Microbiome_Data_Analysis

Set Working Directiory :

```
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

## corrplot 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("Abundance_D3_top_100.csv")
labels <- read.csv("Chemical_Administrated.csv")

# Create labels for prediction
label_dat <- as.numeric(factor(labels$x))

# Choose Microbiome Data
df_data1 <- Data_Set_1[2:101]
data1 <- data.matrix(df_data1)
```

Input Dataset :

```
head(Data_Set_1)
```

```
##   X Otu00001 Otu00057 Otu00023 Otu00002 Otu00046 Otu00003 Otu00213 Otu00015
## 1 1    24945        0        3      123      103       48        0     1292
## 2 2     6773        2       14     9084       14       21        0      515
## 3 3    10172        4        1    20583       47       81        0     2633
## 4 4    24091        0       15      111      107       29        0     7459
## 5 5     4903        0        0     6409        7       11        0      662
## 6 6     6658        2        1     8031       22       18        0      277
##   Otu00007 Otu00049 Otu00083 Otu00203 Otu00207 Otu00018 Otu00028 Otu00013
## 1        1        1       22        1        0       18       10       14
## 2        2        1        1        3        0        4        3        5
## 3        1        0        9       22        0       22       11        7
## 4        1        3       52       14        0       91        3       10
## 5        1        0        2       28        0        2        0        0
## 6        0        2        4       14        0        3        1        5
##   Otu00300 Otu00033 Otu00171 Otu00073 Otu00108 Otu00075 Otu00014 Otu00101
## 1        0       98        0       20        0        2       18       28
## 2        0       19        0       20        0       29        7        4
## 3        0      150        0        9        0        2       55       19
## 4        0      191        0       60        0        2       12       38
## 5        0        6        0        2        0        2        1        1
## 6        0       10        0       12        0        3        5       19
##   Otu00005 Otu00027 Otu00154 Otu00077 Otu00036 Otu00035 Otu00006 Otu00050
## 1      104        8       19        0        1      427      122        2
## 2       25        0        1        0        4       84       33        0
## 3      138        9       10        0       13       34       62        2
## 4      152       14       23        1        3      954      107        8
## 5       20        0        2        0        3       17       26        1
## 6       15        2        5        0        3       22       22        2
##   Otu00559 Otu00056 Otu00022 Otu00009 Otu00393 Otu00024 Otu00189 Otu00012
## 1        0       73        4       40        0        8        0        7
## 2        0       10        6        2        0       15        0        6
## 3        0       21        0       13        0        4        0       10
## 4        0       51        3       14        0        7        0       27
## 5        0        1        1        1        0        5        0        4
## 6        0        9        0        1        0        7        0        1
##   Otu00011 Otu00162 Otu00346 Otu00090 Otu00111 Otu00048 Otu00194 Otu00119
## 1       25        0        0        0        2        2        4        0
## 2        9        0        0        0        0        3        0        1
## 3       58        0        0        1        0        1        0        0
## 4       20        0        1        1        0       11        0        1
## 5        4        0        0        0        0        0        0        0
## 6        5        3        0        0        0        3        0        0
##   Otu00020 Otu00039 Otu00044 Otu00081 Otu00275 Otu00184 Otu00099 Otu00059
## 1       18        0        3        7       11        1        1        5
## 2        3        3        0        0        5        0        0        0
## 3       47        4        3        4        7        0        0        6
## 4       19        4        0        1       13        0        0        1
## 5        5        1        4        0        0        0        0        0
## 6        1        1        4        0        8        0        0        1
##   Otu00040 Otu00160 Otu00010 Otu00512 Otu00008 Otu00004 Otu00107 Otu00053
## 1        1       12       21        0       12       59        0        5
```

```
## 2        1        1        4        0        7       58        0        2
## 3        3        2       71        0       61       83        1       13
## 4        1       11       34        0       28       55        1        6
## 5        0        0        2        0        1       16        0        1
## 6        1        5        6        0        9       30        0        5
##   Otu00078 Otu00110 Otu00091 Otu00491 Otu00069 Otu00079 Otu00037 Otu00029
## 1        5        3        0        0        1        1       14        7
## 2        1        0        5        0        1        0       12        5
## 3        2       12        2        0        4        1       19        0
## 4       10        2        0        0        2        0       15        1
## 5        0        0        4        0        0        0        0        0
## 6        2       10       10        0        0        0        4        0
##   Otu00178 Otu00038 Otu00041 Otu00092 Otu00234 Otu00514 Otu00058 Otu00047
## 1        0       90        3        0        0        0       18       59
## 2        0       18        1        0        1        0        1       90
## 3        0       57        3        0        6        0        7      110
## 4        0      122       25        1       13        0        1       59
## 5        0        4        1        0        0        0        1        5
## 6        0       30        0        0        1        0        0        4
##   Otu00067 Otu00043 Otu00085 Otu00054 Otu00122 Otu00068 Otu00088 Otu00126
## 1        1        2        7       11       10        3       16        0
## 2        0        4        0        3        2        0      129        0
## 3        5        0        8        6        1        0       14        1
## 4        1        5        0        0        9        2       10        0
## 5        1        1        0        1        0        0        1        0
## 6        0        1        0        7        0        0        0        0
##   Otu00096 Otu00031 Otu00034 Otu00131 Otu00061 Otu00324 Otu00285 Otu00045
## 1        0        0        3        0        1        0        0        2
## 2        0        0        5        0        0        0        0        2
## 3        1       21        6        3        7        0        0       11
## 4        5        2        0        0        0        4        0        2
## 5        0        0        0        0        0        0        0        1
## 6        2        1        3        0        0        0        0        1
##   Otu00032 Otu00120 Otu00264 Otu00607
## 1        4        1        0        0
## 2        4        7        0        0
## 3       25        0        0        0
## 4        4        0        0        0
## 5        1        0        0        1
## 6        3        0        0        0
```

