SIENA WORKSHOP

Introduction to Social Network Analysis with R

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The Netherlands
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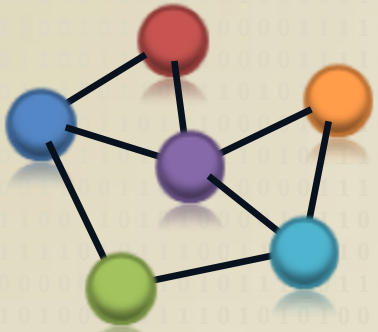
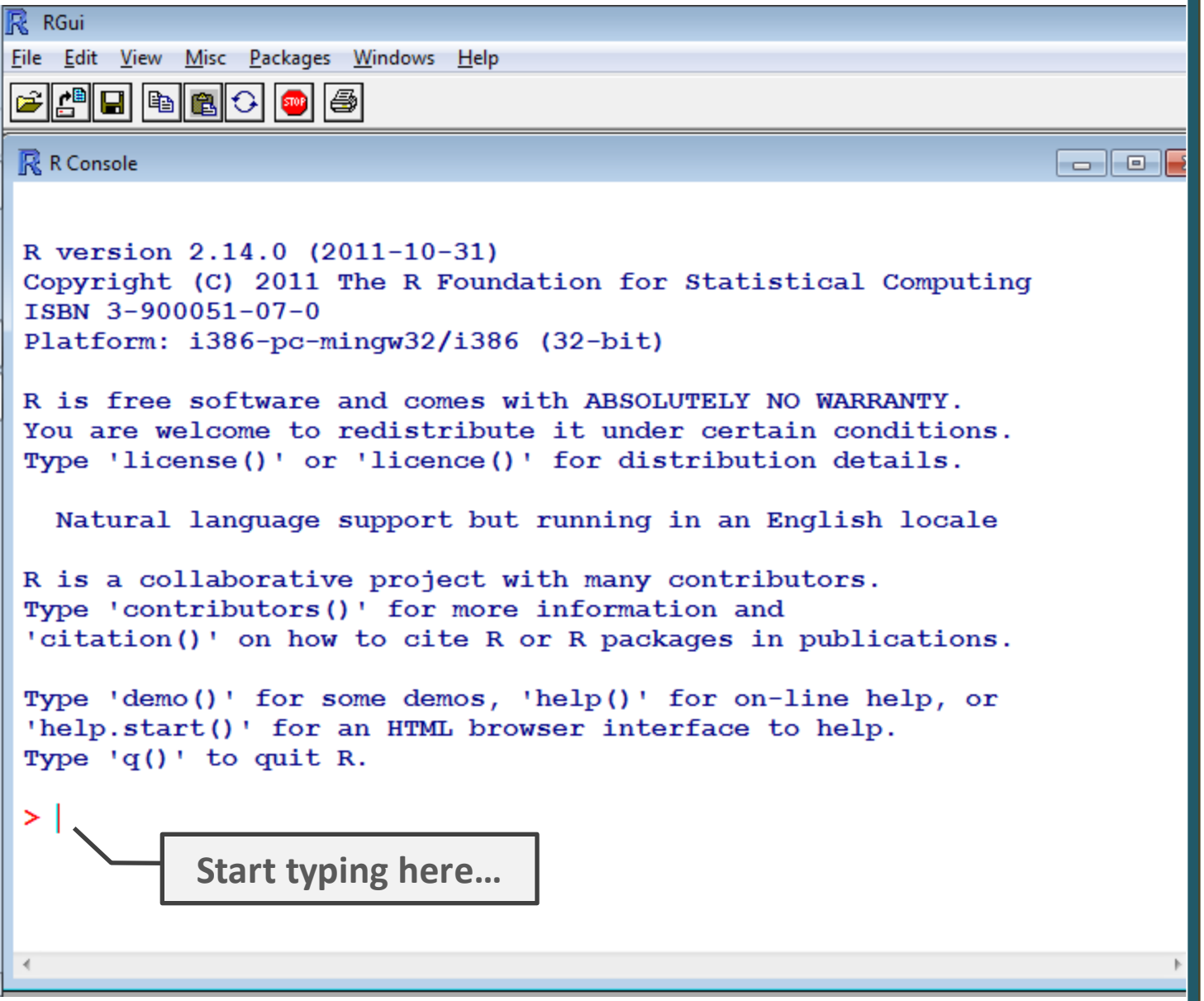


University of Groningen, January 23-27, 2011

Introducing social network data

- Some basic commands in R
- Creating and drawing a network
- Some matrix manipulation and reciprocity
- More matrix manipulation and triad census
- Importing data and analysing some basics

1. SOME BASIC COMMANDS IN R



R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

RGui

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R Console

```
R version 2.14.0 (2011-10-31)
Copyright (C) 2011 The R Foundation for Statistical Computing
ISBN 3-900051-07-0
Platform: i386-pc-mingw32/i386 (32-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
>
```

What is the working directory?

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
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- ls()
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Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd("E:/workshop")
Error: unexpected input in "setwd("
>
```

Change the working directory

Ohoh…something went wrong: (“) is not the same as (")!

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
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Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd("E:/workshop")
Error: unexpected input in "setwd("
> setwd("E:/workshop")
>
```

Change the working directory

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
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Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd("E:/workshop")
Error: unexpected input in "setwd(""
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
>
```

Just checking…

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
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> getwd()
[1] "C:/Users/A/Documents"
> setwd("E:/workshop")
Error: unexpected input in "setwd("
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
>
```

Which files are in my working directory?

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
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Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd(“E:/workshop”)
Error: unexpected input in "setwd(“"
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
>
```

Creates an object and assigns a value to it
Read this as: “a gets 5.264”

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
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- b=3.2
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Type 'demo()' for some demos, 'help()' for on-line help, or
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Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd("E:/workshop")
Error: unexpected input in "setwd(""
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
>
```

Just checking that the program did what I asked…

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
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- ls()
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- c!=13
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- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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R Console

```
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd("E:/workshop")
Error: unexpected input in "setwd(""
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
>
```

Notice that R distinguishes "a" from "A"

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
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- b=3.2
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- c<-a+10
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- ls()
- c==a
- c!=13
- d<-(c!=13)
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- rm(a)
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- rm(a,b,c,d)
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R Console

```
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd("E:/workshop")
Error: unexpected input in "setwd("
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
>
```

Most R-people prefer "<-" over "="

R COMMANDS

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- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
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- rm(a)
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- rm(a,b,c,d)
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R Console

```
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> getwd()
[1] "C:/Users/A/Documents"
> setwd(“E:/workshop”)
Error: unexpected input in "setwd(“"
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
>
```

But it does work…

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
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- d
- rm(a)
- ls()
- rm(a,b,c,d)
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```
> getwd()
[1] "C:/Users/A/Documents"
> setwd(“E:/workshop”)
Error: unexpected input in "setwd(“"
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
>
```

Here is how to multiply

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
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- d
- rm(a)
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- rm(a,b,c,d)
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- ?rm

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R Console

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[1] "C:/Users/A/Documents"
> setwd(“E:/workshop”)
Error: unexpected input in "setwd(“"
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
>
```

And add

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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```
> setwd("E:/workshop")
Error: unexpected input in "setwd(""
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
>
```

Assign this as a new object

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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R Console

```
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
>
```

Yes, this is right…

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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R Console

```
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat" "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat" "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
>
```

What objects did my R program save so far?

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
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```
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat" "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat" "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
>
```

Is “c” equal to “a”?
Note the double “==”! Else, “c” would have gotten the value currently assigned to “a”

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- getwd()
- setwd(“E:/workshop”)
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- getwd()
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- a<-5.264
- a
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R Console

```
[5] "klas03e-friends-waveB.dat" "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat" "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
>
```

Is “c” NOT equal to “a”?
Note that “!” stands for “NOT”

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

RGui

File Edit View Misc Packages Windows Help

R Console

```
[7] "klas03e-friends-waveD.dat" "klas03e-primary.dat"
> a<-5.264
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
>
```

A logical statement can also be assigned to an object

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

RGui

File Edit View Misc Packages Windows Help

R Console

```
> a
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
> d
[1] TRUE
>
```

In this: TRUE = 1 and FALSE = 0

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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R Console

```
[1] 5.264
> A
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
> d
[1] TRUE
> rm(a)
>
```

rm(a) => remove the object “a” from the memory

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

RGui

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R Console

```
Error: object 'A' not found
> b=3.2
> b
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
> d
[1] TRUE
> rm(a)
> ls()
[1] "b" "c" "d"
>
```

Check what is still in your R memory

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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R Console

```
[1] 3.2
> a*3
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
> d
[1] TRUE
> rm(a)
> ls()
[1] "b" "c" "d"
> rm(a,b,c,d)
Warning message:
In rm(a, b, c, d) : object 'a' not found
>
```

Let's remove everything. Note that "a" was already removed and R gives a warning for this (in case you misspelled something).

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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R Console

```
[1] 15.792
> a+10
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
> d
[1] TRUE
> rm(a)
> ls()
[1] "b" "c" "d"
> rm(a,b,c,d)
Warning message:
In rm(a, b, c, d) : object 'a' not found
> ls()
character(0)
>
```

Checking…

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

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R Console

```
[1] 15.264
> c<-a+10
> c
[1] 15.264
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
> d
[1] TRUE
> rm(a)
> ls()
[1] "b" "c" "d"
> rm(a,b,c,d)
Warning message:
In rm(a, b, c, d) : object 'a' not found
> ls()
character(0)
> ?rm
starting httpd help server ... done
>
```

Want to know more about a command? Put "?" in front of it.

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

http://127.0.0.1:

R: Remove Objects from a ...

File Edit View Favorites Tools Help

remove {base} R Documentation

Remove Objects from a Specified Environment

Description

`remove` and `rm` can be used to remove objects. These can be specified successively as character strings, or in the character vector `list`, or through a combination of both. All objects thus specified will be removed.

If `envir` is NULL then the currently active environment is searched first.

If `inherits` is `TRUE` then parents of the supplied directory are searched until a variable with the given name is encountered. A warning is printed for each variable that is not found.

Usage

```
remove(..., list = character(), pos = -1,
       envir = as.environment(pos), inherits = FALSE)

rm     (..., list = character(), pos = -1,
       envir = as.environment(pos), inherits = FALSE)
```

Arguments

100%

R COMMANDS

- getwd()
- setwd(“E:/workshop”)
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

http://127.0.0.1:

R: Remove Objects from a ...

File Edit View Favorites Tools Help

Arguments

`...`	the objects to be removed, as names (unquoted) or character strings (quoted).
`list`	a character vector naming objects to be removed.
`pos`	where to do the removal. By default, uses the current environment. See 'details' for other possibilities.
`envir`	the `environment` to use. See 'details'.
`inherits`	should the enclosing frames of the environment be inspected?

Details

The `pos` argument can specify the environment from which to remove the objects in any of several ways: as an integer (the position in the `search` list); as the character string name of an element in the search list; or as an `environment` (including using `sys.frame` to access the currently active function calls). The `envir` argument is an alternative way to specify an environment, but is primarily there for back compatibility.

It is not allowed to remove variables from the base environment and base namespace, nor from any environment which is locked (see `lockEnvironment`).

Earlier versions of R incorrectly claimed that supplying a character vector in `...` removed the objects named in the character vector, but it removed the character vector. Use the `list` argument to specify objects *via* a character vector.

References

100%

R COMMANDS

- getwd()
- setwd("E:/workshop")
- setwd("E:/workshop")
- getwd()
- list.files()
- a<-5.264
- a
- A
- b=3.2
- b
- a*3
- a+10
- c<-a+10
- c
- ls()
- c==a
- c!=13
- d<-(c!=13)
- d
- rm(a)
- ls()
- rm(a,b,c,d)
- ls()
- ?rm

2. CREATING AND PLOTTING A NETWORK

RGui

File Edit View Misc Packages Windows Help

R Console

```
> ls()
[1] "a" "b" "c"
> c==a
[1] FALSE
> c!=13
> rm(a)
> ls()
[1] "b" "c" "d"
> rm(a,b,c,d)
Warning message:
In rm(a, b, c, d) : object 'a' not found
> ls()
character(0)
> ?rm
starting httpd help server ... done
> install.packages("sna")
Installing package(s) into 'C:/Users/A/D ry/2.14'
(as 'lib' is unspecified)
--- Please select a CRAN mirror for use in this session ---
```

It's asking you which server you want to get the package from…

CRAN mirror

- Argentina (La Plata)
- Argentina (Mendoza)
- Australia (Canberra)
- Australia (Melbourne)
- Austria
- Belgium
- Brazil (PR)
- Brazil (RJ)
- Brazil (SP 1)
- Brazil (SP 2)
- Canada (BC)
- Canada (NS)
- Canada (ON)
- Canada (QC 1)
- Canada (QC 2)
- Chile
- China (Beijing 1)
- China (Beijing 2)
- China (Beijing 3)
- China (Hefei)
- China (Xiamen)
- Colombia (Bogota)
- Colombia (Cali)

OK Cancel

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
> ls()
[1] FALSE
> c!=13
[1] TRUE
> d<-(c!=13)
> d
[1] TRUE
> rm(a)
> ls()
[1] "b" "c" "d"
> rm(a,b,c,d)
Warning message:
In rm(a, b, c, d) : object 'a' not found
> ls()
character(0)
> ?rm
starting httpd help server ... done
> install.packages("sna")
Installing package(s) into 'C:/Users/A/D ... ry/2.14'
(as 'lib' is unspecified)
--- Please select a CRAN mirror for use in this session ---
```

Let's go for somewhere nearby

CRAN mirror

- Mexico (Texcoco)
- Netherlands (Amsterdam)
- Netherlands (Utrecht)
- New Zealand
- Norway
- Philippines
- Poland (Oswiecim)
- Poland (Wroclaw)
- Russia
- Singapore
- Slovakia 1
- Slovakia 2
- South Africa
- Spain (Madrid)
- Sweden
- Switzerland
- Taiwan (Taichung)
- Taiwan (Taipei)
- Thailand
- UK (Bristol)
- UK (London)
- UK (St Andrews)
- USA (AZ)

OK Cancel

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
> rm(a)
>
[
> rm(a,b,c,d)
Warning message:
In rm(a, b, c, d) : object 'a' not found
> ls()
character(0)
> ?rm
starting httpd help server ... done
> install.packages("sna")
Installing package(s) into 'C:/Users/A/Documents/R/win-library/2.14'
(as 'lib' is unspecified)
--- Please select a CRAN mirror for use in this session ---
trying URL 'http://cran-mirror.cs.uu.nl/bin/windows/contrib/2.14/sna_$
Content type 'application/zip' length 828235 bytes (808 Kb)
opened URL
downloaded 808 Kb

package 'sna' successfully unpacked and MD5 sums checked

The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> |
```

