Introduction
–Seminar–

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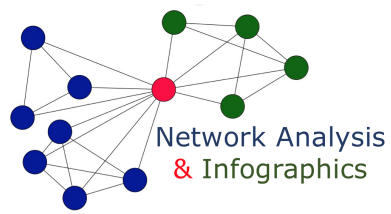
Business School
University of Sussex



Week 1: 28 January 2022

Learning Outcomes

	Learning outcome	Assessment mode
1	Explain the concept of network and list the main network indicators	ESS
2	Describe and apply the major techniques for the collection of network data and their statistical analysis	ESS, GPN + GWS
3	Identify the main characteristics of networks by means of network measures	ESS, GPN + GWS
4	Employ network analysis techniques to produce network data-based infographics	GPN + GWS

Note: ESS: Essay; GPN: Group Presentation; GWS: Group Written Submission

Overview

1. The ‘old school’ exercise
2. R, RStudio, and igraph
3. Ready ...?
4. Some useful (and freely available) resources to learn R

The ‘old school’ exercise

The 'old school' exercise

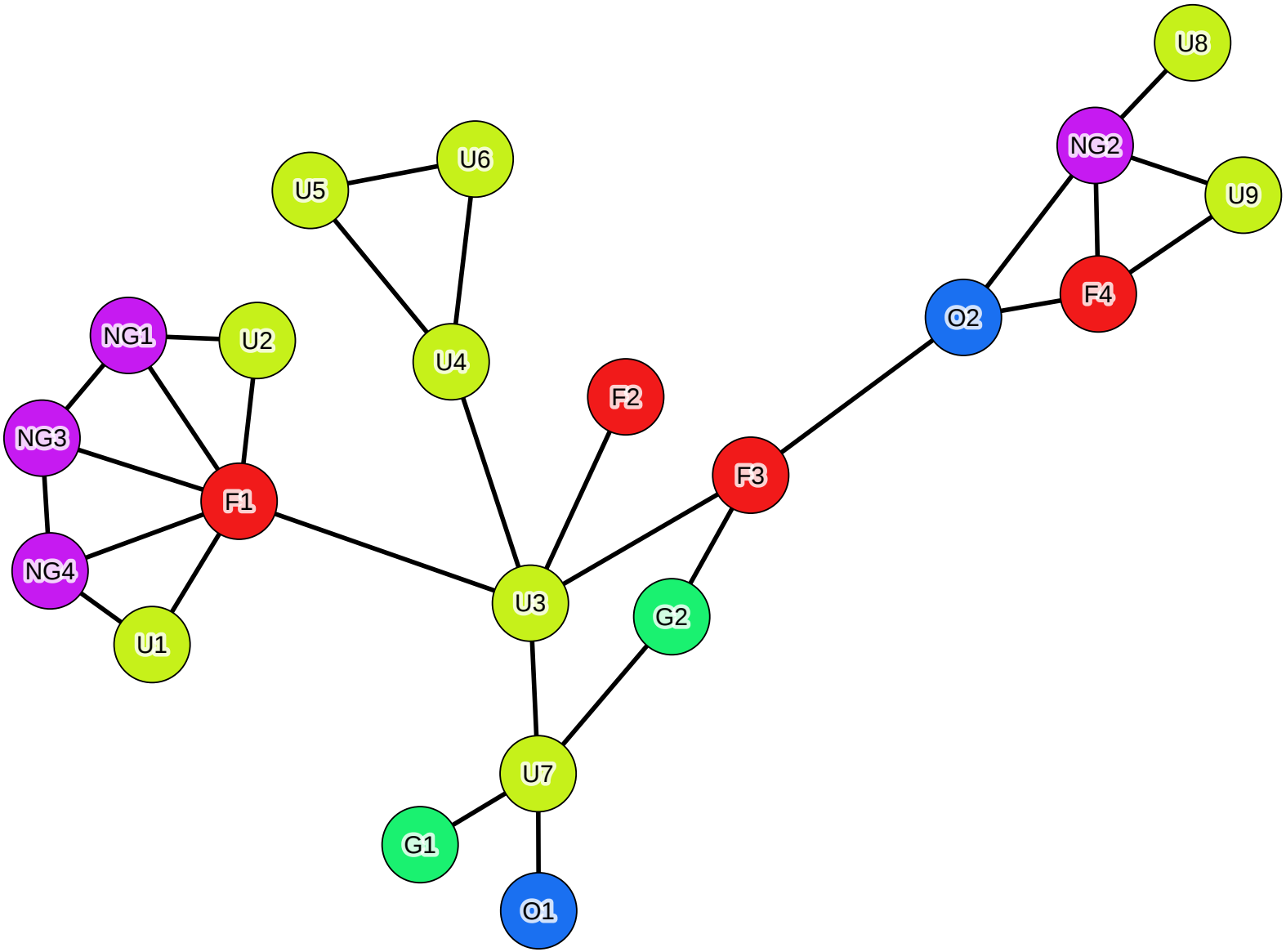
You are provided with a list 20 R&D projects. These projects involve different types of organisations. You are requested to:

