

OPRE 6398.001 Prescriptive Analytics

Reading 5*

Put yourself in the position of the team that schedules the aircraft for Delta Airlines. There are over 2,500 flights in the United States, Canada, and Mexico on a daily basis. There are 450 planes available, but they aren't all the same - in fact, there are 10 different groups that vary by size, speed, and other characteristics. On top of this, a maintenance schedule for the aircraft must be included and allowance must be made for the flight crews - pilots are limited in the types of airplanes they are certified to fly and they need enough rest each day. Some cities allow certain models of aircraft to operate at certain times of the day (because of noise created, for example). Other constraints need to be imposed too, such as that the same plane must be used for certain continuing flights. Clearly, it is a very complex task even to develop a feasible schedule.

Running such a fleet of aircraft is very expensive, so it is crucial for Delta to design a scheduling system to maximize profitability by eliminating empty seats while simultaneously minimizing operating costs, which include personnel cost, fuel cost, and maintenance cost. There is also a cost of spill, which refers to the number of passengers that are not carried due to insufficient capacity. For instance, if a small plane is scheduled for a given flight segment but the number of people who want to fly could fill a jumbo jet, the airline loses a lot of potential revenue.

In 1991, Delta began the Coldstart project to address the problem of fleet scheduling, i.e., assigning a particular set of aircraft to specific markets with an aim to have the right plane at the right place at the right time. The result of the undertaking was the formulation of a very large mixed integer linear program, whose objective is to minimize the total operating and spill costs subject to the restrictions described above. In all, there are about 40,000 constraints as well as 60,000 decision variables, of which 40,000 are integer-valued. This large-scale problem was run on a powerful computer daily.

The Coldstart model was implemented in September 1992, and by the summer of 1993 it was saving Delta approximately \$220,000 per day. Management projection called for estimated savings of \$300 million over a three-year period. Delta is not the only airline using integer programming for fleet and crew scheduling. American Airlines also reports substantial profit improvement with similar models.

* Adapted from Subramanian, R., Scheff, R., Jr., Quillinan, J., Wiper, D., and Marsten, R. Coldstart: Fleet assignment at Delta Air Lines. *Interfaces*, 1994, January-February, 104-120.