Modelling road network of Indian cities

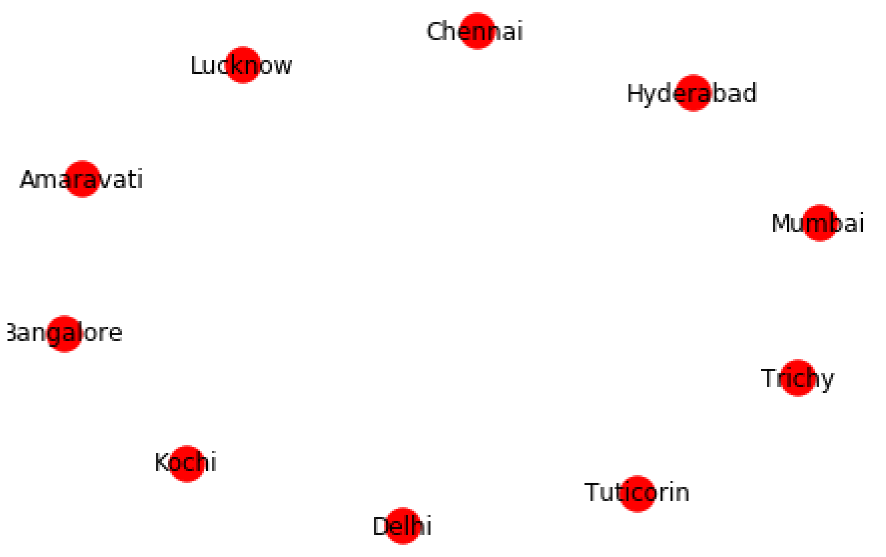
In [1]:

```
import networkx as nx
import matplotlib.pyplot as plt
```

In [2]:

```
G = nx.Graph() #Undirected NULL graph
#G = nx.DiGraph() #Directed Graph
cities = ['Delhi', 'Trichy', 'Mumbai', 'Tuticorin', 'Chennai', 'Kochi', 'Hyderabad'
for city in cities:
    G.add_node(city)
nx.draw(G, with_labels=1)
plt.show()
```

```
/home/gokul/anaconda2/lib/python2.7/site-packages/networkx/drawing/nx_
pylab.py:126: MatplotlibDeprecationWarning: pyplot.hold is deprecated.
    Future behavior will be consistent with the long-time default:
    plot commands add elements without first clearing the
    Axes and/or Figure.
  b = plt.ishold()
/home/gokul/anaconda2/lib/python2.7/site-packages/networkx/drawing/nx_
pylab.py:138: MatplotlibDeprecationWarning: pyplot.hold is deprecated.
    Future behavior will be consistent with the long-time default:
    plot commands add elements without first clearing the
    Axes and/or Figure.
  plt.hold(b)
/home/gokul/anaconda2/lib/python2.7/site-packages/matplotlib/__init__.
py:917: UserWarning: axes.hold is deprecated. Please remove it from yo
ur matplotlibrc and/or style files.
  warnings.warn(self.msg_depr_set % key)
/home/gokul/anaconda2/lib/python2.7/site-packages/matplotlib/rcsetup.p
y:152: UserWarning: axes.hold is deprecated, will be removed in 3.0
  warnings.warn("axes.hold is deprecated, will be removed in 3.0")
```



```
In [3]:
```

