INFSCI 2725 Data Analytics

Assignment 8 – Social Network Analysis

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Student name: Ting LI

pittUserLogin: til42

Tutor name: Marek Druzdzel

1. Apply the HIS algorithm to the following network (No one correct answer)

Figure 1 is the original graph, and its adjacency matrix is illustrated below Figure 1. Figure 2 and Figure 3 illustrate the authority nodes and hub nodes based on node size respectively, and top 5 authority nodes and hub nodes are marked with red. We can see in Figure 2 that node 10 has the largest size, which is the authority with highest authority score. Although Figure 2 at the first glance seems to have the largest in-links of 4, however, it is not the authority belonging to top 5, which can be attributed to the fact that the nodes link to it are not important hubs. From Figure 3, we can see that node 12 is the most important hub.

Figure 1

```
       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13] [,14] [,15]
 [1,]    0    0    0    0    1    0    0    0    0     0     0     0     0     0     0
 [2,]    0    0    0    0    1    1    0    0    0     1     0     0     0     0     0
 [3,]    0    0    0    0    0    0    0    0    0     0     0     0     0     0     0
 [4,]    0    0    0    0    0    0    1    1    1     0     0     0     0     0     0
 [5,]    0    0    0    0    0    0    0    1    0     1     0     0     0     0     0
 [6,]    1    1    0    0    0    0    1    0    0     0     0     0     0     0     0
 [7,]    0    0    1    0    0    0    0    0    0     0     0     0     0     0     0
 [8,]    0    0    0    0    0    0    0    0    0     0     0     0     0     0     0
 [9,]    0    0    0    0    0    0    0    0    0     0     0     0     0     0     0
[10,]    0    0    0    0    0    0    0    0    0     0     0     0     0     0     0
[11,]    0    1    0    0    0    0    0    0    0     0     0     0     0     0     0
[12,]    1    0    0    0    0    0    0    0    0     1     0     0     1     0     0
[13,]    0    0    1    0    0    0    0    0    0     0     0     0     0     0     0
[14,]    0    0    1    0    0    0    0    0    0     0     0     0     0     0     0
[15,]    0    0    1    1    0    0    0    0    1     0     0     0     0     0     0
```
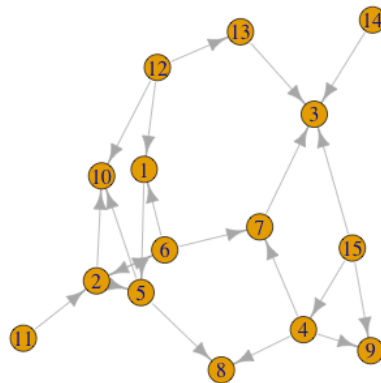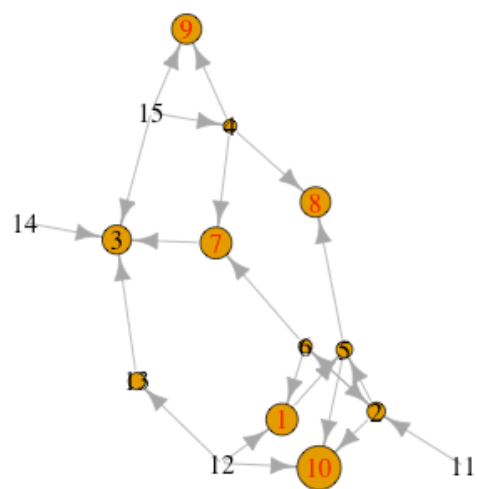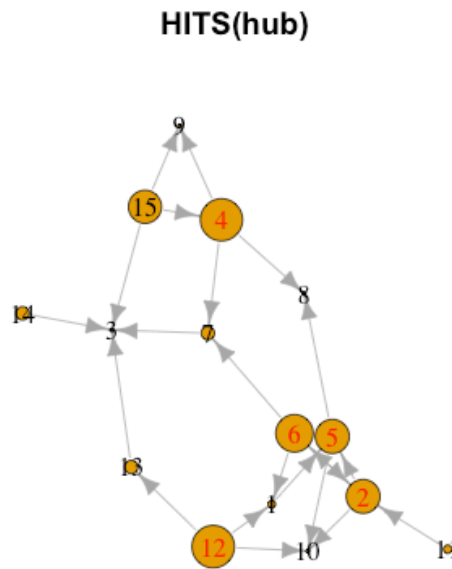
Adjacency Matrix

HITS(authority)

Figure 2

HITS(hub)

Figure 3

2. Find the Hubs and Authorities of the graphs below given by HITS. Are the results consistent with the notions of Hubs and Authorities?

