Example Igraph

This is an R Markdown Notebook. When you execute code within the notebook, the results appear beneath the code.

Creating the environment

Set working directroy

```
setwd("C:/Users/Sebastian/Google Drive/DOCTORADO/INTERNSHIP/Kentucky University/Activities Internship/F
```

Upload packages

```
library(igraph)
```

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

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

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

Create functions

```
giant.component <- function(graph) {
        cl <- clusters(graph)
        induced.subgraph(graph, which(cl$membership == which.max(cl$csize)))}
```

Getting Data

```
nodes.raw <-  read.csv("Example_Nodes_SNAOrganization.csv", stringsAsFactors = FALSE)
edges.raw <- read.csv("Example_Edges_SNAOrganization.csv", stringsAsFactors = FALSE)

head(nodes.raw)
```

```
##   id
## 1 n0
## 2 n1
## 3 n2
## 4 n3
## 5 n4
## 6 n5
```

```
##                                                                                                  lab
## 1                   El-adaway Ih, 2017, J Infrastruct Syst, V23, Doi 10.1061/(asce)is.1943-555x.00003
## 2                                                                Haghani A., 2003, Transport Res Rec, P1
## 3                                  Brush Er, 2013, Plos Comput Biol, V9, Doi 10.1371/journal.pcbi.10031
## 4                                                                Lam Whk, 2002, J Adv Transport, V36, P1
## 5                                                                      Cook W., 1998, Combinatorial Opti
## 6 Perez-cartagena Ri, 2005, J Transp Eng-asce, V131, P904, Doi 10.1061/(asce)0733-947x(2005)131:12(90
```

```
head(edges.raw)
```

```
##   Source Target     Type
## 1     n0    n16 Directed
## 2     n0    n25 Directed
## 3     n0    n28 Directed
## 4     n0    n29 Directed
## 5     n0    n39 Directed
## 6     n0    n62 Directed
```

Cleaning Data

Creating our graph object

```
net.clean.1 <- graph.data.frame(d = edges.raw, directed = TRUE,
                                vertices = nodes.raw)
net.clean.1 <- simplify(net.clean.1)

summary(net.clean.1)
```

```
## IGRAPH DN-- 8097 10145 --
## + attr: name (v/c), label (v/c)
```

Adding in and out degree network metrics

```
V(net.clean.1)$indegree <- degree(net.clean.1, mode = "in")
V(net.clean.1)$outdegree <- degree(net.clean.1, mode = "out")

head(as_data_frame(net.clean.1, what = "vertices"))
```

```
##    name
## n0   n0
## n1   n1
## n2   n2
## n3   n3
## n4   n4
## n5   n5
##                                                                                                  la
## n0                   El-adaway Ih, 2017, J Infrastruct Syst, V23, Doi 10.1061/(asce)is.1943-555x.0000
## n1                                                                Haghani A., 2003, Transport Res Rec, P
## n2                                  Brush Er, 2013, Plos Comput Biol, V9, Doi 10.1371/journal.pcbi.1003
## n3                                                                Lam Whk, 2002, J Adv Transport, V36, P
## n4                                                                      Cook W., 1998, Combinatorial Opt
## n5 Perez-cartagena Ri, 2005, J Transp Eng-asce, V131, P904, Doi 10.1061/(asce)0733-947x(2005)131:12(9
```

```
##    indegree outdegree
## n0        0        83
## n1        1         0
## n2        1         0
## n3        1         0
## n4        1         0
## n5        1         0
```

Deleting nodes with in-degree 1 and out-degree 0

```
net.clean.2 <- delete.vertices(net.clean.1, V(net.clean.1)[indegree == 1 &
                                                             outdegree == 0])

head(as_data_frame(net.clean.2, what = "vertices"))
```

```
##     name
## n0    n0
## n6    n6
## n8    n8
## n11  n11
## n12  n12
## n14  n14
##                                                                                label
## n0  El-adaway Ih, 2017, J Infrastruct Syst, V23, Doi 10.1061/(asce)is.1943-555x.0000331
## n6    Pryke S.d., 2004, Constr Manag Ec, V22, P787, Doi Doi 10.1080/0144619042000206533
## n8   Ruan X., 2012, Construction Managem, V30, P5, Doi Doi 10.1080/01446193.2011.654127
## n11                                                 West D. B., 1996, Intro Graph Theory
## n12         Labianca G, 2006, Acad Manage Rev, V31, P596, Doi 10.5465/amr.2006.21318920
## n14                Ahuja Mk, 2003, Manage Sci, V49, P21, Doi 10.1287/mnsc.49.1.21.12756
##     indegree outdegree
## n0         0        83
## n6         4         0
## n8         2         0
## n11        2         0
## n12        4         0
## n14        5         0
```

