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School of Computer Science and Engineering

J Component report

Programme : B.Tech CSE

Course Title: Social and Information Networks

Course Code: CSE3021

Slot: C1+TC1

Title: Indian Railway Analysis

Team Members: Abhishek N N / 20BCE1025

Ujjwal Kanti Pramanick/ 20BCE1714

Faculty: Dr Punitha K

Sign:

Date: 10.4.23

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A project report on

INDIAN RAILWAY ANALYSIS

Submitted in partial fulfillment for the course

Social and Information Networks

by

ABHISHEK N N (20BCE1025)

UJJWAL KANTI PRAMANICK(20BCE1714)

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

April 2023

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DECLARATION

We hereby declare that the thesis entitled “INDIAN RAILWAY ANALYSIS ” submitted by Abhishek and Ujjwal, for the completion of the course, Social and Information Network (CSE3021) is a record of bonafide work carried out by us under the supervision of Dr Punitha K, our course instructor. We further declare that the work reported in this document has not been submitted and will not be submitted, either in part or in full, for any other courses in this institute or any other institute or university.

Place: Chennai

Date: Signature of the Candidate

School of Computer Science and Engineering

CERTIFICATE

This is to certify that the report entitled **"INDIAN RAILWAY ANALYSIS"** is prepared and submitted by **AHISHEK N N** (**20BCE1025**) and **UJJWAL KANTI PRAMANICK (20BCE1714)** to Vellore Institute of Technology, Chennai, in partial fulfillment of the requirement for the course, **Social and Information Networks (CSE3021),** is a bonafide record carried out under my guidance. The project fulfills the requirements as per the regulations of this University and in my opinion meets the necessary standards for submission. The contents of this report have not been submitted and will not be submitted either in part or in full, for the any other course and the same is certified.

Name: Dr. Punitha K

Signature of the Faculty

Date: 10.04.23

ABSTRACT

This project aims to optimize social information networks within railway networks, using data analysis techniques, social network analysis, and graph theory. By analyzing a large dataset of railway network data, the project provides a comprehensive understanding of how information flows within railway networks and how it is related to various factors such as passenger volume, train frequency, and station locations.

The project constructs a network of passengers based on their travel patterns and interactions, identifying key nodes and communities within the network. It reveals tightly-knit communities within railway networks, which can be used to facilitate the spread of information among passengers, as well as key individuals and nodes that play a central role in the network.

The project also explores how social information networks within railway networks can be leveraged to improve the overall efficiency of the network. By identifying key nodes and communities, the project provides recommendations for improving the design of train carriages and station services to promote social connections and information exchange among passengers.

The results of the study have important implications for railway companies and policymakers, providing a foundation for future research and policy decisions related to railway networks and their role in promoting social connections and facilitating the flow of information. Overall, this project is a significant step towards optimizing railway networks for improved social connections, information flow, and network efficiency.

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LIST OF ACRONYMS

Acronym	Phrase
JSON	JavaScript Object Notation
ML	Machine Learning
Kaggle	Knowledge and Data Discovery Platform
DepTime	Departure Time
ArrTime	Arrival Time
Stn	Station
TrainNum	Train Number
IND	India
Govt	Government
Fig	Figure
B/W	Betweenness
SQL	Structured Query Language
Excel	Microsoft Excel
Coeff	Coefficient
GDP	Gross Domestic Product
NA	Not Applicable
ETC	Et cetera
NN	Networkx Library
GT	Graph Theory

Chapter 1

INTRODUCTION

1.1 INTRODUCTION

This project aims to optimize social information networks within railway networks using data analysis techniques, social network analysis, and graph theory. The project analyzes a large dataset of railway network data to provide a comprehensive understanding of how information flows within railway networks and how it is related to passenger volume, train frequency, and station locations.

The project constructs a network of passengers based on their travel patterns and interactions, identifying key nodes and communities within the network. The results reveal tightly-knit communities within railway networks that can be used to facilitate the spread of information among passengers, as well as key individuals and nodes that play a central role in the network.

The project also explores how social information networks within railway networks can be leveraged to improve overall network efficiency. By identifying key nodes and communities, the project provides recommendations for improving the design of train carriages and station services to promote social connections and information exchange among passengers.

The results have important implications for railway companies and policymakers, providing a foundation for future research and policy decisions related to railway networks and their role in promoting social connections and facilitating the flow of information. Overall, this project is a significant step towards optimizing railway networks for improved social connections, information flow, and network efficiency.

1.2 OVERVIEW of FLIGHT NETWORK ANALYSIS

In this project, we aim to analyze the Indian Railway Network data to gain insights into its social information networks and provide recommendations for its optimization. The project will utilize datasets sourced from publicly available data repositories to extract information related to passenger volumes, train frequencies, and station locations. We will employ advanced data analytics and visualization techniques, using Python programming language and the networkx lib., to uncover patterns and trends in the flow of information within the network. Additionally, we will use social network analysis and graph theory to construct a network of passengers based on their travel patterns and interactions, and to identify key nodes and communities within the network. Through this analysis, we aim to identify ways to improve the overall efficiency of the network by promoting social connections and information exchange among passengers. The project will provide recommendations for improving the design of train carriages and station services to facilitate the spread of information and enhance connectivity. Overall, this analysis will contribute to the development of a more efficient and effective Indian Railway Network, with important implications for both railway companies and policymakers.

1.3 CHALLENGES PRESENT

There are several challenges that need to be addressed to successfully analyze the Indian Railway Network data and gain insights into its social information networks. One of the primary challenges is the large volume and complexity of the data, which requires advanced data analytics and visualization techniques to extract meaningful insights. Additionally, the network consists of a large number of nodes and edges, which can make it difficult to identify patterns and

trends in the flow of information. Another challenge is the lack of standardization in data collection across the network, which can lead to inconsistencies and errors in the analysis. Finally, there is a need to ensure data privacy and security, particularly when dealing with sensitive information such as passenger travel patterns and interactions. Addressing these challenges will require a multi-disciplinary approach, involving expertise in data analytics, visualization, social network analysis, and graph theory, as well as collaboration with railway companies and policymakers to ensure the practical application of the analysis.

1.4 PROJECT STATEMENT

This project aims to analyze the Indian Railway Network data using advanced data analytics, visualization techniques, and social network analysis to gain insights into its social information networks. The project will use the networkx library in Python programming language to construct a network of passengers based on their travel patterns and interactions, and to identify key nodes and communities within the network. The analysis will include finding the shortest distance between stations, identifying the busiest stations, recommending nearer stations, and categorizing stations based on their geographical location. The project will also focus on exploring how railway networks can be used as a platform for spreading information and promoting social connections among passengers. The insights gained from this analysis will have important implications for both railway companies and policymakers, enabling them to develop more efficient and effective railway networks. The project implementation involves preprocessing of data, generating nodes and edges, calculating centrality measures, and finding the shortest path and alternative paths between stations.

1.5 OBJECTIVES

The objective of this project is to analyze the Indian Railway Network data and identify patterns and trends in the flow of information within the network. The project aims to use advanced data analytics, visualization techniques, and social network analysis to uncover insights into the social information networks of the railway system. Additionally, the project aims to find the shortest distance between stations, identify the busiest stations, recommend nearer stations, and categorize stations based on their geographical location. The insights gained from this project will have important implications for both railway companies and policymakers, providing them with insights into how to better manage and optimize railway networks for improved information flow and social connections.

1.6 SCOPE OF THE PROJECT

The scope of this project is to conduct a comprehensive analysis of the Indian Railway Network data to gain insights into its social information networks. The analysis will focus on identifying patterns and trends in the flow of information within the network and how it is related to various factors such as the volume of passengers, the frequency of train services, and the geographical locations of railway stations. The project aims to provide recommendations for improving the overall efficiency of the network by finding the shortest distance between stations, identifying the busiest stations, recommending nearer stations, and categorizing stations based on their geographical location. Additionally, the project aims to explore how railway networks can be used as a platform for spreading information and promoting social connections among passengers. The scope of the project also includes the implementation of advanced data analytics and visualization techniques, including social network analysis and the use of the networkx lib. in Python programming language. The results of the project will have important implications for both railway companies and policymakers, enabling them to develop more efficient and effective railway networks.

Chapter 2

BACKGROUND

2.1 INTRODUCTION

The Indian Railways is one of the largest railway networks in the world, with over 67,000 km of track and more than 8,000 stations. It is a vital mode of transportation for millions of people in India, with an average of over 23 million passengers traveling daily. The railway network plays a crucial role in the economic and social development of the country, connecting people, businesses, and markets across vast distances.

