Analysis of Global Air Traffic Network

Introduction

The global air transport network dataset was selected for this project, focusing on air routes due to its personal relevance and importance. As an international student, my experience with the complexities of global air travel sparked my interest in understanding the intricate airline network. This dataset provides the opportunity to delve into the global route structure, revealing the factors that influence travel efficiency and convenience. This project aims to analyze networks to identify key airports based on centrality.

Dataset Description

The datasets, "airports.csv" and "routes.csv," comprise extensive information about global air travel networks:

Airports.csv: This file lists global airports, providing a comprehensive set of details for each, including names, IATA codes, and geographical information. The dataset contains several columns, but for the purpose of this project, only specific fields like the airport name and IATA code were used.
Routes.csv: This file documents airline routes, indicating the source and destination airports by their IATA codes. Like the airports file, it contains multiple columns, but the focus was on the columns relevant to mapping the flight routes.

These datasets underpin the construction of a directed graph that represents the global air traffic network.

Methodology

1. Data Processing

Rust's powerful file handling and parsing capabilities were leveraged to process the CSV files. The process_airports_file function maps airport IATA codes to their names, while process_route_file extracts flight routes as pairs of source and destination airport codes.

2. Graph Construction

A directed graph was constructed from the processed data. Each node represents an airport, and each edge denotes a flight route. The map_airports_to_integers function assigns a unique integer to each airport, facilitating efficient graph operations.

3. Centrality Analysis

Using the constructed graph, we computed the degree centrality of each node. This measure reflects the number of direct connections an airport has with others in the network, indicating its importance or influence.

4. Testing Approach

Testing Framework

To ensure the robustness of the code, a series of tests were implemented. These tests aimed to validate the functionality of the data processing and graph construction components.

Sample Data Test

A specific test, test_process_airports_file, was designed to confirm the accurate parsing and mapping of airport data. By creating a sample "sample_airports.csv" file and running the processing function, the test verifies that the correct mapping of IATA codes to airport names is achieved.

Results and Discussion

The analysis yielded the following top 10 airports by degree centrality:

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Top 10 Airports by Degree Centrality:
Frankfurt am Main Airport: 239 connections
Charles de Gaulle International Airport: 237 connections
Amsterdam Airport Schiphol: 232 connections
Istanbul Airport: 227 connections
Hartsfield Jackson Atlanta International Airport: 217 connections
Beijing Capital International Airport: 206 connections
Chicago O'Hare International Airport: 206 connections
Munich Airport: 191 connections
Domodedovo International Airport: 189 connections
Dubai International Airport: 188 connections
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These results provide insightful information about the hubs in the global air traffic network. Airports like Frankfurt, Charles de Gaulle, and Amsterdam Schiphol emerge as pivotal nodes, underlining their strategic importance in global air traffic.