

Microbiome_Data_Analysis

Set Working Directory :

```
setwd("/Users/Vartika_Bisht/Individual_Project")
```

Load all source codes :

```
source("Penalty_Function.R")
source("Incorporate_Groups.R")
source("Required_Libraries.R")
```

```
##
## -----
## Welcome to dendextend version 1.13.4
## Type citation('dendextend') for how to cite the package.
##
## Type browseVignettes(package = 'dendextend') for the package vignette.
## The github page is: https://github.com/talgalili/dendextend/
##
## Suggestions and bug-reports can be submitted at: https://github.com/talgalili/dendextend/issues
## Or contact: <tal.galili@gmail.com>
##
## To suppress this message use: suppressPackageStartupMessages(library(dendextend))
## -----

##
## Attaching package: 'dendextend'

## The following object is masked from 'package:stats':
##
##      cutree

## Loading required package: Matrix

## Loaded glmnet 4.0

## network: Classes for Relational Data
## Version 1.16.0 created on 2019-11-30.
## copyright (c) 2005, Carter T. Butts, University of California-Irvine
##                      Mark S. Handcock, University of California -- Los Angeles
##                      David R. Hunter, Penn State University
##                      Martina Morris, University of Washington
##                      Skye Bender-deMoll, University of Washington
## For citation information, type citation("network").
## Type help("network-package") to get started.
```

```

## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa

##
## Attaching package: 'gplots'

## The following object is masked from 'package:stats':
##
##     lowess

## corrrplot 0.84 loaded

##
## Attaching package: 'plotly'

## The following object is masked from 'package:ggplot2':
##
##     last_plot

## The following object is masked from 'package:stats':
##
##     filter

## The following object is masked from 'package:graphics':
##
##     layout

## Loading required package: viridisLite

## NOTE: Either Arial Narrow or Roboto Condensed fonts are required to use these themes.

##     Please use hrbrthemes::import_roboto_condensed() to install Roboto Condensed and

##     if Arial Narrow is not on your system, please see https://bit.ly/arialnarrow

##
## Attaching package: 'igraph'

## The following object is masked from 'package:plotly':
##
##     groups

## The following objects are masked from 'package:network':
##
##     %c%, %s%, add.edges, add.vertices, delete.edges, delete.vertices,
##     get.edge.attribute, get.edges, get.vertex.attribute, is.bipartite,
##     is.directed, list.edge.attributes, list.vertex.attributes,
##     set.edge.attribute, set.vertex.attribute

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

```

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

## Loading required package: usethis

## Loading required package: grid

## =====
## ComplexHeatmap version 2.2.0
## Bioconductor page: http://bioconductor.org/packages/ComplexHeatmap/
## Github page: https://github.com/jokergoo/ComplexHeatmap
## Documentation: http://jokergoo.github.io/ComplexHeatmap-reference
##
## If you use it in published research, please cite:
## Gu, Z. Complex heatmaps reveal patterns and correlations in multidimensional
##   genomic data. Bioinformatics 2016.
## =====

##
## Attaching package: 'ComplexHeatmap'

## The following object is masked from 'package:plotly':
##
##      add_heatmap

## The following object is masked from 'package:network':
##
##      %v%

## Loading required package: lattice
```

```
source("Borrowed_Functions.R")
source("MicrobiomeAnalyst.R")
source("best_epsilon_DBSCAN.R")
```

Load Data Set :

```
# Load Dataset 2
Data_Set_1 <- read.csv("adenoma.csv",1)
# Choose Microbiome Data
df_data1 <- Data_Set_1[2:101]
data1 <- data.matrix(df_data1)
# Create labels
meta_data <- read.csv("meta date.csv")
label_dat <- as.numeric(factor(meta_data$dx))
```

Input Dataset :

```
head(df_data1)
```

```
##      0tu000153 0tu000653 0tu000813 0tu000226 0tu000645 0tu000460 0tu000620
## 1          0          0          0          0          0          0          0
## 2          0          0          0          0          0          0          0
## 3          2          1          0          0          0          0          0
## 4          0          0          0          2          0          0          0
## 5          1          0          0          0          0          0          0
## 6          0          0          0          0          0          0          0
##      0tu000397 0tu000115 0tu000400 0tu001119 0tu000359 0tu000315 0tu000485
## 1          1          0          2          0          0          0          0
## 2          0          0          0          0          0          0          0
## 3          0          0          0          0          0          3          7
## 4          0          84          2          0          0          0          0
## 5          0          0          0          0          0          2          0
## 6          0          0          2          0          0          0          0
##      0tu000169 0tu000334 0tu000186 0tu000121 0tu001568 0tu000211 0tu000413
## 1          2          0          1          26          0          0          1
## 2          6          3          0          7          0          123          0
## 3          0          14          31          28          0          0          0
## 4          1          1          4          0          0          175          20
## 5          0          0          13          0          0          1          0
## 6          1          0          0          1          0          0          0
##      0tu000374 0tu000124 0tu000393 0tu000358 0tu000013 0tu001109 0tu000284
## 1          2          6          2          0          439          0          0
## 2          3          38          0          0          74          0          6
## 3          2          3          3          2          5          0          7
## 4          0          3          0          0          28          0          0
## 5          0          28          0          0          262          0          0
## 6          2          32          3          12          399          0          0
##      0tu000095 0tu000060 0tu000108 0tu000306 0tu000375 0tu000079 0tu000046
## 1          1          10          0          0          6          117          22
## 2          0          8          6          0          0          3          433
## 3          11          79          0          0          0          7          71
## 4          27          172          9          0          0          13          26
## 5          5          0          20          0          0          0          0
## 6          0          6          1          0          0          68          12
##      0tu000713 0tu000038 0tu000294 0tu000684 0tu000084 0tu001914 0tu000331
## 1          0          0          0          0          2          0          1
## 2          0          0          0          0          75          0          0
## 3          0          2          0          0          0          0          0
## 4          0          1          0          0          1          0          0
## 5          0          87          0          0          2          0          0
## 6          0          0          0          0          16          0          14
##      0tu001212 0tu000042 0tu000454 0tu000283 0tu001205 0tu000117 0tu000984
## 1          1          2          0          1          1          1          0
## 2          0          10          0          0          0          0          0
## 3          1          0          0          0          0          3          0
## 4          0          9          0          0          0          0          0
## 5          0          109          0          0          0          11          0
## 6          0          18          0          0          0          0          0
##      0tu000165 0tu000183 0tu000012 0tu000242 0tu001485 0tu000507 0tu000394
## 1          4          0          236          0          0          3          4
```

## 2	13	200	74	0	0	0	0
## 3	0	0	317	0	0	0	0
## 4	1	39	106	0	0	1	0
## 5	7	0	8	4	0	0	0
## 6	1	0	159	0	0	0	0
##	0tu000391	0tu000639	0tu000035	0tu000201	0tu000378	0tu000402	0tu001169
## 1	0	0	265	0	0	0	0
## 2	0	0	0	0	0	0	0
## 3	0	0	0	0	0	1	0
## 4	0	0	153	0	93	1	1
## 5	0	0	2	0	0	0	0
## 6	0	0	139	0	0	1	0
##	0tu001023	0tu001162	0tu001004	0tu000071	0tu000717	0tu000589	0tu000800
## 1	0	0	0	36	1	0	0
## 2	7	0	0	27	0	0	0
## 3	0	0	0	0	0	0	0
## 4	0	0	0	7	0	11	0
## 5	0	0	0	0	0	0	0
## 6	0	0	0	107	0	0	0
##	0tu000103	0tu001098	0tu000588	0tu001204	0tu000288	0tu001209	0tu000846
## 1	0	0	1	0	1	0	0
## 2	0	0	0	0	0	0	0
## 3	4	0	2	0	0	0	0
## 4	0	0	0	0	1	0	0
## 5	0	0	0	0	0	0	0
## 6	0	0	0	0	0	0	0
##	0tu000099	0tu001438	0tu000853	0tu000785	0tu000349	0tu000640	0tu000100
## 1	15	0	1	0	0	0	25
## 2	10	0	0	0	0	0	3
## 3	13	0	0	0	0	0	52
## 4	6	0	0	0	0	0	2
## 5	0	0	0	0	0	0	47
## 6	3	0	0	0	0	0	7
##	0tu000175	0tu000185	0tu005596	0tu000790	0tu000252	0tu001350	0tu000385
## 1	8	0	0	0	0	0	8
## 2	0	0	0	0	1	0	10
## 3	0	184	0	0	7	0	27
## 4	21	0	0	0	0	0	2
## 5	0	172	0	0	3	0	13
## 6	10	0	0	0	0	0	31
##	0tu000407	0tu002730	0tu000303	0tu000821	0tu000632	0tu000039	0tu000150
## 1	0	0	0	0	2	14	0
## 2	0	0	0	0	0	185	0
## 3	1	0	0	0	0	0	4
## 4	0	0	0	0	6	97	86
## 5	0	0	0	0	0	129	0
## 6	0	0	1	0	0	50	12
##	0tu000179	0tu000952					
## 1	3	0					
## 2	0	0					
## 3	3	0					
## 4	0	0					
## 5	6	0					
## 6	1	0					

Input Data for Module 1 (Features) :