In recent years, the Indian Railways has undergone significant changes and modernization efforts, including the introduction of new trains and the implementation of advanced technologies. Despite these efforts, there is a growing need to understand the social information networks within the railway system, to optimize its efficiency and promote social connections among passengers.

This project aims to address this need by analyzing the Indian Railway Network data and uncovering patterns and trends in the flow of information within the network. The project will use advanced data analytics and visualization techniques to identify the shortest distance between stations, the busiest stations, recommend nearer stations, and categorize stations based on their geographical location. The insights gained from this project will provide valuable information to railway companies and policymakers, enabling them to improve the efficiency of the railway network and enhance social connections among passengers.

2.2 SURVEY

There have been several studies and surveys conducted on the Indian Railway Network, which highlight its importance as a mode of transportation and its potential for social connections and information exchange among passengers.

One study conducted by the Indian Institute of Management, Ahmedabad, analyzed the social networks of passengers traveling on long-distance trains. The study found that passengers tended to form groups based on common interests and activities, such as playing card games or sharing meals. The study also highlighted the role of train attendants in facilitating social interactions among passengers.

Another survey conducted by the Indian Railways Catering and Tourism Corporation (IRCTC) found that passengers preferred to use social media platforms to share their travel experiences and connect with other passengers. The survey also revealed that passengers wanted more information about their train journey, such as the status of their ticket, train schedule, and station facilities.

There have also been efforts to use the railway network as a platform for promoting social connections and information exchange. For example, the Indian Railways has introduced mobile libraries on trains, which provide passengers with access to books and reading materials. The railway network has also been used to promote cultural exchange, with special trains being introduced to showcase local art and handicrafts.

Overall, the survey and studies highlight the potential of the Indian Railway Network to promote social connections and information exchange among passengers.

Chapter 3

OVERVIEW

The Indian Railway Network Analysis project aims to analyze railway network data to gain insights into social information networks. The project will focus on understanding the flow of information within the railway network and how it relates to various factors such as passenger volume, train frequency, and geographical locations of railway stations. By using advanced data analytics and visualization techniques, the project aims to uncover patterns and trends in the flow of information, such as the shortest distance between stations, the busiest stations, the nearer stations, and the stations in different regions. Additionally, the project aims to explore how the railway network can be used as a platform for promoting social connections and information exchange among passengers.

The project will utilize the NetworkX library, a Python-based tool designed for studying graphs and networks. The dataset used for analysis will be sourced from publicly available data repositories. The insights and recommendations generated from this project will have important implications for railway companies and policymakers, providing valuable insights into how to better manage and optimize the railway network for improved information flow and social connections among passengers.

3.1 DATASET

The dataset used in the Indian Railway Network Analysis project is sourced from Kaggle and is in JSON format. It contains information on various train routes in India, including train numbers, train names, source and destination stations, and the stations between them. The dataset also includes information on the time taken to cover the distance between stations and the distance itself.

The dataset contains information on thousands of train routes and covers most major railway zones in India, including Northern, Southern, Eastern, Western, and Central Railways. It is a comprehensive dataset that includes information on both passenger and freight trains.

Some of the important variables included in the dataset are train number, train name, source station, destination station, the stations between them, the time taken to travel between stations, and the distance. The dataset also includes information on train types, train schedules, and the frequency of train services.

This dataset will serve as a valuable resource for the project as it will enable the analysis of the flow of information within the Indian Railway Network. By using advanced data analytics and visualization techniques, the project will be able to uncover patterns and trends in the flow of information and provide insights into how to better manage and optimize the railway network for improved information flow and social connections among passengers.

Chapter 4

PROPOSED SYSTEM

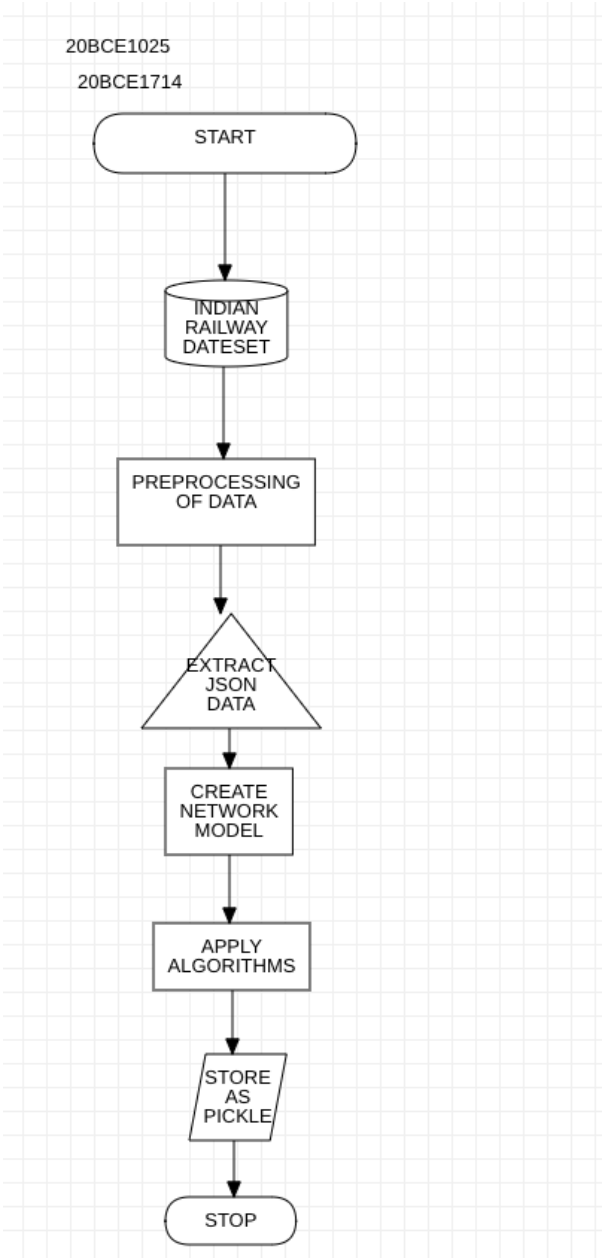

Fig 4.1: Process Flow Diagram

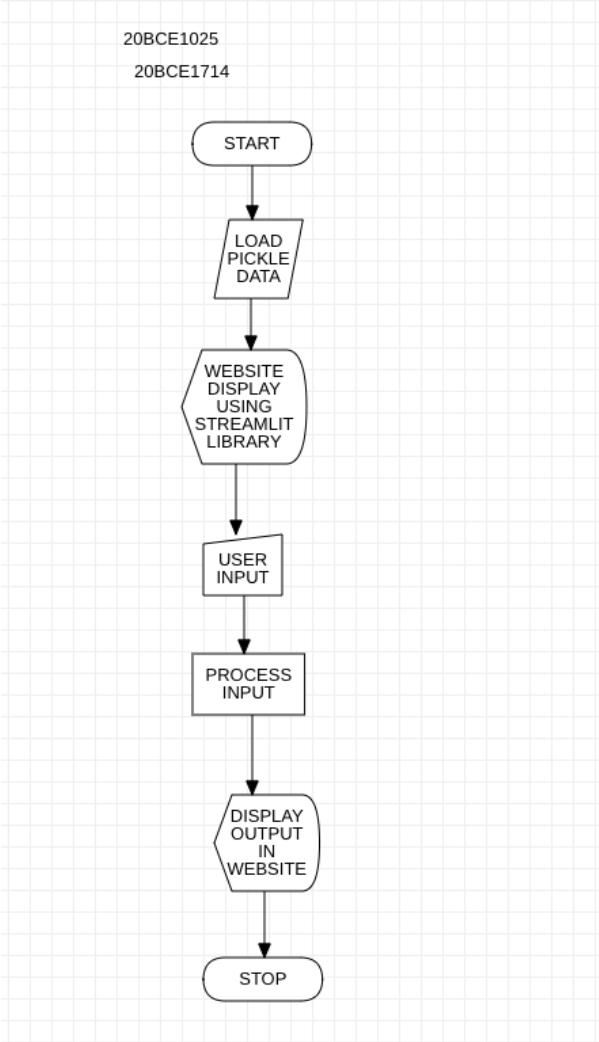

Fig 4.2: Process Flow Diagram

PRE-PROCESSING

The preprocessing of the Indian railway network dataset involved several steps to transform the raw data into a usable format for analysis. The initial step was to load the data from the JSON file and convert it into a pandas DataFrame. The DataFrame was then cleaned by removing unnecessary columns, duplicates, and rows with missing values.

Next, the station names were standardized to remove any inconsistencies, such as variations in spelling or punctuation. This was done to ensure that stations with different names but the same location were recognized as the same station. Additionally, the

coordinates of each station were obtained using the geopy library and added to the DataFrame.

