# FOSSEE Summer Internship on Social Network Analysis using R Studio

A REPORT

submitted by

**Arnab Karmakar (19BAI1090) (**Vellore Institute of Technology, Chennai)

Under the guidance of **Prof. Mohana N ,** department of mathematics, VIT Chennai

*in partial fulfilment for the award*

of

**B. Tech. CSE with Specialization in Artificial Intelligence and Machine Learning**

**School of Computer Science and Engineering**

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

July 23rd - August 29th, 2021

# School of Computer Science and Engineering

## DECLARATION

I hereby declare that the project entitled **“FOSSEE** Summer Internship on Social Network Analysis using R Studio” submitted by me to the School of Computer Science and Engineering, Vellore Institute of Technology, Chennai Campus, Chennai 600127 in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology – CSE with Specialization in Artificial Intelligence and Machine Learning** is a record of bonafide work carried out by me**.** I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma of this institute or of any other institute or university.

Signature

**Arnab Karmakar (19BAI1090)**

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

## School of Computer Science and Engineering

## DECLARATION

I hereby declare that the project entitled **"FOSSEE** Summer Internship on Social Network Analysis using R Studio" submitted by me to the School of Computer Science and Engineering, Vellore Institute of Technology, Chennai Campus, Chennai 600127 in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology – CSE with Specialization in Artificial Intelligence and Machine Learning** is a record of bonafide work carried out by me. I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma of this institute or of any other institute or university.

Signature

**Arnab Karmakar (19BAI1090)**

# School of Computer Science and Engineering

## CERTIFICATE

The project report entitled "**FOSSEE** Summer Internship on Social Network Analysis using R Studio" is prepared and submitted by **Arnab Karmakar (Register No:19BAI1090)**. It has been found satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology – CSE with Specialization in Artificial Intelligence and Machine Learning** in Vellore Institute of Technology, Chennai, India.

**Examined by**:

**Examiner I** **Examiner II**

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

## School of Computer Science and Engineering

## CERTIFICATE

The project report entitled "**FOSSEE** Summer Internship on Social Network Analysis using R Studio" is prepared and submitted by **Arnab Karmakar (Register No:19BAI1090)**. It has been found satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology – CSE with Specialization in Artificial Intelligence and Machine Learning** in Vellore Institute of Technology, Chennai, India.

**Examined by:**

| | |
|---|---|
| | R. Sujithra 24/11/22 |
| **Examiner I** | **Examiner II** |
| | R. SUJITHRA |

**VIT®**

**Vellore Institute of Technology**

(Deemed to be University under section 3 of UGC Act, 1956)

**CHENNAI**

# Internship Certificate

**Awarded by**

**FOSSEE Club of VIT Chennai**

**This is to certify that Mr./Ms.**……………Arnab Karmakar……………**of** ……………VIT Chennai……………**has completed one month period (July 10th to July 30th 2021 and five Saturdays and Sundays of August 2021) of internship under**……………Prof Mohana N……………**School of Computer Science and Engineering (SCOPE), VIT Chennai and Free/Libre and Open Source Software for Education (FOSSEE) club of IIT Bombay, operating at VIT Chennai. During the period of his/her internship programme he/she has successfully completed R Case Study** ……………Social Network Analysis using Rstudio…………… **and submitted to IIT Bombay FOSSEE - R Project of Govt of India.**

Awarded on 10th of February, 2022

**Dr. T. Subbulakshmi**
**Coordinator/ Professor-SCOPE**
**IIT Bombay-FOSSEE Club**
**VIT Chennai**

# ACKNOWLEDGEMENT

I want to express my sincere gratitude to Prof. Mohana N, Department of Mathematics VIT, Chennai, for creating the FOSSEE Internship program and providing students an opportunity to participate in it. I would also like to thank for her immense support, patience, motivation, knowledge & influence throughout this internship and for helping me on various statistical models. I would also like to thank the other fellows who got selected along with me, namely M. S Naman for his support, intellectual discussions and enthusiasm. I am very grateful to be given such a fantastic opportunity to work on this exciting project.

- Dr. Sweetlin Hemalatha C, Head of the Department (HoD), B.Tech. CSE with Specialization in Artificial Intelligence and Machine Learning. SCOPE, VIT Chennai
- Dr. Ganesan R, Dean of the School of Computer Science & Engineering, VIT Chennai
- Dr. Parvathi R, Associate Dean (Academics) of the School of Computer Science & Engineering, VIT Chennai
- Dr. Geetha S, Associate Dean (Research) of the School of Computer Science & Engineering, VIT Chennai
- Prof. Mohana N, Department of Mathematics VIT, Chennai

# CONTENTS

# LIST OF Keywords

| Keywords | Expansion |
| --- | --- |
| Social Network Analysis | Analysis of social networks is the study of their structure and their effects on health, building on the theoretical constructs of sociology and the mathematical underpinnings of graph theory. Structure refers to the regularities in the patterning of relationships between individuals, groups and/or organizations. |
| Social Networking | A network of individuals (friends, acquaintances, co-workers, etc.) linked by interpersonal relationships.: An online service or his website for people to build and maintain relationships. |
| Demographic indicators | Vital statistics include indicators that measure population size, sex ratio, population density, and dependency rate. Vital statistics include birth rate, mortality rate, natural growth rate, life expectancy at birth, mortality rate, birth rate, etc. |
| Hyperlinking networks | Hyperlink network analysis (HNA) is closely related to social network analysis. HNA explores relationships between actors. Actors can be people, organizations, or websites/blogs. |
| Computer Mediated Communication | Computer-mediated communication (CMC), wherein people use computers and networks to communicate with one another, makes communication across great distances and different time zones convenient, eliminating the time and geographic constraints of in-person communication. |
| Tcl / Tk Network Graph | Tcl is a general purpose multi-paradigm system programming language. It is a scripting language that aims at providing the ability for applications to communicate with each other. On the other hand, Tk is a cross platform widget toolkit used for building GUI in many languages. |
| Plot genvector Centrality on Betweeness | Eigenvector Centrality is an algorithm that measures the transitive influence of nodes. Relationships originating from high-scoring nodes contribute more to the score of a node than connections from low-scoring nodes. |

s

# ABSTRACT

Social Network Analysis is a widely used method of psychology, such as social science, economics, and other fields. What is different about this view that's it doesn’t focus to individuals or to others sectors of society but by the relationship between them. In this paper my purpose is to give a general overview of this concept, providing a description of the key resources and topics covered in Network Analysis. Initially, I will focus on the methodological and systematic analysis of the analysis. In the last section, I shall show the latest lessons on the Internet Network and its relationships with Information Technologies, especially online. Lastly, I shall represent you how this method can be helpful in learning some of the web materials.

# 1 INTRODUCTION

Every kind of social aggregation can be represented in terms of units composing this aggregation and relations between these units. This kind of representation of a social structure is called “Social Network”. In a social network, every unit, usually called “social actor” (a person, a group, an organization, a nation, a blog and so on), is represented as a node. A relation is represented as a linkage or a flow between these units. The set of possible relations is potentially infinite; the term relation can have many different meanings: acquaintance, kinship, evaluation of another person, the need of a commercial exchange, physical connections, the presence in a web-page of a link to another page and so on. Therefore, the objects under observation are not individuals and their attributes, but the relationships between individuals and their structure. The advantage of such a representation is that it permits the analysis of social processes as a product of the relationships among social entities. In Social Network Analysis we can study two different kinds of variables: structural and composition. Variables of the first type are the most important in this field because they represent the different kinds of ties between social actors (friendship, trust and so on).

# 2 Methodology

## Data Exploration

Loading Social Network Data:- Loading An Edgelist

- directed vs. undirected
- SNA data also can also be represented as a sociomatrix

```
# Social Network Analysis
library(igraph)
g <- graph(c(1,2,2,3,3,4,4,1),
        directed = F,
        n=7)
plot(g,
    vertex.color = "green",
    vertex.size = 40,
    edge.color = 'red')
g[]

g1 <- graph(c("Amy", "Ram", "Ram", "Li", "Li", "Amy",
      "Amy", "Li", "Kate", "Li"),
      directed=T)
plot(g1,
    vertex.color = "green",
    vertex.size = 40,
    edge.color = 'red')
```

```
g1

# Network measures
degree(g1, mode='all')
degree(g1, mode='in')
degree(g1, mode='out')

diameter(g1, directed=F, weights = NA)
edge_density(g1, loops = F)
ecount(g1)/(vcount(g1)*(vcount(g1)-1))
reciprocity(g1)
closeness(g1, mode='all', weights = NA)
betweenness(g1, directed=T, weights=NA)
edge_betweenness(g1)
```

*Untitled - Notepad

File Edit Format View Help

```
plot(net,
     vertex.color = rainbow(52),
     vertex.size = V(net)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.fruchterman.reingold)
plot(net,
     vertex.color = rainbow(52),
     vertex.size = V(net)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.graphopt)
plot(net,
     vertex.color = rainbow(52),
     vertex.size = V(net)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.kamada.kawai)

# Hub and officials
hs <- hub_score (net) $ vector
such as <- authority.score (net) $ vector
par (mfrow = c (1,2))
set.seed (123)
structure (net,
     vertex.size = hs * 30,
     main = 'Hubs',
     vertex.color = rainbow (52),
     edge.arrow.size = 0.1,
     layout = layout.kamada.kawai)
set.seed (123)
structure (net,
     vertex.size=as*30,
     main = 'Authorities',
     vertex.color = rainbow(52),
     edge.arrow.size=0.1,
     layout = layout.kamada.kawai)
par(mfrow=c(1,1))

# Community detection
net <- graph.data.frame(y, directed = F)
cnet <- cluster_edge_betweenness(net)
plot(cnet,
     net,
     vertex.size = 10,
     vertex.label.cex = 0.8)
```

Ln 71, Col 1 | 100% | Windows (CRLF) | UTF-8

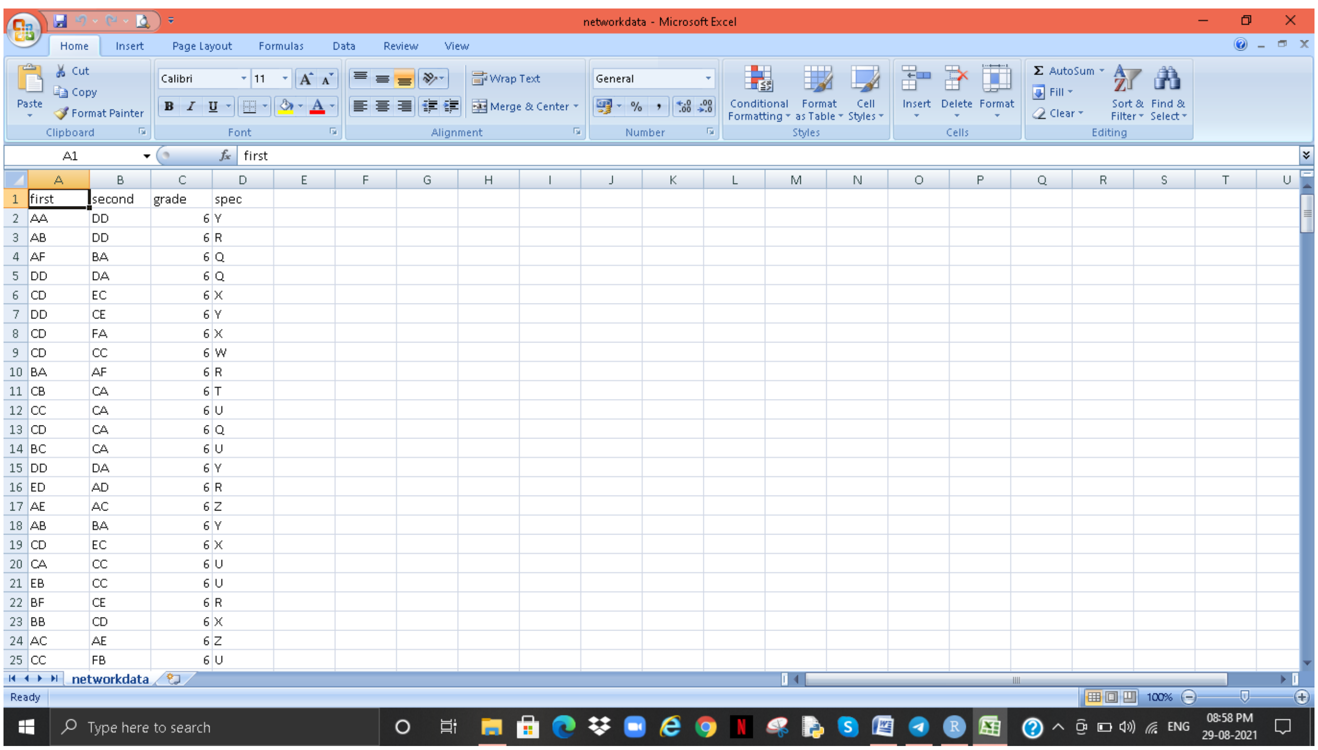
*Untitled - Notepad

File Edit Format View Help

```
# Read the data file
data <- read.csv (file.choose (), header = T)
y <- data.frame (data $ first, data $ second)

# Create a network
inetha <- graph.data.frame (y, directed = T)
V (net)
E (net)
V (net) $ label <- V (net) $ name
V (net) $ degree <- degree (net)

# Histogram node degree
hist (V (net) $ degree,
     icol = 'green',
     main = 'Histogram for Node Degree',
     ylab = 'Frequency',
     xlab = 'Viewing qualifications')

# Drawing of a network
set.seed (222)
structure (net,
     vertex.color = 'green',
     vertext.size = 2,
     edge.arrow.size = 0.1,
     vertex.label.cex = 0.8)

# Highlighting degrees & layouts
plot(net,
     vertex.color = rainbow(52),
     vertex.size = V(net)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.fruchterman.reingold)
plot(net,
     vertex.color = rainbow(52),
     vertex.size = V(net)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.graphopt)
plot(net,
     vertex.color = rainbow(52),
     vertex.size = V(net)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.kamada.kawai)

# Hub and officials
```

