Network Analysis with R —> work in progres

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set proper pdf encoding

remove all lists

```
ls()
```

```
## character(0)
```

```
rm(list = ls())
```

install/ load needed packages

install.packages("igraph") library(igraph)

read data - manual selection

```
SMEnetw <- read.csv(file.choose(), header = T, sep = ";", fileEncoding="UTF-8-BOM")
str(SMEnetw)
```

```
## 'data.frame':    264 obs. of  3 variables:
##  $ SMEstart        : Factor w/ 16 levels "A","B","C","D",..: 1 13 4 6 5 12 7 15 2 10 ...
##  $ SMEend          : Factor w/ 18 levels "A","B","D","E",..: 18 2 11 17 7 18 2 11 17 7 ...
##  $ ContactFrequency: int  4 2 5 7 8 5 3 5 7 8 ...
```

```
#fix(SMEnetw)
SME_analysis <- data.frame(SMEnetw$SMEstart, SMEnetw$SMEend, SMEnetw$ContactFrequency)
library(igraph)
```

```
## Warning: package 'igraph' was built under R version 3.6.3
```

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

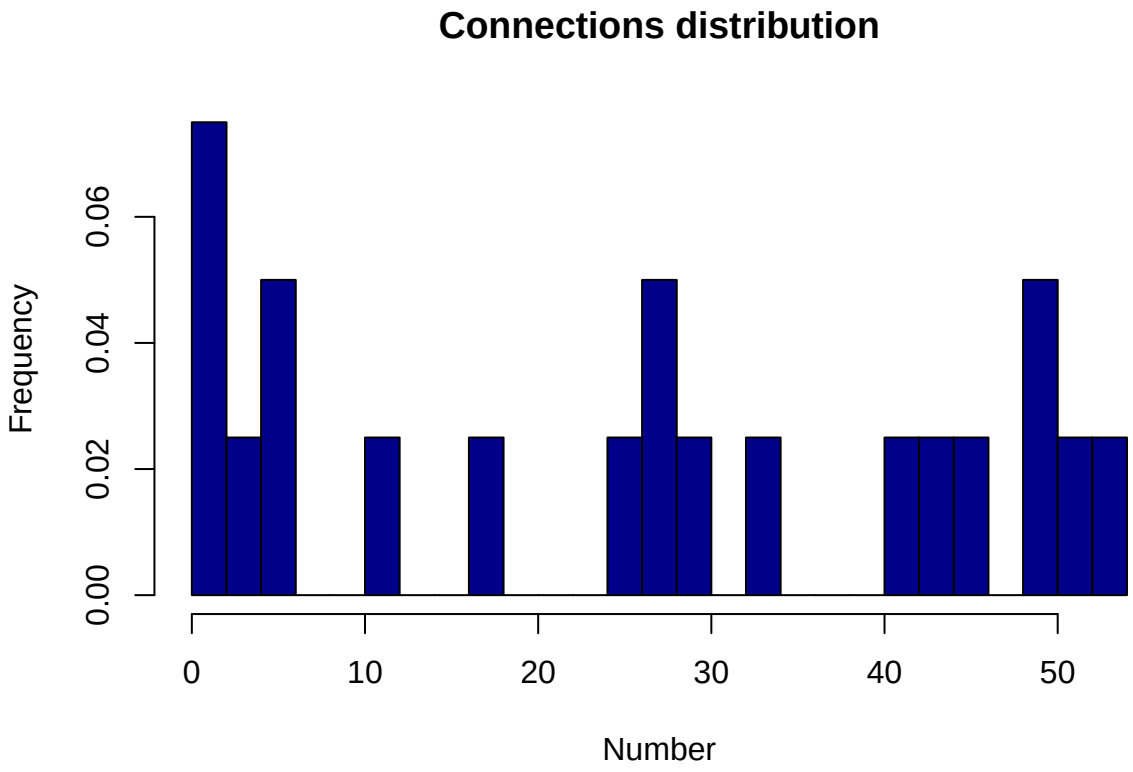
```
## The following objects are masked from 'package:stats':
##
##     decompose, spectrum
```

