In-Class Exercise 9: Visualising and Analysing Network Data with R

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Overview

In this hands-on exercise, you will learn how to visualising network data using R.

By the end of this hands-on exercise, you will be able to:

- create graph object data frames, manipulate them using appropriate functions of *dplyr*, *lubridate*, and *tidygraph*,
- build network graph visualisation using appropriate functions of *ggraph*,
- compute network geometrics using *tidygraph*,
- build advanced graph visualisation by incorporating the network geometrics, and
- build interactive network visualisation using *visNetwork* package.

Getting Started

Installing and launching R packages

In this hands-on exercise, four network data modelling and visualisation packages will be installed and launched. They are igraph, tidygraph, ggraph and visNetwork. Beside these four packages, tidyverse and lubridate, an R package specially designed to handle and wrangling time data will be installed and launched too.

The code chunk:

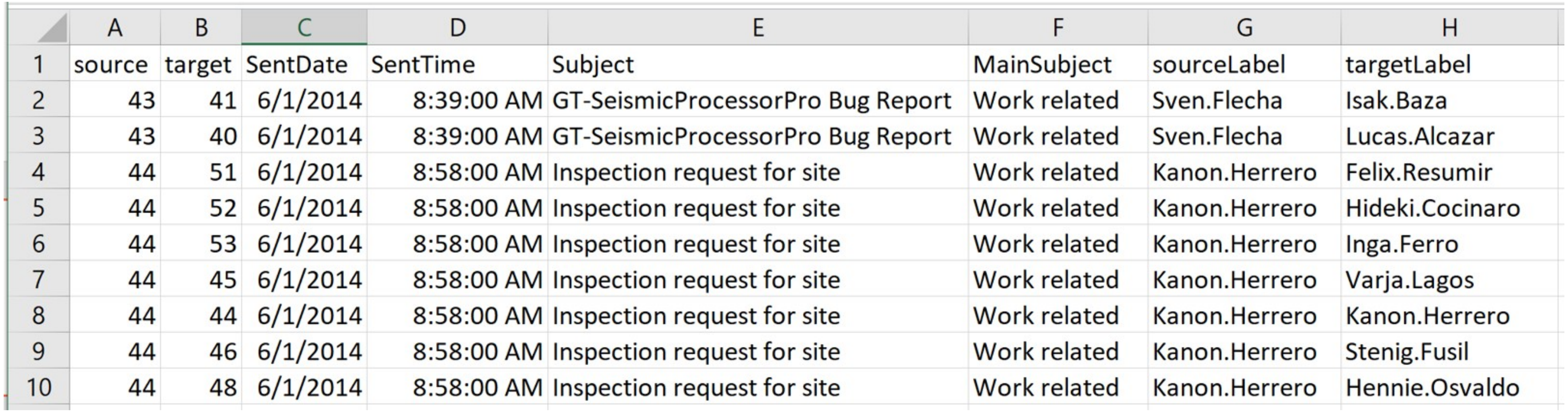
```r
packages = c('igraph', 'tidygraph', 
             'ggraph', 'visNetwork', 
             'lubridate', 'clock',
             'tidyverse')

for(p in packages){
  if(!require(p, character.only = T)){
    install.packages(p)
  }
  library(p, character.only = T)
}
```

The Data

The data sets used in this hands-on exercise is from an oil exploration and extraction company. There are two data sets. One contains the nodes data and the other contains the edges (also know as link) data.

The edges data

- *GAStech-email_edges.csv* which consists of two weeks of 9063 emails correspondances between 55 employees

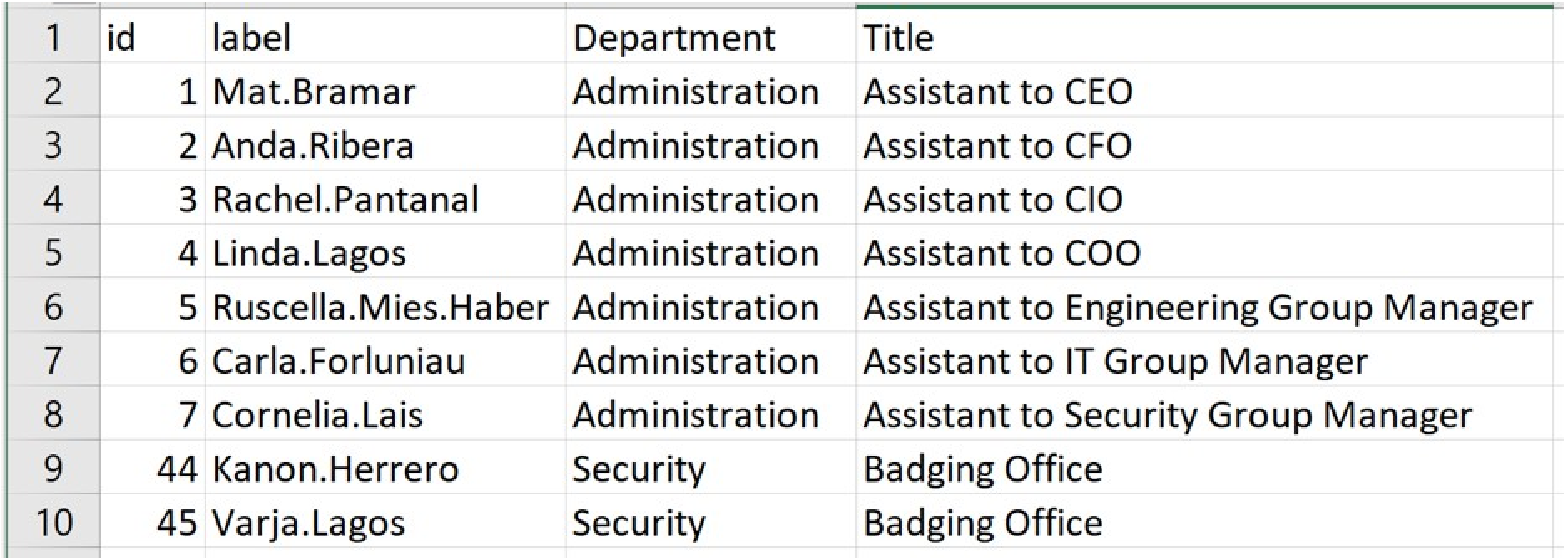


	A	B	C	D	E	F	G	H
1	source	target	SentDate	SentTime	Subject	MainSubject	sourceLabel	targetLabel
2	43	41	6/1/2014	8:39:00 AM	GT-SeismicProcessorPro Bug Report	Work related	Sven.Flecha	Isak.Baza
3	43	40	6/1/2014	8:39:00 AM	GT-SeismicProcessorPro Bug Report	Work related	Sven.Flecha	Lucas.Alcazar
4	44	51	6/1/2014	8:58:00 AM	Inspection request for site	Work related	Kanon.Herrero	Felix.Resumir
5	44	52	6/1/2014	8:58:00 AM	Inspection request for site	Work related	Kanon.Herrero	Hideki.Cocinaro
6	44	53	6/1/2014	8:58:00 AM	Inspection request for site	Work related	Kanon.Herrero	Inga.Ferro
7	44	45	6/1/2014	8:58:00 AM	Inspection request for site	Work related	Kanon.Herrero	Varja.Lagos
8	44	44	6/1/2014	8:58:00 AM	Inspection request for site	Work related	Kanon.Herrero	Kanon.Herrero
9	44	46	6/1/2014	8:58:00 AM	Inspection request for site	Work related	Kanon.Herrero	Stenig.Fusil
10	44	48	6/1/2014	8:58:00 AM	Inspection request for site	Work related	Kanon.Herrero	Hennie.Osvaldo

The Data

The nodes data

- *GAStech_email_nodes.csv* which consist of the names, department and title of the 55 employees.



1	id	label	Department	Title
2	1	Mat.Bramar	Administration	Assistant to CEO
3	2	Anda.Ribera	Administration	Assistant to CFO
4	3	Rachel.Pantanal	Administration	Assistant to CIO
5	4	Linda.Lagos	Administration	Assistant to COO
6	5	Ruscella.Mies.Haber	Administration	Assistant to Engineering Group Manager
7	6	Carla.Forluniau	Administration	Assistant to IT Group Manager
8	7	Cornelia.Lais	Administration	Assistant to Security Group Manager
9	44	Kanon.Herrero	Security	Badging Office
10	45	Varja.Lagos	Security	Badging Office

Importing network data from files

In this step, you will import GAStech_email_node.csv and GAStech_email_edges.csv into RStudio environment by using *read_csv()* of **readr** package.

```
GAStech_nodes <- read_csv("data/GAStech_email_node.csv")
GAStech_edges <- read_csv("data/GAStech_email_edge-v2.csv")
```

Reviewing the imported data

Next, we will examine the structure of the data frame using *glimpse()* of **dplyr**.

```
glimpse(GAStech_edges)
```

```
## Rows: 9,063
## Columns: 8
## $ source      <dbl> 43, 43, 44, 44, 44, 44, 44, 44, 44, 44, 44, 44, 26, 26, 26~
## $ target      <dbl> 41, 40, 51, 52, 53, 45, 44, 46, 48, 49, 47, 54, 27, 28, 29~
## $ SentDate    <chr> "6/1/2014", "6/1/2014", "6/1/2014", "6/1/2014", "6/1/2014"~
## $ SentTime    <time> 08:39:00, 08:39:00, 08:58:00, 08:58:00, 08:58:00, 08:58:0~
## $ Subject     <chr> "GT-SeismicProcessorPro Bug Report", "GT-SeismicProcessorP~
## $ MainSubject <chr> "Work related", "Work related", "Work related", "Work rela~
## $ sourceLabel <chr> "Sven.Flecha", "Sven.Flecha", "Kanon.Herrero", "Kanon.Herr~
## $ targetLabel <chr> "Isak.Baza", "Lucas.Alcazar", "Felix.Resumir", "Hideki.Coc~
```

Warning: The output report of GAStech_edges above reveals that the *SentDate* is treated as "Character"" data type instead of *date* data type. This is an error! Before we continue, it is important for us to change the data type of *SentDate* field back to "Date"" data type.

Wrangling time

The code chunk below will be used to perform the changes.

```
GAStech_edges$SentDate  = dmy(GAStech_edges$SentDate)
GAStech_edges$Weekday = wday(GAStech_edges$SentDate,
                             label = TRUE,
                             abbr = FALSE)
```

Things to learn from the code chunk above:

- both *dmy()* and *wday()* are functions of **lubridate** package. lubridate is an R package that makes it easier to work with dates and times.
- *dmy()* transforms the SentDate to Date data type.
- *wday()* returns the day of the week as a decimal number or an ordered factor if label is TRUE. The argument abbr is FALSE keep the daya spells in full, i.e. Monday. The function will create a new column in the data.frame i.e. Weekday and the output of *wday()* will save in this newly created field.
- the values in the *Weekday* field are in ordinal scale.