Ln 71, Col 1 | 100% | Windows (CRLF) | UTF-8

source target
1 2
1 10
2 1
2 10
3 7
4 7
4 209
5 132
6 150
7 3
7 4
7 9
8 106
8 115
9 1
9 2
9 7
10 1
10 2
11 133
11 218
12 88

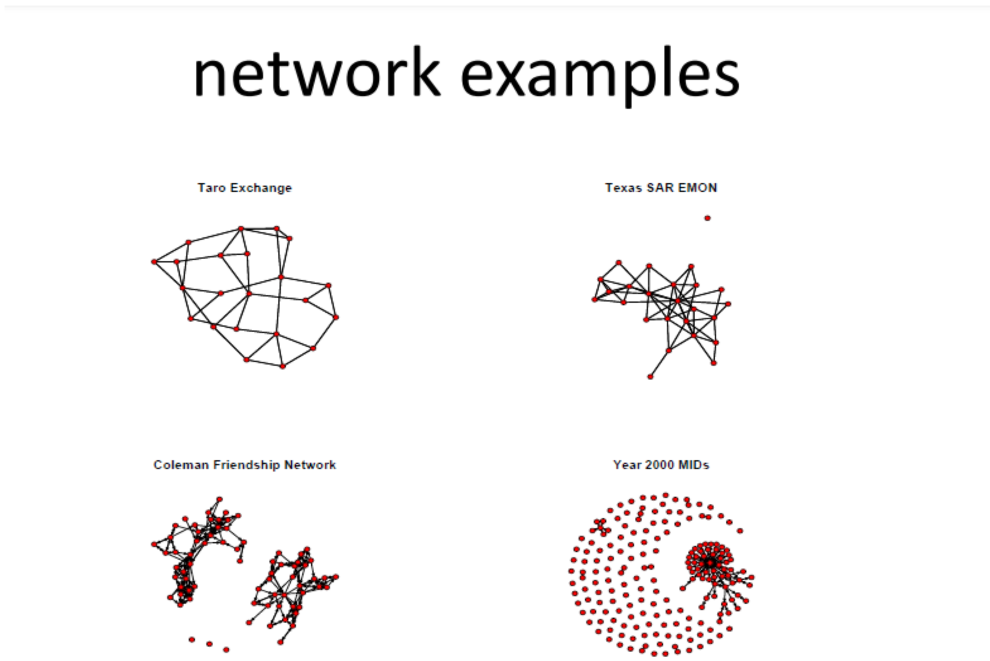


| first | second | grade | spec |
|---|---|---|---|
| AA | DD | 6 | Y |
| AB | DD | 6 | R |
| AF | BA | 6 | Q |
| DD | DA | 6 | Q |
| CD | EC | 6 | X |
| DD | CE | 6 | Y |
| CD | FA | 6 | X |
| CD | CC | 6 | W |
| BA | AF | 6 | R |
| CB | CA | 6 | T |
| CC | CA | 6 | U |
| CD | CA | 6 | Q |
| BC | CA | 6 | U |
| DD | DA | 6 | Y |
| ED | AD | 6 | R |
| AE | AC | 6 | Z |
| AB | BA | 6 | Y |
| CD | EC | 6 | X |
| CA | CC | 6 | U |
| EB | CC | 6 | U |
| BF | CE | 6 | R |
| BB | CD | 6 | X |
| AC | AE | 6 | Z |
| CC | FB | 6 | U |

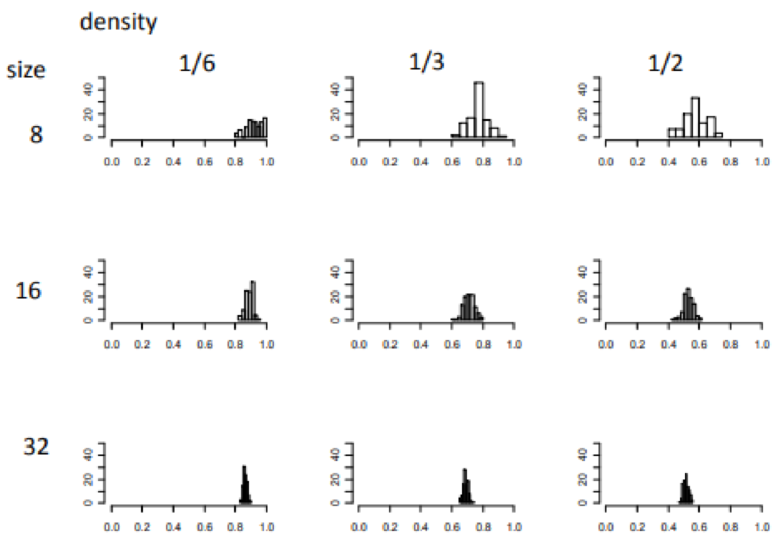
# 4 Data Analysis

Differ by Graph index

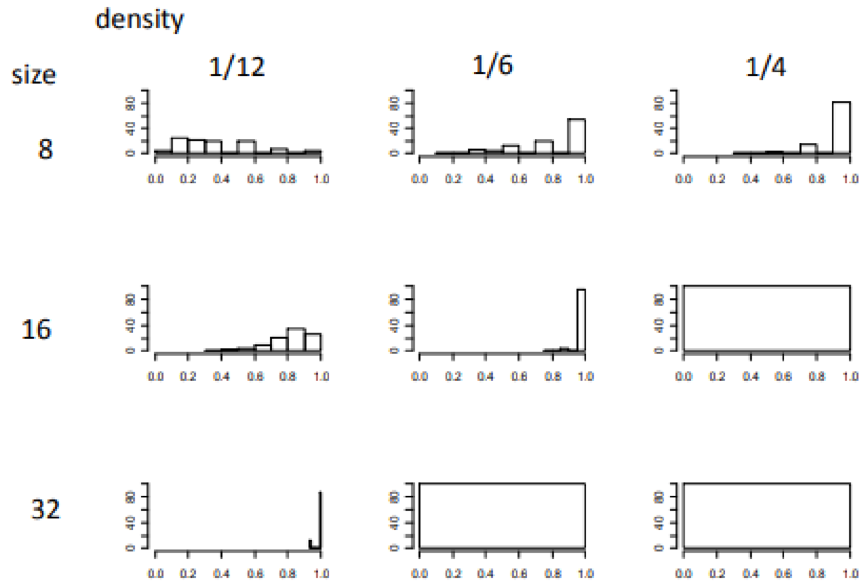
- Degree distribution
- average node-to-node distance – average shortest path length
- clustering coefficient – Global, local



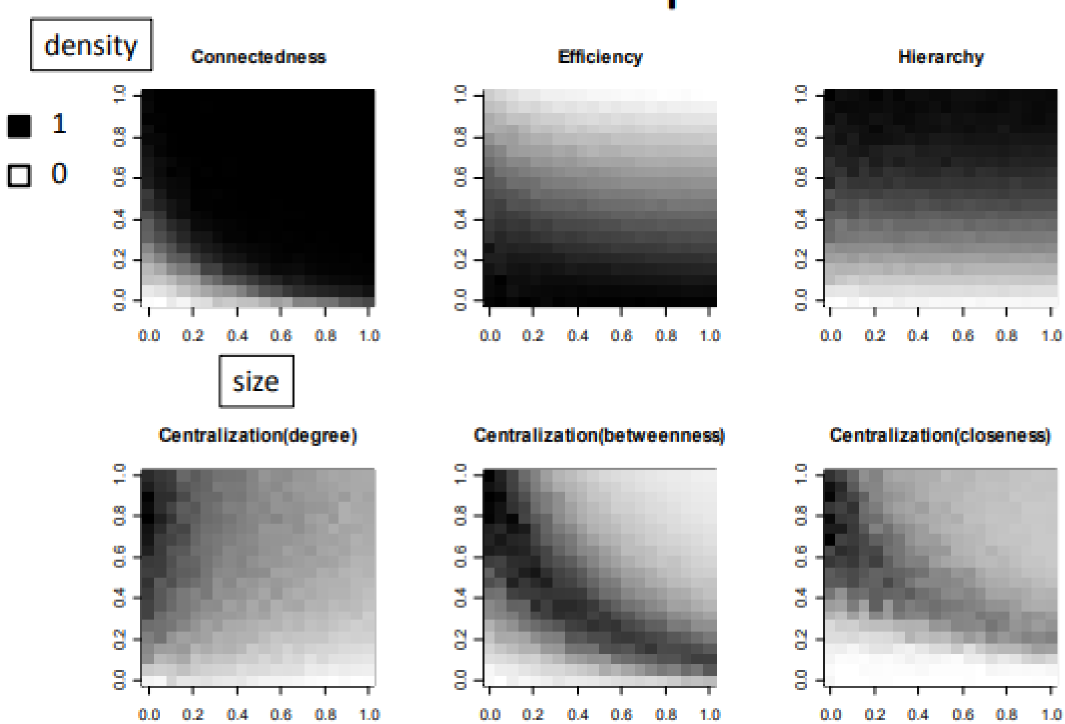
# efficiency distribution by graph size and density



# connectedness distribution by graph size and density



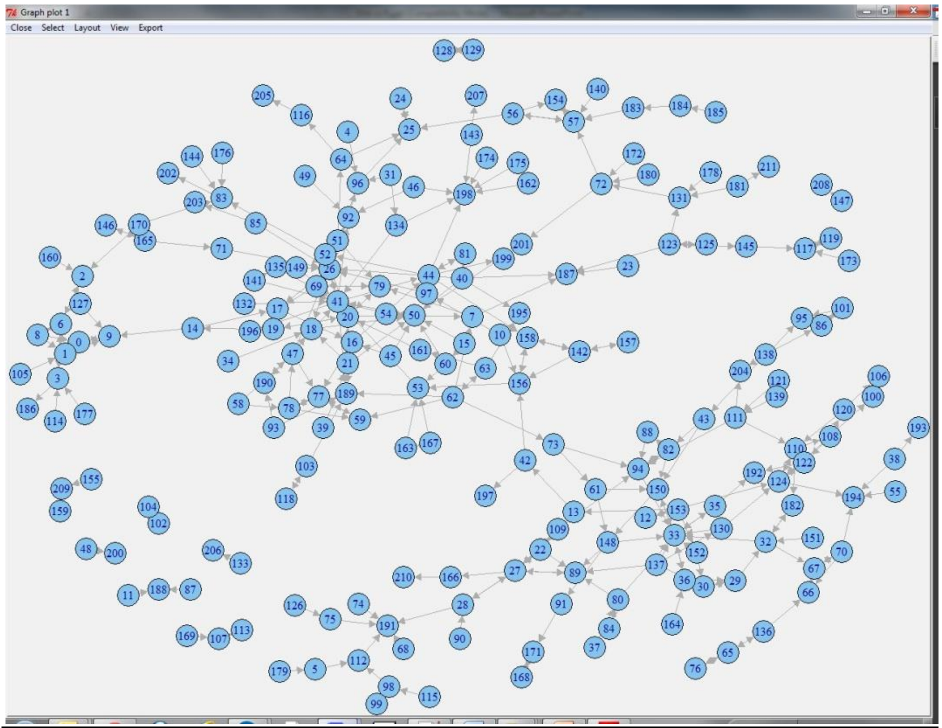

# GLI map



# 5 Visualizing Social Networks (Tcl/Tk Network Graph)

tkplot(igraph,

layout=layout.fruchterman.reingold)




## 1) Finding Key Actors

### Centrality Measures

Medium or prominence is a well-known metric for determining a person's position within the overall structure of a social network. It can be computed using a variety of measures. Diploma, betweenness, proximity, and eigenvector centrality are the most commonly utilised. The first three were proposed by Freeman (1978) and are best suited for low-bandwidth networks. Brin and Page (2012) recently came up with extensions for weight loss networks. Analog (1987) presented the fourth measure, eigenvector centrality, which is based entirely on a spectral graph approach. It gained a lot of traction once it was utilised as the foundation for the well-known Google PageRank algorithm, which we'll go over in the next part. Whereas other quantitative measures for individual degree are proposed in the literature, we will focus on defining median values in this section. These processes determine the individual's relative cost within the network, indicating how relationships are targeted on some persons and, as a result, providing information on the societal power.