```
head(as.data.frame(data1))
```

```
##      Otu000153 Otu000653 Otu000813 Otu000226 Otu000645 Otu000460 Otu000620
## 1           0           0           0           0           0           0           0
## 2           0           0           0           0           0           0           0
## 3           2           1           0           0           0           0           0
## 4           0           0           0           2           0           0           0
## 5           1           0           0           0           0           0           0
## 6           0           0           0           0           0           0           0
##      Otu000397 Otu000115 Otu000400 Otu001119 Otu000359 Otu000315 Otu000485
## 1           1           0           2           0           0           0           0
## 2           0           0           0           0           0           0           0
## 3           0           0           0           0           0           3           7
## 4           0           84           2           0           0           0           0
## 5           0           0           0           0           0           2           0
## 6           0           0           2           0           0           0           0
##      Otu000169 Otu000334 Otu000186 Otu000121 Otu001568 Otu000211 Otu000413
## 1           2           0           1          26           0           0           1
## 2           6           3           0           7           0          123           0
## 3           0          14          31          28           0           0           0
## 4           1           1           4           0           0          175          20
## 5           0           0          13           0           0           1           0
## 6           1           0           0           1           0           0           0
##      Otu000374 Otu000124 Otu000393 Otu000358 Otu000013 Otu001109 Otu000284
## 1           2           6           2           0          439           0           0
## 2           3          38           0           0           74           0           6
## 3           2           3           3           2           5           0           7
## 4           0           3           0           0          28           0           0
## 5           0          28           0           0          262           0           0
## 6           2          32           3          12          399           0           0
##      Otu000095 Otu000060 Otu000108 Otu000306 Otu000375 Otu000079 Otu000046
## 1           1          10           0           0           6          117          22
## 2           0           8           6           0           0           3          433
## 3          11          79           0           0           0           7           71
## 4          27          172           9           0           0          13          26
## 5           5           0          20           0           0           0           0
## 6           0           6           1           0           0          68          12
##      Otu000713 Otu000038 Otu000294 Otu000684 Otu000084 Otu001914 Otu000331
## 1           0           0           0           0           2           0           1
## 2           0           0           0           0          75           0           0
## 3           0           2           0           0           0           0           0
## 4           0           1           0           0           1           0           0
## 5           0          87           0           0           2           0           0
## 6           0           0           0           0          16           0          14
##      Otu001212 Otu000042 Otu000454 Otu000283 Otu001205 Otu000117 Otu000984
## 1           1           2           0           1           1           1           0
## 2           0          10           0           0           0           0           0
## 3           1           0           0           0           0           3           0
## 4           0           9           0           0           0           0           0
## 5           0          109           0           0           0          11           0
## 6           0          18           0           0           0           0           0
##      Otu000165 Otu000183 Otu000012 Otu000242 Otu001485 Otu000507 Otu000394
```

## 1	4	0	236	0	0	3	4
## 2	13	200	74	0	0	0	0
## 3	0	0	317	0	0	0	0
## 4	1	39	106	0	0	1	0
## 5	7	0	8	4	0	0	0
## 6	1	0	159	0	0	0	0
##	0tu000391	0tu000639	0tu000035	0tu000201	0tu000378	0tu000402	0tu001169
## 1	0	0	265	0	0	0	0
## 2	0	0	0	0	0	0	0
## 3	0	0	0	0	0	1	0
## 4	0	0	153	0	93	1	1
## 5	0	0	2	0	0	0	0
## 6	0	0	139	0	0	1	0
##	0tu001023	0tu001162	0tu001004	0tu000071	0tu000717	0tu000589	0tu000800
## 1	0	0	0	36	1	0	0
## 2	7	0	0	27	0	0	0
## 3	0	0	0	0	0	0	0
## 4	0	0	0	7	0	11	0
## 5	0	0	0	0	0	0	0
## 6	0	0	0	107	0	0	0
##	0tu000103	0tu001098	0tu000588	0tu001204	0tu000288	0tu001209	0tu000846
## 1	0	0	1	0	1	0	0
## 2	0	0	0	0	0	0	0
## 3	4	0	2	0	0	0	0
## 4	0	0	0	0	1	0	0
## 5	0	0	0	0	0	0	0
## 6	0	0	0	0	0	0	0
##	0tu000099	0tu001438	0tu000853	0tu000785	0tu000349	0tu000640	0tu000100
## 1	15	0	1	0	0	0	25
## 2	10	0	0	0	0	0	3
## 3	13	0	0	0	0	0	52
## 4	6	0	0	0	0	0	2
## 5	0	0	0	0	0	0	47
## 6	3	0	0	0	0	0	7
##	0tu000175	0tu000185	0tu005596	0tu000790	0tu000252	0tu001350	0tu000385
## 1	8	0	0	0	0	0	8
## 2	0	0	0	0	1	0	10
## 3	0	184	0	0	7	0	27
## 4	21	0	0	0	0	0	2
## 5	0	172	0	0	3	0	13
## 6	10	0	0	0	0	0	31
##	0tu000407	0tu002730	0tu000303	0tu000821	0tu000632	0tu000039	0tu000150
## 1	0	0	0	0	2	14	0
## 2	0	0	0	0	0	185	0
## 3	1	0	0	0	0	0	4
## 4	0	0	0	0	6	97	86
## 5	0	0	0	0	0	129	0
## 6	0	0	1	0	0	50	12
##	0tu000179	0tu000952					
## 1	3	0					
## 2	0	0					
## 3	3	0					
## 4	0	0					
## 5	6	0					

6 1 0

Input Data for Module 1 (Output Variable: Given Variable) :

#Labels

`as.character(meta_data$dx)`