Reviewing the revised date fields

Table below shows the data structure of the reformatted *GAStech_edges* data frame

```
## Rows: 9,063
## Columns: 9
## $ source      <dbl> 43, 43, 44, 44, 44, 44, 44, 44, 44, 44, 44, 44, 26, 26, 26~
## $ target      <dbl> 41, 40, 51, 52, 53, 45, 44, 46, 48, 49, 47, 54, 27, 28, 29~
## $ SentDate    <date> 2014-01-06, 2014-01-06, 2014-01-06, 2014-01-06, 2014-01-0~
## $ SentTime    <time> 08:39:00, 08:39:00, 08:58:00, 08:58:00, 08:58:00, 08:58:0~
## $ Subject     <chr> "GT-SeismicProcessorPro Bug Report", "GT-SeismicProcessorP~
## $ MainSubject <chr> "Work related", "Work related", "Work related", "Work rela~
## $ sourceLabel <chr> "Sven.Flecha", "Sven.Flecha", "Kanon.Herrero", "Kanon.Herr~
## $ targetLabel <chr> "Isak.Baza", "Lucas.Alcazar", "Felix.Resumir", "Hideki.Coc~
## $ Weekday     <ord> Monday, Monday, Monday, Monday, Monday, Monday, Monday, Mo~
```

Wrangling attributes

A close examination of *GAStech_edges* data.frame reveals that it consists of individual e-mail flow records. This is not very useful for visualisation.

In view of this, we will aggregate the individual by date, senders, receivers, main subject and day of the week.

Things to learn from the code chunk above:

- four functions from **dplyr** package are used. They are: *filter()*, *group()*, *summarise()*, and *ungroup()*.
- The output data.frame is called **GAStech_edges_aggregated**.
- A new field called *Weight* has been added in GAStech_edges_aggregated.

The code chunk:

```
GAStech_edges_aggregated <- GAStech_edges %>%
  filter(MainSubject == "Work related") %>%
  group_by(source, target, Weekday) %>%
    summarise(Weight = n()) %>%
  filter(source!=target) %>%
  filter(Weight > 1) %>%
  ungroup()
```

Reviewing the revised edges file

Table below shows the data structure of the reformatted *GAStech_edges* data frame

```
## Rows: 1,456
## Columns: 4
## $ source  <dbl> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,~
## $ target  <dbl> 2, 2, 2, 2, 3, 3, 3, 3, 4, 4, 4, 4, 5, 5, 5, 5, 6, 6, 6, 6, 7,~
## $ Weekday <ord> Monday, Tuesday, Wednesday, Friday, Monday, Tuesday, Wednesday~
## $ Weight  <int> 4, 3, 5, 8, 4, 3, 5, 8, 4, 3, 5, 8, 4, 3, 5, 8, 4, 3, 5, 8, 4,~
```

Creating network objects using tidygraph

Two functions of **tidygraph** package can be used to create network objects, they are:

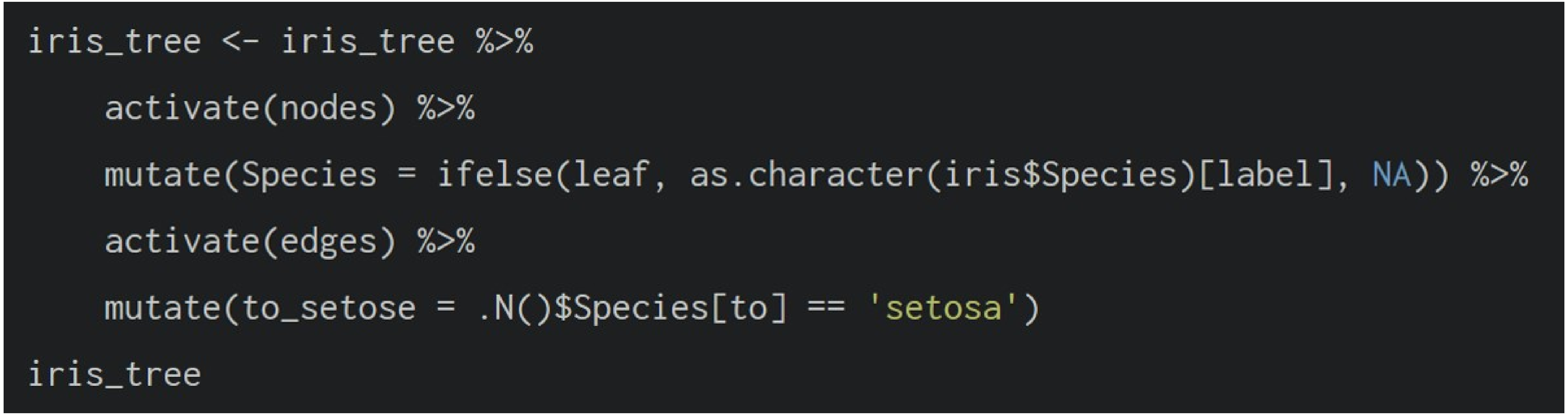
- *tbl_graph()* creates a network object from nodes and edges data.
- *as_tbl_graph()* converts network data and objects to a tbl_graph network.

The tbl_graph object

- **tbl_graph** objects can be created directly using the *tbl_graph()* function.
- *as_tbl_graph()* function can be used to convert r objects below into **tbl_graph** objects.
  - a node data.frame and an edge data.frame,
  - data.frame, list, matrix from base,
  - igraph from igraph,
  - network from network,
  - dendrogram and hclust from stats,
  - Node from data.tree,
  - phylo and evonet from ape, and
  - graphNEL, graphAM, graphBAM from graph (in Bioconductor).

The dplyr verbs in tidygraph

- *activate()* verb from **tidygraph** serves as a switch between tibbles for nodes and edges. All dplyr verbs applied to **tbl_graph** object are applied to the active tibble.



```
iris_tree <- iris_tree %>%
    activate(nodes) %>%
    mutate(Species = ifelse(leaf, as.character(iris$Species)[label], NA)) %>%
    activate(edges) %>%
    mutate(to_setose = .N()$Species[to] == 'setosa')
iris_tree
```

- In the above the *.N()* function is used to gain access to the node data while manipulating the edge data. Similarly *.E()* will give you the edge data and *.G()* will give you the **tbl_graph** object itself.

Using tbl_graph() to build tidygraph data model.

In this section, you will use *tbl_graph()* of **tinygraph** package to build an tidygraph's network graph data.frame.

Before typing the codes, you are recommended to review to reference guide of *tbl_graph()*

```
GAStech_graph <- tbl_graph(nodes = GAStech_nodes,
                           edges = GAStech_edges_aggregated,
                           directed = TRUE)
```

Reviewing the output tidygraph's graph object

```
GAStech_graph
```

```
## # A tbl_graph: 54 nodes and 1456 edges
## #
## # A directed multigraph with 1 component
## #
## # Node Data: 54 x 4 (active)
##      id label               Department     Title
##   <dbl> <chr>               <chr>          <chr>
## 1     1 Mat.Bramar          Administration Assistant to CEO
## 2     2 Anda.Ribera         Administration Assistant to CFO
## 3     3 Rachel.Pantanal     Administration Assistant to CIO
## 4     4 Linda.Lagos         Administration Assistant to COO
## 5     5 Ruscella.Mies.Haber Administration Assistant to Engineering Group Manag~
## 6     6 Carla.Forluniau     Administration Assistant to IT Group Manager
## # ... with 48 more rows
## #
## # Edge Data: 1,456 x 4
##    from    to Weekday   Weight
##   <int> <int> <ord>      <int>
## 1     1     2 Monday         4
## 2     1     2 Tuesday        3
## 3     1     2 Wednesday      5
## # ... with 1,453 more rows
```

Reviewing the output tidygraph's graph object

- The output above reveals that *GAStech_graph* is a tbl_graph object with 54 nodes and 4541 edges.
- The command also prints the first six rows of "Node Data" and the first three of "Edge Data".
- It states that the Node Data is **active**. The notion of an active tibble within a tbl_graph object makes it possible to manipulate the data in one tibble at a time.

Changing the active object

The nodes tibble data frame is activated by default, but you can change which tibble data frame is active with the *activate()* function. Thus, if we wanted to rearrange the rows in the edges tibble to list those with the highest "weight" first, we could use *activate()* and then *arrange()*.

For example,

```
GAStech_graph %>%
  activate(edges) %>%
  arrange(desc(Weight))
```

Visit the reference guide of *activate()* to find out more about the function.

Plotting Network Data with ggraph package

ggraph is an extension of **ggplot2**, making it easier to carry over basic ggplot skills to the design of network graphs.

As in all network graph, there are three main aspects to a **ggraph**'s network graph, they are:

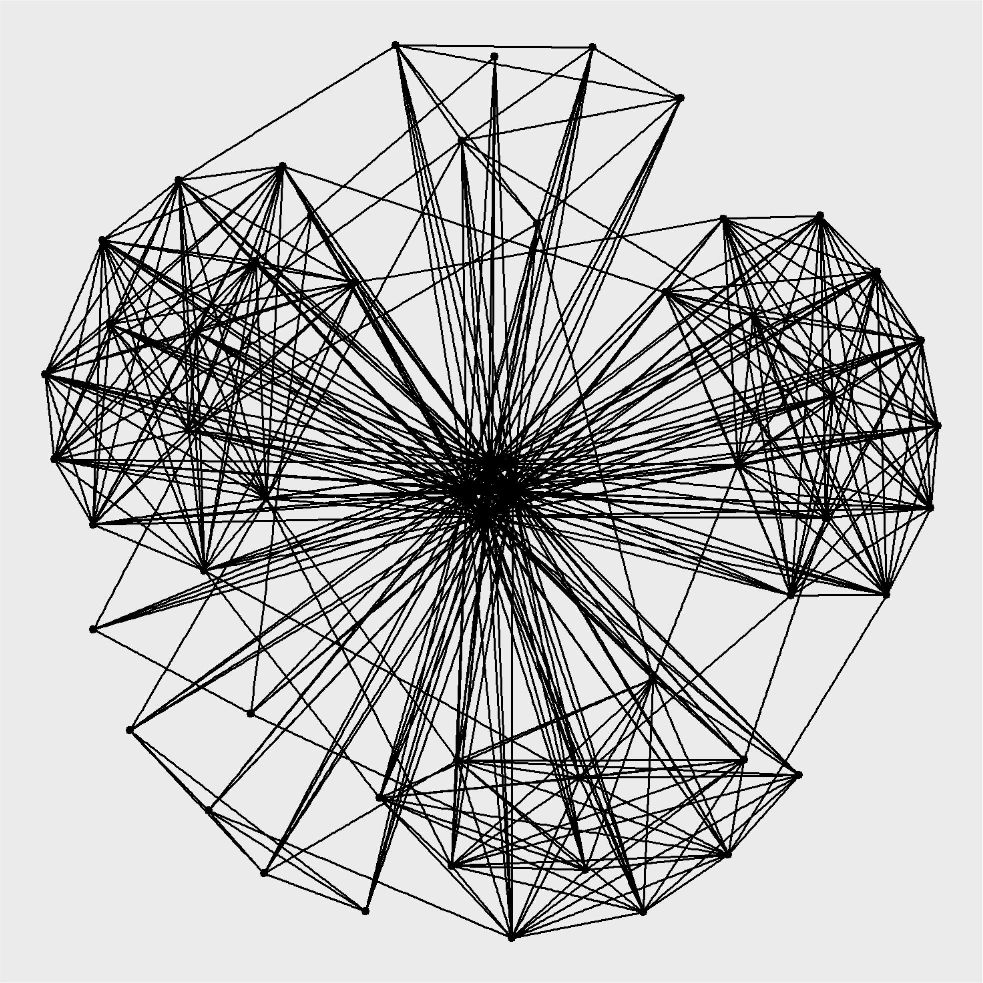
- nodes,
- edges and
- layouts.