1. Draw a network the depicts the collaboration activity of firms on projects (inter-organisational network)
2. Which are the most influential organisations in this network?
3. Which are the most critical organisations for the cohesion of the network?
4. Upload a picture of your network
   `https://padlet.com/yaslan2/oysry42vouhcetvt`

R&D project	List of partners
Proj01	U2, F1, NG1
Proj02	U1, NG4, F1
Proj03	NG3, NG1, F1
Proj04	NG3, NG4, F1
Proj05	U3, F1
Proj06	U3, F2
Proj07	U3, F3
Proj08	U3, U4
Proj09	F1
Proj10	U5
Proj11	U4, U5, U6
Proj12	U3, U7
Proj13	U7, G1
Proj14	U7, O1
Proj15	U7, G2
Proj16	G2, F3
Proj17	F3, O2
Proj18	O2, F4, NG2
Proj19	F4, U9, NG2
Proj20	NG2, U8

Firm (F); University (U);
Gov. (G); Non-Gov. (NG);
Other (O)

The ‘old school’ exercise



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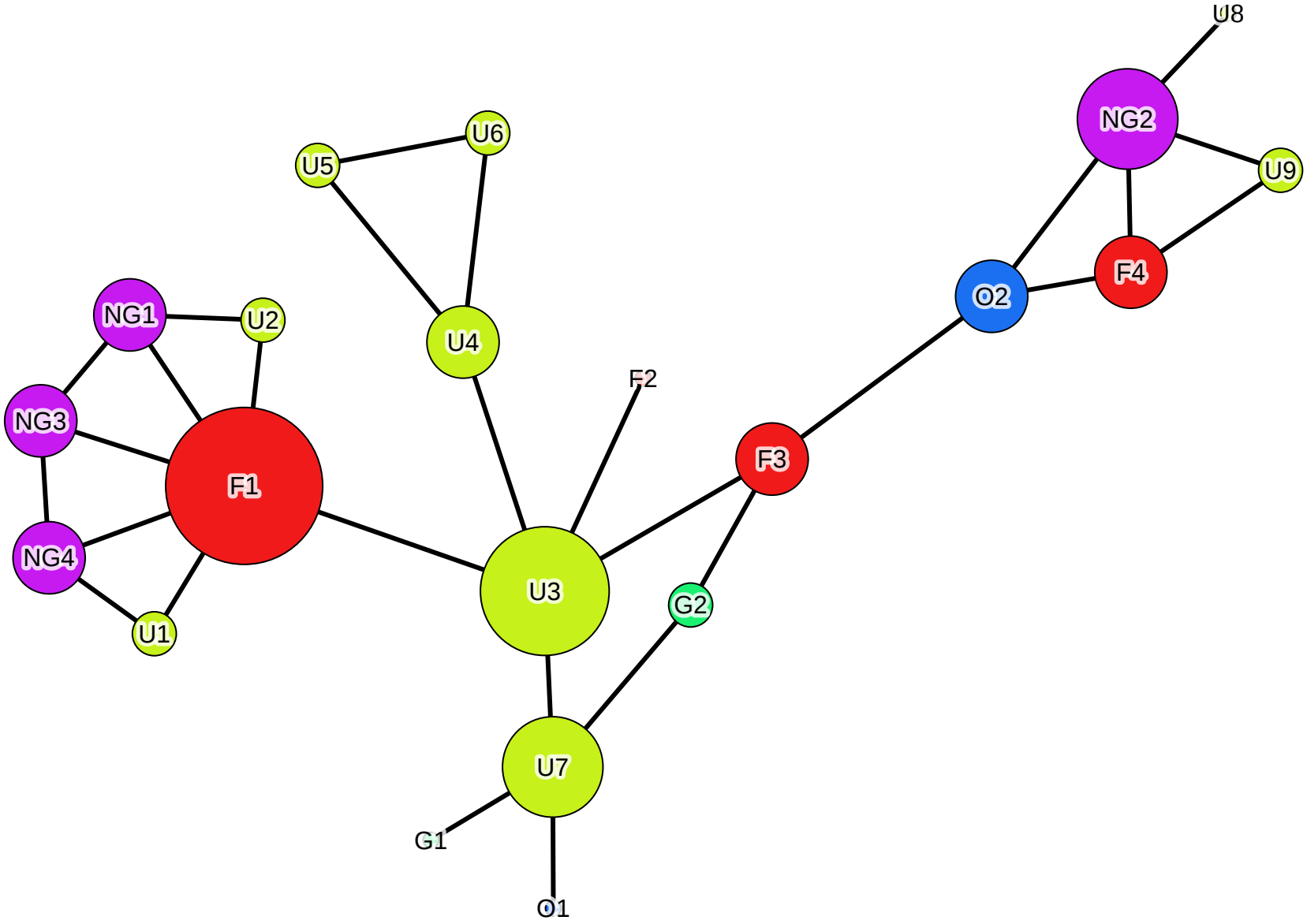

