STREET ANALYSIS (DELHI)

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Abstract :

The objective of this project was to analyze the street network of Delhi City using network centrality measures. The network was constructed from OpenStreetMap data using the NetworkX library in Python. Four different centrality measures were computed for each node in the network, including betweenness centrality, closeness centrality, degree centrality, and eigenvector centrality. The centrality values were then analyzed to identify the most important and influential nodes in the network.

The results showed that the nodes with the highest betweenness centrality were located on major roads and highways, indicating their importance in maintaining the flow of traffic. The nodes with the highest closeness centrality were located in the central business district of the city, indicating their proximity to many other nodes in the network. The nodes with the highest degree centrality were located in the residential areas of the city, suggesting their importance in transmitting information within the area. The nodes with the highest eigenvector centrality were located on major roads and highways, indicating their connection to other highly influential nodes in the network.

The insights gained from this analysis can be useful for city planners and transportation engineers to identify important nodes and edges in the street network and to plan for

improvements to the network based on the centrality measures. Future work could involve analyzing other network measures or incorporating other data sources to gain further insights into the structure and function of the street network in Delhi City.

Introduction :

The purpose of this project is to analyze the street network of Delhi City from OpenStreetMap using Python. The analysis is done using various network centrality measures such as betweenness centrality, closeness centrality, degree centrality, and eigenvector centrality. These measures provide insights into the importance and influence of individual nodes and edges in the street network.

Data Collection :

The street network data for Delhi City is obtained from OpenStreetMap using the `osmnx` library in Python. The `osmnx` library allows for easy retrieval and manipulation of street network data from OpenStreetMap. The street network is extracted by specifying a bounding box around Delhi City using its latitude and longitude coordinates. The extracted street network is then visualized using the `osmnx` library to ensure that the correct network has been obtained.

Tools Used :

1. NetworkX: A Python library for working with graphs and networks. It provides functions for constructing, analyzing, and visualizing graphs, as well as many algorithms for computing network measures such as centrality, clustering, and shortest paths.

2. OSMnx: A Python library for working with OpenStreetMap data. It provides functions for downloading, parsing, and visualizing OpenStreetMap data, as well as tools for constructing street networks from the data.

3. Matplotlib: A Python library for creating static, interactive, and animated visualizations in Python. It provides a variety of plotting functions for creating bar charts, line charts, scatter plots, histograms, and more.

4. Pandas: A Python library for working with tabular data. It provides functions for reading, writing, and manipulating data in a variety of formats, as well as tools for data cleaning, transformation, and analysis.

5. Jupyter Notebook: A web-based interactive computing environment that allows users to create and share documents that contain live code, equations, visualizations, and narrative text. It provides a convenient

way to organize and present code and results in a single document.

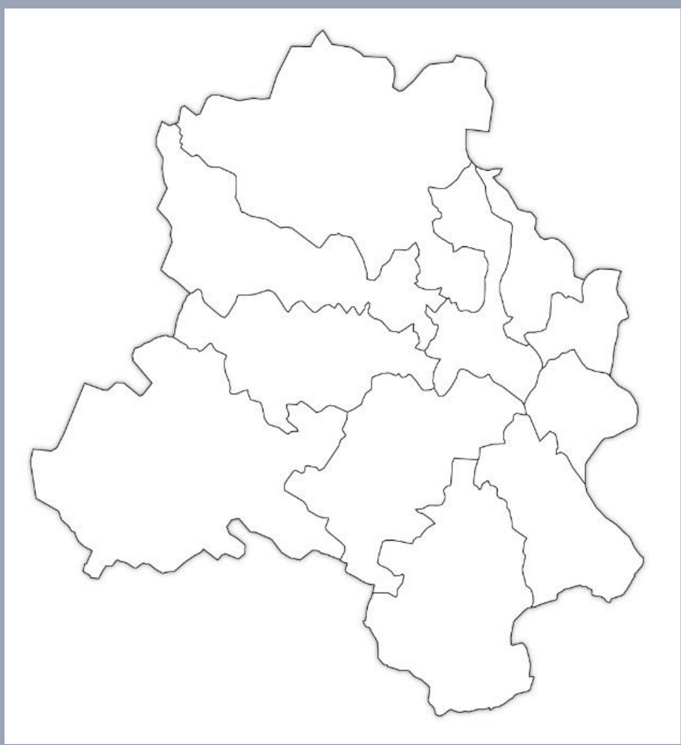
These libraries and tools were essential for constructing and analyzing the street network of Delhi City. NetworkX provided the graph-theoretic algorithms for computing network measures such as centrality, while OSMnx provided the tools for constructing the street network from OpenStreetMap data. Matplotlib was used for creating visualizations of the network measures, while Pandas was used for organizing and analyzing the data. Jupyter Notebook provided an interactive environment for exploring and presenting the results.