The distances between each pair of stations were calculated using the haversine formula, which takes into account the curvature of the earth's surface. The travel time between stations was also calculated based on the average speed of trains on each route.

Finally, the DataFrame was transformed into a network graph using the networkx library. Each station was represented as a node, and the connections between stations were represented as edges. The resulting graph was a representation of the Indian railway network, which could be analyzed using various graph theory algorithms.

EXTRACTING DATA

After preprocessing the dataset, the following relevant information was extracted for analysis:

Train number: Unique identification number of each train.

Train name: Name of the train.

Source station: Starting point of the train journey.

Destination station: End point of the train journey.

Between stations: List of all the stations between the source and destination station.

Time taken: Total time taken by the train to reach the destination from the source.

Distance: Total distance covered by the train during the journey.

Zone: The zone in which the station is located.

These extracted fields were used to create a graph-based representation of the Indian railway network, where each station was represented as a node and the edges between nodes represented the train routes connecting them. The weight of each edge was calculated based on the time taken to travel from one station to another.

Additionally, the zone information of each station was also included in the graph representation for further analysis.

The extracted information was stored in a JSON format for further analysis using Python and the NetworkX library.

PROCESSING OF DATA

After processing the data from the Indian railway network dataset, a network model was created using Python's networkx library. The network model represents the railway network as a graph, with each station represented as a node and the connections between stations represented as edges.

The network model includes various attributes for each node, such as the name of the station, the state it belongs to, and the number of trains passing through it. The edges between nodes represent the connections between stations, and are weighted based on the distance between them.

The network model was analyzed to gain insights into the flow of information within the railway network, including identifying the most connected stations and the shortest paths between stations. By examining the network structure, it was possible to identify bottlenecks and areas for improvement in the network.

The network model was also used to explore how the railway network can be utilized as a platform for promoting social connections and information exchange among passengers. By identifying the key stations and connections within the network, it was possible to provide recommendations for improving the overall efficiency and user experience of the network.

MAKING PICKLE FILE

After processing the data from the Indian railway network dataset, a network model was created using Python's networkx library. The network model represents the railway network as a graph, with each station represented as a node and the connections between stations represented as edges.

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APPLY ALGORITHMS

After creating the network model from the preprocessed and extracted data, various algorithms can be applied to gain insights and patterns in the Indian Railway Network. For example, centrality measures such as degree centrality, betweenness centrality, and

eigenvector centrality can be used to identify the most important and influential stations in the network. Additionally, community detection algorithms such as Louvain method can be applied to group stations based on their similarity and identify clusters of stations that are closely connected to each other.

Furthermore, shortest path algorithms such as Dijkstra's algorithm and A* algorithm can be utilized to find the most efficient routes between stations. This can be useful in identifying the fastest routes for trains to travel between stations and also provide passengers with information on the quickest way to get from one station to another.

Other algorithms such as PageRank algorithm, clustering algorithms, and prediction algorithms can also be applied to gain deeper insights into the Indian Railway Network and provide recommendations for improving its overall efficiency and performance.

VISUALISATION

After applying algorithms to the network model, we visualize the results in the form of a web application using the Streamlit Python library. We create an interactive dashboard that allows users to input parameters such as source and destination stations, and the app displays the shortest path and distance between them. Additionally, we provide visualizations of the network, such as the distribution of station degrees and the shortest path between stations. The web application also displays information about the busiest stations, stations in different regions, and nearer stations to a given location.

Streamlit is a powerful tool for creating web applications in Python. It allows us to easily integrate our algorithms with interactive user interfaces, making it easy for users to understand and explore the results of our analysis. The web application created using Streamlit

makes our analysis accessible to a wider audience, allowing them to explore the insights gained from the Indian railway network data in an intuitive and engaging way.

4.2 LIBRARIES

The following libraries are used in the context at hand to accomplish specific tasks:

- networkx: A Python library that enables the creation, manipulation, and study of complex networks, such as graphs and nodes. It offers an extensive set of tools for analyzing and visualizing network data, which is particularly useful for various Machine Learning applications.
- numpy: A widely used Python library for scientific computing, particularly in the fields of Mathematics, Physics, and Engineering. It provides an efficient interface for handling large multi-

dimensional arrays and matrices, along with an extensive set of mathematical functions to perform operations on them.

- matplotlib.pyplot: A Python library for creating high-quality visualizations, including line plots, scatter plots, histograms, and bar charts. It provides a flexible interface for customizing plots with various attributes, such as colors, fonts, and labels.
- pandas: A data manipulation library that provides easy-to-use data structures and data analysis tools for working with structured data. It allows for efficient data ingestion, cleaning, and transformation, along with flexible data querying and aggregation capabilities.
- pickle: A built-in Python module for object serialization and deserialization, which allows for the conversion of complex data structures into a format that can be easily stored and retrieved from disk.
- streamlit: A Python library for building interactive web applications, particularly in the field of Machine Learning. It offers a simple and intuitive interface for creating customizable web pages, incorporating data visualizations, and interacting with Machine Learning models in real-time.

Chapter 5

METHODOLOGY

5.1 METHODOLOGY

First, the raw dataset obtained from Kaggle was preprocessed to remove any duplicates, missing values, and irrelevant columns. The dataset was then converted into a suitable format for network analysis.

Next, the required information was extracted from the preprocessed dataset, such as train numbers, names, source and destination stations, distances, and times.

A network model was created from the extracted data using the NetworkX Python library. The nodes of the network represent railway stations, and the edges represent the connections between them.

Various algorithms were applied to the network model to analyze and extract useful information, such as the shortest path between stations, the most connected stations, and the betweenness centrality of stations.

Finally, the results were visualized using the Streamlit Python library to create an interactive website. The website includes a search feature to find the shortest path between two stations, a map showing the location of the stations, and graphs showing the distribution of different metrics across the network.

The methodology used in this project provides a comprehensive analysis of the Indian railway network and its various components.

Chapter 6

IMPLEMENTATION

6.1 PROCESSING

Code:

Read JSON File:

```
import json
stations_dataset = json.load(open('./dataset/stations.json'))
trains_dataset = json.load(open('./dataset/trains.json'))
import networkx as nx
G = nx.MultiDiGraph()
```

Adding Nodes To Graph:

```
for station in stations_dataset["features"]:
    if station["geometry"]==None or station["properties"]==None or
station["properties"]["state"]==None or
station["properties"]["code"]==None or
station["properties"]["name"]==None or
station["properties"]["zone"]==None or
station["properties"]["address"]==None:
        continue
    G.add_node(station["properties"]["code"],
name=station["properties"]["name"], zone=station["properties"]["zone"],
state=station["properties"]["state"])
```

Adding Edges To Graph:

```
for train in trains_dataset["features"]:
    if train["geometry"]==None or train["properties"]==None or
train["geometry"]["coordinates"]==None or
train["properties"]["zone"]==None or
train["properties"]["from_station_code"]==None or
train["properties"]["duration_m"]==None or
train["properties"]["number"]==None or
train["properties"]["to_station_code"]==None or
train["properties"]["duration_h"]==None or
train["properties"]["distance"]==None:
        continue
    G.add_edge(train["properties"]["from_station_code"],
train["properties"]["to_station_code"],
distance=train["properties"]["distance"],
```

```
minute=(train["properties"]["duration_h"]*60 +
train["properties"]["duration_m"]),
number=train["properties"]["number"])
Removing Nodes With Degree 0
l=list(G.nodes())
for n in l:
    if (G.degree(n)==0):
        G.remove_node(n)

Saving Graph Using Pickle
import pickle
print(type(G))
dbfile = open('graph_after_removing_zero_degree_nodes', 'ab')
pickle.dump(G, dbfile)
dbfile.close()

Graph Visualisation
nx.draw(G, node_size=10)
```