Greater center levels were associated with much more prominent characters inside the group, as their central location grants them benefits such as easier and faster access to various personalities.

```
'

Metrics of actor centrality include:
•       degree
(number of connections)
•       betweenness
(number of shortest paths an actor is on)
•       closeness
(relative distance to all other actors)
•       eigenvector centrality
(leading eigenvector of sociomatrix)

Calculating Centrality Measures
metrics <- data.frame(  deg=degree(igraph), # degree
bet=betweenness(igraph), # betweenness
clo=closeness(igraph), # closeness  eig=evcent(igraph)$vector, # eig.cent.  cor=graph.coreness(igraph) # coreness
)
```

## 2) Plot Eigenvector Centrality on Betweenness

**This measure assesses how a protagonist is linked to certain other well-linked individuals and is predicated on the distribution of correlated values in each and every region. A first eigenvalues of the data structure is given this position. The basic premise of embedded is that a person's ability and status are continuously determined by the power and position of his switching. Figures who really are immediately linked to a certain personality, described to as the psyche, are called to as Changes over time. Alters is a term widely used in the examination of a narcissistic shared community. In other words, we can state that a single node's lengths are proportional to the combined of its nearby items.**

**• Alternatively is to adjust / reverse eigenvector central ness during fossil testing.**

**- A character with a high concentration and low eigenvector centrality may be an important gate keeper for the middle character.**

**- A low-key character and a high middle eigenvector may have a unique access to mid-level players.**

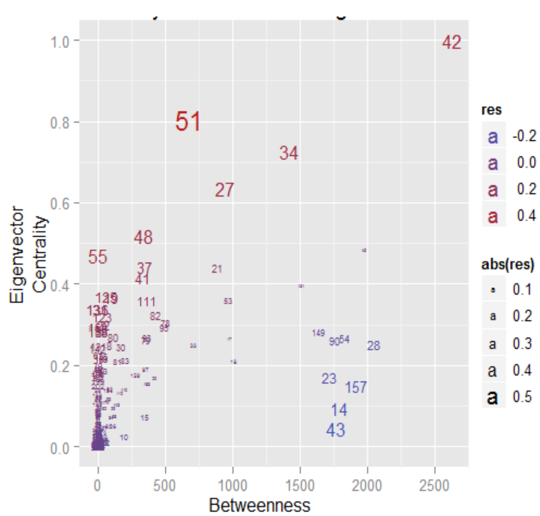
## 3) Visualizing with ggplot2

library(ggplot2)  ggplot(

metrics,

aes(x=bet,y=eig,

```
label=rownames(metrics),  colour=res,size=abs(res))
)+
xlab("Betweenness Centrality")+  ylab("Eigenvector Centrality")+  geom_text()+
opts(title="Key Actor Analysis  for Hartford Drug Users")
```




# 4) Hierarchical clustering

**It is a common approach for locating organisations because it does not require any estimations of membership organization, participation, or frequency. Agglomerative methods are based on a "excited formal organisation" (small groups in 's increasingly that are aggregated into larger groups), which is commonly depicted by a graph. The multilayer structure is revealed. Such characteristics are quite valuable.**
**In the available domains, there is less information regarding the network's plant communities. Additionally, these approaches have been shown to be particularly efficient in controlling fuzzy clustering challenges, giving particularly appealing for graph division and group recognition.**

**The classic cluster formation procedure, which is based on the criterion of strong affinity, is relatively simple. The decision of template matching, which is then used to determine exactly close those items were, is usually the initial step.**
**The items are defined by the a regional or global attribute. Semantic similarity, Weaving scale, Geometric or Midtown relationships, and humming distances are instances of these kind of behaviours. The best match among all sets of items is then calculated.**

**The purpose of cluster analysis in graphs is to group identical nodes together. The structural qualities of nodes in a network can be used to determine similarities / difference. For particular, the number of related neighbours among network cells can be regarded as a measure of resemblance, and nodes with the most common neighbours can be categorised into a single group (Stamm and Fast (1994)). Endpoints from same population are not aggregated into a single cluster when this criterion is used (Newman 2004). Different measurements and methodologies for capturing the plant communities of systems via clustering algorithm have been developed.**

# 6 Results

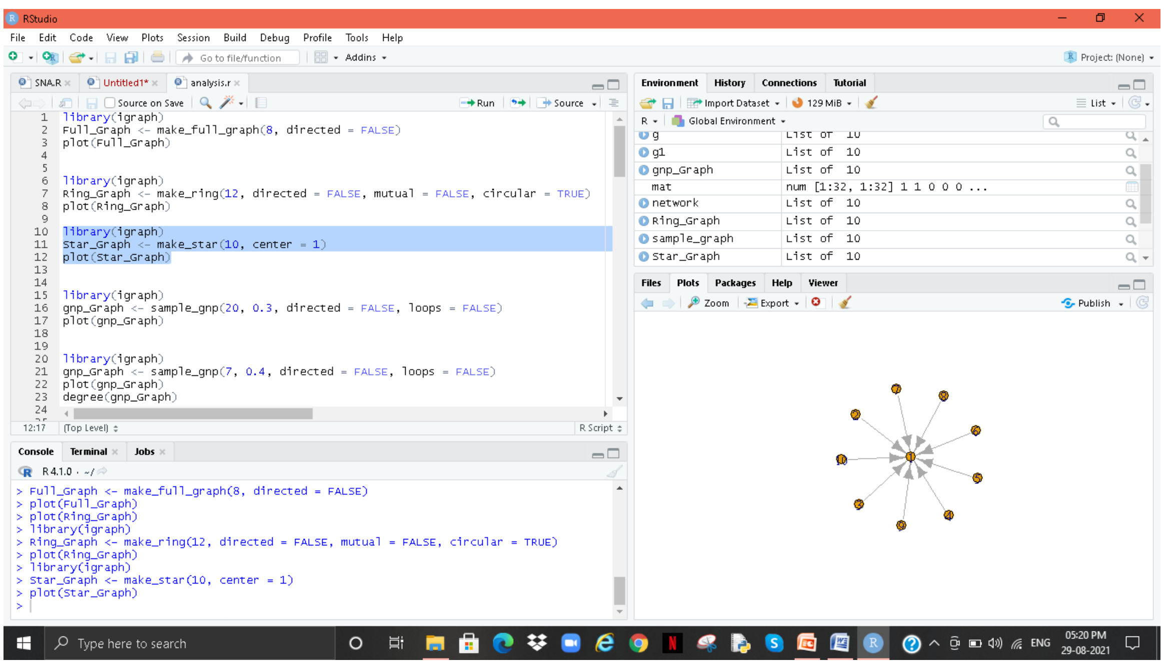
# Graph Representations

**Charts are forms of metadata architectures that have been addressed in the literature: category organization and divisional structure. These formats are appropriate for saving diagrams on a system so that technical solutions may examine these. Action listings & neighbouring listings are examples of collection architectures.**

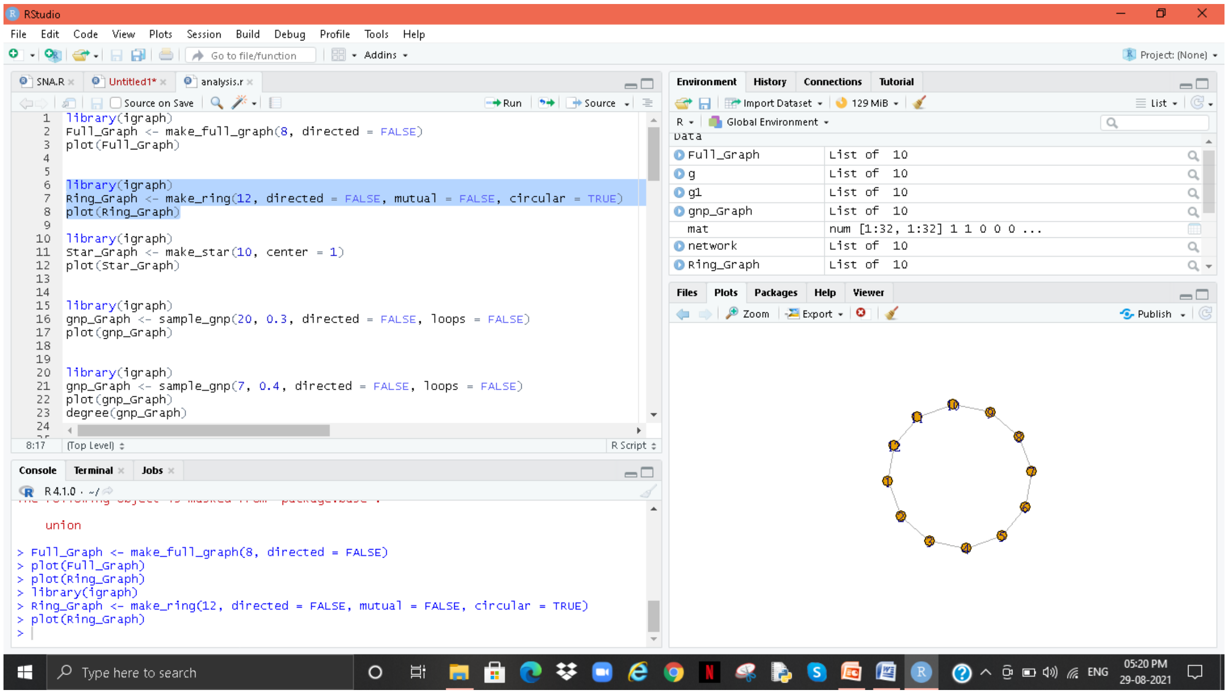
**Tiny diagrams have less hard drive capacity, making them excellent for archiving.**

**On the other hand, matrix structures such as the Incidence Matrix, the Adjacence Matrix or the Social Matrix, the Laplacean matrices (which contain both adjacent and degree information) and the distant matrices (adjacent matrices with the same length as the matrix entries are shorter than the pairs of headers). Ways) are suitable for referring to complete matrices. A variety of graphs can be used to model different types of social networks.**