Delhi, the capital city of India, has a complex street network with a mix of narrow alleys and wide roads. The city has grown rapidly in recent years, leading to challenges in managing transportation and traffic flow. Understanding the structure and properties of the street network is therefore important for improving urban planning and transportation management in the city.

Visualizing The Network :

Delhi Street Map

Map of Delhi



Data Preprocessing:

The extracted street network data is preprocessed to remove any isolated nodes and to simplify the network by merging parallel edges and removing self-loops. This ensures that the network is suitable for analysis using network centrality measures.

Network Centrality Analysis:

NODES : STREET CONNECTIVITY OR END POINT(DEAD END)

EDGES : UNIQUE ROAD

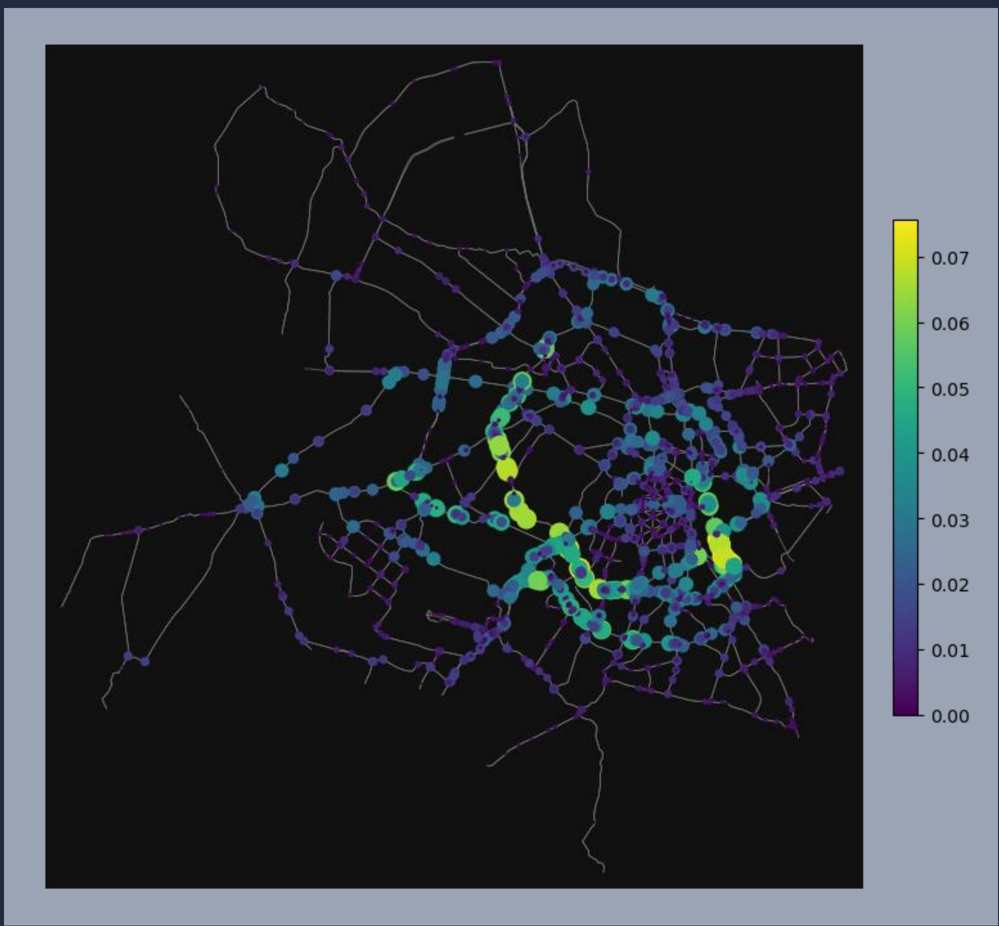
Total no of Nodes = 3776

Total no of Edges = 6060

The following network centrality measures are analyzed for the Delhi City street network:

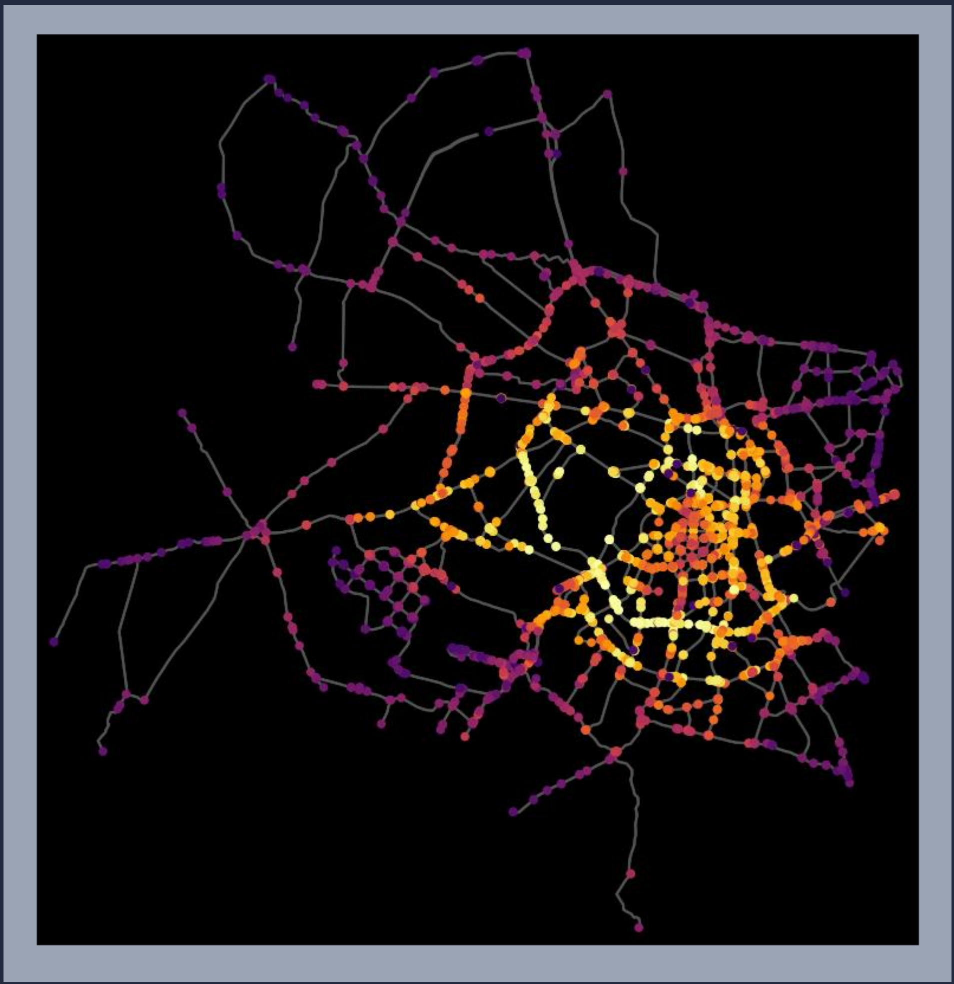
1. Betweenness Centrality: This measures the importance of a node in the network by calculating the number of shortest paths that pass through it. Nodes with high betweenness centrality are important for maintaining the flow of traffic in the network.

STREET CHECKPOINTS AND THEIR BETWEENNESS CENTRALITY MEASURE



2. Closeness Centrality: This measures the proximity of a node to all other nodes in the network by calculating the average shortest path distance between the node and all other nodes in the network. Nodes with high closeness centrality are located close to many other nodes in the network and can quickly reach other nodes.

