Flight, Aircraft, and Crew Integrated Recovery Policies for Airlines - A Deep Reinforcement Learning Approach

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Abstract:

Airline schedules are easily affected by disruptions, leading to flight delays or (and) cancellations, causing significant financial losses to airline companies and inconvenience for passengers. When making recovery decisions, airlines need to simultaneously consider various entities, including flights, aircraft, and crew. This paper examines the integrated recovery policies for airlines to help re-schedule flights, re-route aircraft, and reassign crew members. To realize quick responses upon the occurrence of disruptions, an attention-based end-to-end deep reinforcement learning approach is proposed to learn a parameterized stochastic policy for the integrated airline recovery problem. Numerical experiments based on randomly generated disruption instances demonstrate that the proposed method outperforms the existing approaches and is applicable in realistic situations. The key insights obtained from our analyses are summarized as follows: (1) traditionally, among all disruption sources, it is most challenging and time-consuming to determine the recovery policies in reaction to aircraft delays and airport closures. However, the new approach developed in this study overcomes this difficulty and can provide high-quality recovery policies for aircraft delays and airport closures quickly. Thus, our work is especially valuable for airports and regions that suffer from frequent flight delays and closures, and can significantly improve their operational efficiency and service quality; (2) when traditional approaches are applied, the adoption of the well-known schedule robustness enhancement strategy 'crew follow aircraft' generally leads to high operations costs. Differently, our proposed approach can apply this strategy without encountering a significant cost growth. Therefore, airlines can fully leverage this strategy to gain additional advantages; (3) our developed new approach demonstrates high generality to accommodate various disruptions, which can benefit airlines and airports in the highly-volatile environment with various unpredictable events.

Keywords:

Flight disruption, integrated recovery, deep reinforcement learning.