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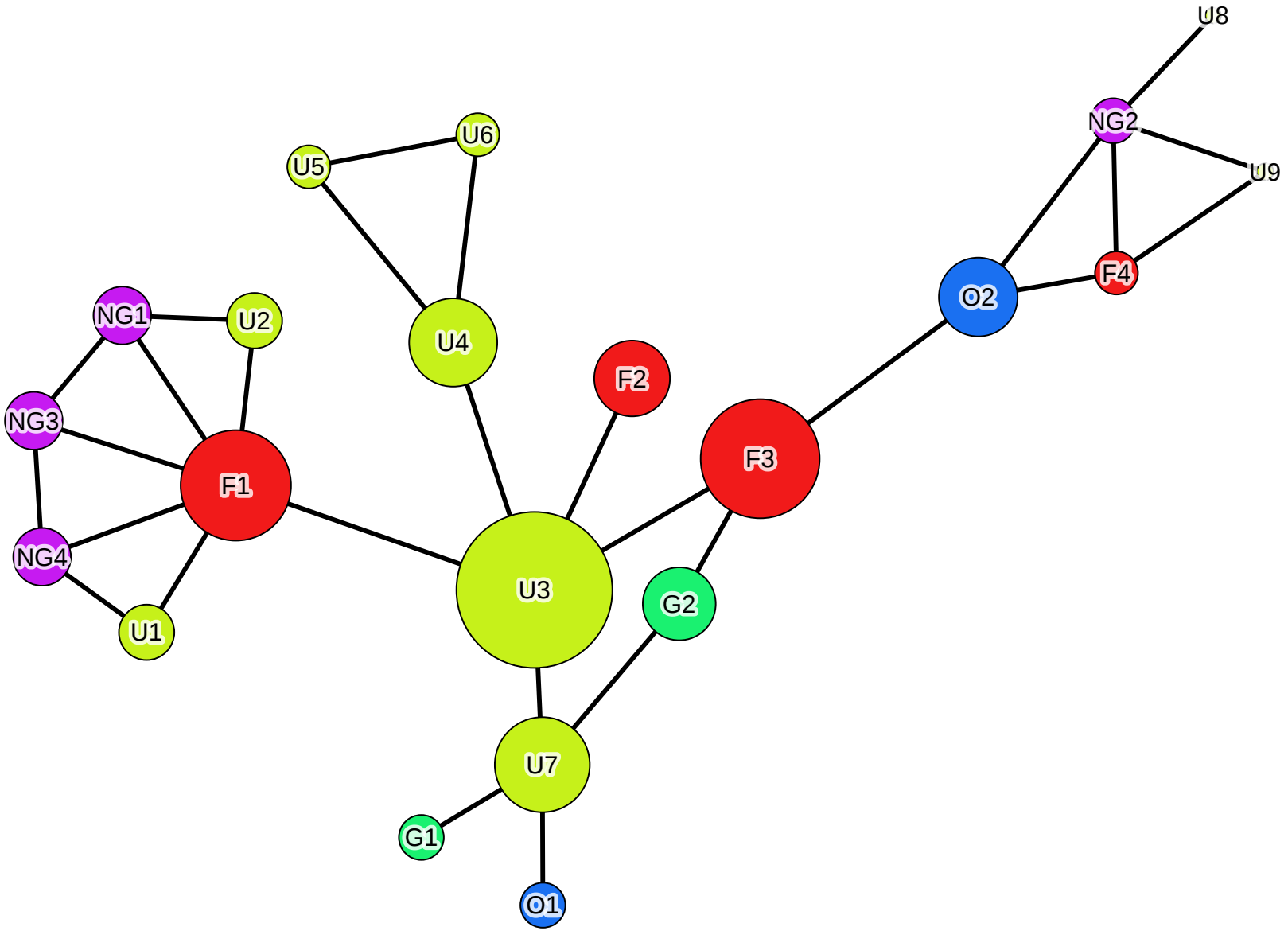

