

Mini Project on

“Applying betweenness centrality measure to identify prominent district of each state in India”

Submitted by

Vicky Kumar Yadav

17-1-5-016

Under the Supervision of

Dr. Naresh Babu M.

Assistant Professor

Department of CSE

NIT Silchar



Department of Computer Science and Engineering

National Institute of Technology Silchar

(an Institute of National Importance)

Cachar District, Assam 788010

Contents

1. Abstract	3
2. Methodology(Algorithm used)	3-4
3. System Requirements	4
4. Implementation	5-8
5. Results	8-48
6. Conclusion	48
7. References	49

Abstract

In general there are various measures to determine the importance of a district in each state. It can be the education or the natural beauty. But in this project we considered the Betweenness Centrality of a location of districts. The main idea of betweenness can be understood as the connectivity of a district with other district within a state. So, development of most prominent district is important for overall development of the state.

To calculate Betweenness Centrality you take every pair of the network and count how many times a node can interrupt the shortest paths (geodesic distance) between the two nodes of the pair. Thus, it can be considered as logical base to define importance of a district within a state.

In this report first we are going to see the algorithms that we are going to use for calculation. The complexity of the algorithm is $O(N*N*(N+M))$ where N is the number of node and M is the total number of edges that connect the state to its neighbor. Then we are going to see the system requirements to run the code of the which is written in C++.

After all this we will see the implementation of the algorithm in C++. Also we will see the Python code which was used to generate the graph of all the nodes and districts for every state.

Finally we will see the result of all the states. For every state there is the graph of the state is given along with the most prominent district. A table is also given for every state where the Betweenness of each district is given in one column and name of the district in the previous column. Then we finally will have the result and conclusion on the entire work and the reasoning of the output and what we can gain from the outputs.

Methodology(Algorithm used)

The algorithm used is constructive in nature. I developed the idea from the formula that is required for calculation of Betweenness Centrality.

We first make an adjacency list of edges from the input graph and then apply this algorithm.

Algorithm :

For every pair of nodes :

Two functions are used:

store_par_bfs(start_node, end_node, dis, graph)://calculates all parent nodes which gives minimum distance.

Set distance[top] <- 0

push start_node in q queue.

while queue is not empty do:

For all child of top element:

if distance[top]>distance[child]+1 //shorter distance

```

        Clear previous paths .
        Store this child in a vector .
        distance[top] <- distance[child]+1.
    Else if distance[top] := distance [child]+1//more parents giving same dis.
        store this child in vector.
all_paths(parents matrix,path vector,end_node,start_node) ://it is a recursive helper function
that retrives all possible minimum paths.
    If start_node := end_node
        store this path in a data structure(vector of vectors)
    Else
        For all possible parents of end_node:
            store parent in path vector
            all_paths(parent matrix,path vector, parents,start_node)
            remove parent from path vector.
If no path is present Betweenness for all nodes is 0 and continue
Else
    For all the nodes ing graph:
        if node is present in any path
            Increment frequency of that node by 1.
For all the nodes in the graph :
    Betweenness centrality of node += node+(frequency/total_no._of_paths)

```

System Requirements

Applications used :

1. Spyder to genrate graph with python script.
2. Geany to write and compile code.
3. Libre Office Writer to write the report.
4. Operating sytem Linux(Ubuntu).

System configuration :

1. Intel(R) Pentium(R) CPU 3825U @ 1.90GHz
2. Width 64 bits.
3. RAM 4 GB.
4. Storage memory consumed approximately 10 MB.
5. 1280x800 resolution

Implementation

Betweenness calculation code

```
#include<bits/stdc++.h>
#define int long long int
#define pb push_back
#define endl '\n'
using namespace std;
const int INF = 1e10L;
void all_paths(vector<int> path[],vector<int> &v,int node,int
beg,vector<vector<int>>&ans)// Backtracking all paths using possible parents;
{
    if(node==beg)//reaching the beginning
    {
        ans.pb(v);
        return ;
    }
    for(auto x:path[node])//Taking one of the path
    {
        v.pb(x);
        all_paths(path,v,x,beg,ans);
        v.pop_back();
    }
}

void store_par_bfs(int beg,vector<int> path[],vector<int> &dis,vector<int>
graph[])// finding parents of each node which will contribute to shortest path
{
    dis[beg]=0;//beginning is at distance 0
    queue<int> q;
    q.push(beg);
    while(!q.empty())
    {
        int par=q.front();
        q.pop();
        for(auto child:graph[par])
        {
            if(dis[child]>dis[par]+1)//if shorter path is available
            {
                q.push(child);
                dis[child]=dis[par]+1;
                path[child].clear();
            }
        }
    }
}
```

```

        path[child].pb(par);
    }
    else if(dis[child]==dis[par]+1)//if multiple path is available
    {
        path[child].pb(par);
    }
}
}
}
int32_t main()
{
    int i,j,k,n,m;//n->number of districts
    string s,t,state;
    cin>>n;
    double BC[n+1]={0};//Betweenness centrality of each districts
    map<string,int> mp;
    map<int,string> mpr;
    map<pair<int,int>,int> mpe;
    for(i=0;i<n;i++)//mapping nodes using numbers
    {
        cin>>s;
        mp[s]=i;
        mpr[i]=s;
    }
    vector<int> graph[n+1];
    cin>>m;
    for(i=0;i<m;i++)
    {
        cin>>s>>t;
        if(mpe[{mp[s],mp[t]}])continue;//checking already provided edges
        graph[mp[s]].pb(mp[t]);
        graph[mp[t]].pb(mp[s]);
        mpe[{mp[s],mp[t]}]=1;
        mpe[{mp[t],mp[s]}]=1;
    }
    int nosp[n+1]={0},tnsp=0;//nosp-> Number of shortest path, tnsp-> total
                                number of shortest path
    for(i=0;i<n;i++)
    {
        for(j=i+1;j<n;j++)
        {
            memset(nosp,0,sizeof(nosp));

```

```

vector<int>dis(n+1,INF);
vector<int> path[n+1];//stores possible parents
vector<int> v;
vector<vector<int>> ans;
tnsp=0;
store_par_bfs(i,path,dis,graph);
all_paths(path,v,j,i,ans);
for(k=0;k<ans.size();k++)
{
    for(auto x:ans[k])
    {
        nosp[x]++;
    }
}
tnsp=ans.size();
if(tnsp==0)
continue;
for(k=0;k<n;k++)//Calculating contribution in each pair of nodes
{
    if(k==i or k==j)continue;
    BC[k]+=(double)((double)nosp[k]/tnsp);
}
}
int mx=max_element(BC,BC+n+1)-BC;//Finding prominent using maximum
                                betweenness centrality
cout<<"Most prominent distric in "<<state<<" is
"<<mpr[mx]<<". "<<endl<<endl;
cout<<"Betweenness centrality of all disticts of "<<state<<"
are : "<<endl<<endl;
for(i=0;i<n;i++)
cout<<mpr[i]<<" "<<BC[i]<<endl;
}

