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Report of Homework 2

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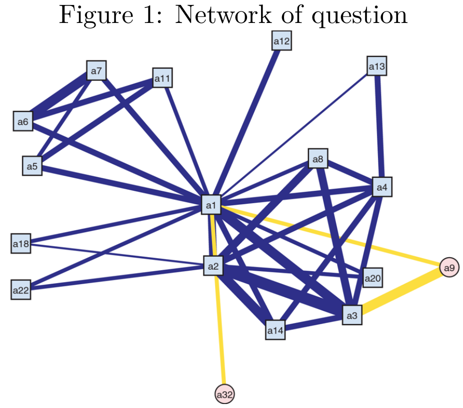
1 Question

First, construct a network data set for the graph in the next slide Then, create an approximately similar graph based on your network data set Finally, using degree centrality to adjust the size of nodes appropriately

Figure 1: Network of question



1.1 Theory

The create a readable and effective graph. There are a lot of way to change the graph. The first question we need to consider is that what type of graph is effective? An effective network graph should illustrate the essential information of the network. There are a guidelines that can help people create a effective graph.

- Minimize edge crossings

- Minimize the variability of the edge lengths
- Minimize the variability of the edge lengths
- Maximize the angle between edges when they cross or join nodes
- Minimize the total space used for the network display

There are a lot of algorithms that can automatic help us such as ”Force-directed algorithms”,”Springs”,”Equilibrium”,” Reingold algorithm” etc.
Also, we can change the type or color of node and edge or define the width of edge. By using this method, we can also achieve the goal of making network graph effective. And use the method of centrality, closeness, betweenness to change the size of node.

1.2 Result

1.2.1 Define Network

First thing is to define the network. I use the link list to show the graph. I define the node name and set it to undirect graph. The link list of the network is

$$\{a1\} \rightarrow \left\{\begin{matrix} a2 & a3 & a4 & a5 & a6 & a7 & a8 & a9 & a11 & a12 \\ a13 & a14 & a18 & a20 & a22 & a32 & & & & \end{matrix}\right\}$$
$$\{a2\} \rightarrow \{a1 \quad a3 \quad a4 \quad a8 \quad a14 \quad a18 \quad a20 \quad a22\}$$
$$\{a3\} \rightarrow \{a1 \quad a2 \quad a4 \quad a8 \quad a9 \quad a14\}$$
$$\{a4\} \rightarrow \{a1 \quad a2 \quad a3 \quad a8 \quad a13 \quad a14\}$$
$$\{a5\} \rightarrow \{a1 \quad a7 \quad a11\}$$
$$\{a6\} \rightarrow \{a1 \quad a7 \quad a11\}$$
$$\{a7\} \rightarrow \{a1 \quad a5 \quad a6\}$$
$$\{a8\} \rightarrow \{a1 \quad a2 \quad a3 \quad a4\}$$
$$\{a9\} \rightarrow \{a1 \quad a3\}$$
$$\{a11\} \rightarrow \{a1 \quad a5 \quad a6\}$$
$$\{a12\} \rightarrow \{a1\}$$
$$\{a13\} \rightarrow \{a1 \quad a4\}$$
$$\{a14\} \rightarrow \{a1 \quad a2 \quad a3 \quad a4\}$$
$$\{a18\} \rightarrow \{a1 \quad a2\}$$
$$\{a20\} \rightarrow \{a1 \quad a2\}$$
$$\{a22\} \rightarrow \{a1 \quad a2\}$$
$$\{a32\} \rightarrow \{a1\}$$

1.2.2 Define edge width

The next step is to define the edge width. Depend of the problem graph and the order of each edge. The define was show in the table 1.

1.2.3 Define edge color

After defining the edge width,from the table 1. I define the color of edge. Notice that most of edge is navy(blue) color but for the edge[8,16,26], their color is different. I set it to yellow.