Input Data for Module 1 (Features) :

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

```
##   Otu00001 Otu00057 Otu00023 Otu00002 Otu00046 Otu00003 Otu00213 Otu00015
## 1    24945        0        3      123      103       48        0     1292
## 2     6773        2       14     9084       14       21        0      515
## 3    10172        4        1    20583       47       81        0     2633
## 4    24091        0       15      111      107       29        0     7459
## 5     4903        0        0     6409        7       11        0      662
## 6     6658        2        1     8031       22       18        0      277
##   Otu00007 Otu00049 Otu00083 Otu00203 Otu00207 Otu00018 Otu00028 Otu00013
```

```
##   1         1         1        22         1         0        18        10        14
##   2         2         1         1         3         0         4         3         5
##   3         1         0         9        22         0        22        11         7
##   4         1         3        52        14         0        91         3        10
##   5         1         0         2        28         0         2         0         0
##   6         0         2         4        14         0         3         1         5
##     Otu00300 Otu00033 Otu00171 Otu00073 Otu00108 Otu00075 Otu00014 Otu00101
##   1         0        98         0        20         0         2        18        28
##   2         0        19         0        20         0        29         7         4
##   3         0       150         0         9         0         2        55        19
##   4         0       191         0        60         0         2        12        38
##   5         0         6         0         2         0         2         1         1
##   6         0        10         0        12         0         3         5        19
##     Otu00005 Otu00027 Otu00154 Otu00077 Otu00036 Otu00035 Otu00006 Otu00050
##   1       104         8        19         0         1       427       122         2
##   2        25         0         1         0         4        84        33         0
##   3       138         9        10         0        13        34        62         2
##   4       152        14        23         1         3       954       107         8
##   5        20         0         2         0         3        17        26         1
##   6        15         2         5         0         3        22        22         2
##     Otu00559 Otu00056 Otu00022 Otu00009 Otu00393 Otu00024 Otu00189 Otu00012
##   1         0        73         4        40         0         8         0         7
##   2         0        10         6         2         0        15         0         6
##   3         0        21         0        13         0         4         0        10
##   4         0        51         3        14         0         7         0        27
##   5         0         1         1         1         0         5         0         4
##   6         0         9         0         1         0         7         0         1
##     Otu00011 Otu00162 Otu00346 Otu00090 Otu00111 Otu00048 Otu00194 Otu00119
##   1        25         0         0         0         2         2         4         0
##   2         9         0         0         0         0         3         0         1
##   3        58         0         0         1         0         1         0         0
##   4        20         0         1         1         0        11         0         1
##   5         4         0         0         0         0         0         0         0
##   6         5         3         0         0         0         3         0         0
##     Otu00020 Otu00039 Otu00044 Otu00081 Otu00275 Otu00184 Otu00099 Otu00059
##   1        18         0         3         7        11         1         1         5
##   2         3         3         0         0         5         0         0         0
##   3        47         4         3         4         7         0         0         6
##   4        19         4         0         1        13         0         0         1
##   5         5         1         4         0         0         0         0         0
##   6         1         1         4         0         8         0         0         1
##     Otu00040 Otu00160 Otu00010 Otu00512 Otu00008 Otu00004 Otu00107 Otu00053
##   1         1        12        21         0        12        59         0         5
##   2         1         1         4         0         7        58         0         2
##   3         3         2        71         0        61        83         1        13
##   4         1        11        34         0        28        55         1         6
##   5         0         0         2         0         1        16         0         1
##   6         1         5         6         0         9        30         0         5
##     Otu00078 Otu00110 Otu00091 Otu00491 Otu00069 Otu00079 Otu00037 Otu00029
##   1         5         3         0         0         1         1        14         7
##   2         1         0         5         0         1         0        12         5
##   3         2        12         2         0         4         1        19         0
##   4        10         2         0         0         2         0        15         1
##   5         0         0         4         0         0         0         0         0
```

```
## 6        2       10       10        0        0        0        4        0
##   Otu00178 Otu00038 Otu00041 Otu00092 Otu00234 Otu00514 Otu00058 Otu00047
## 1        0       90        3        0        0        0       18       59
## 2        0       18        1        0        1        0        1       90
## 3        0       57        3        0        6        0        7      110
## 4        0      122       25        1       13        0        1       59
## 5        0        4        1        0        0        0        1        5
## 6        0       30        0        0        1        0        0        4
##   Otu00067 Otu00043 Otu00085 Otu00054 Otu00122 Otu00068 Otu00088 Otu00126
## 1        1        2        7       11       10        3       16        0
## 2        0        4        0        3        2        0      129        0
## 3        5        0        8        6        1        0       14        1
## 4        1        5        0        0        9        2       10        0
## 5        1        1        0        1        0        0        1        0
## 6        0        1        0        7        0        0        0        0
##   Otu00096 Otu00031 Otu00034 Otu00131 Otu00061 Otu00324 Otu00285 Otu00045
## 1        0        0        3        0        1        0        0        2
## 2        0        0        5        0        0        0        0        2
## 3        1       21        6        3        7        0        0       11
## 4        5        2        0        0        0        4        0        2
## 5        0        0        0        0        0        0        0        1
## 6        2        1        3        0        0        0        0        1
##   Otu00032 Otu00120 Otu00264 Otu00607
## 1        4        1        0        0
## 2        4        7        0        0
## 3       25        0        0        0
## 4        4        0        0        0
## 5        1        0        0        1
## 6        3        0        0        0
```

