Aircraft scheduling on multiple runways

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Background:
Scheduling aircrafts on single or multiple runways is an important and difficult problem. This problem involves how aircrafts are sequenced on a runway and how they are assigned to runways has a significant impact on the utilization of the runways as well as on meeting the landing and departure target times. Most of the literature focuses on landing operations on a single runway as it is an easier problem to solve.

Objective:
This project was funded by Qatar Foundation to address the scheduling problem of both landing and departing aircrafts on multiple runways as they attempt to meet aircraft target times. The problem is further complicated when considering sequence-dependent separation times on each runway to avoid wake-vortex effects.

Methods:
This research project is based on a two-pronged approach. First, mathematical optimization models were developed to find optimal runway assignments and aircraft sequences on each runway. Due to the significant computational complexity of the problem, a second approach was developed to find near-optimal solution through the development of local search algorithms and metaheuristics, especially for larger problems.

Results:
Several optimization models were developed and the most effective one was selected to find solutions to the problem. The solution effectiveness was enhanced by developing valid inequalities to the mathematical program, which significantly reduced the computational time necessary to solve the problem. Optimal solutions were obtained for problem instances much more difficult than any accounted for in data of available literature. A scheduling index, local search algorithms and metaheuristics (Simulated Annealing and Metaheuristic for Randomized Priority Search-MetaRaPS) were also developed to solve the problem. The results show that optimal or near optimal solutions were obtained for all instances, and the value of the proposed approximate algorithms becomes more evident as the problem size increases.

Conclusions:
The research done in this project demonstrates that there is added value in assigning aircrafts to runways and sequencing them using more optimized methods than the most commonly used approach of first-come-first-served. This research has the potential to change how airports schedule aircrafts in order to increase the runway utilization and better meet the landing and departing target times.