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

```
SMEnetwork <- graph.data.frame(SME_analysis, directed = TRUE)
```

see contact frequency

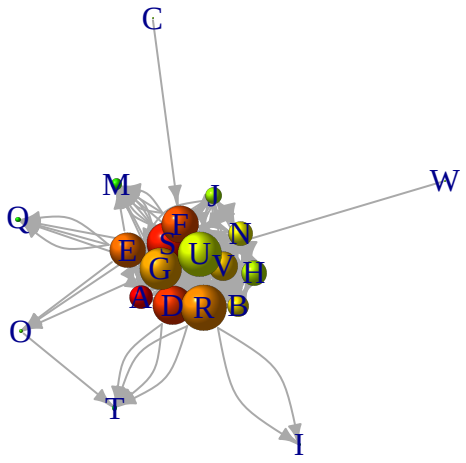
```
V(SMEnetwork)$ContactFrequency <- degree(SMEnetwork)
hist(V(SMEnetwork)$ContactFrequency, breaks = 25, prob = T,
     col = 'dark blue',
     main = 'Connections distribution',
     ylab = 'Frequency',
     xlab = 'Number')
```



basic plot

```
plot(SMEnetwork,
     vertex.color = rainbow(53),
     vertex.shape="sphere",
```

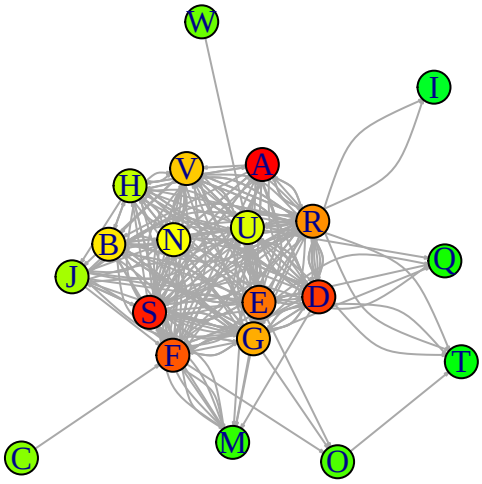
```
     vertex.size = V(SMEnetwork)$ContactFrequency*0.4,
     edge.arrow.size = 0.5,
     layout=layout.fruchterman.reingold)
```




```
#lot(net2, vertex.shape="none", vertex.label=nodes2$media,

 #    vertex.label.color=V(net2)$color, vertex.label.font=2.5,

  #   vertex.label.cex=.6, edge.color="gray70",  edge.width=2)
```

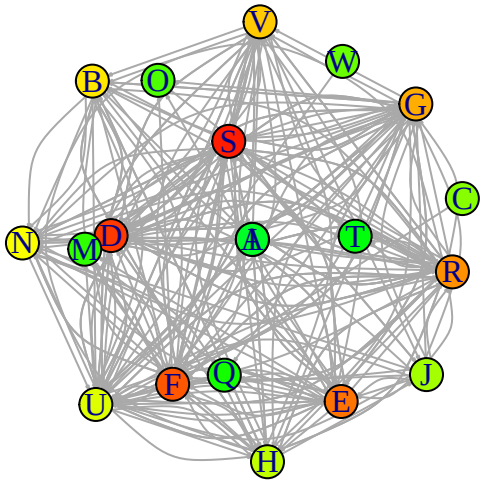
outliers detection (probe)

```
plot(SMEnetwork,
     vertex.color = rainbow(53),
     # vertex.size = V(SMEnetwork)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.kamada.kawai)
```



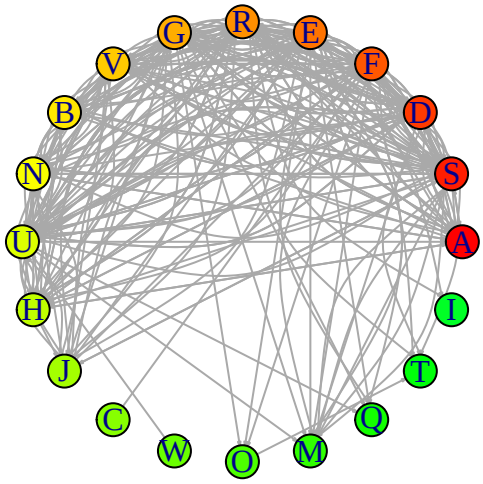
spherical view

```
plot(SMEnetwork,
     vertex.color = rainbow(53),
     # vertex.size = V(SMEnetwork)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.sphere)
```