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

```
#Labels
as.character(labels$x)
```

```
##   [1] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##   [5] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##   [9] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [13] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [17] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [21] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [25] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [29] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [33] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [37] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [41] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [45] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [49] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [53] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [57] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [61] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [65] "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep" "Vanc/Met/Strep"
##  [69] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
##  [73] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
```

```
##  [77] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
##  [81] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
##  [85] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
##  [89] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
##  [93] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
##  [97] "Met"            "Met"            "Met"            "Met"
## [101] "Met"            "Met"            "Met"            "Met"
## [105] "Met"            "Met"            "Met"            "Met"
## [109] "Met"            "Met"            "Met"            "Met"
## [113] "Met"            "Met"            "Met"            "Met"
## [117] "Met"            "Met"            "Met"            "Met"
## [121] "Met"            "Met"            "Met"            "Met"
## [125] "Met"            "Met"            "Met"            "Met"
## [129] "Met"            "Met"            "Met"            "NoAbx"
## [133] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [137] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [141] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [145] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [149] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [153] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [157] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [161] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [165] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [169] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [173] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [177] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [181] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [185] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [189] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [193] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [197] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [201] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [205] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [209] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [213] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [217] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [221] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [225] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [229] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [233] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [237] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [241] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [245] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [249] "NoAbx"          "NoAbx"          "NoAbx"          "NoAbx"
## [253] "NoAbx"          "NoAbx"          "NoAbx"          "Strep/Met"
## [257] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [261] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [265] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [269] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [273] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [277] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [281] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [285] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
## [289] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep/Met"
```

```
## [293] "Strep/Met"      "Strep/Met"      "Strep/Met"      "Strep"
## [297] "Strep"          "Strep"          "Strep"          "Strep"
## [301] "Strep"          "Strep"          "Strep"          "Strep"
## [305] "Strep"          "Strep"          "Strep"          "Strep"
## [309] "Strep"          "Strep"          "Strep"          "Strep"
## [313] "Strep"          "Strep"          "Strep"          "Strep"
## [317] "Strep"          "Strep"          "Strep"          "Strep"
## [321] "Strep"          "Strep"          "Strep"          "Strep"
## [325] "Strep"          "Strep"          "Strep"          "Strep"
## [329] "Strep"          "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [333] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [337] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [341] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [345] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [349] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [353] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [357] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [361] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [365] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [369] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [373] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [377] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [381] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [385] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [389] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [393] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [397] "Vanc/Met"       "Vanc/Met"       "Vanc/Met"       "Vanc/Met"
## [401] "Vanc/Met"       "Vanc"           "Vanc"           "Vanc"
## [405] "Vanc"           "Vanc"           "Vanc"           "Vanc"
## [409] "Vanc"           "Vanc"           "Vanc"           "Vanc"
## [413] "Vanc"           "Vanc"           "Vanc"           "Vanc"
## [417] "Vanc"           "Vanc"           "Vanc"           "Vanc"
## [421] "Vanc"           "Vanc"
```

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

```
#Desired Labels
label_dat
```

```
##   [1] 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
##  [38] 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 2 2 2 2 2 2
##  [75] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1
## [112] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
## [149] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
## [186] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
## [223] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 4 4 4
## [260] 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 3
## [297] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 6 6 6 6
## [334] 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6
## [371] 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 5 5 5 5 5 5
## [408] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
```

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))
```

```
##   Otu00001 Otu00057 Otu00023 Otu00002 Otu00046 Otu00003 Otu00213 Otu00015
## 1        1        8       15       22       29       36       43       50
## 2        1        8       15       22       29       36       43       50
## 3        1        8       15       22       29       36       43       50
## 4        1        8       15       23       29       36       43       50
## 5        1        8       15       22       29       36       43       50
## 6        1        8       15       23       29       36       43       50
##   Otu00007 Otu00049 Otu00083 Otu00203 Otu00207 Otu00018 Otu00028 Otu00013
## 1       57       64       71       78       85       92       99      106
## 2       57       64       71       78       85       92       99      106
## 3       57       64       71       78       85       92       99      107
## 4       57       64       71       78       85       92       99      106
## 5       57       64       71       78       85       92       99      107
## 6       57       64       71       79       85       92       99      106
##   Otu00300 Otu00033 Otu00171 Otu00073 Otu00108 Otu00075 Otu00014 Otu00101
## 1      113      120      127      134      141      148      155      162
## 2      113      126      127      134      141      148      155      162
## 3      113      121      127      134      141      148      155      162
## 4      113      120      127      134      141      148      155      162
## 5      113      122      127      134      141      148      155      162
## 6      113      120      127      134      141      148      155      162
##   Otu00005 Otu00027 Otu00154 Otu00077 Otu00036 Otu00035 Otu00006 Otu00050
## 1      169      176      183      190      197      204      211      218
## 2      169      176      183      190      197      204      211      218
## 3      169      176      183      190      197      204      211      218
## 4      169      176      183      190      197      204      211      218
## 5      169      176      183      190      197      204      211      218
## 6      169      176      183      190      197      204      211      218
##   Otu00559 Otu00056 Otu00022 Otu00009 Otu00393 Otu00024 Otu00189 Otu00012
## 1      225      232      239      246      253      260      267      274
## 2      225      232      239      246      253      260      267      274
## 3      225      232      239      246      253      260      267      274
## 4      225      232      239      246      253      260      267      274
## 5      225      232      239      246      253      260      267      274
## 6      225      232      239      246      253      260      267      274
##   Otu00011 Otu00162 Otu00346 Otu00090 Otu00111 Otu00048 Otu00194 Otu00119
## 1      281      288      295      302      309      316      323      330
```