Extract giant component

```
net.clean.3 <- giant.component(net.clean.2)

summary(net.clean.3)
```

```
## IGRAPH DN-- 1062 3115 --
## + attr: name (v/c), label (v/c), indegree (v/n), outdegree (v/n)
```

Tidying Data

```
net.tidied.1 <- net.clean.3
```

Delete attributes in and out degree

```
net.tidied.2 <- delete_vertex_attr(net.tidied.1, "outdegree" )
net.tidied.3 <- delete_vertex_attr(net.tidied.2, "indegree" )
net.tidied <- net.tidied.3

summary(net.tidied)
```

```
## IGRAPH DN-- 1062 3115 --
## + attr: name (v/c), label (v/c)
```

Exploratory Analysis

Global properties

Density

```
graph.density(net.tidied)
```

```
## [1] 0.00276451
```

Transitivity

```
transitivity(net.tidied, type = "global")
```

```
## [1] 0.0236434
```

Diameter

```
diameter(net.tidied, directed = TRUE, weights = NA)
```

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

Centralization

```
centr_degree(net.tidied, mode = "all")$centralization
```

```
## [1] 0.04298756
```

Local properties

Degree: in and out

```
V(net.tidied)$indegree <- degree(net.tidied, mode = "in")
V(net.tidied)$outdegree <- degree(net.tidied, mode = "out")
V(net.tidied)$degree <- degree(net.tidied, mode = "all")
```

Betweenness

```
V(net.tidied)$bet <- betweenness(net.tidied)
```

Bonacich

```
V(net.tidied)$bonacich <- power_centrality(net.tidied)
```

Transitivity

```
V(net.tidied)$transitivity <- transitivity(net.tidied, type = "local")

head(as_data_frame(net.tidied, what = "vertices"))
```

```
##     name
## n0    n0
## n6    n6
## n8    n8
## n11  n11
## n12  n12
## n14  n14
##                                                                                                label
## n0  El-adaway Ih, 2017, J Infrastruct Syst, V23, Doi 10.1061/(asce)is.1943-555x.0000331
## n6    Pryke S.d., 2004, Constr Manag Ec, V22, P787, Doi Doi 10.1080/0144619042000206533
## n8   Ruan X., 2012, Construction Managem, V30, P5, Doi Doi 10.1080/01446193.2011.654127
## n11                                                    West D. B., 1996, Intro Graph Theory
## n12         Labianca G, 2006, Acad Manage Rev, V31, P596, Doi 10.5465/amr.2006.21318920
## n14                Ahuja Mk, 2003, Manage Sci, V49, P21, Doi 10.1287/mnsc.49.1.21.12756
##     indegree outdegree degree bet bonacich transitivity
## n0         0        23     23   0 1.840989  0.003952569
## n6         4         0      4   0 0.000000  0.000000000
## n8         2         0      2   0 0.000000  0.000000000
## n11        2         0      2   0 0.000000  0.000000000
## n12        4         0      4   0 0.000000  0.000000000
## n14        5         0      5   0 0.000000  0.000000000
```

Subgroups and communities

Based on greedy optimization of modularity

```
community <- cluster_fast_greedy(as.undirected(net.tidied))
V(net.tidied)$community <- community$membership

table(V(net.tidied)$community)
```

```
##
##   1   2   3   4   5   6   7   8   9  10  11
##  94  79 125 171 152 144  48 117  64  47  21
```