```
## [1] "normal" "normal" "normal" "adenoma" "normal" "normal" "cancer"
## [8] "normal" "normal" "cancer" "normal" "adenoma" "adenoma" "normal"
## [15] "adenoma" "cancer" "normal" "adenoma" "normal" "normal" "adenoma"
## [22] "adenoma" "adenoma" "normal" "adenoma" "normal" "normal" "adenoma"
## [29] "adenoma" "normal" "normal" "adenoma" "normal" "normal" "normal"
## [36] "normal" "normal" "normal" "normal" "normal" "normal" "normal"
## [43] "normal" "adenoma" "normal" "adenoma" "normal" "adenoma" "adenoma"
## [50] "adenoma" "normal" "adenoma" "adenoma" "normal" "adenoma" "adenoma"
## [57] "normal" "normal" "normal" "normal" "adenoma" "adenoma" "normal"
## [64] "adenoma" "normal" "normal" "normal" "normal" "normal" "normal"
## [71] "adenoma" "normal" "adenoma" "normal" "adenoma" "adenoma" "cancer"
## [78] "normal" "normal" "normal" "adenoma" "adenoma" "normal" "cancer"
## [85] "adenoma" "adenoma" "normal" "adenoma" "adenoma" "adenoma" "normal"
## [92] "adenoma" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma"
## [99] "cancer" "normal" "adenoma" "adenoma" "cancer" "adenoma" "normal"
## [106] "normal" "adenoma" "cancer" "cancer" "cancer" "normal" "cancer"
## [113] "normal" "adenoma" "adenoma" "adenoma" "cancer" "adenoma" "normal"
## [120] "adenoma" "normal" "normal" "cancer" "adenoma" "normal" "adenoma"
## [127] "normal" "cancer" "normal" "cancer" "cancer" "normal" "cancer"
## [134] "adenoma" "cancer" "normal" "cancer" "adenoma" "adenoma" "normal"
## [141] "adenoma" "cancer" "cancer" "cancer" "cancer" "adenoma" "adenoma"
## [148] "cancer" "cancer" "normal" "cancer" "adenoma" "adenoma" "adenoma"
## [155] "adenoma" "adenoma" "adenoma" "cancer" "cancer" "adenoma" "cancer"
## [162] "cancer" "cancer" "normal" "adenoma" "adenoma" "adenoma" "adenoma"
## [169] "adenoma" "cancer" "adenoma" "cancer" "cancer" "adenoma" "cancer"
## [176] "adenoma" "adenoma" "cancer" "cancer" "cancer" "cancer" "adenoma"
## [183] "cancer" "cancer" "cancer" "cancer" "cancer" "adenoma" "cancer"
## [190] "adenoma" "adenoma" "adenoma" "adenoma" "cancer" "cancer" "cancer"
## [197] "cancer" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma"
## [204] "normal" "cancer" "cancer" "cancer" "cancer" "cancer" "cancer"
## [211] "cancer" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma"
## [218] "normal" "cancer" "normal" "cancer" "normal" "normal" "adenoma"
## [225] "normal" "normal" "cancer" "cancer" "cancer" "adenoma" "adenoma"
## [232] "adenoma" "adenoma" "cancer" "normal" "normal" "cancer" "normal"
## [239] "adenoma" "adenoma" "adenoma" "cancer" "cancer" "cancer" "adenoma"
## [246] "cancer" "normal" "adenoma" "cancer" "adenoma" "adenoma" "cancer"
## [253] "adenoma" "cancer" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma"
## [260] "cancer" "cancer" "adenoma" "normal" "cancer" "cancer" "adenoma"
## [267] "adenoma" "normal" "adenoma" "adenoma" "adenoma" "adenoma" "cancer"
## [274] "adenoma" "adenoma" "cancer" "adenoma" "cancer" "adenoma" "cancer"
## [281] "adenoma" "normal" "cancer" "normal" "normal" "normal" "cancer"
## [288] "normal" "adenoma" "normal" "normal" "adenoma" "adenoma" "adenoma"
## [295] "adenoma" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma" "cancer"
## [302] "cancer" "cancer" "adenoma" "adenoma" "adenoma" "adenoma" "adenoma"
## [309] "adenoma" "normal" "normal" "adenoma" "adenoma" "adenoma" "normal"
## [316] "adenoma" "cancer" "cancer" "normal" "cancer" "normal" "adenoma"
```



```
## [323] "normal" "normal" "normal" "adenoma" "cancer" "normal" "normal"
## [330] "normal" "normal" "normal" "normal" "normal" "cancer" "normal"
## [337] "normal" "normal" "cancer" "normal" "normal" "normal" "normal"
## [344] "cancer" "normal" "normal" "adenoma" "adenoma" "normal" "normal"
## [351] "adenoma" "cancer" "cancer" "normal" "normal" "adenoma" "adenoma"
## [358] "adenoma" "adenoma" "cancer" "normal" "adenoma" "adenoma" "adenoma"
## [365] "adenoma" "adenoma" "adenoma" "cancer" "normal" "adenoma" "adenoma"
## [372] "adenoma" "adenoma" "normal" "normal" "adenoma" "adenoma" "normal"
## [379] "cancer" "cancer" "normal" "normal" "cancer" "adenoma" "normal"
## [386] "normal" "adenoma" "adenoma" "adenoma" "adenoma" "normal" "normal"
## [393] "adenoma" "normal" "normal" "adenoma" "normal" "normal" "cancer"
## [400] "cancer" "normal" "adenoma" "adenoma" "adenoma" "cancer" "adenoma"
## [407] "cancer" "normal" "normal" "cancer" "cancer" "normal" "cancer"
## [414] "cancer" "cancer" "adenoma" "cancer" "normal" "normal" "normal"
## [421] "cancer" "normal" "normal" "adenoma" "normal" "normal" "normal"
## [428] "adenoma" "normal" "adenoma" "normal" "adenoma" "cancer" "adenoma"
## [435] "normal" "cancer" "cancer" "cancer" "cancer" "adenoma" "adenoma"
## [442] "adenoma" "normal" "normal" "normal" "cancer" "adenoma" "normal"
## [449] "adenoma" "adenoma" "normal" "normal" "normal" "cancer" "normal"
## [456] "cancer" "adenoma" "normal" "adenoma" "adenoma" "cancer" "adenoma"
## [463] "cancer" "adenoma" "normal" "normal" "normal" "normal" "normal"
## [470] "cancer" "normal" "normal" "adenoma" "normal" "normal" "cancer"
## [477] "adenoma" "normal" "normal" "normal" "normal" "adenoma" "adenoma"
## [484] "normal" "normal" "normal" "adenoma" "normal" "adenoma" "normal"
```

Input Data for Module 1 (Output Variable: Desired Labels) :

