Homework 10 - Alligators

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4/27/2021

In this analysis, we looked at the network of the cohort of people in BDS 516: Data Science and Quantitative Modeling, a graduate course taught by Alex Shpenev at the University of Pennsylvania. The data that we use in this analysis were obtained from the survey that students in BDS516 took.

```
# Load packages and an xls file
library(readxl)
library(network)
library(igraph)
library(tidyverse)
hw10<- read_excel("hw10.xlsx")
node<- read_excel("hw10.xlsx", skip = 1)
colnames(node) <- c("ID", 1:40, "trait")
```

The options for each name are the following:

1. I have texted in the last 7 days
2. I have met during my time in MBDS
3. Is my friend
4. I ask for advice/help
5. Asks me for help/advice

Options for the introversion question:

1. Introverted
2. Middle ground
3. Extraverted

##1. Prepare the data for the network analysis (create a separate edge and node list)

```
#create the edge list
edge_prep <- node %>% pivot_longer(col = -c(ID, trait), names_to = "in-tie", values_to = "value") %>%
  rename (`out-tie` = ID)

edgelist <- separate_rows(edge_prep, value, sep =",") %>%
  rename (`tie-type` = value)
as.character(edgelist$`tie-type`)
```

```
##    [1] NA   NA   NA   NA   NA   NA   NA   "4" NA   "4" "1" NA   NA   NA   NA   NA   NA   "1" "2" "3" "4" "5" NA   "
##   [28] "4" NA   NA   NA   NA   NA   NA   NA   "4" NA   NA   NA   NA   "1" "2" "3" "4" "5" NA   "1" "3" "4" "5" N
##   [55] NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   N
##   [82] NA   NA   NA   NA   NA   NA   NA   NA   "2" "1" NA   "1" NA   NA   NA   NA   "1" "2" "3" "4" "5" NA   "1" "
##  [109] NA   "1" "5" NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   "1" "3" "4" "5" NA   "1" "2" "3" "
##  [136] NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   "1" "2" "3" "4" "5" NA   "1" "2" "3" "4" N
```

```
##  [163] "2" "3" "4" "5" NA  NA  NA  NA  NA  "1" "3" "4" NA  NA  NA  NA  NA  "1" "2" "3" "4" "1" "2" "
##  [190] NA  NA  NA  NA  "2" "2" "3" "1" "2" "3" "4" "5" NA  NA  "1" "2" "3" "4" "5" NA  NA  "1" "2" "
##  [217] "4" "5" NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  "3" NA  NA  "3" NA  N
##  [244] NA  NA  NA  NA  NA  NA  NA  "3" NA  NA  NA  "3" NA  NA  NA  NA  NA  NA  NA  NA  "1" "2" "1" N
##  [271] "4" NA  NA  NA  NA  "1" NA  "1" "1" NA  "1" "2" "1" NA  "4" NA  NA  NA  NA  NA  NA  "2" "1" "
##  [298] NA  NA  NA  "2" NA  NA  NA  NA  NA  "1" "2" "3" "5" "2" "3" "4" NA  NA  "1" "2" "3" "4" "5" "
##  [325] "5" "4" "4" NA  "4" NA  "1" "3" "4" NA  NA  "1" "2" "3" "4" "5" "3" NA  "1" "2" "3" "4" "5" "
##  [352] "5" "3" "4" "1" "3" "4" "5" "2" "3" NA  NA  NA  "1" "2" "3" "4" "1" "2" "3" "4" "5" "1" "3" "
##  [379] "3" "4" "5" "1" "3" "4" "5" "1" "3" "4" "5" "2" "2" "3" "4" NA  NA  NA  NA  NA  NA  NA  NA  N
##  [406] NA  "4" NA  "1" NA  NA  "1" "3" NA  NA  NA  NA  NA  "4" NA  NA  NA  NA  NA  NA  "1" "4" "5" "
##  [433] "1" "4" "5" NA  "5" "4" NA  NA  NA  NA  "5" NA  