Chapter 15
Optimization of a Predictive Aircraft Maintenance Routing Model Using Mutated Constrained Particle Swarm Optimization

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ABSTRACT

Aircraft maintenance routing (AMR) is one of the most studied problems in the airline industry and has gained much attention. The aim of this chapter is to solve a mathematical formulation of the daily AMR problem, which aims to minimize the routing cost while incorporating the risk of unscheduled maintenance. This predictive model requires the optimization algorithm to both assure the feasibility of the solution and to continuously track unscheduled maintenance events. To address these issues, the authors propose a hybrid solution approach with two main contributions: it examines the use of a binary version of particle swarm optimization (PSO) adapted to this constrained optimization problem, and it consists of using an adaptive mutation operator designed to deal with unscheduled maintenance.

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INTRODUCTION

The airline network is among the most sophisticated networks. This situation requires airline companies to improve their systems in order to optimize the planning of aircraft maintenance due to its high cost (Fernando et al., 2011). For attending this purpose, researchers have increasingly focused on the aircraft maintenance routing (AMR) problem.

The maintenance is divided into two major categories of visits. Scheduled Maintenance checks and unscheduled Maintenance events. Nowadays, most researchers focus on resolving unscheduled maintenance activities as they are considered as troubleshooting situations and can generate a high cost. Therefore, research in reducing it in a few percentage points would be amply justified.

On the one hand, scheduled maintenance can be summarized as follows; each visit is scheduled according to the number of flight hours or cycles of aircraft flight, which also depends on the international regulations agreed with the Federal Aviation Administration. They include the checks A Check, B Check, C Check, and D Check. On the other hand, unscheduled maintenance has also been divided on the aircraft on ground (AOG), daily check, preflight checks, and service check.

We can see also that the AMR problem can be solved simultaneously with other problems such as the crew scheduling problem and the fleet assignment as in Cohn and Barnhart (2003), Sandhu and Klabjan (2007) and Diaz-Ramirez et al. (2013). Also, Reiners et al. (2012) developed an algorithm for the integrated aircraft scheduling fleeting, which is based on genetic algorithm and Orhan et al. (2011) developed a model which maximizes the utilization of the remaining time.

In this paper, we interest in the resolution of the AMR problem. Integer linear programming (ILP) is one of the most used approaches for solving the AMR problem. Various ILP models have been proposed since 1971, in which Levin (1971) has formulated an ILP model for scheduling and fleet routing problem.

Another ILP model has been proposed by Desaulniers (1997). Also, Subramanian (1994) were interested in a large-scale mixed ILP formulation. Furthermore, one of the most known models of AMR is the one proposed by Sarac et al. (2006) which aims to minimize the costs of the daily maintenance in which the aircraft needs to be maintained at the end of the day. For this model, classical ILP models may have difficulties in finding feasible routes for large scales instances. Also, they may fail to deal with stochastic events.

Therefore, metaheuristics have been used to solve the AMR problem. They can be used to get feasible routes for each aircraft in rapid time to face the occurring stochastic events which may affect the states of the aircraft in the fleet as presented by Basdere14 which have used the compressed annealing metaheuristic to solve this problem.