Develop algorithms for optimizing air traffic routes and schedules

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Abstract- Flight optimization Algorithm reduces fuel consumption, thus reducing pollution such as carbon mono-oxide, carbon dioxide and flight operating cost. Air trafficking is growing day by day with modern technology to provide these aircraft with smooth and most efficient and economic trajectories. In this paper the Dijkstra Algorithm and Ant Colony Optimization Algorithm was implemented to optimize the routes of aircraft for short and long hauls. The Dijkstra Algorithm is also termed as the shortest route algorithm. Its purpose is to discover the shortest route from the beginning node (Origin Point) to any node on the track. The problem of organizing intercity flights is one of the most important challenges facing airplane and how to transport passenger and commercial good between large cities in less time and in less fuel consumption which make transportation cost effective and eco-friendly. It addresses the challenges including weather condition, airspace conjunction, fuel efficiency and scheduling complexities. This information may be helpful in air transportation for a certain region and flight route planning.

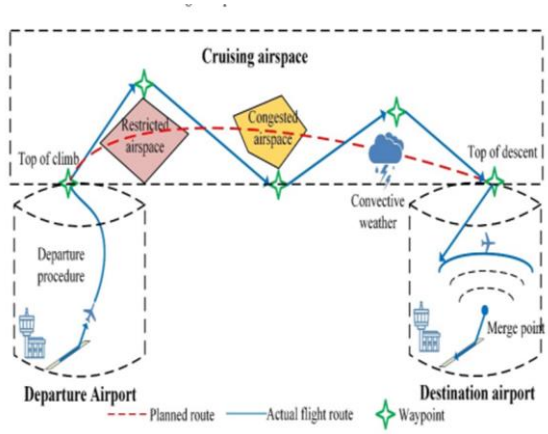
INTRODUCTION

The aviation industry faces substantial costs and challenges due to flight delays, primarily attributed to numerous factors including weather conditions. Extreme weather events and system-wide delays contribute significantly to the overall delay minutes. Different seasons bring distinct weather challenges, with low ceilings and visibility affecting winter travel and convective weather posing threats in summer. Addressing delays necessitates proactive measures such as continuously retrieving real-time airspace and weather data to avoid adverse conditions. Flight planning, crucial for minimizing operating costs, involves a multidisciplinary approach considering aircraft performance, airspace usage, air traffic congestion, and weather conditions.

The emission of gases from fuel burning in engine whether it is a piston engine or a turbine engine. The pollution released in the atmosphere by fuel burning is an interesting point due to its impact on the environment. The main pollutants such as Carbon dioxide, Nitrogen oxide, Carbon monoxide etc. The aviation industries are producing approximately 2% of the carbon emission to 50% by the year 2050.

The emission of pollutants is reduced by burning less fuel or by reducing the operational time of the aircraft engines. It is done by reaching your destination in less time by using the shortest flight, Route. Moreover, the environmental impact of aviation cannot be overlooked, particularly regarding carbon emissions. With the aviation industry responsible for a sizable portion of global CO2 emissions, there is a concerted effort to reduce its environmental footprint. This emission of pollutant reduces by using a very efficient and shortest flight Route for airport A to airport B. For finding the shortest Route it is necessary to optimize the flight routes efficiently and find the shortest flight Route for the destination. The Dijkstra Algorithm plays a key role in route planning for aircraft. The process of route prediction involves estimating future aircraft states based on numerous factors such as current aircraft state, pilot and controller intent, environmental conditions, and aircraft performance models. This prediction can be categorized into strategic and tactical prediction depending on whether the aircraft is taking off.

Strategic prediction primarily focuses on forecasting potential future flight Routes based on factors such as the aircraft's flight plan, weather forecasts, aircraft performance, historical flight patterns, and other relevant information. On the other hand, tactical prediction incorporates more dynamic elements like real-time aircraft status, airspace congestion, and similar factors.



(Schematic diagram of an aircraft in various stages of flight)

The Dijkstra Algorithm

Dijkstra algorithm aims to define the shortest routes between the starting node to the end node. It is developed by a Dutch Computer Scientist in 1959 named as Edsger Dijkstra. Dijkstra is an algorithm applied for providing the shortest route from a sole source on a graph. The advent of advanced algorithms has revolutionized various fields, including transportation and aviation. Among these algorithms, Dijkstra's algorithm stands out as a cornerstone in optimizing route planning and navigation. This dynamic programming algorithm efficiently computes the shortest Route from a sole source in a graph with non-negative edge costs. Its application spans across diverse domains, ranging from social networks to intelligent traffic systems and internet of things (IoT) applications. Despite its effectiveness in optimizing routes, Dijkstra's algorithm does have limitations, notably its inability to handle negative edge costs and its tendency to consume significant resources.