Table 1: P value of Filing and Prevailing Compensation

node	node	edge width	color
a1	a2	10	navy
a1	a3	12	navy
a1	a4	8	navy
a1	a5	8	navy
a1	a6	8	navy
a1	a7	8	navy
a1	a8	6	navy
a1	a9	6	yellow
a1	a11	6	navy
a1	a12	8	navy
a1	a13	4	navy
a1	a14	8	navy
a1	a18	6	navy
a1	a20	6	navy
a1	a22	6	navy
a1	a32	6	yellow
a2	a3	14	navy
a2	a4	8	navy
a2	a8	10	navy
a2	a14	12	navy
a2	a18	4	navy
a2	a20	6	navy
a2	a22	6	navy
a3	a4	8	navy
a3	a8	10	navy
a3	a9	12	yellow
a3	a14	8	navy
a4	a8	8	navy
a4	a13	8	navy
a4	a14	8	navy
a5	a7	6	navy
a5	a11	8	navy
a6	a7	12	navy
a6	a10	8	navy

1.2.4 Define Node color

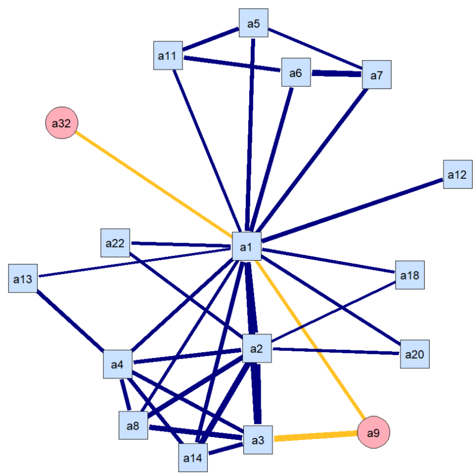
Can be seen that there are two node which they are different color. so I set a9 and a32 node to be light-pink to classify from the mainly part.

1.2.5 Define the node type

They are two type of node shape. One is square and one is circle. So it is easy to define the shape of node.

After all this definition of network. It finally create a graph which is similar to the problem graph.

Figure 2: Network of definition

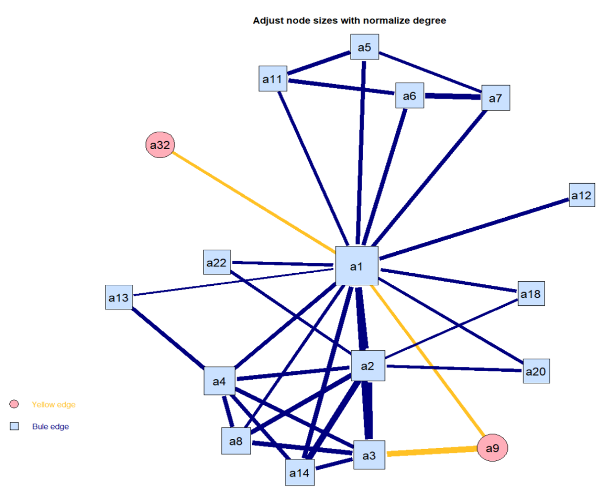


1.2.6 Adjust the size of node

Also, we can adjust the size of node by the degree of node. Before setting the degree, we need to normalize the degree and adjust it in order to create a appropriate result. The adjust node size is

$$nodesize = standardnormal(degree)^2 + 3$$

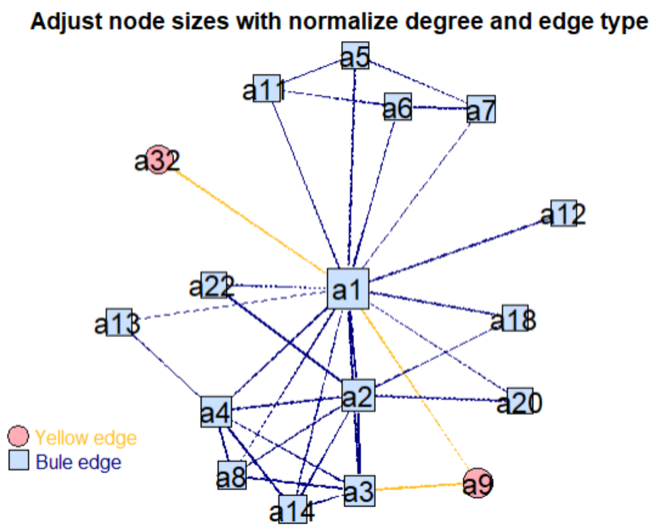
Figure 3: Network of after adjusting the node size by degree



1.2.7 Adjust the shape of edge

Also, we can adjust the shape of edge. It have a lot kind of shape like solid, dashed, dotted or dotdashed.

