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Revenue management

Amir Joshan and Andy Philpott. Photo: Godfrey Boehnke.

You're enduring the Auckland to Los Angeles leg of your long-awaited OE, looking forward to landing in London in 20 hours. Your flights were booked months ago at the lowest rate you could find. The passenger on your left got her ticket yesterday for a conference in San Francisco tomorrow and is working frantically on her presentation. The guy on the right bought his single-leg ticket for a lower price than yours in an airpoints promotion that started a month after you'd paid for your seat.

You don't spare a thought for the airline staff who have to juggle such unconnected and competing demands. NZIMA programme co-director Professor Andy Philpott, PhD student Amir Joshan and honours student Michael Frankovich, however, do. They are developing more sophisticated revenue management models for airlines. This fast-growing area of mathematics was kick-started in the 1980s with the arrival of the first cut-price airline in the USA. It now encompasses hotel, rental car, sports-event seating and electricity markets.

Airline revenue management models are based on the fact that different customers are willing to pay different amounts for the same seat; the models aim to extract greater income from airplane seating by differentiating between these customers.

"It's difficult mathematics because customers don't show up all at once", says Philpott. "The first complication is deciding how many seats should be reserved for possible high fare customers who haven't booked. The second complication is that most itineraries consist of sequences of flights. The airline has to decide whether it is better to accept a single-leg customer or to keep seats free for passengers wanting a longer route."

"The third complication is competition. These decisions are all affected by how other airlines are pricing their seats." As part of his PhD thesis, Amir Joshan is developing a preliminary model that accounts for competition between airlines, using data from Air New Zealand.

"Most airlines use commercial revenue management systems, developed by USA software companies such as Sabre and PROS," says Philpott. They are generally based on heuristics - rules of thumb that perform well in practice but are not necessarily optimal.

Philpott is also working with Garrett Van Ryzin at Columbia University on improving computation methods for solving network revenue management problems. Frankovich is experimenting with different networks, classes of arrival process, during high and low use of an airline. Philpott will meet Van Ryzin in Veinna in August to complete the project.

"We're using the theory of multi-stage stochastic linear programming to develop policies that can be proved to be within a certain tolerance of optimal, but we're still a fair distance from the real picture," says Philpott.

"We sample from an idealised model of arrivals that is based on historical airline data. We develop a policy about whether or not to accept a customer requesting a certain type of seat, and then simulate it in comparison with the deterministic linear programming policies that are typically used in practice. In preliminary experiments our policies are doing better."

By Jenny Rankine

maximize $r^T y$ subject to $Ay \le x$, $y \le E[D]$, $y \ge 0$.