Modeling Crew Itineraries and Delays in the National Air Transportation System

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Abstract

We propose, optimize and validate a methodological framework for estimating the extent of the crew-propagated delays and disruptions (CPDD). We identify the factors that influence the extent of the CPDD, and incorporate them into a robust crew scheduling model. We develop a fast heuristic approach for solving the inverse of this robust crew scheduling problem to generate crew schedules that are similar to real-world crew scheduling samples. We develop a sequence of exact and heuristic techniques to quickly solve the forward problem within a small optimality gap for network sizes that are among the largest in robust crew scheduling literature. Computational results using four large real-world airline networks demonstrate that the crew schedules produced by our approach generate propagation patterns similar to those observed in the real world. Extensive out-of-sample validation tests indicate that the parameters calibrated for one network perform reasonably well for other networks. We provide new insights into the perceived tradeoff between planned costs and delays costs as reflected by actual airline crew schedules. Finally, we present a general approach to estimate the CPDD for any given network using our methodological framework under a variety of data availability scenarios.