Enhanced formulations for the arrival-departure aircraft scheduling problem

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Background and Objectives:
The target of this work is to construct a mathematical model to help resolve aircraft scheduling over multiple runways. This problem is considered a hard topic in transportation research due to the constantly increasing aviation traffic volume around the world. Surprisingly, although there exists an impressive amount of literature for the landing and arrival cases, there is no proposed exact solution to solve this problem. Therefore, the main contribution of this work is to present exact methods involving exact procedures specifically related to this complex arrival-departure variant. This method will solve the problem optimally based on mixed-integer linear formulation with the constraints of limited time windows and separation constraints.

The project was funded by Qatar Foundation. Our objective for the investigation stems from its practical relevance to airports where good scheduling increases the airport capacity, maintains a good level of safety and reduces the controller’s workload.

Methods:
We formulated a basic aircraft sequencing model using a mixed-integer linear formulation. Then, we proposed another model by adding valid inequalities, combining constraints and removing some variables. All these mathematical models are based on linear ordering feature. These models were solved using the mathematical programming language AMPL. Then, we solved them using a professional solver CPLEX.

Results:
We investigated the efficacy of reformulation arrival-departure scheduling problem over multiple runways. The results show that the solver is very effective in obtaining optimal solutions. In fact, the experimental tests reveal that most of instances are solved to optimality within a short time. In addition, we realized that adding the valid inequality constraint among the model yields less CPU (Central Processing Unit) time and less number of nodes.

Conclusion:
We proposed linear ordering formulations for the problem of minimizing total weighted tardiness to sequence arrival-departure aircraft over multiple runways. We presented the results of computational study that were carried out on a large variety of random instances and that shows the importance of reformulating the same problem. Interestingly, we observed that the proposed models enable us to optimally solve problems with up 15 aircraft and four runways.