

# Community Detection Assignment

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SEPTEMBER 6, 2023

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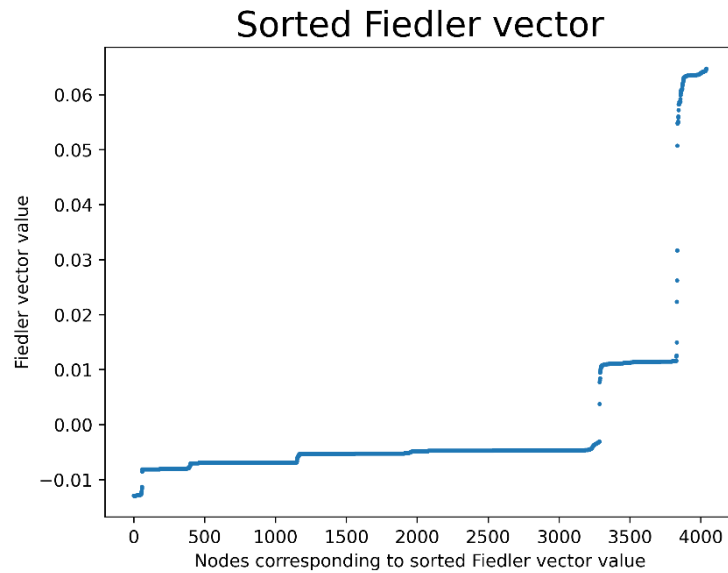
Submitted by: Devesh Varma (M. Tech CSA)  
SR No. 20881



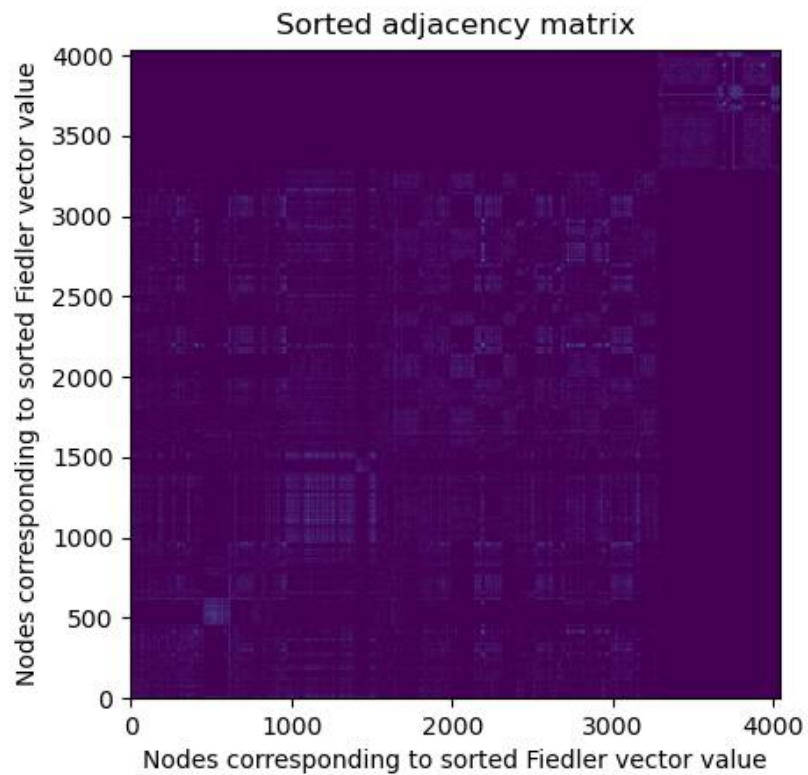
## Question 1:

### 1.1 For Facebook Dataset:

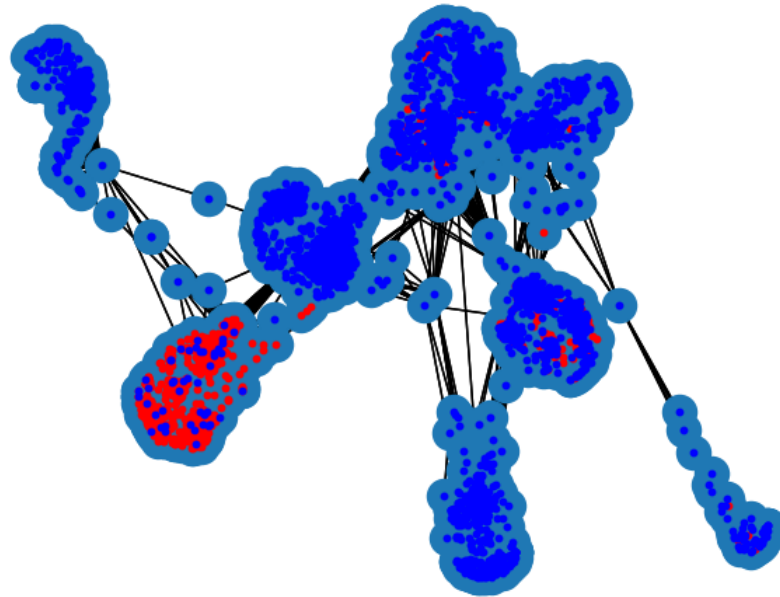
#### 1.1.1 Sorted Fiedler Vector:



#### 1.1.2 Sorted Adjacency Matrix after 1 iteration:

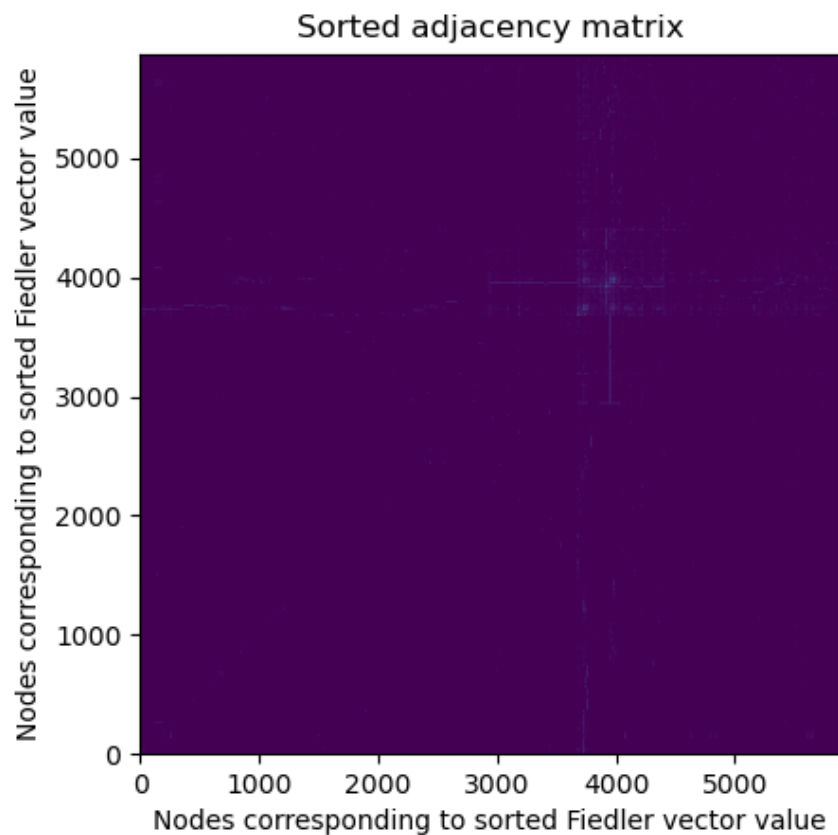


### 1.1.3 Graph partition after 1 iteration:



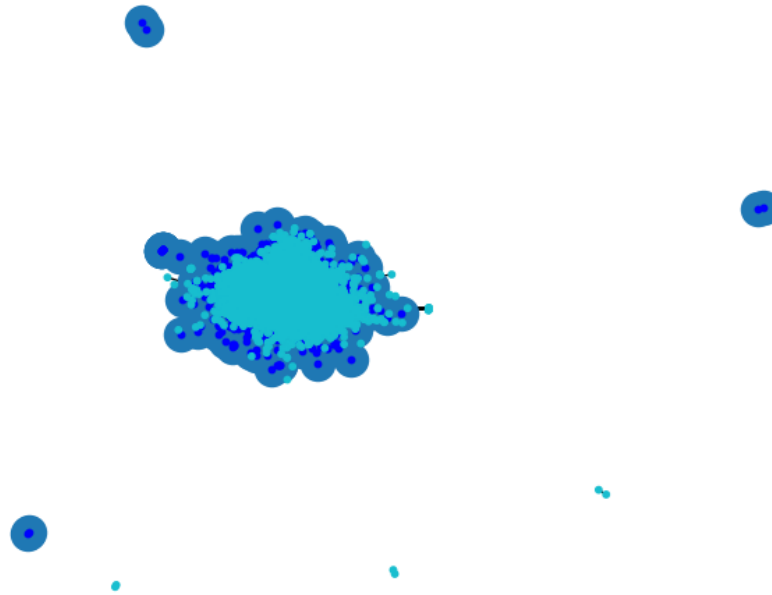
## 1.2 For Bitcoin Dataset:

### 1.2.1 Sorted Adjacency Matrix after 1 iteration:



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### 1.2.3 Graph partition after 1 iteration:



## Question 2:

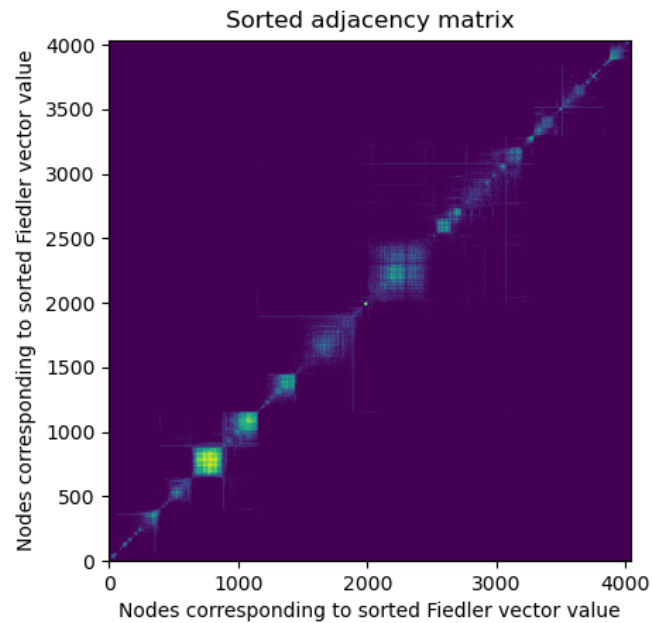
The stopping criteria used was change in modularity. If the modularity didn't increase by at least 0.01, then the algorithm would stop. Doing this manually, I found the modularity is maximum at 10 iterations for Facebook Dataset.

For Bitcoin data, I calculated average weight for edges going in both directions. Number of iterations required was around 20.