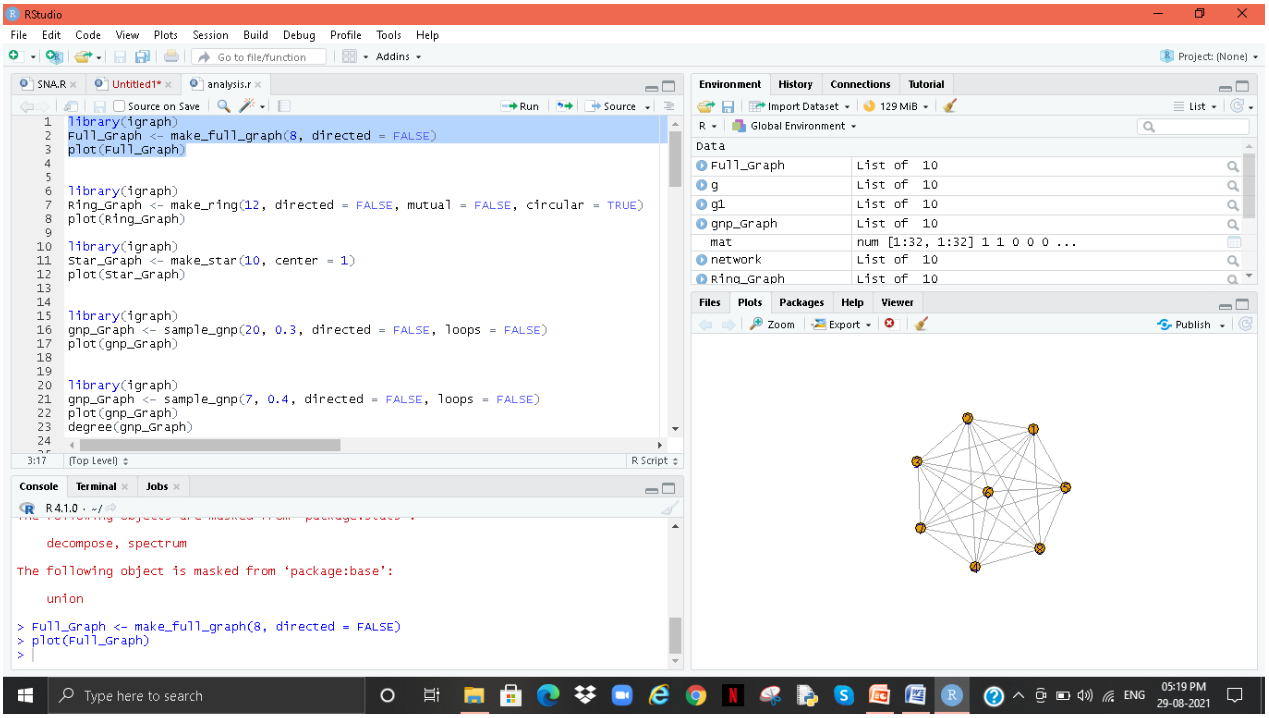
## 1. Star Graph



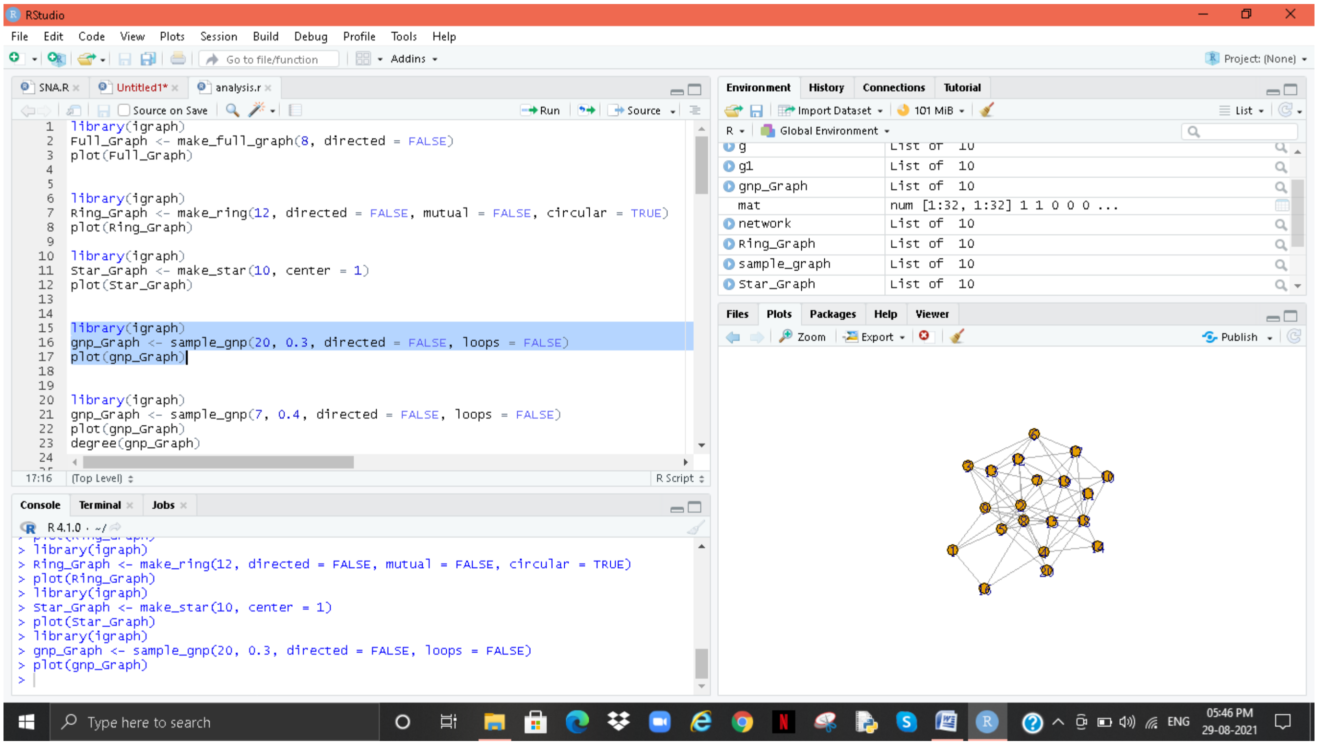

## 2. Ring Graph

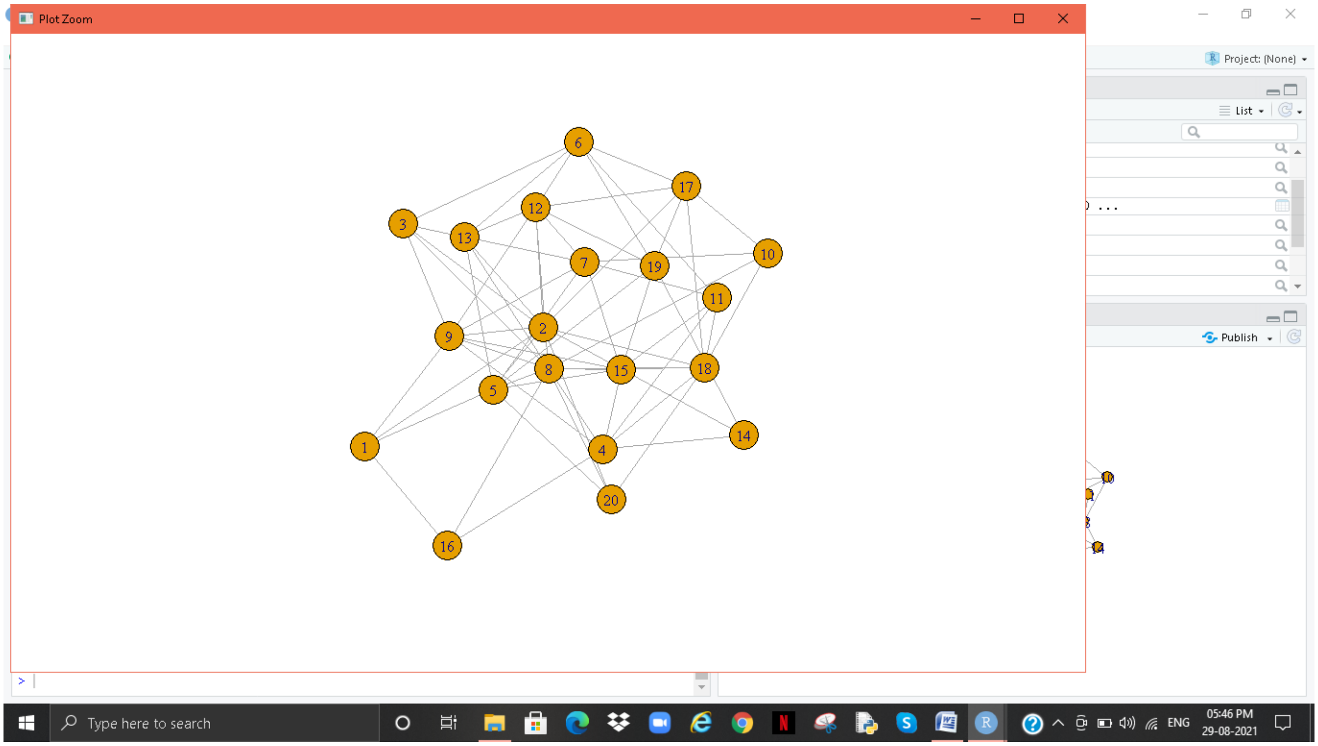



# 3. <u>**Full Graph**</u>

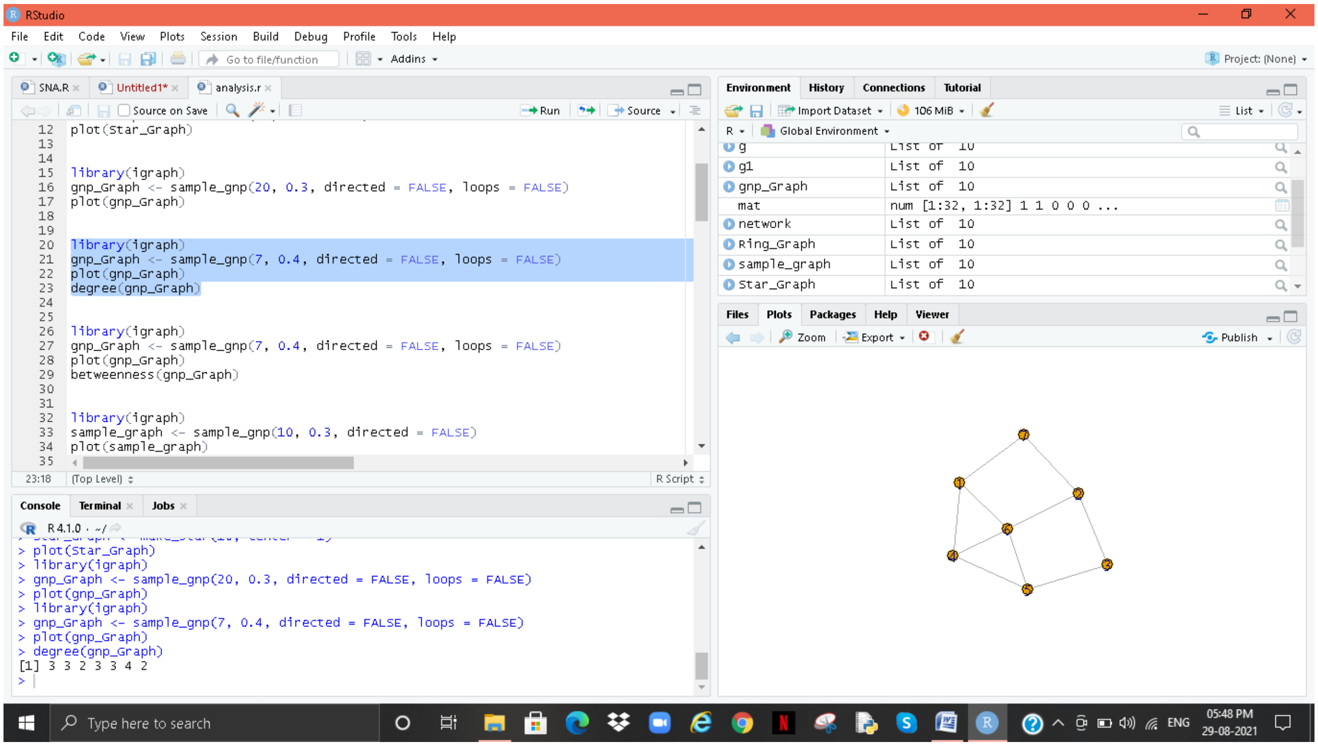

RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
SNA.R
Untitled1*
analysis.r
Source on Save
Run
Source
library(igraph)
Full_Graph <- make_full_graph(8, directed = FALSE)
plot(Full_Graph)
library(igraph)
Ring_Graph <- make_ring(12, directed = FALSE, mutual = FALSE, circular = TRUE)
plot(Ring_Graph)
library(igraph)
Star_Graph <- make_star(10, center = 1)
plot(Star_Graph)
library(igraph)
gnp_Graph <- sample_gnp(20, 0.3, directed = FALSE, loops = FALSE)
plot(gnp_Graph)
library(igraph)
gnp_Graph <- sample_gnp(7, 0.4, directed = FALSE, loops = FALSE)
plot(gnp_Graph)
degree(gnp_Graph)
3:17
(Top Level)
R Script
Console
Terminal
Jobs
R 4.1.0 · ~/
decompose, spectrum
The following object is masked from 'package:base':
union
> Full_Graph <- make_full_graph(8, directed = FALSE)
> plot(Full_Graph)
Environment
History
Connections
Tutorial
Import Dataset
129 MiB
List
Global Environment
Data
Full_Graph List of 10
g List of 10
g1 List of 10
gnp_Graph List of 10
mat num [1:32, 1:32] 1 1 0 0 0 ...
network List of 10
Ring_Graph List of 10
Files
Plots
Packages
Help
Viewer
Zoom
Export
Publish
Type here to search
ENG
05:19 PM
29-08-2021

