AGIFORS SYMPOSIUM – THE LEADING EDGE OF AIRLINE RESEARCH AND DEVELOPMENT

First View: Rapid analysis of breaking news, providing perspective

THE FACTS

The annual Symposium from AGIFORS (Airline Group of the International Federation of Operational Research Societies) was held in Seattle, USA from September 30 to October 4, 2019. AGIFORS is a professional association focusing on operations research solutions for the airline industry, including (but not limited to) algorithms, logistics techniques for flight and crew scheduling, revenue management, operations planning, and finance. The event was jointly hosted by Alaska Airlines and Boeing.

The Symposium is an annual event that has been going on continuously since about 1960. It showcases key innovations that have been researched at airlines from around the world, as well as software vendors serving airlines. This year's symposium had 149 delegates, representing 23 airlines (61 delegates), 29 vendor firms (74 delegates), and 10 academic institutions (14 delegates). It is arguably the best forum for learning about new, leading-edge capabilities that are coming in the airline industry.

THE ANALYSIS

The technical presentations can be roughly divided into two broad categories:

- 10 Commercial applications
- 14 Operations applications

The Commercial applications cover all the technical aspects of revenue generation, including:

- Network Planning
- Revenue Management
- Ancillary services
- Consumer choice of alternative itineraries

The Operations presentations generally focused on improving existing processes, e.g.:

- Block times
- Movement control
- Flight delay simulation to improve on-time performance (OTP)
- Maintenance planning

While there is discussion of airline technologies throughout the entire spectrum of R&D (Research and Development), most of the presentations show new findings and techniques. Most of these are not be quite ready for general use but show innovation and potential to increase revenues or reduce costs. This is representative of the "R" side of R&D. The "D" side comes later, when IT teams begin designing system features and functions that permit the capabilities to be managed by airline workers who don't necessarily have advanced degrees.

The general theme of the conference was the rapid growth of Artificial Intelligence and Machine Learning (AI/ML) applications. These disciplines have been part of the agenda for the last several years but seemed to dominate the field this year. Interest was sufficiently high that the organizers scheduled five talks on AI/ML on Monday afternoon, before the conference officially began. There were over 100 sign-ups to attend this session, which was almost double the typical number of attendees at similar sessions held at past conferences.

This is the first time in recent memory that there were more Operations applications than Commercial (which includes Revenue Management). However, that may not mean very much, as the Commercial applications tend to have greater potential but also tend to need more development before they are ready to be deployed. The Operations applications tend to be less speculative but tend not to have as much impact in terms of revenue gains or cost reductions.

Following is a 1-2 sentence summary of each presentation.

COMMERCIAL PRESENTATIONS:

1. **"A Reinforced-Learning Approach for Calibrating Airlines Itinerary Choice Models with Constrained Demand"** Ahmed Abdelghany, Embry Riddle University. Takes database of 500,000 choices made by consumers and estimates a model that has the best statistical fit with the actual itinerary selected.

2. **"The Role of AI in the Passenger Journey"** Rodrigo Acuna-Agost, Amadeus. Uses AI to determine various points in the journey where the airline can better

understand passenger's choice drivers, predict demand for ancillaries or otherwise create value in each passenger's itinerary.

3. **"Reinforcement Learning Approach for Customer Choice-based Network Revenue Management Problem"** Neda Etebarialamdari, Montreal Institute for Learning Algorithms. Uses AI to influence authorization levels of various booking classes. There is a growing momentum for this exploratory domain, which constitutes a new and potentially disruptive challenge to standard revenue management models.

4. **"Toward a Competitor-Aware Revenue Management System"** Thomas Fiig, Amadeus. Develops forecasts of competitor prices based on market conditions, which are used to predict inventory levels for the airline's flights.

5. **"Quantum Computing for Airline Planning at Jeppesen"** Mattias Gronkvist, Jeppesen. Explores the benefits and difficulties of using a quantum computer for Network Planning. As quantum computers do not yet exist, he could only use a quantum computer simulation to look at a very small problem. More than any of the other presentations, the technology from this presentation appears to be far in the future.

