Social Network Analysis (SNA) Part2

Nik Bear Brown

In this lesson we'll learn the how to implement and analyze Social network analysis (SNA) in R.

Additional packages needed

To run the code you may need additional packages.

- If necessary install the followings packages.

```
install.packages("igraph");
install.packages("tools");
install.packages("visNetwork");
```

```
library(igraph)
```

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

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

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

```
library(tools)
library(visNetwork)
```

```
##
## Attaching package: 'visNetwork'
```

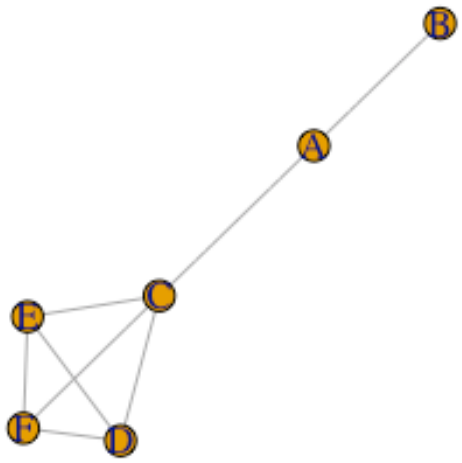
```
## The following object is masked from 'package:igraph':
##
##     %>%
```

Data

We will be creating graphs with the library(igraph).

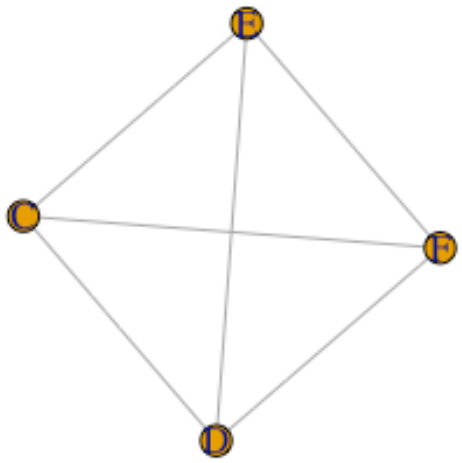
```
# for reproducibility of graphs plots (plot.igraph uses random numbers)
set.seed(3333)
# create an example graph
```

```
D <- read.table(header=T,text=
                  'from to
A B
A C
C D
C F
C E
D E
D F
E F')
g1 <- graph.data.frame(D,directed=F)
# plot the original graph
plot(g1)
```




```
# find all the largest cliques (returns a list of vector of vertiex
ids)
a <- largest.cliques(g1)
# let's just take the first of the largest cliques
# (in this case there's just one clique)
clique1 <- a[[1]]
# subset the original graph by passing the clique vertices
g2 <- graph.full(length(clique1))
V(g2)$name <- V(g1)$name[clique1]
```

```
# plot the clique
plot(g2)
```



In addition we will be using social relations among Renaissance Florentine families (person aggregates) collected by John Padgett from historical documents. The two relations are business ties (PADGB - specifically, recorded financial ties such as loans, credits and joint partnerships) and marriage alliances (PADGM). See http://moreno.ss.uci.edu/data.html#padgett