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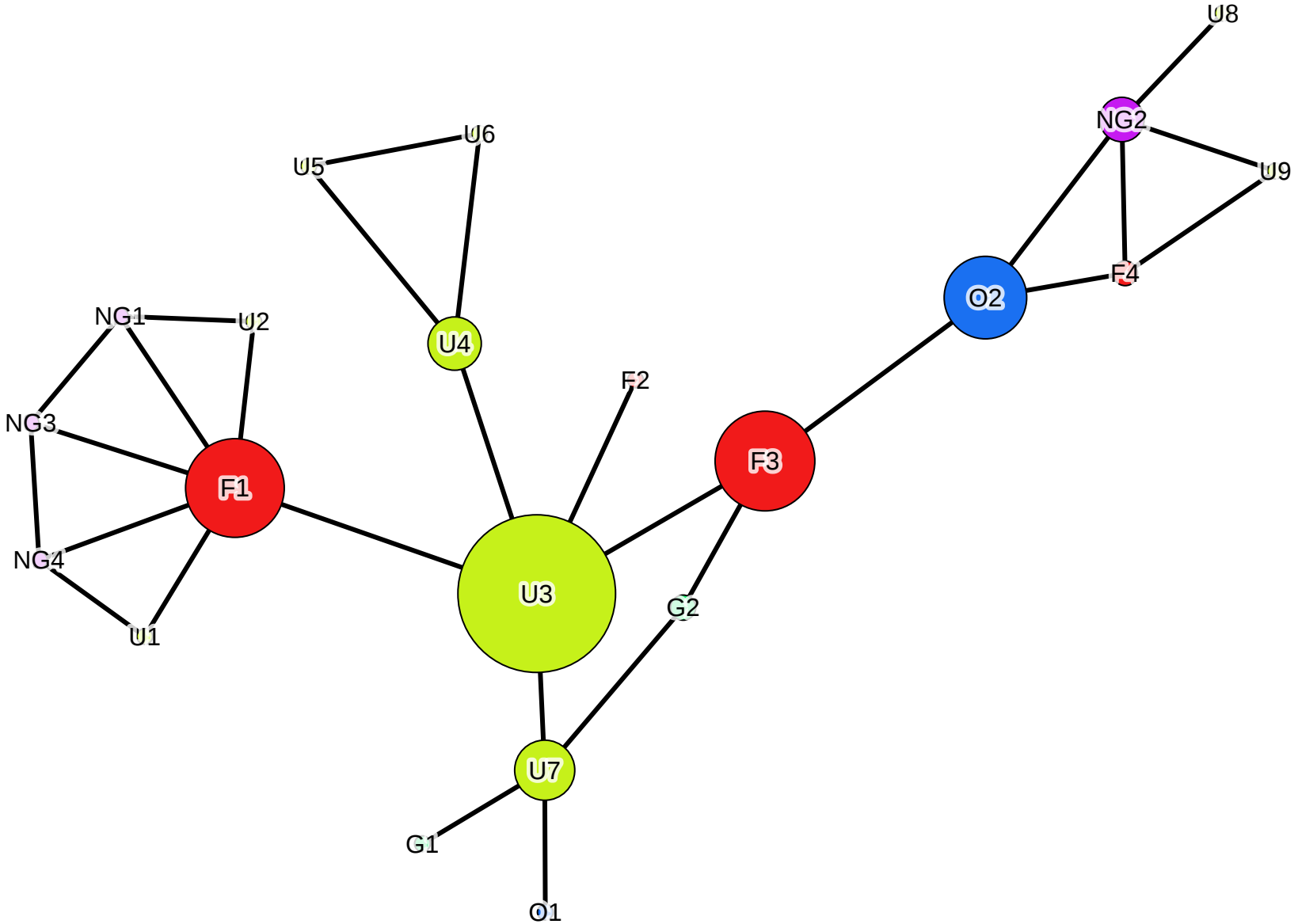
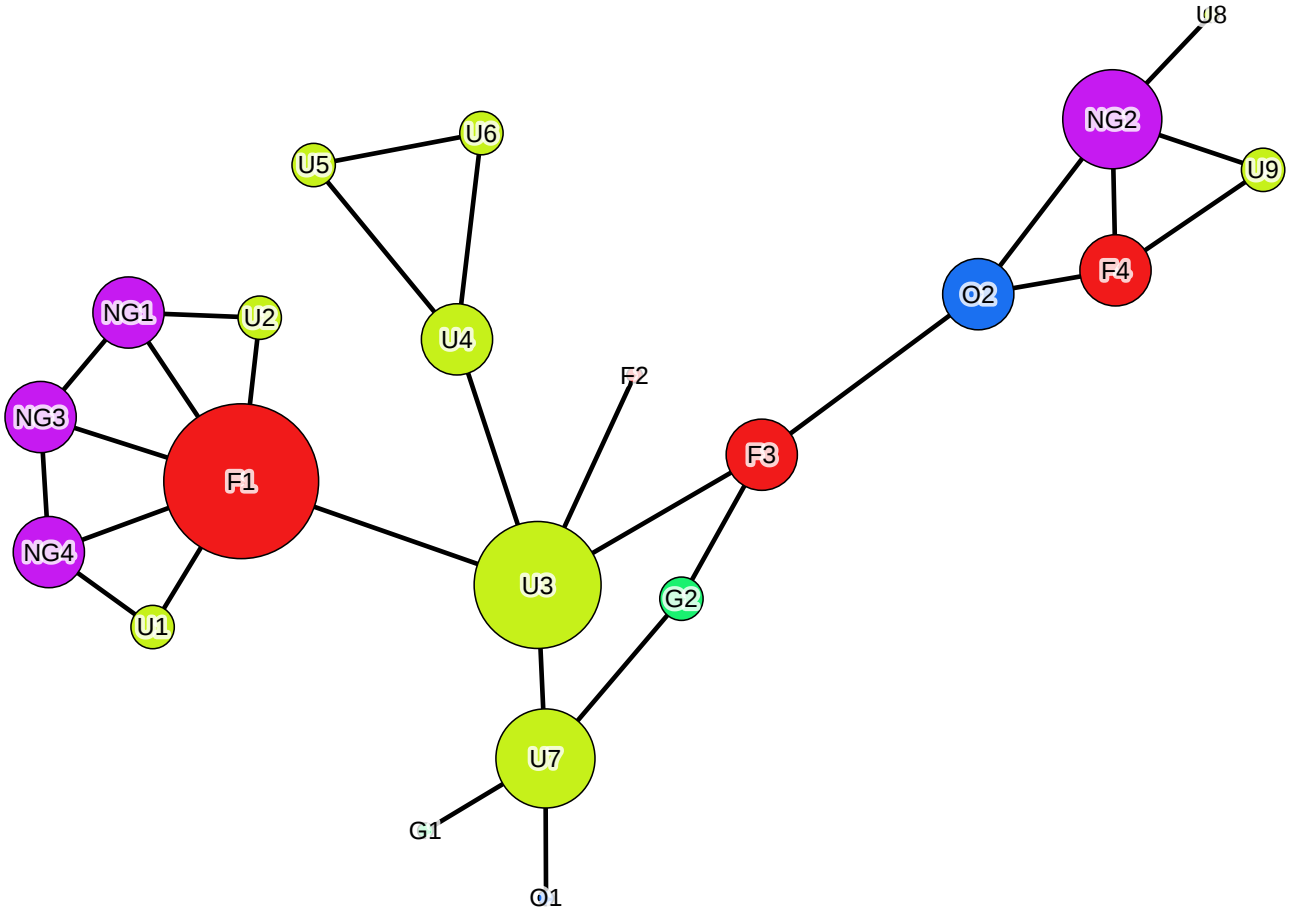