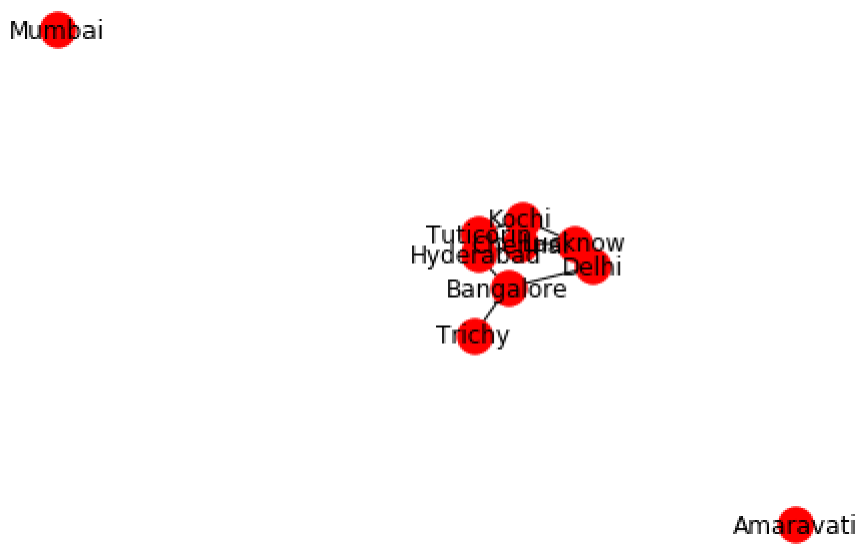
```python
import random as rd
costs = [rd.randint(50, 1000) for x in range(10) ]
print costs
print len(costs)
print "Edges : ", G.number_of_edges()
print "Nodes : ", G.number_of_nodes()
```

```
[363, 587, 639, 691, 207, 344, 804, 119, 743, 734]
10
Edges :  0
Nodes :  10
```

```
In [4]:
```

```python
#Addding 10 edges to the graph
while(G.number_of_edges() != 10):
    city1 = rd.choice(G.nodes())
    city2 = rd.choice(G.nodes())
    wt = rd.choice(costs)#selecting random costs
    if city1 != city2 and G.has_edge(city1, city2) == 0:
        G.add_edge(city1, city2, weight = wt)
print G.edges()
nx.draw(G, with_labels=1)
plt.show()
```

```
[('Hyderabad', 'Tuticorin'), ('Hyderabad', 'Bangalore'), ('Hyderabad',
'Chennai'), ('Chennai', 'Tuticorin'), ('Chennai', 'Lucknow'), ('Luckno
w', 'Delhi'), ('Lucknow', 'Kochi'), ('Delhi', 'Bangalore'), ('Kochi',
 'Tuticorin'), ('Bangalore', 'Trichy')]
```

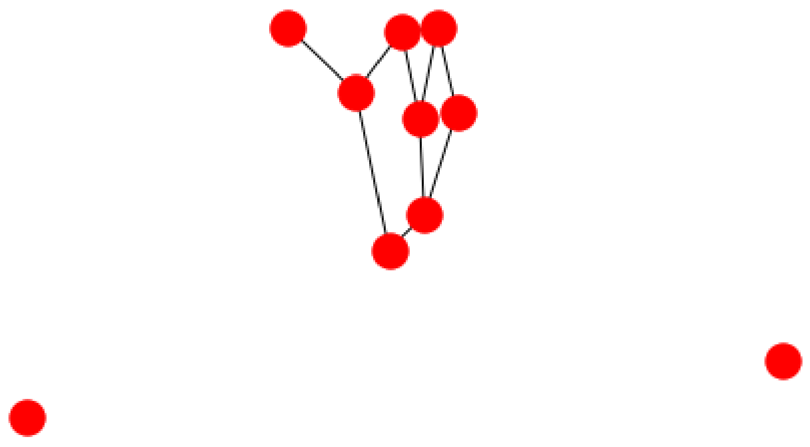


In [5]:

```
pos = nx.spectral_layout(G)
nx.draw(G, pos)
plt.show()
```

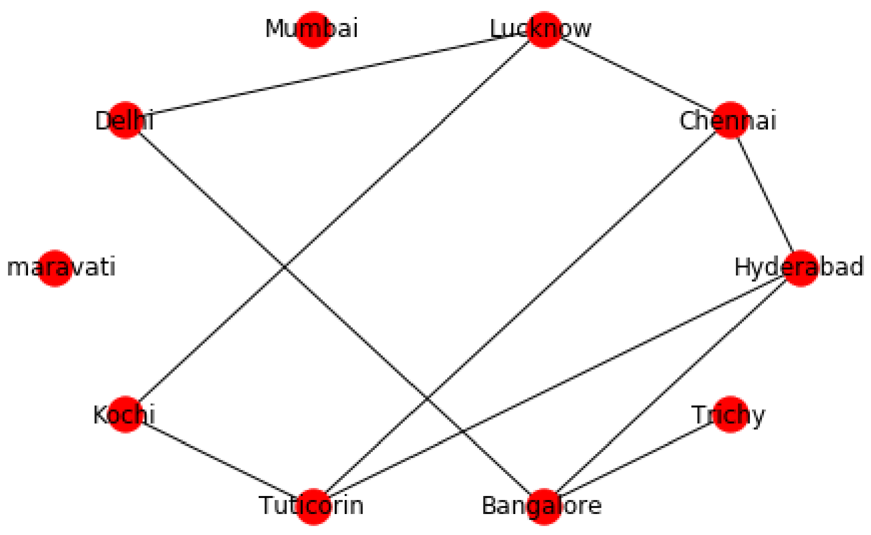
In [6]:

```
pos = nx.spring_layout(G)
nx.draw(G, pos)
plt.show()
```