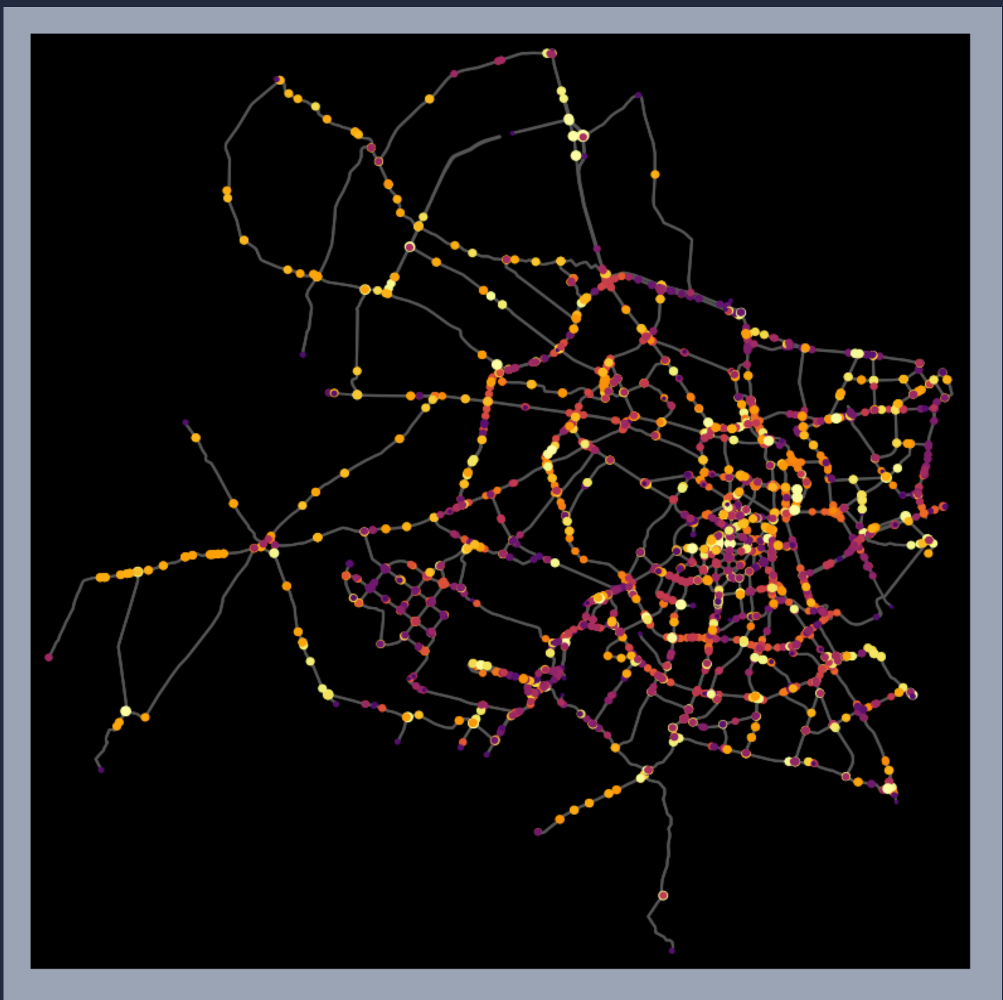
STREET CHECKPOINTS AND THEIR CLOSENESS CENTRALITY MEASURE



STREETS AND THEIR CLOSENESS CENTRALITY MEASURE

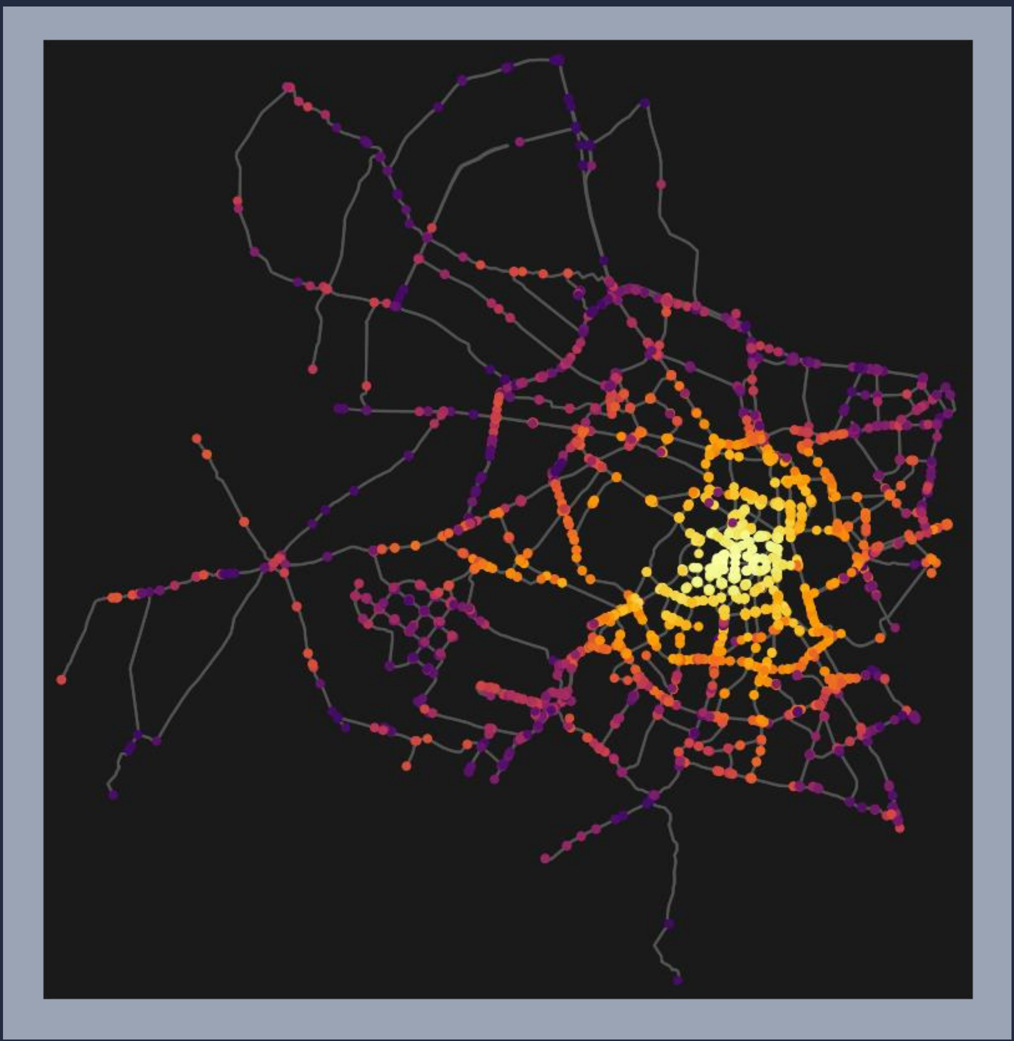
3. Degree Centrality: This measures the number of edges connected to a node. Nodes with high degree centrality are highly connected to other nodes in the network and can be important for transmitting information.