The ‘old school’ exercise

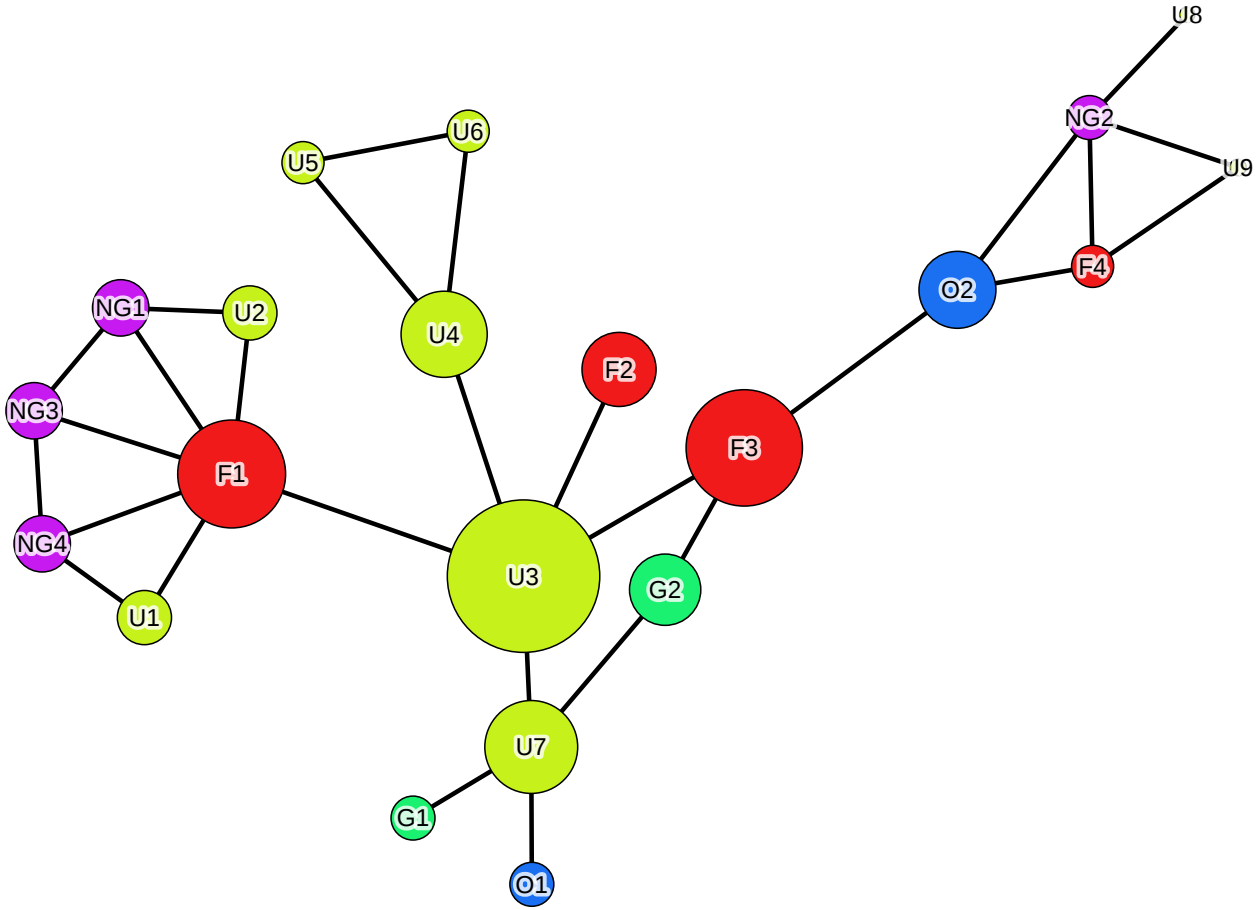
Degree centrality



Node	$C_D(n_i)$
F1	6
F2	1
F3	3
F4	3
G1	1
G2	2
NG1	3
NG2	4
NG3	3
NG4	3
O1	1
O2	3
U1	2
U2	2
U3	5
U4	3
U5	2
U6	2
U7	4
U8	1
U9	2

The ‘old school’ exercise