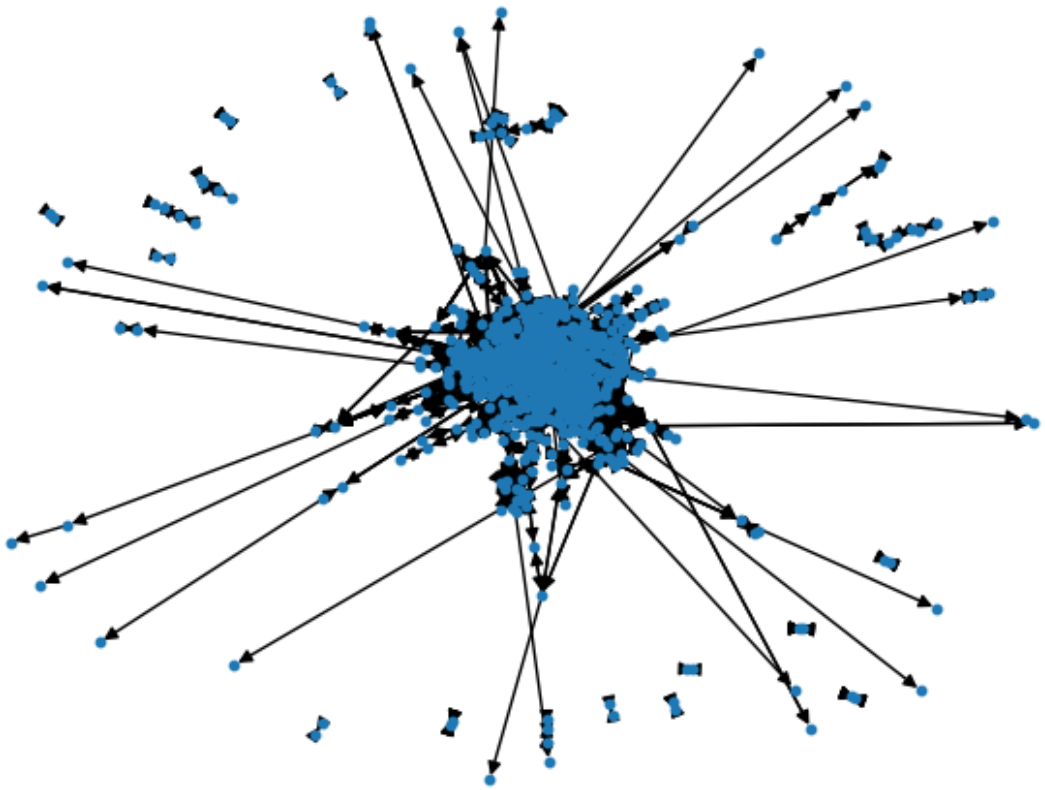

Fig 6.1.1: Visualization Of Graph

Adjacency Matrix Of The Graph

```
import pandas as pd
df =pd.DataFrame(nx.adjacency_matrix(G, weight="distance").todense(),
index=G.nodes(), columns=G.nodes())
```

Listing Busiest Station

```
l=list(G.degree(list(G.nodes())))
l.sort(key=lambda x: x[1], reverse=True)
l[:10] #top 10 nodes with highest degree (stations with most number of
trains)
```

Calcualtion Of Shortest Path Length Using Distance And Time

```
shortestPathByDistanceTimeDF =pd.DataFrame( index=G.nodes(),
columns=G.nodes())
for i in G.nodes():
    for j in G.nodes():
        if i==j:
            continue
        lst=[]
        try:
            lst.append(nx.shortest_path_length(G, source=i, target=j,
weight="distance"))
        except nx.NetworkXNoPath:
            lst.append(None)
        try:
            lst.append(nx.shortest_path_length(G, source=i, target=j,
weight="minute"))
        except nx.NetworkXNoPath:
            lst.append(None)

shortestPathByDistanceTimeDF.loc[i,j] = lst
```

	NZB	KMU	MNM	SNSI	DLJ	PBE	REWA	MBA	ELP	BGNA	...	MKC	BZU	RPR	HZD	KQR	PGMD	PWL	CTO	POY	RGV
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PGMD	[None, None]	[None, None]	[None, None]	[None, None]	[None, None]	[None, None]	[None, None]	[None, None]	[None, None]	[None, None]	...	[None, None]	[None, None]	[None, None]	[None, None]	[None, None]	NaN	[None, None]	[None, None]	[None, None]	[None, None]
PWL	[1924, 1921]	[2955, 3125]	[2872, 2806]	[1466, 1516]	[2102, 2260]	[488, 860]	[1253, 1351]	[684, 690]	[None, None]	[None, None]	...	[998, 1010]	[1339, 1860]	[1343, 1645]	[1325, 1330]	[1112, 1135]	[138, 275]	NaN	[2465, 2616]	[3660, 3746]	[1329, 1720]
CTO	[873, 1025]	[1904, 2235]	[1951, 2240]	[1963, 2450]	[3152, 4135]	[2846, 3745]	[2320, 2990]	[2324, 3285]	[None, None]	[None, None]	...	[1617, 2265]	[2234, 2870]	[2907, 3580]	[2602, 3310]	[2787, 3535]	[2375, 2794]	[2473, 3065]	NaN	[2739, 3180]	[3021, 4010]
POY	[2198, 2620]	[1700, 2020]	[1090, 1355]	[2846, 3196]	[4062, 4730]	[4036, 4575]	[3188, 3985]	[3499, 4210]	[None, None]	[None, None]	...	[2942, 3860]	[2743, 3755]	[3581, 3995]	[3312, 3600]	[3497, 3825]	[3683, 3574]	[3660, 3895]	[2739, 3135]	NaN	[3735, 4300]
RGV	[2287, 2975]	[2818, 3600]	[2880, 3400]	[2480, 2800]	[2701, 3750]	[1046, 1785]	[1595, 2385]	[1055, 1635]	[None, None]	[None, None]	...	[1669, 2360]	[1747, 2510]	[368, 835]	[668, 980]	[455, 815]	[1347, 1765]	[1321, 1670]	[3001, 3670]	[3668, 4340]	NaN

747 rows × 747 columns

Fig 6.1.2: Matrix with shortest distance and time between stations.

Centrality Measures For Each Nodes

Degree Centrality (DC)

nx.degree_centrality(G)

```
Output exceeds the size limit. Open the full output data in a text editor
{'NZB': 0.0160857908847185,
 'KMU': 0.005361930294906166,
 'MNM': 0.002680965147453083,
 'SNSI': 0.028150134048257374,
 'DLJ': 0.002680965147453083,
 'PBE': 0.036193029490616625,
 'REWA': 0.0160857908847185,
 'MBA': 0.005361930294906166,
 'ELP': 0.002680965147453083,
 'BGNA': 0.002680965147453083,
 'NIR': 0.022788203753351208,
 'APDJ': 0.02546916890080429,
 'AWB': 0.005361930294906166,
 'SMNH': 0.00938337801608579,
 'CUPJ': 0.005361930294906166,
 'PBR': 0.032171581769437,
 'GRD': 0.0160857908847185,
 'AGTL': 0.010723860589812333,
 'SOG': 0.01742627345844504,
 'MBF': 0.005361930294906166,
 'CMNR': 0.013404825737265416,
 'DBB': 0.002680965147453083,
 'CPK': 0.005361930294906166,
 'CTA': 0.005361930294906166,
 'CTD': 0.005361930294906166,
...
 'PGMD': 0.002680965147453083,
 'PWL': 0.002680965147453083,
 'CTO': 0.002680965147453083,
 'POY': 0.002680965147453083,
 'RGV': 0.002680965147453083}
```

Fig 6.1.3: Degree Centrality Measures Of Stations.

B/W Centrality

nx.betweenness_centrality(G)

```
Output exceeds the size limit. Open the full output data in a text editor
{'NZB': 0.0015487686456363246,
 'KMU': 0.0023840797452183457,
 'MNM': 0.0,
 'SNSI': 0.004039112898225571,
 'DLJ': 0.0,
 'PBE': 0.0059124287173072596,
 'REWA': 0.00029119241824061885,
 'MBA': 0.00011324730213555454,
 'ELP': 0.0,
 'BGNA': 0.0,
 'NIR': 0.002433490590871578,
 'APDJ': 0.002956170799033934,
 'AWB': 0.0,
 'SMNH': 0.00012313792524979526,
 'CUPJ': 0.0,
 'PBR': 0.007226385749329402,
 'GRD': 0.0024412755761575623,
 'AGTL': 0.000624546883276372,
 'SOG': 0.002522922601721677,
 'MBF': 1.8897734602625202e-05,
 'CMNR': 2.6397498746577842e-05,
 'DBB': 0.0,
 'CPK': 0.0,
 'CTA': 0.0023840797452183457,
 'CTD': 0.0,
...
 'PGMD': 0.0,
 'PWL': 0.0,
 'CTO': 0.0,
 'POY': 0.0,
 'RGV': 0.0}
```

Fig 6.1.4: Betweeness Centrality Measures Of Stations.

SHORTEST PATH

```
p=nx.shortest_path(G, source="HWH", target='CMNR', weight="l")
p
```

```
['HWH', 'BBS', 'TPTY', 'CMNR']
```

Fig 6.1.5: Shortest Path .

SHORTEST PATH LENGTH

```
p=nx.shortest_path_length(nod, source="HWH", target='MAS',
weight="distance")
p
```

```
1662
```

Fig 6.1.6: Shortest Path Length.