```
## 2      281      288      295      302      309      316      323      330
## 3      281      288      295      302      309      316      323      330
## 4      281      288      295      302      309      316      323      330
## 5      281      288      295      302      309      316      323      330
## 6      281      288      295      302      309      316      323      330
##   Otu00020 Otu00039 Otu00044 Otu00081 Otu00275 Otu00184 Otu00099 Otu00059
## 1      337      344      351      358      365      372      379      386
## 2      337      344      351      358      365      372      379      386
## 3      337      344      351      358      365      372      379      386
## 4      337      344      351      358      365      372      379      386
## 5      337      344      351      358      365      372      379      386
## 6      337      344      351      358      365      372      379      386
##   Otu00040 Otu00160 Otu00010 Otu00512 Otu00008 Otu00004 Otu00107 Otu00053
## 1      393      400      407      414      421      428      435      442
## 2      393      400      407      414      421      428      435      442
## 3      393      400      407      414      421      428      435      442
## 4      393      400      407      414      421      428      435      442
## 5      393      400      407      414      421      428      435      442
## 6      393      400      407      414      421      428      435      442
##   Otu00078 Otu00110 Otu00091 Otu00491 Otu00069 Otu00079 Otu00037 Otu00029
## 1      449      456      463      470      477      484      491      498
## 2      449      456      463      470      477      484      491      498
## 3      449      456      463      470      477      484      491      498
## 4      449      456      463      470      477      484      491      498
## 5      449      456      463      470      477      484      491      498
## 6      449      456      463      470      477      484      491      498
##   Otu00178 Otu00038 Otu00041 Otu00092 Otu00234 Otu00514 Otu00058 Otu00047
## 1      505      512      519      526      533      540      547      554
## 2      505      512      519      526      533      540      547      554
## 3      505      512      519      526      533      540      547      554
## 4      505      512      519      526      533      540      547      554
## 5      505      512      519      526      533      540      547      554
## 6      505      512      519      526      533      540      547      554
##   Otu00067 Otu00043 Otu00085 Otu00054 Otu00122 Otu00068 Otu00088 Otu00126
## 1      561      568      575      582      589      596      603      610
## 2      561      568      575      582      589      596      603      610
## 3      561      568      575      582      589      596      603      610
## 4      561      568      575      582      589      596      603      610
## 5      561      568      575      582      589      596      603      610
## 6      561      568      575      582      589      596      603      610
##   Otu00096 Otu00031 Otu00034 Otu00131 Otu00061 Otu00324 Otu00285 Otu00045
## 1      617      624      631      638      645      652      659      666
## 2      617      624      631      638      645      652      659      666
## 3      617      624      631      638      645      652      659      666
## 4      617      624      631      638      645      652      659      666
## 5      617      624      631      638      645      652      659      666
## 6      617      624      631      638      645      652      659      666
##   Otu00032 Otu00120 Otu00264 Otu00607
## 1      673      680      687      694
## 2      673      680      687      694
## 3      673      680      687      694
## 4      673      680      687      694
## 5      673      680      687      694
## 6      673      680      687      694
```

Module 1 Output (Labels):

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