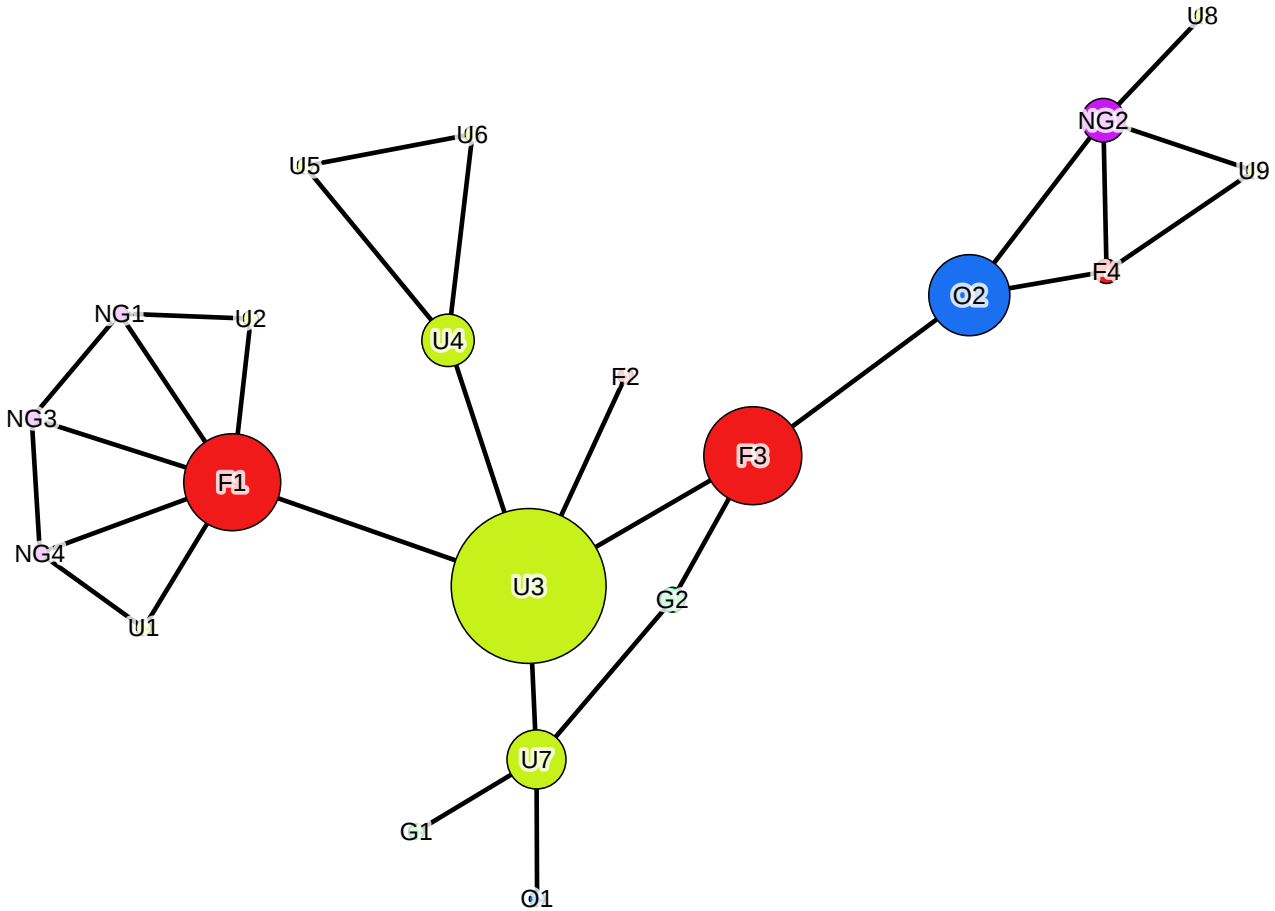
Closeness centrality



Node	$C_C(n_i)$
F1	0.40
F2	0.33
F3	0.42
F4	0.27
G1	0.27
G2	0.33
NG1	0.30
NG2	0.27
NG3	0.30
NG4	0.30
O1	0.27
O2	0.34
U1	0.29
U2	0.29
U3	0.49
U4	0.36
U5	0.27
U6	0.27
U7	0.37
U8	0.22
U9	0.22