STATIONS WITHIN A DISTANCE FROM A PARTICULAR STATION

```
import pickle
with open('nodes.pkl', 'rb') as c:
    nod = pickle.load(c)
P=[]
for s in nod.edges('HWH'):
    # print(s[1])
    if((nx.shortest_path_length(nod, source=s[0], target=s[1],
weight="distance"))<200) and (s[1] not in P):
        P.append(s[1])
# P.sort
x=list(nod.degree(list(P)))
x.sort(key=lambda x: x[1], reverse=True)
# print(x)
dict2={}
for i in x:
    dict2[i]=nx.shortest_path_length(nod, source='HWH', target=i[0],
weight="distance")
print(dict2)
```

```
{('PKU', 37): 71, ('BWN', 28): 107, ('KGP', 28): 115, ('DGHA', 11): 189, ('BHP', 4): 146, ('SIU', 2): 33, ('MYM', 2): 82, ('KIG', 2): 55, ('TAK', 2): 57, (
```

Fig 6.1.7: Stations Within A Distance From A Particular Station

```
#CSV To Dataframe
```

```
import pandas as pd
station_code = pd.read_csv('./dataset/AI&ACategoryStns.csv',
low_memory=False)
station_code
```

	Sr No.	Name of Station	Stn Code	Division	Railway	State	Catg based on Pass earning of
0	1	CST Mumbai	CSTM	BB	CR	Maharashtra	A1
1	2	Lokmanya Tilak (T)	LTT	BB	CR	Maharashtra	A1
2	3	Pune	PA	PA	CR	Maharashtra	A1
3	4	Nagpur	NGP	NGP	CR	Maharashtra	A1
4	5	Kalyan	KYN	BB	CR	Maharashtra	A1
...	...	...	...	...	...	...	...
407	328	Ujjain	WR	UJN	Ratlam	Madhya Pradesh	A
408	329	Valsad	WR	BL	Mumbai Ce	Gujarat	A
409	330	Vapi	WR	VAPI	Mumbai Ce	Gujarat	A
410	331	Veraval	WR	VRL	Bhavnagar	Gujarat	A
411	332	Viramgam	WR	VG	Ahmedabad	Gujarat	A

412 rows × 7 columns

Fig 6.1.8: Details Of The Stations

6.2 VISUALISATION

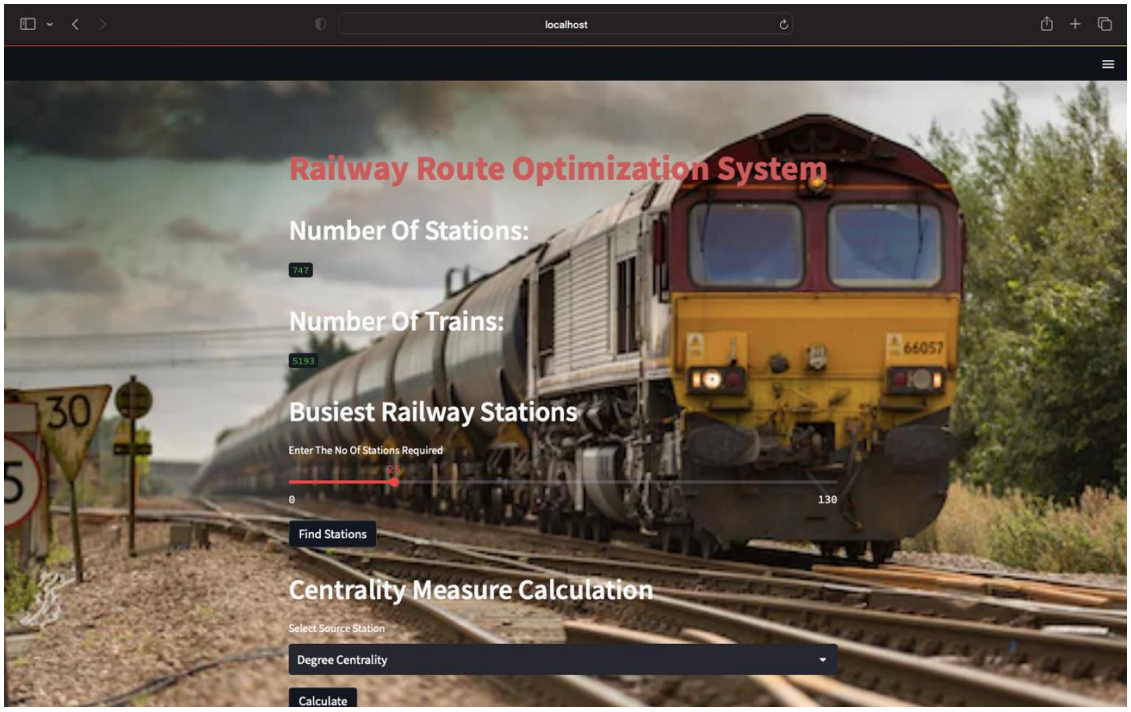

Fig 6.2.1: Website Homepage

Code:

```
import pickle
import streamlit as st
import pandas as pd
import numpy as np
import networkx as nx
page_bg_img = '''
<style>
[data-testid="stAppViewContainer"] {
    background-image: url('https://images.unsplash.com/photo-
1474487548417-781cb71495f3?ixlib=rb-
4.0.3&ixid=MnwxMjA3fDB8MHxzZWFyY2h8M3x8dHJhaW58ZW58MHx8
MHx8&auto=format&fit=crop&w=500&q=60');
    background-size: cover;
}
[data-testid="stSidebar"] {
    background-color: rgba(0,0,0,0.0);
}
h1{
    color: indianred;
}
table{
    background-color: #00425A;
    text-align: center;
}

</style>
'''
st.markdown(page_bg_img, unsafe_allow_html=True)
st.title("Railway Route Optimization System")
with open('nodes.pkl', 'rb') as c:
```

```
    nod = pickle.load(c)
with open('nearstation.pkl', 'rb') as c:
    nearstation = pickle.load(c)

# print no of station and trains
st.header("Number Of Stations: ")
st.write(nod.number_of_nodes())
st.header("Number Of Trains: ")
st.write(nod.number_of_edges())
```

Fig 6.2.2: Number of Stations and Trains.

Code:

```
# listing busiest train
st.header("Busiest Railway Stations ")
stations = st.slider('Enter The No Of Stations Required', 0, 130, 25)
if st.button('Find Stations'):
    l = list(nod.degree(list(nod.nodes())))
    l.sort(key=lambda x: x[1], reverse=True)
    # top 10 nodes with highest degree (stations with most number of
trains)
    busy=l[:stations]
    bstation = pd.DataFrame(busy, columns=['Station', 'No Of Trains'])
    st.table(bstation)
```

	Station	No Of Trains
0	HWH	263
1	NDLS	160
2	MAS	145
3	DLI	139
4	MSB	136
5	SBC	117
6	ADI	112
7	LPI	108
8	HYB	106
9	CSTM	99
10	NZM	99
11	LTT	98
12	PUNE	90
13	SC	90
14	SDAH	87

Fig 6.2.3: Busiest Railway Stations.

Code:

```
# Centrality Measure Calculation
G2 = nx.Graph(nod)
st.header("Centrality Measure Calculation")
centrality = st.selectbox('Select Source Station', ('Degree Centrality',
                    'Closeness Centrality', 'Betweenness Centrality',
'Eigenvector Centrality'))
if st.button('Calculate'):
    if centrality == 'Degree Centrality':
        st.write("Degree Centrality: ", nx.degree_centrality(nod))
    elif centrality == 'Closeness Centrality':
        st.write("Closeness Centrality: ", nx.closeness_centrality(nod))
    elif centrality == 'Betweenness Centrality':
        st.write("Betweenness Centrality: ", nx.betweenness_centrality(nod))
    elif centrality == 'Eigenvector Centrality':
        st.write("Eigenvector Centrality: ", nx.eigenvector_centrality(G2))
```

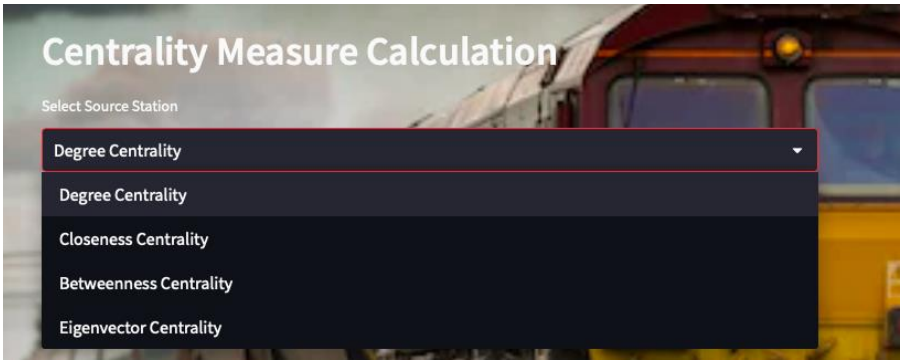

Fig 6.2.4: Busiest Railway Stations.