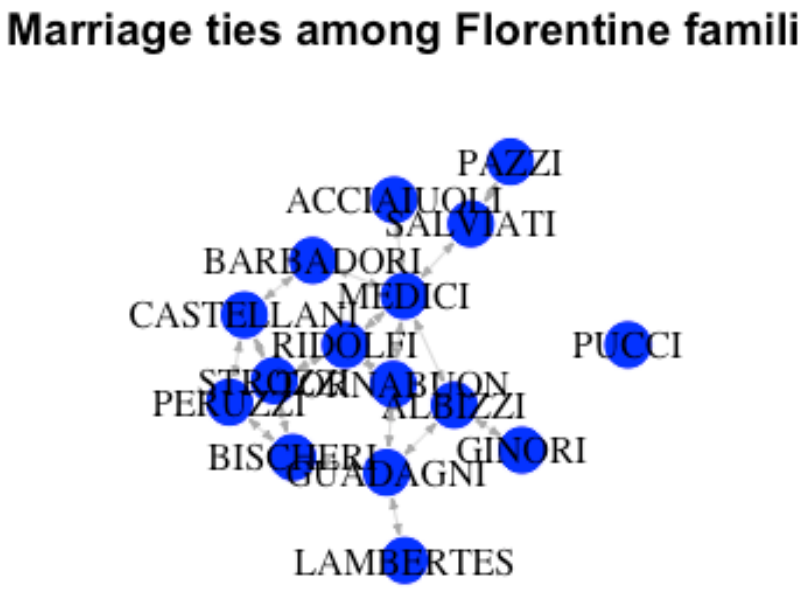
```
# Studying marriage ties among Renaissance Florentine families
data_url <-
'http://nikbearbrown.com/YouTube/MachineLearning/M12/padgett-
cleaned.txt'
padgett.cleaned <- read.table(url(data_url), quote="\"")
```

Cliques and Motifs among Renaissance Florentine families

Find and plot all the largest cliques seperately. Find any significant motifs.

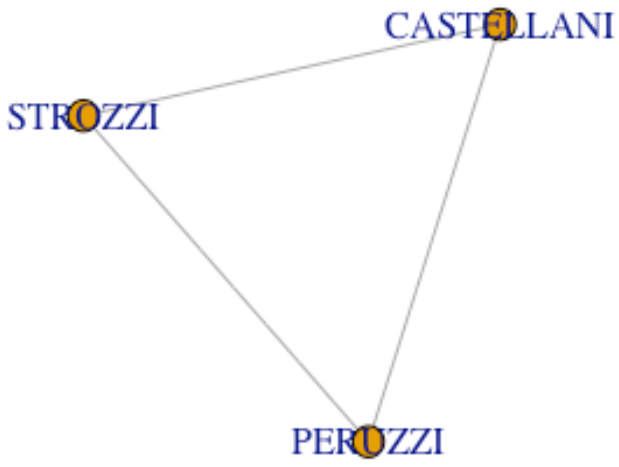
```
florentine_marriage_ties <- padgett.cleaned[1:16,]
rownames(florentine_marriage_ties) <- c("ACCIAIUOLI", "ALBIZZI",
"BARBADORI",
```

```
                                        "BISCHERI", "CASTELLANI",
"GINORI",
                                        "GUADAGNI",
"LAMBERTES","MEDICI",
                                        "PAZZI", "PERUZZI", "PUCCI",
                                        "RIDOLFI", "SALVIATI",
"STROZZI",
                                        "TORNABUON")
colnames(florentine_marriage_ties) <-
rownames(florentine_marriage_ties)
florentine_graph <-
  graph_from_adjacency_matrix(as.matrix(florentine_marriage_ties))
plot(florentine_graph, layout=layout.fruchterman.reingold,
     main = "Marriage ties among Florentine families",
     vertex.label=V(florentine_graph)$name, vertex.size=25,
     vertex.color="blue", vertex.frame.color="white",
     vertex.label.color="black", vertex.label.cex=1,
     edge.arrow.size=0.25, edge.width=0.25)
```