Success… ☺

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
character(0)
> ?rm
starting httpd help server ... done
> install.packages("sna")
Installing package(s) into 'C:/Users/A/Documents/R/win-library/2.14'
(as 'lib' is unspecified)
--- Please select a CRAN mirror for use in this session ---
trying URL 'http://cran-mirror.cs.uu.nl/bin/windows/contrib/2.14/sna_$
Content type 'application/zip' length 828235 bytes (808 Kb)
opened URL
downloaded 808 Kb

package 'sna' successfully unpacked and MD5 sums checked

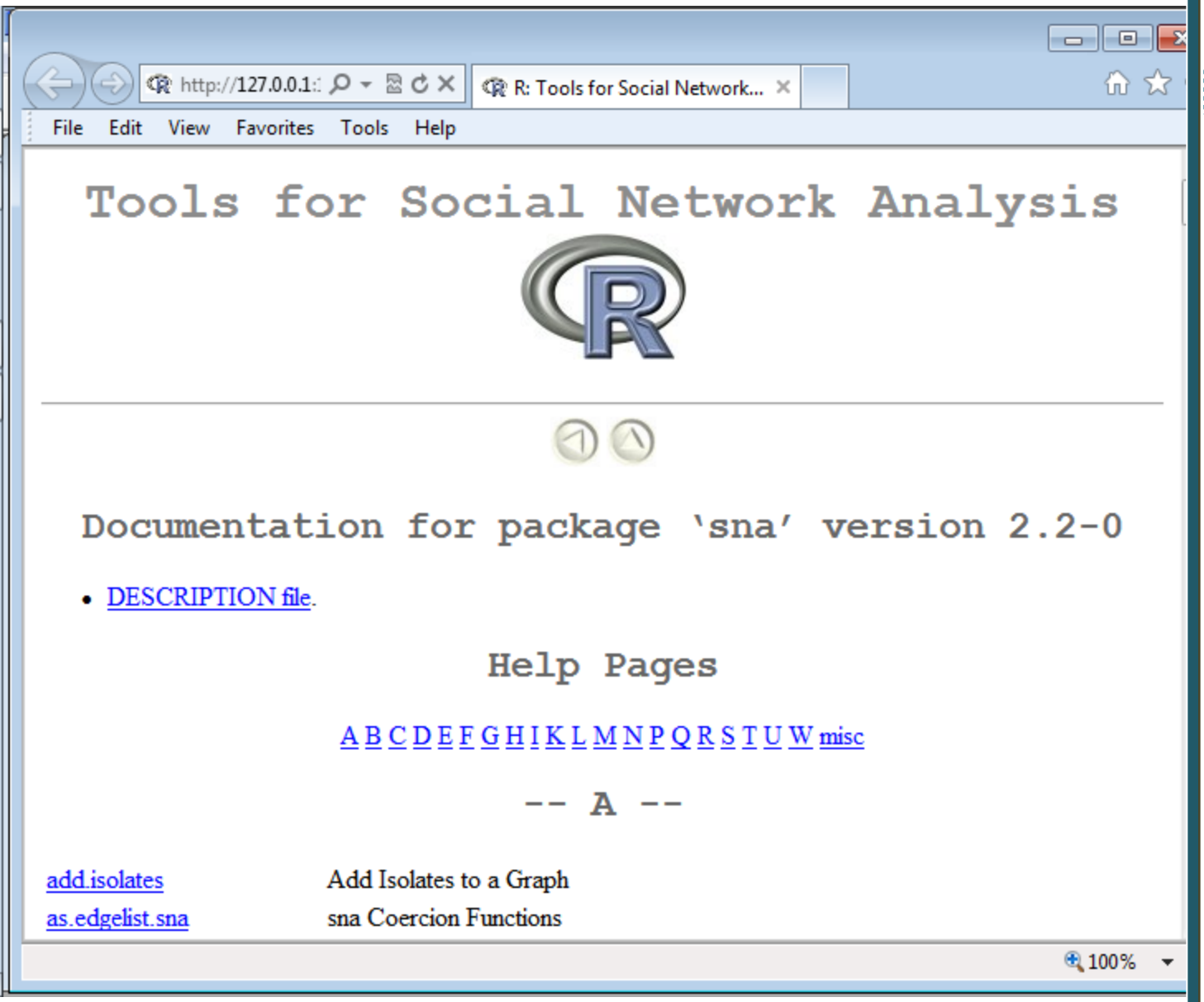
The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
>
```

And this is R 2.14.0… problem?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)



R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
> ?rm
starting httpd help server ... done
> install.packages("sna")
Installing package(s) into 'C:/Users/A/Documents/R/win-library/2.14'
(as 'lib' is unspecified)
--- Please select a CRAN mirror for use in this session ---
trying URL 'http://cran-mirror.cs.uu.nl/bin/windows/contrib/2.14/sna_$
Content type 'application/zip' length 828235 bytes (808 Kb)
opened URL
downloaded 808 Kb

package 'sna' successfully unpacked and MD5 sums checked

The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
>
```

Here is how to create a small matrix and to make it as a matrix

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
> ?rm
starting httpd help server ... done
> install.packages("sna")
Installing package(s) int                    ocuments/R/win-library/2.14'
(as 'lib' is unspecified)
--- Please select a CRAN                     in this session ---
trying URL 'http://cran-m                    bin/windows/contrib/2.14/sna_$
Content type 'application                    8235 bytes (808 Kb)
opened URL
downloaded 808 Kb

package 'sna' successfull                    MD5 sums checked

The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
>
```

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

Here is how to create a small matrix and to make it as a matrix

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
trying URL 'http://cran-mirror.cs.uu.nl/bin/windows/contrib/2.14/sna_$
Content type 'application/zip' length 828235 bytes (808 Kb)
opened URL
downloaded 808 Kb

package 'sna' successfully unpacked and MD5 sums checked

The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> |
```

Check!

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

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R Console

```
opened URL
downloaded 808 Kb

package 'sna' successfully unpacked and MD5 sums checked

The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
>
```

How many actors (number of rows) are in the matrix?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
downloaded 808 Kb

package 'sna' successfully unpacked and MD5 sums checked

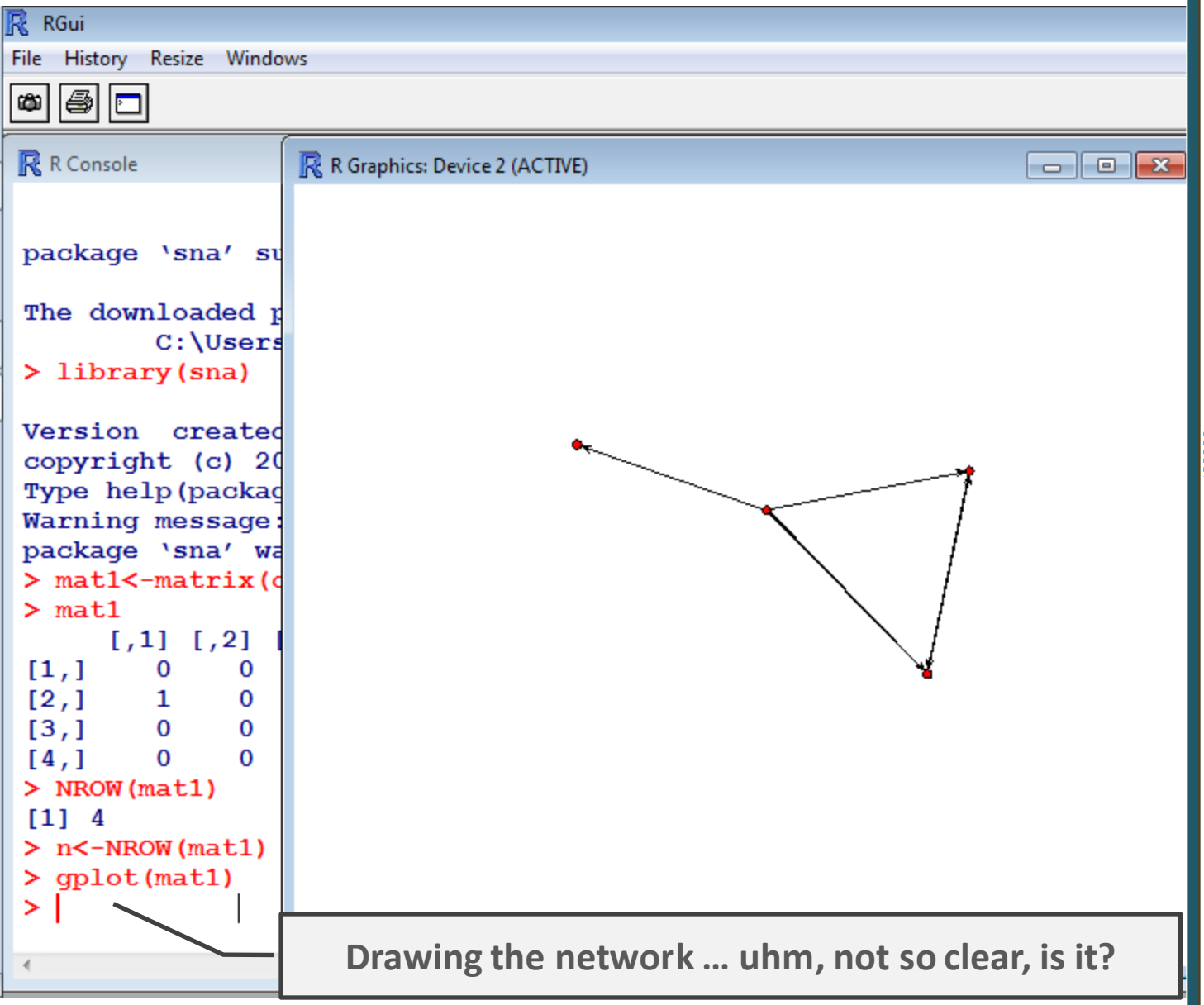
The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
>
```

Let's keep this as an object "n"

R COMMANDS

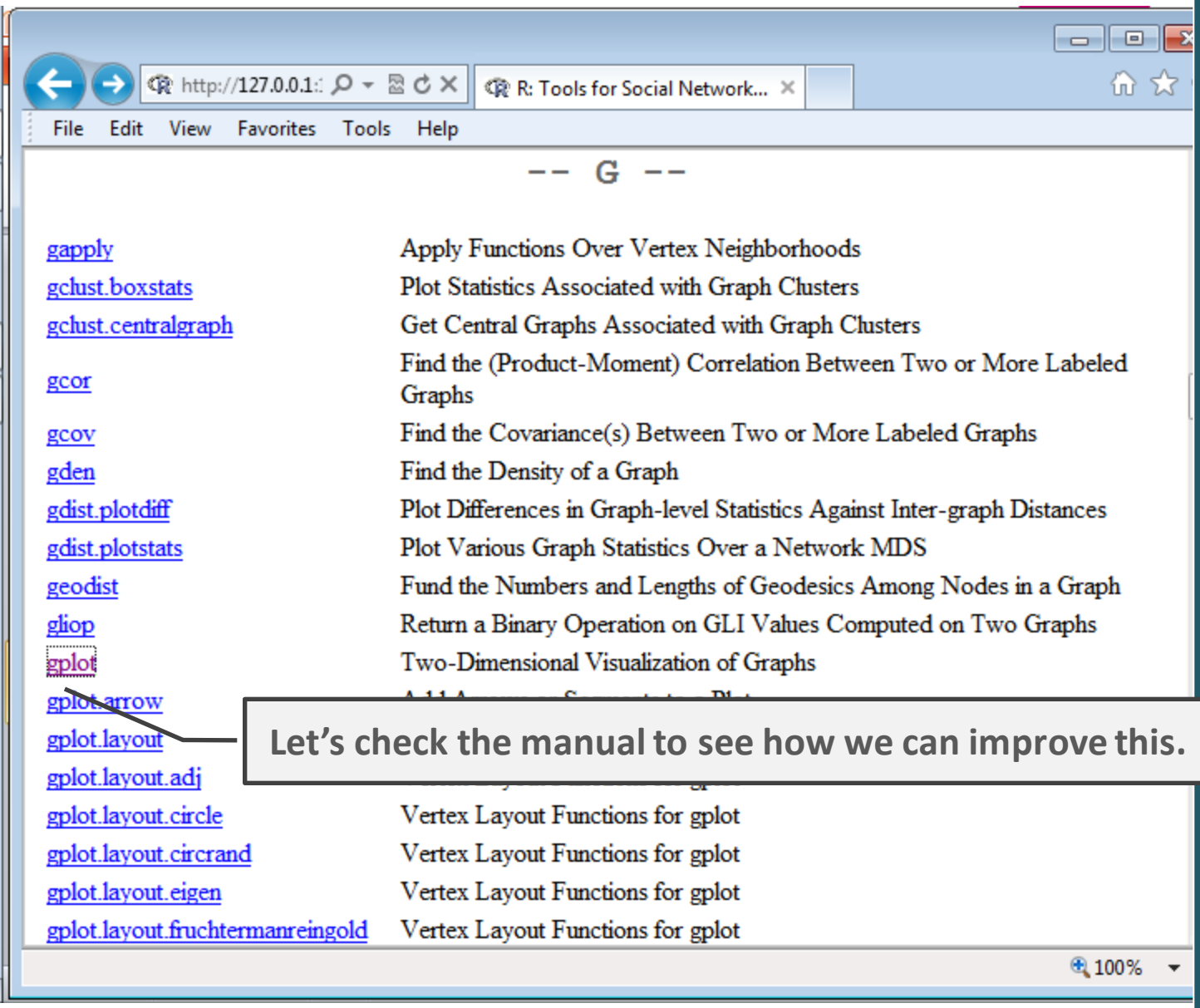
- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)



Drawing the network … uhm, not so clear, is it?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)



Let's check the manual to see how we can improve this.

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

http://127.0.0.1:: R: Two-Dimensional Visuali...

File Edit View Favorites Tools Help

gplot {sna} R Documentation

Two-Dimensional Visualization of Graphs

Description

`gplot` produces a two-dimensional plot of graph `g` in collection `dat`. A variety of options are available to control vertex placement, display details, color, etc.

Usage

```
gplot(dat, g = 1, gmode = "digraph", diag = FALSE,
    label = NULL, coord = NULL, jitter = TRUE, thresh = 0,
    usearrows = TRUE, mode = "fruchtermanreingold",
    displayisolates = TRUE, interactive = FALSE, interact.bycomp = FALSE,
    xlab = NULL, ylab = NULL, xlim = NULL, ylim = NULL, pad = 0.2,
    label.pad =
    label.pos =
    arrowhead.c
    edge.col = 1, label.col = 1, vertex.col = NULL, label.border = 1,
    vertex.border = 1, edge.lty = 1, label.lty = NULL, vertex.lty = 1,
    edge.lwd = 0, label.lwd = par("lwd"), edge.len = 0.5,
    edge.curve = 0.1, edge.steps = 50, loop.steps = 20,
    object.scale = 0.01, uselen = FALSE, usecurve = FALSE,
    suppress.axes = TRUE, vertices.last = TRUE, new = TRUE,
```

100%

Lots of options… what should we look for?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

Let's change this…

And this…

size	arrowhead.cex	expansion factor for edge arrowheads.
	label.cex	character expansion factor for label text.
	loop.cex	expansion factor for loops; may be given as a vector, if loops are to be of different sizes.
	vertex.cex	expansion factor for vertices; may be given as a vector, if vertices are to be of different sizes.
color	edge.col	color for edges; may be given as a vector or adjacency matrix, if edges are to be of different colors.
	label.col	color for vertex labels; may be given as a vector, if labels are to be of different colors.
	vertex.col	color for vertices; may be given as a vector, if vertices are to be of different colors. By default, red is used (or red and blue, for two-mode data).
border color	label.border	label border colors (if boxed.labels==TRUE); may be given as a vector, if label boxes are to have different colors.
	vertex.border	border color for vertices; may be given as a vector, if vertex borders are to be of different colors.
type of line	edge.lty	line type for edge borders; may be given as a vector or adjacency matrix, if edge borders are to have different line types.
	label.lty	line type for label boxes (if boxed.labels==TRUE); may be given as a vector, if label boxes are to have different line types.
	vertex.lty	line type for vertex borders; may be given as a vector or adjacency matrix, if vertex borders are to have different line types.
width	edge.lwd	line width scale for edges; if set greater than 0, edge widths are scaled by edge.lwd*dat. May be given as a vector or adjacency matrix, if edges are to have different line widths.
	label.lwd	line width for label boxes (if boxed.labels==TRUE); may be given as a vector, if label boxes are to have different line widths.

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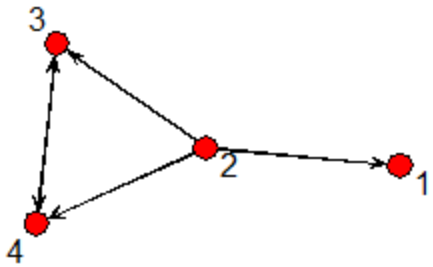
R Console