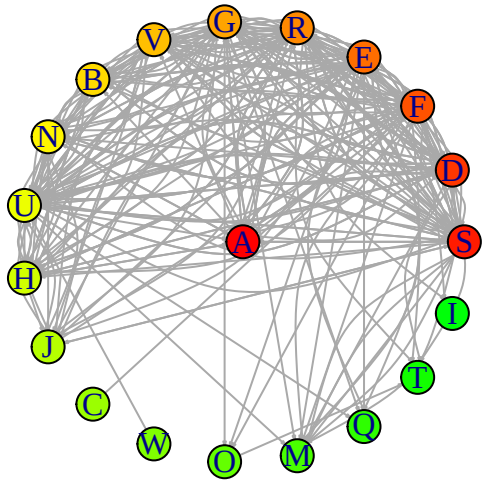
circle

```
plot(SMEnetwork,
     vertex.color = rainbow(53),
     # vertex.size = V(SMEnetwork)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.circle)
```



#star

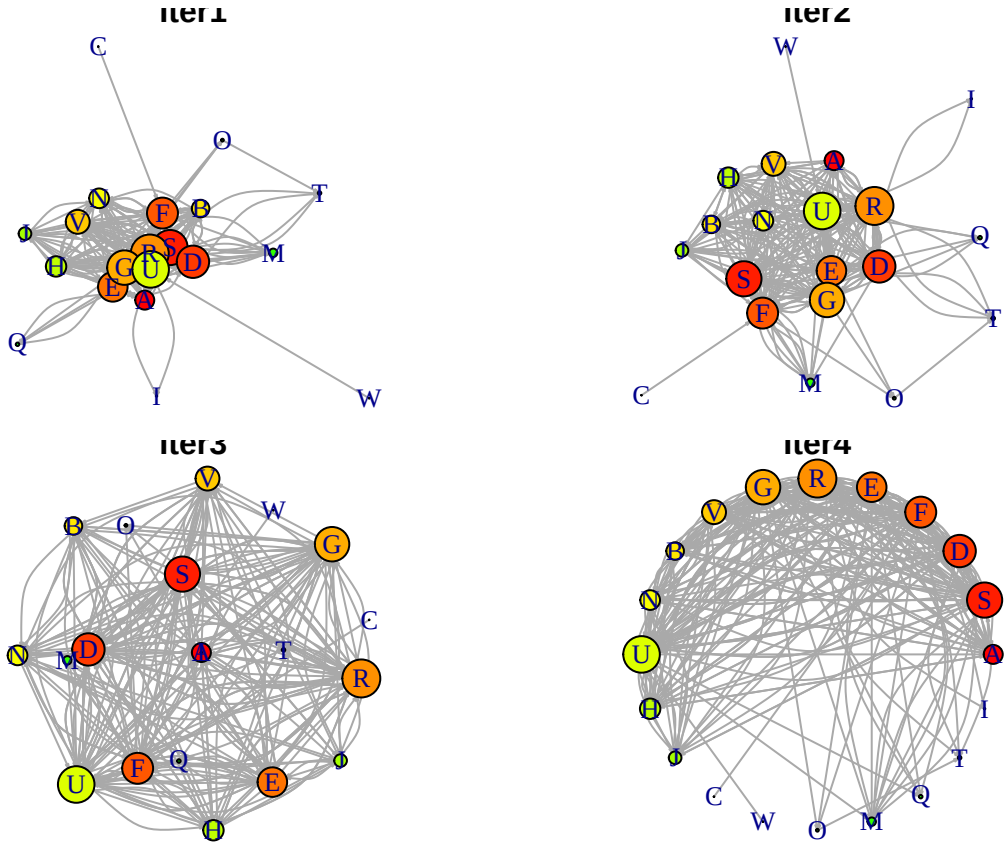
```
plot(SMEnetwork,
     vertex.color = rainbow(56),
     # vertex.size = V(SMEnetwork)$degree*0.4,
     edge.arrow.size = 0.1,
     layout=layout.star)
```