For a comprehensive discussion of each of this aspect of graph, please refer to their respective vignettes provided.

Plotting a basic network graph

The code chunk below uses *ggraph()*, *geom-edge_link()* and *geom_node_point()* to plot a network graph by using *GAStech_graph*. Before your get started, it is advisable to read their respective reference guide at least once.

```
ggraph(GAStech_graph) +
  geom_edge_link() +
  geom_node_point()
```



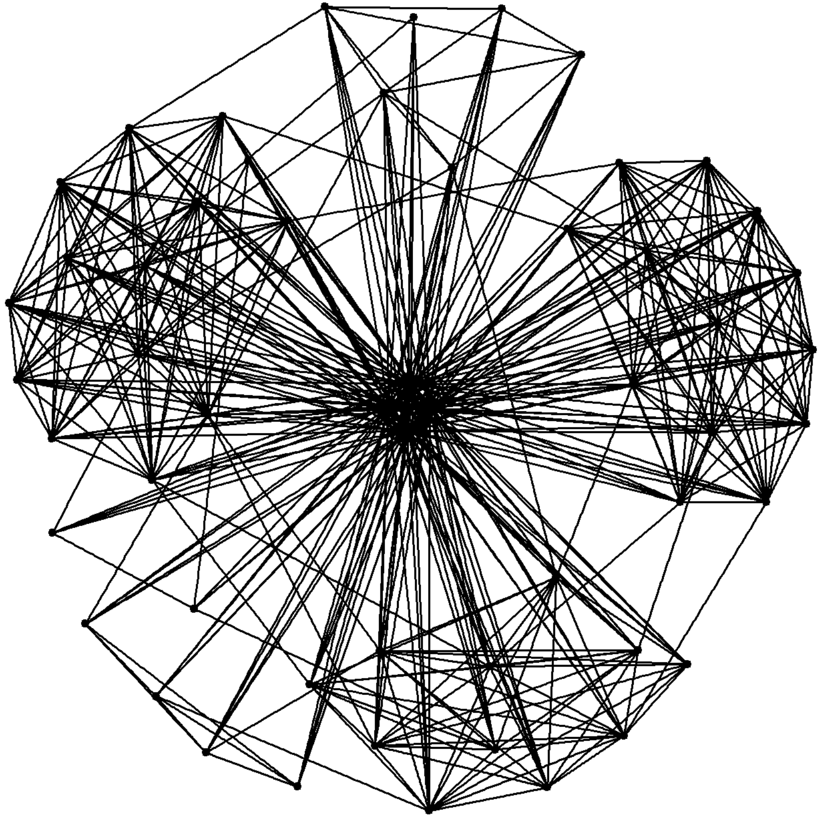
Things to learn from the code chunk above:

- The basic plotting function is *ggraph()*, which takes the data to be used for the graph and the type of layout desired. Both of the arguments for *ggraph()* are built around igraph. Therefore, *ggraph()* can use either an igraph object or a tbl_graph object.

Changing the default network graph theme

In this section, you will use *theme_graph()* to remove the x and y axes. Before your get started, it is advisable to read it's reference guide at least once.

```
g <- ggraph(GAStech_graph) +
  geom_edge_link(aes()) +
  geom_node_point(aes())
g + theme_graph()
```



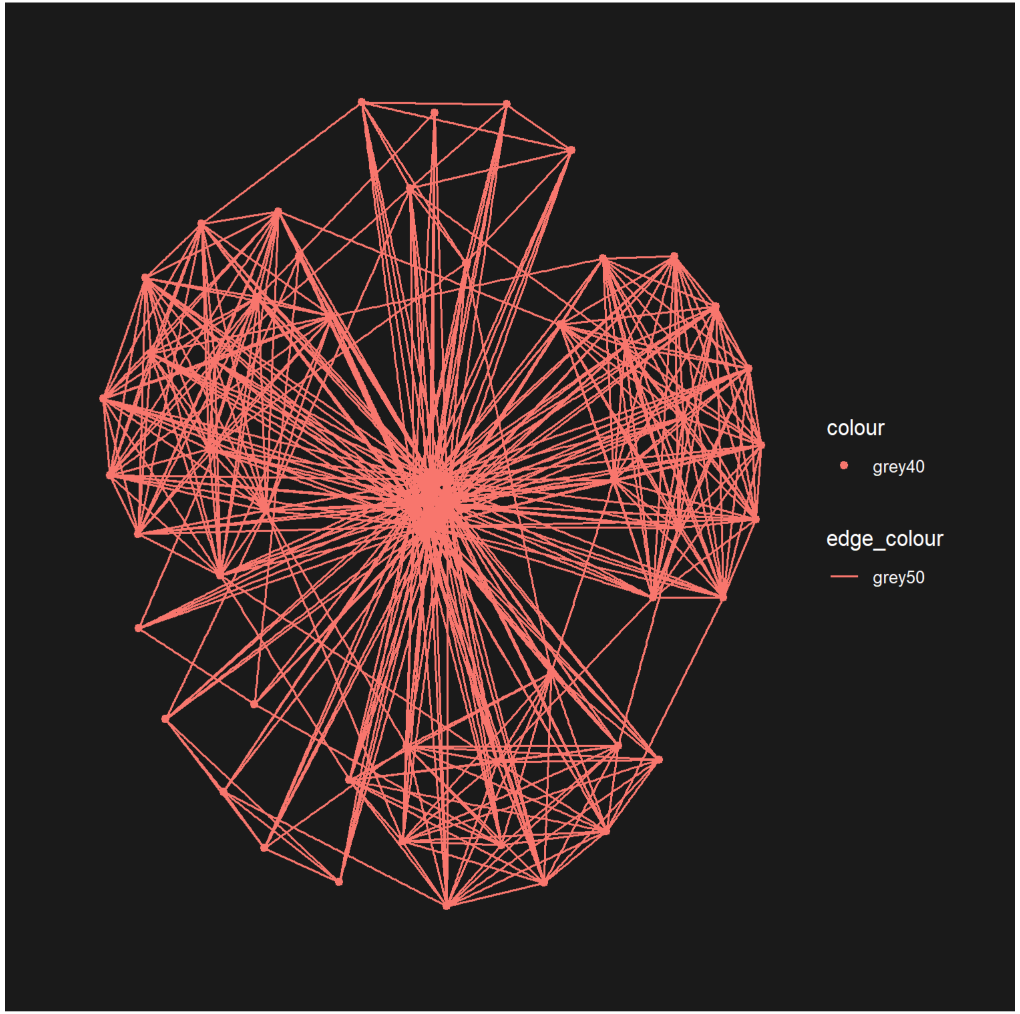
Things to learn from the code chunk above:

- **ggraph** introduces a special ggplot theme that provides better defaults for network graphs than the normal ggplot defaults. *theme_graph()*, besides removing axes, grids, and border, changes the font to Arial Narrow (this can be overridden).
- The ggraph theme can be set for a series of plots with the *set_graph_style()* command run before the graphs are plotted or by using *theme_graph()* in the individual plots.

Changing the coloring of the plot

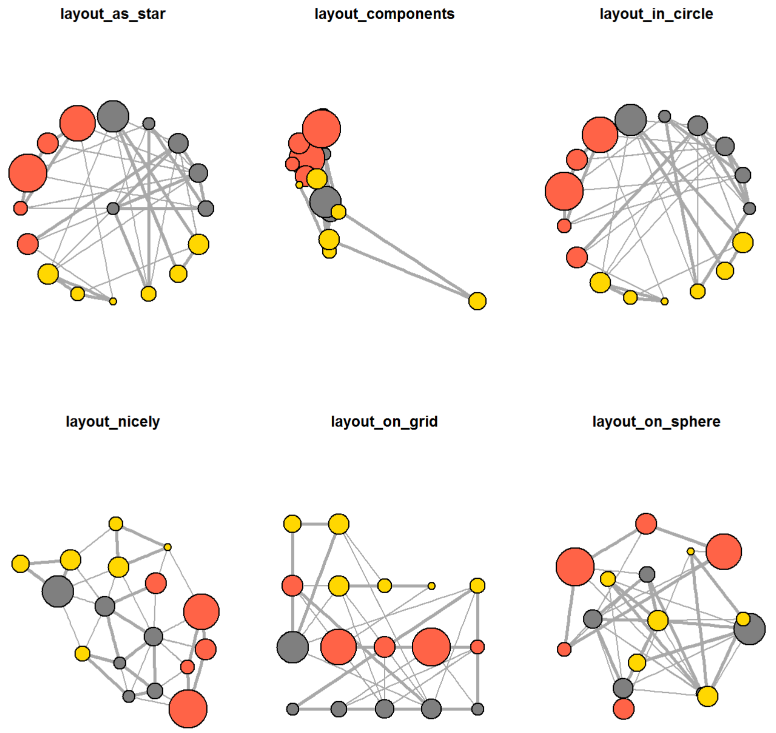
Furthermore, *theme_graph()* makes it easy to change the coloring of the plot.