# 4. Gnp Graph

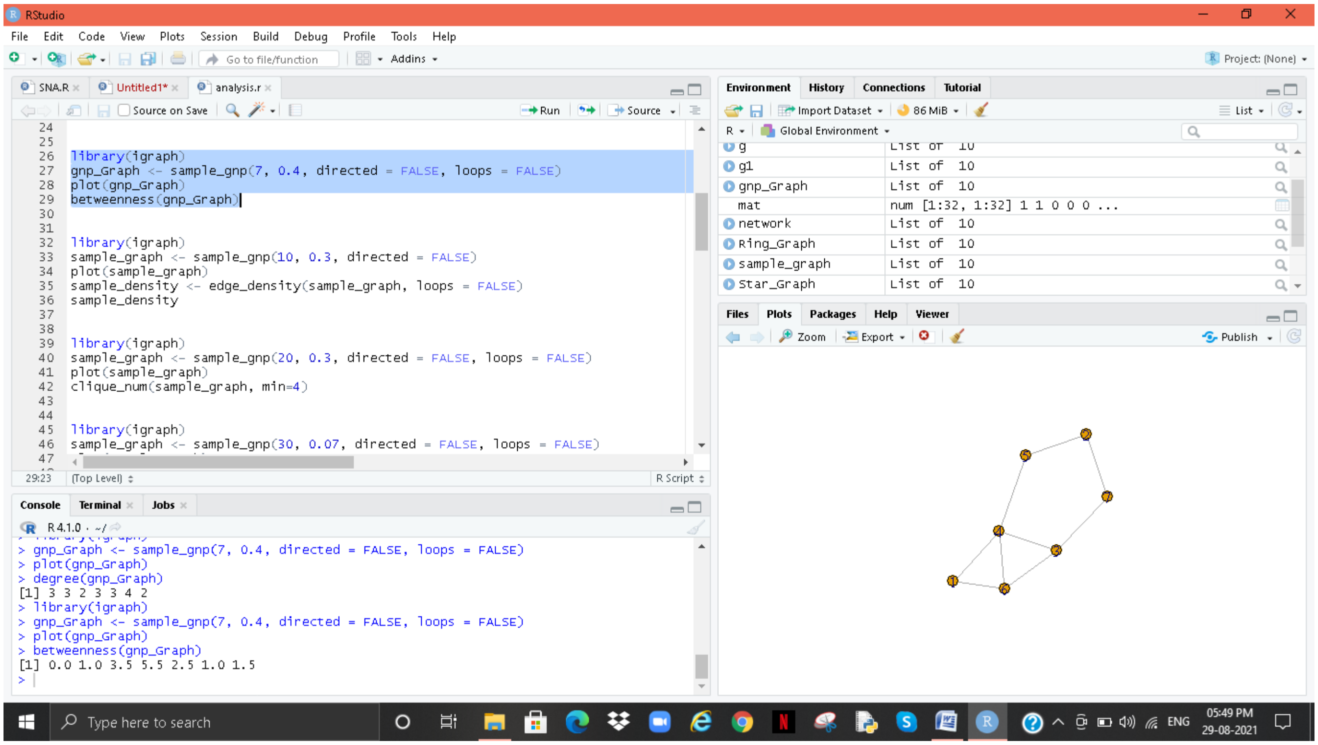




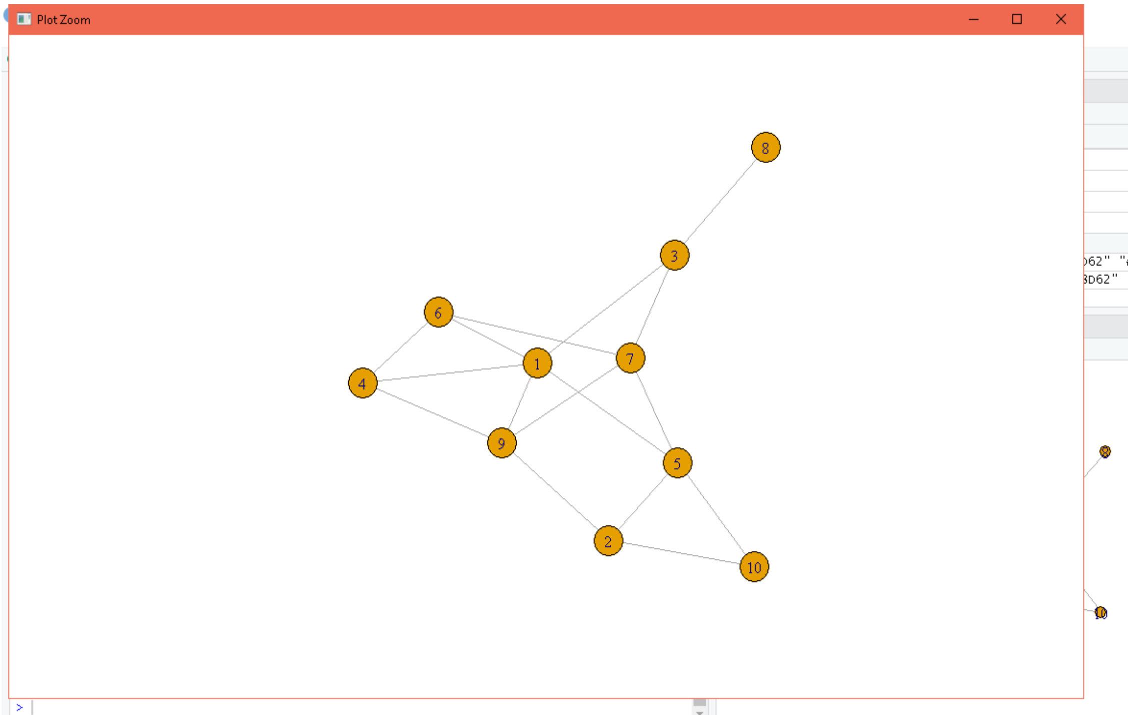
# 5. Gnp Degree Graph

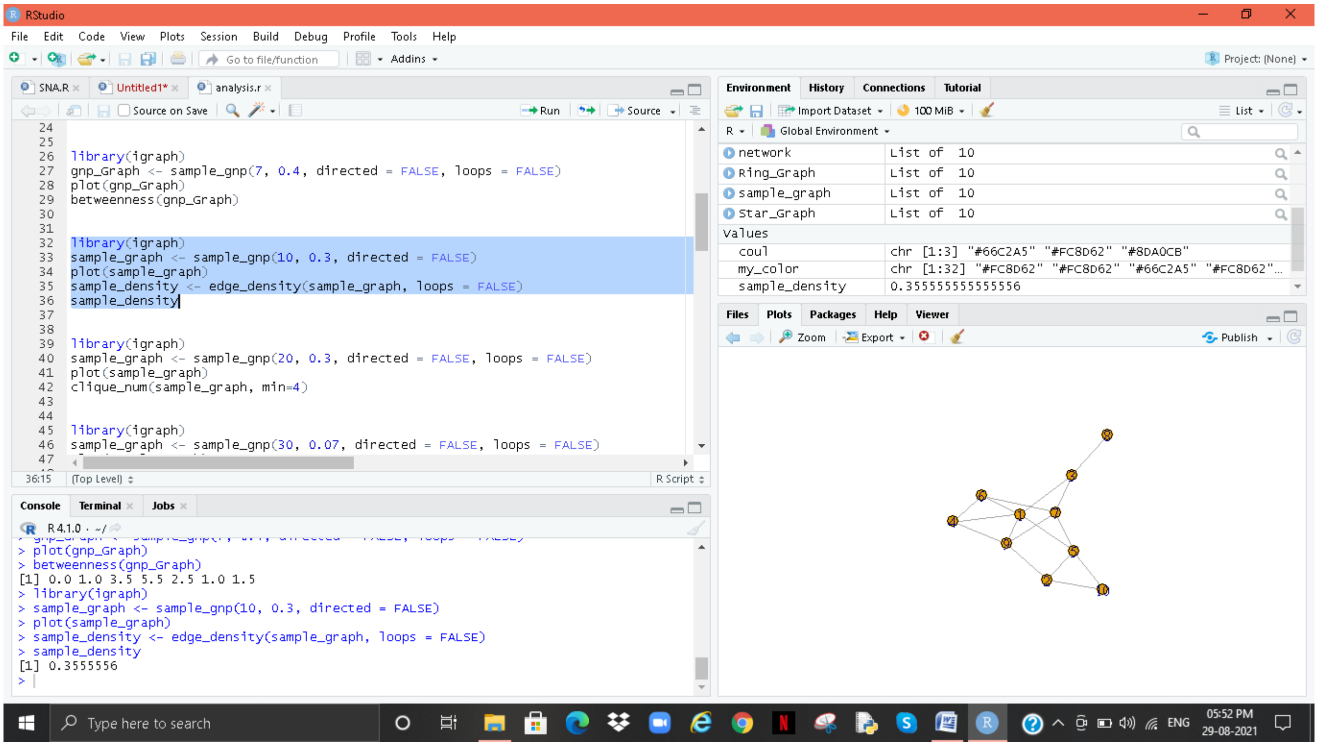



# 6. Gnp Betweeness Graph

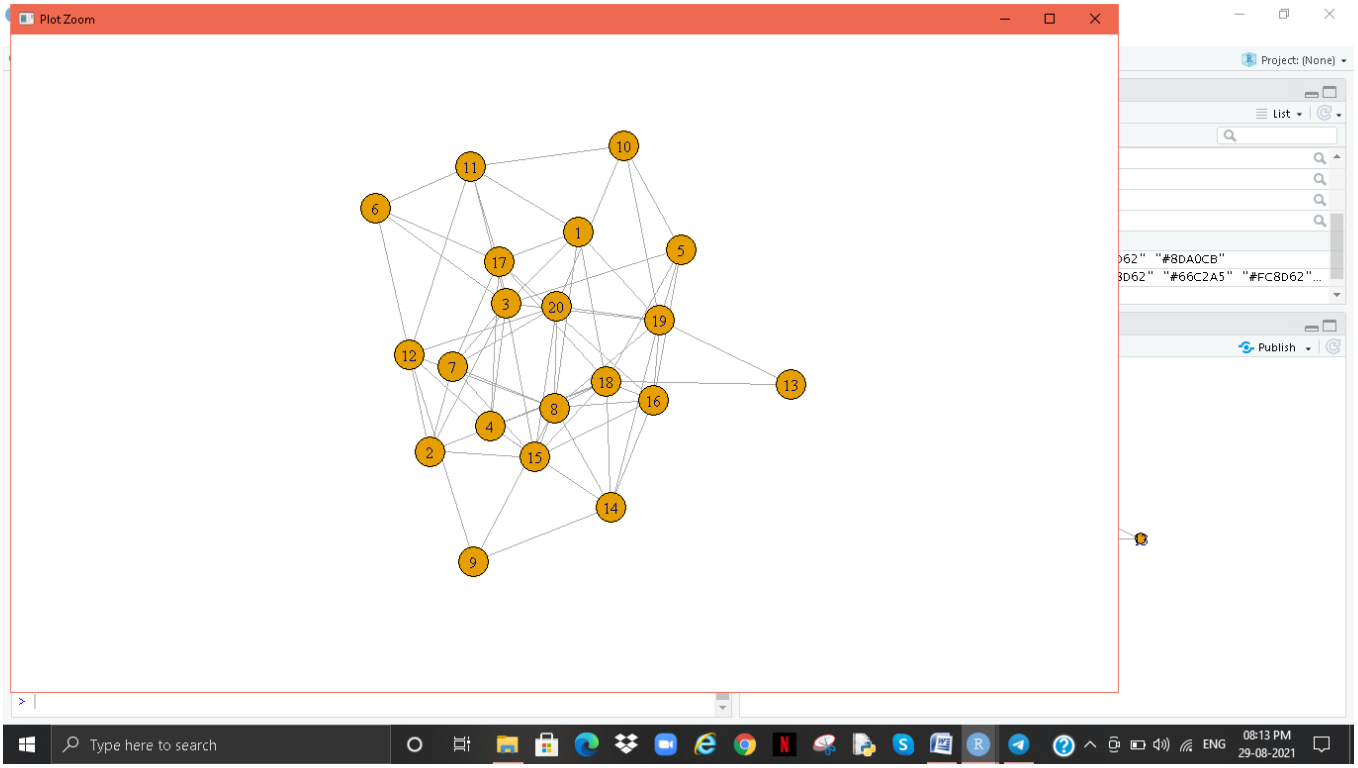


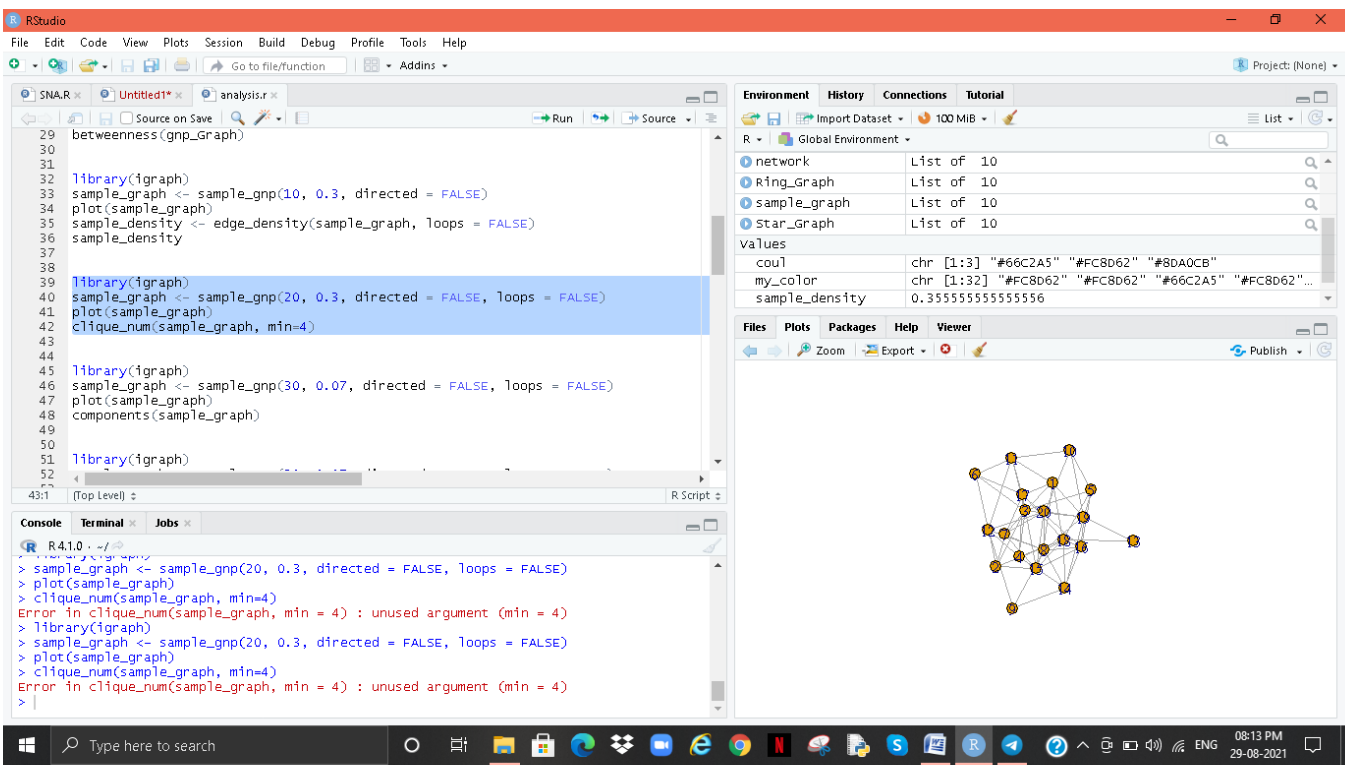

## 7. Density Graph





# 8. Clique Graph


Plot Zoom
10
11
6
1
5
17
3
20
19
12
7
18
13
8
16
4
2
15
14
9
Project: (None)
Publish
Type here to search
ENG
08:13 PM
29-08-2021


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
SNA.R
Untitled1*
analysis.r
Source on Save
Run
Source
betweenness(gnp_Graph)
library(igraph)
sample_graph <- sample_gnp(10, 0.3, directed = FALSE)
plot(sample_graph)
sample_density <- edge_density(sample_graph, loops = FALSE)
sample_density
library(igraph)
sample_graph <- sample_gnp(20, 0.3, directed = FALSE, loops = FALSE)
plot(sample_graph)
clique_num(sample_graph, min=4)
library(igraph)
sample_graph <- sample_gnp(30, 0.07, directed = FALSE, loops = FALSE)
plot(sample_graph)
components(sample_graph)
library(igraph)
43:1
(Top Level)
R Script
Console
Terminal
Jobs
R 4.1.0 · ~/
> sample_graph <- sample_gnp(20, 0.3, directed = FALSE, loops = FALSE)
> plot(sample_graph)
> clique_num(sample_graph, min=4)
Error in clique_num(sample_graph, min = 4) : unused argument (min = 4)
> library(igraph)
> sample_graph <- sample_gnp(20, 0.3, directed = FALSE, loops = FALSE)
> plot(sample_graph)
> clique_num(sample_graph, min=4)
Error in clique_num(sample_graph, min = 4) : unused argument (min = 4)
Environment
History
Connections
Tutorial
Import Dataset
100 MiB
List
Global Environment
network
List of 10
Ring_Graph
List of 10
sample_graph
List of 10
Star_Graph
List of 10
Values
coul
chr [1:3] "#66C2A5" "#FC8D62" "#8DA0CB"
my_color
chr [1:32] "#FC8D62" "#FC8D62" "#66C2A5" "#FC8D62"...
sample_density
0.355555555555556
Files
Plots
Packages
Help
Viewer
Zoom
Export
Publish
Type here to search
ENG
08:13 PM
29-08-2021

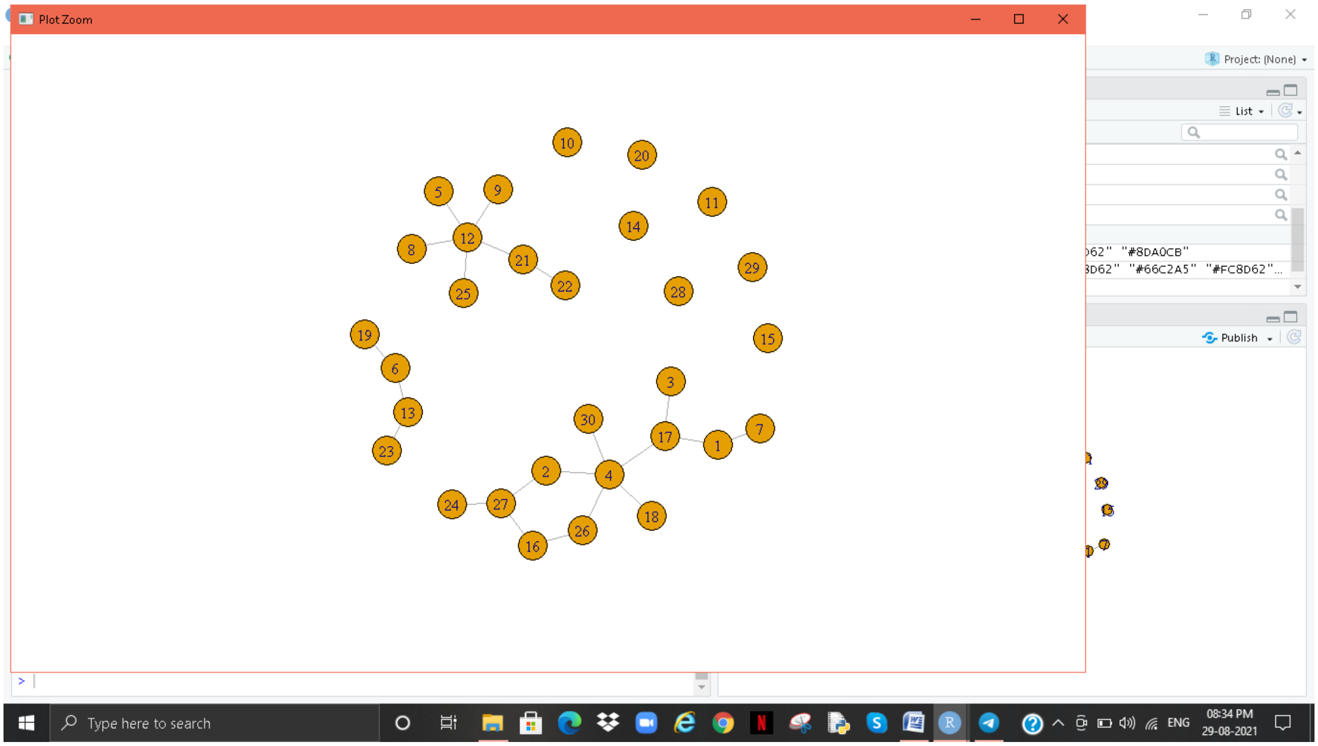
# 9. Component Graph

Libraries (iGraph)

