Chapter 3

Nick Lauerman

13 February 2020

Contents

Libraries and data used

Libraries

```r
library(UserNetR)
library(statnet)
```

```
## Loading required package: tergm
```

```
## Loading required package: ergm
```

```
## Loading required package: network
```

```
## network: Classes for Relational Data
## Version 1.16.0 created on 2019-11-30.
## copyright (c) 2005, Carter T. Butts, University of California-Irvine
##                     Mark S. Handcock, University of California -- Los Angeles
##                     David R. Hunter, Penn State University
##                     Martina Morris, University of Washington
##                     Skye Bender-deMoll, University of Washington
##  For citation information, type citation("network").
##  Type help("network-package") to get started.

##
## ergm: version 3.10.4, created on 2019-06-10
## Copyright (c) 2019, Mark S. Handcock, University of California -- Los Angeles
##                     David R. Hunter, Penn State University
##                     Carter T. Butts, University of California -- Irvine
##                     Steven M. Goodreau, University of Washington
##                     Pavel N. Krivitsky, University of Wollongong
##                     Martina Morris, University of Washington
##                     with contributions from
##                     Li Wang
##                     Kirk Li, University of Washington
##                     Skye Bender-deMoll, University of Washington
##                     Chad Klumb
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("ergm").

## NOTE: Versions before 3.6.1 had a bug in the implementation of the bd()
## constriant which distorted the sampled distribution somewhat. In
## addition, Sampson's Monks datasets had mislabeled vertices. See the
## NEWS and the documentation for more details.

## NOTE: Some common term arguments pertaining to vertex attribute and
## level selection have changed in 3.10.0. See terms help for more
## details. Use 'options(ergm.term=list(version="3.9.4"))' to use old
## behavior.

## Loading required package: networkDynamic

##
## networkDynamic: version 0.10.1, created on 2020-01-16
## Copyright (c) 2020, Carter T. Butts, University of California -- Irvine
##                     Ayn Leslie-Cook, University of Washington
##                     Pavel N. Krivitsky, University of Wollongong
##                     Skye Bender-deMoll, University of Washington
##                     with contributions from
##                     Zack Almquist, University of California -- Irvine
##                     David R. Hunter, Penn State University
##                     Li Wang
##                     Kirk Li, University of Washington
##                     Steven M. Goodreau, University of Washington
##                     Jeffrey Horner
##                     Martina Morris, University of Washington
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("networkDynamic").

##
## tergm: version 3.6.1, created on 2019-06-12
## Copyright (c) 2019, Pavel N. Krivitsky, University of Wollongong
##                     Mark S. Handcock, University of California -- Los Angeles
##                     with contributions from
##                     David R. Hunter, Penn State University
##                     Steven M. Goodreau, University of Washington
##                      Martina Morris, University of Washington
##                      Nicole Bohme Carnegie, New York University
##                      Carter T. Butts, University of California -- Irvine
##                      Ayn Leslie-Cook, University of Washington
##                      Skye Bender-deMoll
##                      Li Wang
##                      Kirk Li, University of Washington
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("tergm").

## Loading required package: ergm.count

##
## ergm.count: version 3.4.0, created on 2019-05-15
## Copyright (c) 2019, Pavel N. Krivitsky, University of Wollongong
##                      with contributions from
##                      Mark S. Handcock, University of California -- Los Angeles
##                      David R. Hunter, Penn State University
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("ergm.count").

## NOTE: The form of the term 'CMP' has been changed in version 3.2 of
## 'ergm.count'. See the news or help('CMP') for more information.

## Loading required package: sna

## Loading required package: statnet.common

##
## Attaching package: 'statnet.common'

## The following object is masked from 'package:base':
##
##     order

## sna: Tools for Social Network Analysis
## Version 2.5 created on 2019-12-09.
## copyright (c) 2005, Carter T. Butts, University of California-Irvine
##  For citation information, type citation("sna").
##  Type help(package="sna") to get started.

## Loading required package: tsna

##
## statnet: version 2019.6, created on 2019-06-13
## Copyright (c) 2019, Mark S. Handcock, University of California -- Los Angeles
##                      David R. Hunter, Penn State University
##                      Carter T. Butts, University of California -- Irvine
##                      Steven M. Goodreau, University of Washington
##                      Pavel N. Krivitsky, University of Wollongong
##                      Skye Bender-deMoll
##                      Martina Morris, University of Washington
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("statnet").

## unable to reach CRAN
```

```
#library(igraph) will be loaded in flow to prevent interferance with statnet
library(intergraph)
```