connect key plots

```
par(mfrow=c(2,2))
par(mar=c(0.25,0.25,0.1,0.1))
plot(SMEnetwork,
     vertex.color = rainbow(53),
     vertex.size = V(SMEnetwork)$ContactFrequency*0.4,
     edge.arrow.size = 0.1,
     main="Iter1",
     cex.main=0.5,
     font.main=1,
     layout=layout.graphopt)
plot(SMEnetwork,
     vertex.color = rainbow(53),
     vertex.size = V(SMEnetwork)$ContactFrequency*0.4,
     edge.arrow.size = 0.1,
     main="Iter2",
     cex.main=0.5,
     font.main=1,
     layout=layout.kamada.kawai)
plot(SMEnetwork,
     vertex.color = rainbow(53),
     vertex.size = V(SMEnetwork)$ContactFrequency*0.4,
```

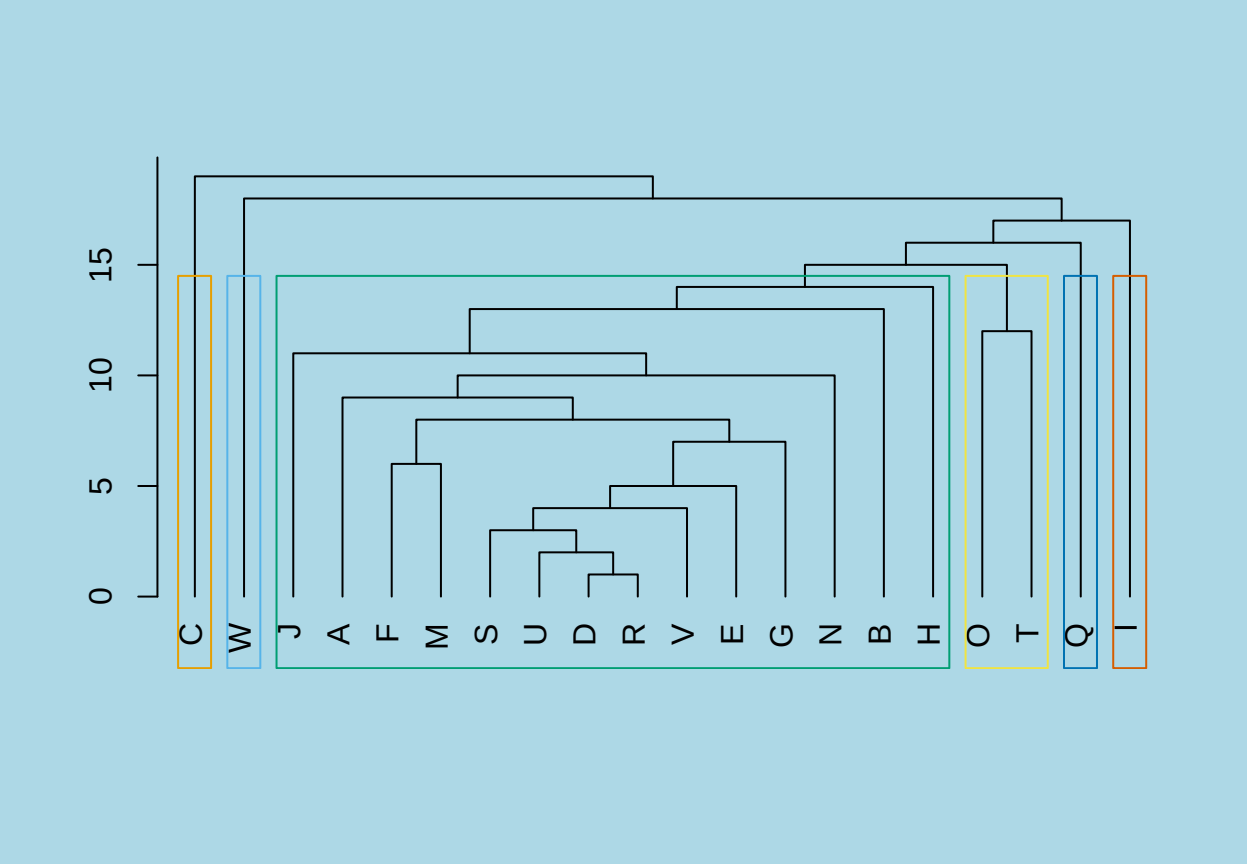
```
     edge.arrow.size = 0.1,
     main="Iter3",
     cex.main=0.5,
     font.main=1,
     layout=layout.sphere)
plot(SMEnetwork,
     vertex.color = rainbow(53),
     vertex.size = V(SMEnetwork)$ContactFrequency*0.4,
     edge.arrow.size = 0.1,
     main="Iter4",
     cex.main=0.5,
     font.main=1,
     layout=layout.circle)
```