NA  NA  NA  NA  NA  "4" NA  NA  NA  "1" "3" "
##  [460] NA  NA  NA  "1" "2" "3" "4" "5" NA  NA  "4" "1" "5" "1" "3" "4" "5" NA  NA  NA  NA  "1" "2" "
##  [487] "4" NA  NA  "1" "2" "3" "4" "5" "1" "3" "4" "5" "4" "5" NA  NA  NA  NA  NA  NA  NA  NA  NA  N
##  [514] "4" "5" "1" "2" "3" "4" "5" NA  "2" "3" "4" NA  NA  NA  NA  NA  NA  NA  NA  NA  "1" "2" "3" "
##  [541] "3" NA  "2" "5" NA  NA  NA  NA  "5" "1" "2" "3" "4" "5" "1" "2" "3" "4" "5" "1" "2" "3" "4" "
##  [568] "3" "4" "5" NA  NA  "2" "3" NA  "2" "3" "4" "5" NA  NA  NA  NA  "1" "2" "3" "2" NA  NA  NA  "
##  [595] "2" "2" "4" NA  NA  "1" "2" "4" NA  "2" "1" "2" "2" NA  "2" "2" "4" "2" "3" "4" "2" NA  NA  "
##  [622] NA  "1" "2" "3" "4" "1" "2" "3" "4" NA  "2" "2" "2" "2" "2" "2" "4" "2" NA  NA  NA  NA  "1" "
##  [649] NA  "1" "2" "3" "4" "5" "1" "2" "3" "4" "5" NA  "4" "1" "4" "5" "4" NA  NA  NA  NA  NA  NA  N
##  [676] "4" "4" "5" "2" NA  NA  NA  "2" "2" "4" NA  "1" "2" "3" "4" "5" "4" NA  NA  NA  NA  NA  "1" "
##  [703] NA  NA  "4" "5" NA  "1" NA  NA  "5" NA  "1" "4" "1" "4" "5" "4" "1" "4" "5" NA  "1" "4" "5" N
##  [730] "1" "3" "4" "5" "4" "5" NA  "1" "2" "3" "4" "1" "3" "4" "5" NA  NA  NA  "4" "5" NA  "1" "4" "
##  [757] "1" "3" "4" "5" NA  NA  NA  "1" "3" "4" "5" "1" "1" "3" "4" "5" NA  NA  NA  NA  NA  "1" "2" "
##  [784] NA  "1" "2" "3" "4" "5" "2" "3" NA  "4" NA  NA  "1" "1" "3" "4" "5" NA  NA  "3" "4" NA  NA  "
##  [811] "3" "4" "5" NA  "1" "3" NA  NA  NA  NA  NA  "1" "2" "3" "4" "5" NA  "1" "2" "3" "4" "5" "2" "
##  [838] "2" "3" "4" "5" "2" "1" "2" "3" "4" "5" NA  NA  NA  NA  NA  NA  NA  "1" "2" "3" "4" "5" NA  "
##  [865] "5" NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  "2" "4" "5" NA  NA  NA  "1" "2" "3" "4" "5" N
##  [892] NA  "4" "5" "1" "4" "5" NA  NA  NA  NA  NA  NA  NA  NA  NA  NA  "1" "2" "3" "4" "5" NA  "3" "
##  [919] NA  NA  "4" NA  "4" NA  "1" "3" "1" "3" NA  NA  NA  NA  "1" "3" "4" "5" NA  "1" "3" "4" "5" "
##  [946] NA  NA  "1" "3" NA  "4" "1" "3" "4" "5" NA  NA  NA  "1" "3" "4" "5" NA  NA  NA  NA  NA  NA  N
##  [973] "4" "5" NA  NA  "4" NA  NA  "1" "2" "4" "5" NA  NA  NA  NA  "1" "2" "3" "4" "5" NA  NA  NA  N
## [1000] "5"
##  [ reached getOption("max.print") -- omitted 320 entries ]
```

```r
edgelist$`tie-type`[is.na(edgelist$`tie-type`)] = 0 #NA values for tie-type to 0
edgelist <- na.omit(edgelist)
edgelist <- edgelist %>%
  arrange(`out-tie`) %>%
  filter(`out-tie` != `in-tie`)
##there are 3 variables in the edge list: out-tie, in-tie, and tie.
#creating nodelist
inclass <- subset(node, select = -c(2:41) )
inclass <- na.omit(inclass)
absent_people <- tibble (ID= c(3,4,8,9,10,11,12,13,14,16,19,21,22,25,26,27,29,37,39), trait = NA) #peop
nodelist <-rbind (inclass, absent_people) %>% arrange(`ID`) #combine  people took the survey and people
```

##2. Calculate measures of centrality and similarity in networks depending on the type of tie? Which tie type generates the most similar network in terms of introversion? Which tie type is the most dissimilar?