Data

```
data("ICTS_G10")
data("DHHS")
```

Creating and managing networks

creating net in netstat

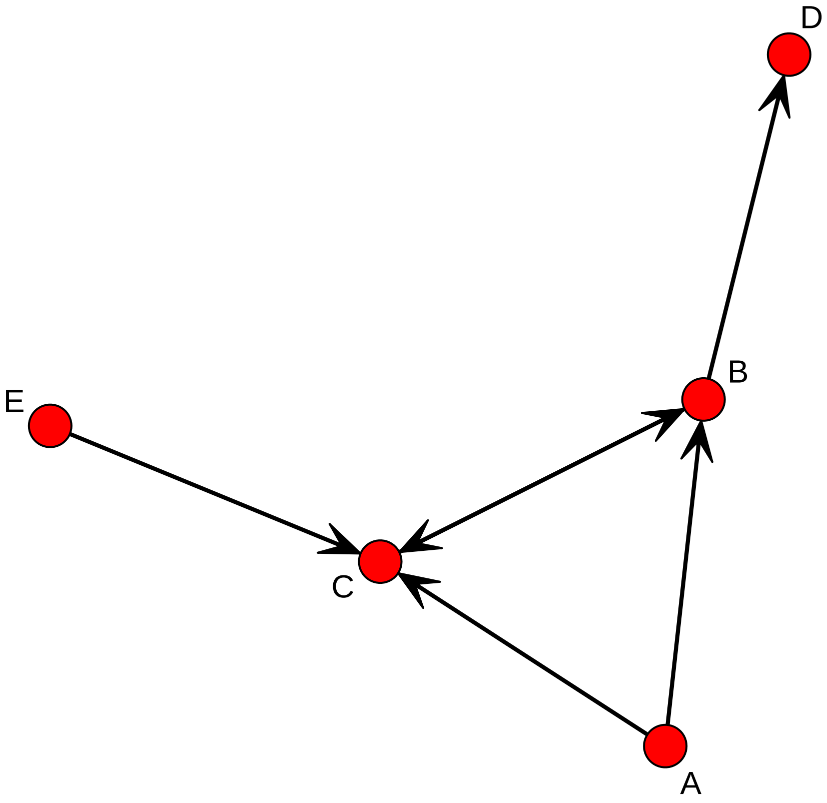
```
netmat1 <- rbind(c(0,1,1,0,0),
                 c(0,0,1,1,0),
                 c(0,1,0,0,0),
                 c(0,0,0,0,0),
                 c(0,0,1,0,0))
rownames(netmat1) <- c("A","B","C","D","E")
colnames(netmat1) <- c("A","B","C","D","E")
net1 <- network(netmat1, matrix.type = "adjacency")
class(net1)
```

```
## [1] "network"
```

```
summary(net1)
```

```
## Network attributes:
##   vertices = 5
##   directed = TRUE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##  total edges = 6
##    missing edges = 0
##    non-missing edges = 6
##  density = 0.3
##
## Vertex attributes:
##   vertex.names:
##    character valued attribute
##    5 valid vertex names
##
## No edge attributes
##
## Network adjacency matrix:
##   A B C D E
## A 0 1 1 0 0
## B 0 0 1 1 0
## C 0 1 0 0 0
## D 0 0 0 0 0
## E 0 0 1 0 0
```

```
gplot(net1,
      vertex.col = 2,
      displaylabels = TRUE)
```



```
netmat2 <- rbind(c(1,2),
                 c(1,3),
                 c(2,3),
                 c(2,4),
                 c(3,2),
                 c(5,3))
net2 <- network(netmat2,
                matrix.type = "edgelist")
network.vertex.names(net2) <- c("A","B","C","D","E")
summary(net2)
```

```
## Network attributes:
##   vertices = 5
##   directed = TRUE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##  total edges = 6
##    missing edges = 0
##    non-missing edges = 6
##  density = 0.3
##
## Vertex attributes:
##   vertex.names:
##    character valued attribute
##    5 valid vertex names
##
## No edge attributes
##
## Network adjacency matrix:
##   A B C D E
## A 0 1 1 0 0
## B 0 0 1 1 0
## C 0 1 0 0 0
## D 0 0 0 0 0
## E 0 0 1 0 0
```

```
as.sociomatrix(net1)
```

```
##   A B C D E
## A 0 1 1 0 0
## B 0 0 1 1 0
## C 0 1 0 0 0
## D 0 0 0 0 0
## E 0 0 1 0 0
```

```
class(as.sociomatrix(net1))
```

```
## [1] "matrix"
```

```
all(as.matrix(net1) == as.sociomatrix(net1))
```

```
## [1] TRUE
```

```
as.matrix(net1, matrix.type = "edgelist")
```

```
##      [,1] [,2]
## [1,]    1    2
## [2,]    3    2
## [3,]    1    3
## [4,]    2    3
## [5,]    5    3
## [6,]    2    4
## attr(,"n")
## [1] 5
## attr(,"vnames")
## [1] "A" "B" "C" "D" "E"
```

