AA 228 Project Proposal

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Final Project Group 2

Autonomous Air-Traffic Control for Weather Interference

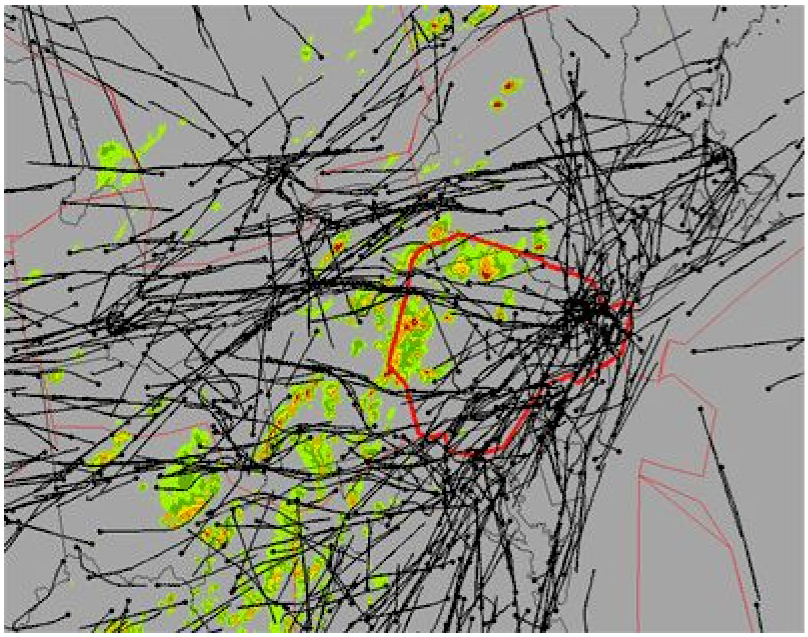

Figure 1: Impacts of a severe thunderstorm in 2013 on flights in the New York City airspace. Image source: [1].

Weather is the largest cause of air traffic delay. From 2008 to 2013, weather caused 69% of delays over 15 minutes [1]. Adverse weather also increases workload for air traffic controllers, particularly in congested airspace over busy airports. Current attempts to handle weather involve issuing different types of mandates to airlines, including:

(1) Severe Weather Avoidance Plan (SWAP) - relocate planes to another part of the country,
(2) Airspace Flow Program (AFP) - reduce hourly flow rates of planes along affected paths, and
(3) Ground Delay Programs (GDPs) - temporarily hold aircraft at their departure airports.

In some cases, however, these mandates are not adequate for preventing large delays. In 2013, a cold front near New York City caused a large storm development in the New York City airspace. Although an AFP was issued an hour before, many aircraft were already en route before the mandate was issued. As a result, there was a large traffic problem, with many planes needing to be rerouted to avoid the storm. In addition, controllers rerouted planes northward in the direction of the evolving storm, resulting in longer reroutes. This event resulted in 69 diverted aircraft, and 55 airborne holdings, with almost 600 departure and arrival cancellations [1].

Given these challenges, we aim to design an autonomous air traffic controller that will dynamically reroute planes around weather interference. Weather patterns can evolve unpredictably, resulting in uncertainty in the weather pattern's trajectory over time. As such, the controller will need to make decisions based on observations of the state of the weather pattern and model predictions of its future development to dynamically route airplanes around the weather front. Such a controller could help air traffic controllers reroute planes to minimize time delays and safely land each aircraft. This controller could also inform the development of algorithms for more comprehensive unmanned air traffic management. The controller will achieve three goals, ranked by priority:

(1) ensure the safety of each aircraft by avoiding collisions with other aircraft and flying directly into severe weather,
(2) allow as many planes as possible to reach their destinations, and
(3) minimize time in air and thereby delays.

In this problem, we will initialize a heterogeneous composition of aircraft in various directions and distances from a target airport. To simplify the problem, all aircraft will fly at a constant altitude of 10,000 feet and constant velocity with respect to time. Each aircraft will be modeled as an object with the following attributes: 2D position (x, y), aircraft type, heading, remaining fuel, fuel consumption rate, and maximum yaw rate. The autonomous aircraft controller will issue waypoints to safely guide aircraft to within a certain radius of the airport, where the aircraft will be handed over to airport control for final approach. The aircraft object will adjust its yaw rate to fly through these target waypoints. Meanwhile, the weather will evolve quasi-stochastically based on meteorological models, which will add uncertainty into the real-time aircraft routing problem. The controller will update its waypoints at a specified frequency. The program's effectiveness will be evaluated by the number of planes safely landed per hour and average delay time, relative to current statistics during an AFP or SWAP.

Works Cited

[1] Federal Aviation Administration, "FAQ: Weather Delay," *NextGen Weather*, 29-Aug-2017. [Online]. Available: https://www.faa.gov/nextgen/programs/weather/faq/. [Accessed: 03-Oct-2019].