# INFX 576: Problem Set 4 - Core/Periphery Structure*

*Suchitra Sundararaman*

*Due: Thursday, February 9, 2017*

**Collaborators: Avanti, Gos, Jay.**

**Instructions:**

Before beginning this assignment, please ensure you have access to R and RStudio.

1. Download the `problemset4.Rmd` file from Canvas. You will also need the data contained in `problemset4_data.Rdata` and the `block.fit` function we used in class.
2. Replace the "Insert Your Name Here" text in the `author:` field with your own full name. Any collaborators must be listed on the top of your assignment.
3. Be sure to include well-documented (e.g. commented) code chucks, figures and clearly written text chunk explanations as necessary. Any figures should be clearly labeled and appropriately referenced within the text.
4. Collaboration on problem sets is acceptable, and even encouraged, but each student must turn in an individual write-up in his or her own words and his or her own work. The names of all collaborators must be listed on each assignment. Do not copy-and-paste from other students' responses or code.
5. When you have completed the assignment and have **checked** that your code both runs in the Console and knits correctly when you click `Knit PDF`, rename the R Markdown file to `YourLastName_YourFirstName_ps4.Rmd`, knit a PDF and submit the PDF file on Canvas.

**Setup:**

In this problem set you will need, at minimum, the following R packages.

```
# Load standard libraries
library(statnet)
load("problemset4_data.Rdata")
load("block.fit.Rdata")
```

**Problem 1: Core/Periphery Structure**

In this problem we will use data from a famous series of studies by Bernard, Killworth, and Sailer[1] on the relationship between observed interaction and informants self-reports of interaction. The specific networks we will use here are from the "behavioral" side, meaning that the $i, j$ cell corresponds to the number of times $i$ and $j$ were *observed* to interact during the data collection period. All interaction is these studies is interpersonal; the study contexts are: (1) communication among radio operators (`bfham`), (2) face-to-face interactions among members of a fraterity (`bkfrat`), (3) face-to-face interactions in a university research group (`bktec`), and (4) face-to-face interactions in a small business (`bkoff`). Here we investigate the possibility of latent two-class structure in these interation networks.

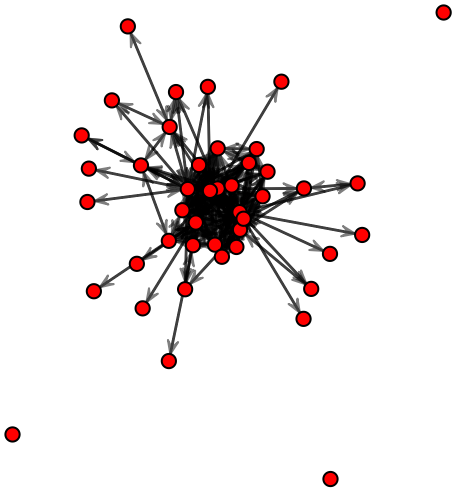
*Problems originally written by C.T. Butts (2009)

[1]Bernard H, Killworth P and Sailer L. (1982). Informant accuracy in social network data V. Social Science Research, 11, 30-66.

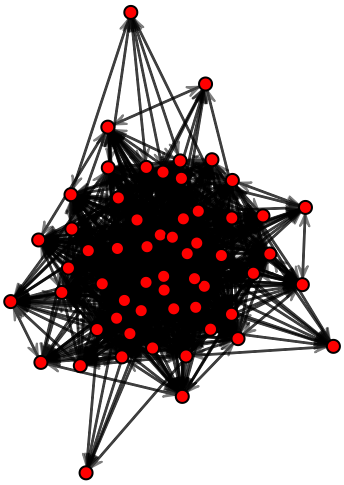
### (a) Network Visualization

To begin visualize each network. You might find it helpful to use transparency when displaying edges using the `edge.col=rgb(0,0,0,0.5)` option of the `gplot` function. Based on each visualization, indicate whether there appears to be a two-class block structure present, and if so what it might be.

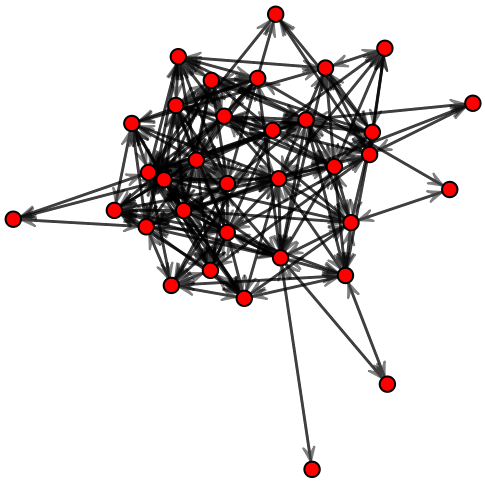
```
par(mfrow=c(1,1))
#Communication among radio operators.

gplot(bkham, edge.col=rgb(0,0,0,0.5), title(main = "bkham"))
```



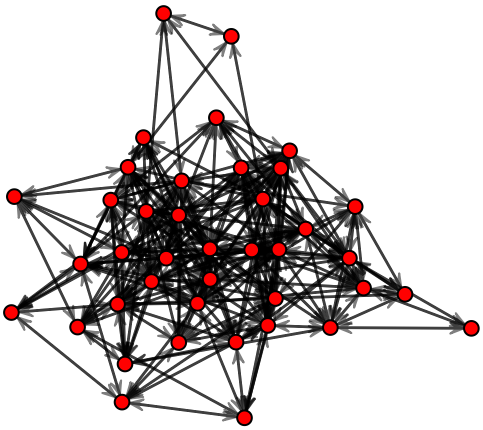
```
#face-to-face interactions among members of a fraterity
gplot(bkfrat, edge.col=rgb(0,0,0,0.5), title(main = "bkfrat"))
```



```
#face-to-face interactions in a university research group
gplot(bktec, edge.col=rgb(0,0,0,0.5), title(main = "bktec"))
```



```
#face-to-face interactions in a small business
gplot(bkoff, edge.col=rgb(0,0,0,0.5), title(main = "bkoff"))
```



There is a possibility of a two-class core-periphery structure in all the networks to some extent, as can be seen from the plot. The core-peripehery structure in the interactions among radio operators and face-to-face interactions among members of a fraternity shows distinct partition between the cores and peripheries or significant within core interactions and core-to-periphery interactions. The face-to-face interactions in a university research group and face-to-face interactions in a small business have lesser within core interactions and the cores do not seem to be physically close to each other. Specifically, in the bkoff network, there is a significant amount of interaction seen within the periphery structure.

### (b) Blockmodels

For each of the BKS networks, fit each of the four non-degrenerate undirected two-class blockmodels. (You may omit the null graph and complete graph blockmodels.) In addition, fit the Borgatti and Everett variant in which only within-class edges are considered. Plot each blocked data matrix with the `plot.sociomatrix` function. Comment on your results.