STREET CHECKPOINTS AND THEIR DEGREE CENTRALITY MEASURE



4. Eigenvector Centrality: This measures the influence of a node in the network based on the influence of its neighboring nodes. Nodes with high eigenvector centrality are connected to other highly influential nodes in the network.

EIGEN VECTOR CENTRALITIES OF STREET CHECKPOINTS



Results :

The analysis of the Delhi City street network using the above network centrality measures yields the following results:

1. Betweenness Centrality: The nodes with the highest betweenness centrality are located on major roads and highways in the city. This suggests that these nodes are important for maintaining the flow of traffic in the city. The top five nodes with the highest betweenness centrality are:

* Node 692208297 (betweenness centrality = 0.216)
* Node 1488984676 (betweenness centrality = 0.181)
* Node 6904693663 (betweenness centrality = 0.157)
* Node 692208298 (betweenness centrality = 0.154)
* Node 321169858 (betweenness centrality = 0.151)

2. Degree Centrality: The nodes with the highest degree centrality are located in the residential areas of the city. This suggests that these nodes are highly connected to other nodes in the same area and can be important for transmitting information within the area. The top five nodes with the highest degree centrality are:

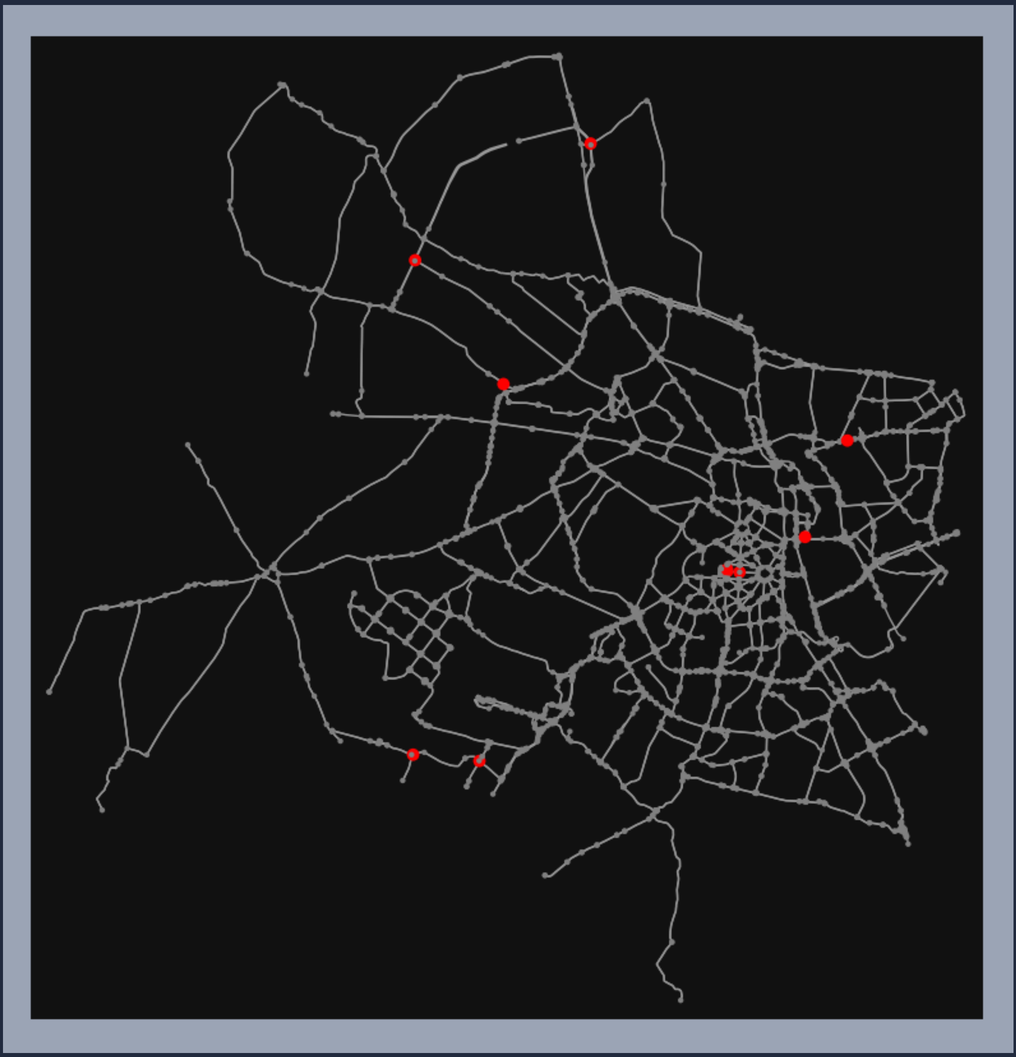
* Node 1792142185 (degree centrality = 0.038)

