What's in the network?

A stepwise overview of working with networked data in *R*

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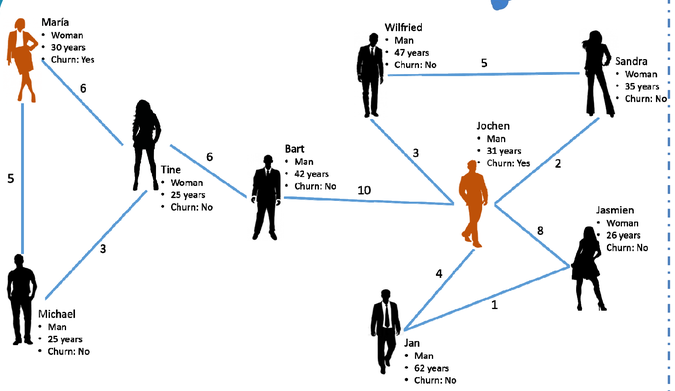
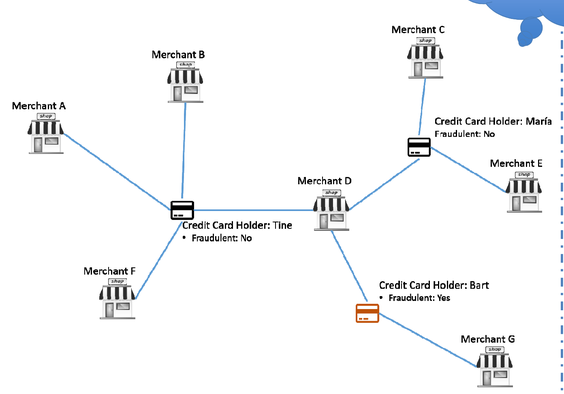
Business cases

Weighted unipartite network



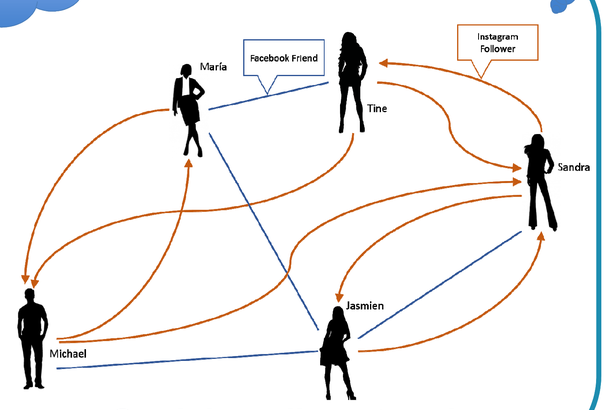
Call network

Bipartite network



Credit card fraud

Directed, multi-edges network



Social media network

- Networks are everywhere!
- They represent any type of connection between persons or objects
- Many applications in marketing, fraud, transportation, retail, biology, research citation, etc.
- Abundance of data leads to new challenges

Data structure

library("igraph")

```
#R code:
#graph g with nodes V(g) and edges E(g)
V(g)$name <- c("María", "Michael",etc.)
V(g)$churn <- c(1,0,0,0,1,etc.)
E(g)$weight <- c(5,6,3,etc.)
```

library("igraph")

```
#R code:
#transform bipartite into unipartite graph
gUnipartite <- bipartite_projection(gBipartite,
multiplicity = T, which = "false", remove.type= T)
```

Adjacency matrix

	María	Michael	Tine	Bart	Jochen	…
María	-	5	6	0	0	…
Michael	5	-	3	0	0	…
Tine	6	3	-	6	0	…
Bart	0	0	6	-	10	…
Jochen	0	0	0	10	-	…
…	…	…	…	…	…	…

library("igraph")

```
#R code:
g <- graph_from_adjacency_matrix(adjmatrix, mode =
"undirected", weighted = (1 | TRUE))
```

Edge list

Source	Target	Weight
María	Michael	5
Michael	Tine	3
Tine	Bart	6
Bart	Jochen	10
…	…	…

library("igraph")

```
#R code:
edges <- as.data.frame(get.edgelist(g))
# create edgelist from graph g
colnames(edges) <-
    c("Source", "Target", "Weight")
#Source = from; Target = to
```

Sparse matrix

	María	Michael	Tine	Bart	…
María	-	-	-	2	…
Michael	-	-	3	-	…
…	…	…	…	…	…

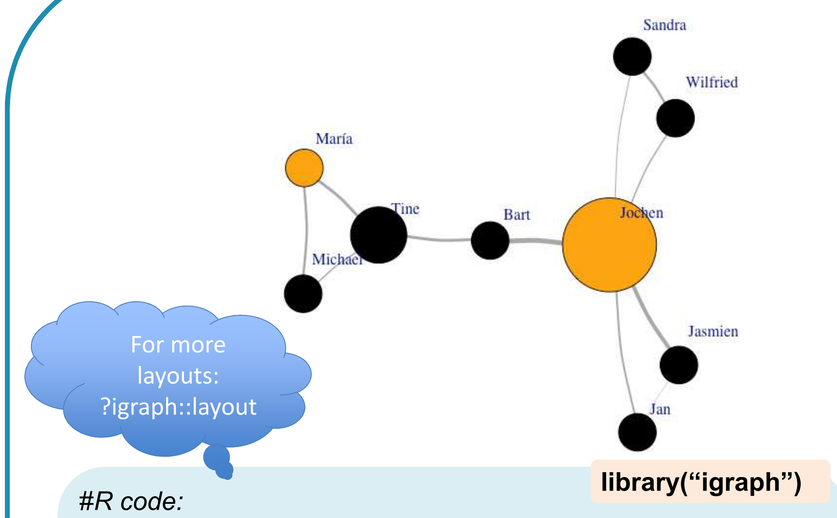
Row	Column	Value
María	Bart	2
Michael	Tine	3
…	…	…

