A Markov Decision Process Framework for Optimal Airport Reconfiguration

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Abstract

The airport runway configuration is defined as a combination set of runways for arrivals and departures used at a point during operation of the airport. An optimal configuration of these runways depends on a number of factors, including traffic demand, wind magnitude and direction, other adverse weather conditions, and noise restrictions, among others. Based on the current state of these factors and predictions of traffic demand and weather conditions, runway configuration changes are made and coordinated between tower controller, other air traffic control facilities, pilots, and ground personnel.

Reconfigurations can be quite disruptive to airport operations; minimizing their frequency and scheduling them well in advance is essential for mitigating some of the added workload for controllers and pilots. Unfortunately, deciding on an appropriate time to change is challenging for human decision makers. Not only do multiple factors need to be evaluated, but the uncertainty in their forecasts must also be considered. Previous optimization methods, such as mixed linear integer programming, have been proposed. Although these methods can reason over a large set of variables, they do not systematically handle the uncertainty associated with weather movement, traffic demands, and other variables.

In this work, we introduce a Markov Decision Process (MDP)-based decision making framework which can reason effectively over the inherent uncertainties and make optimal decisions on if/when to change the airport configuration. In a prototype implementation, we present a single runway with three aircraft and utilize knowledge of the forecasted wind speed and direction to determine whether to keep or change the current runway configuration. Our aim through this work is to present a *framework* for airport reconfiguration which can be scalable to additional aircraft, multiple runways, and various input parameters. This technique will optimize the airport reconfiguration procedure by providing a proactive approach, optimizing not just at the next optimal opportunity for a reconfiguration based on varying atmospheric and traffic conditions in the terminal airspace, but also anticipating future necessary reconfigurations. This will eliminate the inefficiencies of frequent changes currently associated with runway reconfiguration procedures.

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