```
#Desired Labels
label_dat
```

```
## [1] 3 3 3 1 3 3 2 3 3 2 3 1 1 3 1 2 3 1 3 3 1 1 1 3 1 3 3 1 1 3 3 1 1 3 3 1 3 3 3 3
## [38] 3 3 3 3 3 3 1 3 1 3 1 1 1 3 1 1 3 1 1 3 3 3 1 1 3 1 3 3 3 3 3 3 3 1 3 1 3
## [75] 1 1 2 3 3 3 1 1 3 2 1 1 3 1 1 1 3 1 1 1 1 1 1 2 3 1 1 2 1 3 3 1 2 2 2 3
## [112] 2 3 1 1 1 2 1 3 1 3 3 2 1 3 1 3 2 3 2 2 3 2 1 2 3 2 1 1 3 1 2 2 2 2 1 1 2
## [149] 2 3 2 1 1 1 1 1 1 2 2 1 2 2 2 3 1 1 1 1 1 2 1 2 2 1 2 1 1 2 2 2 2 1 2 2 2
## [186] 2 2 1 2 1 1 1 1 2 2 2 2 1 1 1 1 1 1 3 2 2 2 2 2 2 2 1 1 1 1 1 1 3 2 3 2 3
## [223] 3 1 3 3 2 2 2 1 1 1 1 2 3 3 2 3 1 1 1 2 2 2 1 2 3 1 2 1 1 2 1 2 1 1 1 1 1
## [260] 2 2 1 3 2 2 1 1 3 1 1 1 1 2 1 1 2 1 2 1 2 1 3 2 3 3 3 2 3 1 3 3 1 1 1 1 1
## [297] 1 1 1 1 2 2 2 1 1 1 1 1 1 3 3 1 1 1 3 1 2 2 3 2 3 1 3 3 3 1 2 3 3 3 3 3 3
## [334] 3 2 3 3 3 2 3 3 3 3 2 3 3 1 1 3 3 1 2 2 3 3 1 1 1 1 2 3 1 1 1 1 1 1 2 3 1
## [371] 1 1 1 3 3 1 1 3 2 2 3 3 2 1 3 3 1 1 1 1 3 3 1 3 3 1 3 3 2 2 3 1 1 1 2 1 2
## [408] 3 3 2 2 3 2 2 1 2 3 3 3 2 3 3 1 3 3 3 1 3 1 3 1 2 1 3 2 2 2 2 1 1 1 3 3
## [445] 3 2 1 3 1 1 3 3 3 2 3 2 1 3 1 1 2 1 2 1 3 3 3 3 3 2 3 3 1 3 3 2 1 3 3 3 3
## [482] 1 1 3 3 3 1 3 1 3
```

Module 1:

```
## Input : Numeric Labels(label_dat) and Microbiome Abundance Data(data1)
source("Module_1.R")
```

```
## |
## [1] "ANFIS DONE!"
## [1] "New labels have been assigned!"
```

```
## [1] "Rule based matrix is saved!"
## [1] "Scaled Ruled Based Matrix saved"
```

Output : Rule Based Matrix (rules_int) , Scaled Rule Based Matrix (scaled_rules_int) and Labels (lab

Module 1 Output (Rule Based Matrix):

```
head(as.data.frame(rules_int))
```

```
##      Otu000153 Otu000653 Otu000813 Otu000226 Otu000645 Otu000460 Otu000620
## 1           1           8           15           22           29           36           43
## 2           1           8           15           22           29           36           43
## 3           1           8           15           22           29           36           43
## 4           1           8           15           22           29           36           43
## 5           1           8           15           22           29           36           43
## 6           1           8           15           22           29           36           43
##      Otu000397 Otu000115 Otu000400 Otu001119 Otu000359 Otu000315 Otu000485
## 1           50           57           64           71           78           85           92
## 2           53           57           64           71           78           85           92
## 3           50           57           64           71           83           85           92
## 4           50           57           64           71           78           85           92
## 5           50           57           64           71           78           85           92
## 6           50           57           64           71           78           85           92
##      Otu000169 Otu000334 Otu000186 Otu000121 Otu001568 Otu000211 Otu000413
## 1           99          106          113          120          127          134          141
## 2           99          106          113          120          127          134          141
## 3           99          106          113          120          127          134          141
## 4           99          106          113          120          127          134          141
## 5           99          106          113          120          127          134          141
## 6           99          106          113          120          127          134          141
##      Otu000374 Otu000124 Otu000393 Otu000358 Otu000013 Otu001109 Otu000284
## 1          148          155          162          169          176          183          190
## 2          148          155          162          169          176          183          190
## 3          148          155          162          169          176          183          190
## 4          148          156          162          169          179          183          190
## 5          148          155          162          169          176          183          190
## 6          148          156          162          169          177          183          190
##      Otu000095 Otu000060 Otu000108 Otu000306 Otu000375 Otu000079 Otu000046
## 1          197          204          211          218          225          232          239
## 2          197          204          211          218          225          232          239
## 3          197          204          211          218          225          232          239
## 4          197          204          212          218          225          232          239
## 5          203          204          217          218          225          232          239
## 6          197          204          213          218          225          232          239
##      Otu000713 Otu000038 Otu000294 Otu000684 Otu000084 Otu001914 Otu000331
## 1          246          253          260          267          274          281          288
## 2          246          253          260          267          274          281          288
## 3          246          253          260          267          274          281          288
## 4          246          253          260          267          274          281          288
## 5          246          259          260          267          274          281          288
## 6          246          253          260          267          274          281          288
##      Otu001212 Otu000042 Otu000454 Otu000283 Otu001205 Otu000117 Otu000984
## 1          295          302          309          316          323          330          337
```

## 2	295	302	309	316	323	330	337
## 3	296	302	309	316	323	330	337
## 4	295	303	309	316	323	331	337
## 5	295	302	309	316	323	330	337
## 6	295	303	309	316	323	330	337
##	0tu000165	0tu000183	0tu000012	0tu000242	0tu001485	0tu000507	0tu000394
## 1	344	351	358	365	372	379	386
## 2	344	351	358	365	372	379	386
## 3	344	352	358	365	372	379	386
## 4	344	351	358	365	372	379	386
## 5	344	351	358	365	372	379	386
## 6	344	351	358	365	372	379	386
##	0tu000391	0tu000639	0tu000035	0tu000201	0tu000378	0tu000402	0tu001169
## 1	393	400	407	414	421	428	435
## 2	393	400	407	414	421	429	435
## 3	393	400	407	414	421	428	435
## 4	393	400	407	414	421	430	435
## 5	393	400	407	414	421	428	435
## 6	393	400	407	414	421	428	435
##	0tu001023	0tu001162	0tu001004	0tu000071	0tu000717	0tu000589	0tu000800
## 1	442	449	456	463	470	477	484
## 2	442	449	456	463	470	477	484
## 3	442	449	456	463	470	477	484
## 4	442	449	456	463	470	477	484
## 5	442	449	456	463	470	477	484
## 6	442	449	456	463	470	477	484
##	0tu000103	0tu001098	0tu000588	0tu001204	0tu000288	0tu001209	0tu000846
## 1	491	498	505	512	519	526	533
## 2	491	498	505	512	519	526	533
## 3	491	498	505	512	519	526	533
## 4	491	498	505	512	519	526	533
## 5	491	498	505	512	519	526	533
## 6	491	498	505	512	519	526	533
##	0tu000099	0tu001438	0tu000853	0tu000785	0tu000349	0tu000640	0tu000100
## 1	540	547	554	561	568	575	582
## 2	540	549	554	561	568	575	582
## 3	540	547	554	561	568	575	582
## 4	541	547	554	561	568	575	582
## 5	540	547	554	561	568	575	582
## 6	540	547	554	561	568	575	582
##	0tu000175	0tu000185	0tu005596	0tu000790	0tu000252	0tu001350	0tu000385
## 1	589	596	603	610	617	624	631
## 2	589	596	603	610	617	624	631
## 3	589	596	603	610	617	624	632
## 4	589	596	603	610	617	624	631
## 5	589	596	603	610	617	624	631
## 6	589	596	603	610	617	624	632
##	0tu000407	0tu002730	0tu000303	0tu000821	0tu000632	0tu000039	0tu000150
## 1	638	645	652	659	666	673	680
## 2	638	645	652	659	666	673	680
## 3	638	645	652	660	666	673	680
## 4	638	645	652	659	666	674	680
## 5	638	645	652	659	666	673	680
## 6	638	645	652	659	666	674	680

