New Crew-Scheduling Approach Could Cut Air Travel Delays, Save Airlines Millions

A study based on massive amounts of data offers a new way to forecast flight late arrivals and departures and to schedule crews based on expected needs during holiday and other seasonal travel. The new approach could help to cut delays that both frustrate passengers and cost the airlines large sums.

McLean, VA—Flight delays happen most frequently during peak holiday seasons, but no matter when they occur, late arrivals and departures can aggravate passengers and cost airlines millions of dollars. To help address the problem, researchers have used massive amounts of flight arrival and departure data, or big data, to devise a new system for flight-delay forecasting that creates more reliable scheduling.

A poorly designed crew schedule can result in unreliable flight schedules, significantly jeopardizing airline operations and profitability if insufficient crew members are available or other glitches occur, according to the researchers. For that reason, managing airline crew scheduling and costs is one of the most crucial topics for airlines because it yields enormous economic benefits and ranks as the second highest expenditure after fuel costs.

To develop their improved system, the researchers obtained one year of flight data (from April 2015 to March 2016) for Cathay Pacific, a major airline in Hong Kong with operations in 112 airports around the world. They used the data to conduct a series of experiments to get more accurate predictions about when flight arrivals would be delayed given the multiple factors that influence delays.

They also used a model reflecting the many nonlinear factors to help define the best crew pairing. “A crew itinerary is called pairing, which is constructed by a set of duties, consisting of a number of flights, with sit-time and rest period in between as needed, according to the regulations,” the authors explain. Crew pairing is an extremely complex process by which airlines connect the legs of a flight so that the flight crew needed for each airplane is properly assigned and ends up where they live, or their crew base. Using such a data-driven approach to predict flight delays can help airlines generate more reliable crew schedules, which in turn can reduce passenger delays.
The research was published in the online version of Risk Analysis, a publication of the Society for Risk Analysis, in a paper called “Cascading Delay Risk of Airline Workforce Deployments with Crew-Pairing and Schedule Optimization.” The study authors were Sai Ho Chung and Hoi Lam Ma of the Department of Industrial and Systems Engineering, Hong Kong Polytechnic University, and Hing Kai Chan of the University of Nottingham Ningbo China Business School.

For their study, the data collected included flight number, date of flight, scheduled arrival time, actual arrival time, scheduled departure time, actual departure time, flight time, departure airport, arrival airport, and aircraft type, as well as weather data.

To predict flight arrival delays and thereby support the optimal crew pairing, the authors applied a Cascade Neural Network (CNN) approach to capture the nonlinear relationship between various factors, because flight arrival delays are usually influenced by multiple factors.

The CNN modeling included several indicators of factors influencing flight delays. For example, a “Peak Season Indicator” indicated whether the flight day was close to or in the holiday period. A “Peak Typhoon Season Indicator” was used to indicate the chance of a typhoon or hurricane occurring in the month of the flight. A “Flight Time Indicator” was used to analyze the relationship between the flight departure delay and flight arrival delay, which researchers have not studied in the literature to forecast flight arrival delays. In their research, however, the authors write: “We found that many flight arrival delays are caused by flight departure delays.”

Based on their analysis, the authors have proposed a new Flight Time Indicator using the CNN modeling approach. “By comparing our proposed CNN forecasting approach with different traditional methods, the results demonstrated the forecasting accuracy is significantly improved. This demonstrates that forecasting the expected flight departure delay to support the forecasting of flight arrival delay is crucial,” the authors write. The authors later reported to the SRA news editor that they have been communicating with Cathay Pacific about the scheduling method. They are at the stage of applying it to one of the regional flights, Cathay Dragon, for further pilot testing.

The authors add that the CNN forecasting approach can also be used in other domains, such as vessel scheduling. Such scheduling is also an important issue for terminal operations because massive vessels, involving complex operations, are being used more frequently.

Risk Analysis: An International Journal is published by the nonprofit Society for Risk Analysis (SRA), an interdisciplinary, scholarly, international society that provides an open forum for all who are interested in risk analysis, a critical function in complex modern societies. Risk analysis includes risk assessment, risk characterization, risk communication, risk management, and risk policy affecting individuals, public- and private-sector organizations, and societies at a local, regional, national, or global level. www.sra.org

Contact David Clarke davidpaulclarke@gmail.com to arrange an interview with the authors. The complete study is available at: http://onlinelibrary.wiley.com/doi/10.1111/risa.12746/abstract