```
##   [1] -0.8076970 -0.8076970  1.1395522  1.6263645  1.1395522  1.6263645
##   [7] -0.8076970  0.1659276 -0.8076970  0.1659276  0.6527399 -0.8076970
##  [13]  1.1395522  0.1659276  1.6263645  0.1659276 -0.8076970 -0.8076970
##  [19]  1.1395522  1.6263645  1.1395522  1.1395522  0.6527399 -0.8076970
##  [25] -0.8076970  0.1659276  1.1395522  0.1659276 -0.8076970 -0.8076970
##  [31]  1.6263645 -0.8076970 -0.8076970 -0.8076970 -0.8076970  1.6263645
##  [37]  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645
##  [43]  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645
##  [49]  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645
##  [55]  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645
##  [61]  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645
##  [67]  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645
##  [73]  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645  1.6263645
##  [79]  1.6263645  1.6263645  1.6263645  1.6263645 -0.8076970 -0.8076970
##  [85] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
##  [91] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
##  [97] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [103] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [109] -0.8076970 -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093
## [115] -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093
## [121] -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093
## [127] -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093
## [133] -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093 -1.2945093
## [139] -1.2945093 -1.2945093 -1.2945093 -1.2945093 -0.8076970 -0.8076970
## [145] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [151] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [157] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [163] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [169] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [175] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [181] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [187] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [193] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [199] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [205] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [211] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [217] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [223] -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970 -0.8076970
## [229] -0.8076970 -0.8076970 -0.8076970  0.1659276  0.1659276  0.1659276
## [235]  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276
## [241]  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276
## [247]  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276
## [253]  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276  0.1659276
## [259]  0.1659276  0.1659276  0.1659276  0.1659276 -0.3208847 -0.3208847
## [265] -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847
## [271] -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847
## [277] -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847
## [283] -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847
## [289] -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847 -0.3208847
## [295] -0.3208847  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522
```

```
## [301]  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522
## [307]  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522
## [313]  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522
## [319]  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522
## [325]  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522
## [331]  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522  1.1395522
## [337]  0.6527399  0.6527399  0.6527399  0.6527399  0.6527399  0.6527399
## [343]  0.6527399  0.6527399  0.6527399  0.6527399  0.6527399  0.6527399
## [349]  0.6527399  0.6527399  0.6527399  0.6527399  0.6527399  0.6527399
## [355]  0.6527399
```

Module 2:

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

```
## [1] "Epsilon value used : 5.5"
## [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 gro
```

Module 2 Output (Clusters):

```
groups_we_need
```

```
## [[1]]
## [1] "Otu00018" "Otu00029"
```

Module 2 Output (PCA Loadings):

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

```
##                PCA Loadings
## Otu00018 0.711814366997705
## Otu00029 0.702367643713502
```