The ‘old school’ exercise

Betweenness centrality



Node	$C_B(n_i)$
F1	0.42
F2	-
F3	0.42
F4	0.04
G1	-
G2	0.05
NG1	0.00
NG2	0.14
NG3	0.00
NG4	0.00
O1	-
O2	0.34
U1	-
U2	-
U3	0.72
U4	0.19
U5	-
U6	-
U7	0.22
U8	-
U9	-

R, RStudio, and igraph

R, RStudio, and igraph

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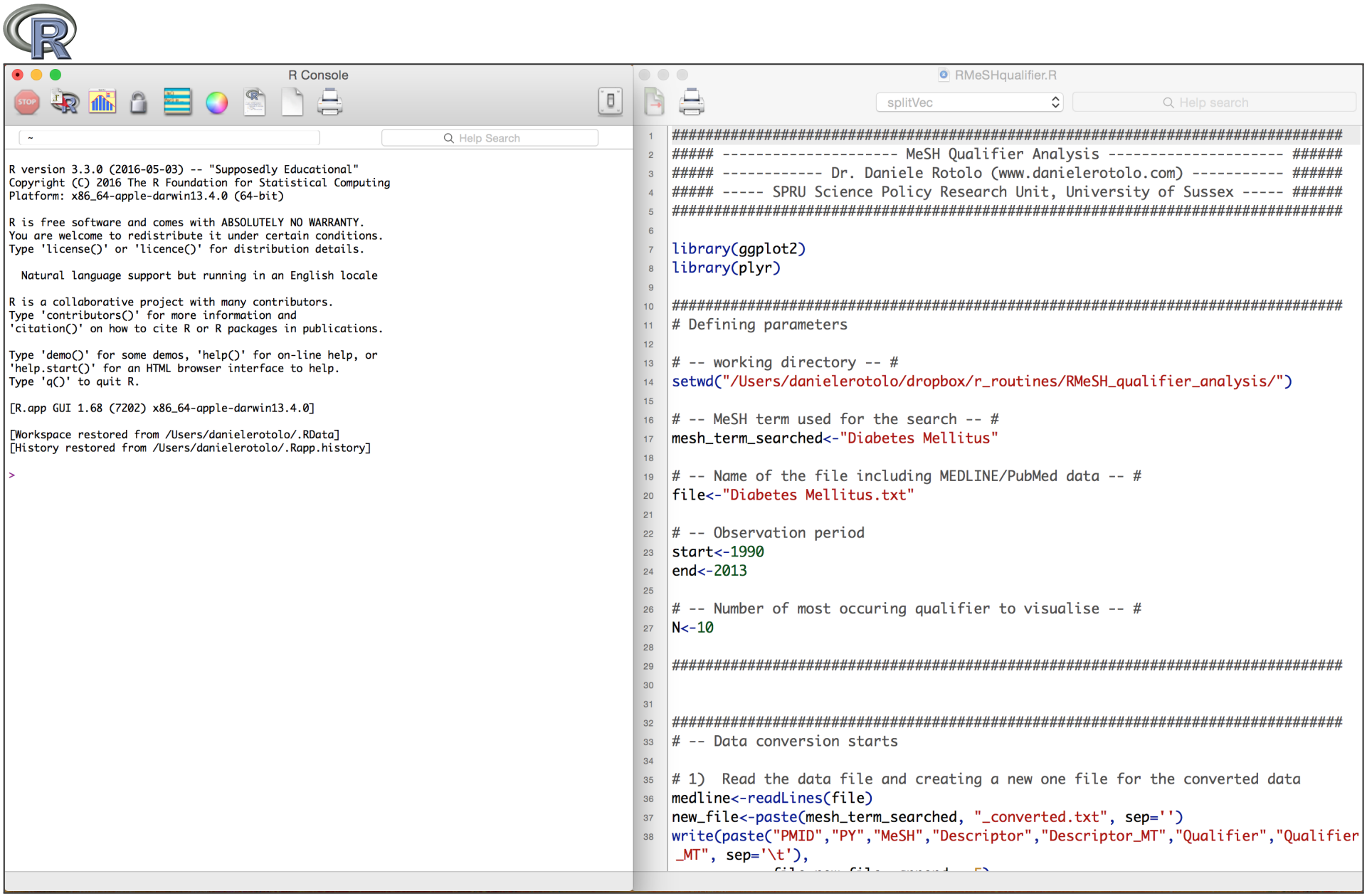
- Runs on Windows, Linux, macOS
- Initially developed for statistical analysis by Robert Gentleman and Ross Ihaka (University of Auckland) – that's why "R".
- Core Group with write access to the R source
- Constantly updated and with access to 19,000 packages (January 2022, `www.r-pkg.org`)