```

Graph Genterator code in python

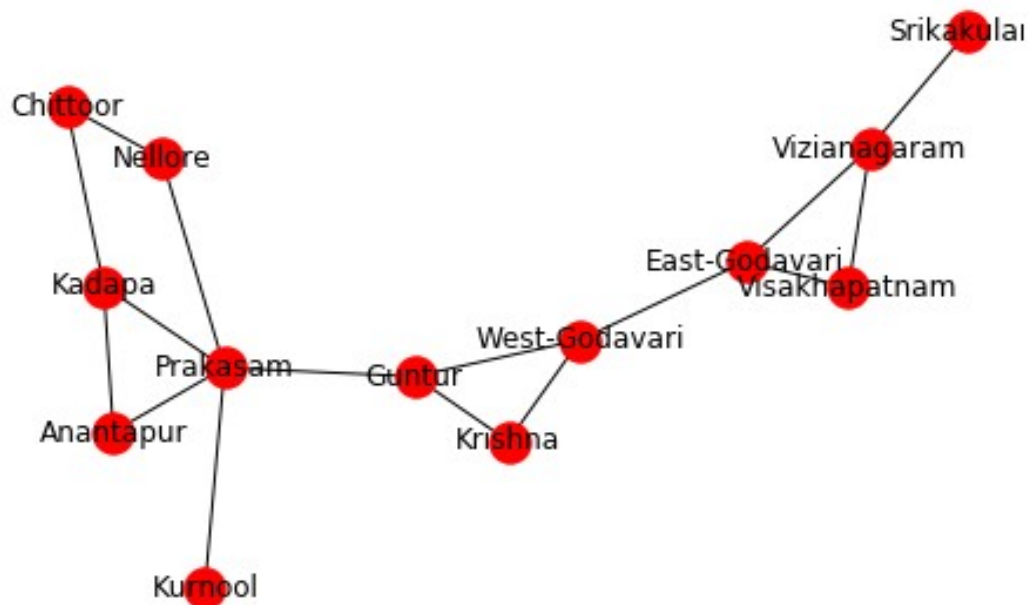
```
import networkx as nx
import matplotlib.pyplot as plt
import pandas as pd

dataset = pd.read_csv('filename.csv')
data_array = dataset.iloc[:].values
G = nx.Graph()
n = set([])
for i in range (len(data_array)):
    n.add(data_array[i][0])
    n.add(data_array[i][1])
for i in n:
    G.add_node(i)
for i in range(len(data_array)):
    G.add_edge(data_array[i][0],data_array[i][1])

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

Results

Andhra_Pradesh :



Most prominent district in Andhra_Pradesh is Prakasam.

Betweenness centrality of all disticts of Andhra_Pradesh are :

Chittoor 0.5

Anantapur 0

Kadapa 5.5

Nell'ore 4.5

Prakasam 40.5

Kurnool 0

Guntur 36

Krishna 0

West-Godavari 32

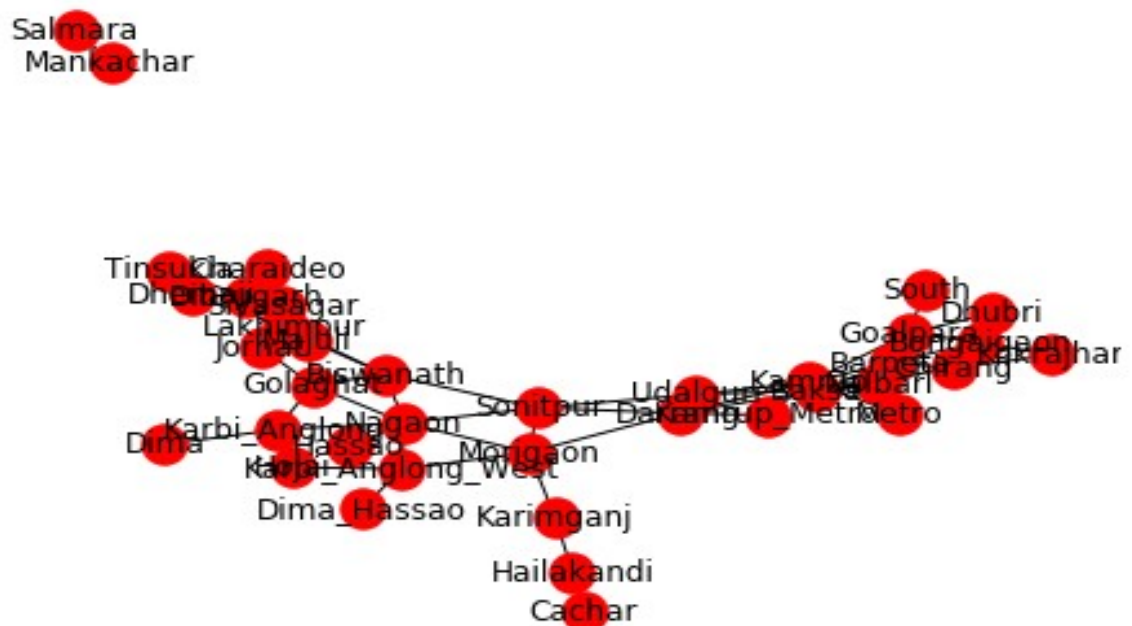
East-Godavari 27

Visakhapatnam 0

Vizianagaram 11

Srikakulam 0

ASSAM :

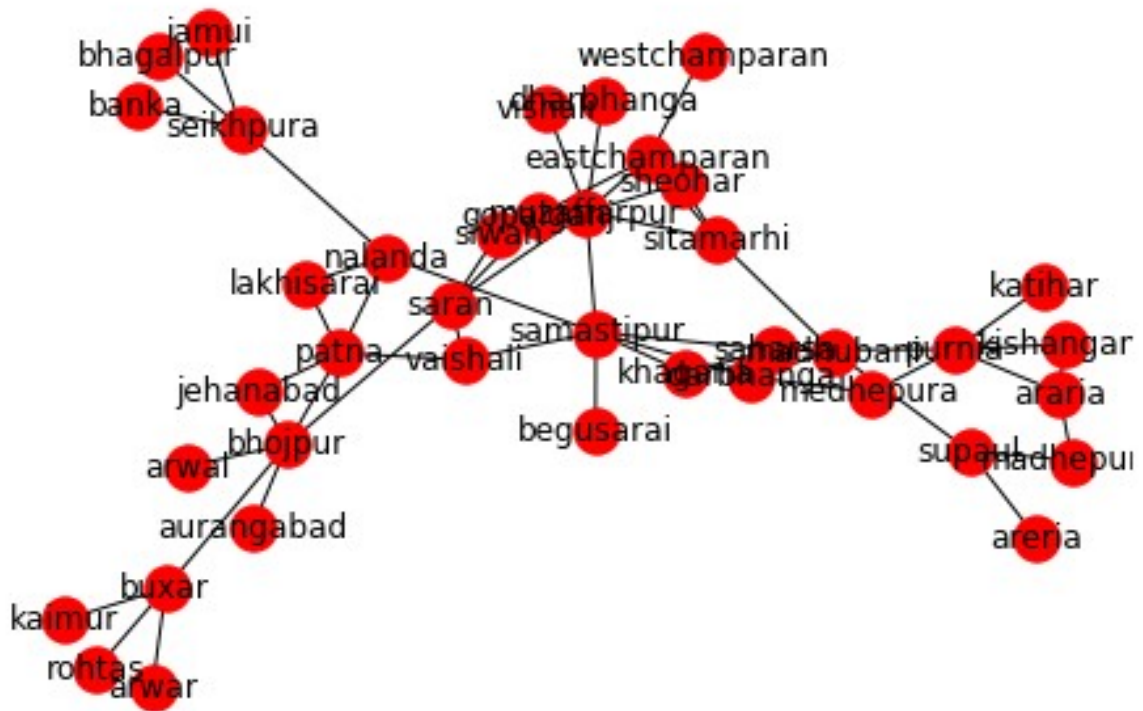


Most prominent district in Assam is Tinsukia.

Betweenness centrality of all districts of Assam are :

Tinsukia 160.193
Dibrugarh 62.963
Dhemaji 5.35
Charaideo 0
Sivasagar 5.97316
Lakhimpur 4.15
Majuli 19.8669
Jorhat 3.05
Biswanath 32.1604
Golaghat 28.2432
Karbi_Anglong 26.7737
Sonitpur 34.7295
Nagaon 99.7807
Hojai 1
Karbi_Anglong_West 38.4667
Dima_Hassao 0
Cachar 0
Hailakandi 30
Karimganj 58
Morigaon 104.422
Udalguri 8.59669
Darrang 65.077
Kamrup_Metro 0
Baksa 37.6493
Nalbari 0
Kamrup 82.1017
Barpeta 16.1857
Chirang 14.2056
Bongaigaon 22.4373
Goalpara 69.6246
Kokrajhar 0
Dhubri 0
South_Salmara_Mankachar 0

Bihar :



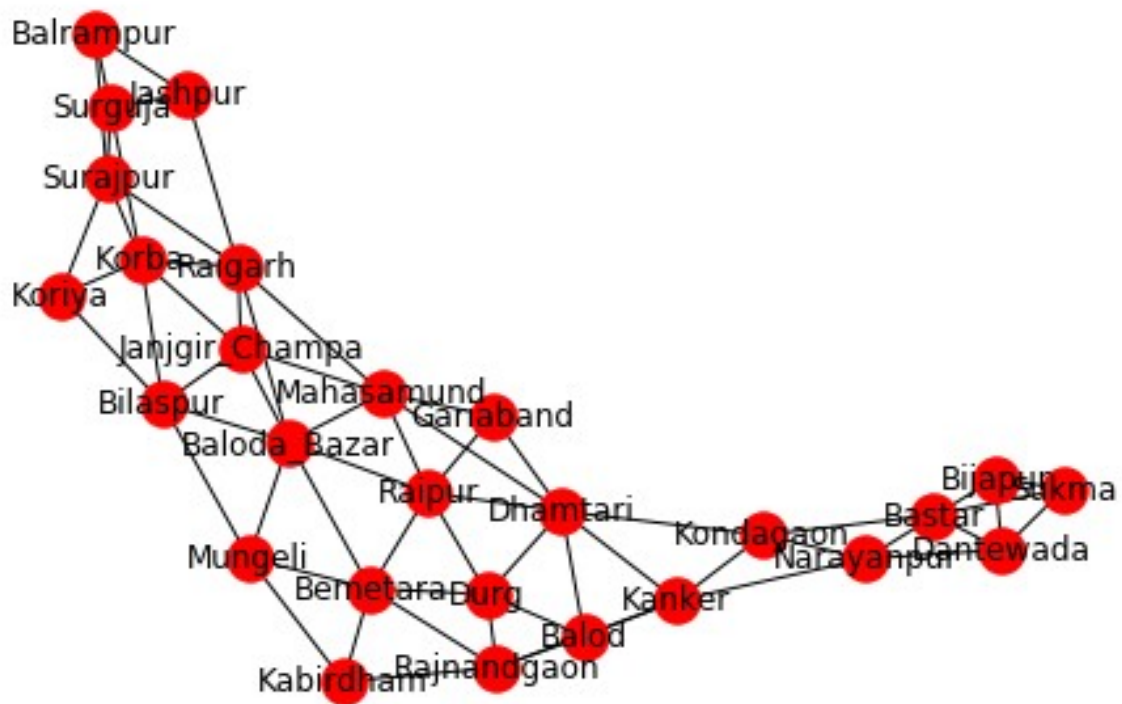
Most prominent district in Bihar is araria.

Betweenness centrality of all districts of Bihar are :

araria 233.575
 arwal 0
 aurangabad 0
 banka 0
 begusarai 0
 bhagalpur 0
 bhojpur 84.6833
 buxar 69.2222
 darbhanga 22.0135
 eastchampan 19.2833
 gaya 0
 gopalganj 2.58333
 jamui 0
 jehanabad 0
 khagaria 0
 kishanganj 0
 kalmur 0

katihar 0
lakhisarai 0
madhubani 9.91905
munger 0
madhepura 0
muzaffarpur 97.2135
nalanda 55.8302
nawada 0
patna 33.2762
puernia 38.45
rohtas 0
saharsa 22.6651
samastipur 83.1754
sheohar 0
sheikhpura 0
saran 42.7206
sitamarhi 8.44444
supaul 7.05556
siwan 0
vaishali 16.8889