Module 2 Output (New Data Frame):

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

```
##   Otu00001 Otu00057 Otu00023 Otu00002 Otu00046 Otu00003 Otu00213 Otu00015
## 1        1        8       15       22       29       36       43       50
## 2        1        8       15       22       29       36       43       50
```

```
## 3        1        8       15       22       29       36       43       50
## 4        1        8       15       23       29       36       43       50
## 5        1        8       15       22       29       36       43       50
## 6        1        8       15       23       29       36       43       50
##   Otu00007 Otu00049 Otu00083 Otu00203 Otu00207 Otu00028 Otu00013 Otu00300
## 1       57       64       71       78       85       99      106      113
## 2       57       64       71       78       85       99      106      113
## 3       57       64       71       78       85       99      107      113
## 4       57       64       71       78       85       99      106      113
## 5       57       64       71       78       85       99      107      113
## 6       57       64       71       79       85       99      106      113
##   Otu00033 Otu00171 Otu00073 Otu00108 Otu00075 Otu00014 Otu00101 Otu00005
## 1      120      127      134      141      148      155      162      169
## 2      126      127      134      141      148      155      162      169
## 3      121      127      134      141      148      155      162      169
## 4      120      127      134      141      148      155      162      169
## 5      122      127      134      141      148      155      162      169
## 6      120      127      134      141      148      155      162      169
##   Otu00027 Otu00154 Otu00077 Otu00036 Otu00035 Otu00006 Otu00050 Otu00559
## 1      176      183      190      197      204      211      218      225
## 2      176      183      190      197      204      211      218      225
## 3      176      183      190      197      204      211      218      225
## 4      176      183      190      197      204      211      218      225
## 5      176      183      190      197      204      211      218      225
## 6      176      183      190      197      204      211      218      225
##   Otu00056 Otu00022 Otu00009 Otu00393 Otu00024 Otu00189 Otu00012 Otu00011
## 1      232      239      246      253      260      267      274      281
## 2      232      239      246      253      260      267      274      281
## 3      232      239      246      253      260      267      274      281
## 4      232      239      246      253      260      267      274      281
## 5      232      239      246      253      260      267      274      281
## 6      232      239      246      253      260      267      274      281
##   Otu00162 Otu00346 Otu00090 Otu00111 Otu00048 Otu00194 Otu00119 Otu00020
## 1      288      295      302      309      316      323      330      337
## 2      288      295      302      309      316      323      330      337
## 3      288      295      302      309      316      323      330      337
## 4      288      295      302      309      316      323      330      337
## 5      288      295      302      309      316      323      330      337
## 6      288      295      302      309      316      323      330      337
##   Otu00039 Otu00044 Otu00081 Otu00275 Otu00184 Otu00099 Otu00059 Otu00040
## 1      344      351      358      365      372      379      386      393
## 2      344      351      358      365      372      379      386      393
## 3      344      351      358      365      372      379      386      393
## 4      344      351      358      365      372      379      386      393
## 5      344      351      358      365      372      379      386      393
## 6      344      351      358      365      372      379      386      393
##   Otu00160 Otu00010 Otu00512 Otu00008 Otu00004 Otu00107 Otu00053 Otu00078
## 1      400      407      414      421      428      435      442      449
## 2      400      407      414      421      428      435      442      449
## 3      400      407      414      421      428      435      442      449
## 4      400      407      414      421      428      435      442      449
## 5      400      407      414      421      428      435      442      449
## 6      400      407      414      421      428      435      442      449
##   Otu00110 Otu00091 Otu00491 Otu00069 Otu00079 Otu00037 Otu00178 Otu00038
```