Looking at the information centrality, tie type 4 (I ask for advice/help) has the greatest centralization while tie type 5 (Asks me for help/advice). Betweenness is also another measure of centrality which shows us how well-connected the parts are. In terms of betweenness, tie type 3 (Is my friend) ranks the highest and tie type 2 (I have met during my time in MBDS) is the lowest. Likewise, tie type 3 also ranks the highest for reciprocity, though tie type 4 ranks the lowest. As for closeness, tie type 2 ranks the closest and tie type 3 is the least closest.

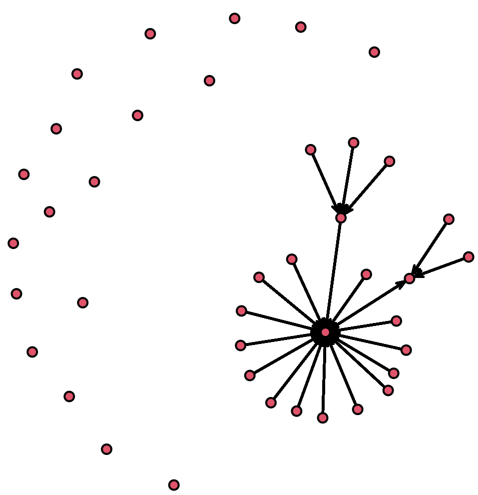
Tie type 1 (I have texted in the last 7 days) generates the most similar network in terms of introversion, while tie type 3 generates the most dissimilar.

```
classnormsnet <- network(edgelist, vertex.attr = nodelist, matrix.type = "edgelist", ignore.eval = FALSE
summary(classnormsnet)
```

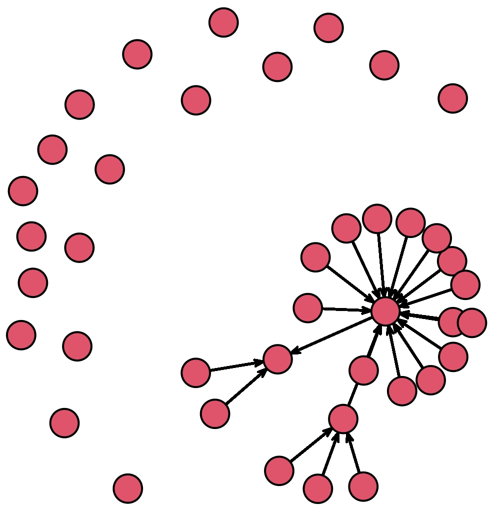
```
## Network attributes:
##   vertices = 40
##   directed = TRUE
##   hyper = FALSE
##   loops = FALSE
##   multiple = FALSE
##   bipartite = FALSE
##  total edges = 1246
##    missing edges = 0
##    non-missing edges = 1246
##  density = 0.7987179
##
## Vertex attributes:
##
##  ID:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.00   10.75   20.50   20.50   30.25   40.00
##
##  trait:
##    numeric valued attribute
##    attribute summary:
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##       1       2       2       2       2       3      19
##   vertex.names:
##    character valued attribute
##    40 valid vertex names
##
## Edge attributes:
##
##  in-tie:
##    character valued attribute
##    attribute summary:
##    the 10 most common values are:
## 18  5  6 28  2 31 29 22 19 34
## 53 50 48 47 44 43 42 41 38 38
##
##  tie-type:
##    character valued attribute
##    attribute summary:
##   0   1   2   3   4   5
## 551 143 133 131 176 112
##
## Network adjacency matrix:
##    1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
## 1  0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 2  0 0 1 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 3  0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