Community detection, outlines grahically community areas

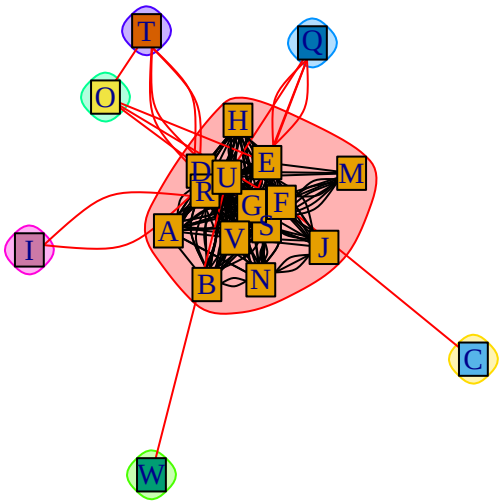
- by dendrogram

```
par(bg="lightblue") # set background

ceb <- cluster_edge_betweenness(SMEnetwork)
dendPlot(ceb, mode="hclust")     # plot(hcd, type = "triangle", ylab = "Height")
```



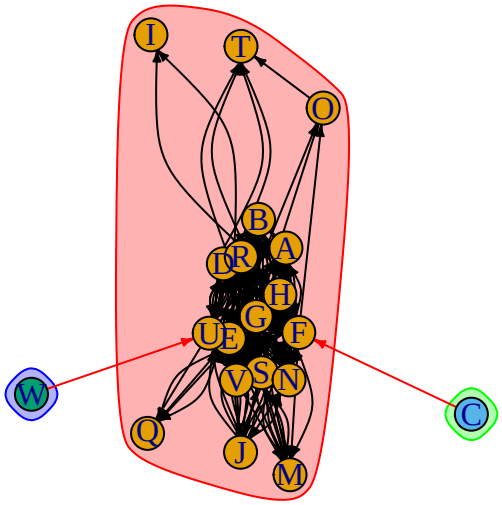
* by network

```
SMEnetwork1 <- igraph::as_data_frame(SMEnetwork)
SMEnetwork2 <- graph.data.frame(SMEnetwork1, directed = F)
cnet <- cluster_edge_betweenness(SMEnetwork2)

plot(cnet,
     SMEnetwork,
     vertex.size = 13,
     vertex.label.cex = 0.9,
     edge.arrow.size=0.1,
     vertex.shape="rectangle",
     vertex.label.dist=0.0,
     edge.arrow.mode=0,
     vertex.size = V(SMEnetwork2)$ContactFrequency*0.2,
     layout=layout.graphopt)
```

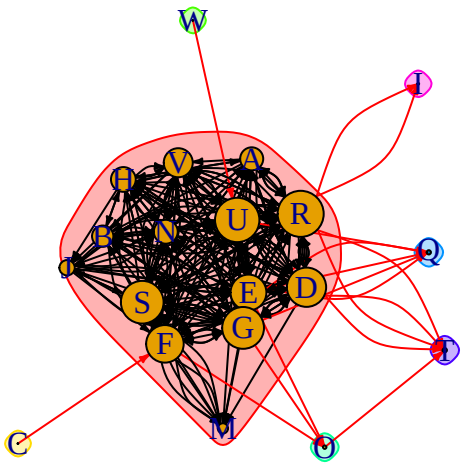


outlining paths

```
clp <- cluster_label_prop(SMEnetwork)

plot(clp, SMEnetwork,  edge.arrow.size = 0.3)
```



