HW2: Community Detection

Your Name Here

Introduction

Welcome to Homework Assignment No. 2. For this week's assignment, you'll need to visit the course website. There, you'll find a shiny app to generate the graph you'll need for your homework assignment.

Instructions

- Input your first and last name
- Input the due date of the assignment [May 4, 2025]
- Download the `.RDS` file which contains your graph
- Load that `.RDS` file into your `R` environment and begin the assignment
  - This can be done with the command, 'readRDS()"

  Note: you may review the answers to graphs from any other **past** date. So, if you'd like to check if your code is correct, feel free to do so; however, you may not view the answers for any future dates. **Be sure to submit the graph/answers for the due date above!**

```
library(igraph)
```

```
Attaching package: 'igraph'

The following objects are masked from 'package:stats':

    decompose, spectrum
```

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

    union
```

```
g <- readRDS("today_graph.rds")
```

Below, you will find a template of the questions and fields to provide answers in either `R` or text format. Please use a mix of code and text to answer each question.

Questions

Question 1. Save the adjacency matrix of your graph object. Refer to W1 for the code. Print the first 3 rows of your matrix using head().

Answer

```
amat <- as_adjacency_matrix(g, sparse = FALSE)
head(amat, 3)
```

```
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13] [,14]
[1,]    0    1    1    1    1    1    1    0    1     1     0     1     0     0
[2,]    1    0    1    1    1    1    0    0    0     1     1     0     1     1
[3,]    1    1    0    1    1    1    0    0    1     0     0     0     0     0
     [,15] [,16] [,17] [,18] [,19] [,20] [,21] [,22] [,23] [,24] [,25] [,26]
[1,]     1     1     0     0     1     1     0     0     0     1     0     0
[2,]     1     0     1     0     1     0     0     0     0     0     1     0
[3,]     0     1     0     1     0     1     0     0     0     0     0     0
     [,27] [,28] [,29] [,30]
[1,]     1     0     0     0
[2,]     1     1     0     1
[3,]     0     0     0     0
```

Question 2. Apply k-means clustering to your adjacency matrix using a range of k-values and save the results. Print the "withinss" for the first three items in the list (hint: use -> results[[i]][["withinss"]], where i = item index). As k increases, does the within-cluster variation for each cluster increase or decrease?

Answer

Question 3. Plot the withinss values for all list items in your k-means clustering results. Based on the plot, what is the most optimal value of 'k' (i.e., number of clusters in your network)?

Answer

Question 4. What is Q for the above finding (hint: you will need use results[[k]][["cluster"]] in the membership argument of modularity())?

Answer

***Question 5*. Apply fuzzy c-means clustering to your adjacency matrix using a range of k-values and save the results. Using the optimal value of k from Q3, print the first 10 rows for the cluster confidence matrix (u). Which node is most likely to be in Cluster k-1?**

Answer

***Question 6*. Apply the Walktrap algorithm to your graph, with t = 4 (default value). Plot the resulting graph and highlight the groups identified in your Walktrap results.**

Answer

***Question 7*. Apply spectral clustering to your graph. You will need both your adjacency matrix and graph object to derive your Laplacian matrix. Use the same value of k as in previous questions. Calculate and report modularity, Q for your results.**

Answer

***Question 8*. Calculate and compare Q (modularity) for each set of results (k-means, c-means, WalkTrap, spectral). Which approach resulted in the highest Q?**

Answer