## Core w/in,out ties

```
bkham1<-block.fit(bkham,c(1,1,1,0))    # Core w/in,out ties
```

```
## Entering annealing loop...
```

```
##  Iteration 100, current GOF is -0.07630422.  (Best GOF=0.1043333)
##  Iteration 200, current GOF is -0.01294682.  (Best GOF=0.1043333)
##  Iteration 300, current GOF is 0.07435421.  (Best GOF=0.1138176)
##  Iteration 400, current GOF is -0.1111042.  (Best GOF=0.1138176)
##  Iteration 500, current GOF is 0.1010596.  (Best GOF=0.1236875)
##  Iteration 600, current GOF is 0.05651637.  (Best GOF=0.1236875)
##  Iteration 700, current GOF is 0.02791956.  (Best GOF=0.1254464)
##  Iteration 800, current GOF is 0.03886714.  (Best GOF=0.1254464)
##  Iteration 900, current GOF is 0.04393351.  (Best GOF=0.1254464)
##  Iteration 1000, current GOF is 0.06656557.  (Best GOF=0.1254464)
##  Iteration 1100, current GOF is 0.09300545.  (Best GOF=0.1381567)
##  Iteration 1200, current GOF is 0.0685023.  (Best GOF=0.1381567)
##  Iteration 1300, current GOF is 0.09303669.  (Best GOF=0.1491697)
##  Iteration 1400, current GOF is 0.1594203.  (Best GOF=0.1594203)
##  Iteration 1500, current GOF is 0.214673.  (Best GOF=0.2189817)
##  Iteration 1600, current GOF is 0.2553997.  (Best GOF=0.2553997)
##  Iteration 1700, current GOF is 0.307621.  (Best GOF=0.307621)
##  Iteration 1800, current GOF is 0.3427936.  (Best GOF=0.3427936)
##  Iteration 1900, current GOF is 0.3427936.  (Best GOF=0.3427936)
##  Iteration 2000, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2100, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2200, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2300, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2400, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2500, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2600, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2700, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2800, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 2900, current GOF is 0.3625934.  (Best GOF=0.3625934)
##  Iteration 3000, current GOF is 0.3625934.  (Best GOF=0.3625934)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.3625934
## Preparing and returning output.
```

```
bkfrat1<-block.fit(bkfrat,c(1,1,1,0))   # Core w/in,out ties
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.1064217.  (Best GOF=0.08789314)
##  Iteration 200, current GOF is 0.01838439.  (Best GOF=0.1251127)
##  Iteration 300, current GOF is -0.07305524.  (Best GOF=0.1251127)
##  Iteration 400, current GOF is -0.04378424.  (Best GOF=0.1251127)
##  Iteration 500, current GOF is 0.0503564.  (Best GOF=0.1251127)
##  Iteration 600, current GOF is -0.0002351878.  (Best GOF=0.1251127)
##  Iteration 700, current GOF is 0.1266077.  (Best GOF=0.1601286)
##  Iteration 800, current GOF is -0.02192129.  (Best GOF=0.1601286)
##  Iteration 900, current GOF is -0.06629472.  (Best GOF=0.1601286)
##  Iteration 1000, current GOF is 0.01609572.  (Best GOF=0.1601286)
##  Iteration 1100, current GOF is 0.07958708.  (Best GOF=0.1601286)
##  Iteration 1200, current GOF is 0.172749.  (Best GOF=0.172749)
##  Iteration 1300, current GOF is 0.09524522.  (Best GOF=0.1942043)
##  Iteration 1400, current GOF is 0.2036325.  (Best GOF=0.2036325)
##  Iteration 1500, current GOF is 0.2966846.  (Best GOF=0.2966846)
##  Iteration 1600, current GOF is 0.3416898.  (Best GOF=0.3416898)
##  Iteration 1700, current GOF is 0.3831944.  (Best GOF=0.3831944)
```

```
##  Iteration 1800, current GOF is 0.3951893.  (Best GOF=0.3951893)
##  Iteration 1900, current GOF is 0.397983.  (Best GOF=0.397983)
##  Iteration 2000, current GOF is 0.397983.  (Best GOF=0.397983)
##  Iteration 2100, current GOF is 0.397983.  (Best GOF=0.397983)
##  Iteration 2200, current GOF is 0.4161331.  (Best GOF=0.4161331)
##  Iteration 2300, current GOF is 0.4161331.  (Best GOF=0.4161331)
##  Iteration 2400, current GOF is 0.4207104.  (Best GOF=0.4207104)
##  Iteration 2500, current GOF is 0.4207104.  (Best GOF=0.4207104)
##  Iteration 2600, current GOF is 0.4207104.  (Best GOF=0.4207104)
##  Iteration 2700, current GOF is 0.4207104.  (Best GOF=0.4207104)
##  Iteration 2800, current GOF is 0.4207104.  (Best GOF=0.4207104)
##  Iteration 2900, current GOF is 0.4207104.  (Best GOF=0.4207104)
##  Iteration 3000, current GOF is 0.4207104.  (Best GOF=0.4207104)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.4207104
## Preparing and returning output.
```

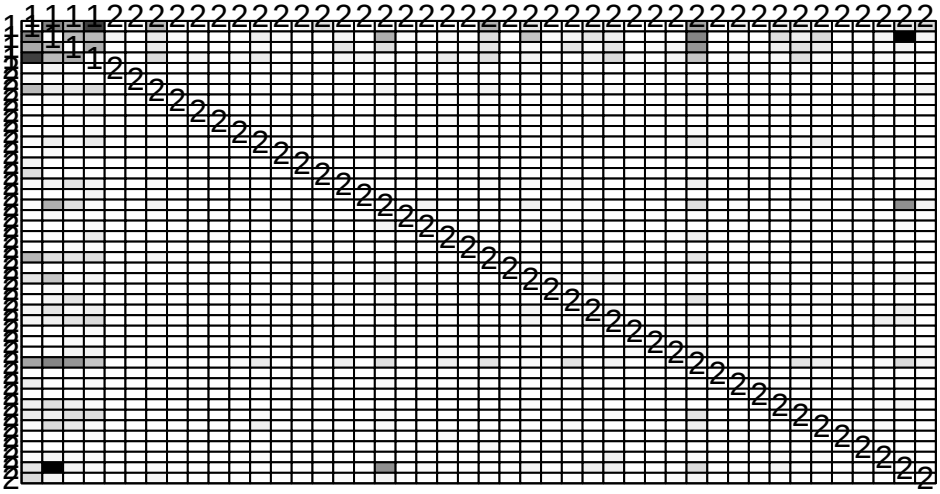
```
bktec1<-block.fit(bktec,c(1,1,1,0))    # Core w/in,out ties
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.06676207.  (Best GOF=0.1061969)
##  Iteration 200, current GOF is 0.06408071.  (Best GOF=0.1061969)
##  Iteration 300, current GOF is 0.03854846.  (Best GOF=0.1061969)
##  Iteration 400, current GOF is 0.07824699.  (Best GOF=0.1148328)
##  Iteration 500, current GOF is -0.02398249.  (Best GOF=0.1148328)
##  Iteration 600, current GOF is -0.01084638.  (Best GOF=0.1148328)
##  Iteration 700, current GOF is 0.09247304.  (Best GOF=0.1162395)
##  Iteration 800, current GOF is -0.132018.  (Best GOF=0.1327571)
##  Iteration 900, current GOF is -0.01159553.  (Best GOF=0.1327571)
##  Iteration 1000, current GOF is 0.0687066.  (Best GOF=0.1327571)
##  Iteration 1100, current GOF is 0.04844602.  (Best GOF=0.1542658)
##  Iteration 1200, current GOF is 0.05682338.  (Best GOF=0.1614627)
##  Iteration 1300, current GOF is 0.1226262.  (Best GOF=0.1614627)
##  Iteration 1400, current GOF is 0.1186161.  (Best GOF=0.1621792)
##  Iteration 1500, current GOF is 0.1547571.  (Best GOF=0.1621792)
##  Iteration 1600, current GOF is 0.1895807.  (Best GOF=0.1958944)
##  Iteration 1700, current GOF is 0.2155603.  (Best GOF=0.2155603)
##  Iteration 1800, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 1900, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2000, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2100, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2200, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2300, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2400, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2500, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2600, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2700, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2800, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 2900, current GOF is 0.22923.  (Best GOF=0.22923)
##  Iteration 3000, current GOF is 0.22923.  (Best GOF=0.22923)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.22923
## Preparing and returning output.
```

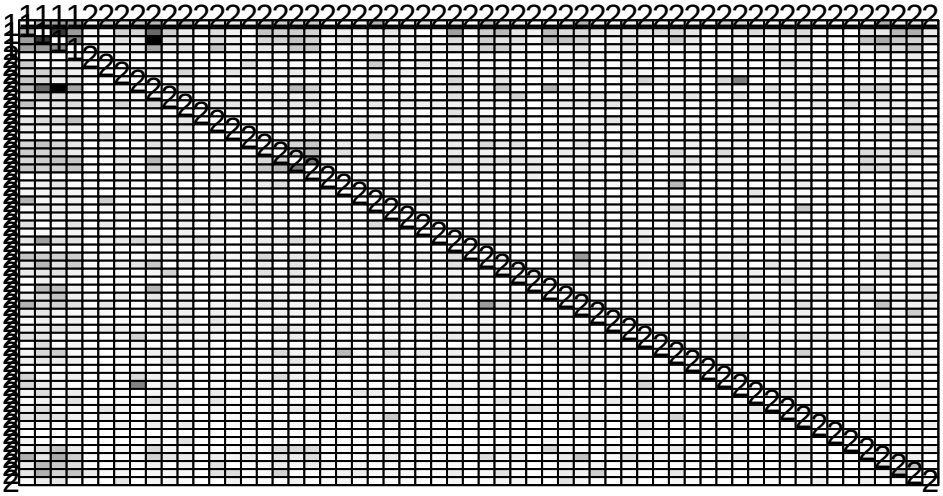
```
bkoff1<-block.fit(bkoff,c(1,1,1,0))    # Core w/in,out ties
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is 0.03668709.  (Best GOF=0.03797191)
##  Iteration 200, current GOF is 0.06811453.  (Best GOF=0.09311783)
##  Iteration 300, current GOF is 0.04320608.  (Best GOF=0.1246298)
##  Iteration 400, current GOF is 0.09496475.  (Best GOF=0.1246298)
##  Iteration 500, current GOF is -0.0628619.  (Best GOF=0.1246298)
##  Iteration 600, current GOF is -0.1479486.  (Best GOF=0.1246298)
##  Iteration 700, current GOF is -0.09730647.  (Best GOF=0.1246298)
##  Iteration 800, current GOF is 0.02513652.  (Best GOF=0.1246298)
##  Iteration 900, current GOF is -0.01938393.  (Best GOF=0.1246298)
##  Iteration 1000, current GOF is 0.07376947.  (Best GOF=0.1246298)
##  Iteration 1100, current GOF is 0.07028081.  (Best GOF=0.1246298)
##  Iteration 1200, current GOF is 0.001117232.  (Best GOF=0.1293566)
##  Iteration 1300, current GOF is 0.0899372.  (Best GOF=0.1293566)
##  Iteration 1400, current GOF is 0.08392705.  (Best GOF=0.1293566)
##  Iteration 1500, current GOF is 0.1505323.  (Best GOF=0.1505323)
##  Iteration 1600, current GOF is 0.2111919.  (Best GOF=0.2111919)
##  Iteration 1700, current GOF is 0.2118476.  (Best GOF=0.2118476)
##  Iteration 1800, current GOF is 0.2150441.  (Best GOF=0.2150441)
##  Iteration 1900, current GOF is 0.2150441.  (Best GOF=0.2150441)
##  Iteration 2000, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2100, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2200, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2300, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2400, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2500, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2600, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2700, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2800, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 2900, current GOF is 0.2258117.  (Best GOF=0.2258117)
##  Iteration 3000, current GOF is 0.2258117.  (Best GOF=0.2258117)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.2258117
## Preparing and returning output.
```