```
## 1      456      463      470      477      484      491      505      512
## 2      456      463      470      477      484      491      505      512
## 3      456      463      470      477      484      491      505      512
## 4      456      463      470      477      484      491      505      512
## 5      456      463      470      477      484      491      505      512
## 6      456      463      470      477      484      491      505      512
##   Otu00041 Otu00092 Otu00234 Otu00514 Otu00058 Otu00047 Otu00067 Otu00043
## 1      519      526      533      540      547      554      561      568
## 2      519      526      533      540      547      554      561      568
## 3      519      526      533      540      547      554      561      568
## 4      519      526      533      540      547      554      561      568
## 5      519      526      533      540      547      554      561      568
## 6      519      526      533      540      547      554      561      568
##   Otu00085 Otu00054 Otu00122 Otu00068 Otu00088 Otu00126 Otu00096 Otu00031
## 1      575      582      589      596      603      610      617      624
## 2      575      582      589      596      603      610      617      624
## 3      575      582      589      596      603      610      617      624
## 4      575      582      589      596      603      610      617      624
## 5      575      582      589      596      603      610      617      624
## 6      575      582      589      596      603      610      617      624
##   Otu00034 Otu00131 Otu00061 Otu00324 Otu00285 Otu00045 Otu00032 Otu00120
## 1      631      638      645      652      659      666      673      680
## 2      631      638      645      652      659      666      673      680
## 3      631      638      645      652      659      666      673      680
## 4      631      638      645      652      659      666      673      680
## 5      631      638      645      652      659      666      673      680
## 6      631      638      645      652      659      666      673      680
##   Otu00264 Otu00607 Otu00018~Otu00029
## 1      687      694           415.266
## 2      687      694           415.266
## 3      687      694           415.266
## 4      687      694           415.266
## 5      687      694           415.266
## 6      687      694           415.266
```

Module 3:

```
## Input : Rule Based matrix with Colinearity Handled (new_data1) and PCA Loadings used to combine grou
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
## Otu00001  9.73792398
## Otu00057 -0.09119350
## Otu00023 -0.09287823
```

```
## Otu00002 -0.09239481
## Otu00046  0.53732866
## Otu00003 -1.10707419
```

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 Microboes from selected features (OTU)
#OTU to Microbes
OTU_file <- read.table("Taxa_D3.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 Microboes 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
## Otu00001      Lactobacillus
## Otu00002 Enterobacteriaceae
## Otu00003     Alloprevotella
## Otu00004         Prevotella
## Otu00005        Bacteroides
## Otu00006        Akkermansia
```