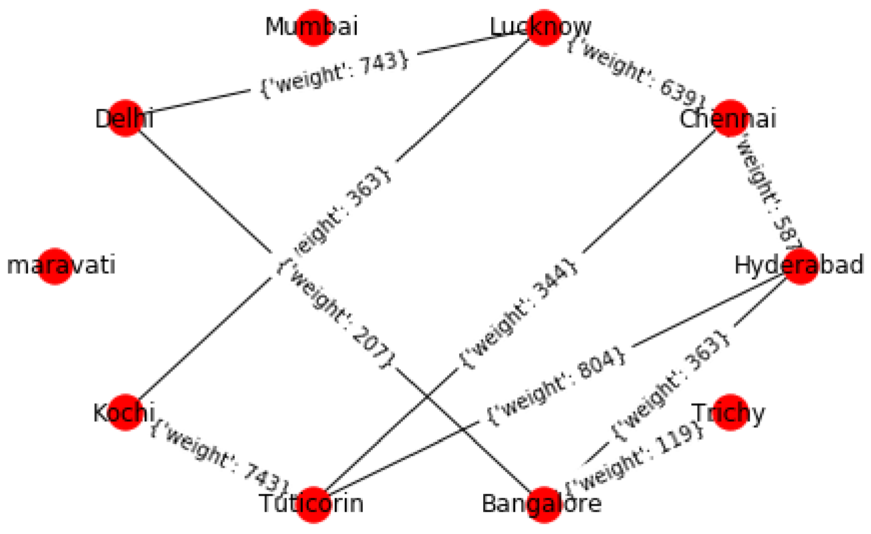
In [7]:

```
pos = nx.circular_layout(G)
nx.draw(G, pos, with_labels=1)
plt.show()
```



In [8]:

```
#Visulaising edge weights
nx.draw(G, pos, with_labels=1)
nx.draw_networkx_edge_labels(G, pos)
plt.show()
```



In [9]:

```
print nx.is_connected(G)
```

```
False
```

In [10]:

```
for u in G.nodes():
    for v in G.nodes():
        print u, v, nx.has_path(G, u, v)
```

```
Hyderabad Hyderabad True
Hyderabad Chennai True
Hyderabad Lucknow True
Hyderabad Mumbai False
Hyderabad Delhi True
Hyderabad Amaravati False
Hyderabad Kochi True
Hyderabad Tuticorin True
Hyderabad Bangalore True
Hyderabad Trichy True
Chennai Hyderabad True
Chennai Chennai True
Chennai Lucknow True
Chennai Mumbai False
Chennai Delhi True
Chennai Amaravati False
Chennai Kochi True
Chennai Tuticorin True
Chennai Bangalore True
Chennai Trichy True
Lucknow Hyderabad True
Lucknow Chennai True
Lucknow Lucknow True
Lucknow Mumbai False
Lucknow Delhi True
Lucknow Amaravati False
Lucknow Kochi True
Lucknow Tuticorin True
Lucknow Bangalore True
Lucknow Trichy True
Mumbai Hyderabad False
Mumbai Chennai False
Mumbai Lucknow False
Mumbai Mumbai True
Mumbai Delhi False
Mumbai Amaravati False
Mumbai Kochi False
Mumbai Tuticorin False
Mumbai Bangalore False
Mumbai Trichy False
Delhi Hyderabad True
Delhi Chennai True
Delhi Lucknow True
Delhi Mumbai False
Delhi Delhi True
Delhi Amaravati False
Delhi Kochi True
Delhi Tuticorin True
Delhi Bangalore True
Delhi Trichy True
Amaravati Hyderabad False
Amaravati Chennai False
Amaravati Lucknow False
Amaravati Mumbai False
Amaravati Delhi False
Amaravati Amaravati True
Amaravati Amaravati True
Amaravati Kochi False
Amaravati Tuticorin False
Amaravati Bangalore False
Amaravati Trichy False
Kochi Hyderabad True
Kochi Chennai True
Kochi Lucknow True
Kochi Mumbai False
Kochi Delhi True
Kochi Amaravati False
Kochi Kochi True
Kochi Tuticorin True
Kochi Bangalore True
Kochi Trichy True
Tuticorin Hyderabad True
Tuticorin Chennai True
Tuticorin Lucknow True
Tuticorin Mumbai False
Tuticorin Delhi True
Tuticorin Amaravati False
Tuticorin Kochi True
Tuticorin Tuticorin True
Tuticorin Bangalore True
Tuticorin Trichy True
Bangalore Hyderabad True
Bangalore Chennai True
Bangalore Lucknow True
Bangalore Mumbai False
Bangalore Delhi True
Bangalore Amaravati False
Bangalore Kochi True
Bangalore Tuticorin True
Bangalore Bangalore True
Bangalore Trichy True
Trichy Hyderabad True
Trichy Chennai True
Trichy Lucknow True
Trichy Mumbai False
Trichy Delhi True
Trichy Amaravati False
Trichy Kochi True
Trichy Tuticorin True
Trichy Bangalore True
Trichy Trichy True
```