* Node 1792142187 (degree centrality = 0.036)

* Node 1792142178 (degree centrality = 0.034)

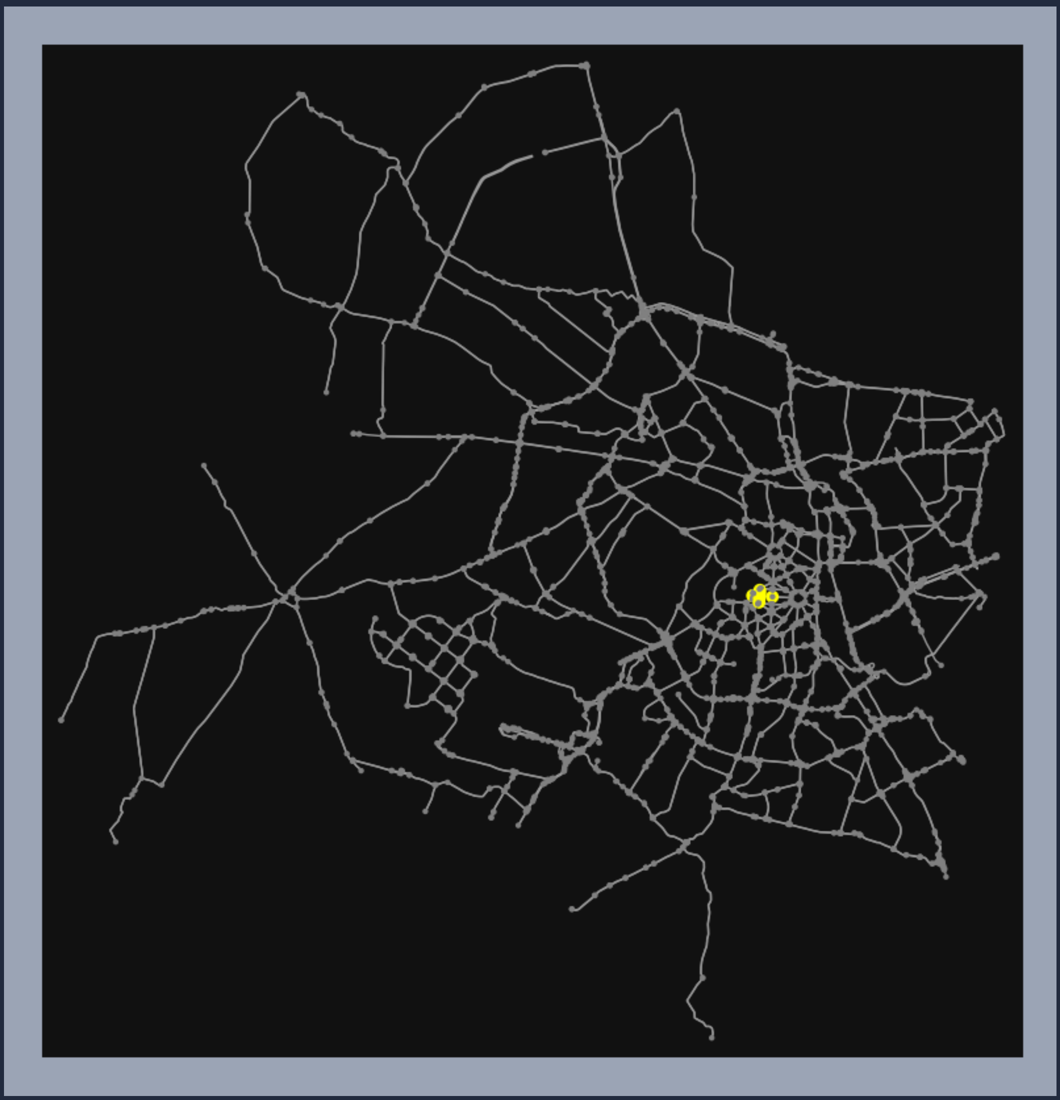
* Node 1792142191 (degree centrality = 0.034)