Managing Node and Tie Attribures

Node attrib

```
set.vertex.attribute(net1,
                     "gender",
                     c("F","F","M","F","M"))
net1 %v% "alldeg" <- degree(net1)
list.vertex.attributes(net1)
```

```
## [1] "alldeg"       "gender"       "na"           "vertex.names"
```

```
summary(net1)
```

```
## Network attributes:
##   vertices = 5
##   directed = TRUE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##  total edges = 6
##    missing edges = 0
##    non-missing edges = 6
##  density = 0.3
##
## Vertex attributes:
##
##  alldeg:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     1.0     1.0     2.0     2.4     4.0     4.0
##
##  gender:
##    character valued attribute
##    attribute summary:
## F M
## 3 2
##   vertex.names:
##    character valued attribute
##    5 valid vertex names
##
## No edge attributes
##
## Network adjacency matrix:
##   A B C D E
## A 0 1 1 0 0
## B 0 0 1 1 0
## C 0 1 0 0 0
## D 0 0 0 0 0
## E 0 0 1 0 0
```

```
get.vertex.attribute(net1, "gender")
```

```
## [1] "F" "F" "M" "F" "M"
```

```
net1 %v% "alldeg"
```

```
## [1] 2 4 4 1 1
```

Tie Attrib

```
list.edge.attributes(net1)
```

```
## [1] "na"
```

```
set.edge.attribute(net1,
                   "rndval",
                   runif(network.size(net1),0,1))
list.edge.attributes(net1)
```

```
## [1] "na"     "rndval"
```

```
summary(net1 %e% "rndval")
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
## 0.09982 0.43651 0.73669 0.60135 0.82524 0.84366
```

```
summary(get.edge.attribute(net1, "rndval"))
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
## 0.09982 0.43651 0.73669 0.60135 0.82524 0.84366
```

```
netval1 <- rbind(c(0,2,3,0,0),
                 c(0,0,3,1,0),
                 c(0,1,0,0,0),
                 c(0,0,0,0,0),
                 c(0,0,2,0,0))
netval1 <- network(netval1,
                   matrix.type = "adjacency",
                   ignore.eval = FALSE,
                   names.eval = "like")
network.vertex.names(netval1) <- c("A","B","C","D","E")
list.edge.attributes(netval1)
```

```
## [1] "like" "na"
```

```
get.edge.attribute(netval1, "like")
```

```
## [1] 2 1 3 3 2 1
```

```
as.sociomatrix(netval1)
```

```
##   A B C D E
## A 0 1 1 0 0
## B 0 0 1 1 0
## C 0 1 0 0 0
## D 0 0 0 0 0
## E 0 0 1 0 0
```

```
as.sociomatrix(netval1)
```

```
##   A B C D E
## A 0 1 1 0 0
## B 0 0 1 1 0
## C 0 1 0 0 0
## D 0 0 0 0 0
## E 0 0 1 0 0
```

Creating network object in igraph

```
detach(package:statnet, unload = TRUE)
detach(package:sna, unload = TRUE)
detach(package:tsna, unload = TRUE)
detach(package:ergm.count, unload = TRUE)
detach(package:tergm, unload = TRUE)
detach(package:networkDynamic, unload = TRUE)
detach(package:ergm, unload = TRUE)
detach(package:network, unload = TRUE)
```

```
## Warning: 'network' namespace cannot be unloaded:
##   namespace 'network' is imported by 'intergraph' so cannot be unloaded
```

```
detach(package:statnet.common, unload = TRUE)
library(igraph)
```

```
##
## Attaching package: 'igraph'

## The following objects are masked from 'package:stats':
##
##     decompose, spectrum

## The following object is masked from 'package:base':
##
##     union
```

```
inet1 <- graph.adjacency(netmat1)
class(inet1)
```

```
## [1] "igraph"
```

```
summary(inet1)
```

```
## IGRAPH dc206de DN-- 5 6 --
## + attr: name (v/c)
```

```
#str(inet1)
inet2 <- graph.edgelist(netmat2)
summary(inet2)
```

```
## IGRAPH dc21cd7 D--- 5 6 --
```

```
V(inet2)$name <- c("A","B","C","D","E")
E(inet2)$val <- c(1:6)
summary(inet2)
```

```
## IGRAPH dc21cd7 DN-- 5 6 --
## + attr: name (v/c), val (e/n)
```

```
#str(inet2)
```

Going back and forth between statman and igraph

```
library(intergraph)
```

```
class(net1)
```

```
## [1] "network"
```

```
net1igraph <- asIgraph(net1)
class(net1igraph)
```

```
## [1] "igraph"
```

```
#str(net1igraph)
```