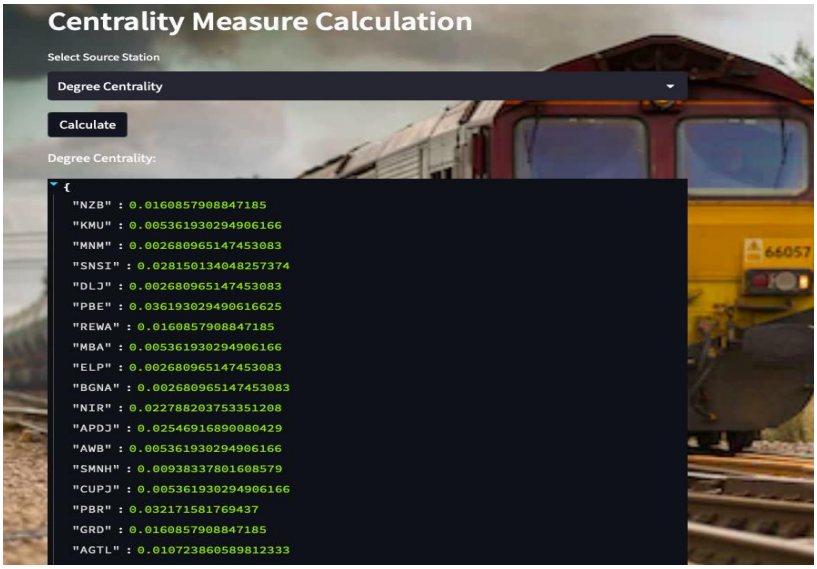

Fig 6.2.5: Centrality Measures.

Code:

```
# Shortest Path Calculation
st.header("Shortest Path Calculation For Train Route")
with open('station.pkl', 'rb') as f:
    mynewlist = pickle.load(f)
import pickle
with open('station_name.pkl', 'rb') as f:
    stationname = pickle.load(f)
option1 = st.selectbox('Select Source Station', stationname.values())
option2 = st.selectbox('Select Destination Station', stationname.values())


if st.button('Find Route'):
```

```
    # route()
    st.write("Route Found")
    st.write("Route is:")
    p = nx.shortest_path(nod, source=[i for i in stationname if
stationname[i]==option1][0],
                         target=[i for i in stationname if
stationname[i]==option2][0], weight="distance")
    q = nx.shortest_path_length(
        nod, source=[i for i in stationname if
stationname[i]==option1][0],target=[i for i in stationname if
stationname[i]==option2][0], weight="distance")
    #Convert List To Table And Display
    temp=[]
    for z in p:
        temp.append(stationname[z])
    shrt_path = pd.DataFrame(temp)
    st.table(shrt_path)
    st.write('Distance travel is: ', q, 'km')
```

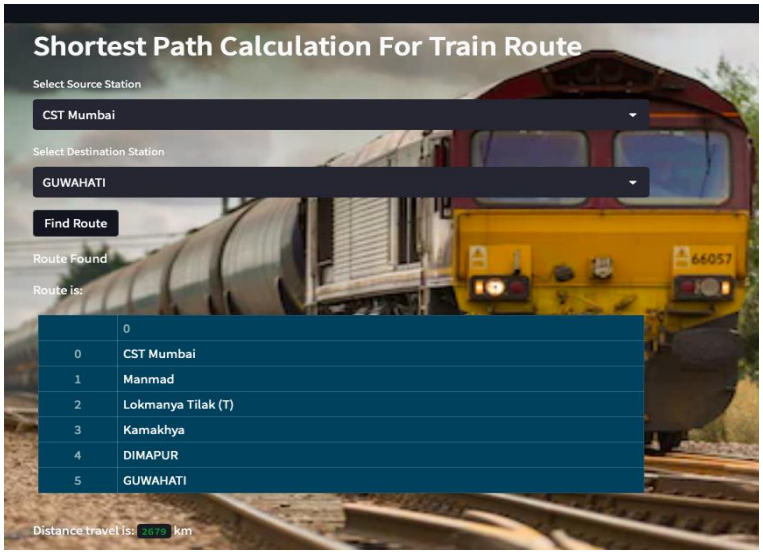

Fig 6.2.6: Shortest Path.

Code:

```
# Clustering Coeff. Calculation
G2 = nx.Graph(nod)
st.header("Clustering Coefficient Calculation")
if st.button('Calculate Clustering Coefficient'):
    st.write("Clustering Coefficient: ", nx.average_clustering(G2))
```

Fig 6.2.7: Articulation Points.

Code:

```
# Bridges Calculation
st.header("Bridges Calculation")
if st.button('Calculate Bridges'):
    st.write("Bridges: ", list(nx.bridges(G2, root='MAS')))
    st.write("Number of Bridges: ", len(list(nx.bridges(G2, root='MAS'))))

# Articulation Points Calculation
st.header("Articulation Points Calculation")
if st.button('Calculate Articulation Points'):
    st.write("Articulation Points: ", list(nx.articulation_points(G2)))
    st.write("Number of Articulation Points: ",
            len(list(nx.articulation_points(G2))))
```

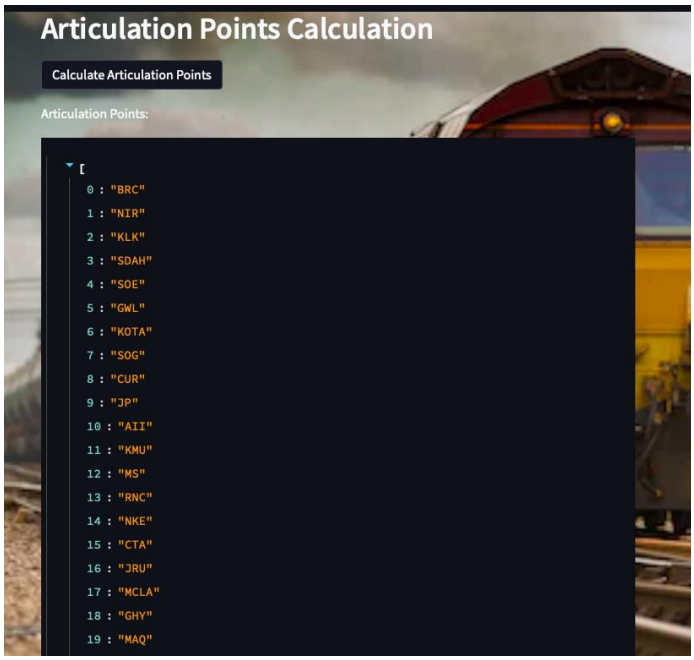

Fig 6.2.8: Efficiency.

Code:

```
# Clustering
st.header("Clustering")
zoneselect = st.selectbox('Select Zone', ('North', 'South', 'East', 'West'))
if zoneselect == 'North':
    a="NDLS"
elif zoneselect == 'South':
    a="MAS"
elif zoneselect == 'East':
    a="HWH"
elif zoneselect == 'West':
    a="BCT"
st.write("Zone Main Station Is: ", a)
distance_possible = st.slider('Choose Max Distance:', 40, 600, 120)
if st.button('Calculate Clustering'):
    P = []
    for s in nod.edges(a):
        # print(s[1])
        if ((nx.shortest_path_length(nod, source=s[0], target=s[1],
weight="distance")) < distance_possible) and (s[1] not in P):
            P.append(s[1])
    # P.sort
    x = list(nod.degree(list(P)))
    x.sort(key=lambda x: x[1], reverse=True)
    # print(x)
    dict2 = {}
    for i in x:
        dict2[i[0]] = nx.shortest_path_length(nod, source='HWH',
target=i[0], weight="distance")
    st.write("Stations in Zone With Most No Of Train Stoppage: ")
    #Convert List To Table And Display
    df = pd.DataFrame(x, columns=['Station', 'No Of Train Stoppage'])
    st.table(df)
    dict3 = sorted(dict2.items(), key=lambda x:x[1])
    st.write("Stations in Zone With Shortest Distance From Main Station:
")
    #Convvert Dictionary To Table And Display
    df = pd.DataFrame(dict3, columns=['Station', 'Distance From Main
Station'])
```

```
st.table(df)
```

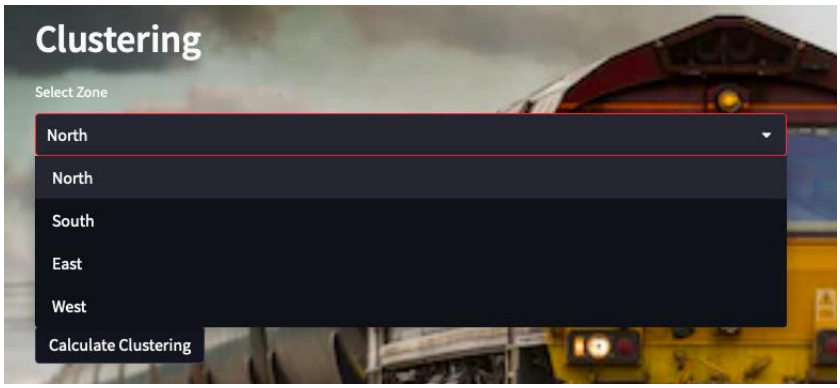

Fig 6.2.9: Airports in a State.