westchanparan 0

Chattisgarh :



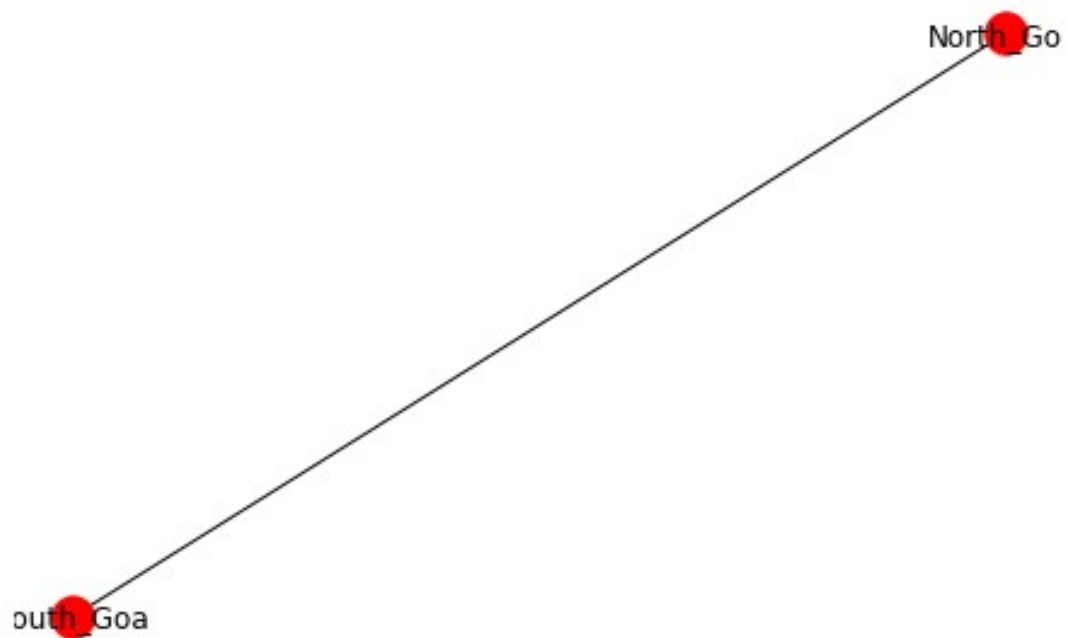
Most prominent district in Chattisgarh is Dhamtari.

Betweenness centrality of all districts of Chattisgarh are :

Balod 1.93333
Baloda_Bazar 47.7464
Balrampur 0.533333
Bastar 23.8881
Bemetara 30.3048
Bijapur 2.15
Bilaspur 23.7536
Dantewada 3.15
Dhamtari 111.957
Durg 6.33333
Gariaband 0
Janjgir_Champa 17.7361
Jashpur 13.2613
Kabirdham 5.43492

Kanker 48.0405
Kondagaon 62.3429
Korba 22.3924
Koriya 1.75952
Mahasamund 94.372
Mungeli 14.3221
Narayanpur 42.1119
Raigarh 77.1865
Raipur 21.4941
Rajnandgaon 25.7857
Sukma 0.5
Surajpur 19.601
Surguja 2.90952

Goa :

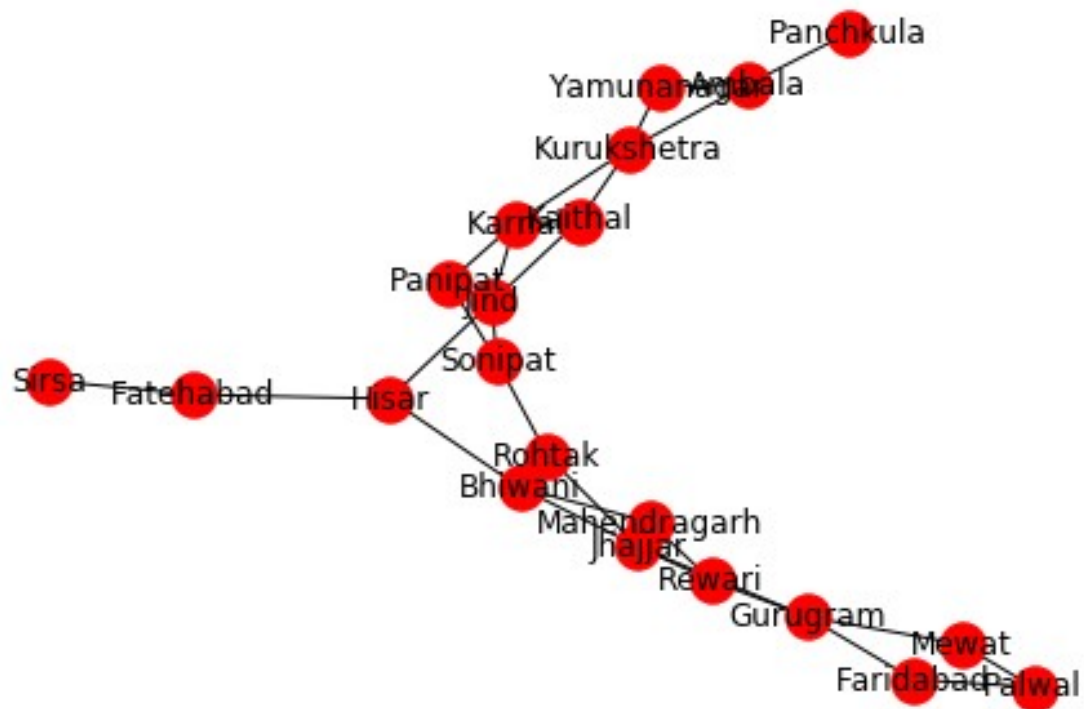


Most prominent district in is North_Goa.

Betweenness centrality of all disticts of are :

North_Goa 0
South_Goa 0

Haryana :



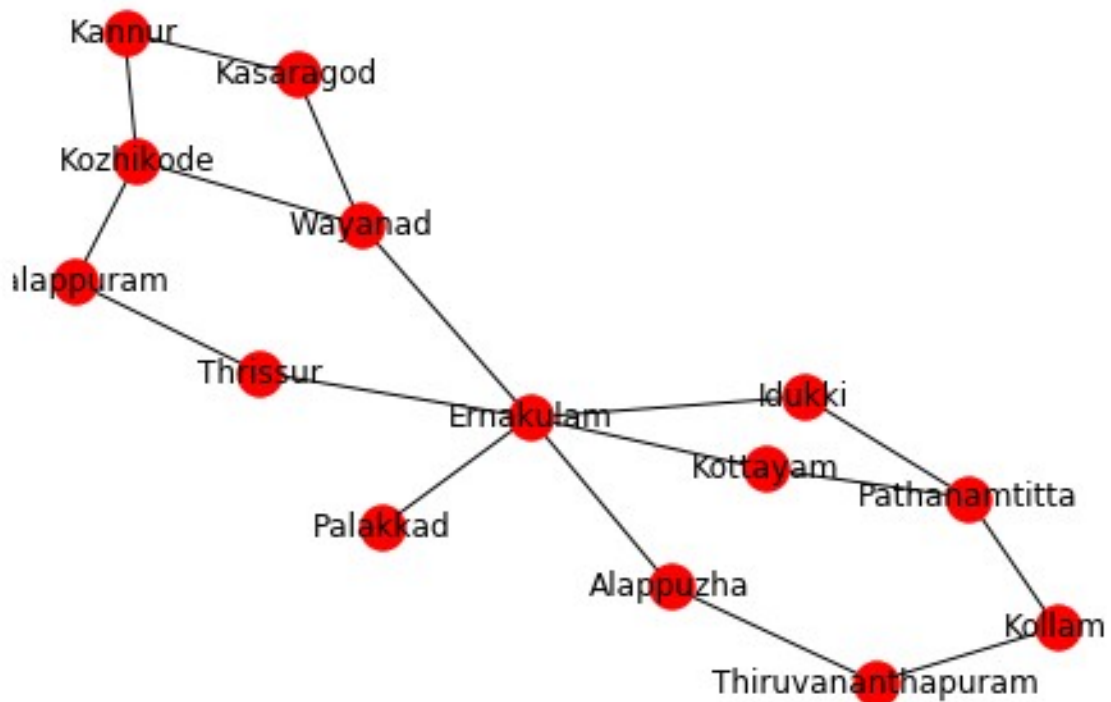
Most prominent district in is Jind.

Betweenness centrality of all districts of are :

Ambala 19
Bhiwani 53.2857
Faridabad 9
Fatehabad 19
Gurugram 51.5
Hisar 69.7857
Jhajjar 65.9405
Jind 75.3452
Kaithal 24.381
Karnal 36.119
Kurukshetra 51
Mahendragarh 4.05952
Mewat 9
Palwal 0.5
Panchkula 0
Panipat 10.1548

Rewari 4.5
Rohtak 38.2143
Sirsa 0
Sonipat 38.2143
Yamunanagar 0.

Kerala :



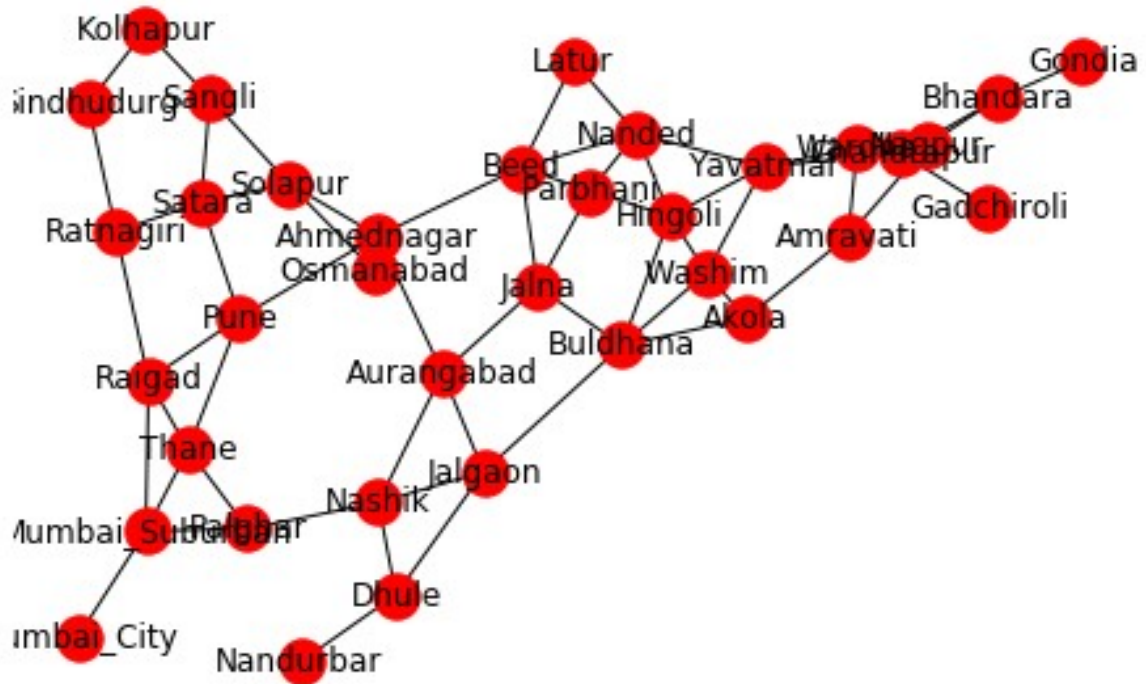
Most prominent district in is Ernakulam.

Betweenness centrality of all districts of are :

Kasaragod 4.5
Kannur 1
Kozhikode 8.5
Wayanad 26
Malappuram 2
Thrissur 8
Palakkad 0
Ernakulam 54.1667
Alappuzha 11.6667

Kottayam 7
 Idukki 7
 Pathanamtitta 8.83333
 Kollam 2.33333
 Thiruvananthapuram 4.

Maharashtra :



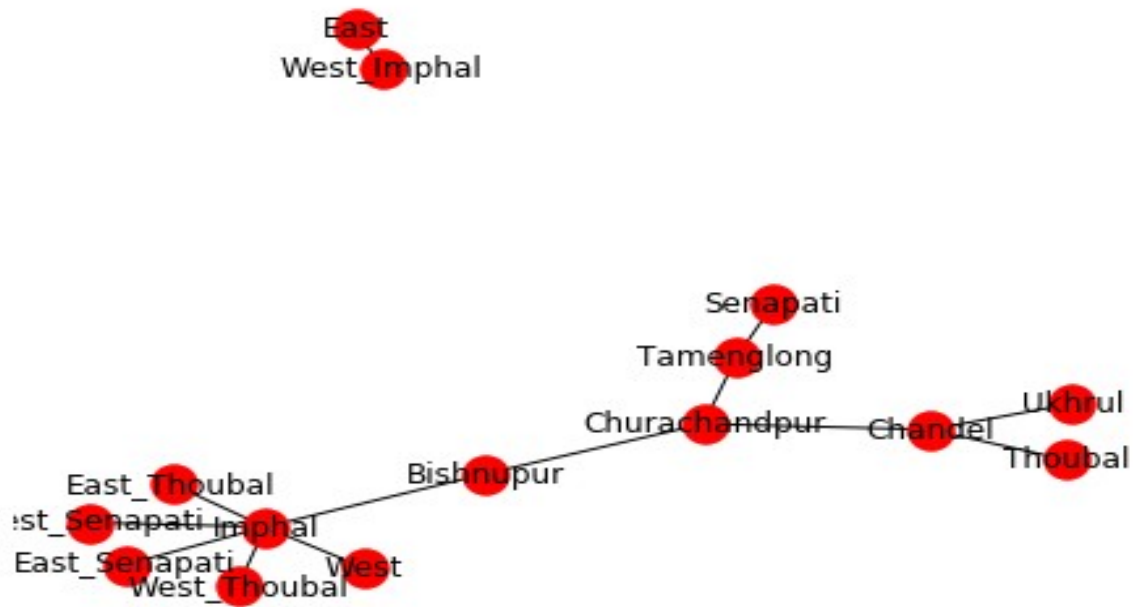
Most prominent district in is Ahmednagar.

Betweenness centrality of all districts of are :

Ahmednagar 220.945
 Akola 40.7135
 Amravati 24.3
 Aurangabad 73.4145
 Beed 165.889
 Bhandara 35
 Buldhana 126.127
 Chandrapur 85.4667
 Dhule 34

Gadchiroli 0
Gondia 0
Hingoli 40.416
Jalgaon 103.796
Jalna 45.0728
Kolhapur 6.79823
Latur 0
Mumbai_City 0
Mumbai_Suburban 42.2651
Nagpur 10.5333
Nanded 121.536
Nandurbar 0
Nashik 80.2636
Osmanabad 0
Palghar 55.6969
Parbhani 13.3455
Pune 97.8755
Raigad 44.543
Ratnagiri 34.1684
Sangli 33.6316
Satara 41.4921
Sindhudurg 5.16667
Solapur 107.061
Thane 27.4985