importing network data

```
detach(package:igraph, unload = TRUE)
library(statnet)
```

```
## Loading required package: tergm
```

```
## Loading required package: ergm
```

```
## Loading required package: network
```

```
## network: Classes for Relational Data
## Version 1.16.0 created on 2019-11-30.
## copyright (c) 2005, Carter T. Butts, University of California-Irvine
##                     Mark S. Handcock, University of California -- Los Angeles
##                     David R. Hunter, Penn State University
##                     Martina Morris, University of Washington
##                     Skye Bender-deMoll, University of Washington
##  For citation information, type citation("network").
##  Type help("network-package") to get started.
```

```
##
## ergm: version 3.10.4, created on 2019-06-10
## Copyright (c) 2019, Mark S. Handcock, University of California -- Los Angeles
##                     David R. Hunter, Penn State University
##                     Carter T. Butts, University of California -- Irvine
##                     Steven M. Goodreau, University of Washington
##                     Pavel N. Krivitsky, University of Wollongong
##                     Martina Morris, University of Washington
##                     with contributions from
##                     Li Wang
##                     Kirk Li, University of Washington
##                     Skye Bender-deMoll, University of Washington
##                     Chad Klumb
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("ergm").
```

```
## NOTE: Versions before 3.6.1 had a bug in the implementation of the bd()
## constriant which distorted the sampled distribution somewhat. In
## addition, Sampson's Monks datasets had mislabeled vertices. See the
## NEWS and the documentation for more details.
## NOTE: Some common term arguments pertaining to vertex attribute and
## level selection have changed in 3.10.0. See terms help for more
## details. Use 'options(ergm.term=list(version="3.9.4"))' to use old
## behavior.
```

```
## Loading required package: networkDynamic
```

```
##
## networkDynamic: version 0.10.1, created on 2020-01-16
## Copyright (c) 2020, Carter T. Butts, University of California -- Irvine
##                     Ayn Leslie-Cook, University of Washington
##                     Pavel N. Krivitsky, University of Wollongong
##                     Skye Bender-deMoll, University of Washington
##                     with contributions from
##                     Zack Almquist, University of California -- Irvine
##                     David R. Hunter, Penn State University
##                     Li Wang
##                     Kirk Li, University of Washington
##                     Steven M. Goodreau, University of Washington
##                     Jeffrey Horner
##                     Martina Morris, University of Washington
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("networkDynamic").
```

```
##
## tergm: version 3.6.1, created on 2019-06-12
## Copyright (c) 2019, Pavel N. Krivitsky, University of Wollongong
##                     Mark S. Handcock, University of California -- Los Angeles
##                     with contributions from
##                     David R. Hunter, Penn State University
##                     Steven M. Goodreau, University of Washington
##                     Martina Morris, University of Washington
##                     Nicole Bohme Carnegie, New York University
##                     Carter T. Butts, University of California -- Irvine
##                     Ayn Leslie-Cook, University of Washington
##                     Skye Bender-deMoll
##                     Li Wang
##                     Kirk Li, University of Washington
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("tergm").
```

```
## Loading required package: ergm.count
```

```
##
## ergm.count: version 3.4.0, created on 2019-05-15
## Copyright (c) 2019, Pavel N. Krivitsky, University of Wollongong
##                     with contributions from
##                     Mark S. Handcock, University of California -- Los Angeles
##                     David R. Hunter, Penn State University
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("ergm.count").
```

```
## NOTE: The form of the term 'CMP' has been changed in version 3.2 of
## 'ergm.count'. See the news or help('CMP') for more information.
## Loading required package: sna
```

```
## Loading required package: statnet.common
```

```
##
## Attaching package: 'statnet.common'
```

```
## The following object is masked from 'package:base':
##
##     order
```

```
## sna: Tools for Social Network Analysis
## Version 2.5 created on 2019-12-09.
## copyright (c) 2005, Carter T. Butts, University of California-Irvine
##  For citation information, type citation("sna").
##  Type help(package="sna") to get started.
```

```
## Loading required package: tsna
```

```
##
## statnet: version 2019.6, created on 2019-06-13
## Copyright (c) 2019, Mark S. Handcock, University of California -- Los Angeles
##                     David R. Hunter, Penn State University
##                     Carter T. Butts, University of California -- Irvine
##                     Steven M. Goodreau, University of Washington
##                     Pavel N. Krivitsky, University of Wollongong
##                     Skye Bender-deMoll
##                     Martina Morris, University of Washington
## Based on "statnet" project software (statnet.org).
## For license and citation information see statnet.org/attribution
## or type citation("statnet").
```

```
## unable to reach CRAN
```

```
netmat3 <- rbind(c("A","B"),
                 c("A","C"),
                 c("B","C"),
                 c("B","D"),
                 c("C","B"),
                 c("E","C"))
net.df <- data.frame(netmat3)
net.df
```

```
##   X1 X2
## 1  A  B
## 2  A  C
## 3  B  C
## 4  B  D
## 5  C  B
## 6  E  C
```

```
write.csv(net.df,
          file = "MyData.csv",
          row.names = FALSE)
net.edge <- read.csv(file = "MyData.csv")
net_import <- network(net.edge,
                      matrix.type = "edgelist")
summary(net_import)
```

```
## Network attributes:
##   vertices = 5
##   directed = TRUE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##  total edges = 6
##    missing edges = 0
##    non-missing edges = 6
##  density = 0.3
##
## Vertex attributes:
##   vertex.names:
##    character valued attribute
##    5 valid vertex names
##
## No edge attributes
##
## Network adjacency matrix:
##   A B C D E
## A 0 1 1 0 0
## B 0 0 1 1 0
## C 0 1 0 0 0
## D 0 0 0 0 0
## E 0 0 1 0 0
```

```
gden(net_import)
```

```
## [1] 0.3
```