Sample_graph <- sample_gnp (30, 0.07, direction = wrong, loop = wrong)

Plot (sample_graph)

Component (sample_graph)



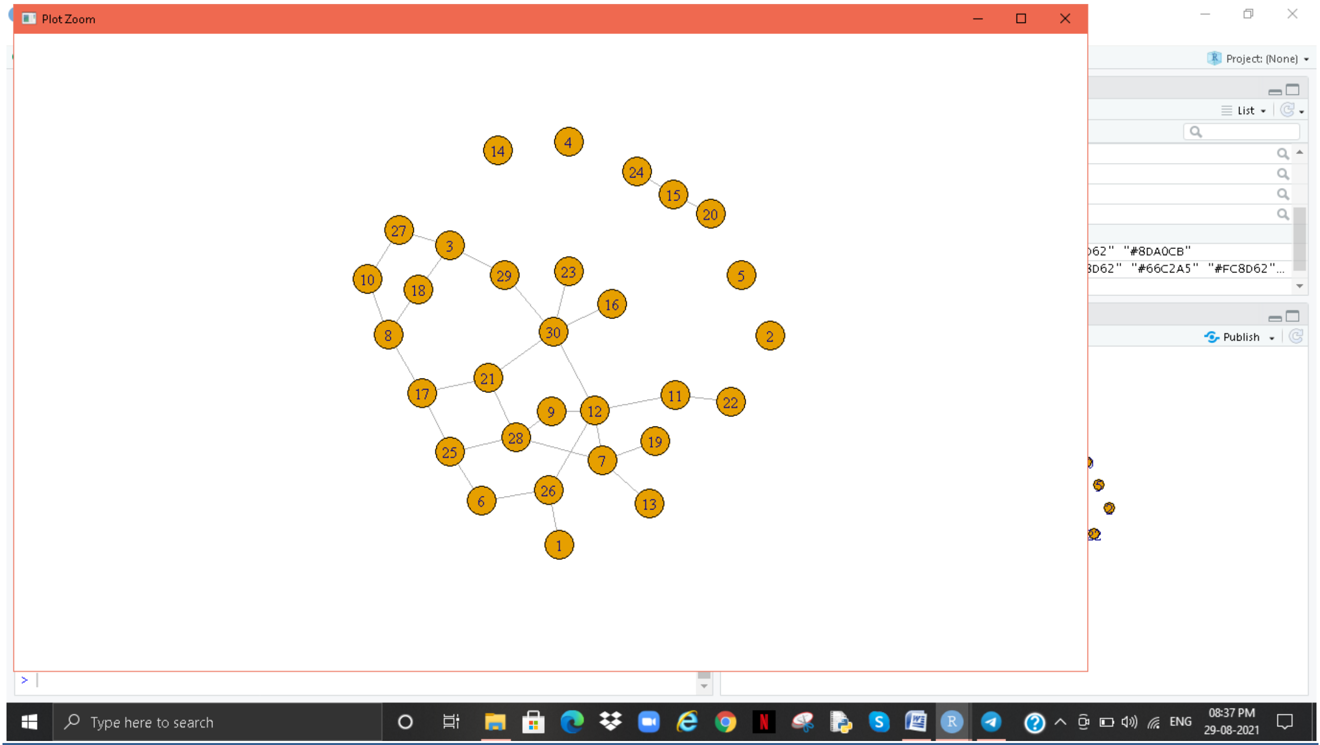
# 10. Graph Network

**Libraries (iGraph)**

**Sample_graph <- sample_gnp (30, 0.07, direction = wrong, loop = wrong)**

**Plot (sample_graph)**

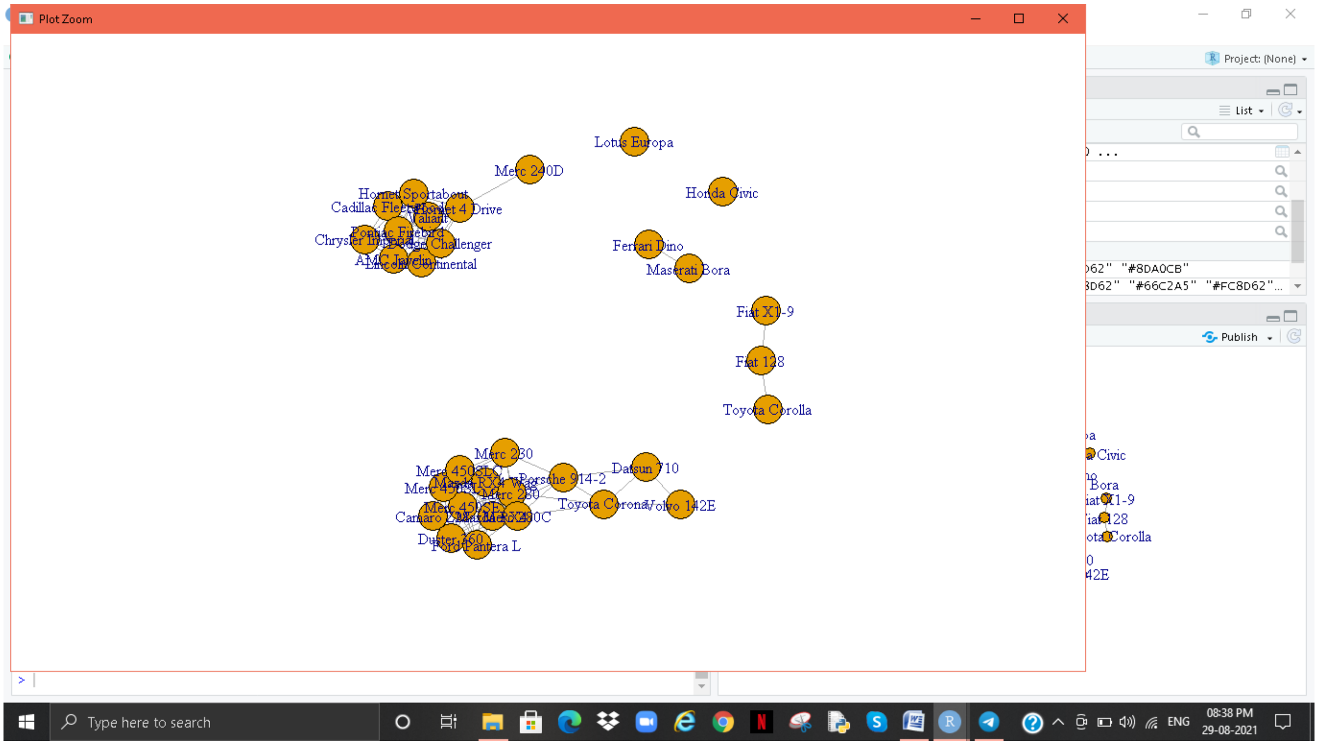
**random_walk (sample_graph, 8, 10, difficulty = "return")**



Libraries (iGraph)

Mat <- core (t (mCars [, c (1,3: 6)]))