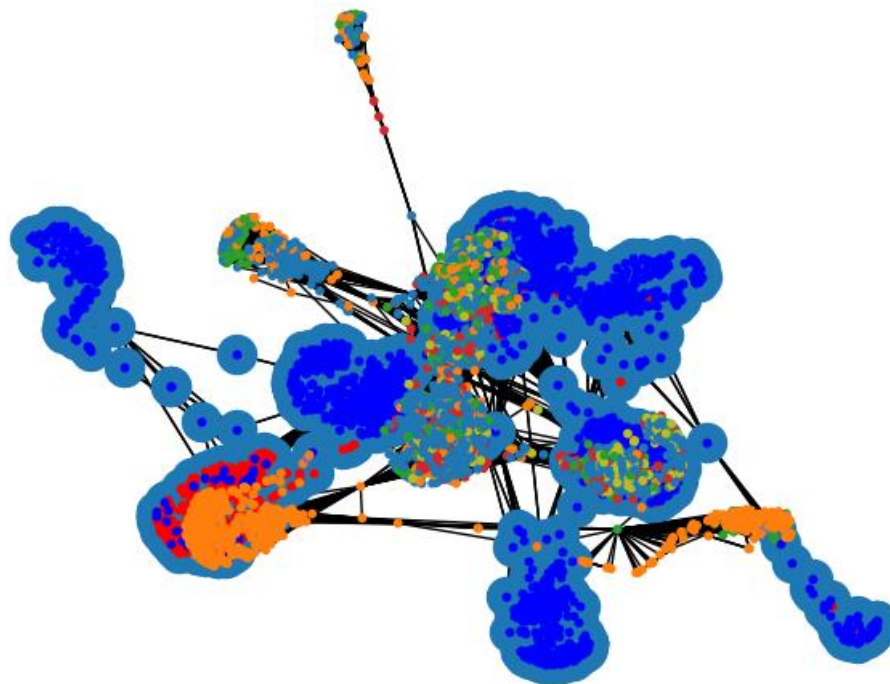
## Question 3:

### 3.1 For Facebook Dataset

#### 3.1.1 Adjacency Matrix after 10 iterations of Spectral Decomposition:

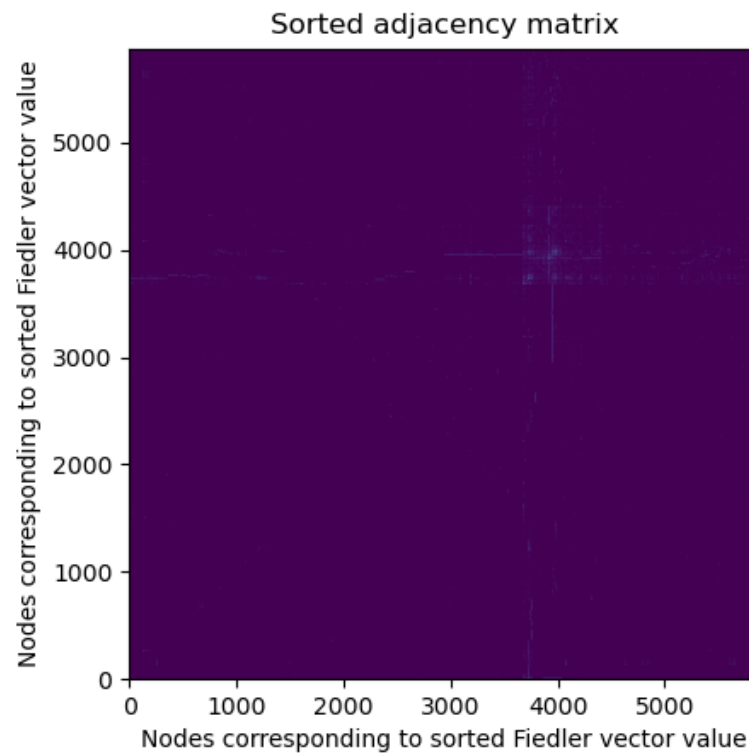


#### 3.1.2 Graph Partition after Spectral Decomposition:

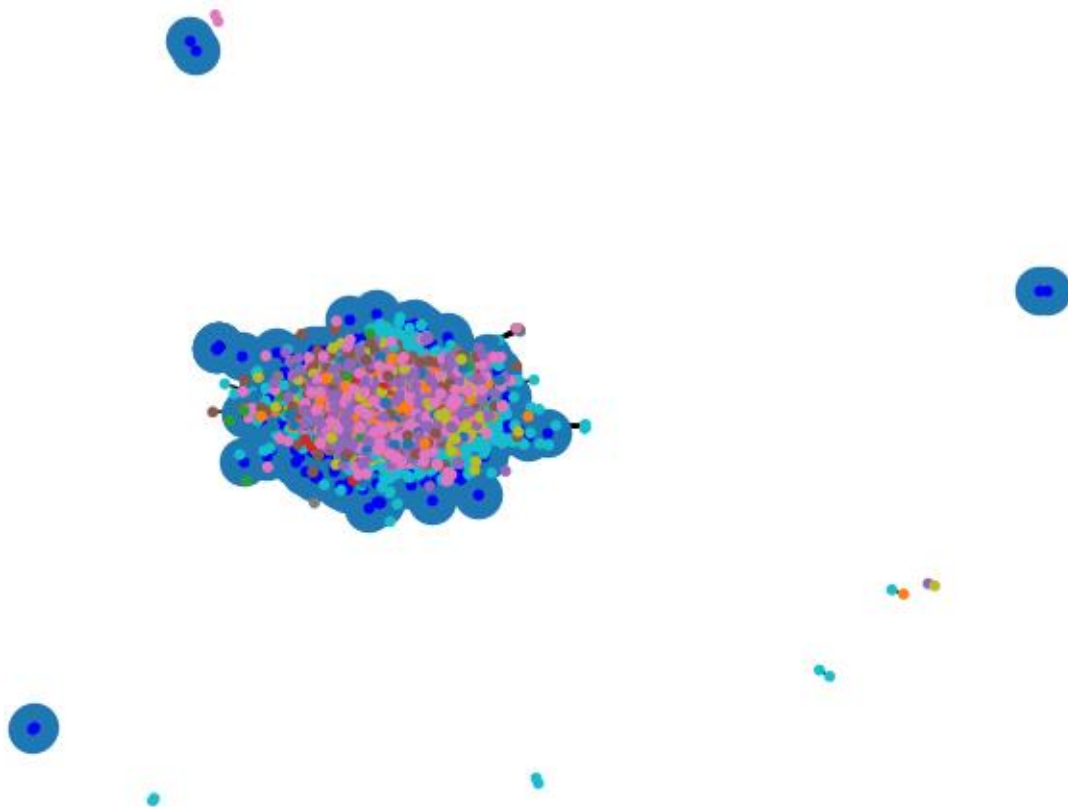


## 3.2 For Bitcoin Dataset:

### 3.2.1 Adjacency Matrix after 10 iterations of Spectral Decomposition:



### 3.2.2 Graph Partition after Spectral Decomposition:

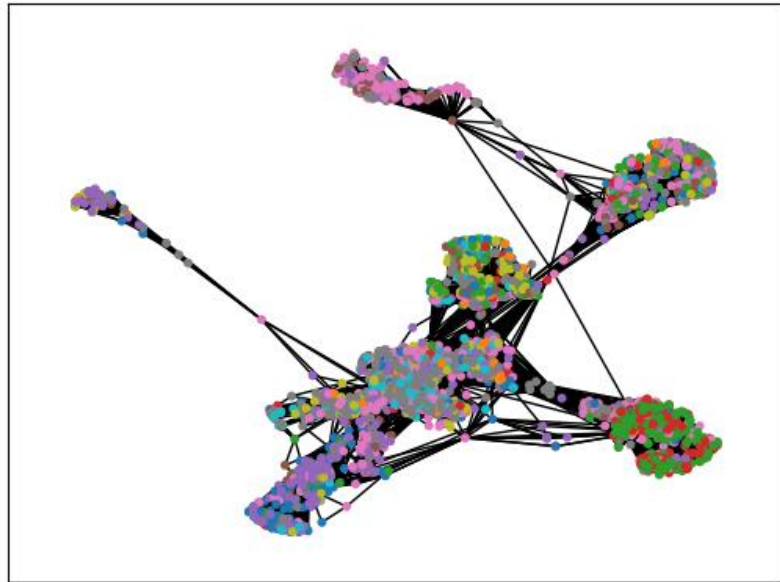


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## Question 4:

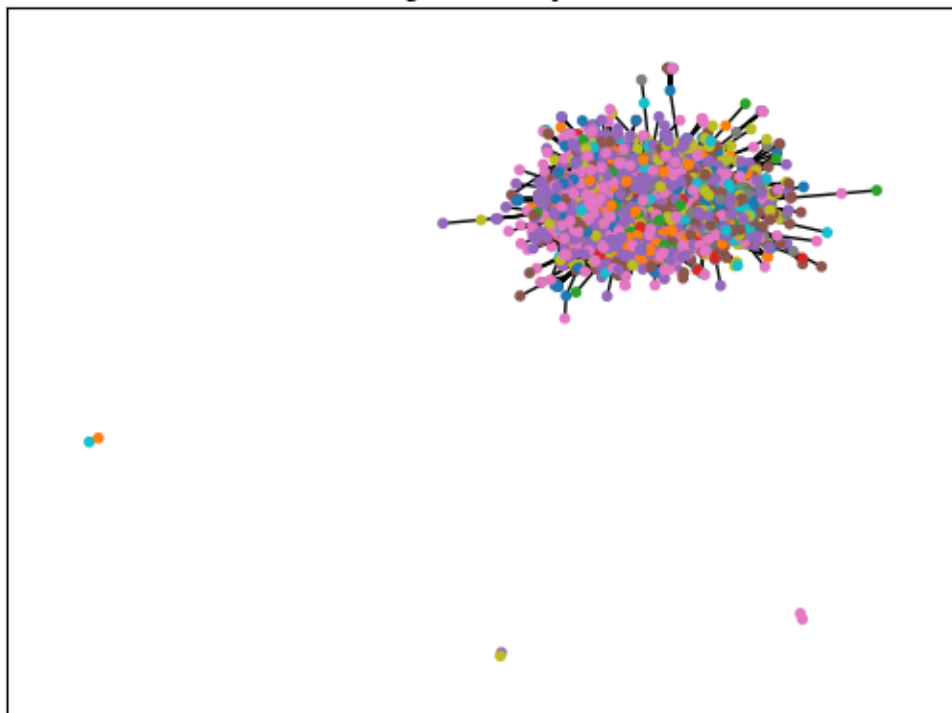
### 4.1 For Facebook Dataset:

Community Graph Louvain



### 4.2 For Bitcoin Dataset:

Community Graph Louvain





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## Question 5:

I have used *Modularity* of a graph as the metric to determine whether the communities formed are good enough or not. The recursive Spectral decomposition and Louvain algorithm would stop when the increase in Modularity starts to plateau.

## Question 6:

### 6.1 For Facebook Dataset:

Running time (on cold cache start) for Spectral Decomposition was: **146.28 seconds**

Running time for Louvain Algorithm was: **46.74 seconds**

### 6.2 For Bitcoin Dataset:

Running time (on cold cache start) for Spectral Decomposition was: **137.16 seconds**

Running time for Louvain Algorithm is: **83.91 seconds**

Total Running Time for entire code is: **762.84 seconds (12.7 minutes)**

## Question 7:

For me, clearly Louvain Algorithm gave rise to better communities for both datasets. Spectral Decomposition took longer to run and also didn't produce the modularity I had expected for some reason.

Also, Spectral Decomposition would have worked better on Bitcoin Dataset, as it is a weighted graph. But the code got too complicated when adding weights, so I couldn't go ahead with that.

### Metrics:

Modularity for Facebook Dataset:

1. For Spectral Decomposition: 0.09
2. For Louvain Algorithm: 0.81

Modularity For Bitcoin Dataset:

1. For Spectral Decomposition: 0.01
2. For Louvain Algorithm: 0.44

\*\*\*\*\* END OF REPORT \*\*\*\*\*