```
package 'sna' successfully

The downloaded packages are
        C:\Users\A\AppData\
> library(sna)

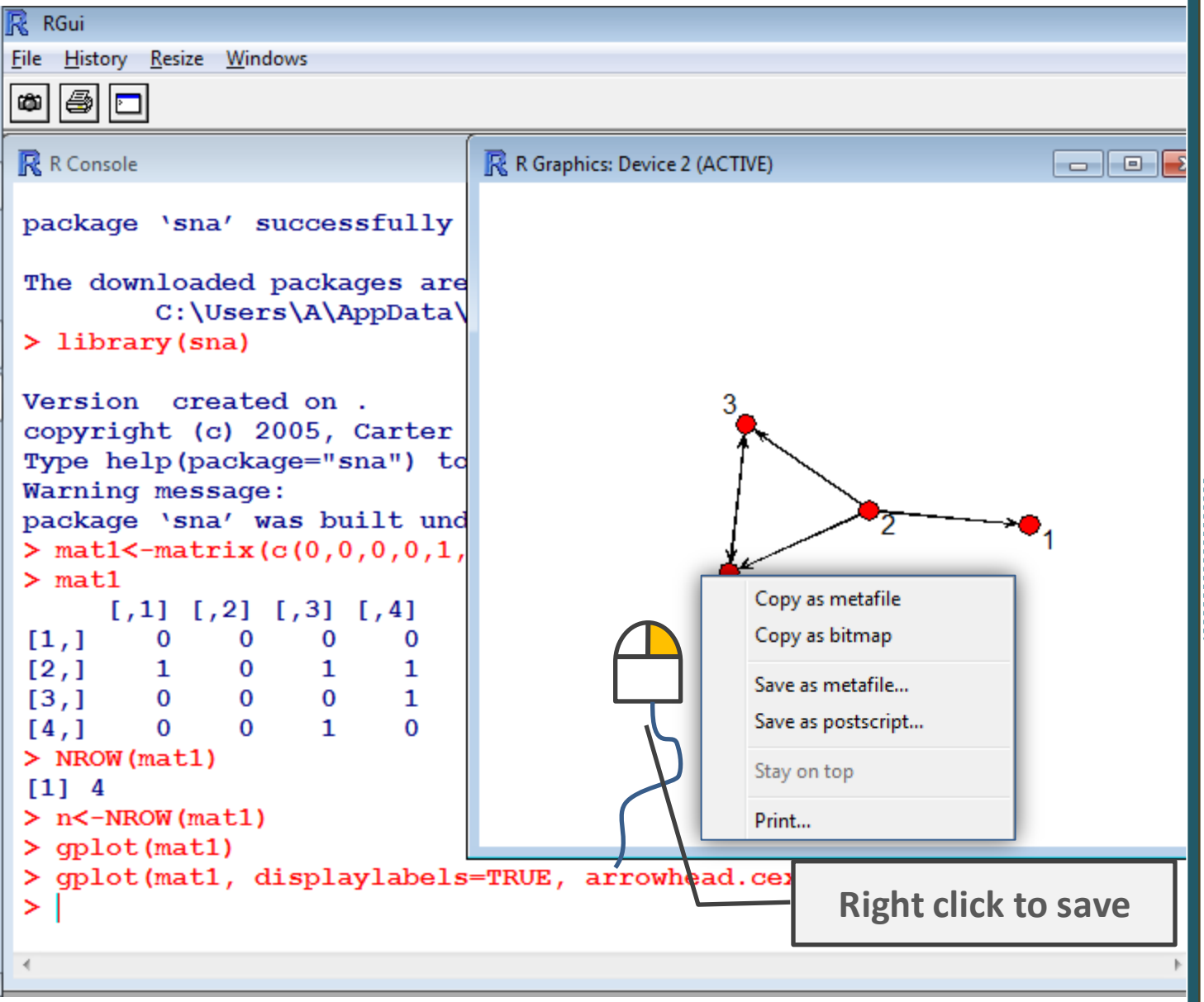
Version  created on .
copyright (c) 2005, Carter
Type help(package="sna") to
Warning message:
package 'sna' was built und
> mat1<-matrix(c(0,0,0,0,1,
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
>
```

R Graphics: Device 2 (ACTIVE)



R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)



R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

RGui

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R Console

```
The downloaded packages are in
        C:\Users\A\AppData\Local\Temp\Rtmpcbartw\downloaded_packages
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
>
```

How many ties of value 1 are there?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

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R Console

```
> library(sna)

Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
>
```

What's the density?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)

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R Console

```
Version  created on .
copyright (c) 2005, Carter T. Butts, University of California-Irvine
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
>
```

This gives the same outcome (if the diagonal values are 0!)

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- ", cmode="outdegree", rescale=FALSE)

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R Console

```
Type help(package="sna") to get started.
Warning message:
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
>
```

We can also sum over the rows… what is this?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- t1, graph", cmode="outdegree", rescale=FALSE)

RGui

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R Console

```
package 'sna' was built under R version 2.14.1
> mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
> colSums(mat1)
[1] 1 0 2 2
>
```

We can also sum over the columns… what is this?

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- t1, graph", cmode="outdegree", rescale=FALSE)

RGui

File Edit View Misc Packages Windows Help

R Console

```
> mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
> colSums(mat1)
[1] 1 0 2 2
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
>
```

Or using “sna” and indicating that cmode=“outdegree”

R COMMANDS

- setwd("E:/workshop")
- install.packages("sna")
- library(sna)
- mat1<-matrix(c(0,0,0,0,1,0,1,1,0,0,0,1,0,0,1,0),4,4,byrow=TRUE)
- mat1
- NROW(mat1)
- n<-NROW(mat1)
- gplot(mat1)
- gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
- sum(mat1)
- gden(mat1)
- sum(mat1)/(n*(n-1))
- rowSums(mat1)
- colSums(mat1)
- degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")

3. SOME MATRIX MANIPULATION/CALCULATION AND RECIPROCITY

RGui

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R Console

```
[1,]    0    0    0    0
[2,]    1    0    1    1
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
> colSums(mat1)
[1] 1 0 2 2
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
> mat1[2,1]
[1] 1
>
```

What is the value of the tie from actor 2 (second row) to actor 1 (first column)?

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- mat2[2,4]<-0
- mat2

RGui

File Edit View Misc Packages Windows Help

R Console

```
[3,]    0    0    0    1
[4,]    0    0    1    0
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
> colSums(mat1)
[1] 1 0 2 2
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
> mat1[2,1]
[1] 1
> mat1[2,1:3]
[1] 1 0 1
>
```

What is the value of the tie from actor 2 to actor 1 to 3?

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 2,4]<-0

RGui

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R Console

```
> NROW(mat1)
[1] 4
> n<-NROW(mat1)
> gplot(mat1)
> gplot(mat1, displaylabels=TRUE, arrowhead.cex=2, vertex.cex=3)
> sum(mat1)
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
> colSums(mat1)
[1] 1 0 2 2
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
> mat1[2,1]
[1] 1
> mat1[2,1:3]
[1] 1 0 1
> mat1[2,]
[1] 1 0 1 1
>
```

What is the value of the tie from actor 2 to all other actors?

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 2,4]<-0

RGui

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R Console

```
[1] 5
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
> colSums(mat1)
[1] 1 0 2 2
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
> mat1[2,1]
[1] 1
> mat1[2,1:3]
[1] 1 0 1
> mat1[2,]
[1] 1 0 1 1
> t(mat1)
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> |
```

The transposed of the matrix

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 2,4]<-0

RGui

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R Console

```
> gden(mat1)
[1] 0.4166667
> sum(mat1)/(n*(n-1))
[1] 0.4166667
> rowSums(mat1)
[1] 0 3 1 1
> colSums(mat1)
[1] 1 0 2 2
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
> mat1[2,1]
[1] 1
> mat1[2,1:3]
[1] 1 0 1
> mat1[2,]
[1] 1 0 1 1
> t(mat1)
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> mat1t<-t(mat1)
>
```

Let's call the transposed of the matrix "mat1t"

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 2,4]<-0

RGui

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R Console

```
> colSums(mat1)
[1] 1 0 2 2
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
> mat1[2,1]
[1] 1
> mat1[2,1:3]
[1] 1 0 1
> mat1[2,]
[1] 1 0 1 1
> t(mat1)
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> mat1t<-t(mat1)
> mat1+mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> |
```

The sum of “mat1” and “mat1t” gives us what?

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 2,4]<-0

RGui

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R Console

```
> degree(mat1, gmode="digraph", diag=FALSE, cmode="outdegree")
[1] 0 3 1 1
> mat1[2,1]
[1] 1
> mat1[2,1:3]
[1] 1 0 1
> mat1[2,]
[1] 1 0 1 1
> t(mat1)
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> mat1t<-t(mat1)
> mat1+mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> sum(mat1+mat1t==2)
[1] 2
>
```

How many cells in this matrix have value 2?

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- [2,4]<-0

RGui

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R Console

```
> mat1[2,1]
[1] 1
> mat1[2,1:3]
[1] 1 0 1
> mat1[2,]
[1] 1 0 1 1
> t(mat1)
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> mat1t<-t(mat1)
> mat1+mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> sum(mat1+mat1t==2)
[1] 2
> sum(mat1+mat1t==1)
[1] 6
>
```

How many cells in this matrix have value 1?

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- [2,4]<-0

RGui

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R Console

```
> mat1[2,1:3]
[1] 1 0 1
> mat1[2,]
[1] 1 0 1 1
> t(mat1)
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> mat1t<-t(mat1)
> mat1+mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> sum(mat1+mat1t==2)
[1] 2
> sum(mat1+mat1t==1)
[1] 6
> sum(mat1+mat1t==0)
[1] 8
> |
```

How many cells in this matrix have value 0? (includes diagonal!)

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- [2,4]<-0

RGui

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R Console

```
[1] 1 0 1 1
> t(mat1)
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> mat1t<-t(mat1)
> mat1+mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> sum(mat1+mat1t==2)
[1] 2
> sum(mat1+mat1t==1)
[1] 6
> sum(mat1+mat1t==0)
[1] 8
> dyad.census(mat1)
     Mut Asym Null
[1,]   1    3    2
>
```

The dyad census/MAN distribution (counts the number of dyads)

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1

RGui

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R Console

```
[1,]    0    1    0    0
[2,]    0    0    0    0
[3,]    0    1    0    1
[4,]    0    1    1    0
> mat1t<-t(mat1)
> mat1+mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> sum(mat1+mat1t==2)
[1] 2
> sum(mat1+mat1t==1)
[1] 6
> sum(mat1+mat1t==0)
[1] 8
> dyad.census(mat1)
     Mut Asym Null
[1,]   1    3    2
> grecip(mat1, measure = c("edgewise"))
Mut
0.4
>
```

$$2*M/(2*M+1*A) = 2*1/(2*1+1*3)=2/5$$

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 0

RGui

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R Console

```
[4,]    0    1    1    0
> mat1t<-t(mat1)
> mat1+mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> sum(mat1+mat1t==2)
[1] 2
> sum(mat1+mat1t==1)
[1] 6
> sum(mat1+mat1t==0)
[1] 8
> dyad.census(mat1)
     Mut Asym Null
[1,]   1    3    2
> grecip(mat1, measure = c("edgewise"))
Mut
0.4
> grecip(mat1, measure = c("dyadic.nonnull"))
 Mut
0.25
>
```

M/(M+A) = 1/(1+3)=1/4

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 0

RGui

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R Console

```
     [,1] [,2] [,3] [,4]
[1,]    0    1    0    0
[2,]    1    0    1    1
[3,]    0    1    0    2
[4,]    0    1    2    0
> sum(mat1+mat1t==2)
[1] 2
> sum(mat1+mat1t==1)
[1] 6
> sum(mat1+mat1t==0)
[1] 8
> dyad.census(mat1)
     Mut Asym Null
[1,]   1    3    2
> grecip(mat1, measure = c("edgewise"))
Mut
0.4
> grecip(mat1, measure = c("dyadic.nonnull"))
 Mut
0.25
> grecip(mat1, measure = c("dyadic"))
Mut
0.5
>
```

$$(M+N)/(M+A+N) = (1+2)/(1+3+2)=3/6$$

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 0

RGui

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R Console

```
[1] 2
> sum(mat1+mat1t==1)
[1] 6
> sum(mat1+mat1t==0)
[1] 8
> dyad.census(mat1)
     Mut Asym Null
[1,]   1    3    2
> grecip(mat1, measure = c("edgewise"))
Mut
0.4
> grecip(mat1, measure = c("dyadic.nonnull"))
 Mut
0.25
> grecip(mat1, measure = c("dyadic"))
Mut
0.5
> mat1*mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    0    0
[3,]    0    0    0    1
[4,]    0    0    1    0
>
```

Cell-multiplication of 2 matrices

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- mat2[2,4]<-0
- mat2

RGui

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R Console

```
     Mut Asym Null
[1,]   1    3    2
> grecip(mat1, measure = c("edgewise"))
Mut
0.4
> grecip(mat1, measure = c("dyadic.nonnull"))
 Mut
0.25
> grecip(mat1, measure = c("dyadic"))
Mut
0.5
> mat1*mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    0    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> mat1%*%mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    1    1
[3,]    0    0    1    0
[4,]    0    0    0    1
> |
```

Matrix-multiplication of 2 matrices

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 0

$$0*0+0*1+0*0+0*0=0$$

$$\begin{array}{c|cccc} & A & B & C & D \\ \hline A & 0 & 0 & 0 & 0 \\ B & 1 & 0 & 1 & 1 \\ C & 0 & 0 & 0 & 1 \\ D & 0 & 0 & 1 & 0 \end{array} \;\%*\%\; \begin{array}{c|cccc} & A & B & C & D \\ \hline A & 0 & 0 & 0 & 0 \\ B & 1 & 0 & 1 & 1 \\ C & 0 & 0 & 0 & 1 \\ D & 0 & 0 & 1 & 0 \end{array} = \begin{array}{c|cccc} & A & B & C & D \\ \hline A & 0 & 0 & 0 & 0 \\ B & 0 & 0 & 1 & 1 \\ C & 0 & 0 & 1 & 0 \\ D & 0 & 0 & 0 & 0 \end{array}$$