Mat [mat <0.995] <- 0

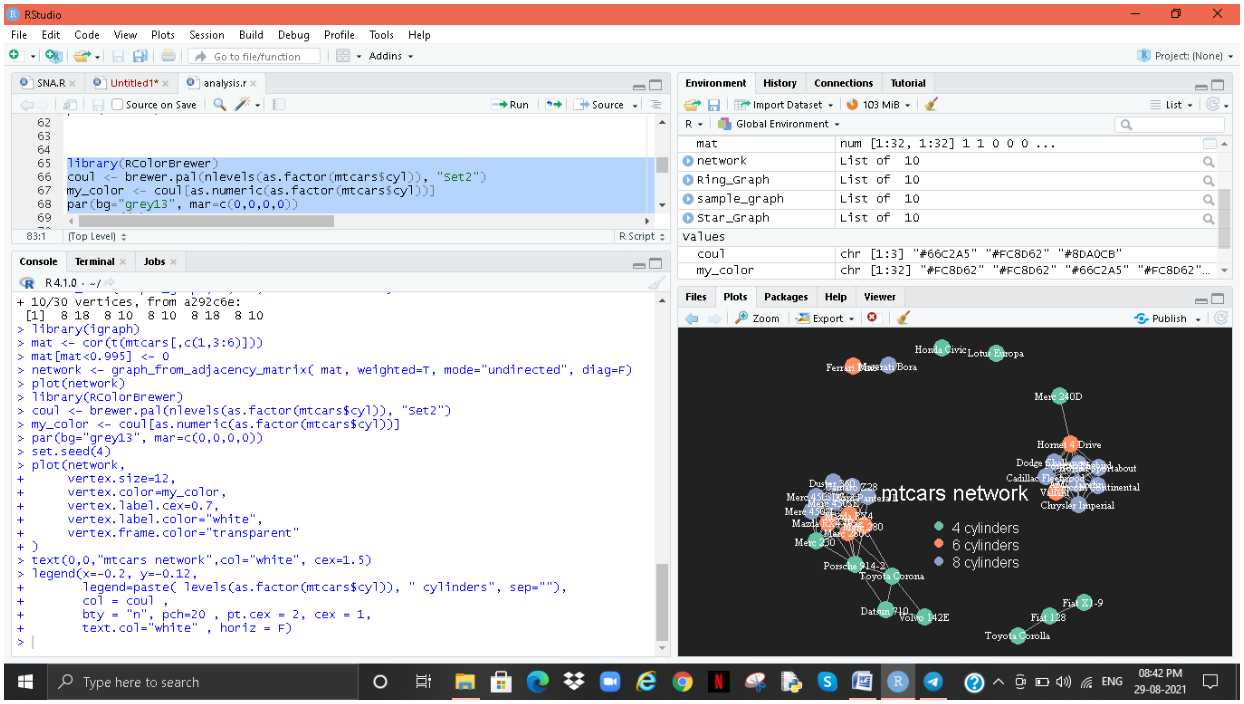


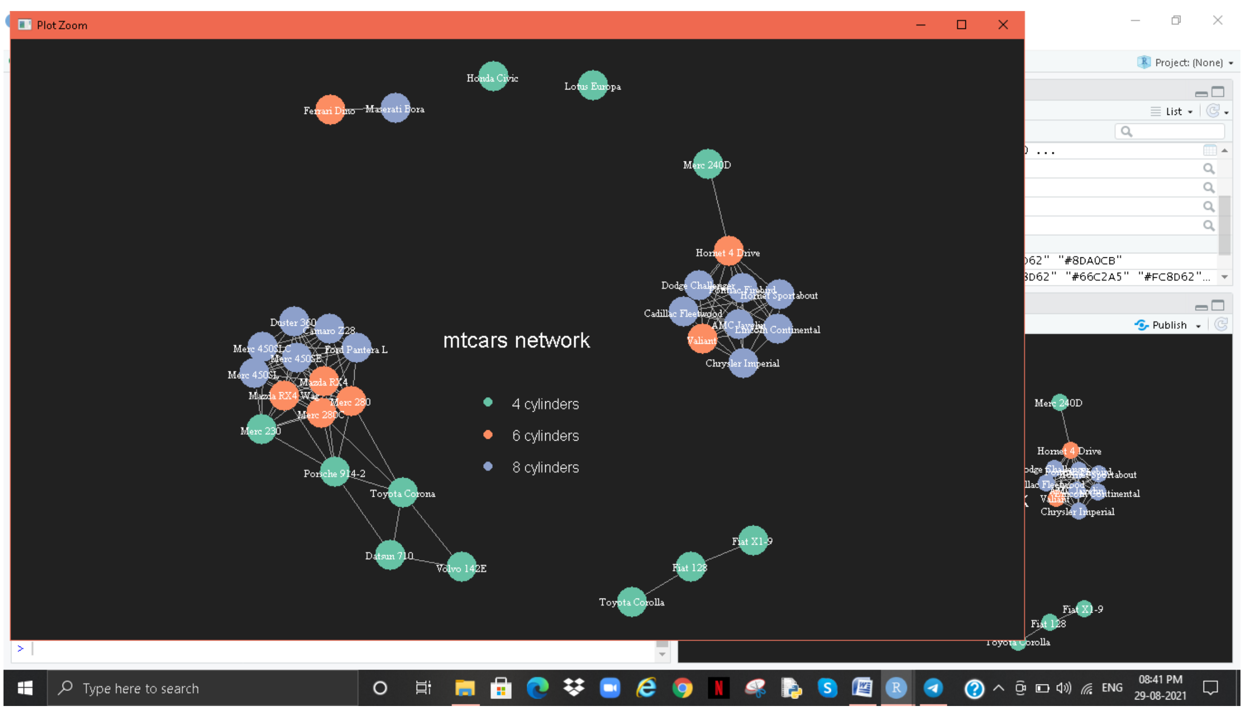

# 11. Final - car to Bluetooth device connections

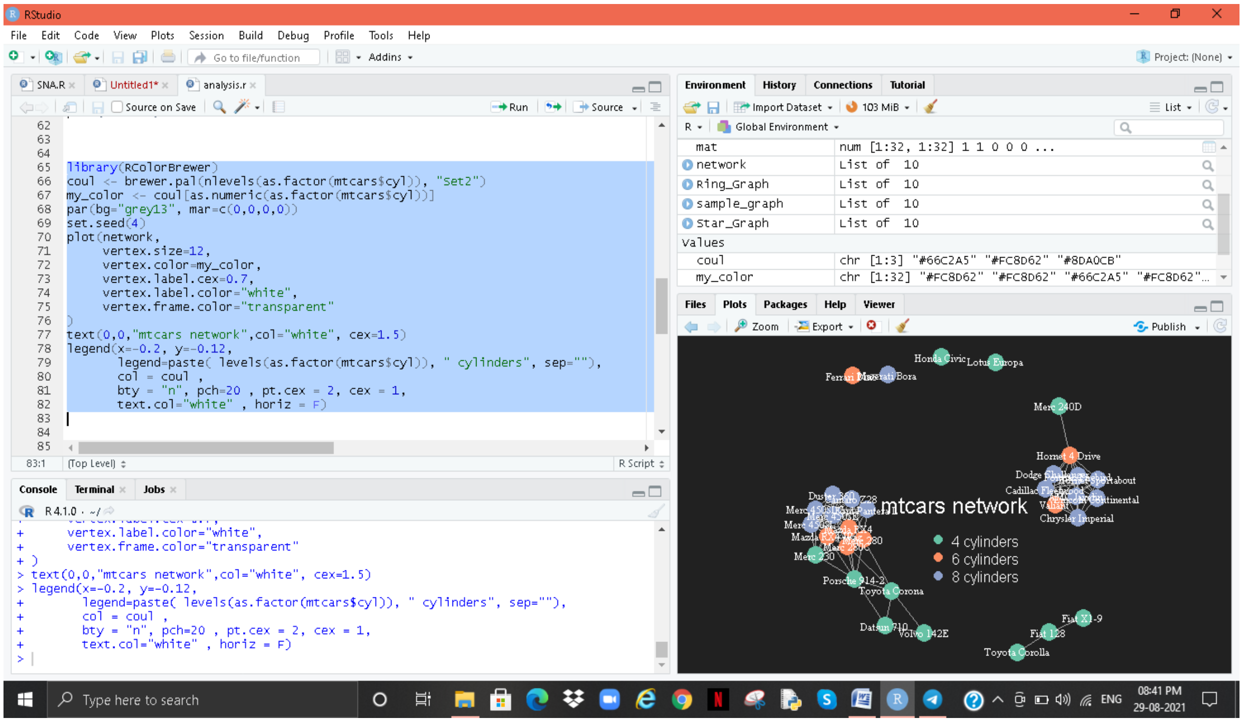
*SNA - Notepad

File Edit Format View Help

```
Libraries (Arcolor Brewer)
coul <- brewer.pal (nlevels (as.factor (mtcars $ cyl)), "Set2")
my_color <- coul [as.numeric (as.factor (mtcars $ cyl))]]
Equals (bg = "gray 13", mar = c (0,0,0,0))
set.seed (4)
Plot (network,
     Head size = 12,
     vertex.color = my_color,
     vertex.label.cex = 0.7,
     vertex.label.color = "white",
     vertex.frame.color = "Transparent"
,
Text (0,0, "mtcars network", col = "white", cex = 1.5)
Legend (x = -0.2, y = -0.12,
       legend = paste (level (as.factor (mtcars $ cyl)), "cylinder", sept = ""),
       Colonel = Kaul,
       bty = "n", pch = 20, pt.cex = 2, cex = 1,
       text.col = "white", horiz = F)
```


RStudio
library(RColorBrewer)
coul <- brewer.pal(nlevels(as.factor(mtcars$cyl)), "Set2")
my_color <- coul[as.numeric(as.factor(mtcars$cyl))]
par(bg="grey13", mar=c(0,0,0,0))
+ 10/30 vertices, from a292c6e:
[1]  8 18  8 10  8 10  8 18  8 10
> library(igraph)
> mat <- cor(t(mtcars[,c(1,3:6)]))
> mat[mat<0.995] <- 0
> network <- graph_from_adjacency_matrix( mat, weighted=T, mode="undirected", diag=F)
> plot(network)
> library(RColorBrewer)
> coul <- brewer.pal(nlevels(as.factor(mtcars$cyl)), "Set2")
> my_color <- coul[as.numeric(as.factor(mtcars$cyl))]
> par(bg="grey13", mar=c(0,0,0,0))
> set.seed(4)
> plot(network,
+      vertex.size=12,
+      vertex.color=my_color,
+      vertex.label.cex=0.7,
+      vertex.label.color="white",
+      vertex.frame.color="transparent"
+ )
> text(0,0,"mtcars network",col="white", cex=1.5)
> legend(x=-0.2, y=-0.12,
+        legend=paste( levels(as.factor(mtcars$cyl)), " cylinders", sep=""),
+        col = coul ,
+        bty = "n", pch=20 , pt.cex = 2, cex = 1,
+        text.col="white" , horiz = F)
mtcars network
4 cylinders
6 cylinders
8 cylinders


Plot Zoom
Honda Civic
Lotus Europa
Ferrari Dino
Maserati Bora
Merc 240D
Hornet 4 Drive
Cadillac Fleetwood
Chrysler Imperial
Duster 360
Ford Pantera L
Merc 450SE
Merc 450SL
Mazda RX4
Merc 280
Merc 280C
Merc 230
Porsche 914-2
Toyota Corona
Datsun 710
Volvo 142E
Fiat X1-9
Fiat 128
Toyota Corolla
mtcars network
4 cylinders
6 cylinders
8 cylinders