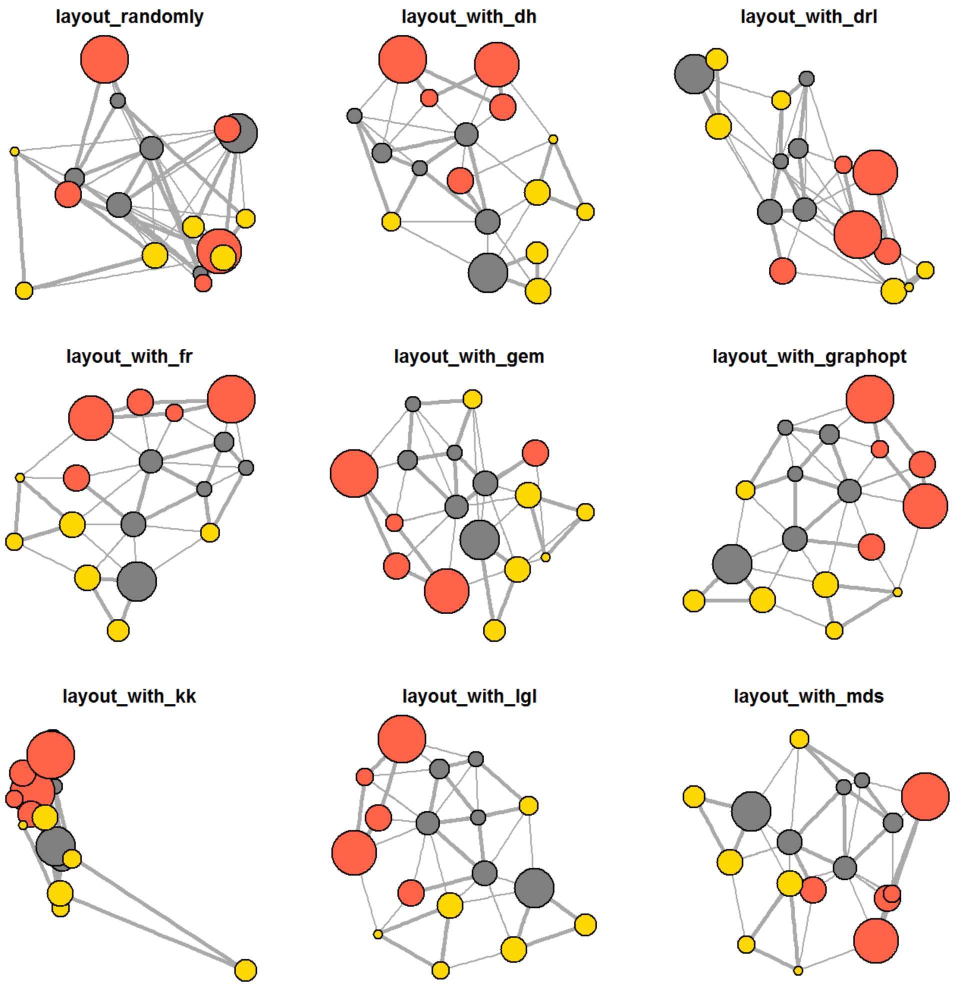
```
g <- ggraph(GAStech_graph) +
  geom_edge_link(aes(colour = 'grey50')) +
  geom_node_point(aes(colour = 'grey40'))

g + theme_graph(background = 'grey10',
                text_colour = 'white')
```



Working with ggraph's layouts

ggraph() support many layout for standard used, they are: star, circle, nicely (default), dh, gem, graphopt, grid, mds, spahere, randomly, fr, kk, drl and lgl. Figures below and on the right show layouts supported by **ggraph()**.





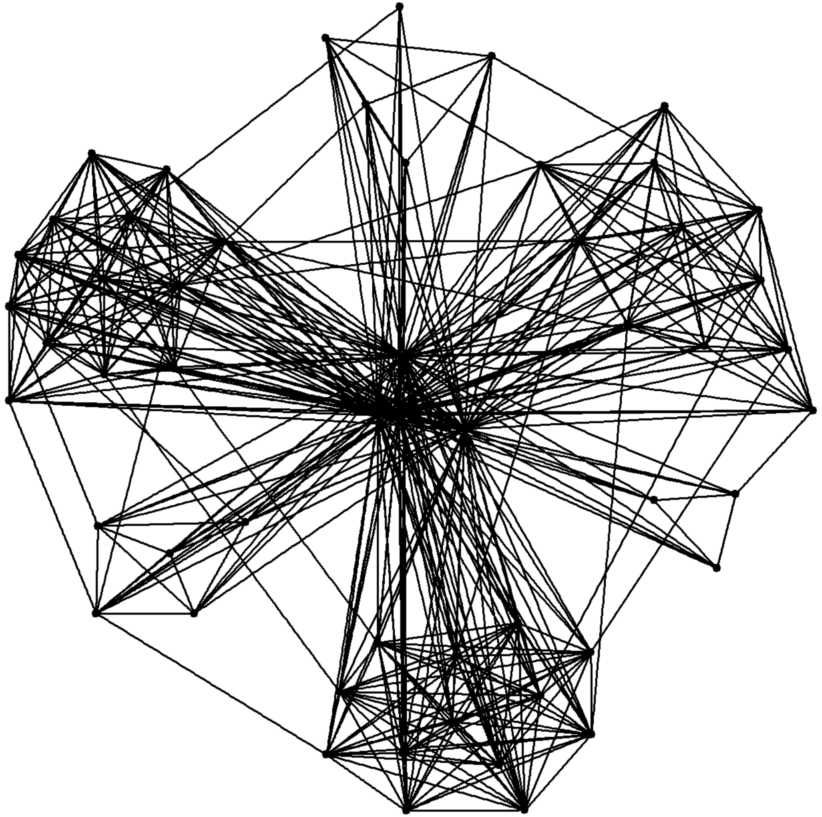
Fruchterman and Reingold layout

The code chunks below will be used to plot the network graph using Fruchterman and Reingold layout.

```
g <- ggraph(GAStech_graph,
            layout = "fr") +
  geom_edge_link(aes()) +
  geom_node_point(aes())

g + theme_graph()
```

Thing to learn from the code chunk above:

- *layout* argument is used to define the layout to be used.



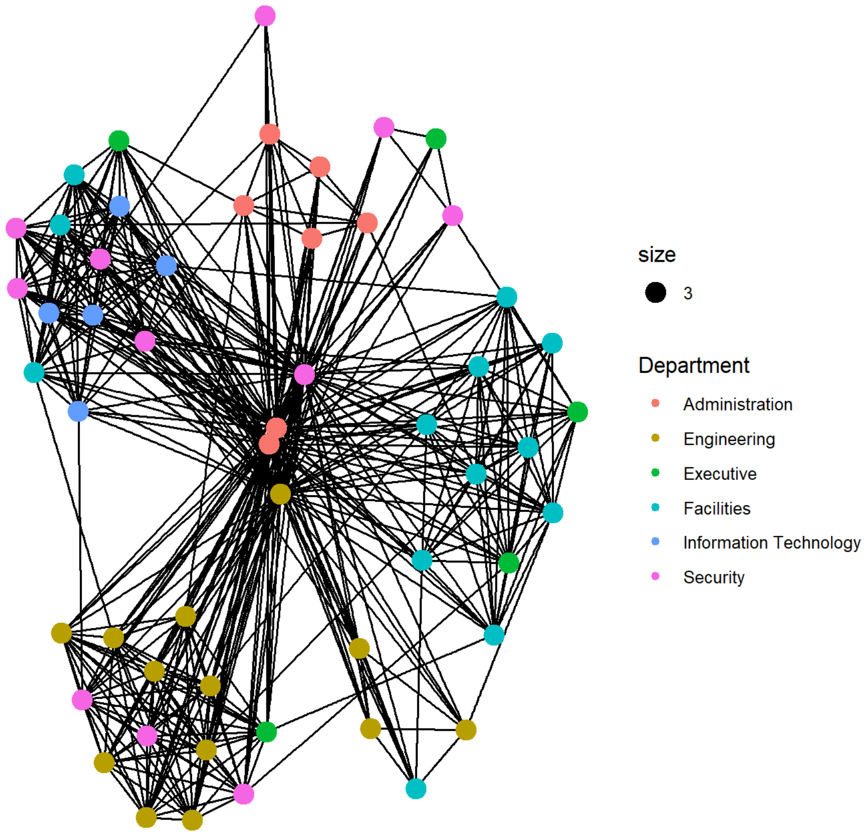
Modifying network nodes

In this section, you will colour each node by referring to their respective departments.

```
g <- ggraph(GAStech_graph,
            layout = "nicely") +
  geom_edge_link(aes()) +
  geom_node_point(aes(colour = Department,
                      size = 3))

g + theme_graph()
```

Things to learn from the code chunks above:

- *geom_node_point* is equivalent in functionality to *geo_point* of **ggplot2**. It allows for simple plotting of nodes in different shapes, colours and sizes. In the codes chnuks above colour and size are used.



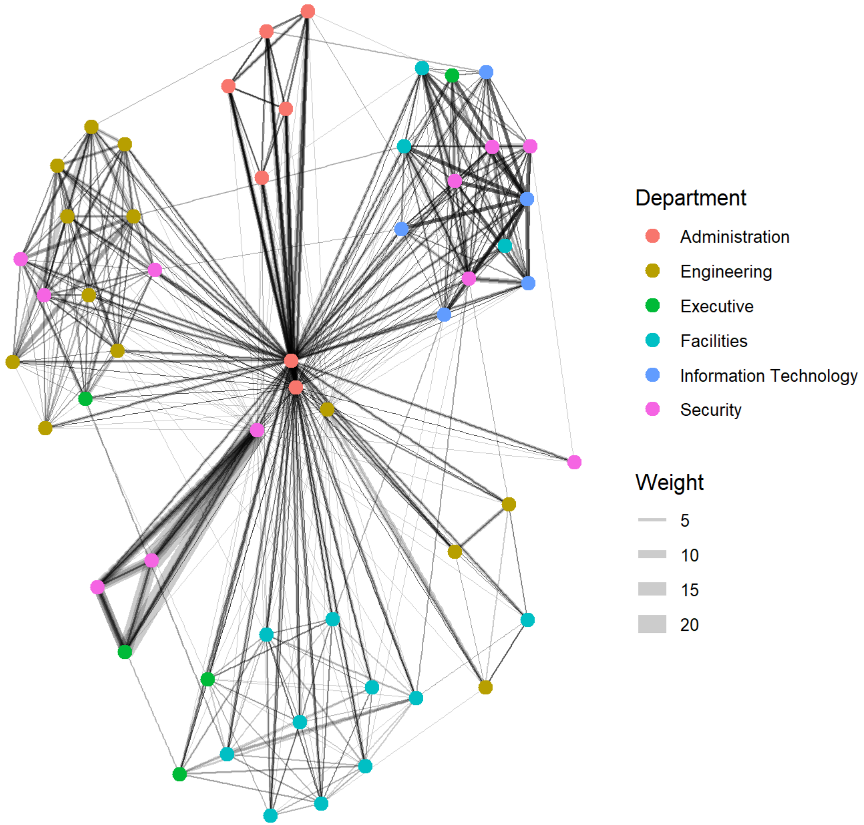
Modifying edges

In the code chunk below, the thickness of the edges will be mapped with the *Weight* variable.

```
g <- ggraph(GAStech_graph,
            layout = "nicely") +
  geom_edge_link(aes(width=Weight),
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = Department),
                  size = 3)
g + theme_graph()
```

Things to learn from the code chunks above:

- *geom_edge_link* draws edges in the simplest way - as straight lines between the start and end nodes. But, it can do more that that. In the example above, argument *width* is used to map the width of the line in proportional to the Weight attribute and argument alpha is used to introduce opacity on the line.