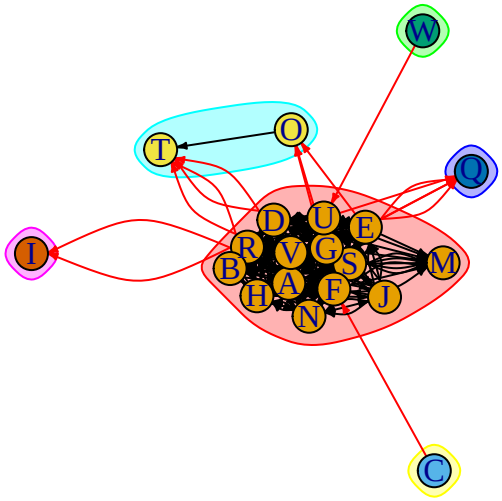

```
SMEnetwork1 <- igraph::as_data_frame(SMEnetwork)
SMEnetwork2 <- graph.data.frame(SMEnetwork1, directed = F)
cnet <- cluster_edge_betweenness(SMEnetwork2)



plot(cnet,
     SMEnetwork,
     vertex.color = rainbow(53),
     vertex.size = V(SMEnetwork)$ContactFrequency*0.4,
     edge.arrow.size = 0.25,
     main="Iter1",
     #cex.main=0.5,
     font.main=1,
     layout=layout.kamada.kawai)
```




```
# greedy method (hiearchical, fast method)
coords = layout_with_fr(SMEnetwork)

c3 = cluster_edge_betweenness(SMEnetwork  * 1.5)

# modularity measure
modularity(c3)
```

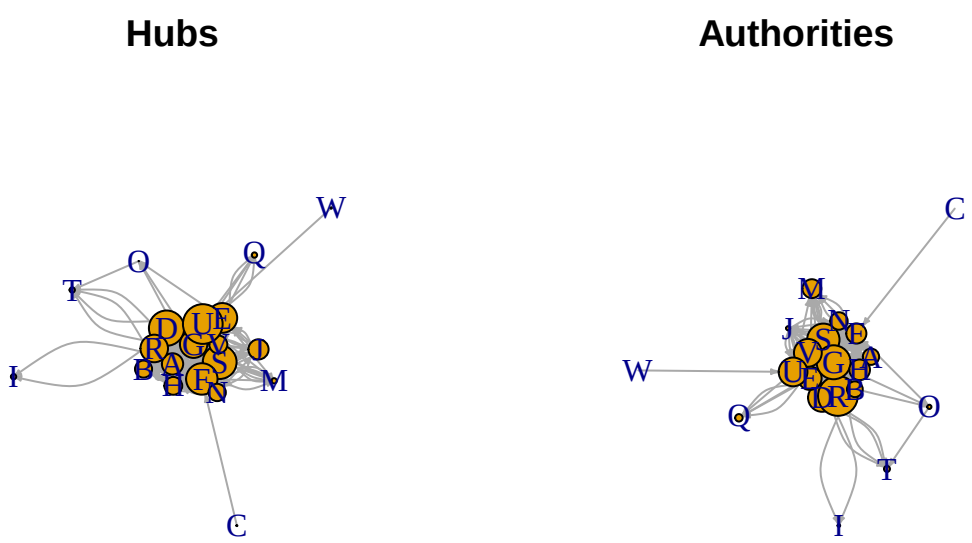
```
## [1] 0.006011823
```

```
# plot communities with shaded regions
plot_shaded_view <- plot(c3, SMEnetwork, edge.arrow.size = 0.25, layout=coords); plot_shaded_view
```




```
## NULL
```

```
hs <- hub_score(SMEnetwork, weights=NA)$vector

as <- authority_score(SMEnetwork, weights=NA)$vector



par(mfrow=c(1,2))

 plot(SMEnetwork, vertex.size=hs*25, main="Hubs", edge.arrow.size = 0.2)

 plot(SMEnetwork, vertex.size=as*25, main="Authorities", edge.arrow.size = 0.2)
```

