AI in a SMART AIRport

Steve Lee
CIO & Group SVP (Technology)
Changi Airport Group (Singapore) Pte. Ltd.

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Changi Airport: Our Terminals

- Four main passenger terminals at Changi (82 Million passenger capacity)
  - Terminal 1: Opened in 1981, refurbished in 1995, recently completed upgrading
  - Terminal 2: Opened in 1990, upgraded in 2006
  - Terminal 3: Opened in 2008
  - Terminal 4: Opens on Oct 31 2017 (16 MPPA)

Opens 2018: Mixed-use complex, incorporating aviation, retail & leisure.

- Singapore’s largest indoor garden and vortex
- Fusion of nature and retail space
Many partners, many missions, ONEChangi

200+ organisations
10,000 frontline staff
40,000 staff
1,800 CAG staff

Creating a service ecosystem

To provide 160,000 customers ONEChangi experience every day
Changi is a Complex System of Systems

- Activities include Airport Operations, Commercial, Air Hub & Emergency Services.

- Four Terminals with floor area > 1,000,000 m² with > 70,000 m² of retail space.

- 58.7 million passengers annually.

- A flight every 90 seconds. 107 scheduled airlines, 380 city links to 90 countries.

How to handle the Diversity, Complexity & Scale?
Can AI really solve all our problems? Ask Siri or Alexa.

Can't we just use artificial intelligence to manage our sales funnel for us?

I found four places that sell funnel cakes fairly close to you.
AI has been around. So what is different now?

I have been following “AI” since last wave circa 1982…

- Heuristics in Search
- Evans & Sunderland GPU for simulators
- Local Optimisation e.g. Genetic Algorithms, Neural Nets
- Autolisp in Autocad
- Image Recognition for military applications
- Expert Systems Simulation & Ops Analysis
- Turbo Prolog: Chess, Language Interface, Knowledge Representation
- OpenGL and Vector based “language” for graphics display across narrow band networks
- Programming Text Adventure Games, Experiments in ELIZA
- Smalltalk & other interesting “grammars”

Access to massive amounts of usable data through sensors & massive computing power easily available.

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CAG is investing in AI to improve/transform

Challenge in past few years was access to usable data

- Airport Service and Retail
  - Ops Anticipation – Example of Arrival Journey
  - Retail / Customer Genome
  - Customer Engagement Channels
    - Chatbots
    - Language Translation to help service staff and our digital channels
- Security & Safety
  - Image Recognition
  - Analytics applications

Must always answer “How can we improve the lives of our customers and employees?”
Journey of Arriving Passengers

- **Takeoff**
  - Has the plane taken off?
  - How many people are on board?

- **Landing**
  - Important to predict landing time due to downstream impact.
  - How early can we know its predicted landing time?
  - Any possible congestion on arrival e.g. stand conflict?

- **At Gate**
  - When will it reach the stand? Enough trolleys?
  - Any potential immigration queue issue?

- **Immigration**
  - Any possible congestion on arrival?
  - Right number of resources deployed?

- **Baggage Claim**
  - Bags unloaded on time? Distance from stands?
  - Any possible congestion at claim hall?

- **Taxi Queue**
  - Predicted taxi demand? Taxi queue buildup?
  - Taxi supply situation – need to activate?
Every day 1,000 flights take off and land in Changi airport from all over the world carrying 160,000 passengers
Predicting Landing Time: AI problem

We adopted a “Hybrid” approach

• Input data:
  – ADS-B location information
  – Flight data from open sources
  – Air Traffic Information e.g. runway in use direction, standard terminal arrival routes (STARS) chosen
  – Weather information e.g. bad weather or wind direction
  – Flight information e.g. aircraft type, pax
  – Actual landing time

• Output data:
  – Predicted landing times upon takeoff
  – Predicted landing times (2 hours away from actual landing time)
We partnered with SITA to set this up.

Predictive Platform
- Historical Data
- Live Data

Neural Network
- DeepLearning4J

Linear Algebra
- ND4J

Optimization
- CUDA
- Optimized Native Code

Hardware
- 8 x Tesla K80 (NVIDIA)
- 4 x CPU (Amazon M4 Instance)

Amazon P2 Instance
Some Technical Points

• Predictive platform is based on machine learning, hence it is split into two modules; a learning model (on the left) and the real-time predictive module (on the right).

• The neural network implementation that we use is provided by DeepLearning4J. DeepLearning4J is supported by ND4J, which is a high performance linear algebra library.

• ND4J is very portable and flexible. It allows us to reduce the training time of the neural network.

• Need to be able to have quick and easy access to GPU computing power. We can re-train our neural network very frequently, and in this way continuously improve the prediction accuracy.

Based on current training improvement, a usable model can be ready in a few months’ time
User Interface is important for AI development
Improving passengers and employees’ lives through landing prediction:

- Improved information sharing with meeters and greeters
- Improved resource allocation for all touchpoints especially aircraft turnaround
- Arrival trolleys fulfillment
- Minimise stand conflicts
- Reducing immigration queue
- Improving taxi queue demand forecast

The better estimate is necessary for improvement but not sufficient. Other measures are needed e.g. concept of operations changes.
Another Possible AI Project

Has the plane taken off?
How many people are on board?

How early can we know its predicted landing time?
Any possible congestion on arrival e.g. stand conflict?

When will it reach the stand? Enough trolleys?
Any potential immigration queue issue?

Any possible congestion on arrival?
Right number of resources deployed?

Bags unloaded on time? Distance from stands?
Any possible congestion at claim hall?

Predicted taxi demand? Taxi queue buildup?
Taxi supply situation – need to activate?
**AI is a key enabler in a SMART* Airport**

**SMART* Airport**

**Key Outcomes:**
- Operational Anticipation & Reaction
- Data-enabled Resource Planning
- Data-driven Platform for Collaboration & Problem Solving

**Key Enablers:**
- Sensor Masterplan
- Data Fusion
- AI/Cognitive Capabilities
- Cyber Security & Information Assurance

*SMART : Service, Safety and Security Management through Analytics and Resource Transformation*
SMART Airport:
Smart People augmented by AI
Thanks!

Recommended to me by Steven Miller, Vice Provost (Research) and immediate past dean School of Information Systems, Singapore Management University.