```
[1,]
> greci
Mut
0.4
> grecip(mat1, measure = c("dyadic.nonnull"))
 Mut
0.25
> grecip(mat1, measure = c("dyadic"))
Mut
0.5
> mat1*mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    0    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> mat1%*%mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    1    1
[3,]    0    0    1    0
[4,]    0    0    0    1
> |
```

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 0

Matrix-multiplication of 2 matrices

0*0+0*1+0*0+0*0=0

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

0*0+0*0+0*0+0*0=0

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

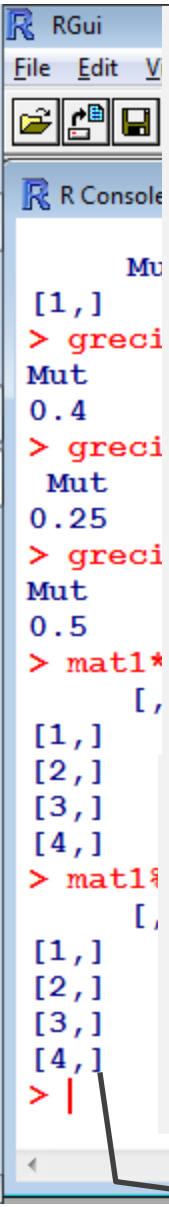
	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

```
[1,]
> greci
Mut
0.4
> greci
 Mut
0.25
> greci
Mut
0.5
> mat1*
     [,
[1,]
[2,]    0    0    0    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> mat1%*%mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    1    1
[3,]    0    0    1    0
[4,]    0    0    0    1
> |
```

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- 0

Matrix-multiplication of 2 matrices



0*0+0*1+0*0+0*0=0

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

0*0+0*0+0*0+0*0=0

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

1*1+0*1+1*0+1*1=1

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

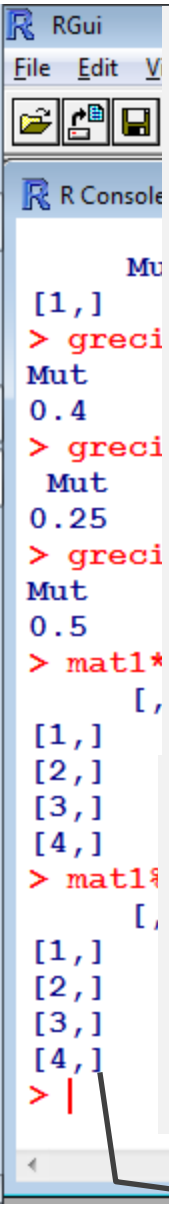
	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1

0

Matrix-multiplication of 2 matrices



0*0+0*1+0*0+0*0=0

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

0*0+0*0+0*0+0*0=0

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

1*1+0*1+1*0+1*1=1

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

%*%

	A	B	C	D
A	0	0	0	0
B	1	0	1	1
C	0	0	0	1
D	0	0	1	0

=

	A	B	C	D
A	0	0	0	0
B	0	0	1	1
C	0	0	1	0
D	0	0	0	0

Matrix-multiplication of 2 matrices… so what is this telling us?

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1

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R Console

```
Mut
0.5
> mat1*mat1t
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    0    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> mat1%*%mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    1    1
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2<-mat1
> mat2[1,4]<-1
> mat2[2,4]<-0
> mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
>
```

Consider this matrix

R COMMANDS

- mat1[2,1]
- mat1[2,1:3]
- mat1[2,]
- t(mat1)
- mat1t<-t(mat1)
- mat1+mat1t
- sum(mat1+mat1t==2)
- sum(mat1+mat1t==1)
- sum(mat1+mat1t==0)
- dyad.census(mat1)
- grecip(mat1, measure = c("edgewise"))
- grecip(mat1, measure = c("dyadic.nonnull"))
- grecip(mat1, measure = c("dyadic"))
- mat1*mat1t
- mat1%*%mat1
- mat2<-mat1
- mat2[1,4]<-1
- mat2[2,4]<-0
- mat2

4. MORE MATRIX MANIPULATION/CALCULATION AND TRIADS

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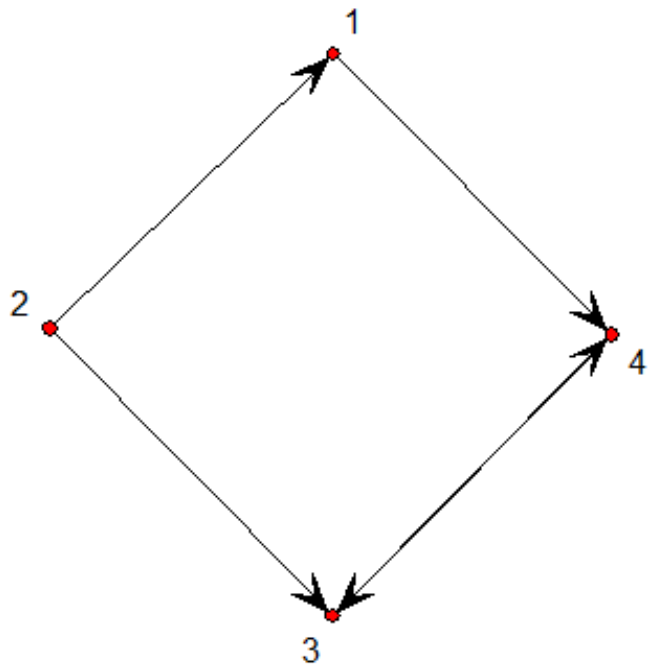
File History Resize Windows

R Console

```
0.5
> mat1*mat1t
     [,1] [,2] [,3
[1,]    0    0    
[2,]    0    0    
[3,]    0    0    
[4,]    0    0    
> mat1%*%mat1
     [,1] [,2] [,3
[1,]    0    0    
[2,]    0    0    
[3,]    0    0    
[4,]    0    0    
> mat2<-mat1
> mat2[1,4]<-1
> mat2[2,4]<-0
> mat2
     [,1] [,2] [,3
[1,]    0    0    
[2,]    1    0    
[3,]    0    0    
[4,]    0    0    
> gplot(mat2, displ
> |
```

R Graphics: Device 2 (ACTIVE)



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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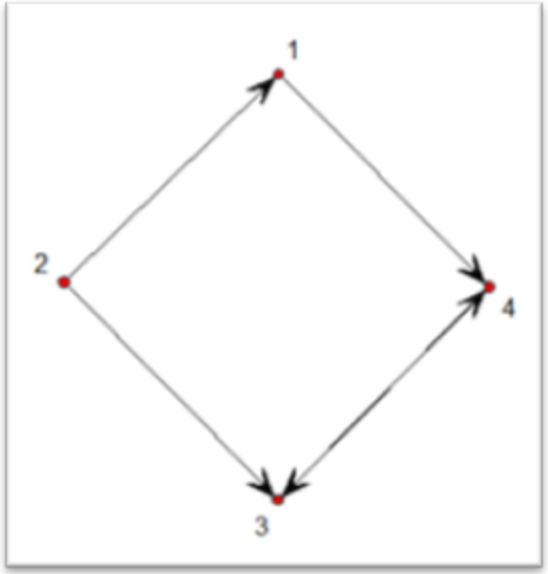
File Edit View Misc Packages Windows Help

R Console

```
[4,]    0    0    1    0
> mat1%*%mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    1    1
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2<-mat1
> mat2[1,4]<-1
> mat2[2,4]<-0
> mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
>
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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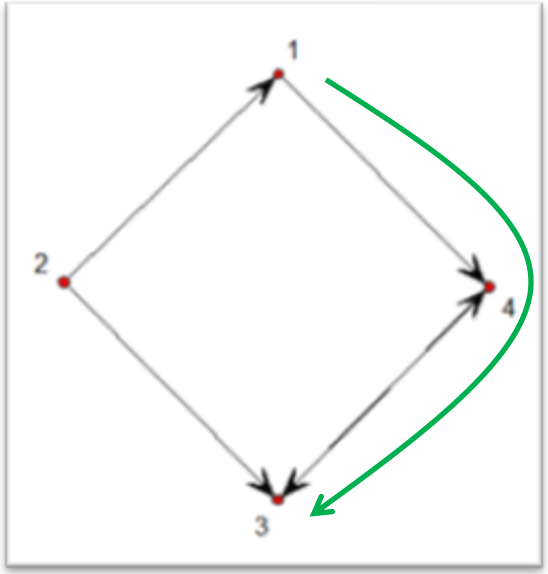
File Edit View Misc Packages Windows Help

R Console

```
[4,]    0    0    1    0
> mat1%*%mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    1    1
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2<-mat1
> mat2[1,4]<-1
> mat2[2,4]<-0
> mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
>
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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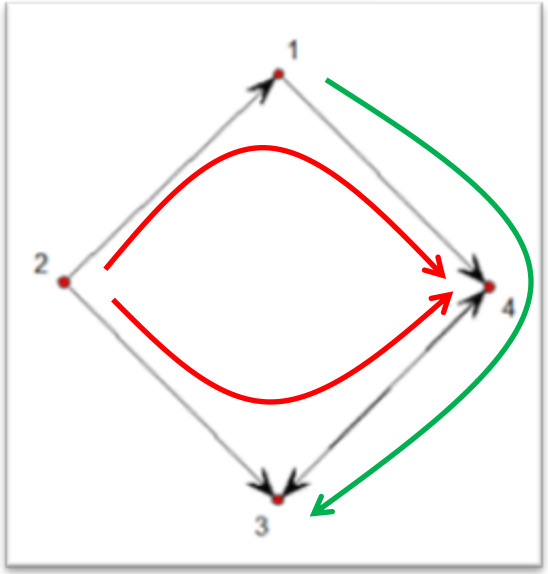
File Edit View Misc Packages Windows Help

R Console

```
[4,]    0    0    1    0
> mat1%*%mat1
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    0
[2,]    0    0    1    1
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2<-mat1
> mat2[1,4]<-1
> mat2[2,4]<-0
> mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
>
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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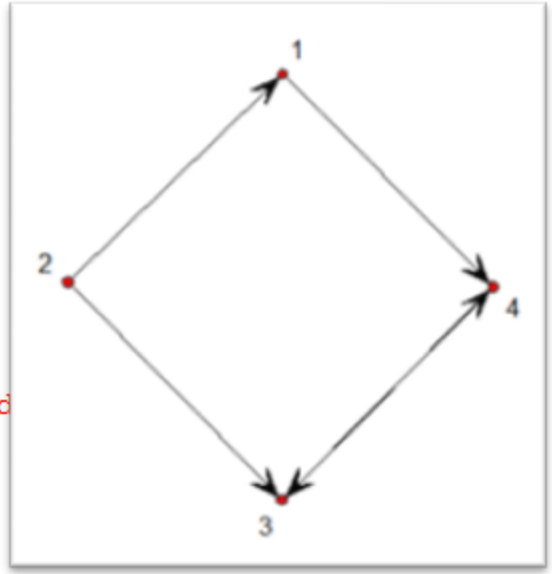
R Console

```
[4,]    0    0    0    1
> mat2<-mat1
> mat2[1,4]<-1
> mat2[2,4]<-0
> mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=TRUE, arrowhead
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2%*%mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
>
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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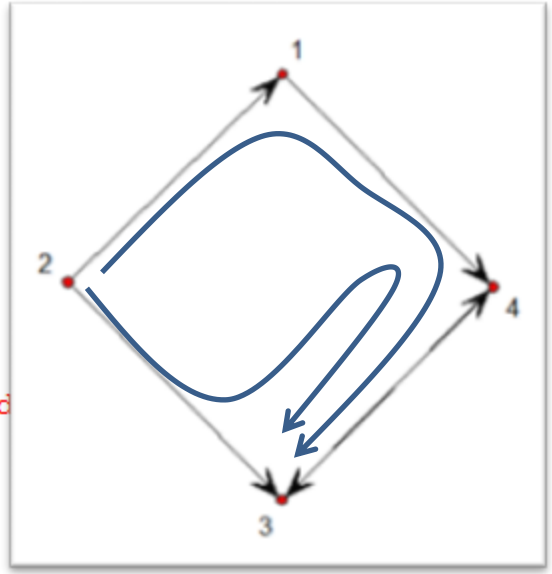
R Console

```
[4,]    0    0    0    1
> mat2<-mat1
> mat2[1,4]<-1
> mat2[2,4]<-0
> mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=TRUE, arrowhead
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2%*%mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
>
```



R COMMANDS

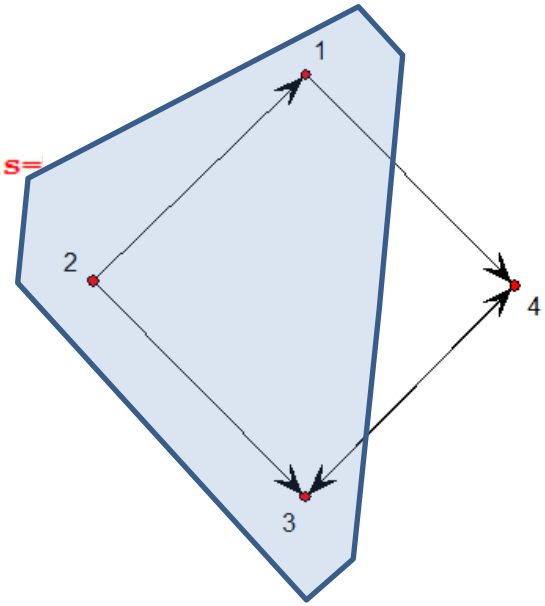
- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

RGui

File Edit View Misc Packages Windows Help

R Console

```
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2%*%mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    1    0    1    2    0    0    0   0    0    0
     120C 210 300
[1,]    0   0   0
>
```

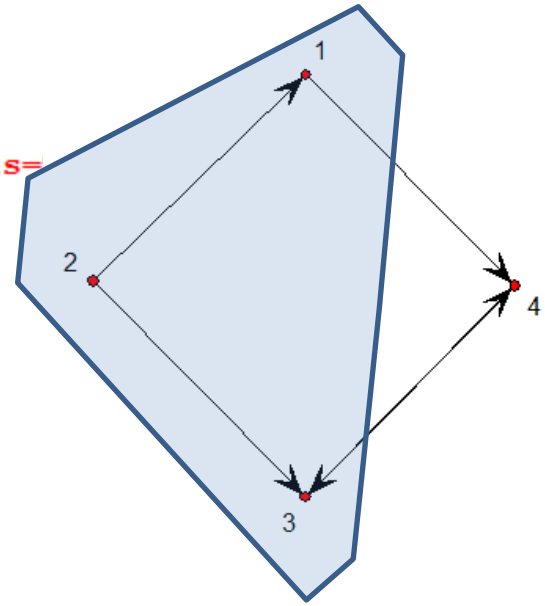


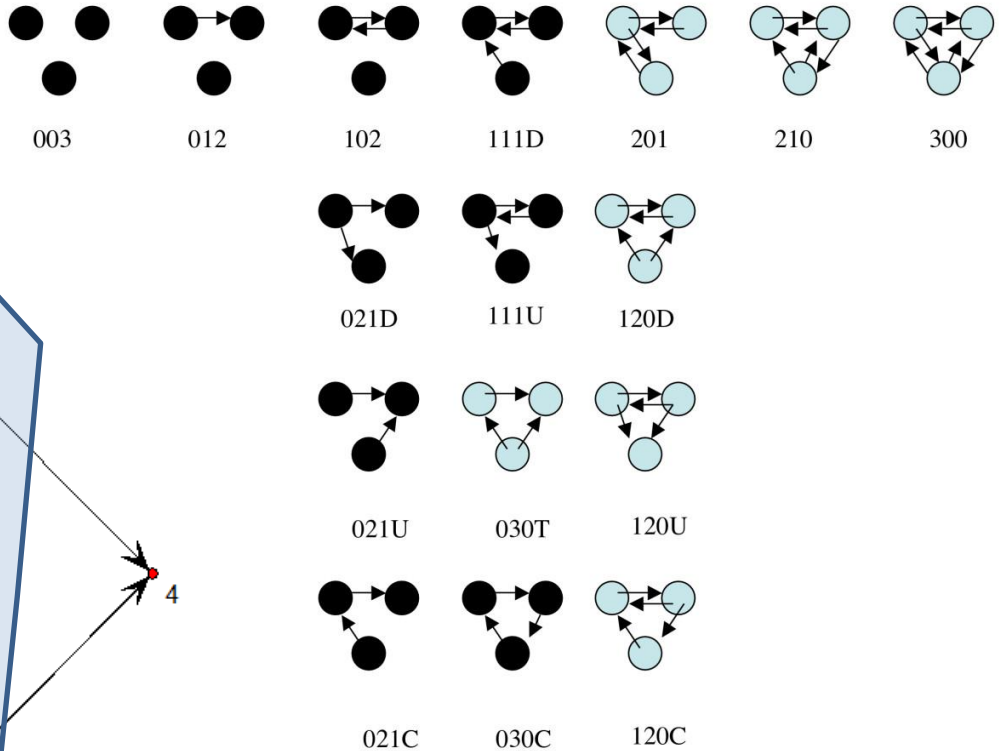
R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

R COMMANDS