6. **"Data-driven Strategies for Optimizing Revenue from both Air Travel and Holiday Packages", Aime Kamgaingkuiteing, Air Transat.** The Air Transat business model sells air seats as a standalone product as well as combined with a hotel package; both should be considered together in developing pricing and availability.

7. **"A New Airline Seat Reassignment Module"** Xiaodong Luo, Sabre. This talk explored methods for reassigning seats when equipment type changes close to departure time. Issues of seat type, number in party, frequent flier status, and customer history come into play.

8. **"Multi-objective Schedule Evaluation"** Sergey Shebalov, Sabre. In supporting the flight schedule, each department optimizes the resources under its control while taking all upstream decisions as hard constraints. This paper looked at the feasibility of including some rules-of-thumb in one area that would avoid high costs in another area, which would lead to a more profitable schedule overall.

9. **"Individualized Dynamic Pricing of Airline Ancillaries"** Kartik Yellepeddi, Deepair. This paper described a Deep Learning approach to pricing ancillary services based on a history of previous requests and offer prices.

10. **"A Novel Load Factor Progression Model based on OTA Search and Transaction Data"** Quanwu Xiao, Ctrip. Describes a methodology for continuously predicting load factor as a function of offers made and accepted through the booking period.

OPERATIONS PRESENTATIONS:

1. **"Modeling Flight Disruptions: Delays and Cancellations"** Javier Avella-Gonzalez, Air Canada. Correlates IROPS activity with weather forecasts, including wind direction and speed, rain, visibility, temperature. The severity of the IROPS event (in terms of delays and cancellations) can then be estimated before it happens, and proactive mitigation steps can be taken.

2. **"I Know What You Loaded Last Summer"** Felix Brandt – FZI Research Center for IT. Forecasts cargo capacity on passenger aircraft based on aircraft cargo configuration, passenger load, and flight plan parameters. This not only results in a more efficient flight trajectory but may also allow additional passengers or cargo to be carried.

3. **"How Much to Invest in Block Times?"** Cristian Carrizo, LATAM. Debunked several myths about block times and suggested a methodology for getting the "right" block times. Main point was that block times are not a tool for improving dependability; rather, they are a necessary and costly ingredient for operating a flight, and airlines should always try to minimize them.

4. **"Medium Haul Fleet Segmentation – A320neo and A321neo Weight Variant Selection"** Joao Andre Ferreira Abreu, TAP Air Portugal. Estimates the weight capacity available for passengers and cargo, taking into account routine variations, which enables higher payload and time/fuel reduction. (This presentation was on the agenda, but the presenter was unable to attend the conference.)

5. **"Stochastic Tankering"** Semi Gabteni, OpenAirlines. Outlines a methodology for optimal fuel tankering (i.e., carrying more fuel than necessary because of a

higher price downstream) when requirements for the next departure are not fully known.

6. **"How Copa Airlines Applies Machine Learning to Increase Operational Efficiency"** Miguel Gaitan, Copa Airlines. Copa uses K Means Clustering to reduce total block hours in their system, while posting the highest on-time performance statistics in the world.

7. **"Weight and Balance Extensions to Minimize Ground Handling Times and Efforts"** Anna Hess, FZI Research Center for IT. For all-cargo aircraft, an optimization methodology for positioning of the ULDs was proposed. The loading procedure can affect efficiency of unloading the aircraft at destination, particularly when the aircraft is making multiple stops.

8. **"Anomaly Detection and Machine Learning for Airplane Maintenance"** Wannes Meert, KU Leuven. Managing maintenance data can be complex because much of the data is unlabeled; maintenance actions can change routine parameters; and every airplane is slightly different. A Machine Learning approach has had success in sorting out some of this complexity.

9. **"Multi-Agent Systemic Approach to Support Dynamic Airline Operations Based on Cloud Computing"** Frank Morales, Boeing. Organizing operational data in the cloud has facilitated data integration between applications and thereby enhanced productivity within the Operations Control Center.