Common network data tasks

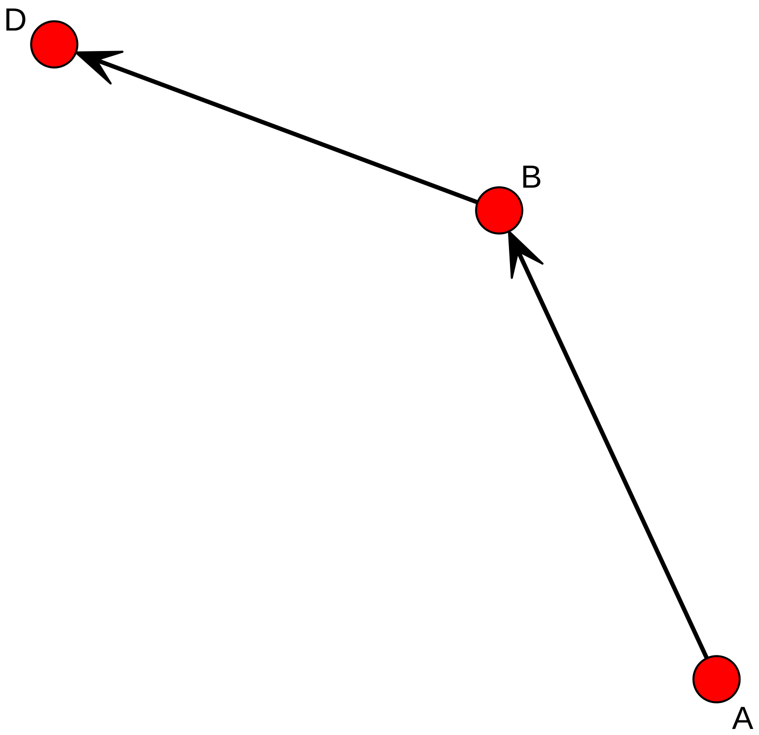
Filtering networks daved on vertex or edge attribute values

Filtering based on Node Values

```
n1F <- get.inducedSubgraph(net1,
                           which(net1 %v% "gender" == "F"))
n1F[,]
```

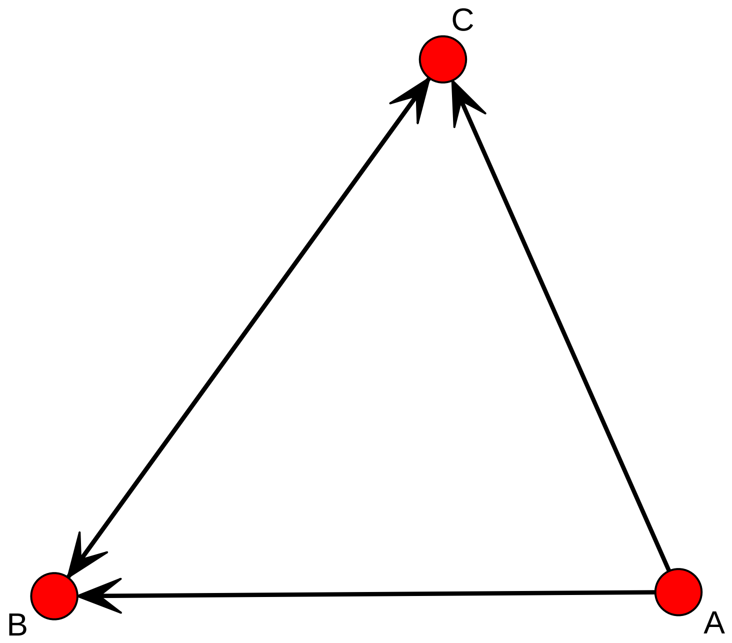
```
##   A B D
## A 0 1 0
## B 0 0 1
## D 0 0 0
```

```
gplot(n1F, displaylabels = TRUE)
```



```
deg <- net1 %v% "alldeg"
n2 <- get.inducedSubgraph(net1, which(deg > 1))
```

```
gplot(n2, displaylabels = TRUE)
```



remove isolates

```
data("ICTS_G10")
summary(ICTS_G10, print.adj = FALSE )
```

```
## Network attributes:
##   vertices = 493
##   directed = FALSE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##   title = G10_Pajek
##  total edges = 1359
##    missing edges = 0 
##    non-missing edges = 1359 
##  density = 0.01120566 
## 
## Vertex attributes:
## 
##  DiscCol:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##    1100    3600    6500    5231    6500    8888 
## 
##  DiscExp:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##    1100    2800    6540    5067    6910    8888 
##   vertex.names:
##    character valued attribute
##    493 valid vertex names
## 
##  year:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##    2008    2008    2009    2009    2010    2010 
## 
## No edge attributes
```

```r
gden(ICTS_G10)
```

```
## [1] 0.01120566
```

```r
length(isolates(ICTS_G10))
```

```
## [1] 96
```

```r
n3 <- ICTS_G10
delete.vertices(n3, isolates(n3))
gden(n3)
```

```
## [1] 0.01728876
```

```r
length(isolates(n3))
```

```
## [1] 0
```