Coreness

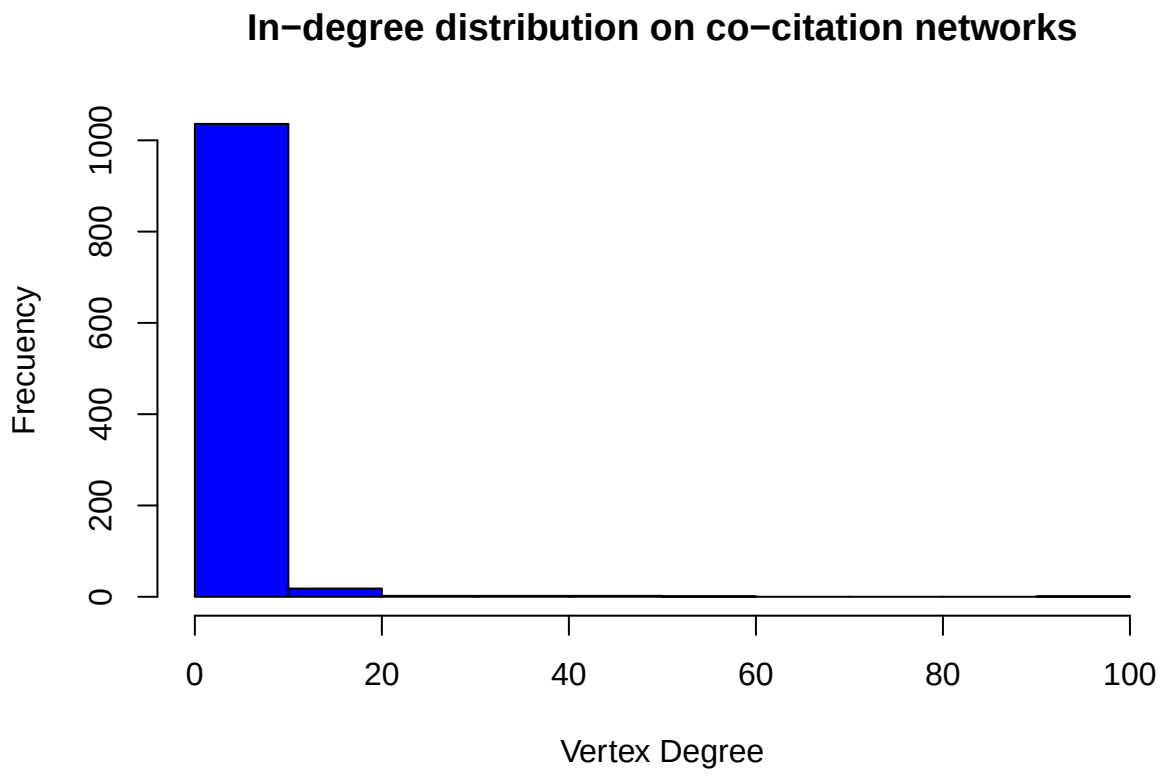
```
V(net.tidied)$coreness <- coreness(net.tidied)

table(V(net.tidied)$coreness)
```

```
##
##   1   2   3   4   5   6   7
##  13 532 185 111 101  78  42
```