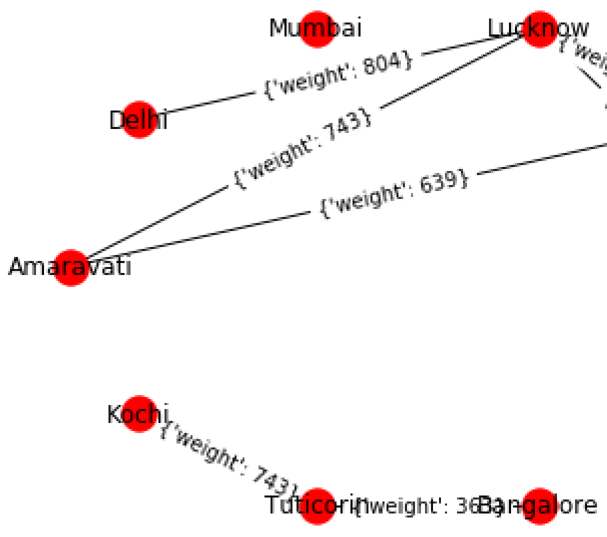
In [11]:

```
#Refer networkx.github.io documentation for dijikstra functions
```

In [12]:

```
#write a module to create the road network
def create_network(cities, costs, numberOfLinks):
    G = nx.Graph()
    for city in cities:
        G.add_node(city)
    while(G.number_of_edges() < numberOfLinks):
        city1 = rd.choice(G.nodes())
        city2 = rd.choice(G.nodes())
        if city1 != city2 and G.has_edge(city1, city2) == 0:
            G.add_edge(city1, city2, weight = rd.choice(costs))
    return G
G = create_network(cities, costs, 8)
print G.number_of_edges()
pos = nx.circular_layout(G)
nx.draw(G, pos, with_labels=1)
nx.draw_networkx_edge_labels(G, pos)
plt.show()
```

```
8
```



In [13]:

```
9999999999
```

Out[13]:

```
9999999999
```

In [17]:

```
G.remove_edge('Trichy', 'Hyderabad')
print nx.dijkstra_path(G, 'Delhi', 'Trichy')
print nx.dijkstra_path_length(G, 'Delhi', 'Trichy')
```

```
---------------------------------------------------------------------------
-----
NetworkXNoPath                            Traceback (most recent call
 last)
<ipython-input-17-a8e33dc32337> in <module>()
      1 G.remove_edge('Trichy', 'Hyderabad')
----> 2 print nx.dijkstra_path(G, 'Delhi', 'Trichy')
      3 print nx.dijkstra_path_length(G, 'Delhi', 'Trichy')

/home/gokul/anaconda2/lib/python2.7/site-packages/networkx/algorithms/
shortest_paths/weighted.pyc in dijkstra_path(G, source, target, weigh
t)
     81     except KeyError:
     82         raise nx.NetworkXNoPath(
---> 83             "node %s not reachable from %s" % (source, targe
t))
     84 
     85 

NetworkXNoPath: node Delhi not reachable from Trichy
```