Wardha 27.5865
Washim 24.6833
Yavatmal 152.715

Manipur :

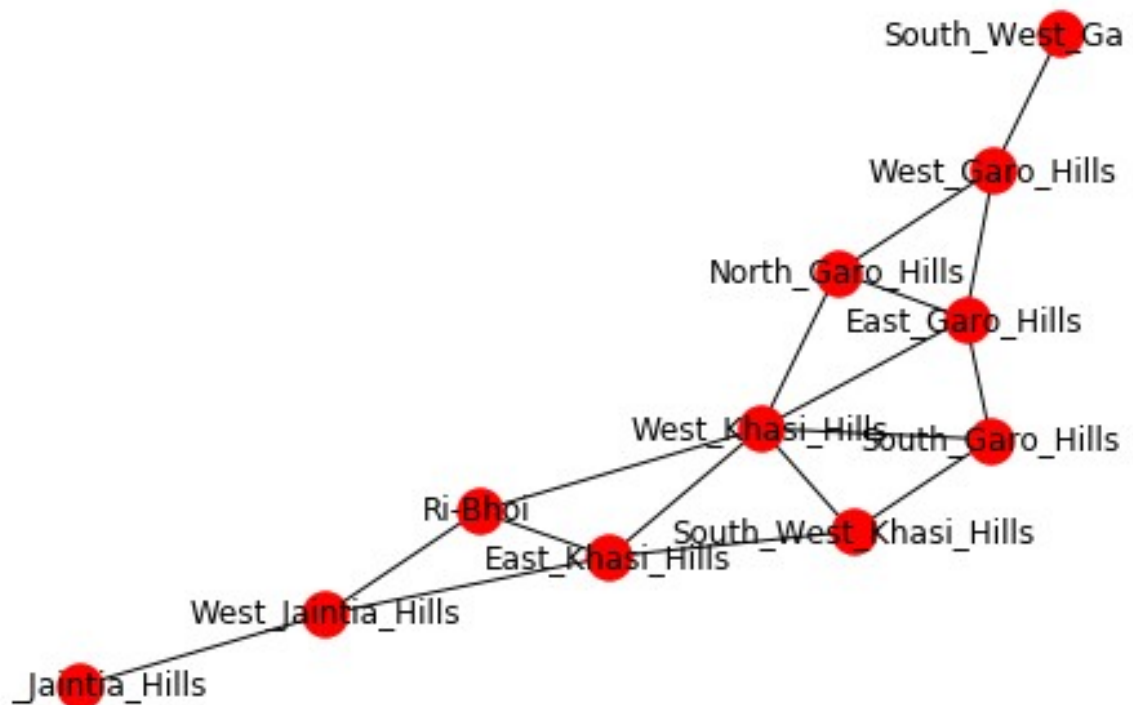


Most prominent district in is Churachandpur.

Betweenness centrality of all districts of are :

Bishnupur 0
Chandel 9
Churachandpur 11
Imphal_East 0
Imphal_West 0
Senapati 0
Tamenglong 5
Thoubal 0
Ukhrul 0

Meghalaya :

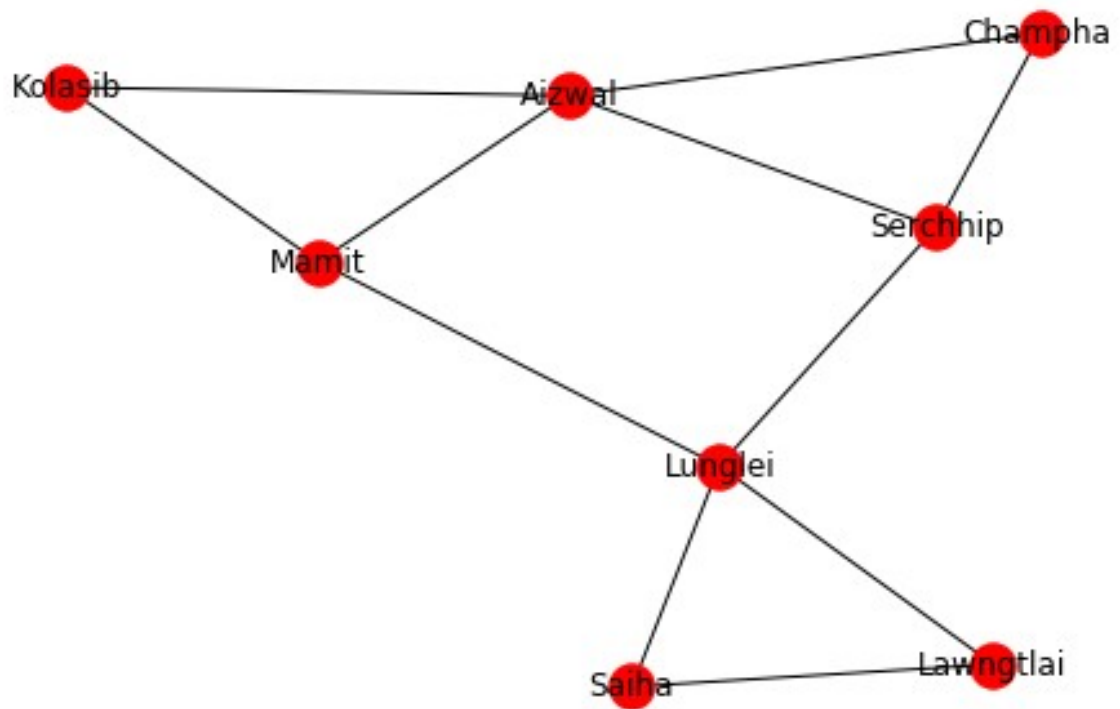


Most prominent district in is West_Khasi_Hills.

Betweenness centrality of all districts of are :

West_Jaintia_Hills 9
East_Jaintia_Hills 0
East_Khasi_Hills 8.83333
West_Khasi_Hills 22.6667
South_West_Khasi_Hills 1.16667
RiBhoi 5.66667
North_Garo_Hills 5.66667
East_Garo_Hills 8.83333
South_Garo_Hills 1.16667
West_Garo_Hills 9
South_West_Garo_Hills 0

Mizoram :

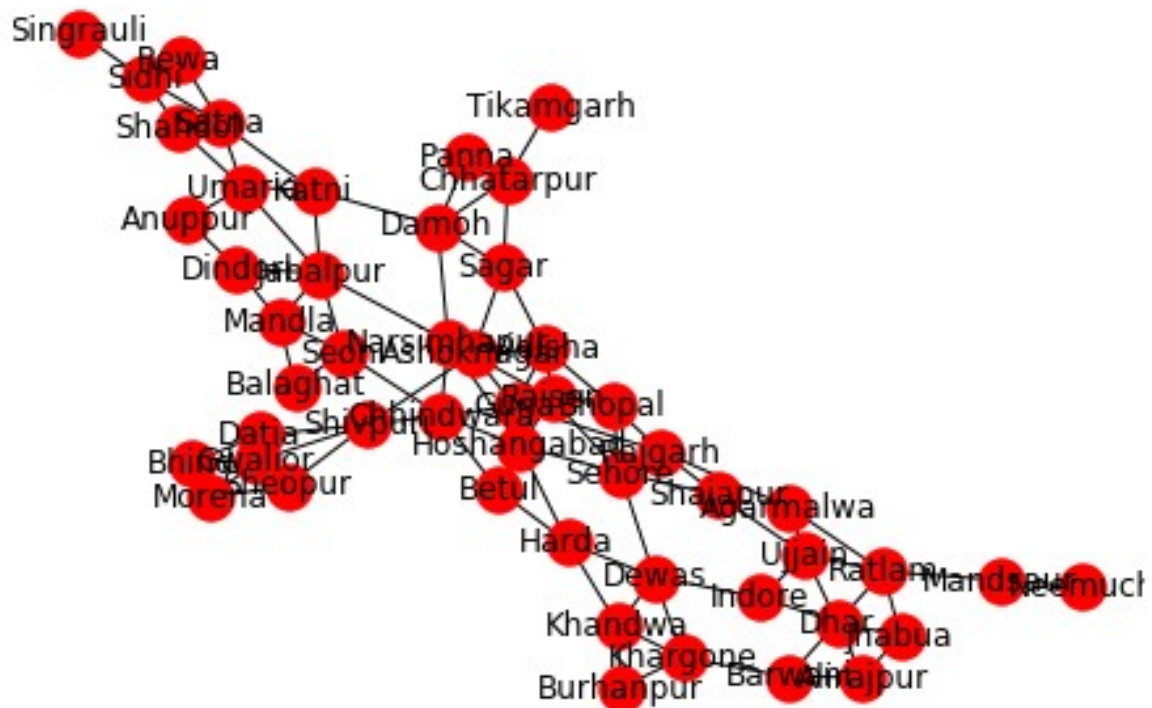


Most prominent district in is Lunglei.

Betweenness centrality of all districts of are :

Aizwal 3.5
Champhai 0
Kolasib 0
Lawngtlai 0
Lunglei 10.5
Mamit 4.5
Saiha 0
Serchhip 4.5

Madhya Pradesh :



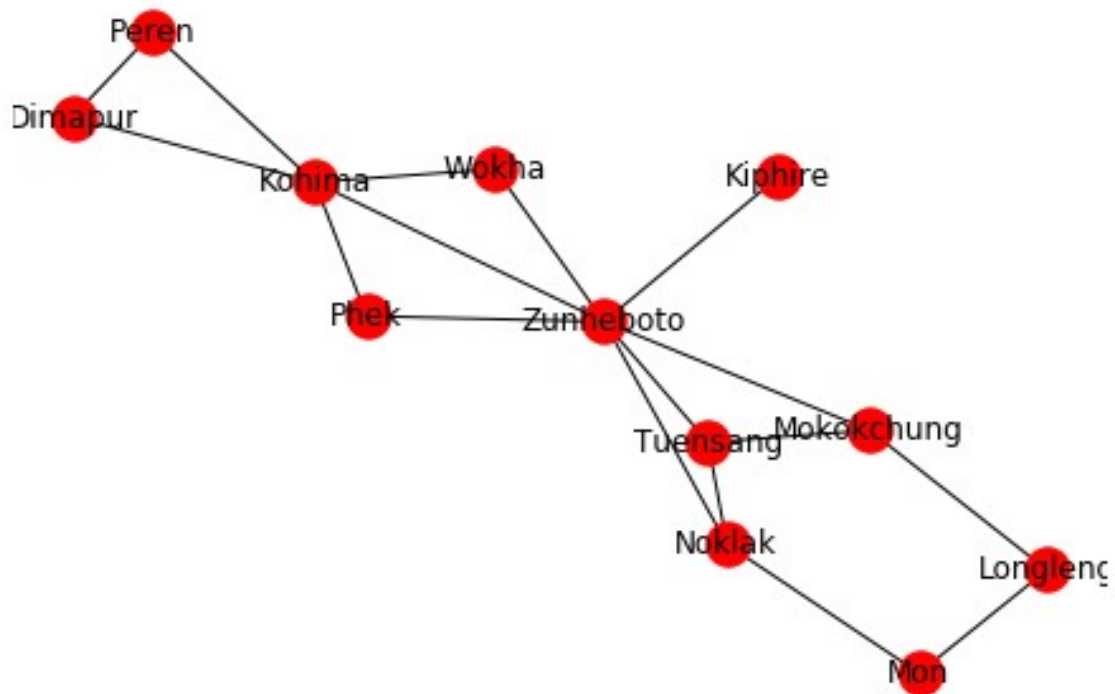
Most prominent district in is Narsimhapur.

Betweenness centrality of all districts of are :

Agarmalwa 129.743
Alirajpur 1.83333
Anuppur 2.46667
Ashoknagar 137.357
Balaghat 0
Barwani 28.619
Betul 13.2681
Bhind 0.5
Bhopal 46.8824
Burhanpur 0
Chhatarpur 56.0057
Chhindwara 74.2461
Damoh 238.877
Datia 23
Dewas 171.775

Dhar 73.0734
Dindori 15.9214
Guna 179.347
Gwalior 46.5
Harda 105.875
Hoshangabad 253.732
Indore 51.3177
Jabalpur 261.241
Jhabua 4.75794
Katni 179.217
Khandwa 47.7566
Khargone 62.781
Mandla 13.0405
Mandsaur 49
Morena 1.5
Narsimhapur 348.655
Neemuch 0
Panna 0
Raisen 183.644
Rajgarh 241.561
Ratlam 136.03
Rewa 0
Sagar 163.532
Satna 128.68
Sehore 287.441
Seoni 54.9379
Shahdol 17.053
Shajapur 85.3039
Sheopur 23
Shivpuri 226.5
Sidhi 49.5
Singrauli 0
Tikamgarh 0
Ujjain 88.2842
Umaria 119.607
Vidisha 119.638

Nagaland :

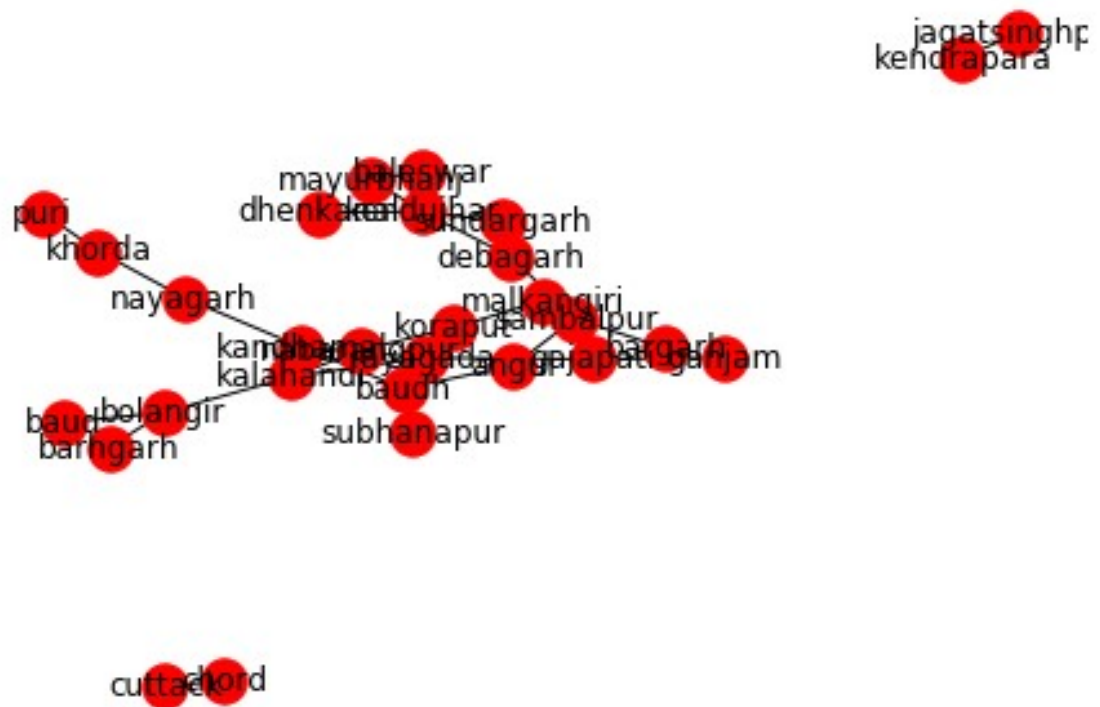


Most prominent district in is Zunheboto.

Betweenness centrality of all districts of are :

Mon 1
Longleng 1
Mokokchung 8
Tuensang 0.5
Noklak 8
Wokha 0
Zunheboto 36
Kiphire 0
Phek 0
Kohima 18.5
Dimapur 0
Peren 0

Odisha :



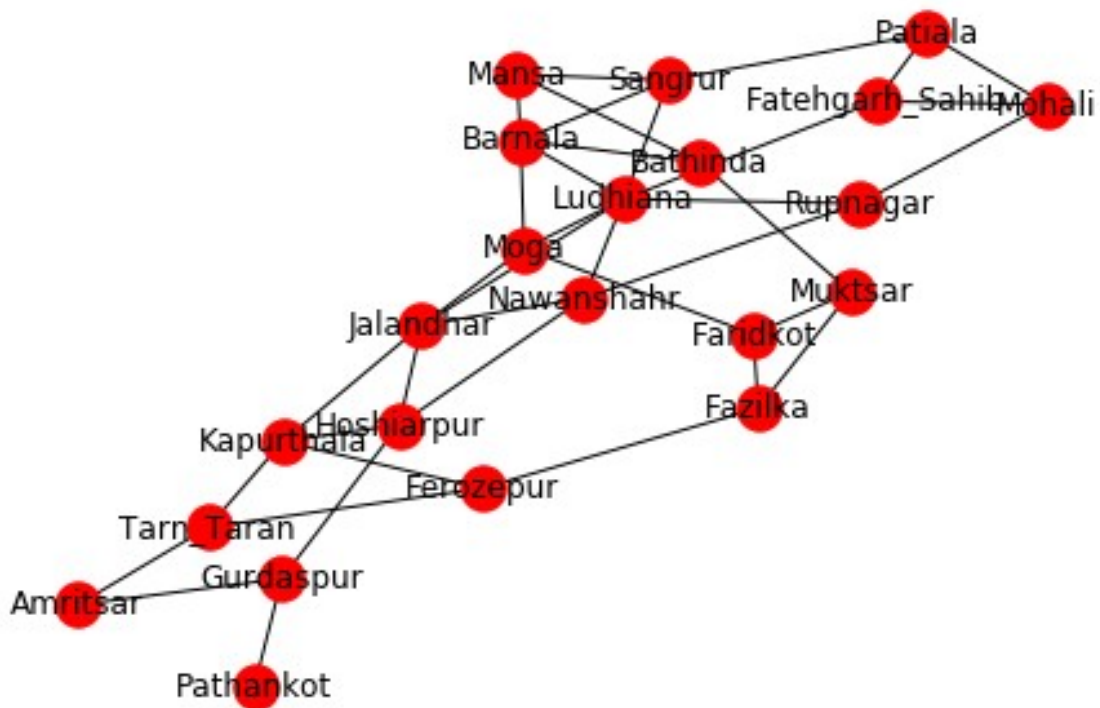
Most prominent district in is angul.

Betweenness centrality of all districts of are :