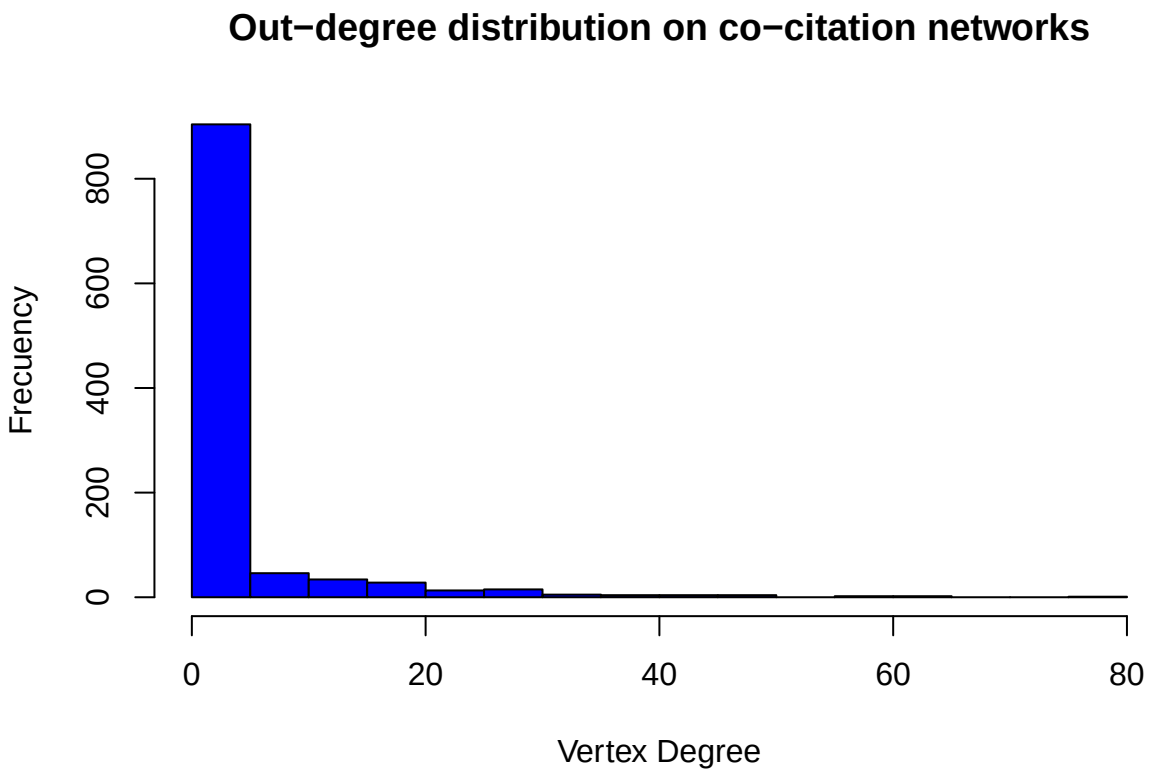
Topological Properties

Degree distribution

```
hist(degree(net.tidied, mode = "in"), col="blue",
     main = "In-degree distribution on co-citation networks",
     xlab = "Vertex Degree", ylab = "Frecuency")
```

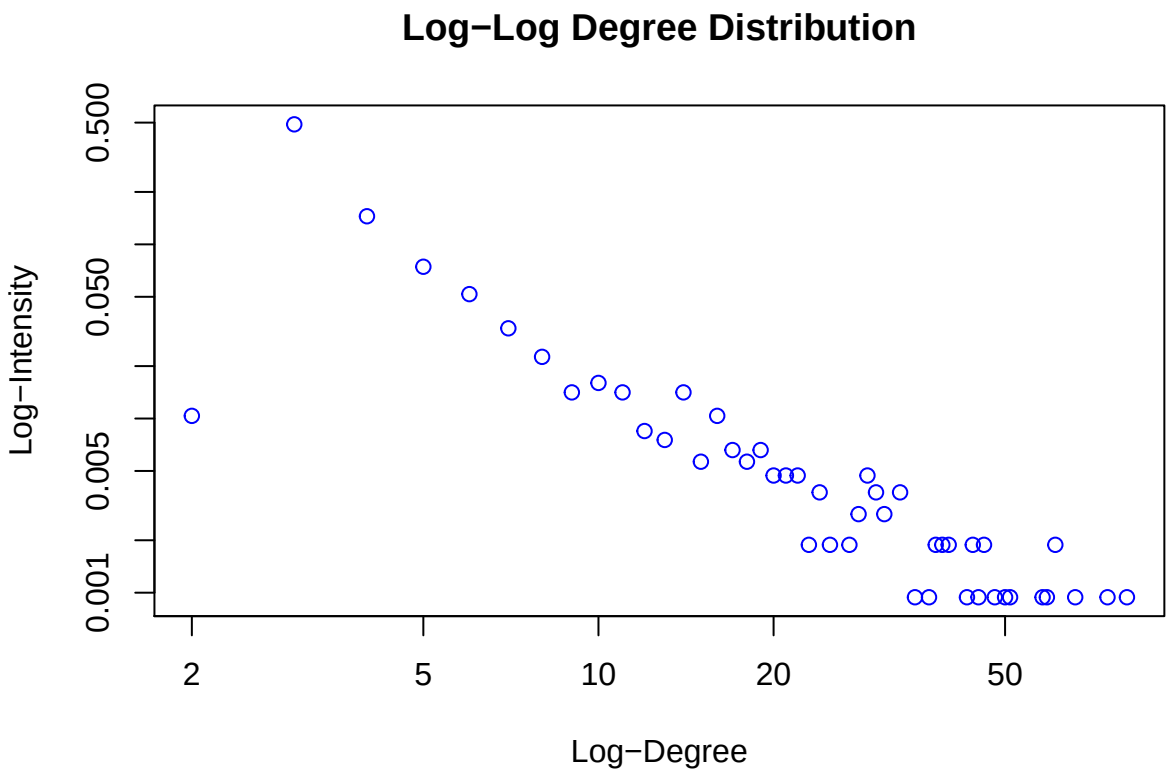



```
hist(degree(net.tidied, mode = "out"), col="blue",
     main = "Out-degree distribution on co-citation networks",
     xlab = "Vertex Degree", ylab = "Frecuency")
```