filtering based on edge values

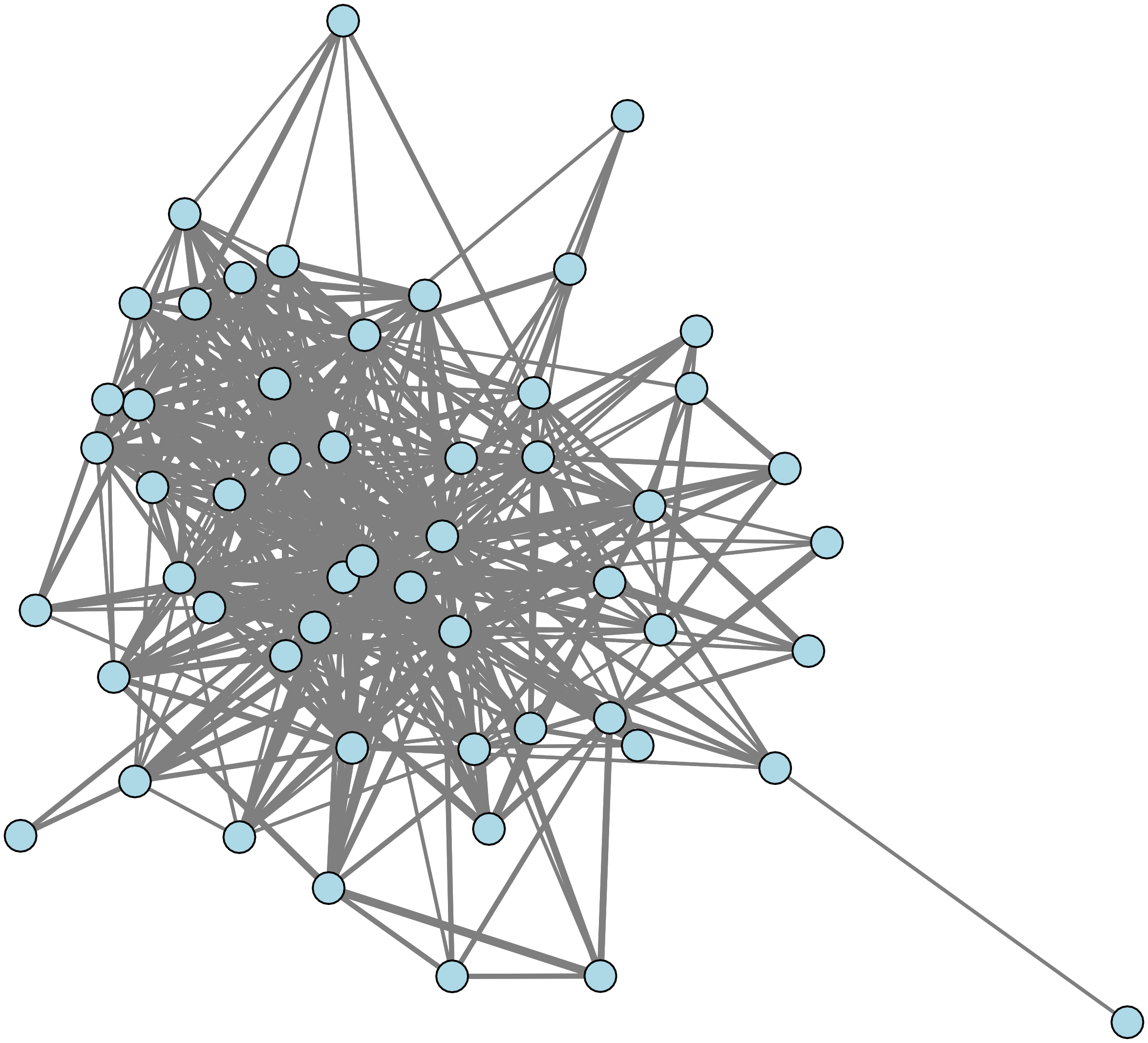
```r
data("DHHS")
summary(DHHS, print.adj = FALSE )
```

```
## Network attributes:
##   vertices = 54 
##   directed = FALSE 
##   hyper = FALSE 
##   loops = FALSE 
##   multiple = FALSE
##   bipartite = FALSE
##   title = DHHS_Collab
##  total edges = 447
##    missing edges = 0
##    non-missing edges = 447
##  density = 0.312369
##
## Vertex attributes:
##
##  agency:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   2.000   6.500   5.185   7.000  10.000
##   vertex.names:
##    character valued attribute
##    54 valid vertex names
##
## Edge attributes:
##
##  collab:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   1.000   2.000   2.199   3.000   4.000
```

```
d <- DHHS
gden(d)
```

```
## [1] 0.312369
```

```
op <- par(mar = rep(0,4))
gplot(d,
      gmode = "graph",
      edge.lwd = d %e% 'collab',
      edge.col = "grey50",
      vertex.col = "lightblue",
      vertex.cex = 1.0,
      vertex.sides = 20)
```



```
par(op)
as.sociomatrix(d)[1:6,1:6]
```

```
##        ACF-1 ACF-2 AHRQ-1 AHRQ-2 AHRQ-3 AHRQ-4
## ACF-1      0     1      0      0      0      0
## ACF-2      1     0      0      0      0      0
## AHRQ-1     0     0      0      1      1      1
## AHRQ-2     0     0      1      0      1      1
## AHRQ-3     0     0      1      1      0      1
## AHRQ-4     0     0      1      1      1      0
```

```
table(d %e% "collab")
```

```
##
##   1   2   3   4
## 163 111  94  79
```