In [19]:

```
G.add_edge('Tuticorin', 'Hyderabad', weight = rd.choice(costs))
print nx.dijkstra_path(G, 'Tuticorin', 'Hyderabad')# source and destination
print nx.dijkstra_path_length(G,'Tuticorin', 'Hyderabad')
```

```
['Tuticorin', 'Hyderabad']
363
```

In [20]:

```
#single source shorest path
print nx.single_source_dijkstra_path(G, 'Tuticorin')# source
print nx.single_source_dijkstra_path_length(G,'Tuticorin')
```

```
{'Hyderabad': ['Tuticorin', 'Hyderabad'], 'Chennai': ['Tuticorin', 'Hy
derabad', 'Lucknow', 'Chennai'], 'Lucknow': ['Tuticorin', 'Hyderabad',
'Lucknow'], 'Delhi': ['Tuticorin', 'Hyderabad', 'Lucknow', 'Delhi'],
 'Hyderabed': ['Tuticorin', 'Hyderabed'], 'Amaravati': ['Tuticorin',
 'Hyderabad', 'Lucknow', 'Amaravati'], 'Kochi': ['Tuticorin', 'Koch
i'], 'Tuticorin': ['Tuticorin'], 'Bangalore': ['Tuticorin', 'Bangalor
e']}
{'Hyderabad': 363, 'Chennai': 1121, 'Lucknow': 1002, 'Delhi': 1806, 'H
yderabed': 587, 'Amaravati': 1745, 'Kochi': 743, 'Tuticorin': 0, 'Bang
alore': 363}
```

Connecting Trichy and Delhi

In [21]:

```
x = [0]
y = [99999999]
cnt  = 0
def make_random_road(cnt):
    cnt = cnt + 1
    city1 = rd.choice(G.nodes())
    city2 = rd.choice(G.nodes())
    wt = rd.choice(costs)
    G.add_edge(city1, city2, weight = wt)
    try:
        distance = nx.dijkstra_path_length(G, 'Trichy', 'Delhi')
        x.append(cnt)
        y.append(distance)
        return cnt
    except:
        print cnt, "Still no path...."
        x.append(cnt)
        y.append(99999999)
        cnt += 1
        make_random_road(cnt)
```

In [23]:

```
make_random_road(0)
```

```
1 Still no path....
3 Still no path....
5 Still no path....
7 Still no path....
9 Still no path....
11 Still no path....
13 Still no path....
15 Still no path....
17 Still no path....
19 Still no path....
21 Still no path....
23 Still no path....
25 Still no path....
27 Still no path....
29 Still no path....
31 Still no path....
33 Still no path....
35 Still no path....
```

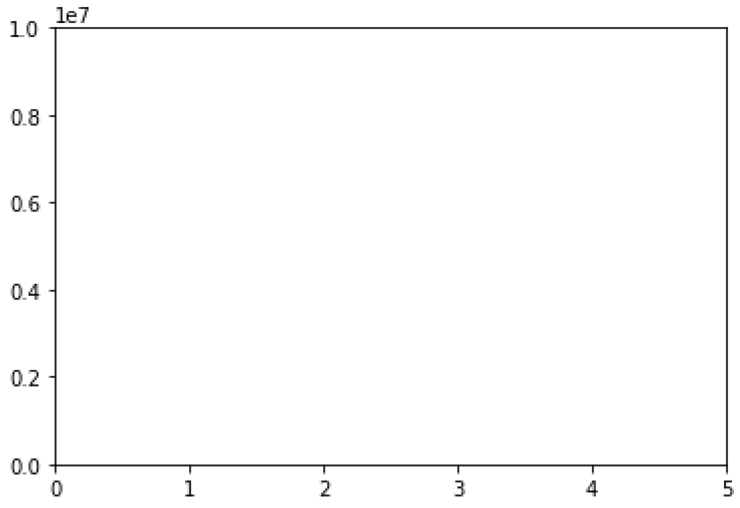
In [24]:

```
print nx.dijkstra_path(G, 'Delhi', 'Trichy')
print nx.dijkstra_path_length(G, 'Delhi', 'Trichy')
```

```
['Delhi', 'Lucknow', 'Bangalore', 'Trichy']
981
```

In [25]:

```
plt.plot(x, y)
plt.axis([0,5,0,10000000])
plt.show()
```


1e7
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
5