

Airport flight gate scheduling with constraint programming

Flight gate scheduling is concerned with finding an assignment of flights to terminal or ramp positions, called gates, and an assignment of the start and completion times of the processing of a flight at its position. A good assignment may reduce the number of aircraft tows required and may lead to reduced setup times for several ground service activities on the ramp as well as in the terminal.

The key idea behind the model presented here is to look at the problem as a modified multimode resource constrained project scheduling problem with a multicriteria objective function. The most important goals are the maximization of a total flight gate preference value and the minimization of the number of tows. The basic optimization algorithm is a truncated branch and bound procedure that branches over gate assignments and the disjunctive constraints used to model the capacity restrictions of the disjunctive resources (gates). The algorithm uses constraint programming techniques to reduce the search space. To cope with large practical problems within the order of magnitude of thousand flights per day, the problem is decomposed into loosely coupled subproblems using a new generic problem partitioning technique. The subproblems are used within a layered branchandbound approach: The search tree is conceptually split into layers that correspond to the subproblems. In each layer, only decision variables of the current subproblem are selected for branching; limited backtracking is performed within the current layer before proceeding to the next layer. Initial solutions obtained in this way are iteratively improved using a Large Neighbourhood Search technique that relaxes some of the decisions and uses the branch and bound algorithm to reform the relaxed part of the solution at a lower cost. The model and algorithm have been evaluated using small manually designed test cases as well as two weeks of a real life flight schedule from a large international airport. A comparison of the computational results with a rule based approach, as often used in commercial systems, shows that the algorithm greatly improves the solution quality.