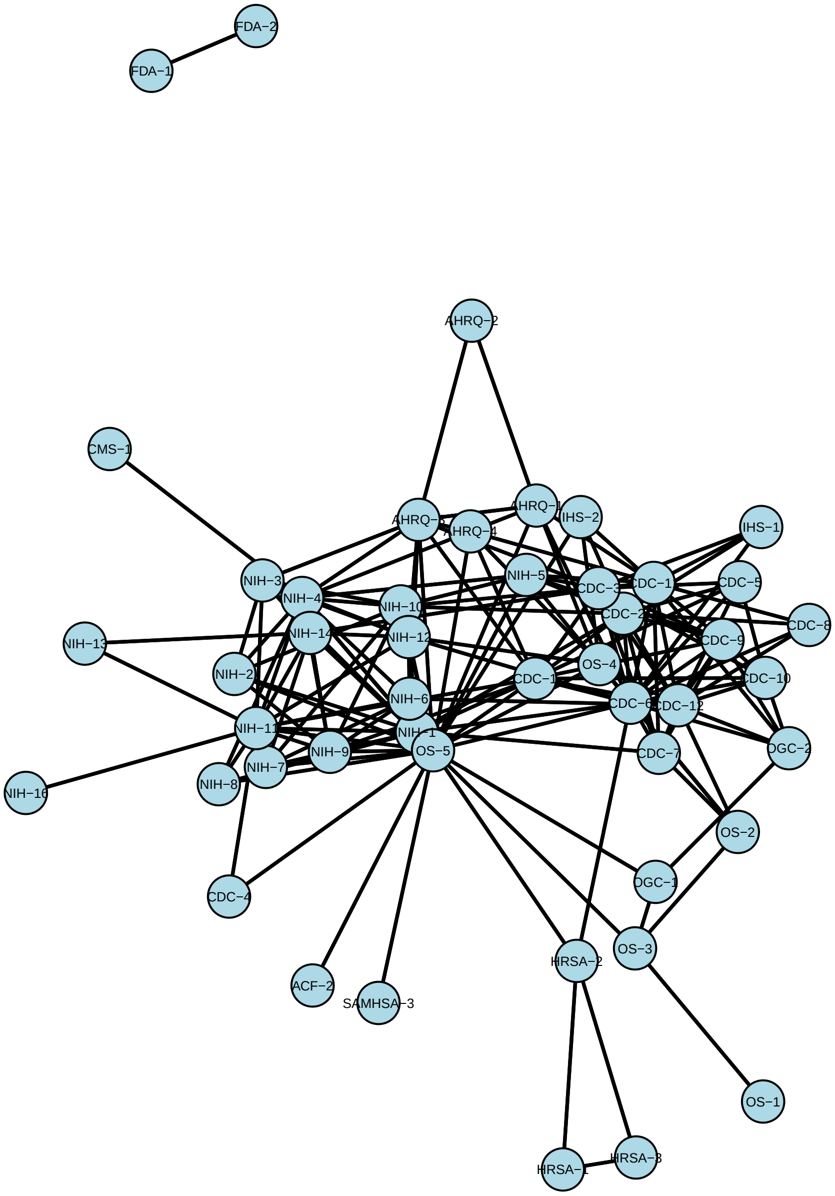
```
d.val <- as.sociomatrix(d, attrname = "collab")
d.val[d.val < 3] <-  0
d.filt <- as.network(d.val,
                     directed = FALSE,
                     matrix.type = "a",
                     ignore.eval = FALSE,
                     names.eval = "collab")
summary(d.filt, print.adj = FALSE)
```

```
## Network attributes:
##   vertices = 54
##   directed = FALSE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##  total edges = 173
##    missing edges = 0
##    non-missing edges = 173
##  density = 0.1208945
##
## Vertex attributes:
##   vertex.names:
##    character valued attribute
##    54 valid vertex names
##
## Edge attributes:
##
##  collab:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   3.000   3.000   3.000   3.457   4.000   4.000
```

