Problem Statement

- **Input** Given a spatial/road network.
- Set of facilities lie along the edges of the network.
- Facilities are categorized into disjoint groups $F_1, F_2, \ldots, F_l$.
- **User Query**: location on the network $q$, query distance $d_q$, facility group $F_i$.
- **Output** Report all the facilities of group $F_i$ which are at a network distance of $d_q$ from $q$. 

G8 Rahul Saladi, Xiaofei Zhao and Akash Agrawal  http://www-users.cs.umn.edu/~rahuls/cs8715/  Categorical Range Queries on Spatial Networks
Figure: Blue and Red points are the facilities. All edges are of unit length. Assume $d_q = 3\sqrt{2}$ units. All the blue points and none of the red points are reported. The network diameter is $3\sqrt{2}$. 
Why is the problem Important/Hard

- **Importance** Extremely useful query for users of GPS and mobile routing apps.
- **Hardness** Existing solutions require scan of the entire network in the worst case.
- **Hardness** Unlike Euclidean space, computing network distance is non-trivial.
- **Existing techniques** require super-linear space to quickly compute network distance.
- **Grand Challenge** Computing network distance in $O(1)$ time using linear space!!
Proposed Approach

New notion of neighbourhood

- Neighbourhood of a vertex
- Neighbourhood of a facility

Data Structures

- **List Structure** List of neighbours of each vertex.
- **Facility Neighbourhood Graph (FNG)** The facilities are the nodes. An edge exists between two facilities if they are neighbours.

Query Algorithm

- Given a query vertex $q$, find all the neighbours of $q$.
- Modified Dijkstra’s algorithm is run on FNG.
Why is the approach novel/better

Novelty

- Queries can be posed on any facility group
- Dijkstra’s algorithm applied on facilities graph. Not on the original network!

Analysis

- **Space occupied** $O(\# \text{ neighbours of all the vertices } + \# \text{ neighbours of all the facilities}).$
- **Query time** $O(\# \text{ neighbours of all the facilities reported}).$

Figure: Best case scenario

Figure: Worst case scenario