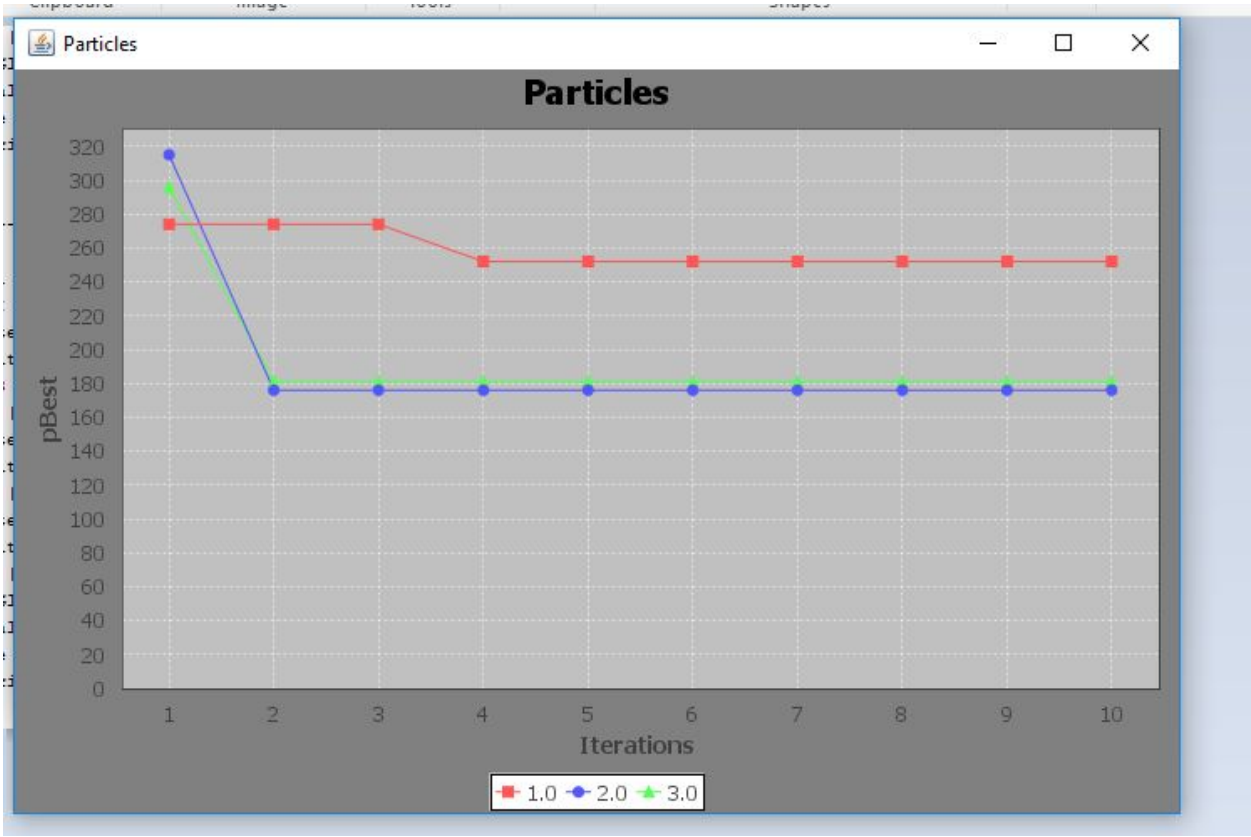
Output:



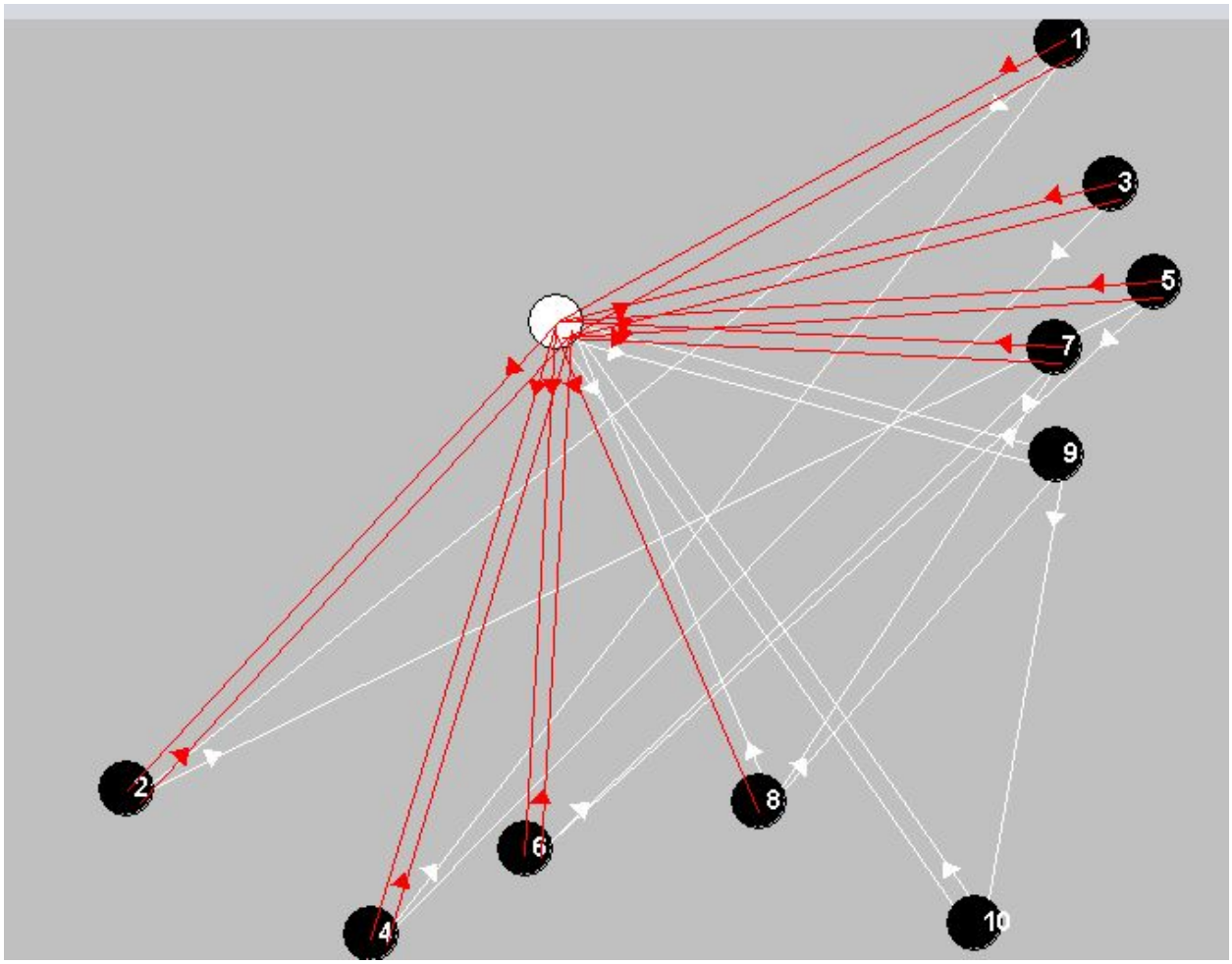
```
------------------------------Iteration :1------------------------------

For particle : 1
PersonalBestRoute [10.0, 10.0, 10.0, 6.514631857797921, 3.305997439120202, 10.0, 10.0, 6.140733754752625, 10.0, 3.5480399675436103]
particle  1 p Fitness 310.0  p BestValue 310.0
P Best Velocity [0.4694599385654312, 4.819838510775472, 2.075366178525269, 2.5146318577979216, 0.30599743912020205, 4.9600244935371505, 5.01677672254678
---------------Global Solution---------------
global FitnessValue  310.0
global BestRoute [10.0, 10.0, 10.0, 6.514631857797921, 3.305997439120202, 10.0, 10.0, 6.140733754752625, 10.0, 3.5480399675436103]
global BestVelocity[0.4694599385654312, 4.819838510775472, 2.075366178525269, 2.5146318577979216, 0.30599743912020205, 4.9600244935371505, 5.0167767225


The most efficient route is : [5, 10, 8, 4, 1, 2, 3, 6, 7, 9]
Salesperson  1 Capacity : 1, Total Rounds : 30, TotalDistance:0  ,Route followed : [0, 5, 0, 10, 0, 8, 0, 8, 0, 4, 0, 4, 0, 1, 0, 1, 0, 1, 0, 2, 0, 2, 0
```

Barchart Representation of particles gbest values





Line chart Representation of Particles



Route Animation