```
##      Otu000179 Otu000952
## 1          687      694
## 2          687      694
## 3          687      694
## 4          687      694
## 5          687      694
## 6          687      694
```

Module 1 Output (Labels):

```
as.data.frame(label_dat)[,1]
```

```
##      [1]  1.21288148  1.21288148  0.06111418 -1.09065311  1.21288148  0.06111418
##      [7] -1.09065311  1.21288148 -1.09065311  0.06111418 -1.09065311 -1.09065311
##     [13]  0.06111418  0.06111418 -1.09065311  1.21288148  1.21288148  1.21288148
##     [19] -1.09065311  1.21288148 -1.09065311 -1.09065311  0.06111418  0.06111418
##     [25]  0.06111418 -1.09065311 -1.09065311  1.21288148 -1.09065311  1.21288148
##     [31] -1.09065311  1.21288148 -1.09065311 -1.09065311  1.21288148  1.21288148
##     [37]  1.21288148 -1.09065311  1.21288148  1.21288148  0.06111418  1.21288148
##     [43]  0.06111418  1.21288148 -1.09065311 -1.09065311  1.21288148 -1.09065311
##     [49]  0.06111418  1.21288148 -1.09065311  1.21288148  1.21288148 -1.09065311
##     [55] -1.09065311 -1.09065311  1.21288148 -1.09065311  1.21288148 -1.09065311
##     [61] -1.09065311  1.21288148 -1.09065311  1.21288148  1.21288148  1.21288148
##     [67]  1.21288148  1.21288148  1.21288148  1.21288148  1.21288148  1.21288148
##     [73]  1.21288148 -1.09065311  1.21288148 -1.09065311  1.21288148 -1.09065311
##     [79] -1.09065311 -1.09065311  1.21288148 -1.09065311 -1.09065311  1.21288148
##     [85] -1.09065311  1.21288148  1.21288148  1.21288148 -1.09065311 -1.09065311
##     [91]  1.21288148 -1.09065311  1.21288148  1.21288148  1.21288148  1.21288148
##     [97]  1.21288148  1.21288148 -1.09065311  1.21288148 -1.09065311  1.21288148
##    [103] -1.09065311 -1.09065311  0.06111418  1.21288148  1.21288148  1.21288148
##    [109] -1.09065311 -1.09065311  1.21288148  0.06111418 -1.09065311 -1.09065311
##    [115]  1.21288148 -1.09065311 -1.09065311 -1.09065311  1.21288148 -1.09065311
##    [121] -1.09065311 -1.09065311 -1.09065311 -1.09065311 -1.09065311  0.06111418
##    [127]  1.21288148 -1.09065311 -1.09065311  1.21288148 -1.09065311  0.06111418
##    [133]  0.06111418  0.06111418  1.21288148  0.06111418  1.21288148 -1.09065311
##    [139] -1.09065311 -1.09065311  0.06111418 -1.09065311  1.21288148  1.21288148
##    [145]  1.21288148 -1.09065311  1.21288148 -1.09065311  1.21288148  0.06111418
##    [151]  1.21288148  0.06111418  0.06111418  1.21288148  0.06111418 -1.09065311
##    [157]  0.06111418  1.21288148  0.06111418 -1.09065311 -1.09065311  1.21288148
##    [163] -1.09065311  0.06111418  0.06111418  0.06111418  0.06111418 -1.09065311
##    [169] -1.09065311  0.06111418  0.06111418  1.21288148  0.06111418 -1.09065311
##    [175] -1.09065311 -1.09065311 -1.09065311 -1.09065311 -1.09065311  0.06111418
##    [181]  0.06111418 -1.09065311  0.06111418  0.06111418  0.06111418  1.21288148
##    [187] -1.09065311 -1.09065311 -1.09065311  0.06111418 -1.09065311  0.06111418
##    [193]  0.06111418 -1.09065311  0.06111418 -1.09065311 -1.09065311  0.06111418
##    [199]  0.06111418  0.06111418  0.06111418 -1.09065311  0.06111418  0.06111418
##    [205]  0.06111418  0.06111418  0.06111418 -1.09065311  0.06111418 -1.09065311
##    [211] -1.09065311 -1.09065311 -1.09065311  0.06111418  0.06111418  0.06111418
##    [217]  0.06111418 -1.09065311 -1.09065311 -1.09065311 -1.09065311 -1.09065311
##    [223] -1.09065311  1.21288148  0.06111418  0.06111418  0.06111418  0.06111418
##    [229]  0.06111418  0.06111418  0.06111418 -1.09065311 -1.09065311 -1.09065311
##    [235] -1.09065311 -1.09065311  1.21288148  0.06111418  1.21288148  0.06111418
##    [241]  1.21288148  1.21288148 -1.09065311  1.21288148  1.21288148  0.06111418
```