```
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2%*%mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    1    0    1    2    0    0    0   0    0    0
     120C 210 300
[1,]    0   0   0
>
```





- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

R COMMANDS

- gplot(mat2

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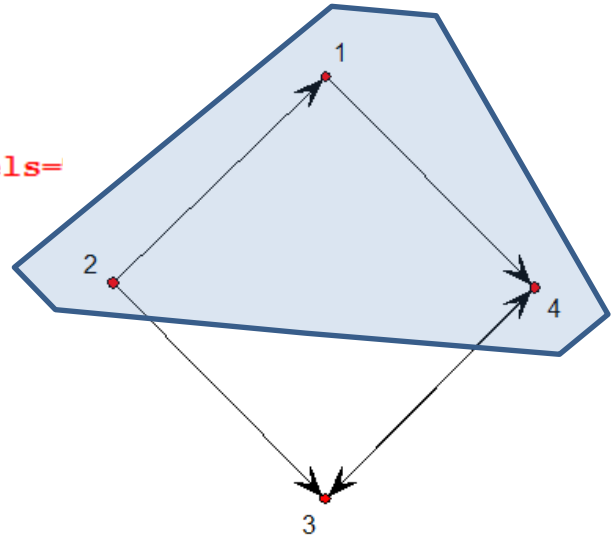
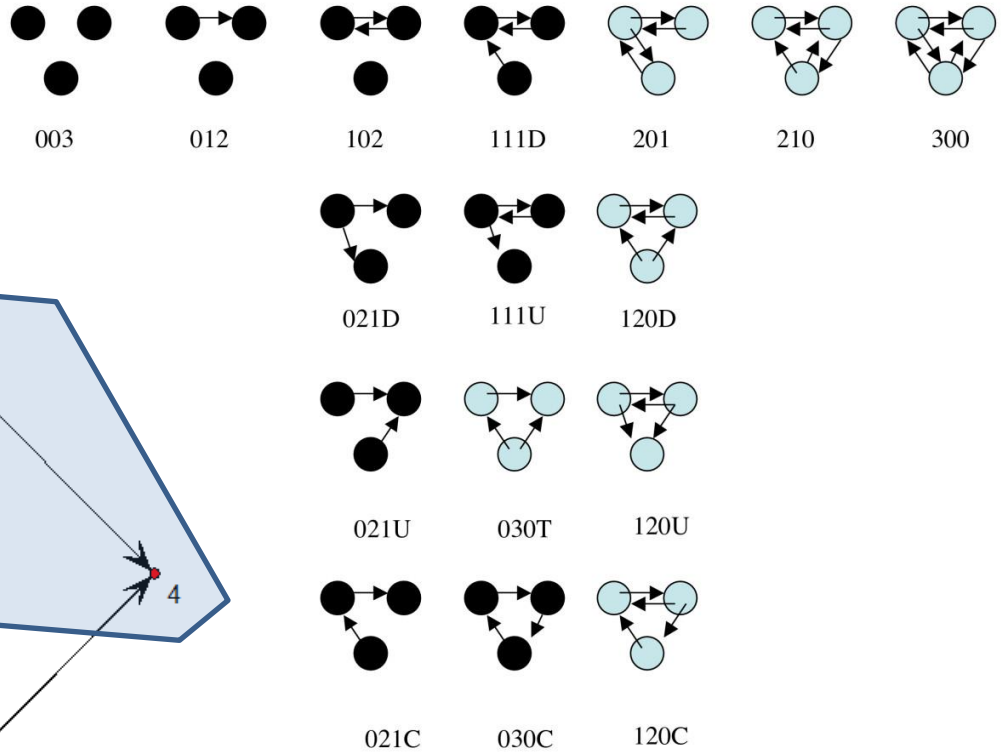
R Console

```
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2%*%mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    1    0    1    2    0    0    0   0    0    0
     120C 210 300
[1,]    0   0   0
>
```





- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

R COMMANDS

- gplot(mat2

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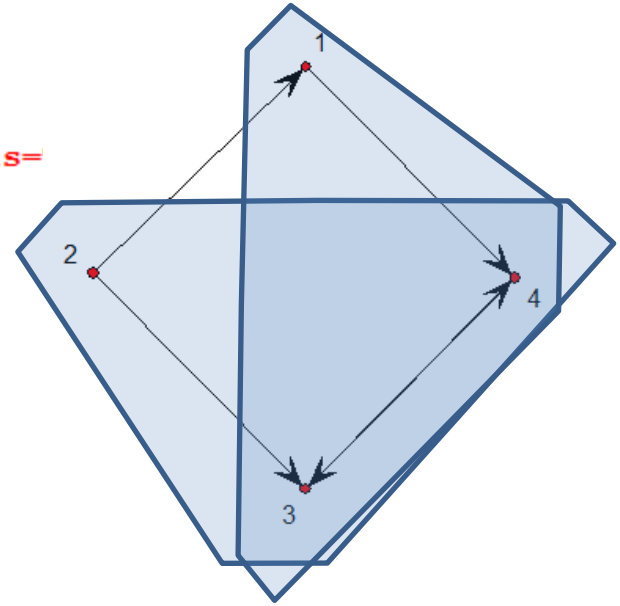
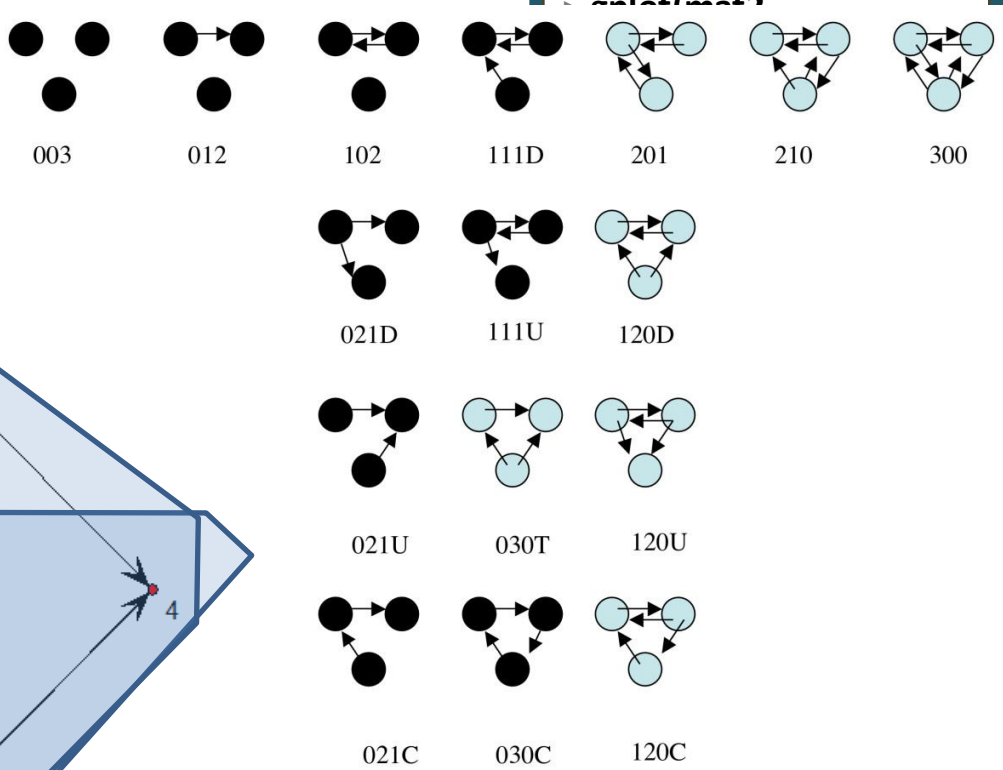
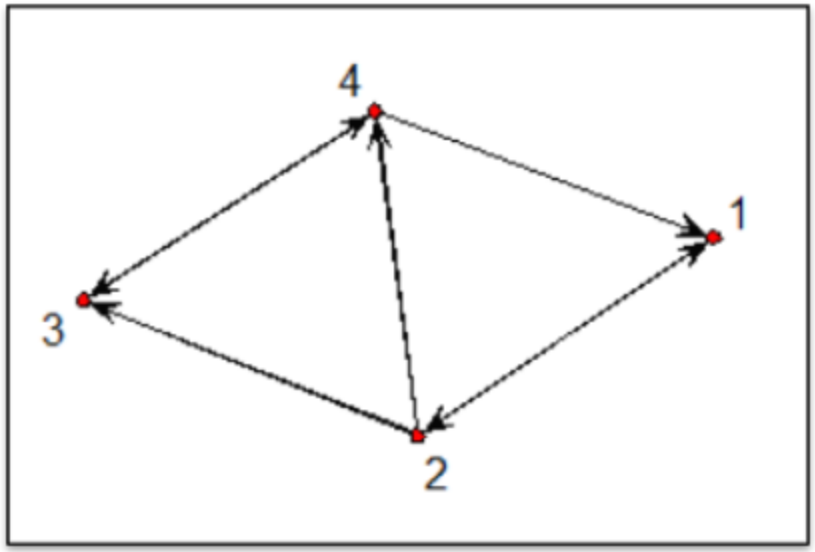
R Console

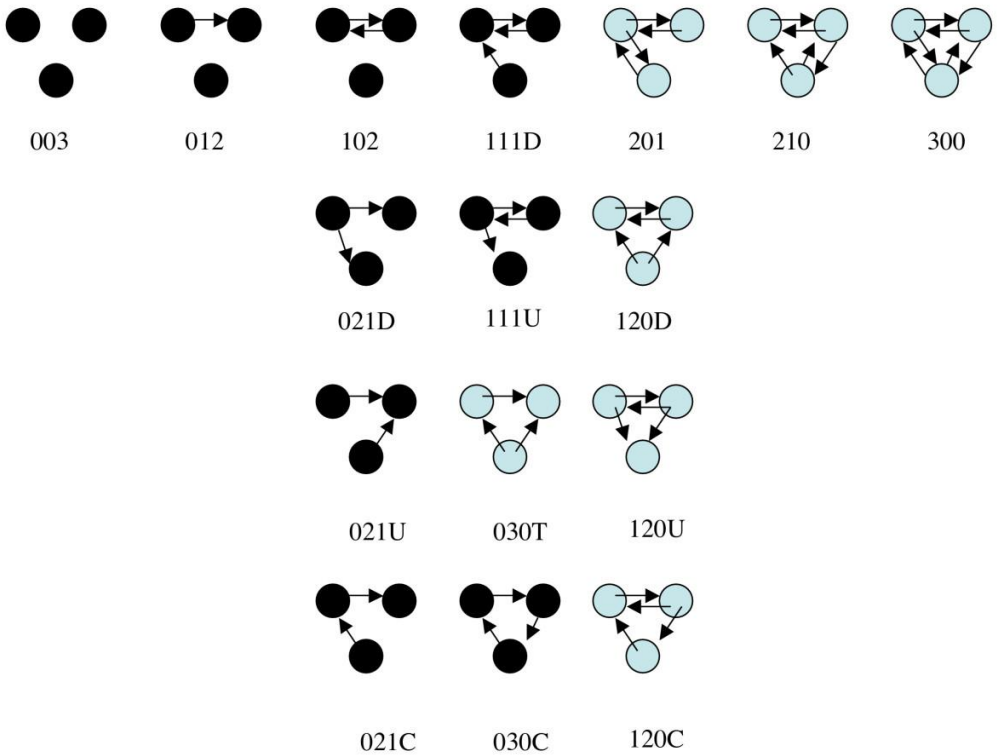
```
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    1    0    1    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> gplot(mat2, displaylabels=
> mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    1    0
[2,]    0    0    0    2
[3,]    0    0    1    0
[4,]    0    0    0    1
> mat2%*%mat2%*%mat2
     [,1] [,2] [,3] [,4]
[1,]    0    0    0    1
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    1    0    1    2    0    0    0   0    0    0
     120C 210 300
[1,]    0   0   0
>
```



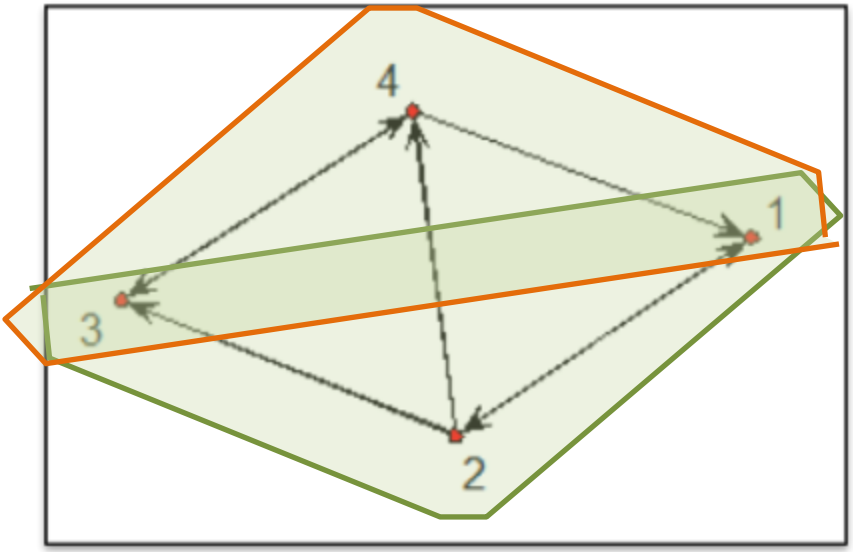


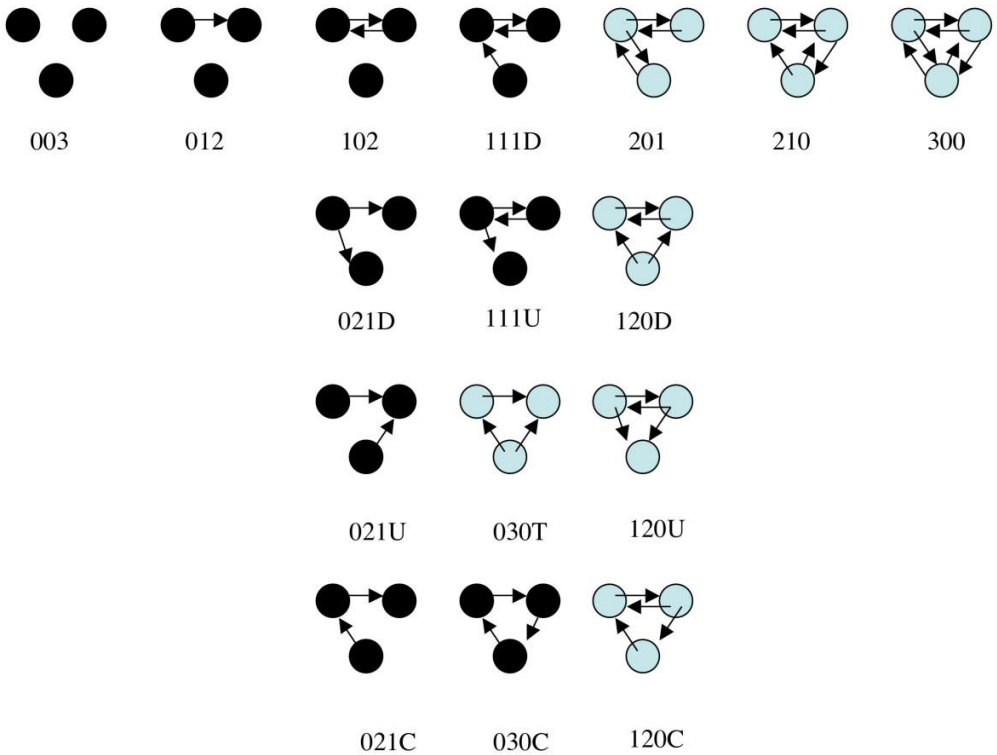
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist



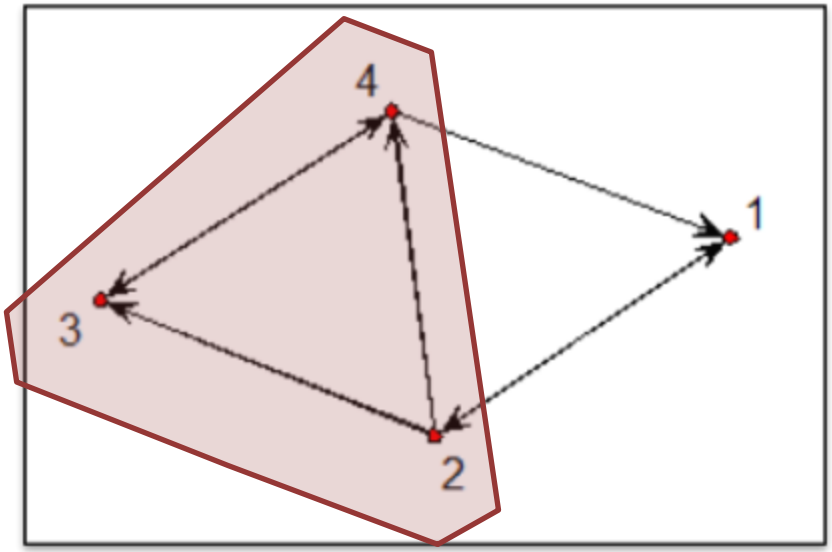


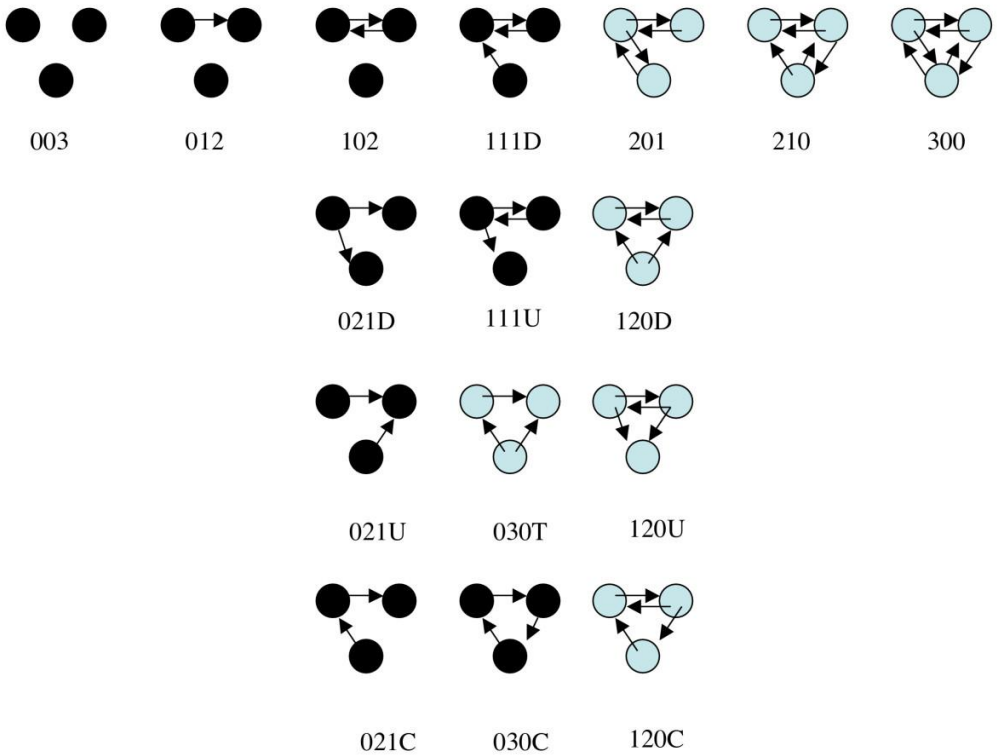