angul 99.5
balangir 0
balasore 0
bargarh 0
bhadra 0
boudh 16
cuttack 0
deogarh 0
dhenkanal 0
gajapati 18
ganjam 0
jagatsinghpur 0
jajpur 0
jharsuguda 0
kandhamal 54
kalahandi 70.5

kendrapara 0
 kendujhar 18.5
 khorda 18
 koraput 19.5
 malkangiri 0
 mayurbhanj 0
 nabarangpur 9
 nayagarh 34
 nuapada 0
 puri 0
 rayagada 53
 sambalpur 18
 subarnapur 0
 sundargarh 0

Punjab :

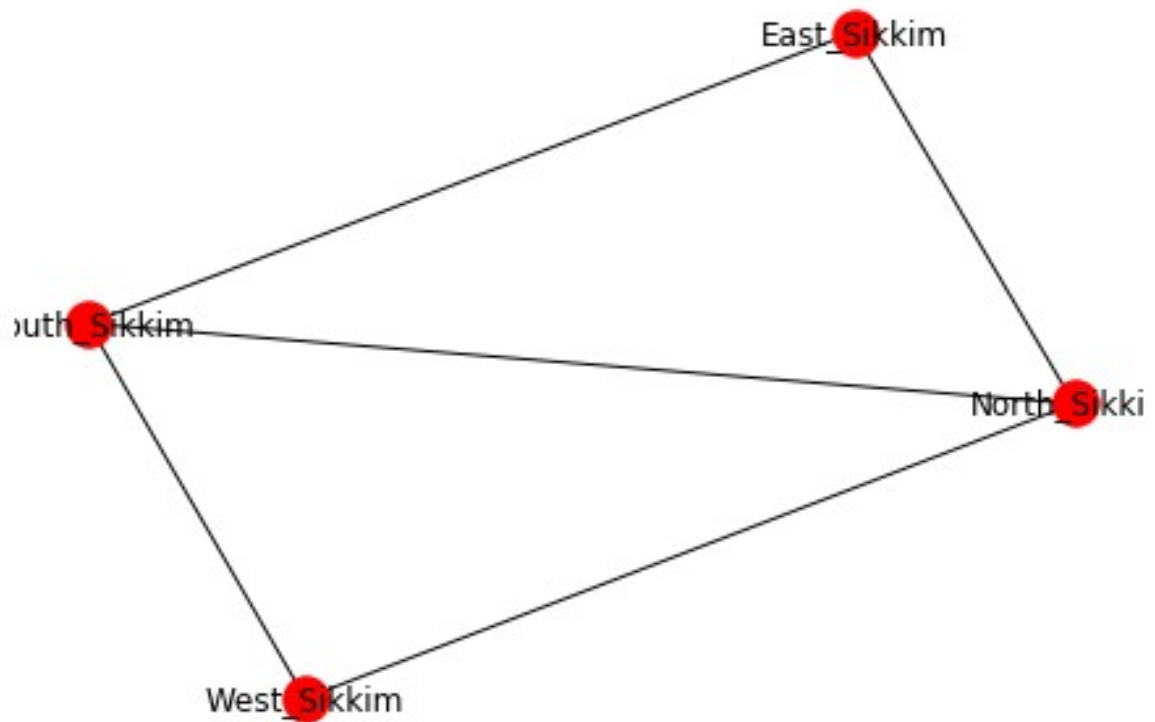


Most prominent district in is Ludhiana.

Betweenness centrality of all disticts of are :

Amritsar 4.66667
Barnala 24.8389
Bathinda 11.0111
Faridkot 14.0167
Fatehgarh_Sahib 9.32857
Fazilka 15.0278
Ferozepur 17.0278
Gurdaspur 28.8698
Hoshiarpur 42.7032
Jalandhar 51.2048
Kapurthala 29.9357
Ludhiana 70.0738
Mansa 2.86667
Moga 31.2389
Muktsar 9.84444
Nawanshahr 23.6841
Pathankot 0
Patiala 4
Rupnagar 11.9095
Mohali 2.57619
Sangrur 17.3786
Tarn_Taran 11.7968

Sikkim :

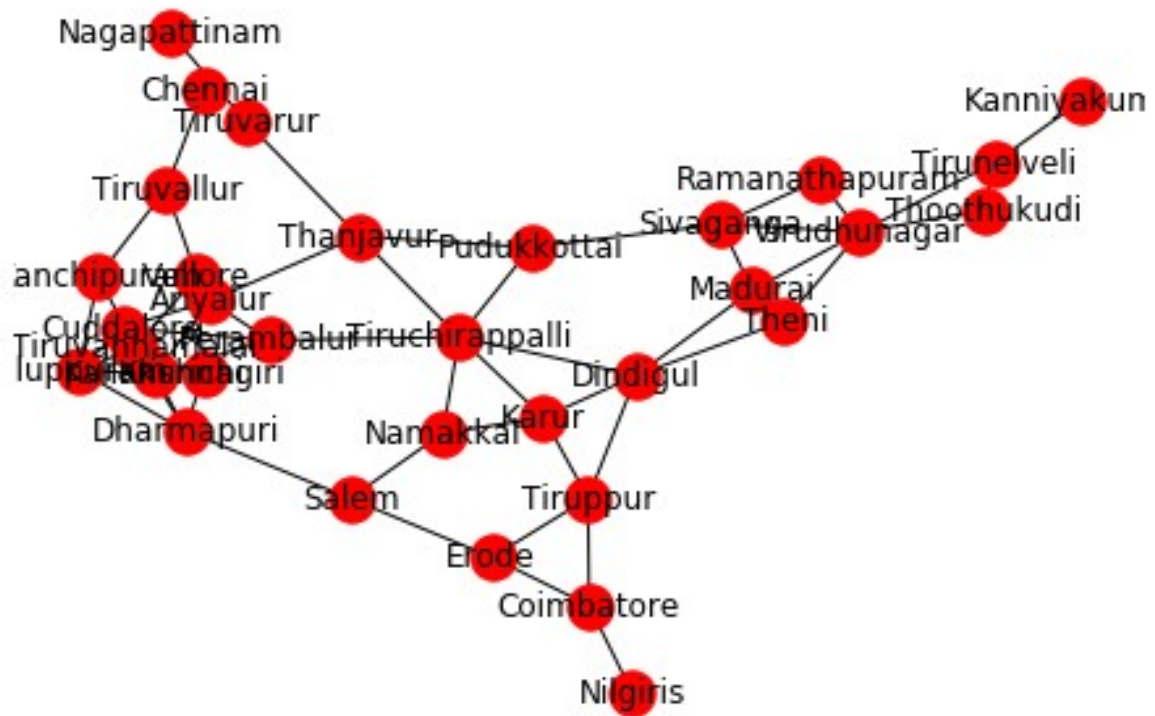


Most prominent district in is North_Sikkim.

Betweenness centrality of all districts of are :

East_Sikkim 0
North_Sikkim 0.5
South_Sikkim 0.5
West_Sikkim 0

Tamil Nadu :



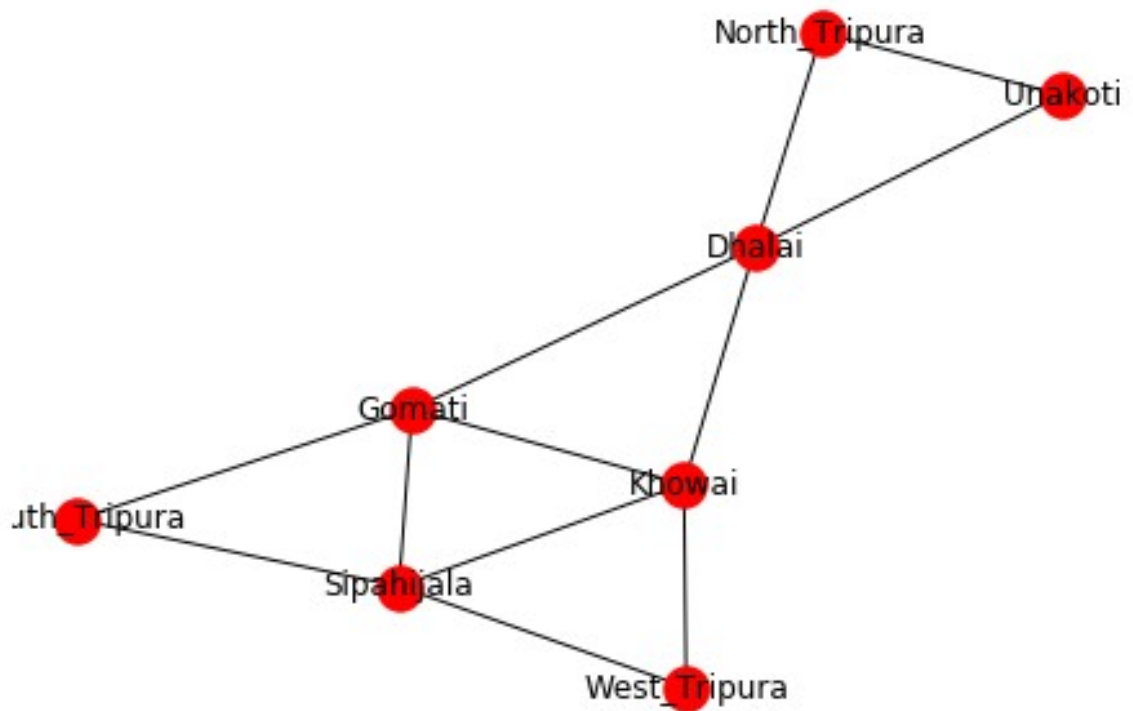
Most prominent district in is Tiruchirappalli.

Betweenness centrality of all districts of are :

Ariyalur 54.2273
 Chennai 0
 Coimbatore 31
 Cuddalore 22.1167
 Dharmapuri 76.8833
 Dindigul 121.08
 Erode 36.8307
 Kallakurichi 103.042
 Kanchipuram 38.5833
 Kanniyakumari 0
 Karur 23.7474
 Krishnagiri 7.58333
 Madurai 39.0567
 Nagapattinam 0
 Namakkal 29.8102

Nilgiris 0
Perambalur 88.0818
Pudukkottai 76.8032
Ramanathapuram 0
Salem 68.8909
Sivaganga 67.3866
Thanjavur 94.1939
Theni 30.8067
Thoothukudi 0
Tiruchirappalli 153.845
Tirunelveli 31
Tiruppur 54.5307
Tiruvallur 31.75
Tiruvannamalai 59.2333
Tiruvarur 31
Vellore 20.4167
Viluppuram 42.9333
Virudhunagar 93.1667

Tripura :

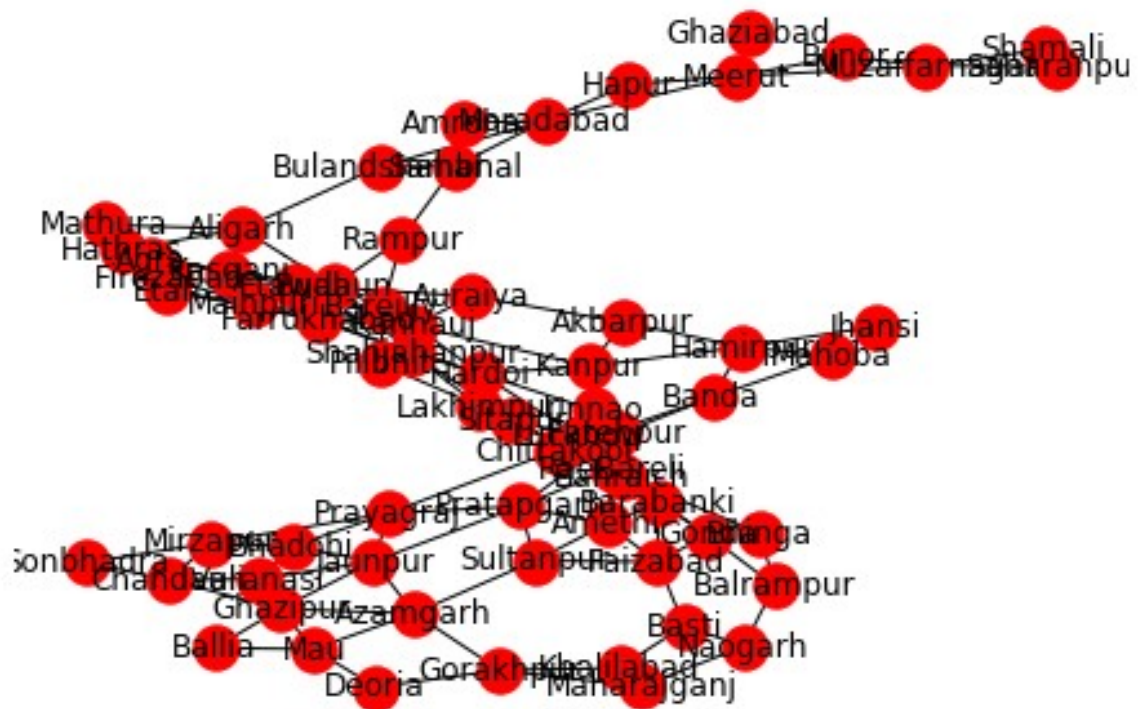


Most prominent district in is Dhalai.

Betweenness centrality of all districts of are :

Dhalai 10
Sipahijala 2
Khowai 5
Gomati 5
Unakoti 0
North_Tripura 0
South_Tripura 0
West_Tripura 0

Uttar Pradesh :



Most prominent distric in is Hardoi.

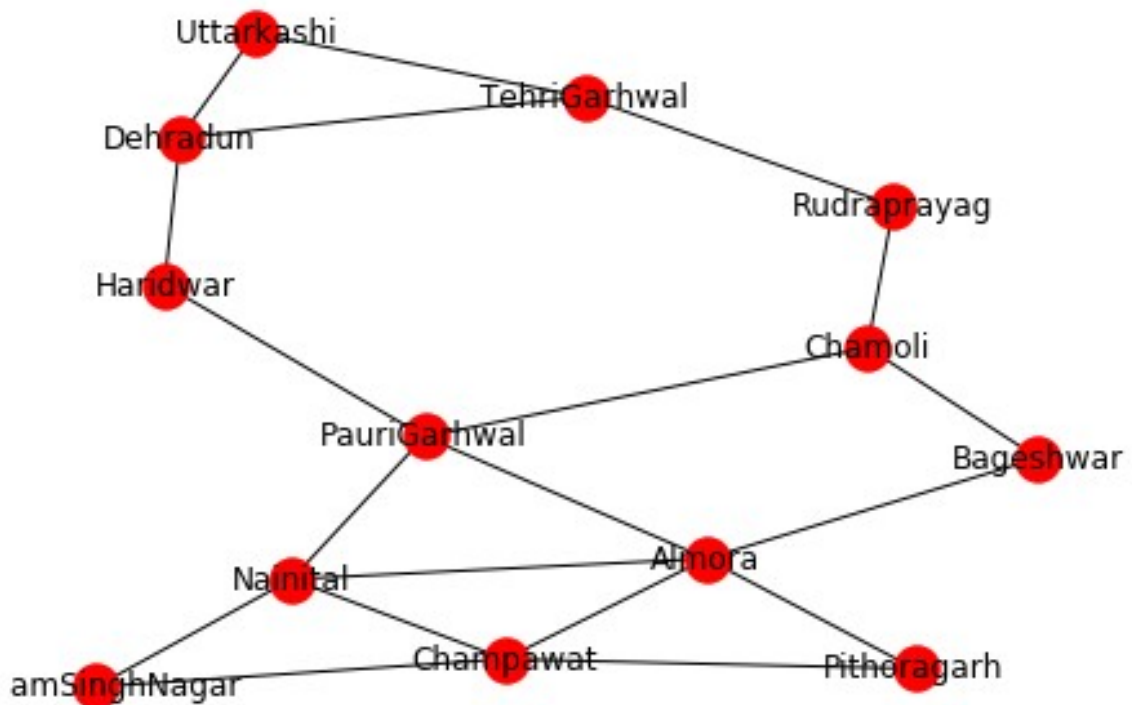
Betweenness centrality of all districts are :