```

## [247] 0.06111418 0.06111418 -1.09065311 -1.09065311 -1.09065311 0.06111418
## [253] 1.21288148 1.21288148 0.06111418 -1.09065311 -1.09065311 0.06111418
## [259] 0.06111418 0.06111418 -1.09065311 0.06111418 1.21288148 -1.09065311
## [265] 0.06111418 -1.09065311 -1.09065311 0.06111418 0.06111418 -1.09065311
## [271] -1.09065311 -1.09065311 -1.09065311 -1.09065311 0.06111418 0.06111418
## [277] -1.09065311 1.21288148 0.06111418 0.06111418 -1.09065311 -1.09065311
## [283] 1.21288148 -1.09065311 -1.09065311 -1.09065311 -1.09065311 0.06111418
## [289] -1.09065311 -1.09065311 -1.09065311 0.06111418 -1.09065311 0.06111418
## [295] -1.09065311 1.21288148 0.06111418 1.21288148 1.21288148 1.21288148
## [301] 0.06111418 1.21288148 -1.09065311 1.21288148 1.21288148 -1.09065311
## [307] -1.09065311 -1.09065311 -1.09065311 -1.09065311 -1.09065311 -1.09065311
## [313] -1.09065311 -1.09065311 0.06111418 0.06111418 -1.09065311 -1.09065311
## [319] -1.09065311 -1.09065311 1.21288148 -1.09065311 -1.09065311 -1.09065311
## [325] -1.09065311 0.06111418 0.06111418 1.21288148 0.06111418 1.21288148
## [331] -1.09065311 1.21288148 1.21288148 1.21288148 -1.09065311 0.06111418
## [337] 1.21288148 1.21288148 1.21288148 1.21288148 1.21288148 1.21288148
## [343] 1.21288148 0.06111418 1.21288148 1.21288148 1.21288148 0.06111418
## [349] 1.21288148 1.21288148 1.21288148 1.21288148 0.06111418 1.21288148
## [355] 1.21288148 -1.09065311 -1.09065311 1.21288148 1.21288148 -1.09065311
## [361] 0.06111418 1.21288148 1.21288148 -1.09065311 -1.09065311 -1.09065311
## [367] -1.09065311 0.06111418 1.21288148 -1.09065311 -1.09065311 -1.09065311
## [373] -1.09065311 -1.09065311 -1.09065311 0.06111418 1.21288148 -1.09065311
## [379] -1.09065311 -1.09065311 -1.09065311 1.21288148 -1.09065311 1.21288148
## [385] 0.06111418 0.06111418 1.21288148 1.21288148 0.06111418 -1.09065311
## [391] 1.21288148 1.21288148 -1.09065311 -1.09065311 -1.09065311 -1.09065311
## [397] 1.21288148 1.21288148 1.21288148 1.21288148 -1.09065311 1.21288148
## [403] 1.21288148 0.06111418 0.06111418 1.21288148 -1.09065311 -1.09065311
## [409] -1.09065311 0.06111418 -1.09065311 0.06111418 1.21288148 1.21288148
## [415] 0.06111418 0.06111418 1.21288148 0.06111418 0.06111418 -1.09065311
## [421] 0.06111418 1.21288148 1.21288148 1.21288148 0.06111418 1.21288148
## [427] 1.21288148 -1.09065311 1.21288148 1.21288148 -1.09065311 1.21288148
## [433] -1.09065311 1.21288148 -1.09065311 -1.09065311 1.21288148 0.06111418
## [439] 0.06111418 0.06111418 0.06111418 -1.09065311 -1.09065311 -1.09065311
## [445] 1.21288148 1.21288148 1.21288148 0.06111418 -1.09065311 1.21288148
## [451] -1.09065311 -1.09065311 1.21288148 1.21288148 1.21288148 0.06111418
## [457] 1.21288148 0.06111418 -1.09065311 1.21288148 -1.09065311 -1.09065311
## [463] 0.06111418 -1.09065311 -1.09065311 1.21288148 1.21288148 1.21288148
## [469] 1.21288148 1.21288148 0.06111418 1.21288148 1.21288148 -1.09065311
## [475] 1.21288148 1.21288148 0.06111418 1.21288148 1.21288148 1.21288148
## [481] 1.21288148 -1.09065311 -1.09065311 1.21288148 1.21288148 1.21288148
## [487] -1.09065311 1.21288148 -1.09065311 1.21288148

```

Module 2:

```

## Input : Scaled Rule Based Matrix (scaled_rules_int)
source("Module_2.R")

```

```

## [1] "Epsilon value used : 11"
## [1] "1 cluster(s) found!"
## [1] "Clustering Done!"
## [1] "Feature's cluster number saved"
## [1] "Grouping Highly Colinear Features Together :-"
## [1] "Clubbing features in a group together"

```

```
## [1] "Features Clubbed and incorporated in a new Data Frame!"
## [1] "Rule Based matrix with Colinearity Handled saved"
## [1] "PCA Loadings used to combine groups saved"
```

Output : Rule Based matrix with Colinearity Handled (new_data1) and PCA Loadings used to combine groups

Module 2 Output (Clusters):

```
groups_we_need
```

```
## [[1]]
## [1] "Otu000226" "Otu000645" "Otu001204"
```

Module 2 Output (PCA Loadings):

```
head(as.data.frame(t(PCA_loadings)))
```

```
##              PCA Loadings
## Otu000226 0.587870296106992
## Otu000645 0.572160149708752
## Otu001204 0.571875229434128
```

Module 2 Output (New Data Frame):

```
head(as.data.frame(new_data1))
```

```
##      Otu000153 Otu000653 Otu000813 Otu000460 Otu000620 Otu000397 Otu000115
## 1           1           8           15           36           43           50           57
## 2           1           8           15           36           43           53           57
## 3           1           8           15           36           43           50           57
## 4           1           8           15           36           43           50           57
## 5           1           8           15           36           43           50           57
## 6           1           8           15           36           43           50           57
##      Otu000400 Otu001119 Otu000359 Otu000315 Otu000485 Otu000169 Otu000334
## 1           64           71           78           85           92           99          106
## 2           64           71           78           85           92           99          106
## 3           64           71           83           85           92           99          106
## 4           64           71           78           85           92           99          106
## 5           64           71           78           85           92           99          106
## 6           64           71           78           85           92           99          106
##      Otu000186 Otu000121 Otu001568 Otu000211 Otu000413 Otu000374 Otu000124
## 1          113          120          127          134          141          148          155
## 2          113          120          127          134          141          148          155
## 3          113          120          127          134          141          148          155
## 4          113          120          127          134          141          148          156
## 5          113          120          127          134          141          148          155
## 6          113          120          127          134          141          148          156
##      Otu000393 Otu000358 Otu000013 Otu001109 Otu000284 Otu000095 Otu000060
## 1          162          169          176          183          190          197          204
## 2          162          169          176          183          190          197          204
## 3          162          169          176          183          190          197          204
```

## 4	162	169	179	183	190	197	204
## 5	162	169	176	183	190	203	204
## 6	162	169	177	183	190	197	204
##	0tu000108	0tu000306	0tu000375	0tu000079	0tu000046	0tu000713	0tu000038
## 1	211	218	225	232	239	246	253
## 2	211	218	225	232	239	246	253
## 3	211	218	225	232	239	246	253
## 4	212	218	225	232	239	246	253
## 5	217	218	225	232	239	246	259
## 6	213	218	225	232	239	246	253
##	0tu000294	0tu000684	0tu000084	0tu001914	0tu000331	0tu001212	0tu000042
## 1	260	267	274	281	288	295	302
## 2	260	267	274	281	288	295	302
## 3	260	267	274	281	288	296	302
## 4	260	267	274	281	288	295	303
## 5	260	267	274	281	288	295	302
## 6	260	267	274	281	288	295	303
##	0tu000454	0tu000283	0tu001205	0tu000117	0tu000984	0tu000165	0tu000183
## 1	309	316	323	330	337	344	351
## 2	309	316	323	330	337	344	351
## 3	309	316	323	330	337	344	352
## 4	309	316	323	331	337	344	351
## 5	309	316	323	330	337	344	351
## 6	309	316	323	330	337	344	351
##	0tu000012	0tu000242	0tu001485	0tu000507	0tu000394	0tu000391	0tu000639
## 1	358	365	372	379	386	393	400
## 2	358	365	372	379	386	393	400
## 3	358	365	372	379	386	393	400
## 4	358	365	372	379	386	393	400
## 5	358	365	372	379	386	393	400
## 6	358	365	372	379	386	393	400
##	0tu000035	0tu000201	0tu000378	0tu000402	0tu001169	0tu001023	0tu001162
## 1	407	414	421	428	435	442	449
## 2	407	414	421	429	435	442	449
## 3	407	414	421	428	435	442	449
## 4	407	414	421	430	435	442	449
## 5	407	414	421	428	435	442	449
## 6	407	414	421	428	435	442	449
##	0tu001004	0tu000071	0tu000717	0tu000589	0tu000800	0tu000103	0tu001098
## 1	456	463	470	477	484	491	498
## 2	456	463	470	477	484	491	498
## 3	456	463	470	477	484	491	498
## 4	456	463	470	477	484	491	498
## 5	456	463	470	477	484	491	498
## 6	456	463	470	477	484	491	498
##	0tu000588	0tu000288	0tu001209	0tu000846	0tu000099	0tu001438	0tu000853
## 1	505	519	526	533	540	547	554
## 2	505	519	526	533	540	549	554
## 3	505	519	526	533	540	547	554
## 4	505	519	526	533	541	547	554
## 5	505	519	526	533	540	547	554
## 6	505	519	526	533	540	547	554
##	0tu000785	0tu000349	0tu000640	0tu000100	0tu000175	0tu000185	0tu005596
## 1	561	568	575	582	589	596	603