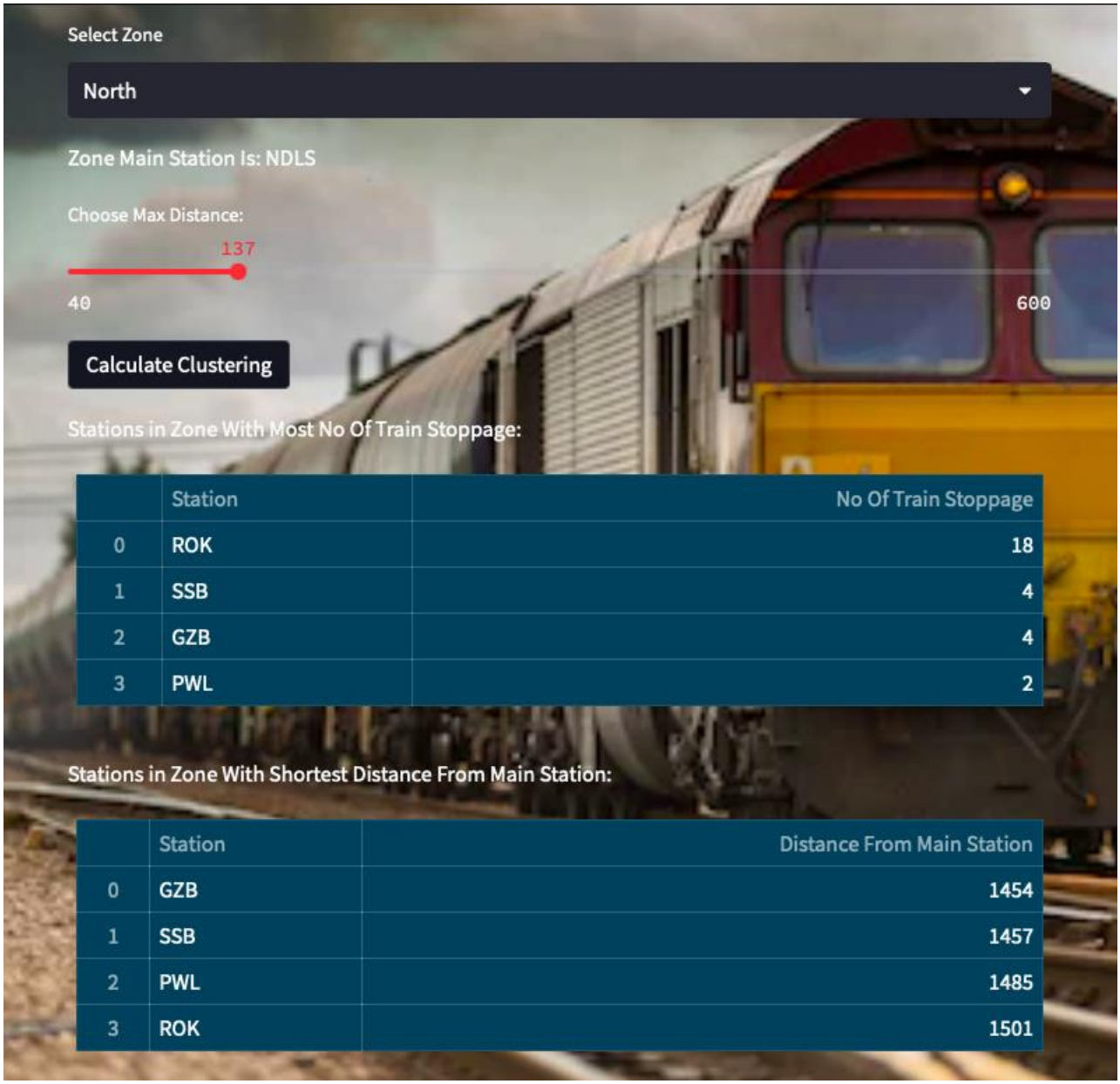

Fig 6.2.10: Stations In Particular Zone.

Code:

```
#Efficiency Calculation
st.header("Efficiency Calculation")
if st.button('Calculate Global Efficiency'):
    st.write("Efficiency: ", nx.global_efficiency(G2))

G0 = nx.Graph(nod)
su1 = st.selectbox('Select Source Airport:', nod.nodes)
des1 = st.selectbox('Select Destination1 Airport:', nod.nodes)
```

```
des2 = st.selectbox('Select Destination2 Airport:', nod.nodes)
if st.button('Calculate Efficiency'):
    st.write("Efficiency: ", nx.efficiency(G0, su1, des1))
    st.write("Efficiency: ", nx.efficiency(G0, su1, des2))
```

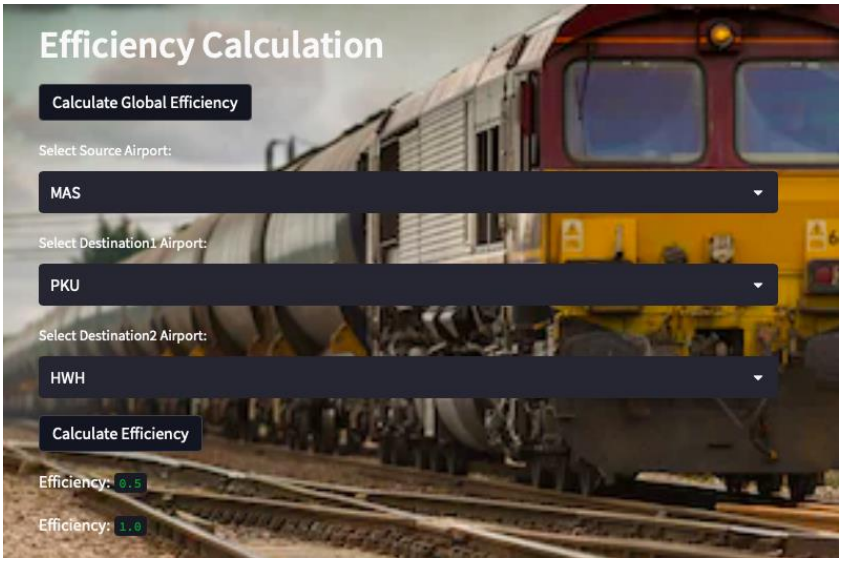

Fig 6.2.11: Airports nearer from a particular airport.

Code:

```
#Station withing a distance from a particular airport
st.header("Find Stations Nearer From A Particular Station")
option8 = st.selectbox('Select Station',stationname.values())
dist = st.slider('Enter The No Of Stations', 0, 20, 5)
op=st.radio("By distance or time", ("distance","time"))
if st.button('Find Stations Nearer:'):
    # route()
    st.write("Stations Found")
    st.write("Stations are:")
    n=nearstation[[i for i in stationname if stationname[i]==option8][0]]
    l=[]
    for idx, x in enumerate(nearstation):
        try:
            l.append((x, int(n[idx][0 if op=="distance" else 1])))
```

```
        except:
            pass
    l.sort(key=lambda x: x[1], reverse=False)
    o=l[0:dist]
    d={}
    for i in o:
        d[i[0]]=i[1]
    state_station = pd.DataFrame.from_dict(d, orient='index',
columns=['Distance' if op=="distance" else "Time"])
    st.table(state_station)
```