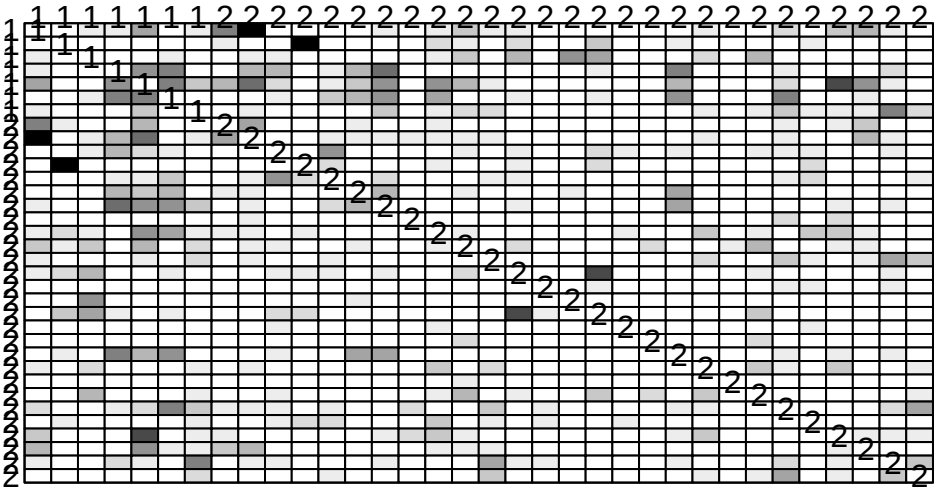
```
lab<-bkham1$block.membership[bkham1$order.vector]
plot.sociomatrix(bkham1$blocked.data,labels=list(lab,lab))
```



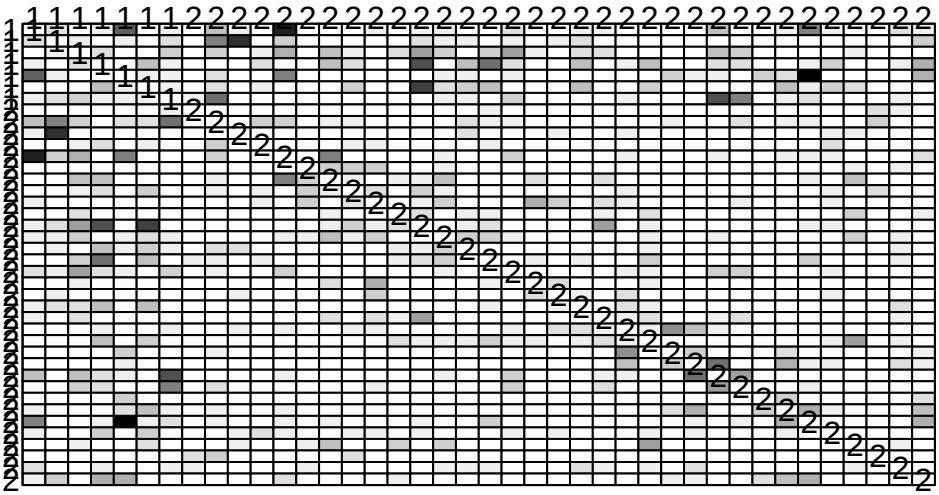
```
lab<-bkfrat1$block.membership[bkfrat1$order.vector]
plot.sociomatrix(bkfrat1$blocked.data,labels=list(lab,lab))
```



```
lab<-bktec1$block.membership[bktec1$order.vector]
plot.sociomatrix(bktec1$blocked.data,labels=list(lab,lab))
```



```
lab<-bkoff1$block.membership[bkoff1$order.vector]
plot.sociomatrix(bkoff1$blocked.data,labels=list(lab,lab))
```



## Core Periphery ties

```
bkham2<-block.fit(bkham,c(0,1,1,0))   # Core periphery ties
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.008750716.  (Best GOF=0.06501815)
##  Iteration 200, current GOF is 0.04006612.  (Best GOF=0.06501815)
##  Iteration 300, current GOF is 0.01012789.  (Best GOF=0.06501815)
##  Iteration 400, current GOF is -0.01294736.  (Best GOF=0.06501815)
##  Iteration 500, current GOF is 0.004200725.  (Best GOF=0.06501815)
##  Iteration 600, current GOF is 0.0409976.  (Best GOF=0.06501815)
##  Iteration 700, current GOF is -0.02024042.  (Best GOF=0.06501815)
##  Iteration 800, current GOF is 0.03382486.  (Best GOF=0.06501815)
##  Iteration 900, current GOF is -0.002294598.  (Best GOF=0.06501815)
##  Iteration 1000, current GOF is 0.02926864.  (Best GOF=0.06501815)
##  Iteration 1100, current GOF is 0.04169621.  (Best GOF=0.06501815)
##  Iteration 1200, current GOF is 0.004869563.  (Best GOF=0.06501815)
##  Iteration 1300, current GOF is 0.06908633.  (Best GOF=0.08665863)
##  Iteration 1400, current GOF is 0.03597668.  (Best GOF=0.08665863)
##  Iteration 1500, current GOF is 0.07772145.  (Best GOF=0.08739436)
##  Iteration 1600, current GOF is 0.1275074.  (Best GOF=0.1275074)
##  Iteration 1700, current GOF is 0.186114.  (Best GOF=0.186114)
##  Iteration 1800, current GOF is 0.2435737.  (Best GOF=0.2435737)
##  Iteration 1900, current GOF is 0.2435737.  (Best GOF=0.2435737)
##  Iteration 2000, current GOF is 0.3134562.  (Best GOF=0.3134562)
##  Iteration 2100, current GOF is 0.3134562.  (Best GOF=0.3134562)
##  Iteration 2200, current GOF is 0.3134562.  (Best GOF=0.3134562)
##  Iteration 2300, current GOF is 0.3134562.  (Best GOF=0.3134562)
##  Iteration 2400, current GOF is 0.3273251.  (Best GOF=0.3273251)
##  Iteration 2500, current GOF is 0.3273251.  (Best GOF=0.3273251)
##  Iteration 2600, current GOF is 0.3273251.  (Best GOF=0.3273251)
##  Iteration 2700, current GOF is 0.3273251.  (Best GOF=0.3273251)
```

```
##  Iteration 2800, current GOF is 0.3273251.  (Best GOF=0.3273251)
##  Iteration 2900, current GOF is 0.3273251.  (Best GOF=0.3273251)
##  Iteration 3000, current GOF is 0.3273251.  (Best GOF=0.3273251)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.3273251
## Preparing and returning output.
```

```
bkfrat2<-block.fit(bkfrat,c(0,1,1,0))   # Core periphery ties
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.04018798.  (Best GOF=0.03166945)
##  Iteration 200, current GOF is 0.0377756.  (Best GOF=0.04841294)
##  Iteration 300, current GOF is -0.02577053.  (Best GOF=0.05381108)
##  Iteration 400, current GOF is -0.04150599.  (Best GOF=0.05381108)
##  Iteration 500, current GOF is 0.01825622.  (Best GOF=0.05381108)
##  Iteration 600, current GOF is -0.01640707.  (Best GOF=0.05381108)
##  Iteration 700, current GOF is -0.0121478.  (Best GOF=0.05381108)
##  Iteration 800, current GOF is 0.005599146.  (Best GOF=0.05381108)
##  Iteration 900, current GOF is 0.02484575.  (Best GOF=0.05381108)
##  Iteration 1000, current GOF is 0.0197967.  (Best GOF=0.05381108)
##  Iteration 1100, current GOF is -0.04579083.  (Best GOF=0.05381108)
##  Iteration 1200, current GOF is 0.02321375.  (Best GOF=0.05381108)
##  Iteration 1300, current GOF is 0.03067931.  (Best GOF=0.05624151)
##  Iteration 1400, current GOF is 0.03805835.  (Best GOF=0.05624151)
##  Iteration 1500, current GOF is 0.21733.  (Best GOF=0.21733)
##  Iteration 1600, current GOF is 0.3054621.  (Best GOF=0.3054621)
##  Iteration 1700, current GOF is 0.3223903.  (Best GOF=0.3223903)
##  Iteration 1800, current GOF is 0.3500983.  (Best GOF=0.3500983)
##  Iteration 1900, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2000, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2100, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2200, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2300, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2400, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2500, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2600, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2700, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2800, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 2900, current GOF is 0.3730622.  (Best GOF=0.3730622)
##  Iteration 3000, current GOF is 0.3730622.  (Best GOF=0.3730622)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.3730622
## Preparing and returning output.
```

```
bktec2<-block.fit(bktec,c(0,1,1,0))   # Core periphery ties
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is 0.02728205.  (Best GOF=0.08462291)
##  Iteration 200, current GOF is 0.04322528.  (Best GOF=0.08462291)
##  Iteration 300, current GOF is -0.04285917.  (Best GOF=0.09744726)
##  Iteration 400, current GOF is 0.05085577.  (Best GOF=0.09744726)
##  Iteration 500, current GOF is -0.02432175.  (Best GOF=0.09744726)
##  Iteration 600, current GOF is -0.008225387.  (Best GOF=0.09744726)
```