```
## 4  0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 5  0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 6  0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 7  1 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 8  0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 9  0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 10 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 11 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 12 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 13 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 14 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 15 0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 16 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 17 0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 18 1 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 19 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 20 0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 21 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 22 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 23 0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 24 0 1 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## 25 0 0 0 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [ reached getOption("max.print") -- omitted 15 rows ]
```

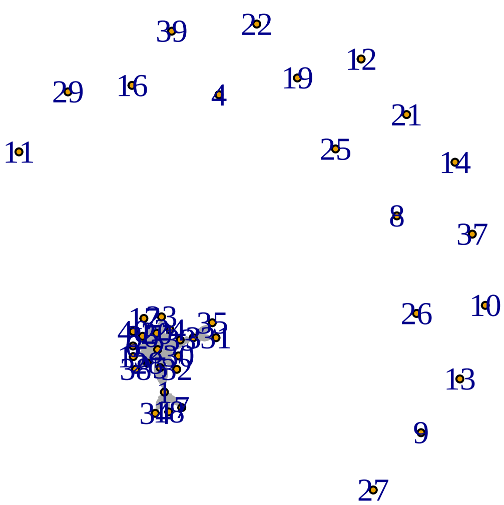
```
plot(classnormsnet, vertex.cex = 1) # very dense
```



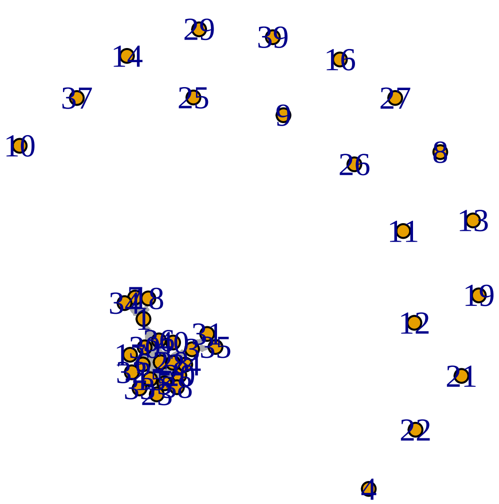
```
plot(classnormsnet, vertex.cex = 3)
```



```r
# graphing the network
network_class <- graph_from_data_frame(d = edgelist, vertices = nodelist, directed = TRUE)
plot(network_class, edge.arrow.size = 0.1, vertex.size = 3)
```



```r
plot(network_class, edge.arrow.size = 0.1, vertex.size = 6)
```



Edgelist based on Tie-Type, Nodelist based on trait

```
# edgelist based on tie-type, nodelist based on trait
edgelist1 <- edgelist %>% filter(`tie-type` == 1)
edgelist2 <- edgelist %>% filter(`tie-type` == 2)
edgelist3 <- edgelist %>% filter(`tie-type` == 3)
edgelist4 <- edgelist %>% filter(`tie-type` == 4)
edgelist5 <- edgelist %>% filter(`tie-type` == 5)
nodelist_introvert <- nodelist %>% filter(trait==1)
nodelist_extrovert <- nodelist %>% filter(trait == 3)
network_class_tietype1 <- graph_from_data_frame(d = edgelist1, vertices = nodelist, directed = TRUE)
network_class_tietype2 <- graph_from_data_frame(d = edgelist2, vertices = nodelist, directed = TRUE)
network_class_tietype3 <- graph_from_data_frame(d = edgelist3, vertices = nodelist, directed = TRUE)
network_class_tietype4 <- graph_from_data_frame(d = edgelist4, vertices = nodelist, directed = TRUE)
network_class_tietype5 <- graph_from_data_frame(d = edgelist5, vertices = nodelist, directed = TRUE)
```

Density Density is the number of ties relative to the number of possible ties

From greatest to least, the rank of tie types in terms of density is as follows:

1. I ask for advice/help (tie type 4)
2. I have texted in the last 7 days (tie type 1)
3. I have met during my time in MBDS (tie type 2)
4. Is my friend (tie type 3)
5. Asks me for help/advice (tie type 5)

```
# density based on tie type
edge_density(network_class_tietype1, loops = F)
```