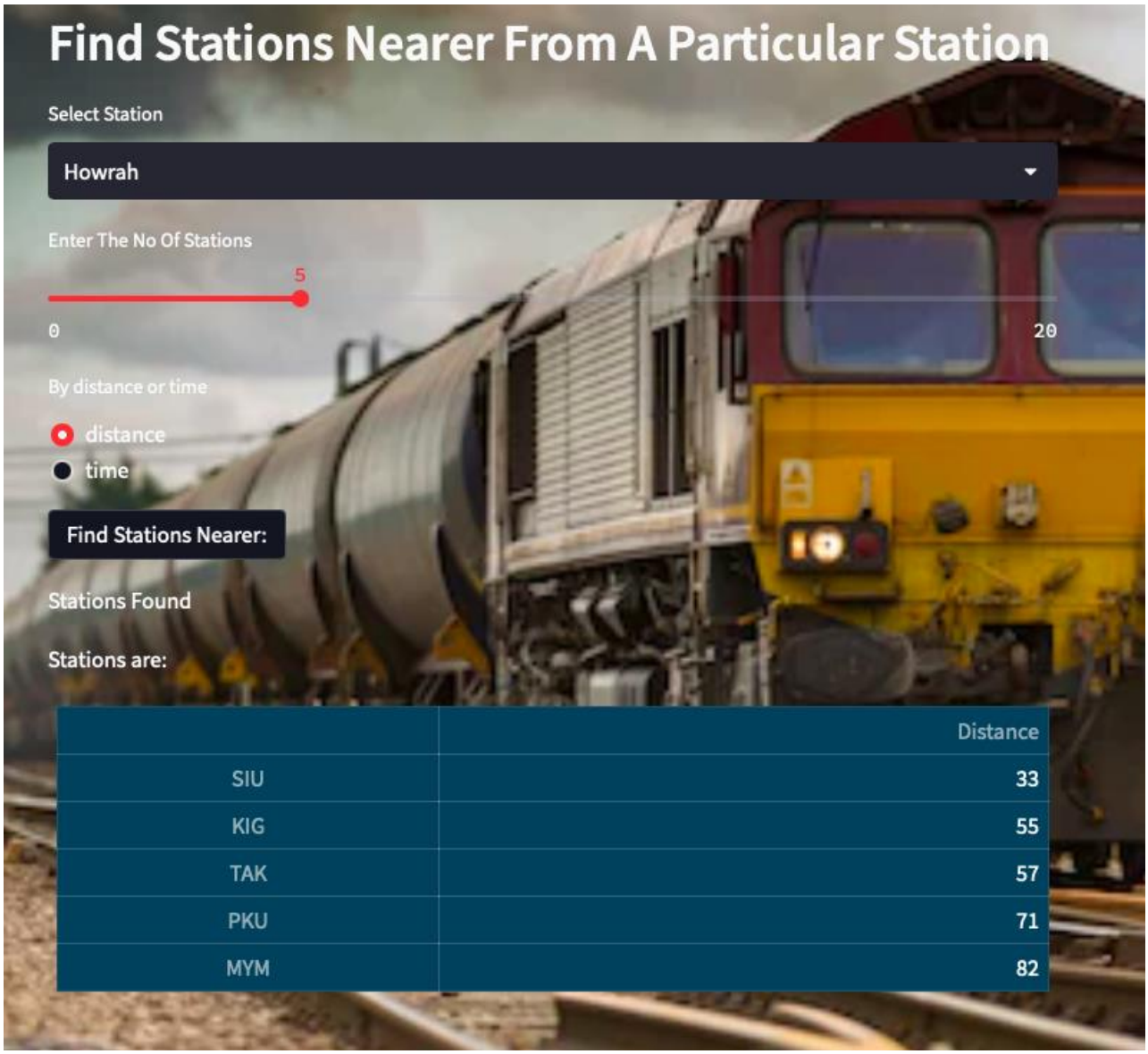

Fig 6.2.12: Airports nearer from a particular airport.

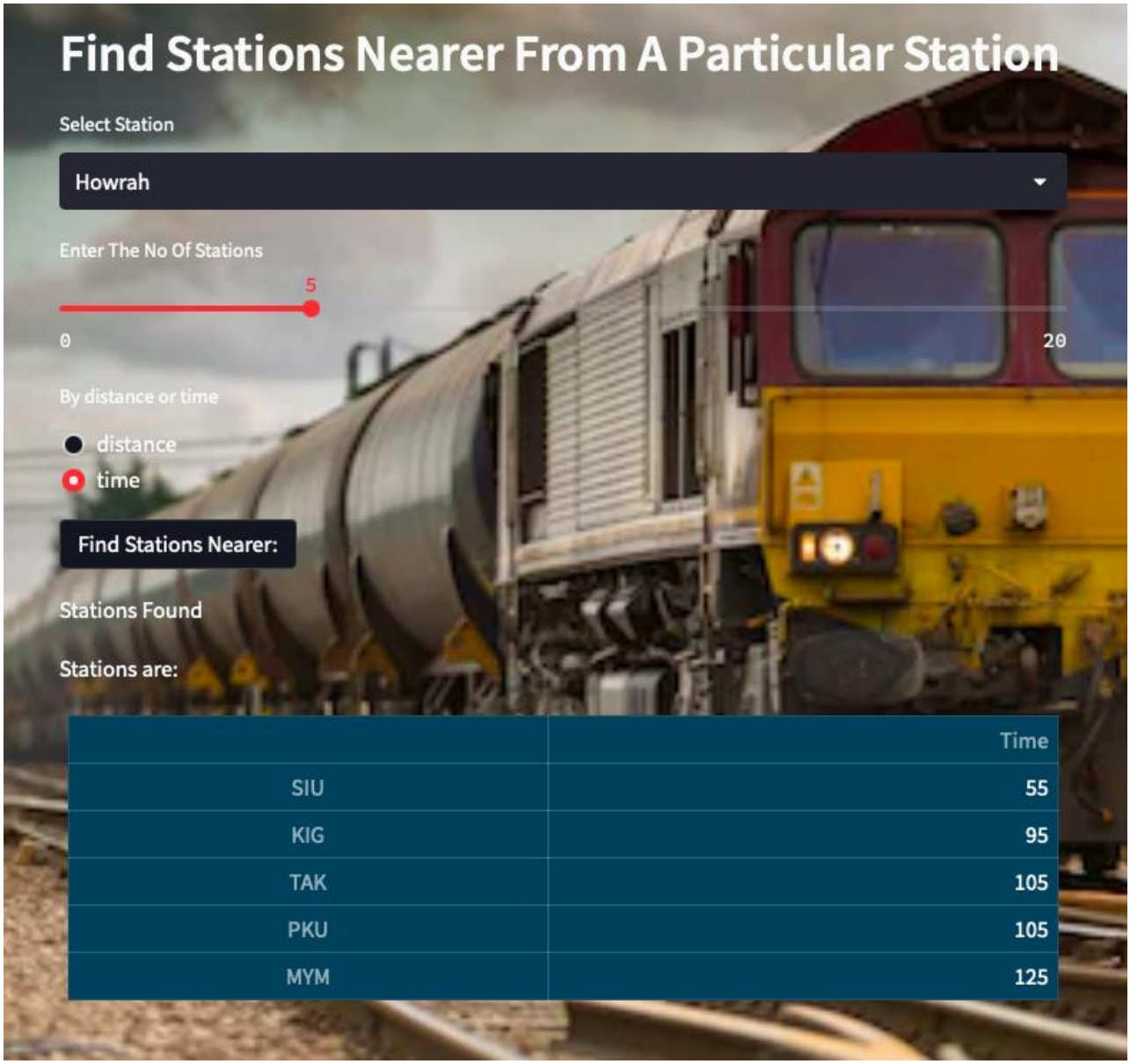

Fig 6.2.13: Airports nearer from a particular airport.

Chapter 7

CONCLUSION & FUTURE WORK

7.1 CONCLUSION & FUTURE WORK

In conclusion, this project has demonstrated the application of network analysis techniques to the Indian railway network dataset. The analysis provided insights into the network structure, station centrality, and the flow of information among stations. It has been observed that some stations have a high degree of centrality and act as hubs for the network, whereas others have lower centrality and act as peripheral stations. Furthermore, the analysis showed that the flow of information among stations is influenced by factors such as the volume of passengers and the frequency of train services. The visualization tool developed using the Streamlit library provided an interactive and user-friendly interface for exploring the network and its properties.

In terms of future work, there is scope for further analysis and improvement of the tool. The analysis can be expanded to include more factors such as the number of platforms, the availability of amenities, and the number of trains passing through each station. Additionally, the tool can be enhanced with predictive analytics to forecast future trends and patterns in the network. Furthermore, the visualization can be improved with more interactive features such as the ability to filter by specific regions, train types, and time periods. Finally, the tool can be integrated with other transportation modes to create a comprehensive multi-modal transportation network analysis tool.

Overall, this project has highlighted the potential of network analysis techniques for understanding and improving transportation networks.

Chapter 8

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