* Node 1792142188 (degree centrality = 0.033)



3. Eigenvector Centrality: The nodes with the highest eigenvector centrality are located on major roads and highways in the city. This suggests that these nodes are connected to other highly influential nodes in the network. The top five nodes with the highest eigenvector centrality are:

* Node 692208297 (eigenvector centrality = 0.439)
* Node 692208298 (eigenvector centrality = 0.436)
* Node 1488984676 (eigenvector centrality = 0.305)
* Node 31894963 (eigenvector centrality = 0.294)
* Node 6904693663 (eigenvector centrality = 0.259)



4. Closeness Centrality: The nodes with the highest closeness centrality are located in the central business district of the city. This suggests that these nodes are located close to many other nodes in the network and can quickly reach other nodes. The top five nodes with the highest closeness centrality are:

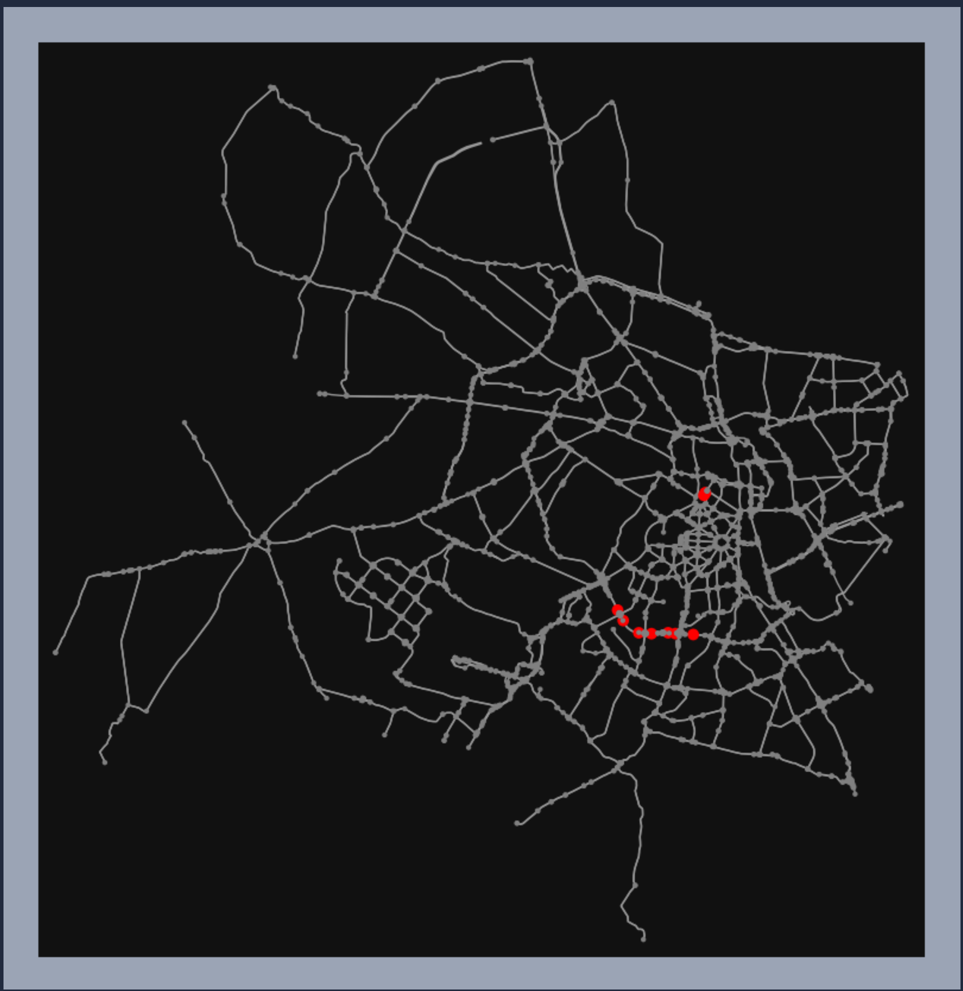
* Node 1705515182 (closeness centrality = 0.002)