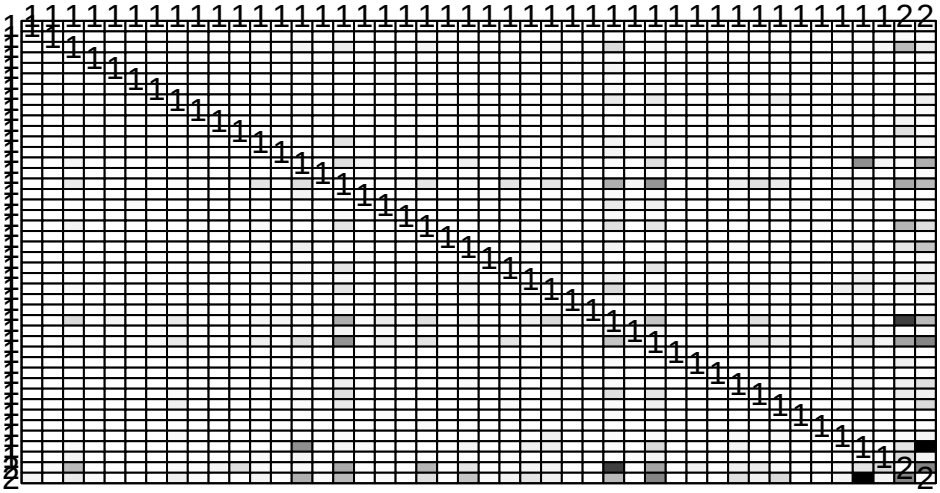
```
##  Iteration 700, current GOF is 0.02218938.  (Best GOF=0.09744726)
##  Iteration 800, current GOF is -0.02262511.  (Best GOF=0.09744726)
##  Iteration 900, current GOF is 0.005743328.  (Best GOF=0.09950584)
##  Iteration 1000, current GOF is -0.02278804.  (Best GOF=0.09950584)
##  Iteration 1100, current GOF is 0.03863208.  (Best GOF=0.09950584)
##  Iteration 1200, current GOF is 0.02015236.  (Best GOF=0.1051565)
##  Iteration 1300, current GOF is 0.06715402.  (Best GOF=0.1051565)
##  Iteration 1400, current GOF is 0.05378782.  (Best GOF=0.1051565)
##  Iteration 1500, current GOF is 0.1056816.  (Best GOF=0.1087254)
##  Iteration 1600, current GOF is 0.1249529.  (Best GOF=0.1249529)
##  Iteration 1700, current GOF is 0.1455693.  (Best GOF=0.1455693)
##  Iteration 1800, current GOF is 0.1602806.  (Best GOF=0.1602806)
##  Iteration 1900, current GOF is 0.1676225.  (Best GOF=0.1676225)
##  Iteration 2000, current GOF is 0.1733062.  (Best GOF=0.1733062)
##  Iteration 2100, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2200, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2300, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2400, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2500, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2600, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2700, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2800, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 2900, current GOF is 0.1791754.  (Best GOF=0.1791754)
##  Iteration 3000, current GOF is 0.1791754.  (Best GOF=0.1791754)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.1791754
## Preparing and returning output.
```

```
bkoff2<-block.fit(bkoff,c(0,1,1,0))   # Core periphery ties
```

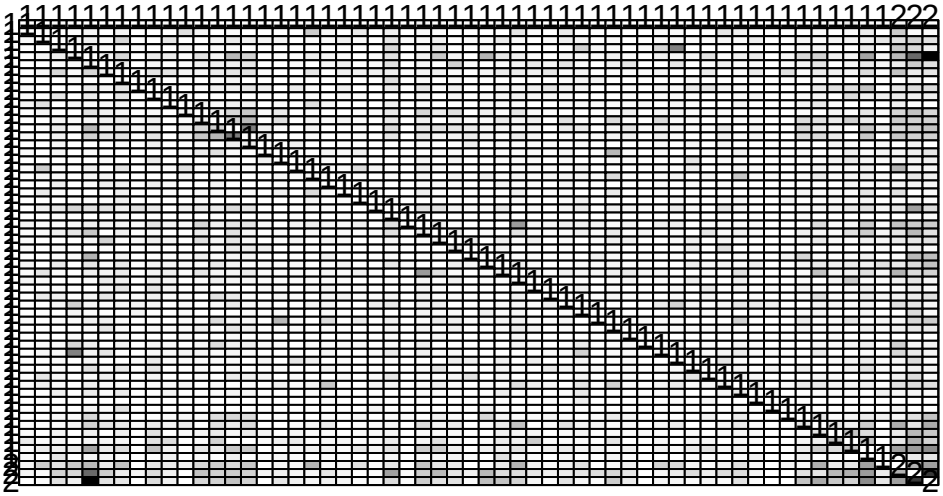
```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.01093548.  (Best GOF=0.07827503)
##  Iteration 200, current GOF is -0.1070526.  (Best GOF=0.07827503)
##  Iteration 300, current GOF is 0.03018412.  (Best GOF=0.07827503)
##  Iteration 400, current GOF is 0.02173029.  (Best GOF=0.08144056)
##  Iteration 500, current GOF is 0.02964091.  (Best GOF=0.08834718)
##  Iteration 600, current GOF is 0.03971307.  (Best GOF=0.08834718)
##  Iteration 700, current GOF is -0.02699986.  (Best GOF=0.08834718)
##  Iteration 800, current GOF is -0.001103014.  (Best GOF=0.08834718)
##  Iteration 900, current GOF is 0.04493582.  (Best GOF=0.08834718)
##  Iteration 1000, current GOF is 0.01223808.  (Best GOF=0.08834718)
##  Iteration 1100, current GOF is 0.0238854.  (Best GOF=0.09574499)
##  Iteration 1200, current GOF is 0.04661969.  (Best GOF=0.09574499)
##  Iteration 1300, current GOF is 0.04925196.  (Best GOF=0.09574499)
##  Iteration 1400, current GOF is 0.09816823.  (Best GOF=0.09816823)
##  Iteration 1500, current GOF is 0.1231681.  (Best GOF=0.1331791)
##  Iteration 1600, current GOF is 0.1329524.  (Best GOF=0.1331791)
##  Iteration 1700, current GOF is 0.1382968.  (Best GOF=0.1430246)
##  Iteration 1800, current GOF is 0.1545356.  (Best GOF=0.1545356)
##  Iteration 1900, current GOF is 0.1629103.  (Best GOF=0.1629103)
##  Iteration 2000, current GOF is 0.1629103.  (Best GOF=0.1629103)
##  Iteration 2100, current GOF is 0.1629103.  (Best GOF=0.1629103)
##  Iteration 2200, current GOF is 0.1629103.  (Best GOF=0.1629103)
##  Iteration 2300, current GOF is 0.1657243.  (Best GOF=0.1657243)
```

```
##  Iteration 2400, current GOF is 0.1705472.  (Best GOF=0.1705472)
##  Iteration 2500, current GOF is 0.1952343.  (Best GOF=0.1952343)
##  Iteration 2600, current GOF is 0.2158784.  (Best GOF=0.2158784)
##  Iteration 2700, current GOF is 0.2158784.  (Best GOF=0.2158784)
##  Iteration 2800, current GOF is 0.2158784.  (Best GOF=0.2158784)
##  Iteration 2900, current GOF is 0.2158784.  (Best GOF=0.2158784)
##  Iteration 3000, current GOF is 0.2158784.  (Best GOF=0.2158784)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.2158784
## Preparing and returning output.
```

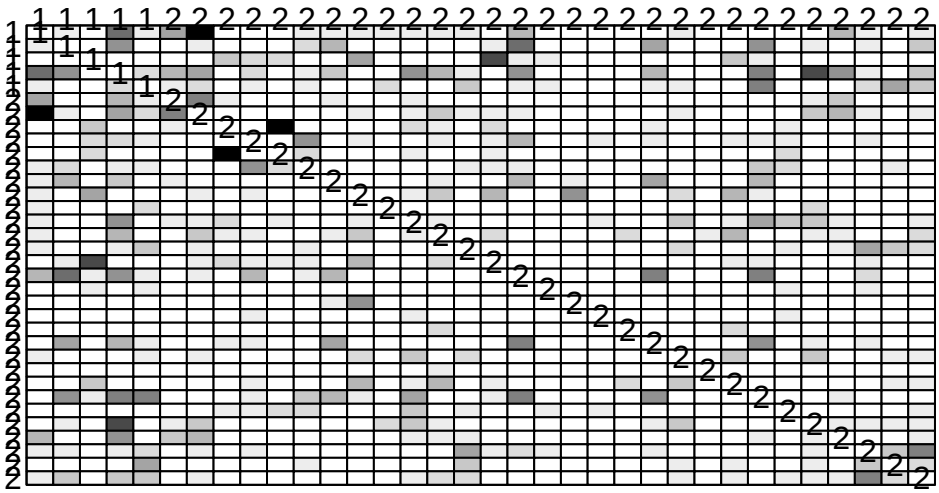
```
lab<-bkham2$block.membership[bkham2$order.vector]
plot.sociomatrix(bkham2$blocked.data,labels=list(lab,lab))
```