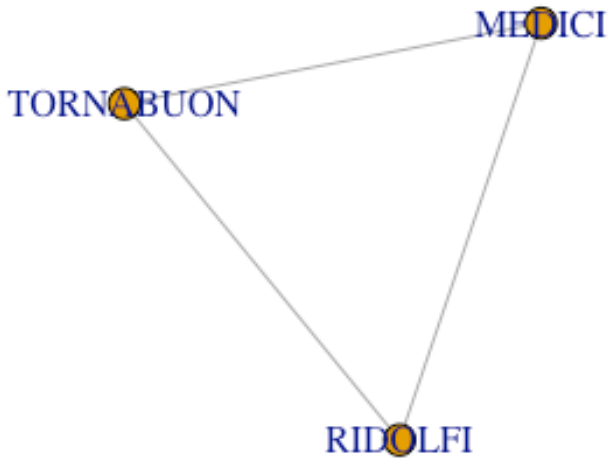

```
count_motifs(florentine_graph, size = 3)

## [1] 41

count_motifs(florentine_graph, size = 4)
```

```
## [1] 91

# find and plot all the largest cliques seperately
florentine_graph_undirected <- as.undirected(florentine_graph)
# following code taken from
# http://stackoverflow.com/questions/26222659/identifying-cliques-in-r
all <- largest_cliques(florentine_graph_undirected)
all

## [[1]]
## + 3/16 vertices, named:
## [1] STROZZI    PERUZZI    CASTELLANI
##
## [[2]]
## + 3/16 vertices, named:
## [1] STROZZI  PERUZZI  BISCHERI
##
## [[3]]
## + 3/16 vertices, named:
## [1] MEDICI    RIDOLFI   TORNABUON

clique_graph1 <- make_full_graph(length(all[[1]]))
V(clique_graph1)$name <- V(florentine_graph_undirected)$name[all[[1]]]
plot(clique_graph1)
```



```r
clique_graph2 <- make_full_graph(length(all[[2]]))
V(clique_graph2)$name <- V(florentine_graph_undirected)$name[all[[2]]]
plot(clique_graph2)
```


```r
clique_graph3 <- make_full_graph(length(all[[3]]))
V(clique_graph3)$name <- V(florentine_graph_undirected)$name[all[[3]]]
plot(clique_graph3)
```




```
# plot all largest cliques
# following code taken from R and Data Mining: Examples and Case
Studies
# by Yanchang Zhao, page 118
florentine_largest_cliques <-
largest_cliques(florentine_graph_undirected)
length(florentine_largest_cliques)

## [1] 3

colorbar <- rainbow(length(florentine_largest_cliques) + 1)
for (i in 1:length(florentine_largest_cliques)) {
  V(florentine_graph_undirected)[florentine_largest_cliques[[i]]]$color
<- colorbar[i+1]
}
plot(florentine_graph_undirected,
mark.groups=florentine_largest_cliques,
     vertex.size=0.3, vertex.label.cex=1, edge.color=rgb(1,0.5,1,1),
     main = "Largest Cliques")
```


```
# plot all maximal cliques
# following code taken from R and Data Mining: Examples and Case
Studies
# by Yanchang Zhao, page 117
florentine_max_cliques <- max_cliques(florentine_graph_undirected)
length(florentine_max_cliques)

## [1] 16

colorbar <- rainbow(length(florentine_max_cliques) + 1)
for (i in 1:length(florentine_max_cliques)) {
  V(florentine_graph_undirected)[florentine_max_cliques[[i]]]$color <-
colorbar[i+1]
}
plot(florentine_graph_undirected, mark.groups=florentine_max_cliques,
     vertex.size=0.3, vertex.label.cex=1, edge.color=rgb(1,0.5,1,1),
     main = "Maximal Cliques")
```


```
# Calculate PageRank of the vertices
ranks_of_families <- page_rank(florentine_graph)$vector
ranks_of_families
```

```
## ACCIAIUOLI    ALBIZZI  BARBADORI   BISCHERI CASTELLANI     GINORI
## 0.03035390 0.07833886 0.04980296 0.06818000 0.06864374 0.03209700
##   GUADAGNI  LAMBERTES     MEDICI      PAZZI    PERUZZI      PUCCI
## 0.09742360 0.03060350 0.14437347 0.03569690 0.06720328 0.00990099
##    RIDOLFI   SALVIATI    STROZZI  TORNABUON
## 0.06888541 0.06069627 0.08722618 0.07057395
```

```
# most important or influential family
which.max(ranks_of_families) # 9 is the index of the vertex
```

```
## MEDICI
##      9
```

Resources

- Network visualization in R with the igraph package

- [Making prettier network graphs with sna and igraph via @rbloggers](http://www.r-bloggers.com/making-prettier-network-graphs-with-sna-and-igraph/)
- igraph R manual pages