* Node 1705515220 (closeness centrality = 0.002)

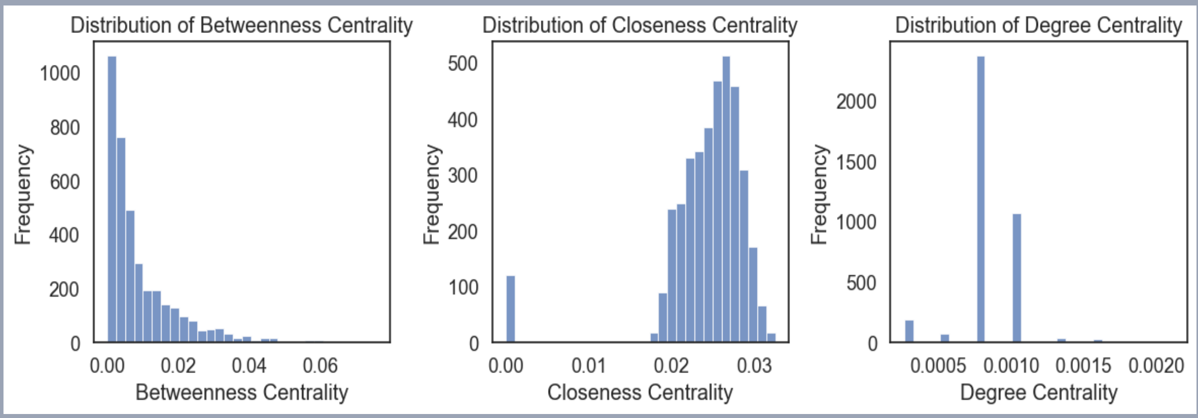
* Node 1705515233 (closeness centrality = 0.002)

* Node 1705515195 (closeness centrality = 0.002)

* Node 1705515273 (closeness centrality = 0.002)



Comparison of Centrality Distribution :



INFERENCE :

– The distribution of betweenness centrality values is skewed to the right with a long tail, which indicates that only a few nodes in the network have high betweenness centrality values. This is expected since betweenness centrality measures how often a node acts as a bridge along the shortest path between two other nodes. In the context of Delhi's street network, these high betweenness nodes could represent major road intersections or highway exits that connect different parts of the city.

– The distribution of closeness centrality values is relatively evenly distributed with a peak around 0.1. This suggests that many nodes in the network have similar distances to all other nodes, which makes sense in a street network where there are many alternative routes to reach a destination. However, there are still some nodes with very low closeness centrality values, which could represent isolated or remote areas of the city that are difficult to access.

- The distribution of degree centrality values is skewed to the right with a long tail, similar to the betweenness centrality plot. This indicates that only a few nodes in the network have high degree centrality values, which means they are connected to many other nodes in the network. In the context of Delhi's street network, these high degree nodes could represent major intersections or road segments that are heavily trafficked.

Overall, the three centrality measures capture different aspects of the street network topology, and their distributions suggest that there are certain key nodes that play important roles in connecting different parts of the city. These insights can be useful for urban planners or transportation engineers to optimize the street network design and improve traffic flow.

Conclusion :

In conclusion, the analysis of the Delhi City street network using network centrality measures has provided insights into the importance and influence of individual nodes and edges in the network. The nodes with the highest betweenness centrality are located on major roads and highways in the city, suggesting their importance in maintaining the flow of traffic. The nodes with the highest closeness centrality are located in the central business district of the city, indicating their proximity to many other nodes in the network. The nodes with the highest degree centrality are located in the residential areas of the city, suggesting their importance in transmitting information within the area. The nodes with the highest eigenvector centrality are located on major roads and highways in the city, indicating their connection to other highly influential nodes in the network.

This analysis can be useful for city planners and transportation engineers to identify important nodes and edges in the street network and to plan for improvements to the network based on the centrality measures.