Creating facet graphs

Another very useful feature of **ggraph** is faceting. In visualising network data, this technique can be used to reduce edge over-plotting in a very meaning way by spreading nodes and edges out based on their attributes. In this section, you will learn how to use faceting technique to visualise network data.

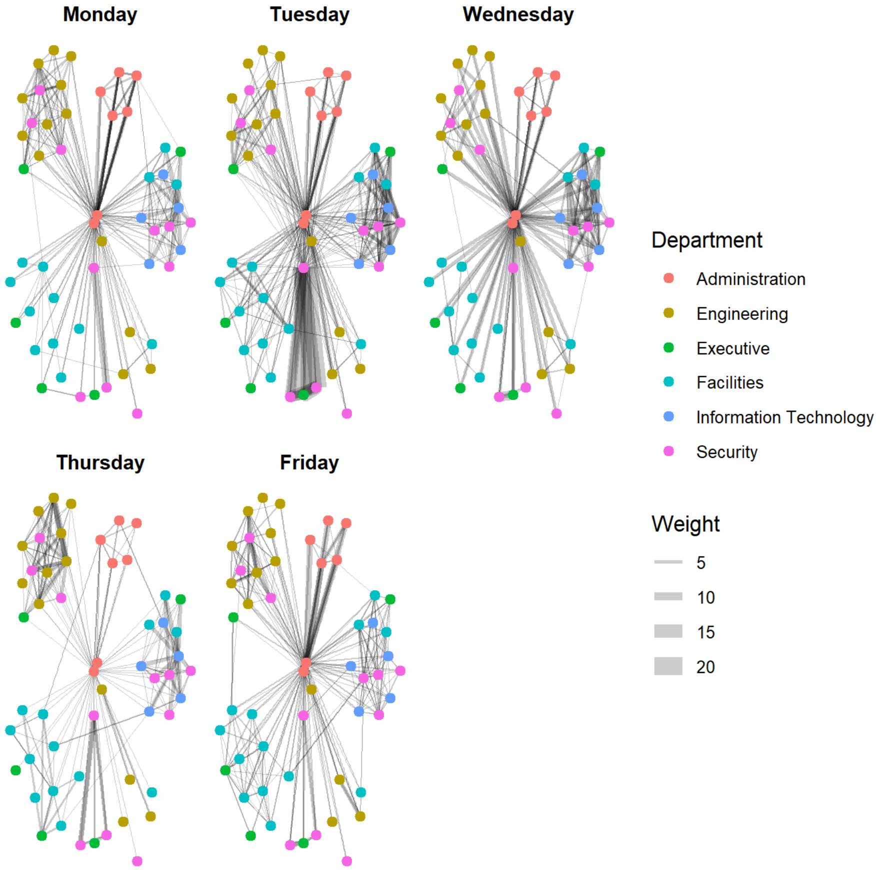
There are three functions in ggraph to implement faceting, they are:

- *facet_nodes()* whereby edges are only draw in a panel if both terminal nodes are present here,
- *facet_edges()* whereby nodes are always drawn in al panels even if the node data contains an attribute named the same as the one used for the edge facetting, and
- *facet_graph()* faceting on two variables simultaneously.

Working with *facet_edges()*

In the code chunk below, *facet_edges()* is used. Before getting started, it is advisable for you to read it's reference guide at least once.

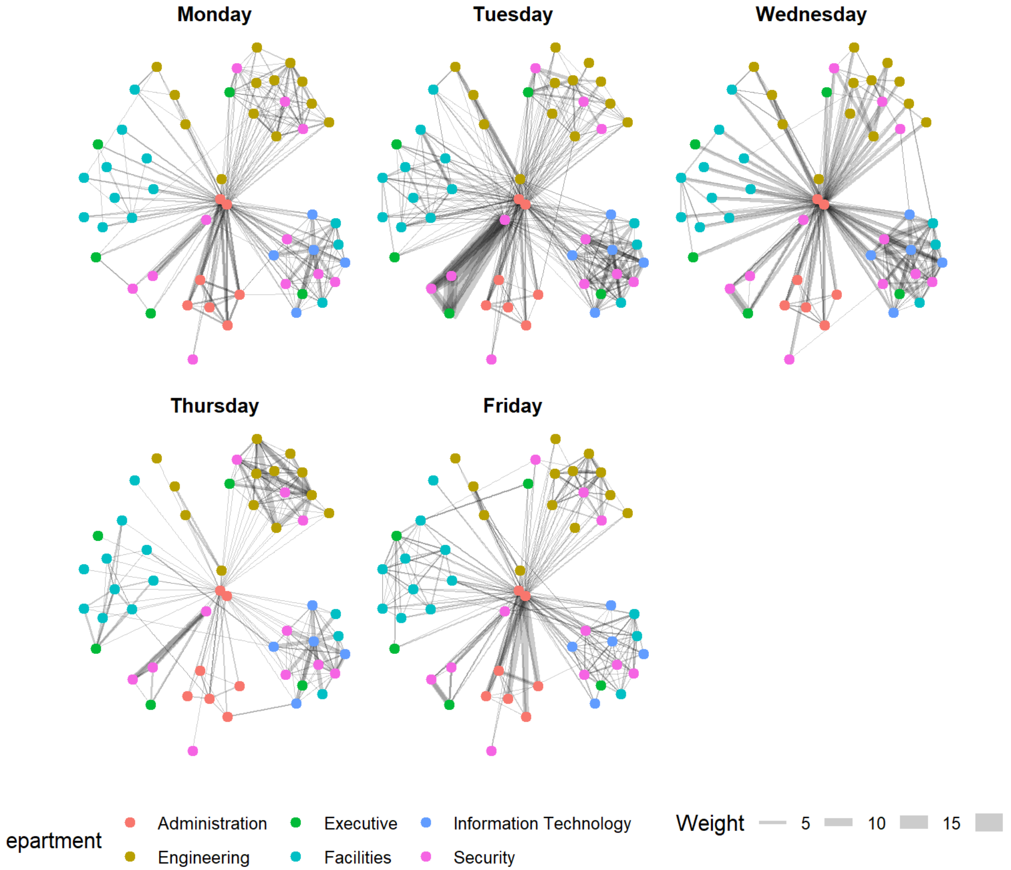
```
set_graph_style()

g <- ggraph(GAStech_graph, 
            layout = "nicely") + 
  geom_edge_link(aes(width=Weight), 
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = Department), 
                  size = 2)
g + facet_edges(~Weekday)
```



Working with *facet_edges()*

The code chunk below uses *theme()* to change the position of the legend.

```
set_graph_style()

g <- ggraph(GAStech_graph,
            layout = "nicely") +
  geom_edge_link(aes(width=Weight),
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = Department),
                  size = 2) +
  theme(legend.position = 'bottom')

g + facet_edges(~Weekday)
```

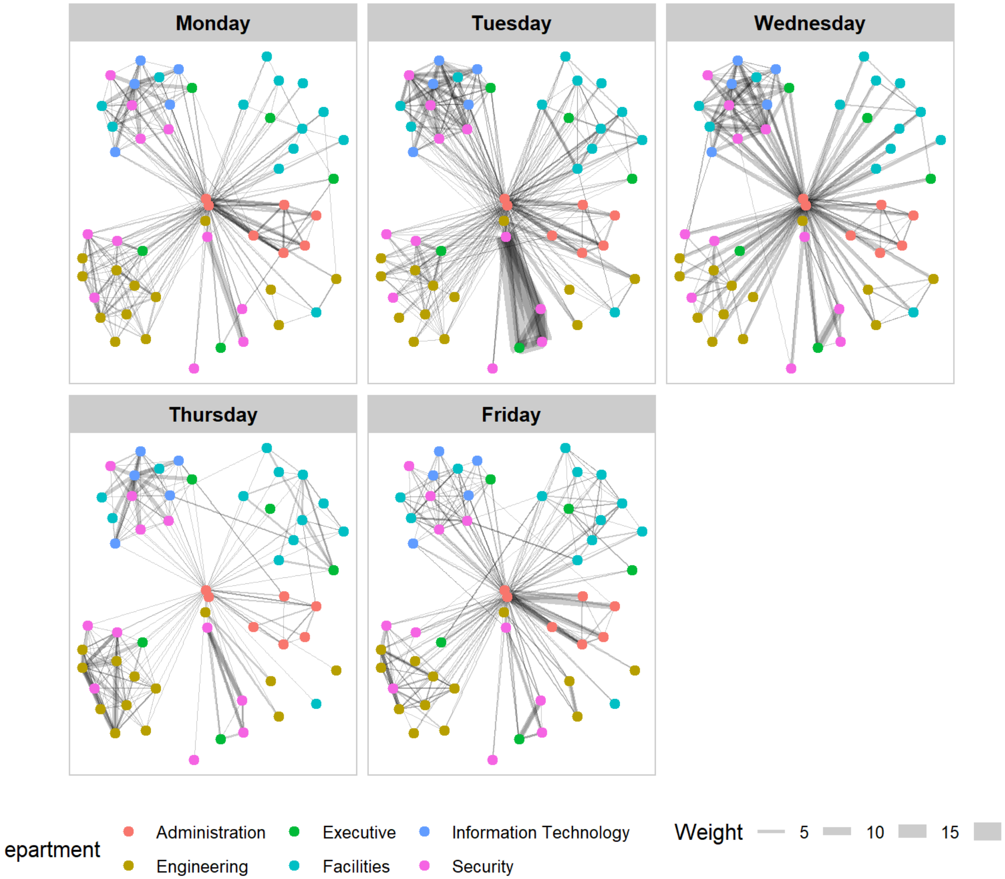


A framed facet graph

The code chunk below adds frame to each graph.

```
set_graph_style()

g <- ggraph(GAStech_graph,
            layout = "nicely") +
  geom_edge_link(aes(width=Weight),
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = Department),
                  size = 2)

g + facet_edges(~Weekday) +
  th_foreground(foreground = "grey80",
                border = TRUE) +
  theme(legend.position = 'bottom')
```

The code chunk below adds frame to each graph.

