

A Column Generation Based Algorithm for Airline Cabin Crew Rostering Problem

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Abstract : In airlines, the crew scheduling problem is usually decomposed into two stages: crew pairing and crew rostering. In the crew pairing stage, pairings are generated such that each flight is covered by exactly one pairing and the overall cost is minimized. In the crew rostering stage, the pairings generated in the crew pairing stage are combined with off days, training and other breaks to create individual work schedules. The paper focuses on cabin crew rostering problem, which is challenging due to the extremely large size and the complex working rules involved. In our approach, the objective of rostering consists of two major components. The first is to minimize the number of unassigned pairings and the second is to ensure the fairness to crew members. There are two measures of fairness to crew members, the number of overnight duties and the total fly-hour over a given period. Pairings should be assigned to each crew member so that their actual overnight duties and fly hours are as close to the expected average as possible. Deviations from the expected average are penalized in the objective function. Since several small deviations are preferred than a large deviation, the penalization is quadratic. Our model of the airline crew rostering problem is based on column generation. The problem is decomposed into a master problem and subproblems. The master problem is modeled as a set partition problem and exactly one roster for each crew is picked up such that the pairings are covered. The restricted linear master problem (RLMP) is considered. The current subproblem tries to find columns with negative reduced costs and add them to the RLMP for the next iteration. When no column with negative reduced cost can be found or a stop criteria is met, the procedure ends. The subproblem is to generate feasible crew rosters for each crew member. A separate acyclic weighted graph is constructed for each crew member and the subproblem is modeled as resource constrained shortest path problems in the graph. Labeling algorithm is used to solve it. Since the penalization is quadratic, a method to deal with non-additive shortest path problem using labeling algorithm is proposed and corresponding domination condition is defined. The major contribution of our model is: 1) We propose a method to deal with non-additive shortest path problem; 2) Operation to allow relaxing some soft rules is allowed in our algorithm, which can improve the coverage rate; 3) Multi-thread techniques are used to improve the efficiency of the algorithm when generating Line-of-Work for crew members. Here a column generation based algorithm for the airline cabin crew rostering problem is proposed. The objective is to assign a personalized roster to crew member which minimize the number of unassigned pairings and ensure the fairness to crew members. The algorithm we propose in this paper has been put into production in a major airline in China and numerical experiments show that it has a good performance.

Keywords : aircrew rostering, aircrew scheduling, column generation, SPPRC

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