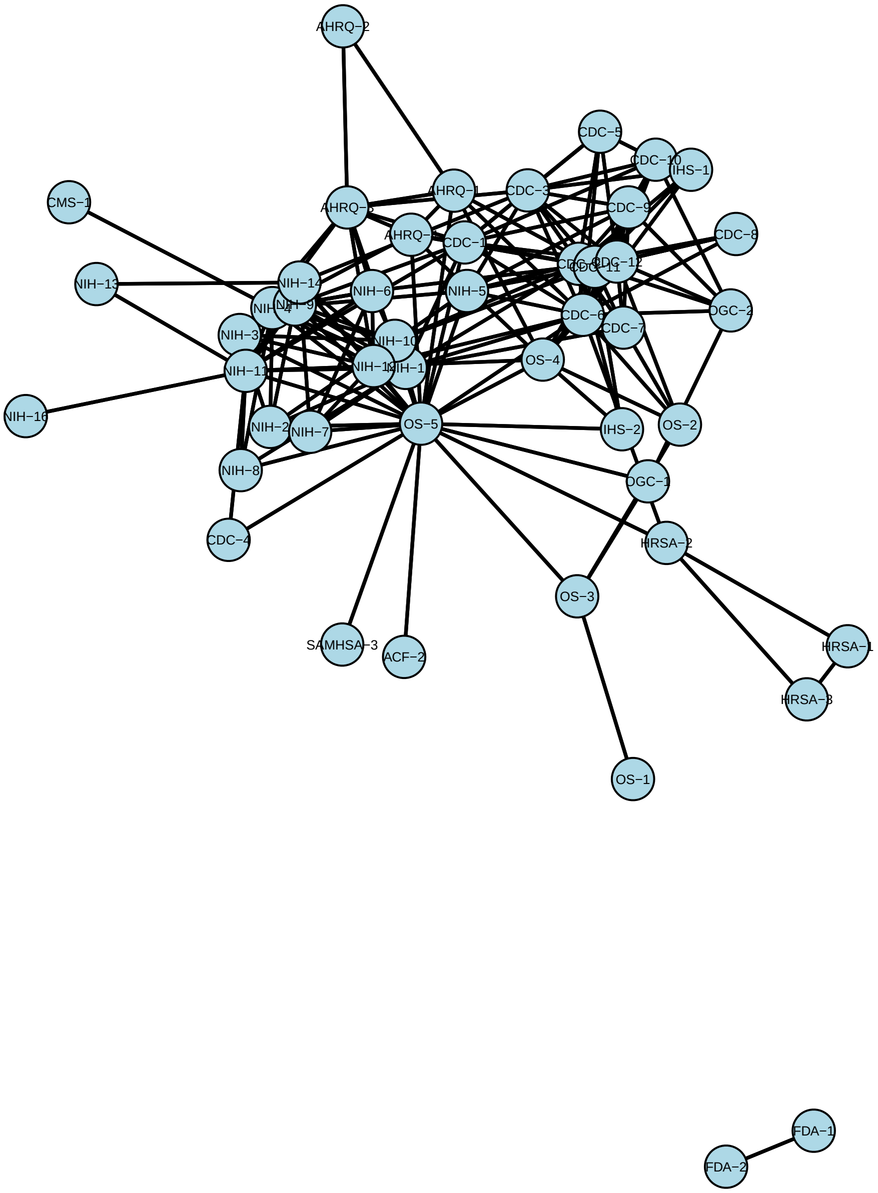
```
gden(d.filt)
```

```
## [1] 0.1208945
```

```
op <- par(mar = rep(0,4))
gplot(d.filt,
      gmode = "graph",
      displaylabels = TRUE,
      vertex.col = "lightblue",
      vertex.cex = 1.3,
      label.cex = 0.4,
      label.pos = 5,
      displayisolates = FALSE)
```



```r
par(op)
op <- par(mar = rep(0,4))
d.val <- as.sociomatrix(d, attrname = "collab")
gplot(d.val,
      gmode = "graph",
      thresh = 2,
      displaylabels = TRUE,
      vertex.col = "lightblue",
      vertex.cex = 1.3,
      label.cex = 0.4,
      label.pos = 5,
      displayisolates = FALSE)
```



```
par(op)
```

transformining directed to non-directed network

```
net1mat <- symmetrize(net1,
                      rule = "weak")
net1mat
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    0    1    1    0    0
## [2,]    1    0    1    1    0
## [3,]    1    1    0    0    1
## [4,]    0    1    0    0    0
## [5,]    0    0    1    0    0
```

```
net1symm <- network(net1mat,
                    matrix.type = "adjacency")
network.vertex.names(net1symm) <- c("A","B","C","D","E")
summary(net1symm)
```

```
## Network attributes:
##   vertices = 5
##   directed = TRUE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##  total edges = 10
##    missing edges = 0
##    non-missing edges = 10
##  density = 0.5
##
## Vertex attributes:
##   vertex.names:
##    character valued attribute
##    5 valid vertex names
##
## No edge attributes
##
## Network adjacency matrix:
##   A B C D E
## A 0 1 1 0 0
## B 1 0 1 1 0
## C 1 1 0 0 1
## D 0 1 0 0 0
## E 0 0 1 0 0
```