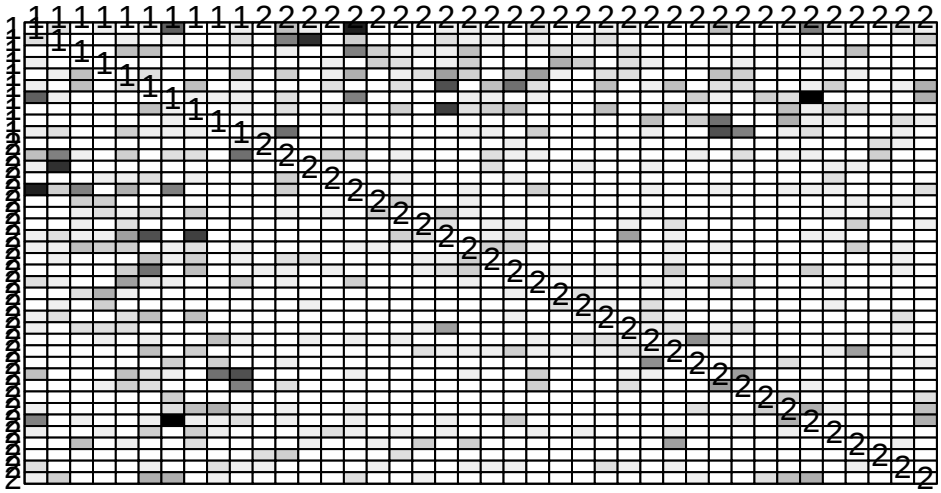
```
lab<-bkfrat2$block.membership[bkfrat2$order.vector]
plot.sociomatrix(bkfrat2$blocked.data,labels=list(lab,lab))
```



```
lab<-bktec2$block.membership[bktec2$order.vector]
plot.sociomatrix(bktec2$blocked.data,labels=list(lab,lab))
```



```
lab<-bkoff2$block.membership[bkoff2$order.vector]
plot.sociomatrix(bkoff2$blocked.data,labels=list(lab,lab))
```



## Isolated core

```
bkham4<-block.fit(bkham,c(1,0,0,0))   # Isolated core
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is 0.01988107.  (Best GOF=0.01988107)
##  Iteration 200, current GOF is -0.04353874.  (Best GOF=0.1855706)
##  Iteration 300, current GOF is 0.02423643.  (Best GOF=0.1855706)
##  Iteration 400, current GOF is 0.1057856.  (Best GOF=0.1855706)
##  Iteration 500, current GOF is 0.06213547.  (Best GOF=0.1855706)
##  Iteration 600, current GOF is 0.0195153.  (Best GOF=0.2416635)
##  Iteration 700, current GOF is -0.024179.  (Best GOF=0.2416635)
##  Iteration 800, current GOF is 0.04308423.  (Best GOF=0.2416635)
##  Iteration 900, current GOF is 0.1467294.  (Best GOF=0.2416635)
##  Iteration 1000, current GOF is 0.0801596.  (Best GOF=0.2416635)
##  Iteration 1100, current GOF is 0.1613798.  (Best GOF=0.2416635)
##  Iteration 1200, current GOF is 0.221487.  (Best GOF=0.2562357)
```

```
##  Iteration 1300, current GOF is 0.2348992.  (Best GOF=0.290449)
##  Iteration 1400, current GOF is 0.3431589.  (Best GOF=0.3431589)
##  Iteration 1500, current GOF is 0.5455599.  (Best GOF=0.5455599)
##  Iteration 1600, current GOF is 0.6479694.  (Best GOF=0.6479694)
##  Iteration 1700, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 1800, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 1900, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2000, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2100, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2200, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2300, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2400, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2500, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2600, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2700, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2800, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 2900, current GOF is 0.6959562.  (Best GOF=0.6959562)
##  Iteration 3000, current GOF is 0.6959562.  (Best GOF=0.6959562)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.6959562
## Preparing and returning output.
```

```
bkfrat4<-block.fit(bkfrat,c(1,0,0,0))   # Isolated core
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is 0.1294334.  (Best GOF=0.1294334)
##  Iteration 200, current GOF is -0.1280452.  (Best GOF=0.1543872)
##  Iteration 300, current GOF is -0.08095837.  (Best GOF=0.1543872)
##  Iteration 400, current GOF is -0.1391901.  (Best GOF=0.1543872)
##  Iteration 500, current GOF is -0.01925663.  (Best GOF=0.1543872)
##  Iteration 600, current GOF is -0.02503002.  (Best GOF=0.1543872)
##  Iteration 700, current GOF is 0.1362077.  (Best GOF=0.1543872)
##  Iteration 800, current GOF is 0.07177447.  (Best GOF=0.164475)
##  Iteration 900, current GOF is 0.1195393.  (Best GOF=0.164475)
##  Iteration 1000, current GOF is 0.01052013.  (Best GOF=0.164475)
##  Iteration 1100, current GOF is 0.03840841.  (Best GOF=0.164475)
##  Iteration 1200, current GOF is 0.2084842.  (Best GOF=0.2197689)
##  Iteration 1300, current GOF is 0.2720734.  (Best GOF=0.272463)
##  Iteration 1400, current GOF is 0.3265576.  (Best GOF=0.3423871)
##  Iteration 1500, current GOF is 0.4426252.  (Best GOF=0.4426252)
##  Iteration 1600, current GOF is 0.4808409.  (Best GOF=0.4808409)
##  Iteration 1700, current GOF is 0.4792937.  (Best GOF=0.4820655)
##  Iteration 1800, current GOF is 0.5181917.  (Best GOF=0.5181917)
##  Iteration 1900, current GOF is 0.5181917.  (Best GOF=0.5181917)
##  Iteration 2000, current GOF is 0.5379771.  (Best GOF=0.5379771)
##  Iteration 2100, current GOF is 0.5418656.  (Best GOF=0.5418656)
##  Iteration 2200, current GOF is 0.5444052.  (Best GOF=0.5444052)
##  Iteration 2300, current GOF is 0.5444052.  (Best GOF=0.5444052)
##  Iteration 2400, current GOF is 0.5444052.  (Best GOF=0.5444052)
##  Iteration 2500, current GOF is 0.5444052.  (Best GOF=0.5444052)
##  Iteration 2600, current GOF is 0.5444052.  (Best GOF=0.5444052)
##  Iteration 2700, current GOF is 0.5444052.  (Best GOF=0.5444052)
##  Iteration 2800, current GOF is 0.5444052.  (Best GOF=0.5444052)
##  Iteration 2900, current GOF is 0.5444052.  (Best GOF=0.5444052)
```

```
##  Iteration 3000, current GOF is 0.5444052.  (Best GOF=0.5444052)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.5444052
## Preparing and returning output.
```

```
bktec4<-block.fit(bktec,c(1,0,0,0))   # Isolated core
```

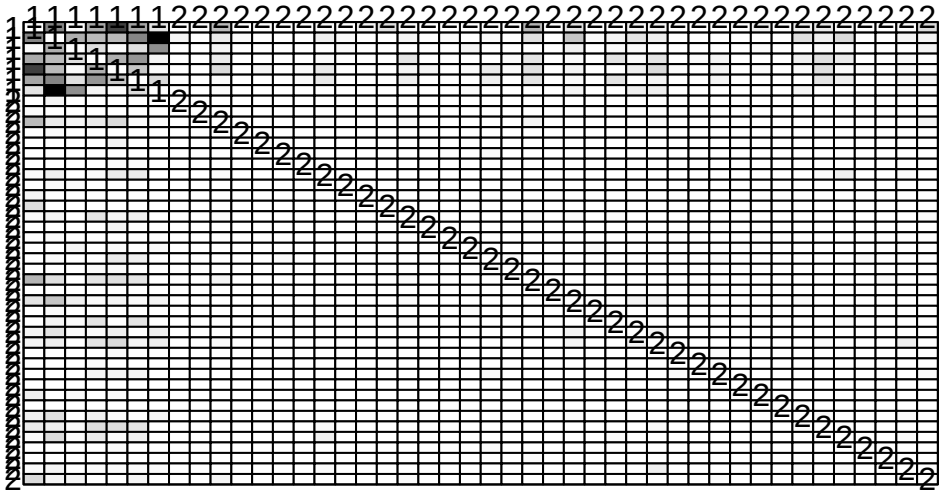
```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.01205834.  (Best GOF=0.1879459)
##  Iteration 200, current GOF is 0.06544246.  (Best GOF=0.1879459)
##  Iteration 300, current GOF is 0.05963214.  (Best GOF=0.1879459)
##  Iteration 400, current GOF is -0.02014005.  (Best GOF=0.1879459)
##  Iteration 500, current GOF is -0.03796807.  (Best GOF=0.2112625)
##  Iteration 600, current GOF is 0.0455924.  (Best GOF=0.2112625)
##  Iteration 700, current GOF is 0.04885265.  (Best GOF=0.2309922)
##  Iteration 800, current GOF is -0.0464695.  (Best GOF=0.2309922)
##  Iteration 900, current GOF is 0.09052851.  (Best GOF=0.2309922)
##  Iteration 1000, current GOF is 0.1107723.  (Best GOF=0.2309922)
##  Iteration 1100, current GOF is 0.05250221.  (Best GOF=0.2309922)
##  Iteration 1200, current GOF is 0.09849104.  (Best GOF=0.2309922)
##  Iteration 1300, current GOF is 0.1308183.  (Best GOF=0.2309922)
##  Iteration 1400, current GOF is 0.2560755.  (Best GOF=0.272236)
##  Iteration 1500, current GOF is 0.3561891.  (Best GOF=0.3561891)
##  Iteration 1600, current GOF is 0.4271353.  (Best GOF=0.4271353)
##  Iteration 1700, current GOF is 0.4271353.  (Best GOF=0.4271353)
##  Iteration 1800, current GOF is 0.4307548.  (Best GOF=0.4307548)
##  Iteration 1900, current GOF is 0.4307548.  (Best GOF=0.4307548)
##  Iteration 2000, current GOF is 0.4373116.  (Best GOF=0.4373116)
##  Iteration 2100, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2200, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2300, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2400, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2500, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2600, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2700, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2800, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 2900, current GOF is 0.4442833.  (Best GOF=0.4442833)
##  Iteration 3000, current GOF is 0.4442833.  (Best GOF=0.4442833)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.4442833
## Preparing and returning output.
```

```
bkoff4<-block.fit(bkoff,c(1,0,0,0))   # Isolated core
```