```
## [1] 0.09166667
```

```
edge_density(network_class_tietype2, loops = F)
```

```
## [1] 0.08525641
```

```
edge_density(network_class_tietype3, loops = F)
```

```
## [1] 0.08397436
```

```
edge_density(network_class_tietype4, loops = F)
```

```
## [1] 0.1128205
```

```
edge_density(network_class_tietype5, loops = F)
```

```
## [1] 0.07179487
```

Reciprocity

From greatest to least, the rank of tie types in terms of reciprocity is as follows:

1. Is my friend (tie type 3)
2. I have met during my time in MBDS (tie type 2)
3. I have texted in the last 7 days (tie type 1)
4. Asks me for help/advice (tie type 5)
5. I ask for advice/help (tie type 4)

```r
#reciprocity
reciprocity(network_class_tietype1)
```

```
## [1] 0
```

```r
reciprocity(network_class_tietype2)
```

```
## [1] 0
```

```r
reciprocity(network_class_tietype3)
```

```
## [1] 0
```

```r
reciprocity(network_class_tietype4)
```

```
## [1] 0
```

```r
reciprocity(network_class_tietype5)
```

```
## [1] 0
```

Transitivity

From greatest to least, the rank of tie types in terms of transitivty is as follows:

1. I have met during my time in MBDS (tie type 2)
2. Is my friend (tie type 3)
3. I ask for advice/help (tie type 4)
4. I have texted in the last 7 days (tie type 1)
5. Asks me for help/advice (tie type 5)

```r
# transitivity
transitivity(network_class_tietype1, type="global")
```

```
## [1] 0
```

```r
transitivity(network_class_tietype2, type="global")
```

```
## [1] 0
```

```r
transitivity(network_class_tietype3, type="global")
```

```
## [1] 0
```

```r
transitivity(network_class_tietype4, type="global")
```

```
## [1] 0
```

```r
transitivity(network_class_tietype5, type="global")
```

```
## [1] 0
```

Diameter

The following tie types have a diameter of 5:

1. I have texted in the last 7 days (tie type 1)
2. I have met during my time in MBDS (tie type 2)
3. Is my friend (tie type 3)

The following tie types have a diameter of 4:

4. I ask for advice/help (tie type 4)
5. Asks me for help/advice (tie type 5)

```r
# Diameter
diameter(network_class_tietype1, directed=F, weights=NA)
```

```
## [1] 4
```

```r
diameter(network_class_tietype2, directed=F, weights=NA)
```

```
## [1] 4
```

```r
diameter(network_class_tietype3, directed=F, weights=NA)
```

```
## [1] 4
```

```r
diameter(network_class_tietype4, directed=F, weights=NA)
```

```
## [1] 4
```

```r
diameter(network_class_tietype5, directed=F, weights=NA)
```

```
## [1] 3
```

Closeness

Closeness measures how close people are to everyone else

From closest to least close, the rank of tie types is as follows:

1. I have met during my time in MBDS (tie type 2)
2. I ask for advice/help (tie type 4)
3. I have texted in the last 7 days (tie type 1)
4. Asks me for help/advice (tie type 5)
5. Is my friend (tie type 3)

```r
#calculating closeness
mean(closeness(network_class_tietype1, mode="all", weights=NA))
```

```
## Warning in closeness(network_class_tietype1, mode = "all", weights = NA): At centrality.c:2784 :clos
## centrality is not well-defined for disconnected graphs
```

```
## [1] 0.0009559908
```

```r
mean(closeness(network_class_tietype2, mode="all", weights=NA))
```

```
## Warning in closeness(network_class_tietype2, mode = "all", weights = NA): At centrality.c:2784 :clos
## centrality is not well-defined for disconnected graphs
```

```
## [1] 0.0008753162
```

```r
mean(closeness(network_class_tietype3, mode="all", weights=NA))
```

```
## Warning in closeness(network_class_tietype3, mode = "all", weights = NA): At centrality.c:2784 :clos
## centrality is not well-defined for disconnected graphs
```

```
## [1] 0.0009559908
```

```r
mean(closeness(network_class_tietype4, mode="all", weights=NA))
```

```
## Warning in closeness(network_class_tietype4, mode = "all", weights = NA): At centrality.c:2784 :clos
## centrality is not well-defined for disconnected graphs
```