References

The data, R code and lessons are based upon:

Graph theory/data structures:
* http://math.tut.fi/~ruohonen/GT_English.pdf
* http://www.cl.cam.ac.uk/teaching/1011/PrincComm/slides-lpr/graph_theory_1-11.pdf
* http://www.researchgate.net/publication/228300013_Graph_Theory_A_Primer_for_Using_R_Visualization_Techniques_in_the_Applications_of_the_Adjacency_Matrix
* http://www.boost.org/doc/libs/1_59_0/libs/graph/doc/graph_theory_review.html

SNA:
* http://files.meetup.com/1406240/sna_in_R.pdf
* http://www2.unb.ca/~ddu/6634/Lecture_notes/Lec1_intro_handout.pdf
* http://www.faculty.ucr.edu/~hanneman/nettext/
* http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.372.1960&rep=rep1&type=pdf
* http://www.rdatamining.com/examples/social-network-analysis

igraph:
* http://statmath.wu.ac.at/research/friday/resources_WS0708_SS08/igraph.pdf
* http://blog.revolutionanalytics.com/2014/11/a-look-at-the-igraph-package.html
* http://www.r-bloggers.com/igraph-and-sna-an-amateurs-dabbling/
* http://www.r-bloggers.com/going-viral-with-rs-igraph-package/
* https://cran.r-project.org/web/packages/igraph/igraph.pdf

Other famous packages for SNA:
* http://www.r-bloggers.com/must-have-r-packages-for-social-scientists/
* https://cran.r-project.org/web/views/SocialSciences.html
* https://cran.r-project.org/web/packages/sna/sna.pdf
* https://cran.r-project.org/web/packages/RSiena/RSiena.pdf
* https://cran.r-project.org/web/packages/network/network.pdf
* https://www.bioconductor.org/packages/release/bioc/manuals/graph/man/graph.pdf
* http://www.statnet.org/

In-depth SNA tutorials:
* http://sna.stanford.edu/rlabs.php
* http://www.stats.ox.ac.uk/~snijders/sna_course.htm
* http://www.shizukalab.com/toolkits

Sample projects:

- http://www.orgnet.com/cases.html

Motifs:
* http://igraph.org/r/doc/motifs.html
* https://en.wikipedia.org/wiki/Network_motif
* http://www.cs.columbia.edu/4761/notes07/chapter8.2-topology.pdf
* https://sites.google.com/site/networkanalysisacourse/schedule/networkmotifs
Cliques:
* http://igraph.org/r/doc/cliques.html
* http://faculty.ucr.edu/~hanneman/nettext/C11_Cliques.html
* https://courses.cs.washington.edu/courses/cse527/01au/oct25/oct25.html
* ttp://www.mathcove.net/petersen/lessons/get-lesson?les=29
* http://news.stanford.edu/news/2014/november/cliques-high-school-110514.html
PageRank:
* http://igraph.org/r/doc/page_rank.html
* http://ilpubs.stanford.edu:8090/422/1/1999-66.pdf
* http://www.cs.princeton.edu/~chazelle/courses/BIB/pagerank.htm
* http://www.stat.cmu.edu/~ryantibs/datamining/lectures/03-pr-marked.pdf
* http://smallstats.blogspot.com/2014/04/from-random-walks-to-personalized.html
* http://blog.revolutionanalytics.com/2014/12/a-reproducible-r-example-finding-the-most-popular-packages-using-the-pagerank-algorithm.html
* Mining Massive Datasets on Coursera - Week 1, Videos 5 through 11 explain PageRank elegantly. The course maybe unavailable (or archived) by the time this module is out

Dataset:
* http://moreno.ss.uci.edu/data.html#padgett
* http://home.uchicago.edu/~jpadgett/papers/unpublished/maelite.pdf

Other SNA:
* http://www.r-bloggers.com/experiments-with-igraph/
* http://cran.us.r-project.org/doc/contrib/Zhao_R_and_data_mining.pdf