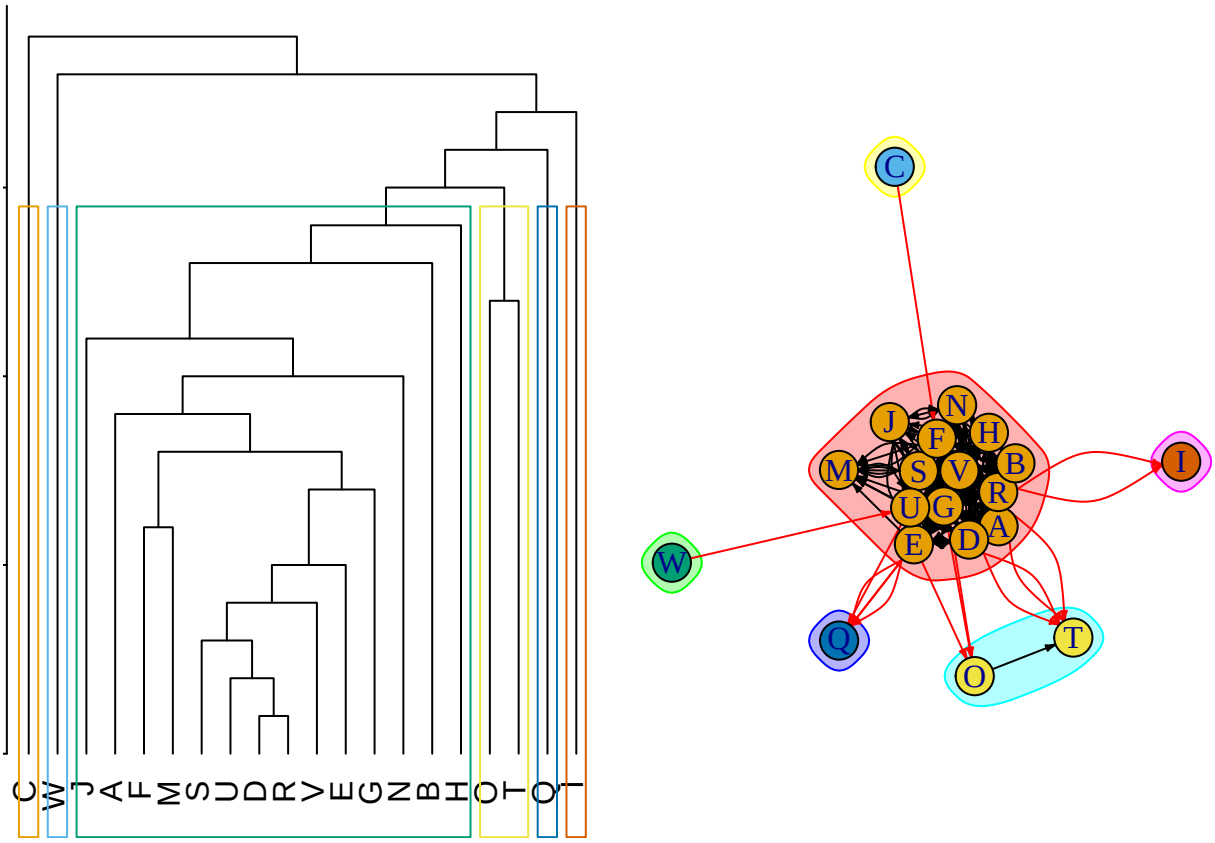



```
 #distances(SMEnetwork)
```

```
par(mfrow=c(1,2))
par(mar=c(0.1,0.1,0.75,0.75))

par(bg="white") # set background

ceb <- cluster_edge_betweenness(SMEnetwork)
dendPlot(ceb, mode="hclust")      # plot(hcd, type = "triangle", ylab = "Height")


# greedy method (hiearchical, fast method)
coords = layout_with_fr(SMEnetwork)

c3 = cluster_edge_betweenness(SMEnetwork  * 1.5)

# modularity measure
modularity(c3)
```

```
## [1] 0.006011823
```

```
# plot communities with shaded regions
plot_shaded_view <- plot(c3, SMEnetwork, edge.arrow.size = 0.25, layout=coords); plot_shaded_view
```