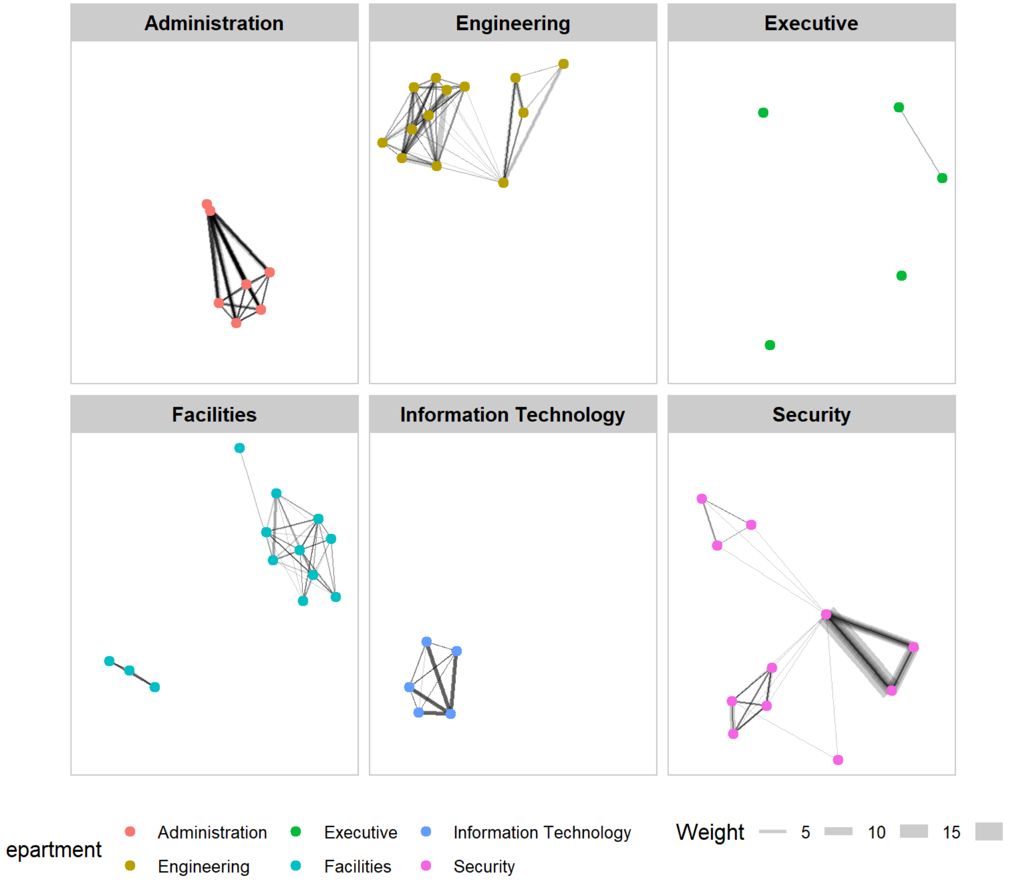


Working with *facet_nodes()*

In the code chunkc below, *facet_nodes()* is used. Before getting started, it is advisable for you to read it's reference guide at least once.

```
set_graph_style()

g <- ggraph(GAStech_graph,
            layout = "nicely") +
  geom_edge_link(aes(width=Weight),
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = Department),
                  size = 2)

g + facet_nodes(~Department)+
  th_foreground(foreground = "grey80",
                border = TRUE) +
  theme(legend.position = 'bottom')
```

In the code chunk below, *facet_nodes()* is used.



Network Metrics Analysis

Computing centrality indices

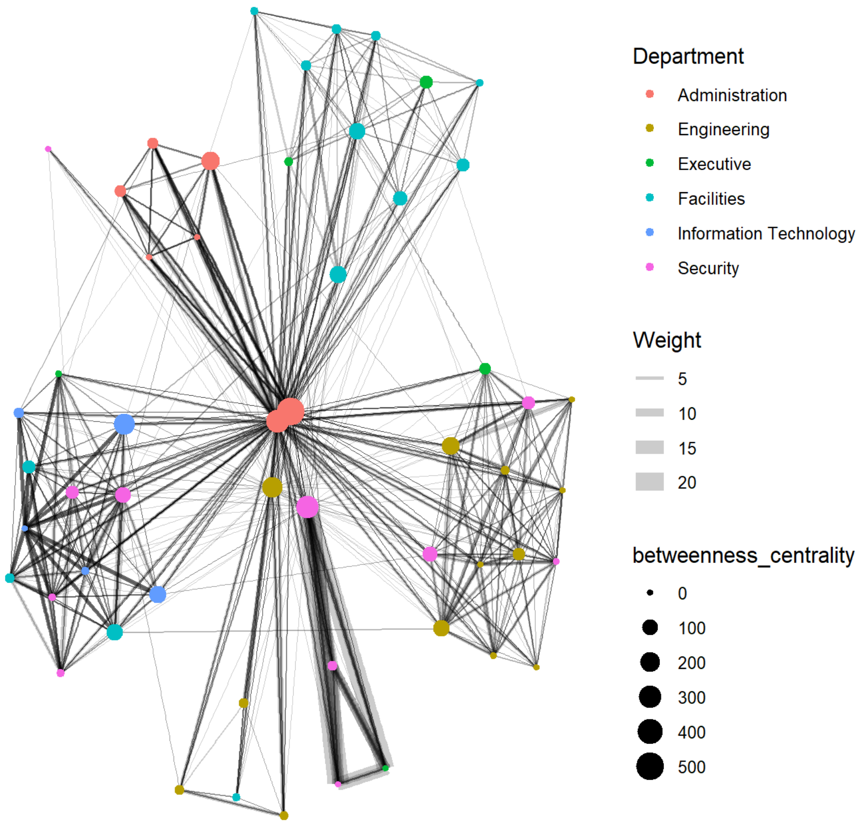
Centrality measures are a collection of statistical indices use to describe the relative important of the actors are to a network. There are four well-known centrality measures, namely: degree, betweenness, closeness and eigenvector. It is beyond the scope of this hands-on exercise to cover the principles and mathematics of these measure here. Students are encouraged to refer to *Chapter 7: Actor Prominence* of **A User's Guide to Network Analysis in R** to gain better understanding of theses network measures.

```
g <- GAStech_graph %>%
  mutate(betweenness_centrality = centrality_betweenness()) %>%
  ggraph(layout = "fr") +
  geom_edge_link(aes(width=Weight),
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = Department,
            size=betweenness_centrality))
g + theme_graph()
```

Things to learn from the code chunk above:

- *mutate()* of **dplyr** is used to perform the computation.
- the algorithm used, on the other hand, is the *centrality_betweenness()* of **tidygraph**.

Network graph with network measures

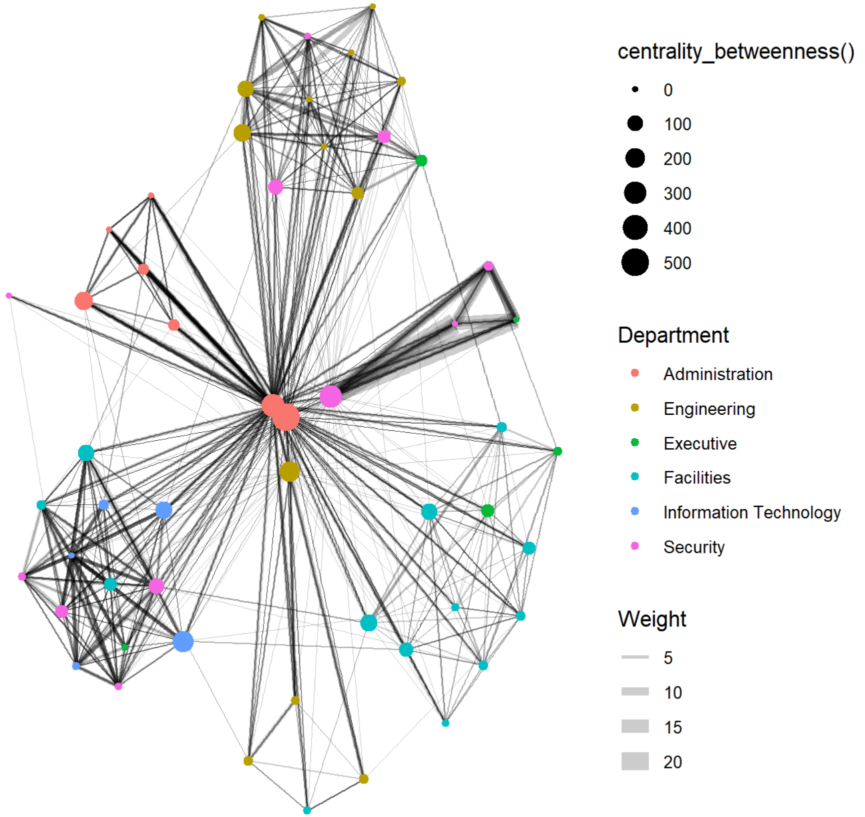


Visualising network metrics

It is important to note that from **ggraph v2.0** onwards tidygraph algorithms such as centrality measures can be accessed directly in ggraph calls. This means that it is no longer necessary to precompute and store derived node and edge centrality measures on the graph in order to use them in a plot.

```
g <- GAStech_graph %>%
  ggraph(layout = "fr") +
  geom_edge_link(aes(width=Weight),
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = Department,
                      size = centrality_betweenness()))
g + theme_graph()
```

Visualising network metrics



Visualising Community

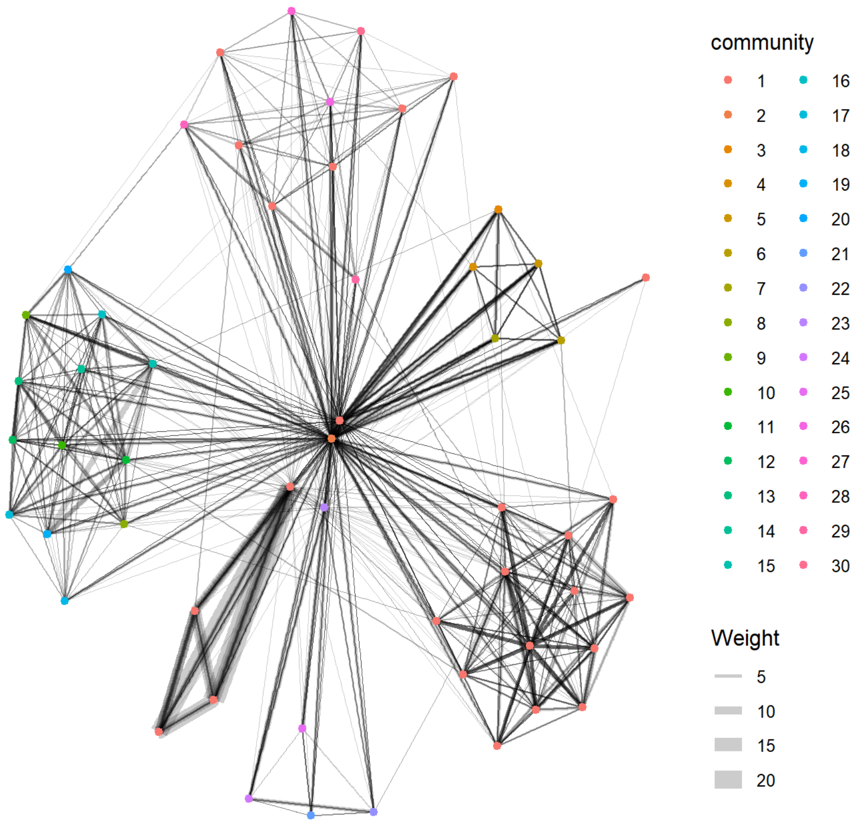
tidygraph package inherits many of the community detection algorithms imbedded into igraph and makes them available to us, including *Edge-betweenness (group_edge_betweenness)*, *Leading eigenvector (group_leading_eigen)*, *Fast-greedy (group_fast_greedy)*, *Louvain (group_louvain)*, *Walktrap (group_walktrap)*, *Label propagation (group_label_prop)*, *InfoMAP (group_infomap)*, *Spinglass (group_spinglass)*, and *Optimal (group_optimal)*. Some community algorithms are designed to take into account direction or weight, while others ignore it. Use this link to find out more about community detection functions provided by tidygraph,