Answer:

For the Figure 4, its adjacency matrix is illustrated in its right side.

The authority score for five nodes are:

1.000000 0.618034 0.000000 0.000000 0.000000

The hub score for five nodes are:

0.381966 0.000000 1.000000 0.618034 0.618034

We can see that node 1 with highest score 1 is authority and node 3 is hub, conforming to the idea that a good hub points to good authorities and a good authority is pointed to by a good hub. Moreover, looking at figure 1, we can see that node 1 has the highest in-links and node 3 has the highest out-links, which are consistent with the notions of Hubs and Authorities.
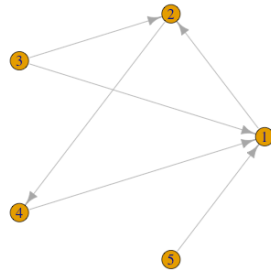
3

```
     [,1] [,2] [,3] [,4] [,5]
[1,]    0    1    0    0    0
[2,]    0    0    0    1    0
[3,]    1    1    0    0    0
[4,]    1    0    0    0    0
[5,]    1    0    0    0    0
```
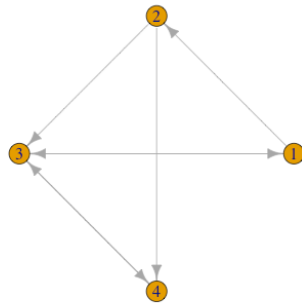
Adjacency Matrix for Figure 4

Figure 4


```
     [,1] [,2] [,3] [,4]
[1,]    0    1    1    0
[2,]    0    0    1    1
[3,]    1    0    0    1
[4,]    0    0    1    0
```

Figure 5   Adjacency Matrix for Figure 5

For above Figure 5, its adjacency matrix is illustrated in its right side.

The authority score for four nodes are:

0.2090569 0.3382612 1.0000000 0.6180340

The hub score for four nodes are:

0.8270909 1.0000000 0.5111703 0.6180340

We can see that node 3 with highest score 1 is authority and node 2 is hub. We can observe from Figure 5 that node 3 has the highest in-links and node 2 has the highest out-links, which also are consistent with the notions of Hubs and Authorities.

R Code

```
library(igraph)
A<-matrix(c(0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,
        0,0,0,0,1,1,0,0,0,1,0,0,0,0,0,
        0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
        0,0,0,0,0,0,1,1,1,0,0,0,0,0,0,
        0,0,0,0,0,0,0,1,0,1,0,0,0,0,0,
        1,1,0,0,0,0,1,0,0,0,0,0,0,0,0,
        0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,
        0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
        0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
        0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
        0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,
        1,0,0,0,0,0,0,0,0,1,0,0,1,0,0,
        0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,
        0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,
        0,0,1,1,0,0,0,0,1,0,0,0,0,0,0),
        nrow=15,ncol=15,byrow=TRUE);

#Get a directed unweighted graph from adjacency matrix
G<-graph.adjacency(A,mode=c("directed"),weighted=NULL);
plot(G)

aut1 = authority.score(G)$vector
hub1 = hub.score(G)$vector
top = order(aut1,decreasing = T)[1:5]
```

```
V(G)$size=abs(aut1)*20
V(G)$label.color="black"
V(G)[top]$label.color="red"
set.seed(1)
plot(G)
title("HITS(authority)")


top1 = order(hub1,decreasing = T)[1:5]
V(G)$size=abs(hub1)*20
V(G)$label.color="black"
V(G)[top1]$label.color="red"
set.seed(1)
plot(G)
title("HITS(hub)")


B<-matrix(c(0,1,0,0,0,
        0,0,0,1,0,
        1,1,0,0,0,
        1,0,0,0,0,
        1,0,0,0,0),
        nrow=5,ncol=5,byrow=TRUE);
G1<-graph.adjacency(B,mode=c("directed"),weighted=NULL);
plot(G1,layout=layout.circle)
aut2 = authority.score(G1)$vector
hub2 = hub.score(G1)$vector


C<-matrix(c(0,1,1,0,
        0,0,1,1,
        1,0,0,1,
        0,0,1,0),
        nrow=4,ncol=4,byrow=TRUE);
```

```
G2<-graph.adjacency(C,mode=c("directed"),weighted=NULL);
plot(G2)
aut3 = authority.score(G2)$vector
hub3 = hub.score(G2)$vector
```