Figure 4: Network of after adjusting the edge shape



2 Appendix

```
#define network
library(statnet)
netmat<- rbind(
  c(1,2),
  c(1,3),
  c(1,4),
  c(1,5),
  c(1,6),
  c(1,7),
  c(1,8),
  c(1,9),
  c(1,10),
  c(1,11),
  c(1,12),
  c(1,13),
  c(1,14),
  c(1,15),
  c(1,16),
  c(1,17),
  c(2,3),
  c(2,4),
```

```
  c(2,8),
  c(2,13),
  c(2,14),
  c(2,15),
  c(2,16),
  c(3,4),
  c(3,8),
  c(3,9),
  c(3,13),
  c(4,8),
  c(4,12),
  c(4,13),
  c(5,7),
  c(5,10),
  c(6,7),
  c(6,10)
)
net<-network(netmat,matrix.type='edgelist',direct=F)
network.vertex.names(net)<-c("a1","a2","a3","a4","a5",
    "a6","a7","a8","a9","a11","a12","a13","a14",
        "a18","a20","a22","a32")
summary(net)

#edge with(define)
edge_width<-c(10,12,8,8,8,8,6,6,6,8,4,
    8,6,6,6,6,14,8,10,12,4,6,6,
    8,10,12,8,8,8,8,6,8,12,8)
edge_width<-edge_width

#test
gplot(net,vertex.cex=2,gmode="graph",
  vertex.col="lightblue",
  edge.lwd=edge_width,
  displaylabels=TRUE,label.pos=5,pad=0.4,label.col="black")

  #edge color(define)
n_edge<-network.edgecount(net)
ecolor<-c()
ecolor[1:n_edge]<-"navy"
ecolor[8]<-"goldenrod1"
ecolor[16]<-"goldenrod1"
ecolor[26]<-"goldenrod1"

#test
op <- par(mar = c(0,0,0,0))
gplot(net,vertex.cex=2,gmode="graph",
  vertex.col="lightblue",
  edge.lwd=edge_width,edge.col=ecolor,
```

```
  displaylabels=TRUE,label.pos=5,pad=0.4,label.col="black")
par(op)

#node color
vcolor<-c()
vcolor[1:17]<-c("lightsteelblue1")
vcolor[9]<-"lightpink1"
vcolor[17]<-"lightpink1"

#test
op <- par(mar = c(0,0,0,0))
gplot(net,gmode="graph",
  vertex.col=vcolor,vertex.cex=2,
  edge.lwd=edge_width,edge.col=ecolor,
  displaylabels=TRUE,label.pos=5,pad=0.2,label.cex=0.75,label.col="black")
par(op)

#node shape
vshape<-c()
vshape[1:17]<-4
vshape[9]<-20
vshape[17]<- 20

#question 2 complete
set.seed(123)
op <- par(mar = c(0,0,0,0))
plot(net,
  vertex.col=vcolor,vertex.cex=3.5,
  vertex.sides = as.integer(vshape),vertex.rot =45,
  edge.lwd=edge_width,edge.col=ecolor,
  displaylabels=TRUE,label.pos=5,pad=0.2,
  label.cex=1.5,label.col="black", mode='fruchtermanreingold')
par(op)


#question 3(1)
# adjust the size of node
#detach("package:igraph", unload=TRUE)
#library(statnet)
deg=degree(net,gmode='graph')
deg
normal_deg=(deg-min(deg))/(max(deg)-min(deg))
normal_deg
set.seed(123)
op <- par(mar = c(0,0,1,0))
plot(net,
  vertex.col=vcolor,vertex.cex=(normal_deg)*2+3,
  vertex.sides = as.integer(vshape),vertex.rot =45,
```

```
  edge.lwd=edge_width,edge.col=ecolor ,
  displaylabels=T,label.pos=5,pad=0.1,
  label.cex=1.5,label.col="black",
  mode='fruchtermanreingold',main='Adjust node sizes with normalize degree')
legend("bottomleft",legend=c("Yellow edge","Bule edge"),
    col = "black", bty = "n", pch=c(21,22) ,
    pt.cex = 2.5,pt.bg= levels(as.factor(vcolor)),
    cex = 1, text.col=levels(as.factor(ecolor)),
    horiz = FALSE, inset =0.1)
```