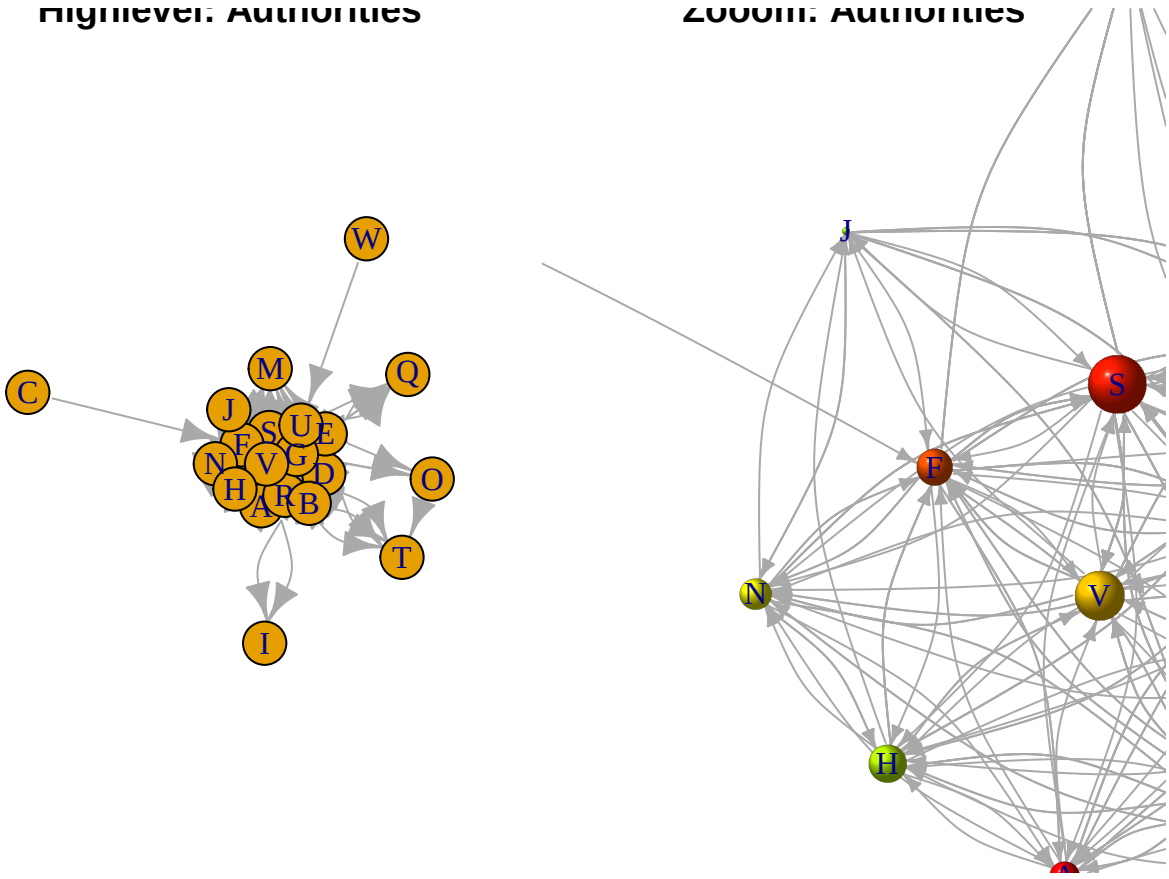



```
## NULL
```

comments: 6 outliers identified for dendrogram (outside green box) and network diagram (outside red area)

additional analysis - do some some zoom for details

```
par(mfrow=c(1,2), mar=c(0,0,0,0))

l <- layout_with_fr(SMEnetwork)
l <- norm_coords(l, ymin=-1, ymax=1, xmin=-1, xmax=1)


plot(SMEnetwork, main="Highlevel: Authorities", rescale=F, layout=l*0.7, cex.main=0.1)
plot(SMEnetwork, vertex.shape="sphere", vertex.color = rainbow(53), vertex.size=as*25, main="Zooom: Aut
```




```
# edge.color=c("gold", "blue",  "tomato", "grey", "red", "yellowgreen", "black"), rescale=F, layout=l*
```