ME 308 – Project Proposal

Team Code: 13
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Topic: Air Traffic Flow Management: A Comprehensive Study on Operations Research in Transportation Systems

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Problem Description:

During the 120 years since the first ever flight of the Wright brothers, the air transport industry has become a major sector of the global economy. Needless to say, this growth has come with an increase in congestion and flight delays. Operations research (OR) has and continues to play a critical role in helping sustain this growth rate and make air travel more convenient.

In this project, we address the problem of air traffic flow management (ATFM) in response to adverse weather conditions. ATFM is the process of strategic scheduling of departures and modification of trajectories when faced with dynamically changing conditions, thereby reducing delay costs and congestion. Weather is estimated to cause nearly two-thirds of flight delays. For example, between 2004 and 2017, around 22% of flights were either delayed or cancelled owing to adverse weather. Given the recent cyclonic developments around the Indian subcontinent, this problem is becoming increasingly relevant to Indian air traffic control systems as well.

Challenges:

There are two main challenges when concerned with developing ATFM algorithms. Firstly, weather conditions are highly uncertain and dynamic in nature. This poses a requirement for algorithms that can be easily updated in the event of new information without having a major impact on other aircraft routes. Secondly, the increasing amount of flight connectivity means that the same aircraft may operate multiple flights in a day resulting in delay propagation.

Primitive ATFM algorithms are resource-heavy since they deal with space-time trajectories of individual aircraft. In order to overcome the computational challenges of these models, many researchers have resorted to algorithms that use aggregate flows. Over time, Eulerian models have proved suitable for such types of feedback control systems in centralized, decentralized as well as distributed network settings (such as multi-airport networks). We discuss a similar model that is capable of processing flight data and training neural networks to calculate and display optimal flight routes.

Deliverables:

A tentative list of deliverables that we hope will result from this project are mentioned below:

1. Gain a well-rounded understanding of OR and its general applications, as well as specific applications in the air transport industry
2. Explore various optimization techniques and their applications both within and outside the airline industry, as well as a first-hand experience of implementing the same for sample flight data (and if time permits, a comparison of a few common optimization techniques in the specific scenario for this project)
3. Analyse the economic impact of OR on the airline industry through a brief cost-benefit study weighing the research and development costs incurred by airlines against the delay/cancellation costs in the long run

Project Timeline:

06/03/2022	Gain a deeper insight into the fundamentals of the topic, including a brief study of relevant real-life examples and review of current ATFM algorithms
20/03/2022	Analyse and review previous works, including research papers, existing models & simulations and any video lectures on the subject
03/04/2022	Modify existing models to make suitable performance improvements; also look up information on flight data and compile into a dataset if needed
10/04/2022	Construct a detailed comparison of existing models against the improved model including graphical and/or pictorial illustrations
24/04/2022	Compile all the work into a detailed report and/or presentation containing the abstract, introduction, literature review, datasets, proposed method, conclusions and references