```

## 2      561      568      575      582      589      596      603
## 3      561      568      575      582      589      596      603
## 4      561      568      575      582      589      596      603
## 5      561      568      575      582      589      596      603
## 6      561      568      575      582      589      596      603
##      0tu000790 0tu000252 0tu001350 0tu000385 0tu000407 0tu002730 0tu000303
## 1      610      617      624      631      638      645      652
## 2      610      617      624      631      638      645      652
## 3      610      617      624      632      638      645      652
## 4      610      617      624      631      638      645      652
## 5      610      617      624      631      638      645      652
## 6      610      617      624      632      638      645      652
##      0tu000821 0tu000632 0tu000039 0tu000150 0tu000179 0tu000952
## 1      659      666      673      680      687      694
## 2      659      666      673      680      687      694
## 3      660      666      673      680      687      694
## 4      659      666      674      680      687      694
## 5      659      666      673      680      687      694
## 6      659      666      674      680      687      694
##      0tu000226~0tu000645~0tu001204
## 1
## 2
## 3
## 4
## 5
## 6
##      322.3259
##      322.3259
##      322.3259
##      322.3259
##      322.3259
##      322.3259

```

Module 3:

```

## Input : Rule Based matrix with Colinearity Handled (new_data1) and PCA Loadings used to combine groups
source("Module_3.R")

```

```

## [1] "Feature Parameters computed and saved"

```

```

## Output : Feature Parameters (feature_parameters)

```

Module 3 Output (Adaptive LASSO Results):

```

head(as.data.frame(feature_parameters))

```

```

##      ADres
## 0tu000153  3.89923235
## 0tu000653 -3.46555890
## 0tu000813 -0.52765964
## 0tu000460 -1.48213454
## 0tu000620  0.01519237
## 0tu000397 -0.63545891

```

Module 4 (TSEA - Specify Disease):


```
#Diseases to look for in TSEA
disease <- c("Colorectal","Crohn","Colon")
```

Module 4 (TSEA Type of feature):

```
TSEA_feature <- "OTU"
```

Module 4 (TSEA - OTU): If Features are OTU and need to be changed into appropriate Microbes for TSEA

```
if(TSEA_feature == "OTU"){
#List of Microbes from selected features (OTU)
#OTU to Microbes
OTU_file <- read.table("final.csv", header = 1)
OTU_index <- which(OTU_file$OTU %in% rownames(feature_parameters))
selected_OTU <- OTU_file[OTU_index,]
feature_inorder <- selected_OTU$OTU
write.csv(selected_OTU,"OTU Microbes Selected Table.csv")

#Valid Microbe Names
OTU_network <- c()
taxa <- strsplit(as.character(selected_OTU$Taxonomy),";")
for(i in 1:length(taxa)){
  if(taxa[[i]][1] == "unclassified(100)") {
    OTU_network <- c(OTU_network,"unclassified")
  } else {
    for(j in rev(taxa[[i]])){
      mname <- substr( j , 1 , nchar(j)-5)
      if(mname != "unclassified"){
        OTU_network <- c(OTU_network,mname)
        break()}
    }
  }
}

Name_Change <- as.data.frame(OTU_network)
rownames(Name_Change) <- feature_inorder
write.csv(Name_Change,"Features to Microbes for TSEA.csv")
}
```

Module 4 (TSEA - Microbes of Different Taxa Level): If Features are Microbes of Different Taxa Level and need to be changed into appropriate Microbes for TSEA

```
if(TSEA_feature == "Microbes"){
#List of Microbes from selected features (Microbes)
Microbes_name <- substring(colnames(rules_int),4)
OTU_network <- c()
for(i in Microbes_name){
  n <- strsplit(i,split='.', fixed=TRUE)[[1]]
  if((length(n)>1)&&(n[2] == "unidentified")){
    OTU_network <- c(OTU_network,sprintf("%s.%s",n[1],n[2]))
  } else {
```

```

    OTU_network <- c(OTU_network,n[1])
  }
}
feature_inorder <- colnames(rules_int)

Name_Change <- as.data.frame(OTU_network)
rownames(Name_Change) <- feature_inorder
write.csv(Name_Change,"Features to Microbes for TSEA.csv")
}

```

Module 4 (TSEA - The names used for TSEA with the feature associated):

```
head(as.data.frame(Name_Change))
```

```

##           OTU_network
## Otu000012      Blautia
## Otu000013  Lachnospiraceae
## Otu000035    Collinsella
## Otu000038  Lachnospiraceae
## Otu000039 Erysipelotrichaceae
## Otu000042  Ruminococcaceae

```

Module 4 (TSEA - The names used for TSEA with the feature associated):