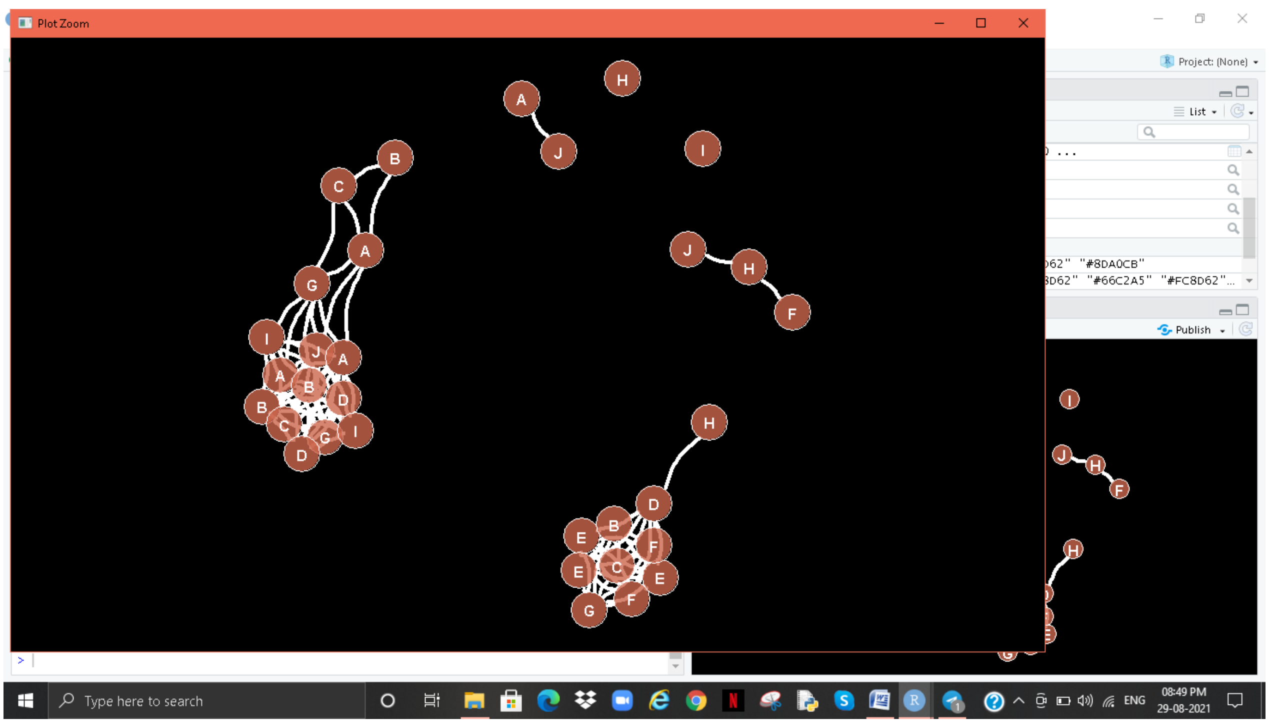


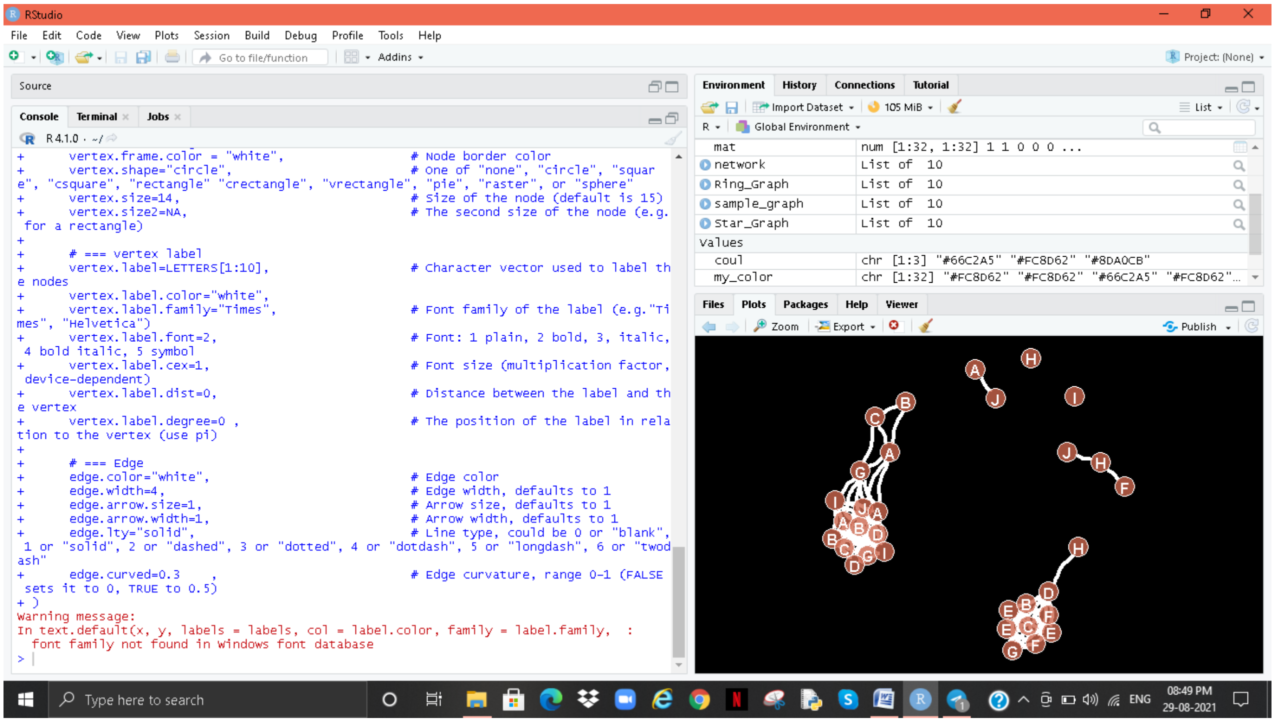

# LABELLED NETWORK ANALYSIS

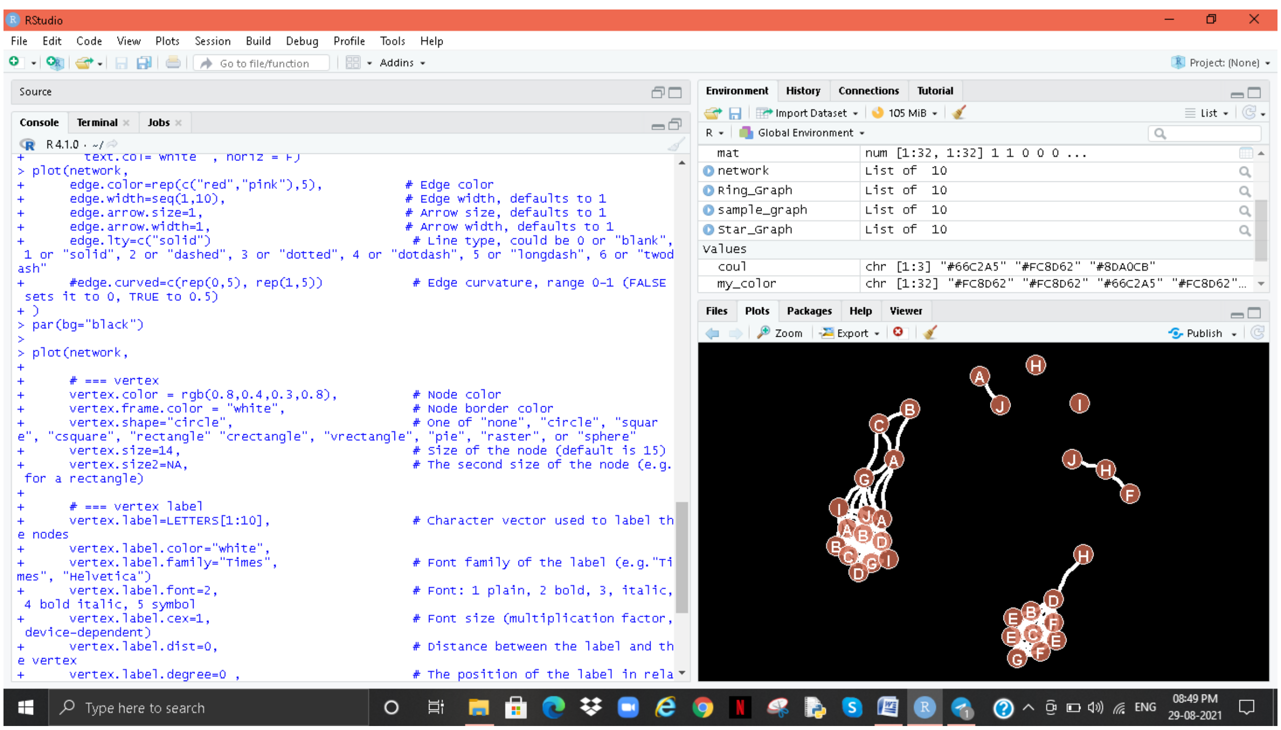
*SNA - Notepad

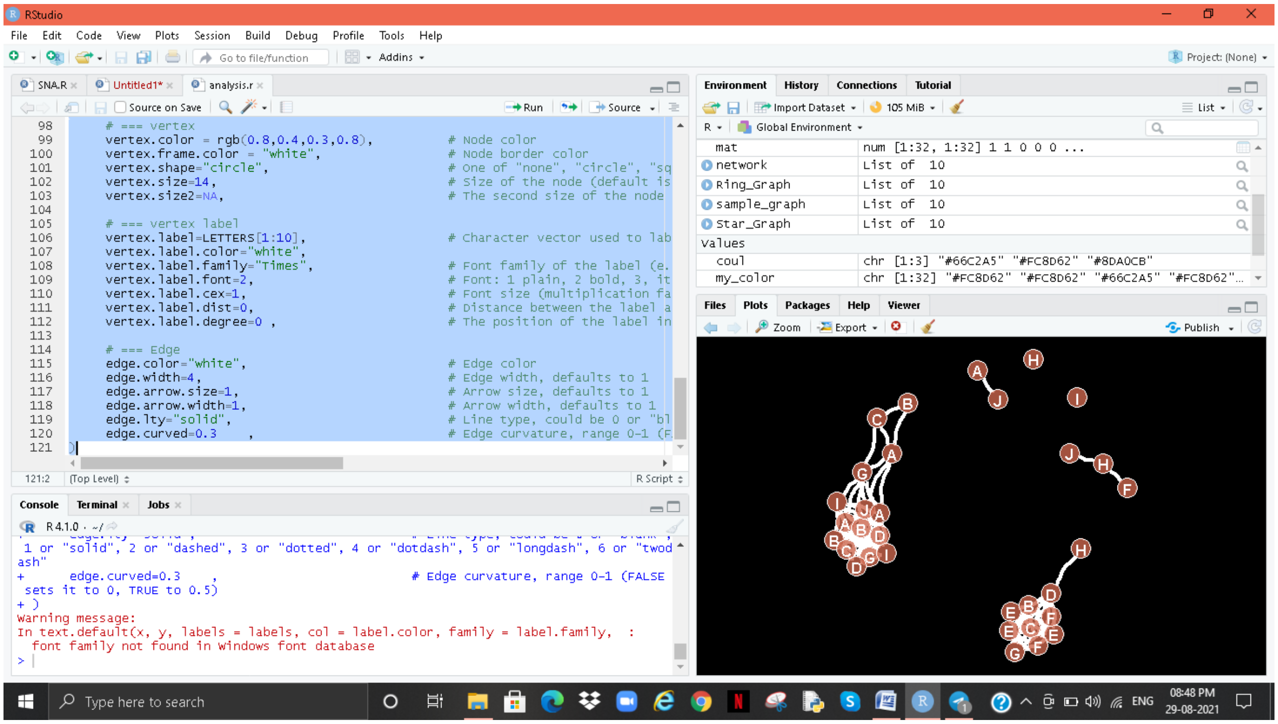
File Edit Format View Help

```
Plot (network,
      Edge. Color = representative (c ("red", "pink"), 5),
      Edge.width = seq (1,10),
      Edge.arrow.size = 1,
      Edge.arrow.width = 1,
      Edge.lty = c ("solid")
      (FALSE sets it to 0 and TRUE to 0.5)
,
Equals (bg = "black")

Plot (network,

      # === Top
      vertex.color = rgb (0.8,0.4,0.3,0.8),
      vertex.frame.color = "white",
      vertex.shape = "circle",
      Head size = 14,
      vertex.size2 = NA,

      # === Top label
      vertex.label = characters [1:10],
      vertex.label.color = "white",
      vertex.label.family = "Times",
      vertex.label.font = 2,
      vertex.label.cex = 1,
      vertex.label.dist = 0,
      vertex.label.degree = 0,

      # === Torrent
      Edge. Color = "white",
      Edge. Width = 4,
      Edge.arrow.size = 1,
      Edge.arrow.width = 1,
      Edge.lty = "solid",
      Edge.amp = 0.3,
```




RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Source
Console Terminal Jobs
R 4.1.0 · ~/
+ vertex.frame.color = "white", # Node border color
+ vertex.shape="circle", # One of "none", "circle", "square", "csquare", "rectangle" "crectangle", "vrectangle", "pie", "raster", or "sphere"
+ vertex.size=14, # Size of the node (default is 15)
+ vertex.size2=NA, # The second size of the node (e.g. for a rectangle)
+ # === vertex label
+ vertex.label=LETTERS[1:10], # Character vector used to label the nodes
+ vertex.label.color="white",
+ vertex.label.family="Times", # Font family of the label (e.g."Times", "Helvetica")
+ vertex.label.font=2, # Font: 1 plain, 2 bold, 3, italic, 4 bold italic, 5 symbol
+ vertex.label.cex=1, # Font size (multiplication factor, device-dependent)
+ vertex.label.dist=0, # Distance between the label and the vertex
+ vertex.label.degree=0 , # The position of the label in relation to the vertex (use pi)
+ # === Edge
+ edge.color="white", # Edge color
+ edge.width=4, # Edge width, defaults to 1
+ edge.arrow.size=1, # Arrow size, defaults to 1
+ edge.arrow.width=1, # Arrow width, defaults to 1
+ edge.lty="solid", # Line type, could be 0 or "blank", 1 or "solid", 2 or "dashed", 3 or "dotted", 4 or "dotdash", 5 or "longdash", 6 or "twodash"
+ edge.curved=0.3 , # Edge curvature, range 0-1 (FALSE sets it to 0, TRUE to 0.5)
+ )
Warning message:
In text.default(x, y, labels = labels, col = label.color, family = label.family, :
font family not found in Windows font database
Environment History Connections Tutorial
Global Environment
mat num [1:32, 1:32] 1 1 0 0 0 ...
network List of 10
Ring_Graph List of 10
sample_graph List of 10
Star_Graph List of 10
Values
coul chr [1:3] "#66C2A5" "#FC8D62" "#8DA0CB"
my_color chr [1:32] "#FC8D62" "#FC8D62" "#66C2A5" "#FC8D62"...
Files Plots Packages Help Viewer
Type here to search
08:49 PM
29-08-2021


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Source
Console Terminal Jobs
R 4.1.0 · ~/
> plot(network,
+ edge.color=rep(c("red","pink"),5), # Edge color
+ edge.width=seq(1,10), # Edge width, defaults to 1
+ edge.arrow.size=1, # Arrow size, defaults to 1
+ edge.arrow.width=1, # Arrow width, defaults to 1
+ edge.lty=c("solid") # Line type, could be 0 or "blank", 1 or "solid", 2 or "dashed", 3 or "dotted", 4 or "dotdash", 5 or "longdash", 6 or "twodash"
+ #edge.curved=c(rep(0,5), rep(1,5)) # Edge curvature, range 0-1 (FALSE sets it to 0, TRUE to 0.5)
+ )
> par(bg="black")
> plot(network,
+ # === vertex
+ vertex.color = rgb(0.8,0.4,0.3,0.8), # Node color
+ vertex.frame.color = "white", # Node border color
+ vertex.shape="circle", # One of "none", "circle", "square", "csquare", "rectangle" "crectangle", "vrectangle", "pie", "raster", or "sphere"
+ vertex.size=14, # Size of the node (default is 15)
+ vertex.size2=NA, # The second size of the node (e.g. for a rectangle)
+ # === vertex label
+ vertex.label=LETTERS[1:10], # Character vector used to label the nodes
+ vertex.label.color="white",
+ vertex.label.family="Times", # Font family of the label (e.g."Times", "Helvetica")
+ vertex.label.font=2, # Font: 1 plain, 2 bold, 3, italic, 4 bold italic, 5 symbol
+ vertex.label.cex=1, # Font size (multiplication factor, device-dependent)
+ vertex.label.dist=0, # Distance between the label and the vertex
+ vertex.label.degree=0 , # The position of the label in rela
Environment History Connections Tutorial
Global Environment
mat num [1:32, 1:32] 1 1 0 0 0 ...
network List of 10
Ring_Graph List of 10
sample_graph List of 10
Star_Graph List of 10
Values
coul chr [1:3] "#66C2A5" "#FC8D62" "#8DA0CB"
my_color chr [1:32] "#FC8D62" "#FC8D62" "#66C2A5" "#FC8D62"...
Files Plots Packages Help Viewer
Type here to search
08:49 PM
29-08-2021


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
SNA.R
Untitled1*
analysis.r
Source on Save
Run
Source
# === vertex
vertex.color = rgb(0.8,0.4,0.3,0.8), # Node color
vertex.frame.color = "white", # Node border color
vertex.shape="circle", # One of "none", "circle", "sq
vertex.size=14, # Size of the node (default is
vertex.size2=NA, # The second size of the node
# === vertex label
vertex.label=LETTERS[1:10], # Character vector used to lab
vertex.label.color="white",
vertex.label.family="Times", # Font family of the label (e.
vertex.label.font=2, # Font: 1 plain, 2 bold, 3, it
vertex.label.cex=1, # Font size (multiplication fa
vertex.label.dist=0, # Distance between the label a
vertex.label.degree=0 , # The position of the label in
# === Edge
edge.color="white", # Edge color
edge.width=4, # Edge width, defaults to 1
edge.arrow.size=1, # Arrow size, defaults to 1
edge.arrow.width=1, # Arrow width, defaults to 1
edge.lty="solid", # Line type, could be 0 or "bl
edge.curved=0.3 , # Edge curvature, range 0-1 (F
121:2
(Top Level)
R Script
Console
Terminal
Jobs
R 4.1.0 · ~/
1 or "solid", 2 or "dashed", 3 or "dotted", 4 or "dotdash", 5 or "longdash", 6 or "twod
ash"
+ edge.curved=0.3 , # Edge curvature, range 0-1 (FALSE
sets it to 0, TRUE to 0.5)
+ )
Warning message:
In text.default(x, y, labels = labels, col = label.color, family = label.family, :
font family not found in Windows font database
Environment
History
Connections
Tutorial
Import Dataset
105 MiB
List
Global Environment
mat num [1:32, 1:32] 1 1 0 0 0 ...
network List of 10
Ring_Graph List of 10
sample_graph List of 10
Star_Graph List of 10
Values
coul chr [1:3] "#66C2A5" "#FC8D62" "#8DA0CB"
my_color chr [1:32] "#FC8D62" "#FC8D62" "#66C2A5" "#FC8D62"...
Files
Plots
Packages
Help
Viewer
Zoom
Export
Publish
Type here to search
ENG
08:48 PM
29-08-2021

# 7 CONCLUSIONS

SNA is seldom chastised for concentrating upon methodological issues rather than complicated & profound experimental identifying situations on clear and strong complex algorithms such as computational geometry and relatively non mathematics, as I just stated. This strategy. There are still numerous concerns to be handled in the paradigm, even though there are many empirical issues relating to the potential of researching social elements of an internet.

I've given a quick summary of link prediction methodology, aims, and applications in this presentation. Numerous SNA activities and related duties are carried out while bearing in mind various network types. Hierarchical clustering has become increasingly common today, thanks to the high quality of network troubleshooting and knowledge obtained from data supplied by a multitude of scenarios. As the volume of commitment to providing grows, so does the sophistication.

One of the primary problems right now is advancement with in analysis, management, and exploitation of significantly large connections. It is getting increasingly intensive and complicated as Internet 2.0, Rfid, and other technologies proliferate.

Informatics, Earth Science, Cognitive Science, Mobility Patterns, Recommendations, etc. Fraud detection, along with social media, gene expression, protein interactions, marketing, brainstorming prediction, etc. The recent growing demand for these applications on complex realities also requires progress in the world
Various network topologies such as multi-layered, heterogeneous and development networks. Therefore, this article paves the way for a basic understanding of the more complex issues associated with network analysis.

# 8 REFERENCES


- Abraham, A., Hassanien, A.-E., Sná, V. et al. (2009) Computational social network analysis: Trends, tools and research advances. London: Springer Science & Business Media.

- Adamic, L. A. and Adar, E. (2003) Friends and neighbors on the web. Social networks, 25, 211–230.

- Aggarwal, C. C. (2009) Models for incomplete and probabilistic information. In Managing and Mining Uncertain Data, 1–34.

- A. El-Sheikh and S.D. Pryke, Construct Manag Econ, 28, 1205 (2010).

- D. Hinds and R. M. Lee, Hawaii International Conference on System Sciences, Proceedings of the 41st Annual, IEEE, pp. 323-323 (2008).

- Geek for Geeks.

- H. Kerzner, Advanced project management: Best practices on implementation (2004).

- H.J. Thamhaim and D. L. Wilemon, SLOAN MANAGE REV., 16,31 (1975).

- H.R. Kerzner, Project management: a systems approach to planning, scheduling, and controlling (2013).

- https://www.itm-conferences.org/articles/itmconf/pdf/2016/01/itmconf_ics2016_03011.pdf

- J.R. Turner and R. Muller, Int J Project Manage, 21, 1 (2003).

- M.B. Pinto and J.K. Pinto, JPIM, 7, 200 (1990).

- P.S. Chinowsky, J. Diekmann and J. O'Brien, JCEM, 136, 452 (2009).

- P. Dietrich, IJPM, 37, 49 (2006).

- P. He, B. Li and Y. Huang, Second International Conference on CGC, pp. 418-423 (2012).
- P. Chinowsky, J. Diekmann and V. Gaiotti, JCEM, 134, 804 (2008).
- P. Chinowsky and J.E. Taylor, EPOJ, 2, 15 (2012).
- R. Alsamadani, M. Hallowell and A. N. JavemickWill, CEM, 31, 568 (2013).
- S.D. Pryke, Construct Manag Econ, 23,927 (2005).
- T. Cooke-Davies, Int J Proj Manage, 20, 185 (2002).
- T. Mueller-Prothmann and I. Finke, J. UCS, 10, 691 (2004).
- W.A. Reed, Doctoral dissertation (2006).