```
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    0    0    0    0    2    0    0   0    1    0
     120C 210 300
[1,]    1   0   0
```



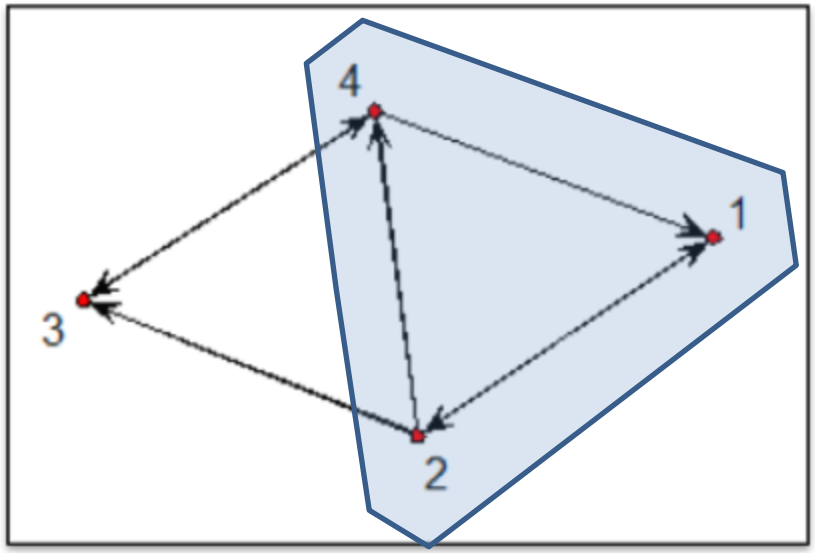


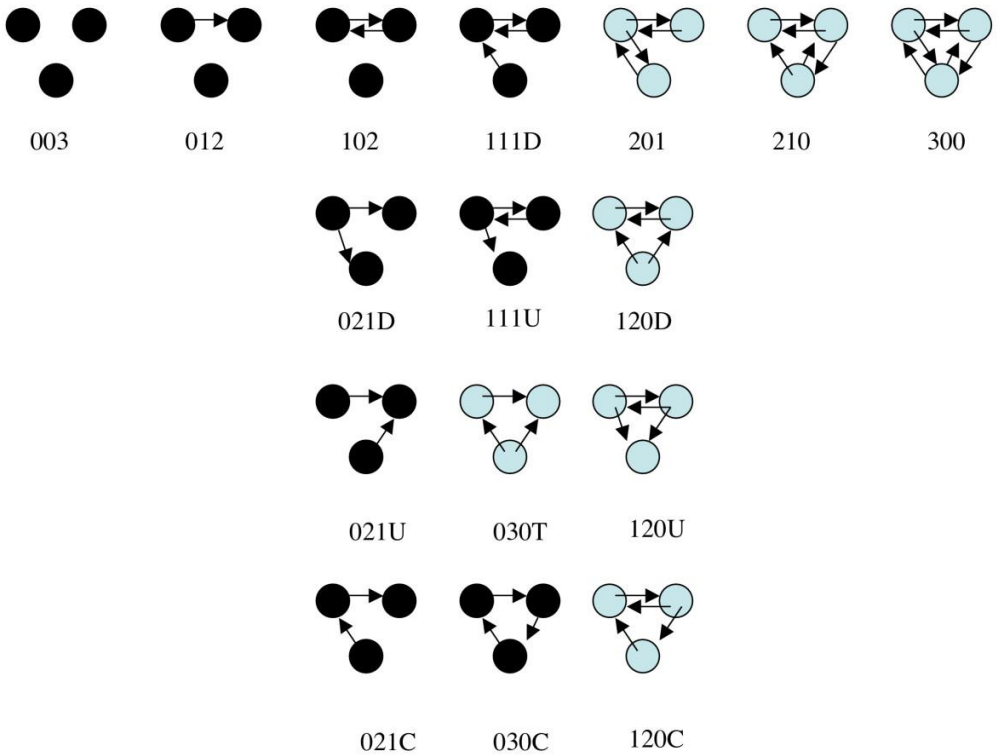

```
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    0    0    0    0    2    0    0   0    1    0
     120C 210 300
[1,]    1   0   0
```






```
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    0    0    0    0    2    0    0   0    1    0
     120C 210 300
[1,]    1   0   0
```






```
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    0    0    0    0    2    0    0   0    1    0
     120C 210 300
[1,]    1   0   0
```

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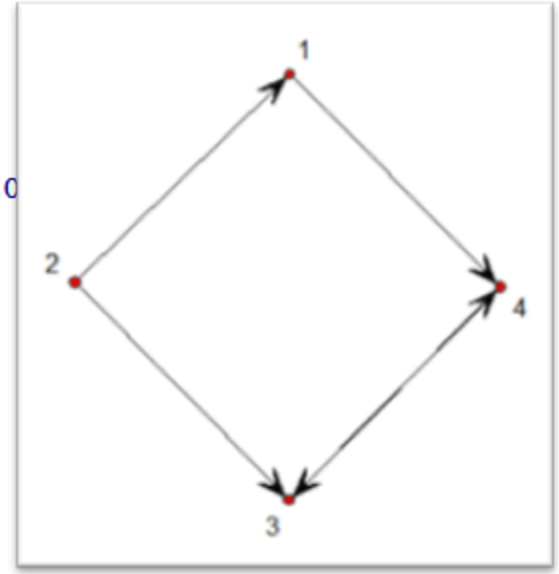
R Console

```
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 0
[1,]   0   0   0    1    0    1    2    0
     120C 210 300
[1,]    0   0   0
> geodist(mat2)
$counts
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    2
[3,]    0    0    1    1
[4,]    0    0    1    1

$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0

> |
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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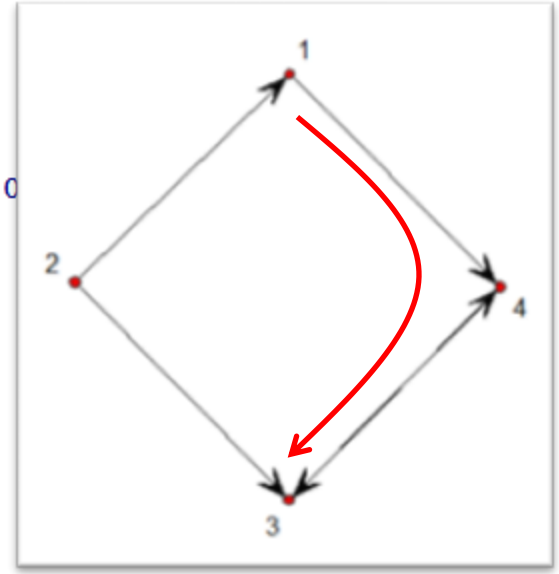
R Console

```
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 0
[1,]   0   0   0    1    0    1    2    0
     120C 210 300
[1,]    0   0   0
> geodist(mat2)
$counts
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    2
[3,]    0    0    1    1
[4,]    0    0    1    1

$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0

> |
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist%in%c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist%in%c(NA)]<-9
- M.gdist

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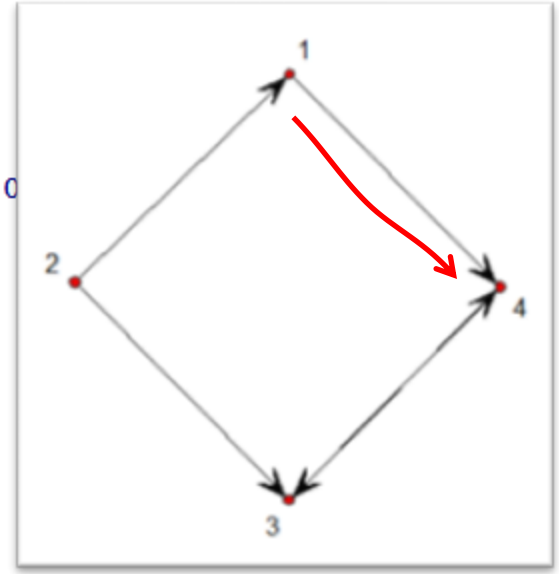
R Console

```
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 0
[1,]   0   0   0    1    0    1    2    0
     120C 210 300
[1,]    0   0   0
> geodist(mat2)
$counts
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    2
[3,]    0    0    1    1
[4,]    0    0    1    1

$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0

> |
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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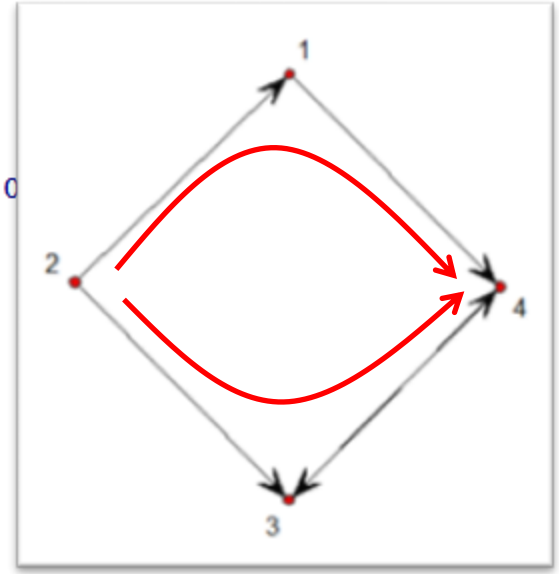
R Console

```
[2,]    0    0    2    0
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 0
[1,]   0   0   0    1    0    1    2    0
     120C 210 300
[1,]    0   0   0
> geodist(mat2)
$counts
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    2
[3,]    0    0    1    1
[4,]    0    0    1    1

$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0

> |
```