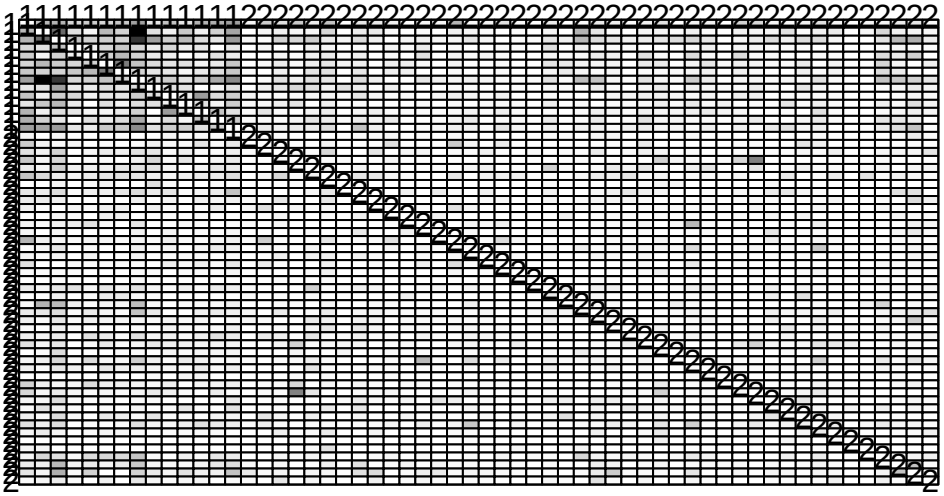
```
## Entering annealing loop...
##  Iteration 100, current GOF is 0.0121376.  (Best GOF=0.05742716)
##  Iteration 200, current GOF is -0.03954751.  (Best GOF=0.08937858)
##  Iteration 300, current GOF is 0.01559842.  (Best GOF=0.08937858)
##  Iteration 400, current GOF is -0.0917134.  (Best GOF=0.08937858)
##  Iteration 500, current GOF is 0.003303577.  (Best GOF=0.08937858)
##  Iteration 600, current GOF is 0.006702854.  (Best GOF=0.08937858)
##  Iteration 700, current GOF is -0.009968848.  (Best GOF=0.09943367)
##  Iteration 800, current GOF is -0.03134037.  (Best GOF=0.111355)
```

```
##  Iteration 900, current GOF is 0.01087007.  (Best GOF=0.111355)
##  Iteration 1000, current GOF is 0.006702854.  (Best GOF=0.163767)
##  Iteration 1100, current GOF is 0.1624989.  (Best GOF=0.1720252)
##  Iteration 1200, current GOF is 0.04474608.  (Best GOF=0.1720252)
##  Iteration 1300, current GOF is 0.2241216.  (Best GOF=0.2368532)
##  Iteration 1400, current GOF is 0.2548896.  (Best GOF=0.2588961)
##  Iteration 1500, current GOF is 0.2235773.  (Best GOF=0.2792588)
##  Iteration 1600, current GOF is 0.2745446.  (Best GOF=0.2792588)
##  Iteration 1700, current GOF is 0.3074255.  (Best GOF=0.3110487)
##  Iteration 1800, current GOF is 0.3066371.  (Best GOF=0.3110487)
##  Iteration 1900, current GOF is 0.3075804.  (Best GOF=0.3110487)
##  Iteration 2000, current GOF is 0.3509034.  (Best GOF=0.3509034)
##  Iteration 2100, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2200, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2300, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2400, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2500, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2600, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2700, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2800, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 2900, current GOF is 0.3523318.  (Best GOF=0.3523318)
##  Iteration 3000, current GOF is 0.3523318.  (Best GOF=0.3523318)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.3523318
## Preparing and returning output.
```

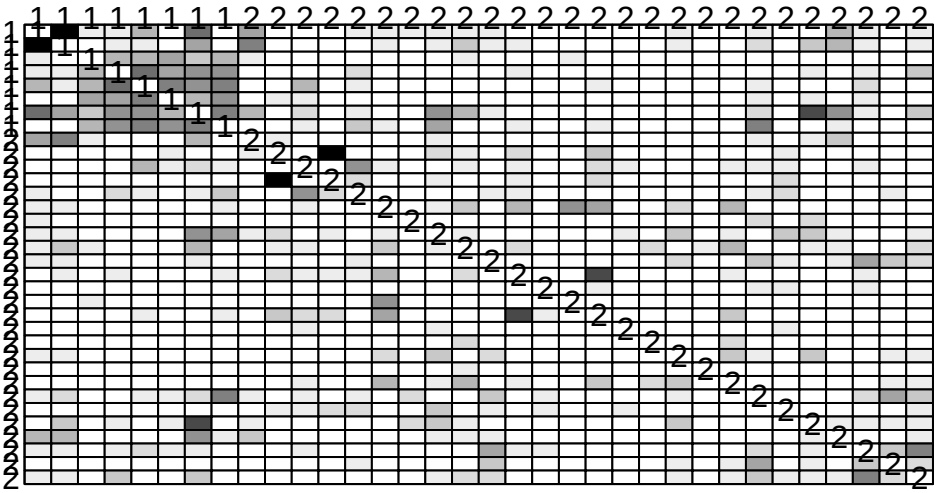
```
lab<-bkham4$block.membership[bkham4$order.vector]
plot.sociomatrix(bkham4$blocked.data,labels=list(lab,lab))
```



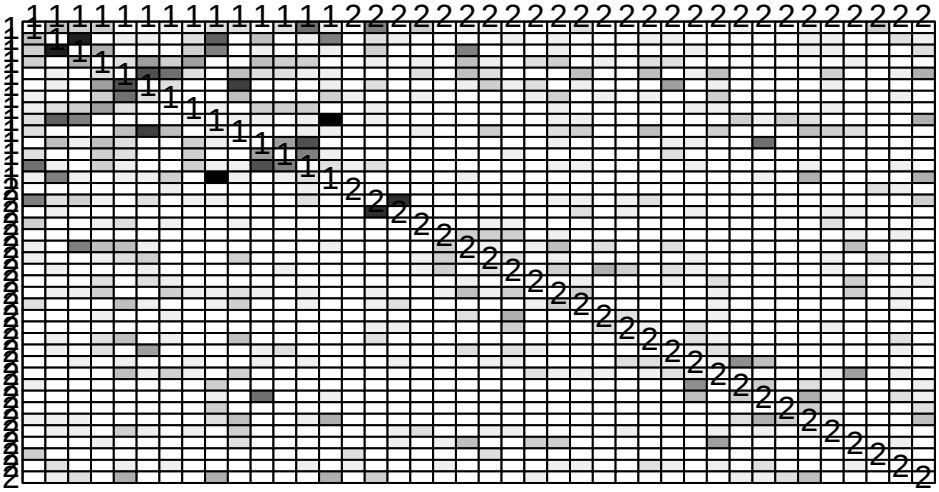
```
lab<-bkfrat4$block.membership[bkfrat4$order.vector]
plot.sociomatrix(bkfrat4$blocked.data,labels=list(lab,lab))
```



```
lab<-bktec4$block.membership[bktec4$order.vector]
plot.sociomatrix(bktec4$blocked.data,labels=list(lab,lab))
```



```
lab<-bkoff4$block.membership[bkoff4$order.vector]
plot.sociomatrix(bkoff4$blocked.data,labels=list(lab,lab))
```