10. **"The Die is Cast"** Tim Nickel, Lufthansa Systems. The recently adopted SESAR ATM solution for European Air Traffic Management imposes requirements on airline Operations Control Centers to communicate with ATM facilities and with other airlines. Those who don't or can't comply will be at a disadvantage in requesting services from the ATM entities.

11. **"Applications of Flight Delay Simulation"** Olga Perederieieva, Merlot.aero. Merlot has developed a simulation model for airline operations, which tracks delays through an airline's network until the end of the current day. This type of model can pinpoint flights or stations in the airline's network that are vulnerable to delays.

12. **"Comparing the Performance of AutoML Against Custom Models for Incident Report Classification"** Reuben Pereira, Air Canada. Using a Machine

Learning approach, Air Canada has developed a system for electronically reading free-form safety incident reports and classifying them according to incident type and disposition.

13. **"Applying Reinforcement Learning within the Flight Ops Environment"** Manuel van Esch – ZeroG. Reinforcement Learning is an A-I technology that can be configured to act as an assistant to the human controller, offering suggestions for recovery options as well as learning from the controller the characteristics of solutions that are likely to be accepted.

14. **"The 3 Success Criteria to Use Optimization in Highly Human-Dependent Environment"** Valentin Weber, Amadeus. Operations control depends not only on systems that provide data, but also on the humans that provide judgment in the face of uncertainty. A methodology is presented that combines both to achieve faster and more effective decisions.

THE SPECULATION

All new technologies will continue to be refined and grow their constituencies roughly proportional to the new value they are creating. Inevitably, as a new technology matures, the value creation will slow down, and investments will shift to other areas that are more productive. That does not signify that the technology is obsolete, only that the experts in that technology are no longer producing major innovations; i.e., it has become "mature".

We may be nearing the state of maturing technology—with slower gains in capability—for both the Commercial and the Operational initiatives.

On the Commercial side, it has become increasingly difficult to identify actionable trends, around which new sources of revenue can be devised. In addition, the airline product has become considerably more complex, as it often includes ancillary revenue that is difficult to analyze outside of the total revenue package. For example, if the seat upgrade the customer just purchased had not been available, would the customer have purchased a different ticket? The answer could affect pricing decisions.

The Operations side has a different problem: there's an ocean of data to be mined, but we are still asking human controllers to make snap judgments with whatever they can process. For any operational problem, there will be lots of available data, and any one data item might be the decisive factor in solving the problem, or it may be completely

irrelevant. Right now, there is no easy way to tell the difference. AI/ML offers a solution to this problem, but it will take some time to develop and perfect.

AI/ML techniques have a serious deficiency that is going to limit their use in airline Operations until it is solved: AI/ML solutions are not (currently) auditable. The nature of AI/ML is to sift through vast quantities of historical data and search for patterns that give guidance to its recommended solution. These patterns become sufficiently complex that no human being can reverse engineer them in any reasonable length of time. This is not usually a problem for Commercial applications, as the exposure from implementing a flawed algorithm is generally limited to selling a few seats at too low a price. For Operations, however, the worst-case result could be exposing the aircraft to a safety issue such as running too low on fuel. Until there is a clear audit trail that can explain how an AI/ML algorithm produced a particular recommendation, use of these technologies will have to be limited.

Even if there is little substantial progress on these problems for the next few years, there is still plenty of opportunity to make incremental gains that will have real value to airlines. The AGIFORS Symposium showed that there is a rich inventory of ideas circulating within the Operations Research community, and any one of them could turn out to be the "Next Big Thing". AGIFORS conferences have always been a good forum for exploring the leading edge of the airline business, and they can be expected to continue in this role in the future.

T2RL is an independent research and consulting company that specialises in the market place for airline IT systems. Based on data gathered and analysed since the year 2000 it has defined and tracked classifications of airlines and their IT providers. Its research is used by airlines to enable them to make informed choices of systems and vendors and by the vendors to help them develop products that best meet the current and future needs of the airline industry. For further information, visit our website at www.t2rl.com.