```
## [1] 0.0009131176
```

```r
mean(closeness(network_class_tietype5, mode="all", weights=NA))
```

```
## Warning in closeness(network_class_tietype5, mode = "all", weights = NA): At centrality.c:2784 :clos
## centrality is not well-defined for disconnected graphs
```

```
## [1] 0.0007701825
```

Betweenness

Betweenness is the shortest paths between nodes that go through a given node

From most betweenness to least betweenness, the rank of ties in terms of betweenness is as follows:

1. Is my friend (tie type 3)
2. I ask for advice/help (tie type 4)
3. Asks me for help/advice (tie type 5)
4. I have texted in the last 7 days (tie type 1)
5. I have met during my time in MBDS (tie type 2)

```r
mean(betweenness(network_class_tietype1, directed=F, weights=NA))
```

```
## [1] 6.8
```

```r
mean(betweenness(network_class_tietype2, directed=F, weights=NA))
```

```
## [1] 5.625
```

```r
mean(betweenness(network_class_tietype3, directed=F, weights=NA))
```

```
## [1] 6.8
```

```r
mean(betweenness(network_class_tietype4, directed=F, weights=NA))
```

```
## [1] 6.2
```

```r
mean(betweenness(network_class_tietype5, directed=F, weights=NA))
```

```
## [1] 2.9
```

Degree

Degree looks at the number of ties in a network

From greatest to least, the rank of tie types in terms of degree is as follows:

1. I ask for advice/help (tie type 4)
2. I have texted in the last 7 days (tie type 1)
3. I have met during my time in MBDS (tie type 2)
4. Is my friend (tie type 3)
5. Asks me for help/advice (tie type 5)

```r
mean(degree(network_class_tietype1, mode="all"))
```

```
## [1] 7.15
```

```r
mean(degree(network_class_tietype2, mode="all"))
```

```
## [1] 6.65
```

```r
mean(degree(network_class_tietype3, mode="all"))
```

```
## [1] 6.55
```

```r
mean(degree(network_class_tietype4, mode="all"))
```

```
## [1] 8.8
```

```r
mean(degree(network_class_tietype5, mode="all"))
```

```
## [1] 5.6
```

Centrality Degree

Information Centrality is the number of all paths between nodes that go through a given node

From greatest centralization to least centralization, the rank of tie types is as follows:

1. I ask for advice/help (tie type 4)
2. I have met during my time in MBDS (tie type 2)
3. Is my friend (tie type 3)
4. I have texted in the last 7 days (tie type 1)
5. Asks me for help/advice (tie type 5)

```r
centr_degree(network_class_tietype1, mode="in", normalized=T)
```

```
## $res
##  [1] 24 96 23  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [38]  0  0  0
##
## $centralization
## [1] 2.369872
##
## $theoretical_max
## [1] 1560
```

```r
centr_degree(network_class_tietype2, mode="in", normalized=T)
```

```
## $res
##  [1] 24 77 32  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [38]  0  0  0
##
## $centralization
## [1] 1.889103
##
## $theoretical_max
## [1] 1560
```

```r
centr_degree(network_class_tietype3, mode="in", normalized=T)
```

```
## $res
##  [1] 20 84 27  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [38]  0  0  0
##
## $centralization
## [1] 2.069872
##
```

```
## $theoretical_max
## [1] 1560
```

```
centr_degree(network_class_tietype4, mode="in", normalized=T)
```

```
## $res
##  [1]  27 118  31   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
## [28]   0   0   0   0   0   0   0   0   0   0   0   0   0
##
## $centralization
## [1] 2.912821
##
## $theoretical_max
## [1] 1560
```

```
centr_degree(network_class_tietype5, mode="in", normalized=T)
```

```
## $res
##  [1] 21 70 21  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [38]  0  0  0
##
## $centralization
## [1] 1.723077
##
## $theoretical_max
## [1] 1560
```

Mean Distance

The mean distance between nodes, in order from least to greatest, is as follows:

1. Is my friend (tie type 3)
2. I ask for advice/help (tie type 4)
3. I have met during my time in MBDS (tie type 2)
4. I have texted in the last 7 days (tie type 1)
5. Asks me for help/advice (tie type 5)