## Borgatti-Everette

```
bkham5<-block.fit(bkham,c(1,0,0,1))  #
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.03647958.  (Best GOF=0.008761572)
##  Iteration 200, current GOF is 0.02813213.  (Best GOF=0.06255169)
##  Iteration 300, current GOF is -0.01563098.  (Best GOF=0.06255169)
##  Iteration 400, current GOF is -0.02209518.  (Best GOF=0.1132698)
##  Iteration 500, current GOF is -0.005042481.  (Best GOF=0.1132698)
##  Iteration 600, current GOF is 0.08696124.  (Best GOF=0.1132698)
##  Iteration 700, current GOF is -0.04458398.  (Best GOF=0.1132698)
##  Iteration 800, current GOF is 0.006609288.  (Best GOF=0.1132698)
##  Iteration 900, current GOF is -0.0364364.  (Best GOF=0.1132698)
##  Iteration 1000, current GOF is 0.04583413.  (Best GOF=0.1132698)
##  Iteration 1100, current GOF is -0.01156282.  (Best GOF=0.1132698)
##  Iteration 1200, current GOF is -0.0329352.  (Best GOF=0.1132698)
##  Iteration 1300, current GOF is 0.07189525.  (Best GOF=0.1132698)
##  Iteration 1400, current GOF is 0.08833619.  (Best GOF=0.1132698)
##  Iteration 1500, current GOF is 0.1715757.  (Best GOF=0.1784883)
##  Iteration 1600, current GOF is 0.1693878.  (Best GOF=0.1851686)
##  Iteration 1700, current GOF is 0.1973628.  (Best GOF=0.2007238)
##  Iteration 1800, current GOF is 0.2014411.  (Best GOF=0.2014411)
##  Iteration 1900, current GOF is 0.2023839.  (Best GOF=0.2043102)
##  Iteration 2000, current GOF is 0.2074051.  (Best GOF=0.2086138)
##  Iteration 2100, current GOF is 0.2086138.  (Best GOF=0.2093311)
##  Iteration 2200, current GOF is 0.2093311.  (Best GOF=0.2096077)
##  Iteration 2300, current GOF is 0.2093311.  (Best GOF=0.2096077)
##  Iteration 2400, current GOF is 0.2096077.  (Best GOF=0.2096077)
##  Iteration 2500, current GOF is 0.2096077.  (Best GOF=0.2096077)
##  Iteration 2600, current GOF is 0.2096077.  (Best GOF=0.2096077)
##  Iteration 2700, current GOF is 0.2096077.  (Best GOF=0.2096077)
##  Iteration 2800, current GOF is 0.2096077.  (Best GOF=0.2096077)
##  Iteration 2900, current GOF is 0.2096077.  (Best GOF=0.2096077)
##  Iteration 3000, current GOF is 0.2096077.  (Best GOF=0.2096077)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.2096077
## Preparing and returning output.
```

```
bkfrat5<-block.fit(bkfrat,c(1,0,0,1))  #
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is -0.004889268.  (Best GOF=0.01618216)
##  Iteration 200, current GOF is -0.01127817.  (Best GOF=0.05537469)
##  Iteration 300, current GOF is -0.02037441.  (Best GOF=0.05537469)
##  Iteration 400, current GOF is 0.008373965.  (Best GOF=0.05537469)
##  Iteration 500, current GOF is 0.0003942023.  (Best GOF=0.07265891)
##  Iteration 600, current GOF is 0.01135993.  (Best GOF=0.07265891)
##  Iteration 700, current GOF is -0.02733045.  (Best GOF=0.07265891)
##  Iteration 800, current GOF is -0.03119287.  (Best GOF=0.07265891)
##  Iteration 900, current GOF is 0.07265891.  (Best GOF=0.07265891)
##  Iteration 1000, current GOF is -0.01138379.  (Best GOF=0.07265891)
##  Iteration 1100, current GOF is 0.01104153.  (Best GOF=0.07265891)
```

```
##  Iteration 1200, current GOF is -0.008953352.  (Best GOF=0.07265891)
##  Iteration 1300, current GOF is 0.06871006.  (Best GOF=0.08120115)
##  Iteration 1400, current GOF is 0.1396073.  (Best GOF=0.1454158)
##  Iteration 1500, current GOF is 0.1712344.  (Best GOF=0.1751511)
##  Iteration 1600, current GOF is 0.2079012.  (Best GOF=0.2079012)
##  Iteration 1700, current GOF is 0.2409674.  (Best GOF=0.2409674)
##  Iteration 1800, current GOF is 0.2794652.  (Best GOF=0.2794652)
##  Iteration 1900, current GOF is 0.2837599.  (Best GOF=0.2858872)
##  Iteration 2000, current GOF is 0.2966321.  (Best GOF=0.2966321)
##  Iteration 2100, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2200, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2300, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2400, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2500, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2600, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2700, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2800, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 2900, current GOF is 0.2987915.  (Best GOF=0.2987915)
##  Iteration 3000, current GOF is 0.2987915.  (Best GOF=0.2987915)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.2987915
## Preparing and returning output.
```

```
bktec5<-block.fit(bktec,c(1,0,0,1))  #
```

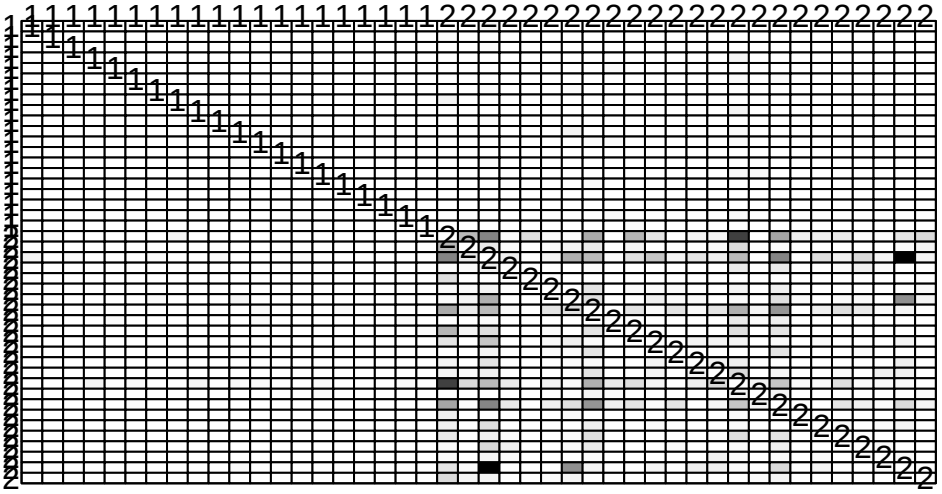
```
## Entering annealing loop...
##  Iteration 100, current GOF is 0.07416529.  (Best GOF=0.07824079)
##  Iteration 200, current GOF is -0.01957109.  (Best GOF=0.1976925)
##  Iteration 300, current GOF is 0.01463622.  (Best GOF=0.1976925)
##  Iteration 400, current GOF is 0.1185719.  (Best GOF=0.1976925)
##  Iteration 500, current GOF is -0.02104774.  (Best GOF=0.1976925)
##  Iteration 600, current GOF is 0.002254886.  (Best GOF=0.1976925)
##  Iteration 700, current GOF is 0.1732452.  (Best GOF=0.1976925)
##  Iteration 800, current GOF is 0.1002303.  (Best GOF=0.1976925)
##  Iteration 900, current GOF is 0.05005355.  (Best GOF=0.1976925)
##  Iteration 1000, current GOF is 0.07212755.  (Best GOF=0.1976925)
##  Iteration 1100, current GOF is 0.0857728.  (Best GOF=0.1976925)
##  Iteration 1200, current GOF is -0.003856181.  (Best GOF=0.1976925)
##  Iteration 1300, current GOF is 0.1326243.  (Best GOF=0.1976925)
##  Iteration 1400, current GOF is 0.1597507.  (Best GOF=0.2029684)
##  Iteration 1500, current GOF is 0.1735967.  (Best GOF=0.2029684)
##  Iteration 1600, current GOF is 0.1984679.  (Best GOF=0.2029684)
##  Iteration 1700, current GOF is 0.2039201.  (Best GOF=0.2066189)
##  Iteration 1800, current GOF is 0.2039201.  (Best GOF=0.2066189)
##  Iteration 1900, current GOF is 0.2099162.  (Best GOF=0.2099162)
##  Iteration 2000, current GOF is 0.2106944.  (Best GOF=0.2106944)
##  Iteration 2100, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 2200, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 2300, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 2400, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 2500, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 2600, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 2700, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 2800, current GOF is 0.2486246.  (Best GOF=0.2486246)
```

```
##  Iteration 2900, current GOF is 0.2486246.  (Best GOF=0.2486246)
##  Iteration 3000, current GOF is 0.2486246.  (Best GOF=0.2486246)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.2486246
## Preparing and returning output.
```