R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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R Console

```
[3,]    0    0    0    1
[4,]    0    0    1    0
> triad.census(mat2)
     003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,]   0   0   0    1    0    1    2    0    0    0   0    0    0
     120C 210 300
[1,]    0   0   0
> geodist(mat2)
$counts
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    2
[3,]    0    0    1    1
[4,]    0    0    1    1

$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0

> GM<-geodist(mat2)
>
```

What if I want to know who is reached by whom?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist%in%c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist%in%c(NA)]<-9
- M.gdist

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R Console

```
[1,]    0    0    0
> geodist(mat2)
$counts
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    2
[3,]    0    0    1    1
[4,]    0    0    1    1

$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0

> GM<-geodist(mat2)
> GM$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0
>
```

What if I want to know who is reached by whom?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist%in%c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist%in%c(NA)]<-9
- M.gdist

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R Console

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

$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0

> GM<-geodist(mat2)
> GM$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0
> GM$gdist<Inf
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> |
```

What if I want to know who is reached by whom?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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R Console

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

> GM<-geodist(mat2)
> GM$gdist
     [,1] [,2] [,3] [,4]
[1,]    0  Inf    2    1
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0
> GM$gdist<Inf
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach<-(GM$gdist<Inf)
> M.reach
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> |
```

What if I want to know who is reached by whom?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

RGui

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R Console

```
[1,]     0   Inf     2     1
[2,]     1     0     1     2
[3,]   Inf   Inf     0     1
[4,]   Inf   Inf     1     0
> GM$gdist<Inf
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach<-(GM$gdist<Inf)
> M.reach
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach*1
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    1
[3,]    0    0    1    1
[4,]    0    0    1    1
> |
```

What if I want to know who is reached by whom?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

RGui

File Edit View Misc Packages Windows Help

R Console

```
[2,]    1    0    1    2
[3,]  Inf  Inf    0    1
[4,]  Inf  Inf    1    0
> GM$gdist<Inf
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach<-(GM$gdist<Inf)
> M.reach
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach*1
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    1
[3,]    0    0    1    1
[4,]    0    0    1    1
> M.gdist<-GM$gdist
>
```

What if I want to have a matrix with the geodesic distances, but where non-reachable is indicated as missing?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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R Console

```
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach<-(GM$gdist<Inf)
> M.reach
      [,1]  [,2] [,3] [,4]
[1,]  TRUE FALSE TRUE TRUE
[2,]  TRUE  TRUE TRUE TRUE
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach*1
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    1
[3,]    0    0    1    1
[4,]    0    0    1    1
> M.gdist<-GM$gdist
> M.gdist[M.gdist %in% c(Inf)]<-NA
> M.gdist
     [,1] [,2] [,3] [,4]
[1,]    0   NA    2    1
[2,]    1    0    1    2
[3,]   NA   NA    0    1
[4,]   NA   NA    1    0
> |
```

What if I want to have a matrix with the geodesic distances, but where non-reachable is indicated as missing?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

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R Console

```
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach*1
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    1
[3,]    0    0    1    1
[4,]    0    0    1    1
> M.gdist<-GM$gdist
> M.gdist[M.gdist %in% c(Inf)]<-NA
> M.gdist
     [,1] [,2] [,3] [,4]
[1,]    0   NA    2    1
[2,]    1    0    1    2
[3,]   NA   NA    0    1
[4,]   NA   NA    1    0
> M.gdist[M.gdist %in% c(NA)]<-9
> M.gdist
     [,1] [,2] [,3] [,4]
[1,]    0    9    2    1
[2,]    1    0    1    2
[3,]    9    9    0    1
[4,]    9    9    1    0
>
```

What if I want to have a matrix with the geodesic distances, but where non-reachable is indicated as missing?

R COMMANDS

- gplot(mat2, displaylabels=TRUE, arrowhead.cex=2)
- mat2%*%mat2
- mat2%*%mat2%*%mat2
- triad.census(mat2)
- geodist(mat2)
- GM<-geodist(mat2)
- GM$gdist
- GM$gdist<Inf
- M.reach<-(GM$gdist<Inf)
- M.reach
- M.reach*1
- M.gdist<-GM$gdist
- M.gdist[M.gdist %in% c(Inf)]<-NA
- M.gdist
- M.gdist[M.gdist %in% c(NA)]<-9
- M.gdist

5. NOW SOME REAL DATA

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R Console

```
[3,] FALSE FALSE TRUE TRUE
[4,] FALSE FALSE TRUE TRUE
> M.reach*1
     [,1] [,2] [,3] [,4]
[1,]    1    0    1    1
[2,]    1    1    1    1
[3,]    0    0    1    1
[4,]    0    0    1    1
> M.gdist<-GM$gdist
> M.gdist[M.gdist %in% c(Inf)]<-NA
> M.gdist
     [,1] [,2] [,3] [,4]
[1,]    0   NA    2    1
[2,]    1    0    1    2
[3,]   NA   NA    0    1
[4,]   NA   NA    1    0
> M.gdist[M.gdist %in% c(NA)]<-9
> M.gdist
     [,1] [,2] [,3] [,4]
[1,]    0    9    2    1
[2,]    1    0    1    2
[3,]    9    9    0    1
[4,]    9    9    1    0
> |
```

What if I want to have a matrix with the geodesic distances, but where non-reachable is indicated as missing?

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

File Edit View Misc Packages Windows Help

R Console

```
>
>
>
>
>
>
>
>
>
>
>
>
>
>
> setwd("E:/workshop")
> getwd()
[1] "E:/workshop"
> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
>
```

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

File Edit View Misc Packages Windows Help

R Console

```
3     0     0     0     0     0     0
4     0     0     0     0     0     1
5     1     0     0     0     0     0
6     0     0     0     0     0     0
7     0     1     0     0     0     0
8     1     0     0     0     0     0
9     1     0     0     0     0     0
10    0     0     0     0     0     0
11    0     0     0     0     0     0
12    0     0     0     0     0     0
13    0     0     0     1     0     0
14    0     1     0     0     0     0
15    0     0     0     0     0     0
16    0     0     0     0     0     0
17    0     0     0     1     0     0
18    0     0     0     0     0     1
19    0     0     0     0     0     0
20    0     0     0     0     0     0
21    0     0     0     0     0     0
22    0     0     0     0     1     0
23    0     0     1     0     0     0
24    0     0     0     0     0     0
25    0     0     0     0     0     0
>
```

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

File Edit View Misc Packages Windows Help

R Console

```
5     1     0     0     0     0     0
6     0     0     0     0     0     0
7     0     1     0     0     0     0
8     1     0     0     0     0     0
9     1     0     0     0     0     0
10    0     0     0     0     0     0
11    0     0     0     0     0     0
12    0     0     0     0     0     0
13    0     0     0     1     0     0
14    0     1     0     0     0     0
15    0     0     0     0     0     0
16    0     0     0     0     0     0
17    0     0     0     1     0     0
18    0     0     0     0     0     1
19    0     0     0     0     0     0
20    0     0     0     0     0     0
21    0     0     0     0     0     0
22    0     0     0     0     1     0
23    0     0     1     0     0     0
24    0     0     0     0     0     0
25    0     0     0     0     0     0
> gden(data1)
[1] 0.1033333
>
```

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

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R Console

```
7     0    1    0    0    0    0
8     1    0    0    0    0    0
9     1    0    0    0    0    0
10    0    0    0    0    0    0
11    0    0    0    0    0    0
12    0    0    0    0    0    0
13    0    0    0    1    0    0
14    0    1    0    0    0    0
15    0    0    0    0    0    0
16    0    0    0    0    0    0
17    0    0    0    1    0    0
18    0    0    0    0    0    1
19    0    0    0    0    0    0
20    0    0    0    0    0    0
21    0    0    0    0    0    0
22    0    0    0    0    1    0
23    0    0    1    0    0    0
24    0    0    0    0    0    0
25    0    0    0    0    0    0
> gden(data1)
[1] 0.1033333
> degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", resca$
 [1] 3 3 0 2 3 2 2 4 5 0 2 5 3 4 1 2 4 2 1 2 2 2 5 0 3
>
```

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

File Edit View Misc Packages Windows Help

R Console

```
8     1     0     0     0     0     0
9     1     0     0     0     0     0
10    0     0     0     0     0     0
11    0     0     0     0     0     0
12    0     0     0     0     0     0
13    0     0     0     1     0     0
14    0     1     0     0     0     0
15    0     0     0     0     0     0
16    0     0     0     0     0     0
17    0     0     0     1     0     0
18    0     0     0     0     0     1
19    0     0     0     0     0     0
20    0     0     0     0     0     0
21    0     0     0     0     0     0
22    0     0     0     0     1     0
23    0     0     1     0     0     0
24    0     0     0     0     0     0
25    0     0     0     0     0     0
> gden(data1)
[1] 0.1033333
> degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", resca$
 [1] 3 3 0 2 3 2 2 4 5 0 2 5 3 4 1 2 4 2 1 2 2 2 5 0 3
> outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree"$
> hist(outd1)
```

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

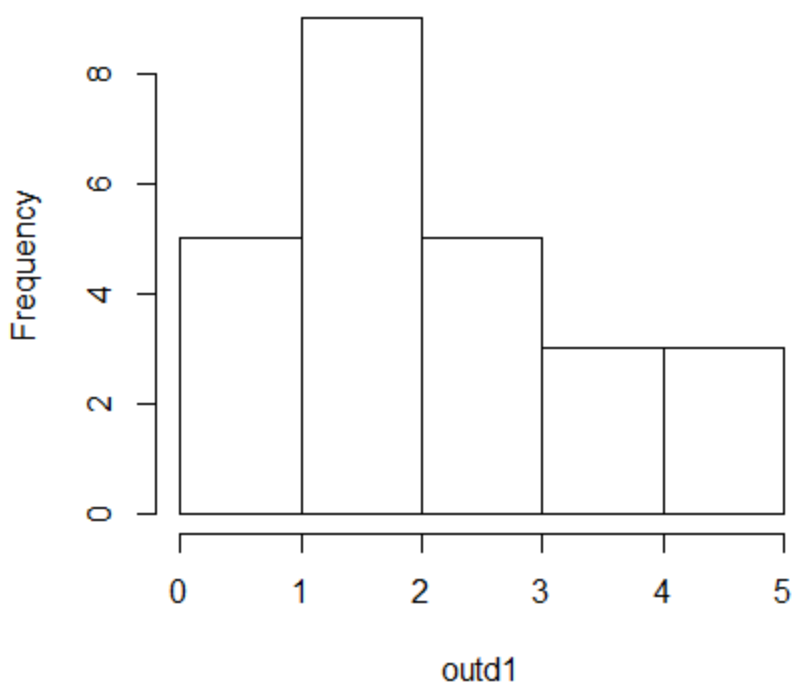
RGui

File History Resize Windows

R Console

```
9     1     0     0     0     0
10    0     0     0     0     0
11    0     0     0     0     0
12    0     0     0     0     0
13    0     0     0     1     0
14    0     1     0     0     0
15    0     0     0     0     0
16    0     0     0     0     0
17    0     0     0     1     0
18    0     0     0     0     0
19    0     0     0     0     0
20    0     0     0     0     0
21    0     0     0     0     0
22    0     0     0     0     1
23    0     0     1     0     0
24    0     0     0     0     0
25    0     0     0     0     0
> gden(data1)
[1] 0.1033333
> degree(data1, gmode="di
 [1] 3 3 0 2 3 2 2 4 5 0
> outd1<-degree(data1, gm
> hist(outd1)
>
```

R Graphics: Device 2 (ACTIVE)



R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

File Edit View Misc Packages Windows Help

R Console

```
13    0    0    0    1    0    0
14    0    1    0    0    0    0
15    0    0    0    0    0    0
16    0    0    0    0    0    0
17    0    0    0    1    0    0
18    0    0    0    0    0    1
19    0    0    0    0    0    0
20    0    0    0    0    0    0
21    0    0    0    0    0    0
22    0    0    0    0    1    0
23    0    0    1    0    0    0
24    0    0    0    0    0    0
25    0    0    0    0    0    0
> gden(data1)
[1] 0.1033333
> degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", resca$
 [1] 3 3 0 2 3 2 2 4 5 0 2 5 3 4 1 2 4 2 1 2 2 2 5 0 3
> outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree"$
> hist(outd1)
> table(outd1)
outd1
0 1 2 3 4 5
3 2 9 5 3 3
>
```

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

File Edit View Misc Packages Windows Help

R Console

```
19    0    0    0    0    0    0
20    0    0    0    0    0    0
21    0    0    0    0    0    0
22    0    0    0    0    1    0
23    0    0    1    0    0    0
24    0    0    0    0    0    0
25    0    0    0    0    0    0
> gden(data1)
[1] 0.1033333
> degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", resca$
 [1] 3 3 0 2 3 2 2 4 5 0 2 5 3 4 1 2 4 2 1 2 2 2 5 0 3
> outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree"$
> hist(outd1)
> table(outd1)
outd1
0 1 2 3 4 5
3 2 9 5 3 3
> ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", $
> hist(ind1)
> table(ind1)
ind1
0 1 2 3 4 5
1 5 9 3 5 2
>
```

R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

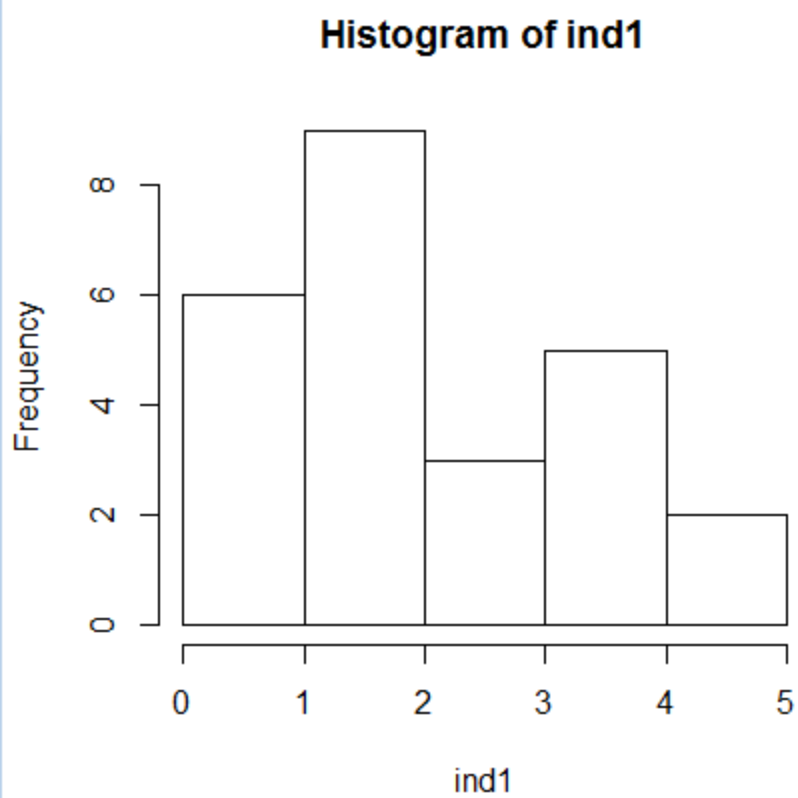
RGui

File History Resize Windows

R Console

```
19    0    0    0    0    0    0
20    0    0    0    0    0    0
21    0    0    0    0    0    0
22    0    0    0    0    1    0
23    0    0    1    0    0    0
24    0    0    0    0    0    0
25    0    0    0    0    0    0
> gden(data1)
[1] 0.1033333
> degree(data1, gmode="dig
 [1] 3 3 0 2 3 2 2 4 5 0 2
> outd1<-degree(data1, gmo
> hist(outd1)
> table(outd1)
outd1
0 1 2 3 4 5
3 2 9 5 3 3
> ind1<-degree(data1, gmod
> hist(ind1)
> table(ind1)
ind1
0 1 2 3 4 5
1 5 9 3 5 2
>
```