In the code chunk below *group_edge_betweenness()* is used.

```
g <- GAStech_graph %>%
  mutate(community = as.factor(group_edge_betweenness(weights = Weight, directed = TRUE))) %>%
  ggraph(layout = "fr") +
  geom_edge_link(aes(width=Weight),
                 alpha=0.2) +
  scale_edge_width(range = c(0.1, 5)) +
  geom_node_point(aes(colour = community))

g + theme_graph()
```

Visualising Community

The output network graph with community coloured



Building Interactive Network Graph with visNetwork

- visNetwork() is a R package for network visualization, using vis.js javascript library.

- *visNetwork()* function uses a nodes list and edges list to create an interactive graph.

    - The nodes list must include an "id" column, and the edge list must have "from" and "to" columns.
    - The function also plots the labels for the nodes, using the names of the actors from the "label" column in the node list.

- The resulting graph is fun to play around with.

    - You can move the nodes and the graph will use an algorithm to keep the nodes properly spaced.
    - You can also zoom in and out on the plot and move it around to re-center it.

Data preparation

Before we can plot the interactive network graph, we need to prepare the data model by using the code chunk below.

```
GAStech_edges_aggregated <- GAStech_edges %>%
  left_join(GAStech_nodes, by = c("sourceLabel" = "label")) %>%
  rename(from = id) %>%
  left_join(GAStech_nodes, by = c("targetLabel" = "label")) %>%
  rename(to = id) %>%
  filter(MainSubject == "Work related") %>%
  group_by(from, to) %>%
    summarise(weight = n()) %>%
  filter(from!=to) %>%
  filter(weight > 1) %>%
  ungroup()
```

Plotting the first interactive network graph

The code chunk below will be used to plot an interactive network graph by using the data prepared.

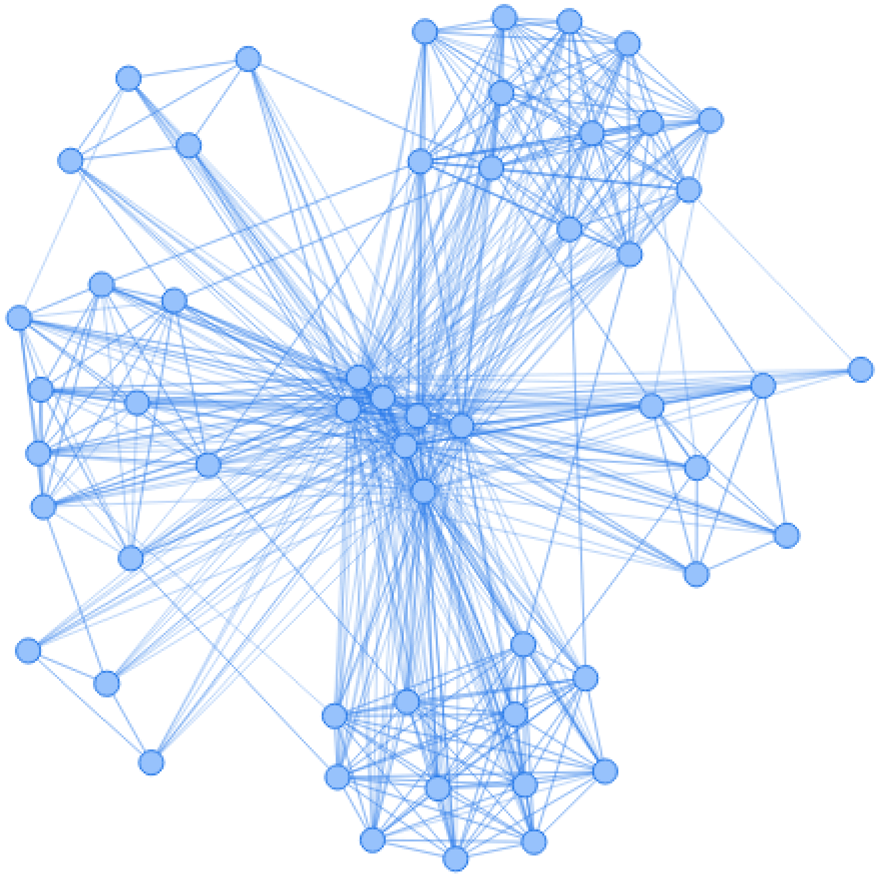
```
visNetwork(GAStech_nodes,
           GAStech_edges_aggregated)
```

Working with layout

In the code chunk below, Fruchterman and Reingold layout is used.

```
visNetwork(GAStech_nodes,
           GAStech_edges_aggregated) %>%
  visIgraphLayout(layout = "layout_with_fr")
```

Visit Igraph to find out more about *visIgraphLayout*'s argument.



Working with visual attributes - Nodes

visNetwork() looks for a field called "group" in the nodes object and colour the nodes according to the values of the group field.

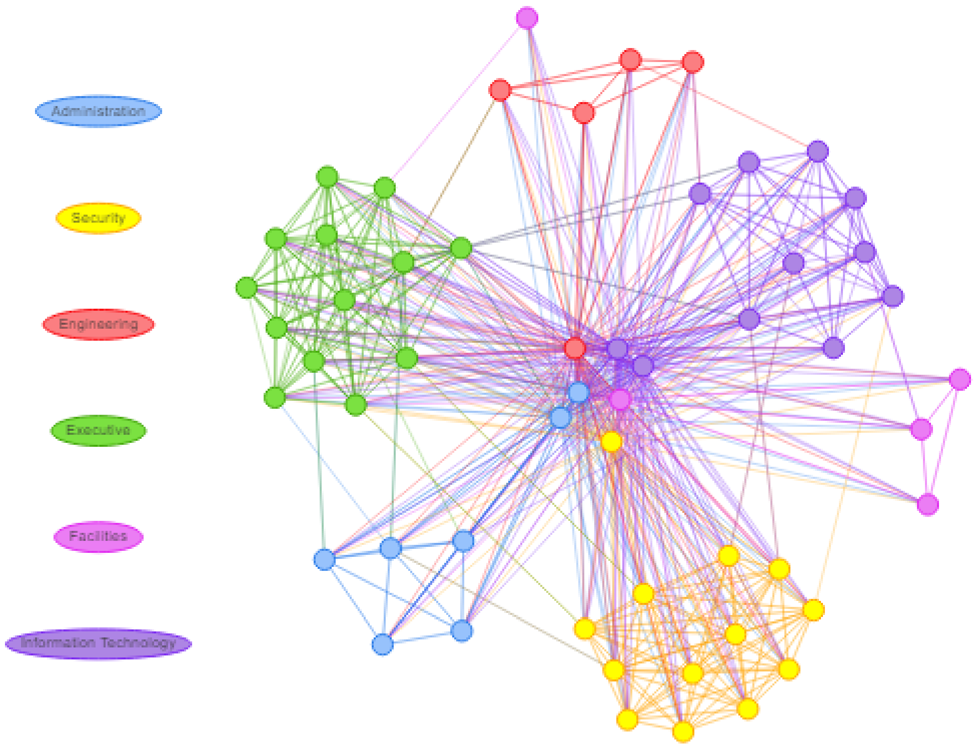
The code chunk below rename Department field to group.

```
GAStech_nodes <- GAStech_nodes %>%
  rename(group = Department)
```

Working with visual attributes - Nodes

When we rerun the code chunk below, visNetwork shades the nodes by assigning unique colour to each category in the *group* field.

```
visNetwork(GAStech_nodes,
           GAStech_edges_aggregated) %>%
  visIgraphLayout(layout = "layout_with_fr") %>
  visLegend() %>%
  visLayout(randomSeed = 123)
```



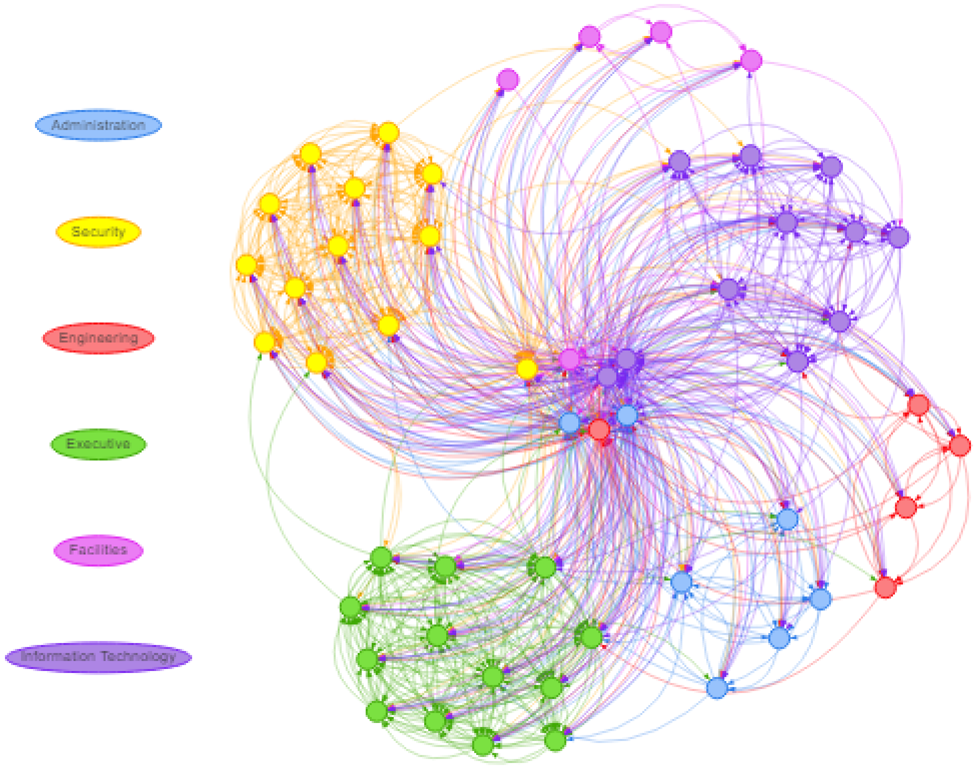
Working with visual attributes - Edges

In the code run below *visEdges()* is used to symbolise the edges.