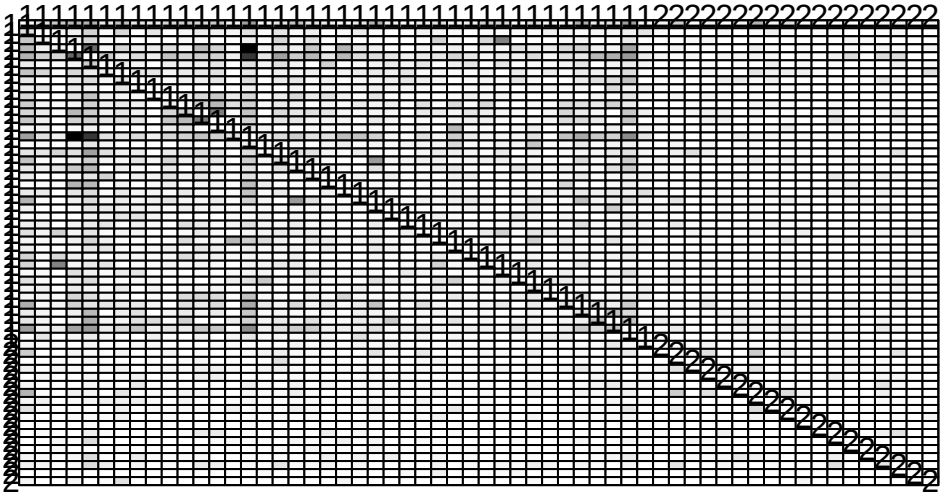
```
bkoff5<-block.fit(bkoff,c(1,0,0,1))  #
```

```
## Entering annealing loop...
##  Iteration 100, current GOF is 0.003741086.  (Best GOF=0.08167098)
##  Iteration 200, current GOF is 0.01093548.  (Best GOF=0.09749683)
##  Iteration 300, current GOF is -0.0178421.  (Best GOF=0.09749683)
##  Iteration 400, current GOF is -0.06561289.  (Best GOF=0.09749683)
##  Iteration 500, current GOF is -0.03510865.  (Best GOF=0.09749683)
##  Iteration 600, current GOF is -0.00345331.  (Best GOF=0.09749683)
##  Iteration 700, current GOF is 0.04015067.  (Best GOF=0.09749683)
##  Iteration 800, current GOF is 0.004173367.  (Best GOF=0.09749683)
##  Iteration 900, current GOF is 0.02820203.  (Best GOF=0.09749683)
##  Iteration 1000, current GOF is -0.03539643.  (Best GOF=0.09749683)
##  Iteration 1100, current GOF is 0.06820288.  (Best GOF=0.09749683)
##  Iteration 1200, current GOF is 0.1447403.  (Best GOF=0.154858)
##  Iteration 1300, current GOF is 0.1577634.  (Best GOF=0.1688004)
##  Iteration 1400, current GOF is 0.1286358.  (Best GOF=0.1708377)
##  Iteration 1500, current GOF is 0.1837356.  (Best GOF=0.1837356)
##  Iteration 1600, current GOF is 0.201329.  (Best GOF=0.2070854)
##  Iteration 1700, current GOF is 0.2411562.  (Best GOF=0.2411562)
##  Iteration 1800, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 1900, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2000, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2100, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2200, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2300, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2400, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2500, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2600, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2700, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2800, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 2900, current GOF is 0.2646491.  (Best GOF=0.2646491)
##  Iteration 3000, current GOF is 0.2646491.  (Best GOF=0.2646491)
## Annealing completed.
## Refining solution via hill-climbing procedure...
##  Refining; current GOF is  0.2646491
## Preparing and returning output.
```

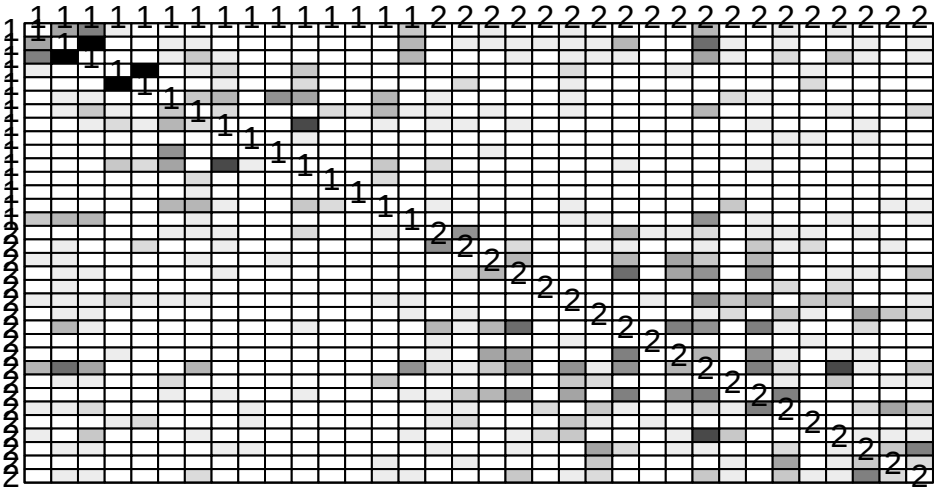
```
lab<-bkham5$block.membership[bkham5$order.vector]
plot.sociomatrix(bkham5$blocked.data,labels=list(lab,lab))
```



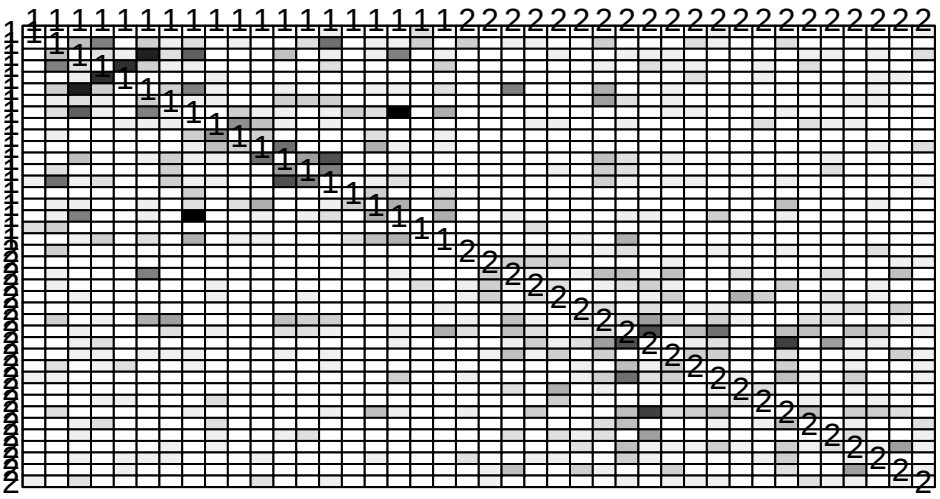
```
lab<-bkfrat5$block.membership[bkfrat5$order.vector]
plot.sociomatrix(bkfrat5$blocked.data,labels=list(lab,lab))
```



```
lab<-bktec5$block.membership[bktec5$order.vector]
plot.sociomatrix(bktec5$blocked.data,labels=list(lab,lab))
```



```
lab<-bkoff5$block.membership[bkoff5$order.vector]
plot.sociomatrix(bkoff5$blocked.data,labels=list(lab,lab))
```



Here the following models are considered: [1,1,1,0], [0,1,1,0], [1,0,0,0], [1,0,0,1] (Borgatti-Everrtte)

Core with in/out interactions: The bktec and bkoff networks do not show strong separation between within core interactions and core-to-periphery interactions. The within core interactions are strong in the bkham and bkfrat networks. The core to periphery interactions can be sparsely seen in the bkham network, but is sgnificant in the bkfrat network.

Core to periphery interaction: The interaction between the core and periphery is increasing in the order of Bkham, bkfrat, bktec,bkoff.

Isolate core: The interactions within core is distinctly seen in the bkham network, whereas for the rest of the networks it is less clear.

Borgatti-Everrtte: In the bktec and bkoff networks, good within core and within periphery interactions can be see. In the bkham network, within core interactions are greater than the within periphery interactions, whereas in the bkfrat network, the periphery intreractions are greater than the within core interations.

### (c) Goodness-of-Fit

Examine the goodness-of-fit scores (in this case, maximized correlations) for each model on each network. Which model fits best (among those which seek to explain all edges)? How much variance is accounted for by each model?

```
# Correlation for bkham network

correlation <- function(bm1,bm2,bm4,bm5){

bm_gof1 <- bm1$block.gof
bm_gof2 <- bm2$block.gof

bm_gof4 <- bm4$block.gof
bm_gof5 <- bm5$block.gof
  corr_vector <- c(bm_gof1,bm_gof2,bm_gof4,bm_gof5)
}

bkham_corr<- correlation(bkham1,bkham2,bkham4,bkham5)
bkfrat_corr<- correlation(bkfrat1,bkfrat2,bkfrat4,bkfrat5)
bktec_corr<- correlation(bktec1,bktec2,bktec4,bktec5)
```

```
bkoff_corr<- correlation(bkoff1,bkoff2,bkoff4,bkoff5)

bkham_corr
```

```
## [1] 0.3625934 0.3273251 0.6959562 0.2096077
```

```
bkfrat_corr
```

```
## [1] 0.4207104 0.3730622 0.5444052 0.2987915
```

```
bktec_corr
```

```
## [1] 0.2292300 0.1791754 0.4442833 0.2486246
```

```
bkoff_corr
```

```
## [1] 0.2258117 0.2158784 0.3523318 0.2646491
```

Considering the 'core with in/out ties' model(as it includes all the edges),we can see that the maximum correlation is for the bkfrat network.(bkfrat_corr)

The calculation of goodness of fit for each model, gives the correlation values of each model on each network. The range of variance accounted by each model for each network is 20% to 42% by the [1,1,1,0] model 15% to 37% by the [0,1,1,0] model 35% to 69% by the [1,0,0,0] model 20% to 31% by the [1,0,0,1] model

### (c) Discussion

Based on the above results, how would you describe the overall structure of these data sets? Are they ultimately similar in form or are there notable differences?

The core periphery structure for the bkham, bkfrat and bktec networks seem to be similar in form for the different models and do not show much variance. The bkoff network shows some variance in terms of the core periphery structure for the different models.