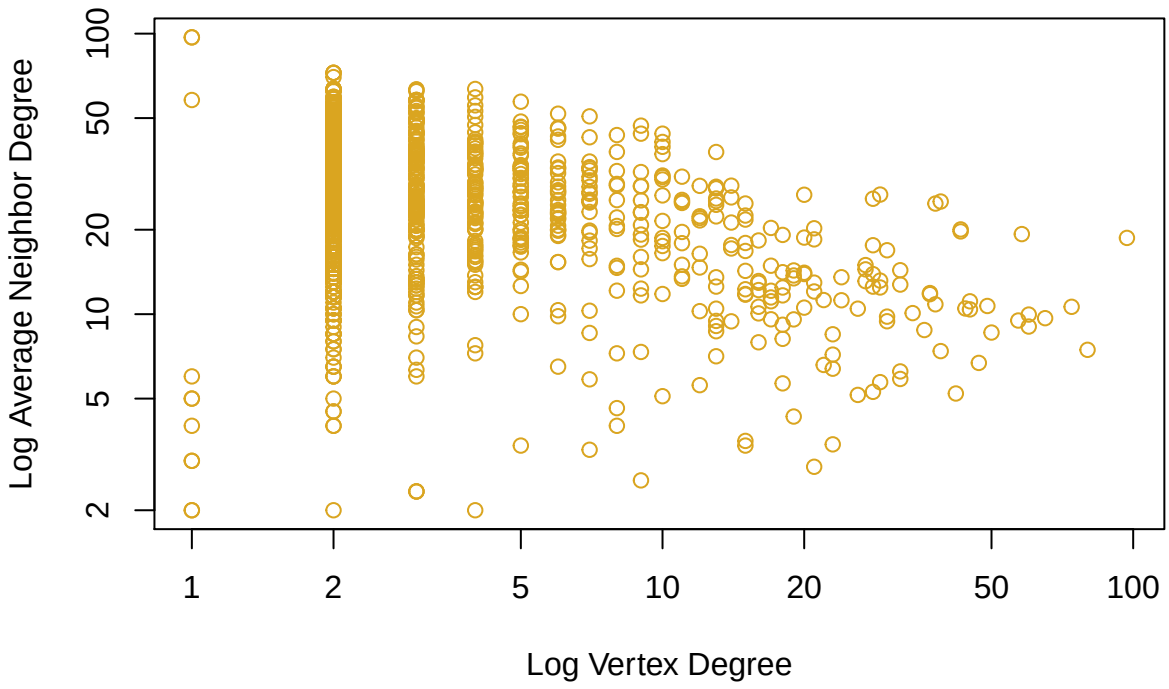
Log-log degree distribution

```
d.net.tidied <- degree(net.tidied, mode = "all")
dd.net.tidied <- degree.distribution(net.tidied)

d <- 1:max(d.net.tidied)
ind <- (dd.net.tidied != 0)
plot(d[ind], dd.net.tidied[ind], log = "xy", col = "blue",
     xlab = c("Log-Degree"), ylab = c("Log-Intensity"),
     main = "Log-Log Degree Distribution")
```



Log Average Neighbor Degree

```
a.nn.deg.net.tidied <- graph.knn(net.tidied,V(net.tidied))$knn
plot(d.net.tidied, a.nn.deg.net.tidied,
     log="xy", col="goldenrod",
     xlab=c("Log Vertex Degree"),
     ylab=c("Log Average Neighbor Degree"))
```