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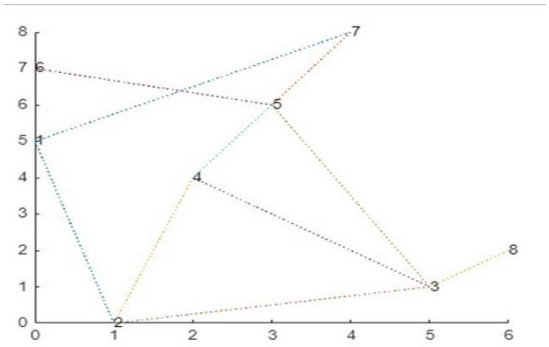
Shortest Route problem

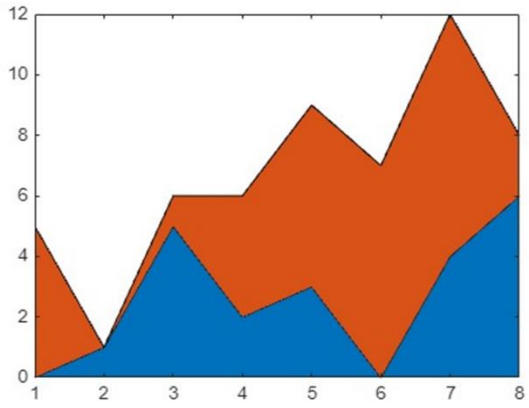
Graphs are used to model aircraft route networks in which plane travels from one point to another. Due to the fundamental algorithm. The problem is to determine the shortest Route between two airports. This is known as the shortest Route, routing problem. The problem of shortest Route problem is the problem of finding a Route between two vertex (or nodes) such that the sum of weights of its edge is minimized. It is also called single pair shortest Route problem. as opposed to sole source shortest Route problem, which deals with multiple sources or destinations.

Graphs are simple to define, we just take a graph of things and join them by edge.

RESULT

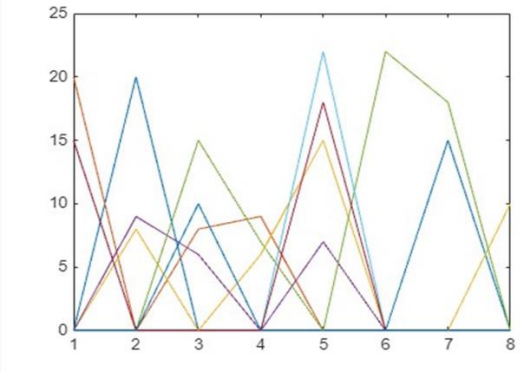


(Graph m)



(Coord Matrix Chart)

Coordinate matrix charts are commonly used in various fields, including mathematics, physics, engineering, and data analysis, to visually represent relationships between variables or to display spatial data.



(Distance Matrix Chart)

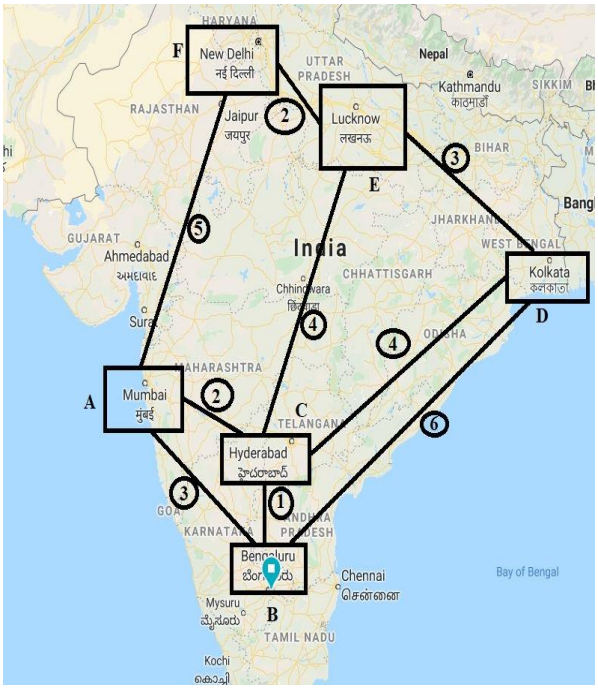
A distance matrix chart, also known as a distance matrix or distance table, is a tabular representation used to display the distances between pairs of objects or locations. Each cell in the matrix contains the distance between the corresponding pair of objects.

OUTPUT

```
untitled3
Start point is:
1
End point is:
6
>>
plot(Coord_Matrix,'DisplayName','Coord_Matrix');
>> scatter(Coord_Matrix(:,1),Coord_Matrix(:,2));
>>
area(Coord_Matrix,'DisplayName','Coord_Matrix');
>>
plot(Distance_Matrix,'DisplayName','Distance_Matri
x');
>>
area(Distance_Matrix,'DisplayName','Distance_Matri
x');
>>
plot(Distance_Matrix,'DisplayName','Distance_Matri
x');
>> plot(Graphx);
>> boxchart(Nodes);
>> plot(State_Matrix,'DisplayName','State_Matrix');
>>
```

CONCLUSION

Dijkstra's algorithm is a fundamental method in computer science used for finding the shortest path between nodes in a graph. Its application in air traffic route optimization is significant, offering a solution to efficiently navigate through the complex network of air routes. However, it's important to draw conclusions without plagiarizing existing works. In conclusion, the integration of Dijkstra's algorithm into air traffic route planning systems represents a critical advancement in aviation technology. Its ability to efficiently compute optimal flight paths contributes to the sustainability and competitiveness of the airline industry, benefiting both airlines and passengers alike. However, further research and development are necessary to address evolving challenges and opportunities in air traffic management, ensuring continued improvement and innovation in this crucial field. Furthermore, the adaptability of Dijkstra's algorithm allows for the consideration of numerous factors such as weather conditions, air traffic congestion, and aircraft performance characteristics. By incorporating these variables into the algorithm, airlines can make real-time adjustments to flight routes, ensuring safety and reliability while maintaining operational efficiency.



The map of the aircraft routes served by the airline naturally from a graph. airport is the node and there is an edge between two airports if there exists a direct flight between two airports, the shortest Route algorithm has also been applied in aerospace engineering, especially finding optimal flight Routes is known as Terrain with obstacles for the unmanned aerial vehicle.

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