```
Microbes <- unique(OTU_network)
Microbes
```

```

## [1] "Blautia"           "Lachnospiraceae"
## [3] "Collinsella"       "Erysipelotrichaceae"
## [5] "Ruminococcaceae"   "Bacteroides"
## [7] "Odoribacter"       "Coprococcus"
## [9] "Pasteurellaceae"   "Clostridium_XlV"
## [11] "Bilophila"         "Catenibacteriu"
## [13] "Dore"              "Prevotella"
## [15] "Clostridiales_unclassified" "Desulfovibrio"
## [17] "Porphyromonas"     "Clostridium_XlVb"
## [19] "Ruminococcus"      "Flavonifractor"
## [21] "Fusobacterium"     "Coriobacteriaceae"
## [23] "Firmicutes_unclassified" "Subdoligranulu"
## [25] "Alistipes"         "Barnesiella"
## [27] "Bacteria_unclassified" "Peptococcus"
## [29] "Megamonas"         "Gemella"
## [31] "Mogibacterium"     "Coprobacillus"
## [33] "Prevotell"         "Parvimonas"
## [35] "Peptostreptococcus" "Anaerococcus"
## [37] "Clostridia_unclassified" "Roseburi"
## [39] "Dialister"         "Eikenell"
## [41] "Corynebacterium"   "Clostridium_sensu_stricto"
## [43] "Megasphaera"       "Porphyromonadaceae"
## [45] "Lachnoanaerobaculum" "Clostridium_XVIII"
## [47] "Howardella"

```

Module 4 (TSEA - The names used for TSEA with the feature associated):

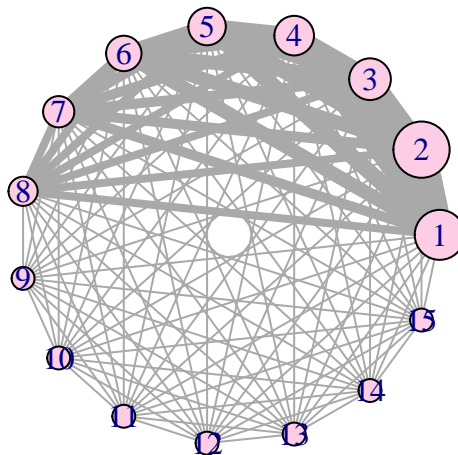
```
## Input : List of Microbes
source("Module_4(TSEA Network).R")

## [1] "----Microbiome Analyst----"
## [1] "Init MicrobiomeAnalyst!"
## [1] "Loaded files from MetaboAnalyst web-server."
## [1] "Loaded files from MetaboAnalyst web-server."
## [1] "Mix Taxa TSEA Results Calculated"
## [1] "Mix Taxa TSEA Disease Specific Results Calculated"
## [1] "Calculating Adjacency Matrix for Network"

## Output : Network and Network Legends with Node size (Legends)
```

Module 4 (TSEA Network):

```
plot(g, layout=layout_in_circle, vertex.size=vertex_wt, edge.width = E(g)$weight)
```



Module 4 (TSEA Network Legends):

```
as.data.frame(Network_Info)
```

##	Node	Microbe Names	Node Size
----	------	---------------	-----------

## 1	1	Lachnospiraceae	14
## 2	2	Blautia	17
## 3	3	Collinsella	10
## 4	4	Erysipelotrichaceae	9
## 5	5	Ruminococcaceae	8
## 6	6	Bacteroides	7
## 7	7	Odoribacter	5
## 8	8	Coproccoccus	4
## 9	9	Pasteurellaceae	1
## 10	10	Clostridium_XIV	1
## 11	11	Bilophila	1
## 12	12	Catenibacteriu	1
## 13	13	Dore	1
## 14	14	Prevotella	1
## 15	15	Clostridiales_unclassified	1

Module 4 (Infusing Data Driven Information): TSEA Network and Adaptive LASSO Results

```
## Input : TSEA Network and Adaptive LASSO Results
Cluster_Parameters <- c()
Cluster_OTU_name <- c()
for (i in Network_Info[, "Microbe Names"]) {
  index <- which(OTU_network %in% i)
  OTU <- as.character(feature_inorder[index])
  Cluster_OTU_name <- append(Cluster_OTU_name, list(OTU))
  if(length(OTU) > 1){
    OTUs_val <- c()
    for (j in OTU) {
      OTUs_val <- c( OTUs_val , abs(feature_parameters[j,]) )
    }
    CP <- (sum(OTUs_val)/length(OTUs_val))[1]
  } else {
    CP <- abs(feature_parameters[OTU,])
  }
  Cluster_Parameters <- c( Cluster_Parameters , CP )
}
Data_Bio_Driven <- cbind(Network_Info, Cluster_Parameters)
rownames(Data_Bio_Driven) <- NULL
write.csv(Data_Bio_Driven, "Biological Network with Data Driven Results fused.csv")
## Output : Data Driven Cluster Parameters added
```

Module 4 (Infusing Data Driven Information): TSEA Network and Adaptive LASSO Results

```
head(as.data.frame(Data_Bio_Driven))
```

##	Node	Microbe Names	Node Size	Cluster_Parameters
## 1	1	Lachnospiraceae	14	0.733759448275849
## 2	2	Blautia	17	0.0226241940657708
## 3	3	Collinsella	10	0.973703215058115
## 4	4	Erysipelotrichaceae	9	1.88183892877409
## 5	5	Ruminococcaceae	8	0.653890940427142
## 6	6	Bacteroides	7	0.410738558507856

Module 4 (Infusing Data Driven Information): Module 2 Clusters and TSEA Network

```
## Input : Module 2 Clusters and TSEA Network  
source("Module_4(Data Driven Network).R")
```

```
## [1] "Calculating Edges and Nodes to be added for the Data Driven Network"
```

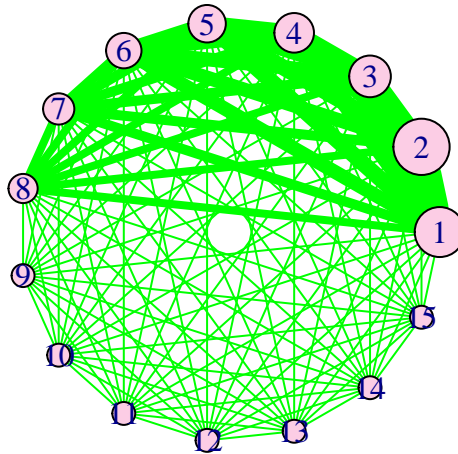
```
## [1] "Final Fused Network Saved!"
```

```
## [1] "Final Fused Network Cluster Information Saved!"
```

```
## Output : Network with Data Driven Clusters
```

Module 4 (Infusing Data Driven Information): Module 2 Clusters and TSEA Network

```
#Green Edges <- TSEA  
#Red Edges <- Data Driven Clusters  
#Pink nodes <- TSEA  
#White nodes <- Data Driven Clusters  
plot(gh, layout=layout_in_circle, vertex.size=vertex_wt_gh, edge.width = E(gh)$weight, edge.color=col_edges)
```



Module 4 (Infusing Data Driven Information): Module 2 Clusters and TSEA Network

```
head(as.data.frame(Data_Bio_Driven_with_clusters))
```

##	Node	Microbe Names	Node	Size	Cluster_Parameters
## 1	1	Lachnospiraceae	14	0.733759448275849	
## 2	2	Blautia	17	0.0226241940657708	
## 3	3	Collinsella	10	0.973703215058115	
## 4	4	Erysipelotrichaceae	9	1.88183892877409	
## 5	5	Ruminococcaceae	8	0.653890940427142	
## 6	6	Bacteroides	7	0.410738558507856	