Present Results

Identifidying key actors in the network: Seminal, Structural, and Current papers

```
df.1 <- as_data_frame(net.tidied, what = "vertices")

df.1 <- df.1[, c("label", "outdegree", "indegree", "bet")]

seminals <- df.1[df.1$outdegree == 0,]
seminals <- head(seminals[order(seminals$indegree,
                                rev(seminals$indegree),
                                decreasing = TRUE), "label"], 10)

structurals <- head(df.1[order(df.1$bet, rev(df.1$bet),
                               decreasing = TRUE), "label"], 10)

currents <- df.1[df.1$indegree == 0,]
currents <- head(currents[order(currents$outdegree,
                                rev(currents$outdegree),
                                decreasing = TRUE), "label"], 10)

key.papers <- data.frame(seminals, structurals, currents, stringsAsFactors = FALSE)
```

```
key.papers
```

```
##                                                                    seminals
## 1                                Wasserman S., 1994, Social Network Anal, P249
## 2                                     Scott J., 1991, Social Network Anal, P92
## 3   Freeman Lc, 1979, Soc Networks, V1, P215, Doi 10.1016/0378-8733(78)90021-7
## 4                                   Borgatti S. P., 2002, Ucinet Windows Softw
## 5            Granovetter Ms, 1973, Am J Sociol, V78, P1360, Doi 10.1086/225469
## 6                                     Burt R. S., 1992, Structural Holes Soc
## 7    Borgatti Sp, 2003, J Manage, V29, P991, Doi 10.1016/s0149-2063(03)00087-4
## 8                                   Hanneman Ra, 2005, Intro Social Network
## 9          Borgatti Sp, 2009, Science, V323, P892, Doi 10.1126/science.1165821
## 10 Borgatti Sp, 2005, Soc Networks, V27, P55, Doi 10.1016/j.socnet.2004.11.008
##                                                                  structurals
## 1                                            Cross R, 2002, Calif Manage Rev, V44, P25
## 2  Borgatti Sp, 2009, J Supply Chain Manag, V45, P5, Doi 10.1111/j.1745-493x.2009.03166.x
## 3     Burt Rs, 2013, Annu Rev Psychol, V64, P527, Doi 10.1146/annurev-psych-113011-143828
## 4          Fattore G, 2009, Health Policy, V92, P141, Doi 10.1016/j.healthpol.2009.03.005
## 5                Hu C, 2008, Int J Hosp Manag, V27, P302, Doi 10.1016/j.ijhm.2007.01.002
## 6                     Kasper C, 2009, Primates, V50, P343, Doi 10.1007/s10329-009-0153-2
## 7           James R, 2009, Behav Ecol Sociobiol, V63, P989, Doi 10.1007/s00265-009-0742-5
## 8         Yousefi-nooraie R, 2012, Bmc Health Serv Res, V12, Doi 10.1186/1472-6963-12-118
## 9   Makagon Mm, 2012, Appl Anim Behav Sci, V138, P152, Doi 10.1016/j.applanim.2012.02.003
## 10             Allen J, 2007, R&d Manage, V37, P179, Doi 10.1111/j.1467-9310.2007.00468.x
##                                                                    currents
## 1            Farine Dr, 2015, J Anim Ecol, V84, P1144, Doi 10.1111/1365-2656.12418
## 2   Conway S, 2014, Brit J Manage, V25, P102, Doi 10.1111/j.1467-8551.2012.00835.x
## 3            Rose Pe, 2015, Anim Welfare, V24, P123, Doi 10.7120/09627286.24.2.123
## 4        El Louadi M, 2008, Knowl Man Res Pract, V6, P199, Doi 10.1057/kmrp.2008.9
## 5          Ho Y, 2013, Asia Pac J Manag, V30, P1265, Doi 10.1007/s10490-011-9268-2
## 6       Diez-vial I, 2014, Knowl Man Res Pract, V12, P276, Doi 10.1057/kmrp.2014.7
## 7      Sutanto J, 2011, Long Range Plann, V44, P421, Doi 10.1016/j.lrp.2011.09.001
## 8          Garcia Md, 2016, Rev Esp Investig Soc, P23, Doi 10.5477/cis/reis.153.23
## 9                                    Khan Gf, 2016, Commun Assoc Inf Sys, V39, P367
## 10 Zheng X, 2016, Int J Proj Manag, V34, P1214, Doi 10.1016/j.ijproman.2016.06.005
```

Export document

```
write.csv(key.papers, "key_papers.csv", row.names = FALSE)
```

Export network

```
write.graph(net.tidied, "net_tidied.graphml", "graphml")
```