Agra 63.1009
Aligarh 318.509
Akbarpur 22.0389
Amethi 70.0084
Amroha 0
Auraiya 19.2496
Azamgarh 206.883
Baghpat 0
Bahraich 213.1
Ballia 0
Balrampur 88.8292
Banda 66.3242
Barabanki 168.214
Bareilly 138.259
Basti 74.7173
Bhadohi 4.98571

Bhinga 46.2755
Bijnor 0
Budaun 422.198
Bulandshahar 251.023
Chandauli 18.8167
Chitrakoot 88.4162
Deoria 4.79286
Etah 52.8378
Etawah 89.4595
Faizabad 188.082
Farrukhabad 415.587
Fatehpur 443.422
Firozabad 1.24167
Gautam_Buddha_Nagar 0
Ghaziabad 0
Ghazipur 122.431
Gonda 160.683
Gorakhpur 91.1708
Hamirpur 108.821
Hapur 0
Hardoi 601.905
Hathras 43.3621
Jalaun 0
Jaunpur 283.482
Jhansi 0
Kannauj 271.912
Kanpur_Dehat 0
Kanpur 437.847
Kasganj 96.541
Kaushambi 0
Khalilabad 13.1738
Kushinagar 0
Lakhimpur 161.222
Lalitpur 0
Lucknow 286.165
Maharajganj 28.1787
Mahoba 9.98938
Mainpuri 34.9791
Mathura 18.9603
Mau 41.5245
Meerut 314
Mirzapur 75.9674

Moradabad 423.875
Muzaffarnagar 130
Naogarh 59.0251
Pilibhit 20.4384
Pratapgarh 497.98
Prayagraj 185.033
RaeBareli 253.998
Rampur 309.811
Saharanpur 0
Sambhal 273.786
Shahjahanpur 441.544
Shamali 0
Sitapur 142.103
Sonbhadra 0
Sultanpur 153.301
Unnao 187.502
Varanasi 13.9159

Uttarakhand :

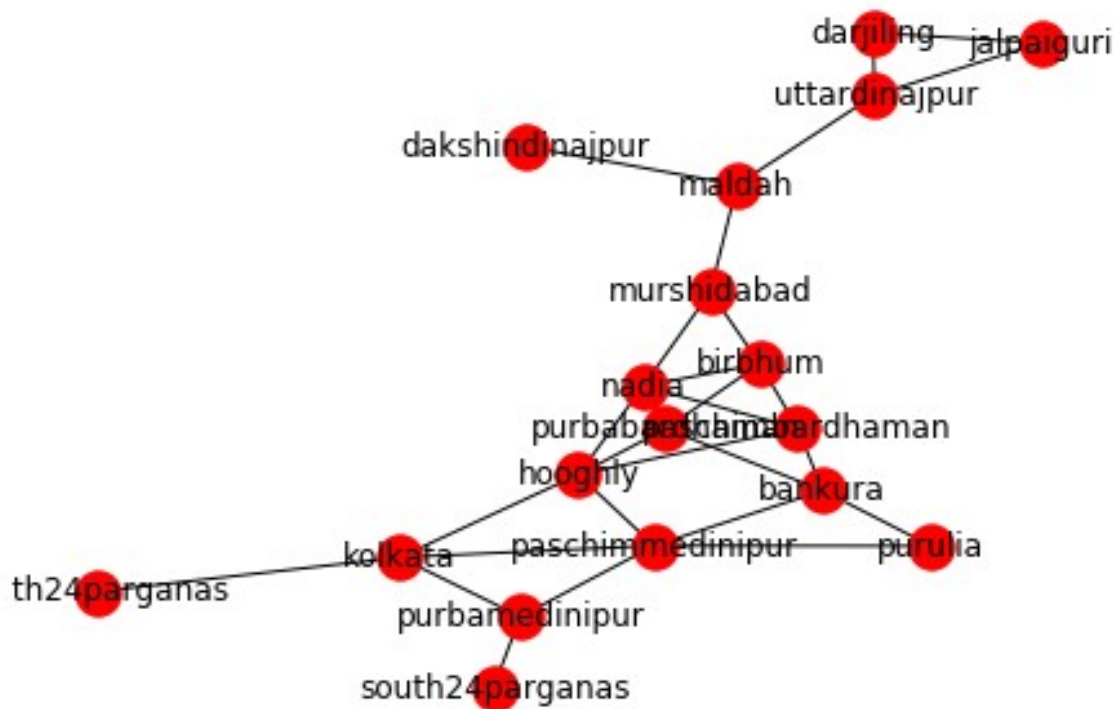


Most prominent distric in is PauriGarhwal.

Betweenness centrality of all disticts of are :

Almora 16.7667
Bageshwar 3.53333
Chamoli 14.6
Champawat 2.5
Dehradun 11.0667
Haridwar 15.7333
Nainital 11.0667
PauriGarhwal 30.1333
Pithoragarh 0
Rudraprayag 8.26667
TehriGarhwal 5.33333
UdhamSinghNagar 0
Uttarkashi 0

West bengal :



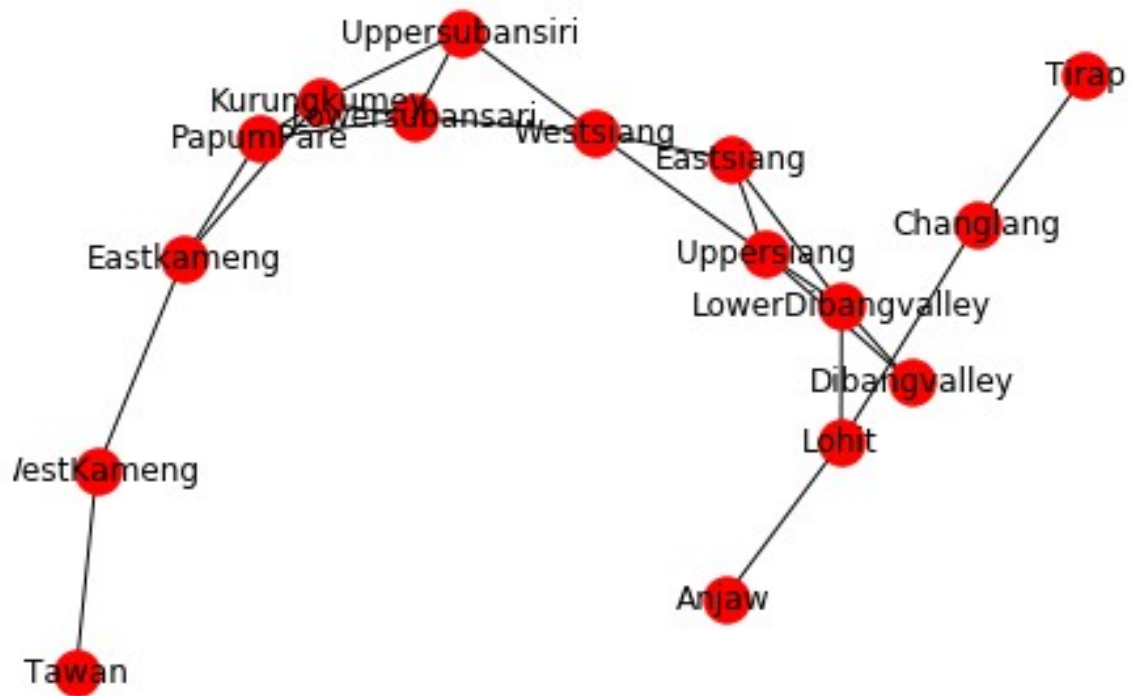
Most prominent distric in is murshidabad.

Betweenness centrality of all disticts of are :

alipurduar 41
bankura 11.15
paschimbardhaman 8.81667
purbabardhaman 8.81667
birbhum 9.75
coochbehar 0
darjeeling 0
uttardinajpur 0
dakshindinajpur 0
hooghly 43.35
hawrah 0
jalpaiguri 0
jhargram 0
kolkata 24.0833
kalimpong 0
malda 0

paschimmedinipur 21.5833
purbamedinipur 15
murshidabad 48
nadia 42.45
north24parganas 0
south24parganas 0
purulia 0

Arunachal Pradesh :

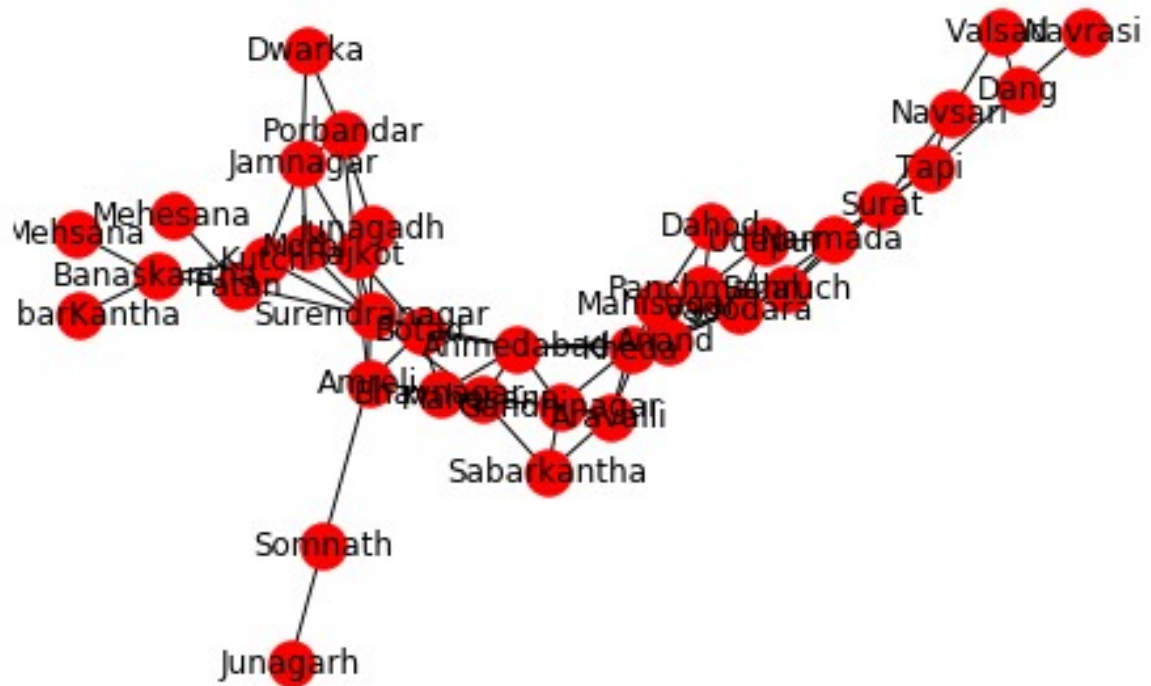


Most prominent distric in Andhra_Pradesh is Prakasam.

Betweenness centrality of all disticts of Andhra_Pradesh are :

Chittoor 0.5