Sparse matrices are useful when you have a lot of missing values ➔ take advantage of white space

library("Matrix")
library("slam")

```
#R code:
#create sparse adjacency matrix from edgelist using Matrix
sparseA <- sparseMatrix(dims=c(length(unique(edges$Source)),
                               length(unique(edges$Target))),
                        i = as.numeric(factor(edges$Source)),
                        j=as.numeric(factor(edges$Target)),
                        x = rep(1, length(as.numeric(edges$Source))) )
#alternatively use simple_triplet_matrix() from slam
```

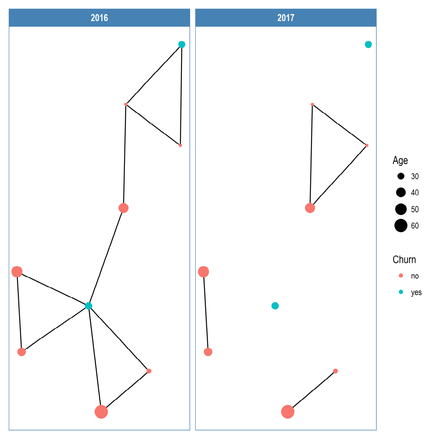
Network visualization



For more layouts: ?igraph::layout

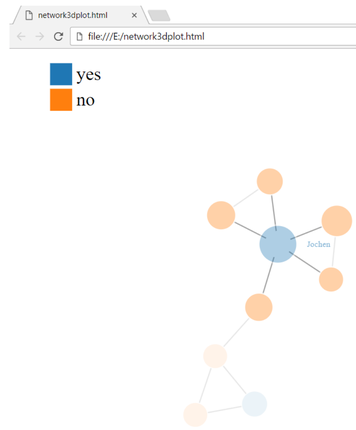
library("igraph")

```
#R code:
# adjust node size and edge width based on degree and weight
respectively; color churners in orange and the other in black
deg <- degree(g, mode="all");
V(g)$size <- deg*10; E(g)$width <- E(g)$weight/2;
V(g)$color <- ifelse(V(g)$churn == 1, "orange", "black");
plot(g, layout = layout.fruchterman.reingold, vertex.label.dist =
1.2, edge.arrow.size = 0.4, edge.curved = 0.1)
```



library("ggraph")

```
#R code:
ggraph(g, layout = "kk") +
  geom_edge_link(show.legend = FALSE) +
  geom_node_point(aes(size = age, color = churn)) +
  facet_edges(~year) +
  theme_graph(foreground = "steelblue", fg_text_colour =
  "white") + geom_node_text(aes(label = name), size = 2)
```



Embed graph visualizations in web-pages, markdown documents, and shiny apps

library("networkd3")

```
#R code:
#Works with an existing igraph object
d3g = igraph_to_networkD3(g,group = data)
# Create force directed network plot
forceNetwork(Links = d3g$links, Nodes = d3g$nodes,
        Source = "Source", Target = "Target", NodeID = "name",
        Group = "churn", zoom = TRUE, legend=TRUE,
        Nodesize = "age", colourScale =
        JS("d3.scaleOrdinal(d3.schemeCategory10);"),
        height= 400, width = 400) %>%
```

Analysis & Modeling

Featurization

library("igraph")

```
#R code:
#centralization measures:
V(g)$degree <- degree(g, mode = "all", loops = F, normalized = T);
V(g)$betweenness <- betweenness(g, directed = F); #requires a lot of computation power
#calculate PageRank for each node, can be personalized e.g. with churn scores
V(g)$page_rank <- page_rank(g, algo = "prpack", vids = V(g), directed = F, damping = 0.85,
    weights = NA, personalized = c(1,0,0,0,1,etc.) )$vector
```

Network learning

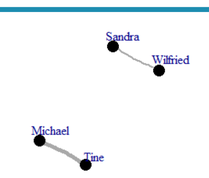
library("igraph")

```
#R code:
#edge prediction:
predict_edges(g, hrg = NULL, start = FALSE,
    num.samples = 10, num.bins = 25)
```

```
#Result
#Most likely edges
Jan – Sandra: 32%
Wilfried – Jasmien: 27%
```

Graph sampling

For more on sampling methods: ?igraph::sample_*



library("igraph")

```
#R code:
#random node sampling:
induced_subgraph(g, v=sample(1:length(V(g)),
    4, replace=FALSE))
```