R, RStudio, and igraph



R, RStudio, and igraph

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- An open-source editor for R
- Developed by a company called RStudio
- Functionalities that are otherwise not available in the standard R editor
- Support, tutorials, webinars

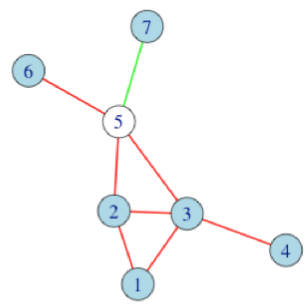
R, RStudio, and igraph

RStudio

```
h2 <- induced_subgraph(g, c(1,2,3,5))
plot(h2)



#---Change noodes's color and size / edges' colors and width
V(g)$color <- "lightblue"
V(g)$size <- 25
E(g)$color <- "red"
E(g)$width <- 2
plot(g, vertex.label = V(g)$id)

E(g) [5 %--% 7]$color<-"green"   #Color specific nodes and edges
V(g) [5]$color<-"white"
plot(g)



#---Create new attributes for nodes and edges
V(g)$att <- c(1,0,1,1,0,1,0)
V(g)$color <- ifelse(V(g)$att == 1, "green", "yellow")
plot(g)

E(g)$value <- c(1.0,2.0,3.5,4.0,5.5,6.8,2.0,1.0)
plot(g, edge.label = E(g)$value)
plot(g, edge.width = E(g)$value)
```

```
> #---Add nodes and vertices and select subgraphs
> h1 <- g + vertices(c(8,9))
> h1 <- h1 + edges(c(8,9), c(1,8))
> plot(h1)
> h2 <- induced_subgraph(g, c(1,2,3,5))
> plot(h2)
> #---Change noodes's color and size / edges' colors and width
> V(g)$color <- "lightblue"
> V(g)$size <- 25
> E(g)$color <- "red"
> E(g)$width <- 2
> plot(g, vertex.label = V(g)$id)
> E(g) [5 %--% 7]$color<-"green"   #Color specific nodes and edges
> V(g) [5]$color<-"white"
> plot(g)
>
```

Environment	
Data	
data	5 obs. of 2 variables
Values	
a	num [1:5] 1 2 3 4 5
b	num [1:3] 2 4 5
c	Factor w/ 5 levels "Aldo","Antonio",..: 1 4 2 3 4 5 2 2
d	List of 3
directory	"/Users/danielerotolo/Dropbox/SNA_IPTS_2015/Lab/igraph"
g	List of 10
h1	List of 10
h2	List of 10
x	5
y	4



R, RStudio, and igraph

Elements of the interface:

- Script: the list of commands we want R to execute
- Console: the list of commands R executes and the outcomes of these
- Environment, History: variables, datasets, and executed commands
- Files, Plot, Packages, Help, Viewer: generated charts, loaded packages, etc.

R, RStudio, and igraph

`http://igraph.org/r/`

- Provides a relatively comprehensive set of tools to perform network analysis

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`http://igraph.org/r/`

- Provides a relatively comprehensive set of tools to perform network analysis
- Developed by Gábor Csárdi (Harvard University) and others
- Excellent textbook [Kolaczyk and Csárdi, 2014]

Ready ...?

Ready ...?

R and RStudio

On campus*

1. Go to http://rstudio.uscs.susx.ac.uk/
2. Access the website by using your University of Sussex account

On your personal computer

1. Install R
2. Install RStudio

RStudio cloud

1. Go to `https://rstudio.cloud`
2. Register and sign in

*You can access the server off campus by using remote desktop
http://www.sussex.ac.uk/its/services/software/windowsremote

Ready ...?
Installing igraph

Through the RStudio interface:

1. Tools
2. Install Packages
3. Search for igraph
4. Tick the box "Install Dependencies"
5. Install

or

Through the RStudio console

```
1 install.packages("igraph")
2 library("igraph")
```

Some useful (and freely available) resources to learn R

- **Books**
  - Harley Wickham and Garrett Grolemund - R for Data Science: generic introduction to R and to the data analysis workflow
  - Claus O. Wilke - Fundamentals of Data Visualisation: mainly based on `ggplot2`, an R package for data visualisation
- **Online courses:** a host of possible choices!
  - RStudio official learning pathways
  - Linkedin Learning
  - Coursera, EdX...
- **Online communities:** practical solutions to specific issues
  - StackOverFlow - Q&A about coding problems
  - GitHub - a bit more advanced, repository of routines
- **Twitter:** #rstats and @rstatstweet

Next time ...

Next time ...

- **Lecture: Network definition**
  - Definition of network and different types of networks
  - Overview of the historical and disciplinary origins of (social) network analysis
  - Network visualisation standards

- **Seminar: Network definition**
  - Short intro to R
  - Basic commands

Questions

References I

Kolaczyk, E. and Csárdi, G. (2014).

Statistical analysis of network data with R, volume 65.
Springer-Verlag, New York, NY, USA.