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

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

```
##  [1] "Lactobacillus"             "Enterobacteriaceae"
##  [3] "Alloprevotella"            "Prevotella"
##  [5] "Bacteroides"               "Akkermansia"
##  [7] "Betaproteobacteria"        "Porphyromonadaceae"
##  [9] "Anaeroplasma"              "Burkholderiales"
## [11] "Bacteroidales"             "Ureaplasma"
## [13] "Helicobacter"              "Bifidobacterium"
## [15] "Enterococcus"              "Parabacteroides"
## [17] "unclassifie"               "Alistipes"
## [19] "Clostridium_sensu_stricto" "Allobaculum"
## [21] "Odoribacter"               "Ruminococcus"
## [23] "Barnesiella"               "Bacteroidetes"
## [25] "Clostridium_XlV"           "Mucispirillum"
## [27] "Turicibacter"              "Clostridium_XVIII"
## [29] "Paenibacillus"             "Firmicutes"
## [31] "Barnesiell"                "Streptococcus"
## [33] "Lysinibacillu"             "Desulfovibrio"
## [35] "Clostridium_X"             "Flavonifractor"
## [37] "Clostridiales"             "Clostridium_XI"
## [39] "Bacillu"                   "Bacteria"
```

```
## [41] "Desulfovibrionaceae"       "Lachnospiraceae"
## [43] "Ruminococcaceae"           "Anaerostipes"
## [45] "Ruminococcus2"             "Olsenella"
## [47] "Bacillales"                "Paenibacillu"
## [49] "Bordetell"                 "Cellulomona"
```

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

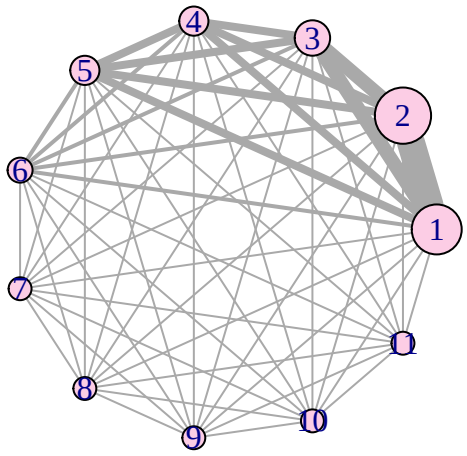
```
## Input : List of Microbes
source("Module_4(TSEA Network).R")
```

```
## [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 Enterobacteriaceae        14
## 2     2      Lactobacillus        17
## 3     3     Alloprevotella         7
## 4     4         Prevotella         4
## 5     5        Bacteroides         4
## 6     6        Akkermansia         2
## 7     7 Betaproteobacteria         1
## 8     8 Porphyromonadaceae         1
## 9     9       Anaeroplasma         1
## 10   10    Burkholderiales         1
## 11   11      Bacteroidales         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 Enterobacteriaceae        14 0.0923948088183669
## 2    2      Lactobacillus        17   3.30746681903195
## 3    3     Alloprevotella         7   1.10707418925536
## 4    4         Prevotella         4  0.179657049384006
## 5    5        Bacteroides         4  0.166161897597375
## 6    6        Akkermansia         2 0.0486266166250415
```

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")
```

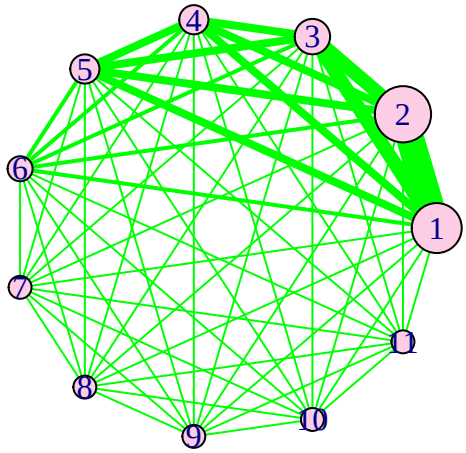
```
## [1] "Calculating Edges and Nodes to be added for the Data Driven Network"
```

```
## [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 Cluslters
#Pink nodes <- TSEA
#White nodes <- Data Driven Cluslters
plot(gh, layout=layout_in_circle, vertex.size=vertex_wt_gh,edge.width = E(gh)$weight,edge.color=col_edg
```



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 Enterobacteriaceae        14 0.0923948088183669
## 2    2      Lactobacillus        17   3.30746681903195
## 3    3     Alloprevotella         7   1.10707418925536
## 4    4         Prevotella         4  0.179657049384006
## 5    5        Bacteroides         4  0.166161897597375
## 6    6        Akkermansia         2 0.0486266166250415
```