- The argument *arrows* is used to define where to place the arrow.
- The *smooth* argument is used to plot the edges using a smooth curve.

```
visNetwork(GAStech_nodes,
           GAStech_edges_aggregated) %>%
  visIgraphLayout(layout = "layout_with_fr") %>
  visEdges(arrows = "to",
           smooth = list(enabled = TRUE,
                         type = "curvedCW")) %>
  visLegend() %>%
  visLayout(randomSeed = 123)
```

Visit Option to find out more about visEdges's argument.

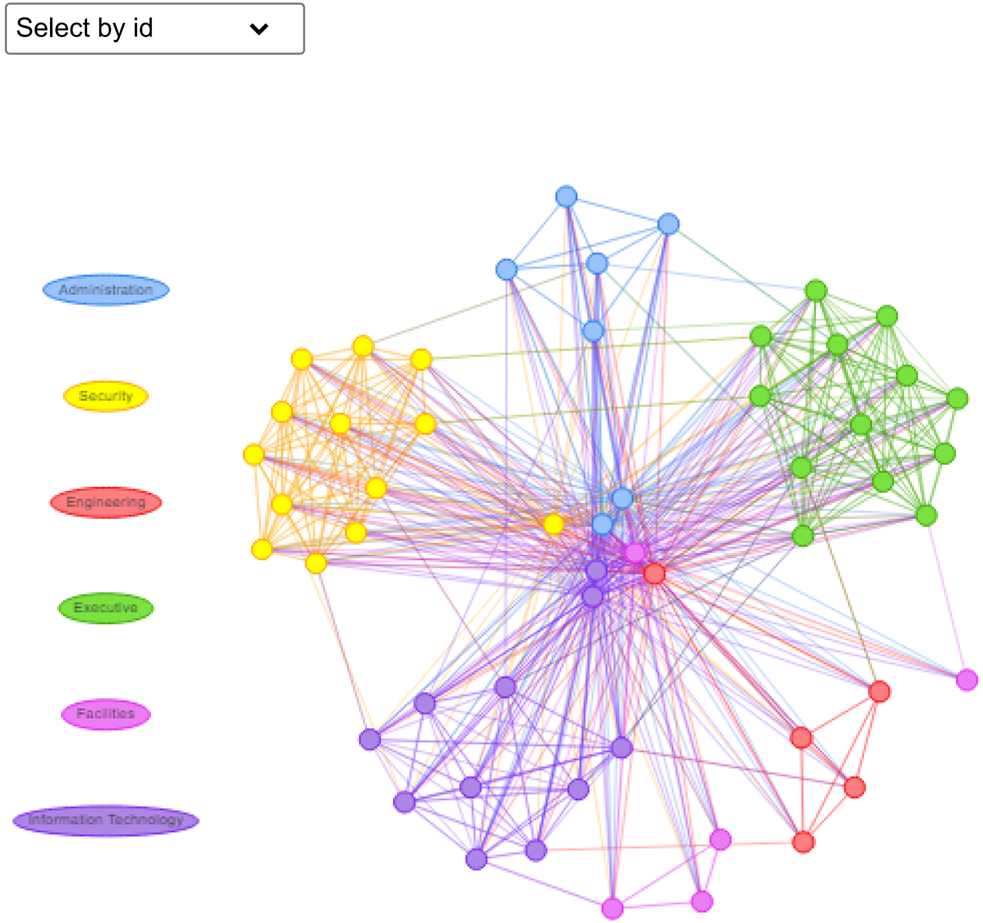


Interactivity

In the code chunk below, *visOptions()* is used to incorporate interactivity features in the data visualisation.

- The argument *highlightNearest* highlights nearest when clicking a node.
- The argument *nodesIdSelection* adds an id node selection creating an HTML select element.

```
visNetwork(GAStech_nodes,
           GAStech_edges_aggregated) %>%
  visIgraphLayout(layout = "layout_with_fr") %>
  visOptions(highlightNearest = TRUE,
             nodesIdSelection = TRUE) %>%
  visLegend() %>%
  visLayout(randomSeed = 123)
```



Visit Option to find out more about visOption's argument.

Bipartitle Network

In this section, we will learn how to transform a transaction data set into a network graph by using tidygraph. The data we are going to use is the *cc_data.csv* data from VAST Challenge 2021.

First let us parse the data into R Studio by using *read_csv()*.

```
cc_data <- read_csv("data/cc_data.csv")
```

Next, we should take a quick look at the imported tibble data.frame.

```
glimpse(cc_data)
```

```
## Rows: 1,490
## Columns: 4
## $ timestamp  <chr> "01/06/2014 07:28", "01/06/2014 07:34", "01/06/2014 07:35",~
## $ location   <chr> "Brew've Been Served", "Hallowed Grounds", "Brew've Been Se~
## $ price      <dbl> 11.34, 52.22, 8.33, 16.72, 4.24, 4.17, 28.73, 9.60, 16.90, ~
## $ last4ccnum <dbl> 4795, 7108, 6816, 9617, 7384, 5368, 7253, 4948, 9683, 8129,~
```

The code chunk used to parse the csv file into R Studio.

```
cc_data <- read_csv("data/cc_data.csv")
```

The code chunk used to check for data.table structure.

```
glimpse(cc_data)
```

Notice that the *timestamp* field is in character format and not in date-time format.

Transforming data

Write a code chunk to perform the following tasks:

- transforming values in *timestamp* field into correct date-time format.
- transforming values in *last4ccnum* field to character data type.
- deriving a day-of-month field from timestamp.
- deriving a hour-of-day field from timestamp. The code chunk:

```
cc_data$timestamp <-  date_time_parse(cc_data$timestamp,
                                      zone = "",
                                      format = "%m/%d/%Y %H:%M")
cc_data$last4ccnum <- as.character(cc_data$last4ccnum)
cc_data$Day  = get_day(cc_data$timestamp)
cc_data$Hour = get_hour(cc_data$timestamp)
```

Creating Nodes list

In this section, we will perform the following task:

- to get the distinct card users from the “last4ccnum” column.
- to rename the column with the "last4ccnum" as “label” to adopt the vocabulary used by network analysis packages.
- to repeat the same steps for "location" column.
- to join both the sources and destinations data frames

```
sources <- cc_data %>%
  distinct(last4ccnum) %>%
  rename(label = last4ccnum)

destinations <- cc_data %>%
  distinct(location) %>%
  rename(label = location)
```

To create a single dataframe with a column with the unique users and locations, *full_join()* is used. This is because we want to include all unique places from both the sources and the destinations of ccdata.

```
cc_nodes <- full_join(sources,
                      destinations,
                      by = "label")
```

Next, *rowid_to_column()* is used to add an “id” column to the nodes data frame.

```
cc_nodes <- cc_nodes %>%
  rowid_to_column("id")
```

Creating Edges list

Creating an edge list is similar to the above, but it is complicated by the need to deal with two ID columns instead of one. We also want to create a weight column that will note the amount of letters sent between each set of nodes. The code chunk below will be used to accomplish the task.

```
edges <- cc_data %>%
  group_by(last4ccnum, location, Day, Hour) %>%
  summarise(weight = n()) %>%
  ungroup()
edges
```

```
## # A tibble: 1,490 x 5
##    last4ccnum location                Day  Hour weight
##    <chr>      <chr>                 <int> <int>  <int>
##  1 1286       Abila Zacharo             6    13      1
##  2 1286       Abila Zacharo             9    13      1
##  3 1286       Abila Zacharo            13    13      1
##  4 1286       Abila Zacharo            16    13      1
##  5 1286       Ahaggo Museum            18    14      1
##  6 1286       Brew've Been Served       6     8      1
##  7 1286       Brew've Been Served       7     7      1
##  8 1286       Brew've Been Served       8     8      1
##  9 1286       Brew've Been Served       9     8      1
## 10 1286       Brew've Been Served      10     8      1
## # ... with 1,480 more rows
```

Tidying Edges list

Like the node list, cc_edges now has the basic form that we want, but we again have the problem that the "source" and "destination" columns contain labels rather than IDs. The code chunk below is used to address this issue.

```
cc_edges <- edges %>%
  left_join(cc_nodes,
            by = c("last4ccnum" = "label")) %>%
  rename(from = id)
```

```
cc_edges <- cc_edges %>%
  left_join(cc_nodes,
            by = c("location" = "label")) %>%
  rename(to = id)
```

Now that edges has "from" and "to" columns with node IDs, we need to reorder the columns to bring "from" and "to" to the left of the data frame. This task will be accomplished by using *select()* of **dplyr** as shown below.

```
cc_edges <- select(cc_edges, from, to,
                   Day, Hour, weight)
cc_edges
```

```
## # A tibble: 1,490 x 5
##     from    to   Day  Hour weight
##    <int> <int> <int> <int>  <int>
##  1    27    71     6    13      1
##  2    27    71     9    13      1
##  3    27    71    13    13      1
##  4    27    71    16    13      1
##  5    27    87    18    14      1
##  6    27    56     6     8      1
##  7    27    56     7     7      1
##  8    27    56     8     8      1
##  9    27    56     9     8      1
## 10    27    56    10     8      1
```

Building tidygraph network graph data object

In the code chunk below, *tbl_graph()* of **tidygraph** package is used to build a network object by using a node list and an edge list.

```
cc_graph <- tbl_graph(nodes = cc_nodes,
                      edges = cc_edges,
                      directed = FALSE)
```

```
cc_graph
```

```
## # A tbl_graph: 89 nodes and 1490 edges
## #
## # An undirected multigraph with 1 component
## #
## # Node Data: 89 x 2 (active)
##      id label
##   <int> <chr>
## 1     1 4795
## 2     2 7108
## 3     3 6816
## 4     4 9617
## 5     5 7384
## 6     6 5368
## # ... with 83 more rows
## #
## # Edge Data: 1,490 x 5
##    from    to   Day  Hour weight
##   <int> <int> <int> <int>  <int>
## 1    27    71     6    13      1
## 2    27    71     9    13      1
## 3    27    71    13    13      1
## # ... with 1,487 more rows
```

Visualising the network

Figure below shown a network graph created by using cc_graph network object.

The code chunk used to create the network graph.

```
ggraph(cc_graph,
       layout = "lgl") +
  geom_edge_link(aes()) +
  geom_node_point(aes()) +
  theme_graph()
```