R Graphics: Device 2 (ACTIVE)



R COMMANDS

- setwd("E:/workshop")
- list.files()
- data1<-read.table("klas03e-friends-waveA.dat")
- data1
- gden(data1)
- degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", rescale=FALSE)
- hist(outd1)
- table(outd1)
- ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", rescale=FALSE)
- hist(ind1)
- table(ind1)

RGui

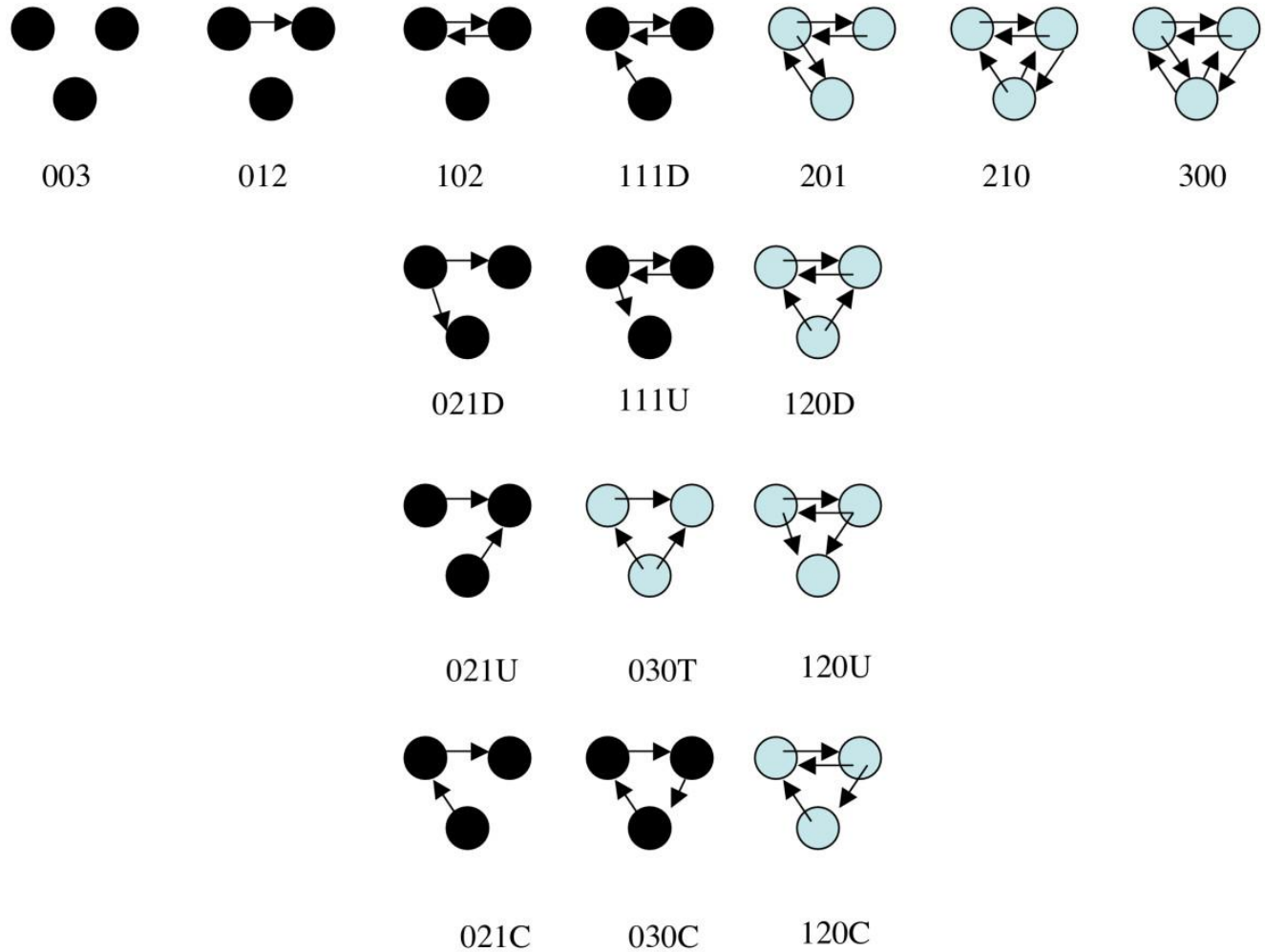
File Edit View Misc Packages Windows Help

R Console

```
25    0    0    0    0    0    0
> gden(data1)
[1] 0.1033333
> degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree", resca$
 [1] 3 3 0 2 3 2 2 4 5 0 2 5 3 4 1 2 4 2 1 2 2 2 5 0 3
> outd1<-degree(data1, gmode="digraph", diag=FALSE, cmode="outdegree"$
> hist(outd1)
> table(outd1)
outd1
0 1 2 3 4 5
3 2 9 5 3 3
> ind1<-degree(data1, gmode="digraph", diag=FALSE, cmode="indegree", $
> hist(ind1)
> table(ind1)
ind1
0 1 2 3 4 5
1 5 9 3 5 2
> dyad.census(data1)
     Mut Asym Null
[1,]  21   20  259
> grecip(data1, measure = c("edgewise"))
      Mut
0.6774194
>
```

R COMMANDS

- dyad.census(data1)
- grecip(data1, measure = c("edgewise"))
- triad.census(data1)
- geodist(data1)
- list.files()
- attr<-read.table("klas03e-demographics.dat")
- attr
- attr[,1]
- gender<-attr[,1]
- gplot(data1, displaylabels=TRUE,arrowhead.cex=2,vertex.cex=3,vertex.col=gender




```
> triad.census(data1)
      003 012 102 021D 021U 021C 111D 111U 030T 030C 201 120D 120U
[1,] 1454 363 407    8    8    6   10   19    1    0   4    6    1
     120C 210 300
[1,]    0   7   6
>
```

R COMMANDS

- dyad.census(data1)
- grecip(data1, measure = c("edgewise"))
- triad.census(data1)
- geodist(data1)
- list.files()
- attr<-read.table("klas03e-demographics.dat")
- attr
- attr[,1]
- gender<-attr[,1]
- gplot(data1, displaylabels=TRUE,arrowhead.cex=2,vertex.cex=3,vertex.col=gender

RGui

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R Console

```
$gdist
      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12]
 [1,]    0    6    9  Inf    1    9    3    1    1     2     5     2
 [2,]  Inf    0    3  Inf  Inf    3  Inf  Inf  Inf   Inf     1   Inf
 [3,]  Inf  Inf    0  Inf  Inf  Inf  Inf  Inf  Inf   Inf   Inf   Inf
 [4,]    5    7   10    0    4   10    4    5    4     3     6     3
 [5,]    2    6    9  Inf    0    9    3    1    1     2     5     2
 [6,]  Inf  Inf  Inf  Inf  Inf    0  Inf  Inf  Inf   Inf   Inf   Inf
 [7,]  Inf    3    6  Inf  Inf    6    0  Inf  Inf     2     2   Inf
 [8,]    2    6    9  Inf    1    9    3    0    1     1     5     2
 [9,]    1    5    8  Inf    1    8    2    1    0     2     4     1
[10,]  Inf  Inf  Inf  Inf  Inf  Inf  Inf  Inf  Inf     0   Inf   Inf
[11,]  Inf    1    4  Inf  Inf    4  Inf  Inf  Inf   Inf     0   Inf
[12,]    2    4    7  Inf    1    7    1    2    1     1     3     0
[13,]  Inf    1    3  Inf  Inf    3  Inf  Inf  Inf   Inf     1   Inf
[14,]  Inf    2    5  Inf  Inf    5    1  Inf  Inf     1     1   Inf
[15,]  Inf  Inf  Inf  Inf  Inf    1  Inf  Inf  Inf   Inf   Inf   Inf
[16,]    3    5    8  Inf    2    8    2    3    2     1     4     1
[17,]  Inf    1    3  Inf  Inf    3  Inf  Inf  Inf   Inf     1   Inf
[18,]    5    7   10    1    4   10    4    5    4     3     6     3
[19,]  Inf  Inf  Inf  Inf  Inf    1  Inf  Inf  Inf   Inf   Inf   Inf
[20,]    3    7   10  Inf    1   10    4    1    2     2     6     3
[21,]  Inf    3    6  Inf  Inf    6    1  Inf  Inf     2     2   Inf
[22,]  Inf  Inf    1  Inf  Inf  Inf  Inf  Inf  Inf   Inf   Inf   Inf
```

R COMMANDS

- dyad.census(data1)
- grecip(data1, measure = c("edgewise"))
- triad.census(data1)
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R Console

```
[10,]   Inf   Inf   Inf
[11,]     2     4   Inf
[12,]     5     7   Inf
[13,]     1     3   Inf
[14,]     3     5   Inf
[15,]   Inf   Inf   Inf
[16,]     6     8   Inf
[17,]     1     3   Inf
[18,]     8    10     1
[19,]   Inf   Inf   Inf
[20,]     8    10   Inf
[21,]     4     6   Inf
[22,]   Inf     1   Inf
[23,]     0     2   Inf
[24,]   Inf     0   Inf
[25,]     7     9     0

> list.files()
[1] "klas03e-alcohol.dat"        "klas03e-delinquency.dat"
[3] "klas03e-demographics.dat"   "klas03e-friends-waveA.dat"
[5] "klas03e-friends-waveB.dat"  "klas03e-friends-waveC.dat"
[7] "klas03e-friends-waveD.dat"  "klas03e-primary.dat"
> attr<-read.table("klas03e-demographics.dat")
> |
```

R COMMANDS

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RGui

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R Console

```
3    1 12   1   1
4    2 12   1   1
5    2 12   1   1
6    1 12   1   1
7    2 12   1   1
8    2 12   1   1
9    2 12   1   1
10   2 12   1   1
11   1 12   1   1
12   2 11   1   1
13   1 12   1   1
14   2 12   1   3
15   1 12   1   0
16   2 12   1   1
17   1 12   1   1
18   2 12   1   1
19   1 12   1   1
20   2 12   1   2
21   2 12   1   3
22   1 12   1   1
23   1 12   1   1
24   1 12   1   2
25   2 12   1   1
> |
```

R COMMANDS

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RGui

File Edit View Misc Packages Windows Help

R Console

```
5    2 12   1   1
6    1 12   1   1
7    2 12   1   1
8    2 12   1   1
9    2 12   1   1
10   2 12   1   1
11   1 12   1   1
12   2 11   1   1
13   1 12   1   1
14   2 12   1   3
15   1 12   1   0
16   2 12   1   1
17   1 12   1   1
18   2 12   1   1
19   1 12   1   1
20   2 12   1   2
21   2 12   1   3
22   1 12   1   1
23   1 12   1   1
24   1 12   1   2
25   2 12   1   1
> attr[,1]
 [1] 2 1 1 2 2 1 2 2 2 2 1 2 1 2 1 2 1 2 1 2 2 1 1 1 2
>
```

R COMMANDS

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RGui

File Edit View Misc Packages Windows Help

R Console

```
6    1 12   1   1
7    2 12   1   1
8    2 12   1   1
9    2 12   1   1
10   2 12   1   1
11   1 12   1   1
12   2 11   1   1
13   1 12   1   1
14   2 12   1   3
15   1 12   1   0
16   2 12   1   1
17   1 12   1   1
18   2 12   1   1
19   1 12   1   1
20   2 12   1   2
21   2 12   1   3
22   1 12   1   1
23   1 12   1   1
24   1 12   1   2
25   2 12   1   1
> attr[,1]
 [1] 2 1 1 2 2 1 2 2 2 2 1 2 1 2 1 2 1 2 1 2 2 1 1 1 2
> gender<-attr[,1]
>
```

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RGui

File Edit View Misc Packages Windows Help

R Console

```
7    2 12   1   1
8    2 12   1   1
9    2 12   1   1
10   2 12   1   1
11   1 12   1   1
12   2 11   1   1
13   1 12   1   1
14   2 12   1   3
15   1 12   1   0
16   2 12   1   1
17   1 12   1   1
18   2 12   1   1
19   1 12   1   1
20   2 12   1   2
21   2 12   1   3
22   1 12   1   1
23   1 12   1   1
24   1 12   1   2
25   2 12   1   1
> attr[,1]
 [1] 2 1 1 2 2 1 2 2 2 2 1 2 1 2 1 2 1 2 1 2 2 1 1 1 2
> gender<-attr[,1]
> gplot(data1, displaylabels=TRUE,arrowhead.cex=2,vertex.cex=3,vertex$
>
```

R COMMANDS

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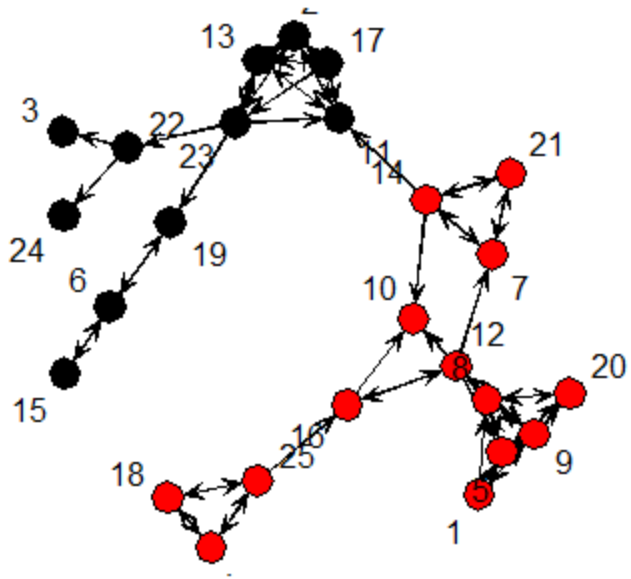
RGui

File History Resize Windows

R Console

```
7    2 12   1   1
8    2 12   1   1
9    2 12   1   1
10   2 12   1   1
11   1 12   1   1
12   2 11   1   1
13   1 12   1   1
14   2 12   1   3
15   1 12   1   0
16   2 12   1   1
17   1 12   1   1
18   2 12   1   1
19   1 12   1   1
20   2 12   1   2
21   2 12   1   3
22   1 12   1   1
23   1 12   1   1
24   1 12   1   2
25   2 12   1   1
> attr[,1]
 [1] 2 1 1 2 2 1 2 2 2 2 1
> gender<-attr[,1]
> gplot(data1, displaylabe
>
```

R Graphics: Device 2 (ACTIVE)



R COMMANDS

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The end