Anantapur 0
Kadapa 5.5
Nellore 4.5
Prakasam 40.5
Kurnool 0
Guntur 36
Krishna 0
West-Godavari 32
East-Godavari 27
Visakhapatnam 0
Vizianagaram 11
Srikakulam 0

Gujrat :



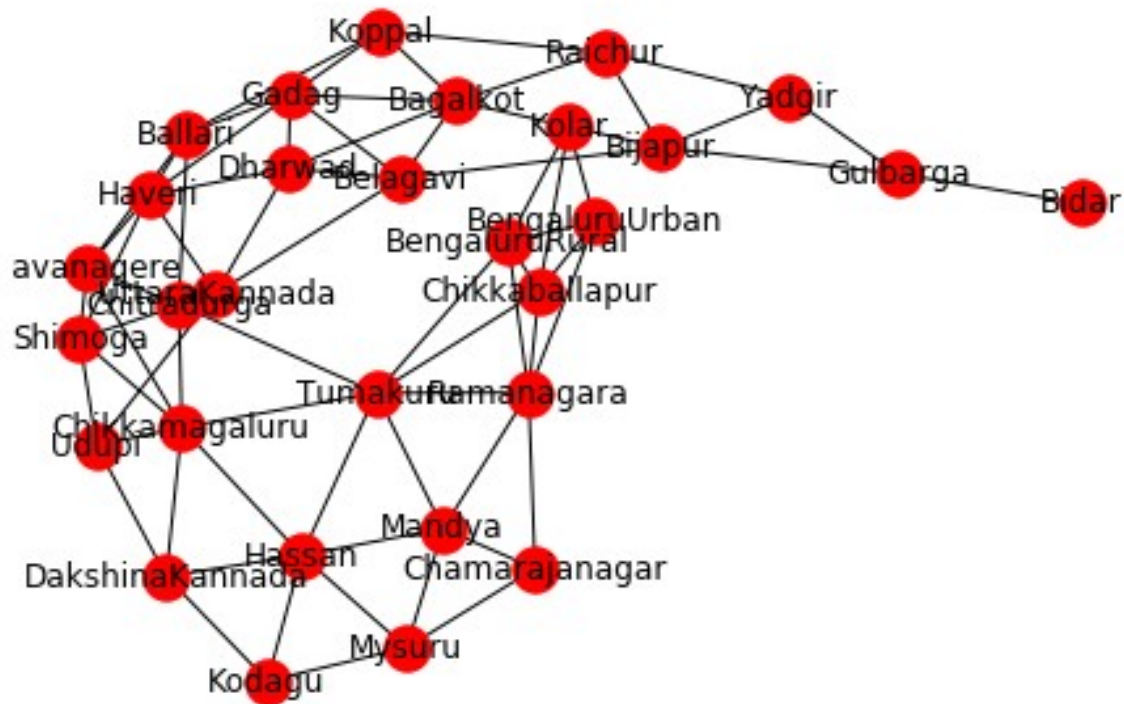
Most prominent district in is Ahmedabad.

Betweenness centrality of all districts of are :

Ahmedabad 290.233
Amreli 13.7738
Anand 0
Aravalli 3.56667
Banaskantha 28
Bharuch 0
Bhavnagar 8.90238
Botad 19.3881
Udaipur 12.75
Dahod 0.95
Dangs 0
Dwarka 0
Gandhinagar 7.11667
Somnath 8.90238
Jamnagar 56.5714

Junagadh 1.41667
Kachchh 0
Kheda 51.2
Mahisagar 7.81667
Mehsana 0
Morbi 0.583333
Narmada 20.75
Navsari 1
Panchmahal 10.8833
Patan 1.75
Porbandar 6.11905
Rajkot 20.0571
Sabarkantha 6.58333
Surat 9.3
Surendranagar 14.6857
Tapi 9.3
Vadodara 30
Valsad 7.4

Karnataka :



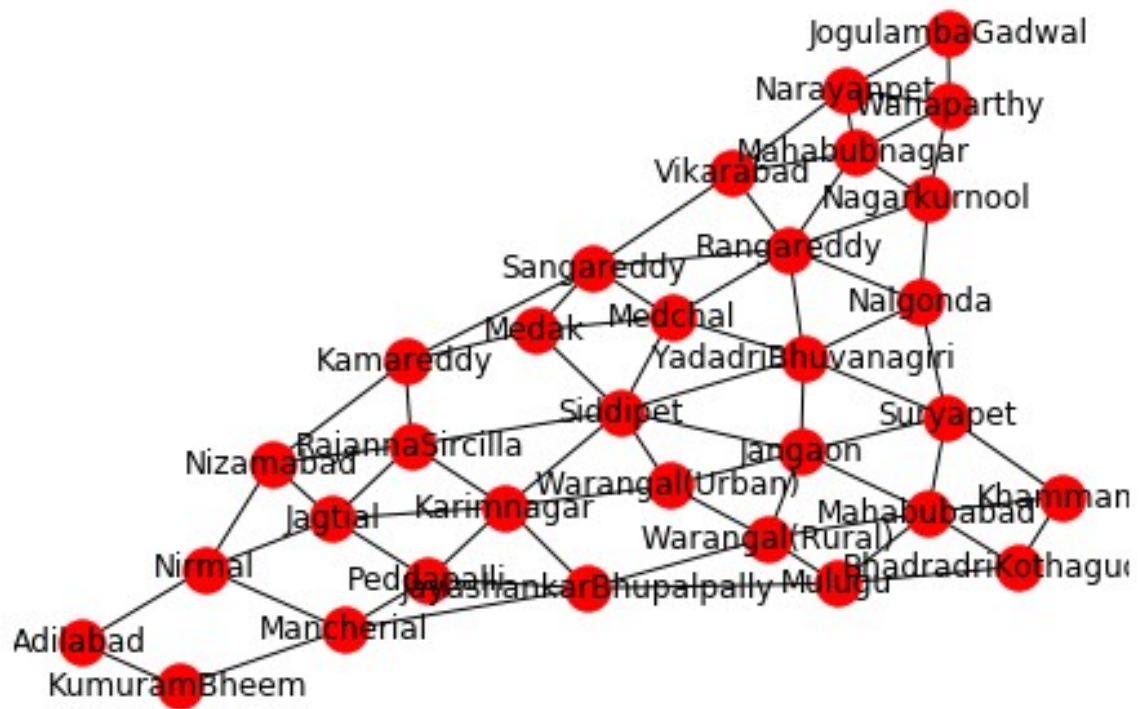
Most prominent district in is Tumakuru.

Betweenness centrality of all districts of are :

Bagalkot 23.8458
Belagavi 57.1955
BengaluruUrban 1.06667
BengaluruRural 19.5024
Ballari 93.8935
Bidar 0
Bijapur 58.5856
Chamarajanagar 2.21667
Chikmagalur 89.1144
Chikkaballapur 19.5024
Chitradurga 88.1013
Dakshinakannada 22.9055
Davanagere 20.7938
Dharwad 9.61821
Gadag 29.5644

Gulbarga 28
Haveri 21.2928
Hassan 40.43
Kolar 0
Koppal 48.0689
Kodagu 3.30689
Mandya 16.6186
Mysuru 6.26471
Ramanagara 24.1131
Raichur 25.1006
Shimoga 29.7439
Tumakuru 137.387
Udupi 45.4024
UttaraKannada 67.6121
Yadgir 4.75325

Telangana :



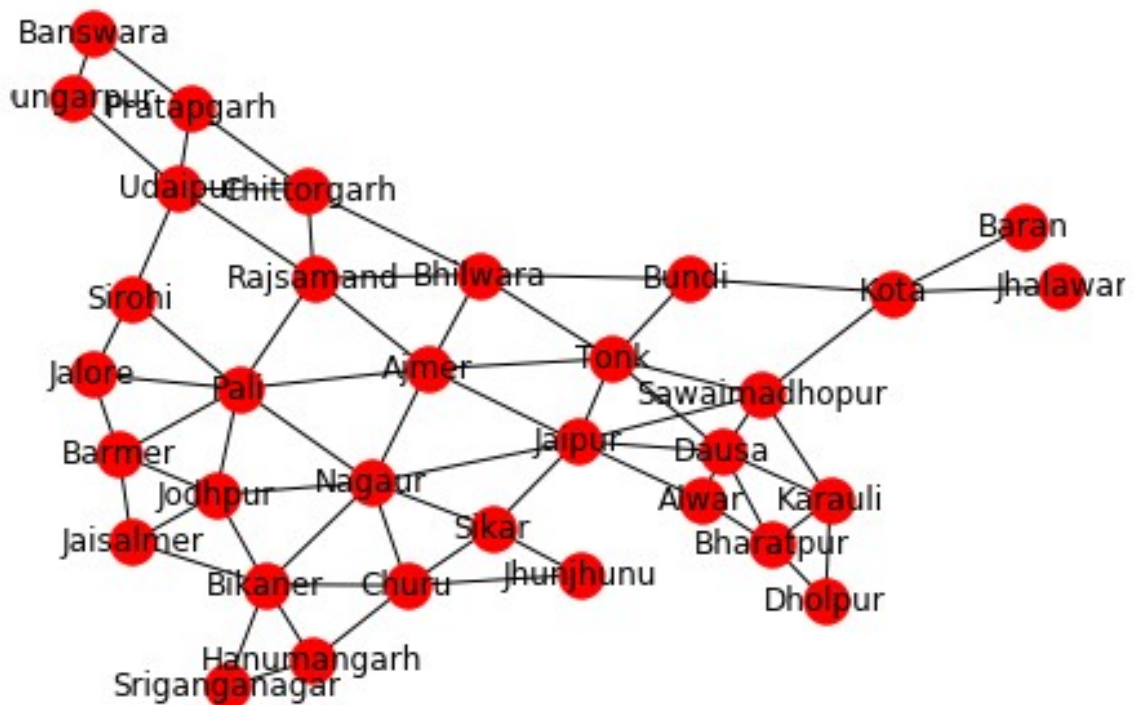
Most prominent district is Siddipet.

Betweenness centrality of all districts are :

Adilabad 4.97772
Bhadrachalam 2.74444
Hyderabad 0
Jagtial 18.939
Jangaon 51.4942
JayashankarBhupalpally 56.5489
JogulambaGadwal 0
Kamareddy 55.3679
Karimnagar 62.38
Khammam 5.04048
KumuramBheem 4.23077
Mahabubabad 38.7007
Mahabubnagar 20.1409
Mancherial 39.3088
Medak 9.82195
Medchal 26.2155

Mulugu 20.8772
Nagarkurnool 29.2406
Nalgonda 36.6039
Narayanpet 18.5835
Nirmal 42.5187
Nizamabad 42.8986
Peddapalli 11.9435
RajannaSircilla 33.8166
Rangareddy 82.0952
Sangareddy 61.6053
Siddipet 99.3417
Suryapet 47.0157
Vikarabad 38.4427
Wanaparthi 14.1399
Warangal(Rural) 26.8981
Warangal(Urban) 8.23645
YadadriBhuvanagiri 71.8309

Rajasthan :