```
mean_distance(network_class_tietype1, directed=T)
```

```
## [1] 1.575
```

```
mean_distance(network_class_tietype2, directed=T)
```

```
## [1] 1.583333
```

```
mean_distance(network_class_tietype3, directed=T)
```

```
## [1] 1.575
```

```
mean_distance(network_class_tietype4, directed=T)
```

```
## [1] 1.578947
```

```
mean_distance(network_class_tietype5, directed=T)
```

```
## [1] 1.392857
```

Which tie type generates the most similar network in terms of introversion? Which tie type is the most dissimilar?

In terms of introversion:

Most similar network: "I have texted in the last 7 days"

Most dissimilar network: "Is my friend"

```
node <- nodelist
node[is.na(node)] <- -1
net <- graph_from_data_frame(d = edgelist, vertices = node, directed = TRUE)
net1 <- graph_from_data_frame(d = edgelist1, vertices = node, directed = TRUE)
net2 <- graph_from_data_frame(d = edgelist2, vertices = node, directed = TRUE)
net3 <- graph_from_data_frame(d = edgelist3, vertices = node, directed = TRUE)
net4 <- graph_from_data_frame(d = edgelist4, vertices = node, directed = TRUE)
net5 <- graph_from_data_frame(d = edgelist5, vertices = node, directed = TRUE)
#filter edgelist for all 5 tie types...then calculate this measure for 5 networks and see which is most
#Similarity
assortativity(net1, V(net1)$trait, directed=T)
```

```
## [1] -0.5815749
```

```
assortativity(net2, V(net2)$trait, directed=T)
```

```
## [1] -0.6688433
```

```
assortativity(net3, V(net3)$trait, directed=T)
```

```
## [1] -0.6573574
```

```
assortativity(net4, V(net4)$trait, directed=T)
```

```
## [1] -0.6198843
```

```
assortativity(net5, V(net5)$trait, directed=T)
```

```
## [1] -0.6045513
```

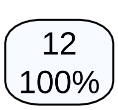
##3 Do introverts tend to be at the periphery while extraverts are in the center of the network? Motivate.

We use both decision tree and regression to examine if introverts tend to be at the periphery while extraverts are in the center of the network. The input is the trait (level of introvert/extravert) and the output is the degree/betweenness.

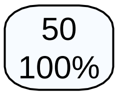
Both the decision tree models are unable to predict any patterns. The regression model also does not show any significances. The small sample size is our limitation. We come to conclude that trait (introvert/extravert) does not predict where introverts andextraverts are in the network.

```
library(rpart)
library(rpart.plot)
library(caret)

#decision tree: betweenness and trait
tree_bt <- nodelist %>% mutate (between = betweenness(network_class, directed=F, weights=NA))
model_tree_bt <- rpart(between ~ as.factor(trait), method = "anova", data = tree_bt, cp = 0.00001)
rpart.plot(model_tree_bt)
```



```r
#decision tree: degree and trait
tree_dg <- nodelist %>% mutate (degree = degree(network_class, mode="in"))
model_tree_dg <- rpart(degree ~ as.factor(trait), method = "anova", data = tree_dg, cp = 0.00001)
rpart.plot(model_tree_dg)
```




```r
#regression: bewteenness and trait
summary(lm(between ~ as.factor(trait), data = tree_bt))
```

```
##
## Call:
## lm(formula = between ~ as.factor(trait), data = tree_bt)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -67.0   -3.8   -3.8   -3.8  134.0
##
## Coefficients:
##                              Estimate           Std. Error t value Pr(>|t|)
## (Intercept)        0.00000000000002868 23.55702301508688024   0.000   1.0000
## as.factor(trait)2  3.79999999999995364 25.80542578606287307   0.147   0.8846
## as.factor(trait)3 66.99999999999995737 33.31466143707099548   2.011   0.0595 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 40.8 on 18 degrees of freedom
##   (19 observations deleted due to missingness)
## Multiple R-squared:  0.2597, Adjusted R-squared:  0.1775
## F-statistic: 3.158 on 2 and 18 DF,  p-value: 0.06676
```

Contribution: Kim worked on Q1, Ryan and Ammar worked on Q2, and Elaina and Meghan worked on Q3.