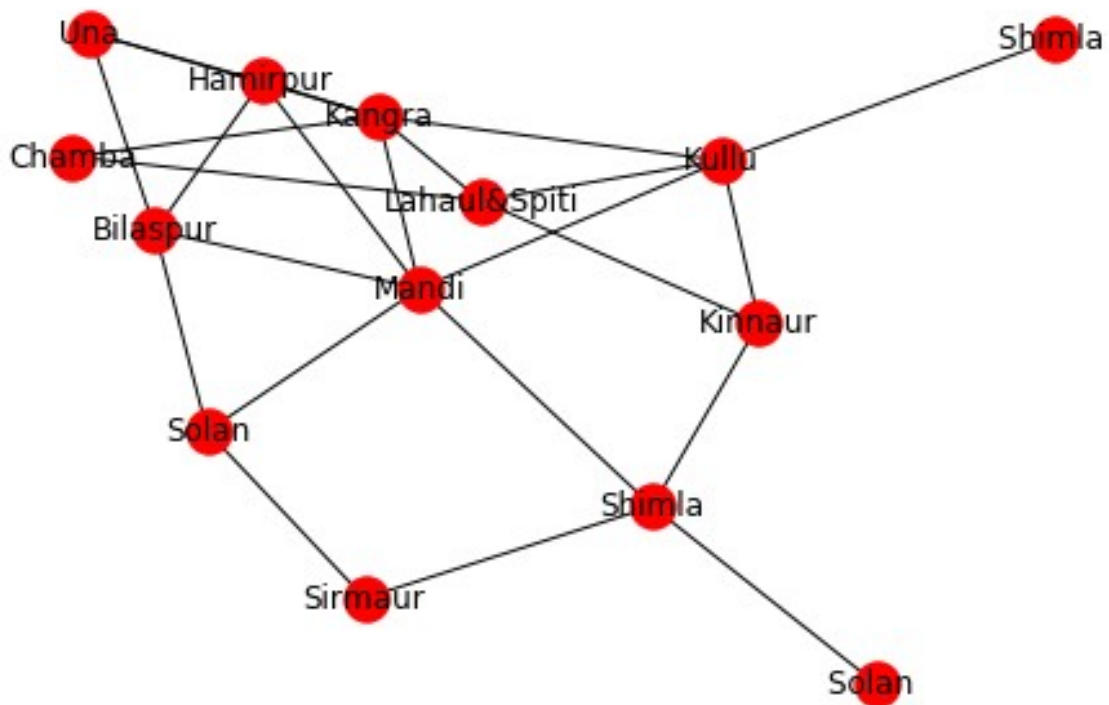
Most prominent district in is Jaipur.

Betweenness centrality of all districts of are :

Ajmer 85.7593
Alwar 11.2541
Banswara 0.5
Baran 0
Barmer 8.42143
Bharatpur 12.3448
Bhilwara 70.0252
Bikaner 53.9254
Bundi 30.1607
Chittorgarh 43.4622
Churu 25.3481
Dausa 48.0767
Dholpur 0
Dungarpur 6.41408
Hanumangarh 1.33333
Jaipur 136.95

Jaisalmer 2.61667
Jalore 2.74524
Jhalawar 0
Jhunjhunu 0
Jodhpur 26.6841
Karauli 20.1552
Kota 62.0833
Nagaur 133.484
Pali 100.143
Pratapgarh 23.5859
Rajsamand 66.5234
Sawaimadhopur 72.9586
Sikar 28.9861
Sirohi 20.0511
Sriganganagar 0
Tonk 61.4675
Udaipur 54.5411

Himachal Pradesh :

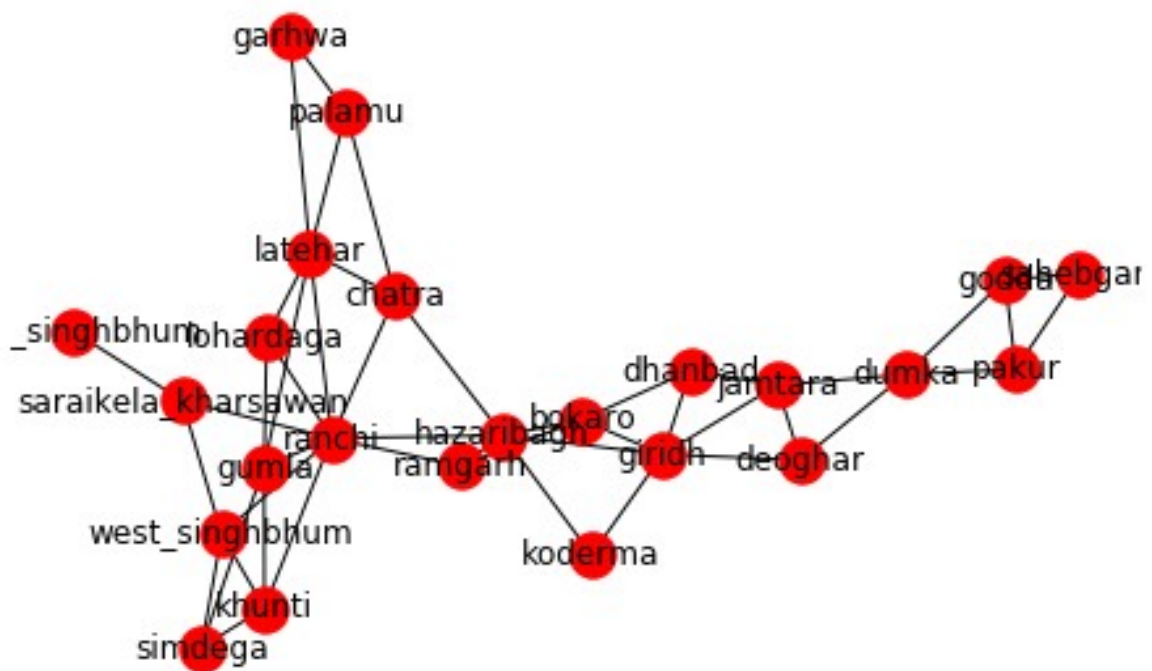


Most prominent district in is Kangra.

Betweenness centrality of all districts are :

Bilaspur 3.56667
Chamba 0
Hamirpur 1.45
Kangra 13.83333
Kinnaur 1.7
Kullu 6.51667
Lahaul&Spiti 3.65
Mandi 11.9167
Shimla 8.71667
Sirmaur 0
Solan 4.73333
Una 0.916667

Jharkhand :



Most prominent district in is Ranchi.

Betweenness centrality of all districts are :

garhwa 0
palamu 4.03571
latehar 24.2143
chatra 26.3048
hazaribagh 117.674
koderma 0
giridih 100.029
ramgarh 7.59286
bokaro 13.0714
dhanbad 2.96667
gumla 10.6667
lohardaga 0
simdega 0.333333
ranchi 120.112
khunti 4.91667
west_singhbhum 7.58333
saraikela_kharsawan 22
east_singhbhum 0
jamtara 39.5667
deoghar 32.9333
dumka 60
pakur 10.5
godda 10.5
sahebganj 0

Conclusion

The conclusion which can be derived from this project are :

1. Betweenness Centrality can be considered as very good measure of importance of a district if we consider distances as a prominent factor.
2. In a graph if we remove a node and the shortest distance between all other pair of nodes is not effected than Betweenness centrality of that node is zero.
3. If number of nodes in graph is less than three then the Betweenness centrality of all nodes are zero. That is we need atleast three nodes to calculate Betweenness of nodes.

References

1. [google.com](https://www.google.com)
2. [wikkipedia.com](https://www.wikipedia.com)
3. [googlemaps.com](https://www.googlemaps.com)
4. [spyder-ide.com](https://www.spyder-ide.com)
5. Introduction to algorithms book.
6. [Geeksforgeeks.com](https://www.geeksforgeeks.com)