Big Data Analytics for the Study of Intermodal Passenger Behaviour

Ricardo Herranz, Nommon
- Technology-based company based in Madrid, founded in 2012
- 30 people team, ~2.5 M€ turnover
- Information, quantitative analysis and decision support tools for the planning and management of transportation systems
- Research-intensive organisation: R&D spending around 50% of revenue
- Business Units:
  - Kineo Mobility Analytics
  - Aviation
  - Transport & Mobility
The planning and management of transport systems requires accurate, reliable and updated information on transport supply and travel demand. While high-quality transport supply information is increasingly available, travel demand data is in most cases the big unknown.
Travel surveys

- High cost
- Time consuming
  - Small samples
  - Quality of information
  - Outdated information
  - Information not fully adapted to the problem

...so, for decades, we have developed a lot of theory to fill these gaps
Opportunities

Mobile devices

Sensors

Geolocation data

Passive data collection

“Objective” data

Longitudinal data - permanently updated
New big data sources allow us to produce high-quality travel demand information, and they more and more integrated into transport planning and traffic management.

- Bigger samples lead to better segmentation of demand.
- Longitudinal data lead to a richer variety of observed travel behaviour.

This results in improved, permanently updated models.
So what about aviation?
The vision of a passenger-centric air transport system

Flightpath 2050: passenger-centric air transport system thoroughly integrated with other transport modes, with the goal of taking travellers from door to door predictably and efficiently

- Admittedly, air transport operations have so far lacked a passenger-oriented perspective, with performance objectives and decision criteria not necessarily taking into account the ultimate consequences for the passenger

- Understanding travel behaviour is an essential enabler for realising the vision of a passenger-centric air transport system. However, research has so far been constrained by the limited availability of mobility data:
  - Typically cross-sectional (static) demographic and economic datasets
  - Small samples
  - Assumptions about the permanence of behavioural traits over time... which is more and more questionable: rapid technology evolution, impact of COVID-19, etc. are leading to increasingly fast changes in travel behaviour
Study of passenger behaviour

Traditional approach

Travel surveys

Aviation passenger intelligence solutions

New opportunities

Big Data Analytics for the Study of Intermodal Passenger Behaviour
Big data and travel behaviour

- New, citizen-centric data sources are beginning to be successfully exploited in other areas of transportation: what are the opportunities for improving decision-making in air transport?

- How can different passenger-centric geolocated data coming from smart personal devices be analysed and combined with more traditional demographic, economic and air transport databases to extract relevant information about passengers’ behaviour and inform decision making processes?
- H2020 - SESAR Exploratory Research - ATM Excellent Science & Outreach
- ER-02-2015: Data Science in ATM
- [www.bigdata4atm.eu](http://www.bigdata4atm.eu)
Door-to-Door
- Mobile phone data
- Twitter data

Door-to-Kerb
- Google data
- Public transport Smart Card data
- Mobile phone data

Gate-to-Gate
- FlightRadar24 data

Kerb-to-Door
- Google data
- Public transport Smart Card data
- Mobile phone data

Intra-airport
- Beacon data
- Roaming pass data
- Credit card data

Big Data Analytics for the Study of Intermodal Passenger Behaviour
A snapshot of results:
the example of mobile phone records
The data

Anonymised mobile phone data provided by Orange Spain

- Spatio-temporal data: time and cell tower to which the user is connected every time an event occurs
- Orange’s clients + roamers that connect to Orange’s network
- Sample of around 27% of the total population
Big Data Analytics for the Study of Intermodal Passenger Behaviour
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Input data:
- Mobile devices
- Land use / Pol
- Transport network & Supply of transport services
- Sociodemographic statistics
- Other demand data

Kineo Analytics Platform:
- Data pre-processing and cleansing
- Sample selection
- Activity and trip detection
- Sample expansion
- Generation of output indicators

Output indicators:
- Travel demand
- Travel times
Modal share

Catchment areas

No Train trips  No Air trips  [No Train trips - No Air trips]
Door-to-door travel times

Trips from the Canary Islands to peninsular Spain
Trips arriving in Madrid from the rest of Spain: D2D travel time

- Half an hour to arrive to the airport
- 2 hours at departing airport
- Less than 1 hour at destination airport
- Almost 1 hour to reach final destination
Door-to-door travel times

<table>
<thead>
<tr>
<th>AIRPORT</th>
<th>K2G TIME</th>
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<tbody>
<tr>
<td>JEREZ</td>
<td>1.5</td>
</tr>
<tr>
<td>FEDERICO GARCIA LORCA/GRANADA-JAEN</td>
<td>1.5</td>
</tr>
<tr>
<td>ASTURIAS</td>
<td>1.6</td>
</tr>
<tr>
<td>ALMERIA</td>
<td>1.7</td>
</tr>
<tr>
<td>VIGO</td>
<td>1.7</td>
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<tr>
<td>BARCELONA/EL PRAT</td>
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<tr>
<td>GRAN CANARIA</td>
<td>1.8</td>
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<tr>
<td>SANTIAGO</td>
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<tr>
<td>IBIZA</td>
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<td>SAN SEBASTIAN</td>
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<td>LA PALMA</td>
<td>2.0</td>
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<tr>
<td>LANZAROTE</td>
<td>2.1</td>
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<tr>
<td>TENERIFE NORTE</td>
<td>2.1</td>
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<tr>
<td>PALMA DE MALLORCA</td>
<td>2.1</td>
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<tr>
<td>VALENCIA/MANISES</td>
<td>2.2</td>
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<tr>
<td>TENERIFE SUR/REINA SOFIA</td>
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<td>ALICANTE-ELCHE</td>
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<td>A CDRUNA</td>
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<td>SEVILLA</td>
<td>2.4</td>
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<td>FUERTEVENTURA</td>
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<tr>
<td>MALAGA/COSTA DEL SOL</td>
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<tr>
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<tr>
<td>BILBAO</td>
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<td>SANTANDER SEVE BALLESTEROS</td>
<td>2.8</td>
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</tbody>
</table>

Trips arriving in Madrid from the rest of Spain: time at origin (left) and destination (right) airports.
Other relevant projects
Leisure/business passenger identification: fusion with survey data

Leisure trips proportion depending on go-return date in EMMA MAD 2018 survey

<table>
<thead>
<tr>
<th>Go date</th>
<th>Return date</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mon</td>
</tr>
<tr>
<td>M</td>
<td>30%</td>
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<tr>
<td>Tu</td>
<td>11%</td>
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<tr>
<td>W</td>
<td>15%</td>
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<td>Th</td>
<td>14%</td>
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<td>F</td>
<td>35%</td>
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<tr>
<td>Sa</td>
<td>100%</td>
</tr>
<tr>
<td>Su</td>
<td>19%</td>
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</tbody>
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Mobility monitoring during the COVID-19 crisis
Conclusions and future directions
The promise of Big Data

Data streams generated by smart personal devices offer a great potential for analysing passenger behaviour with an unprecedented level of detail
These data also come with a number of challenges:

- Noise and errors
- Biases
- Less explanatory power: behavioural information not always directly observable, it has to be inferred
- Limited sociodemographic information
- Computational challenges
- Additional regulatory, organisational and business challenges (privacy, algorithmic transparency, business models...)

But...
No single data source provides the full picture: need for data fusion

Blend airport-specific data with external data to realise full potential

Algorithms matter: devil’s in the details

Rigorous validation is essential

Need for more applied research at the intersection of data science and transportation modelling, in close collaboration with airports
Future research: new SESAR ER projects

TRANSLIT
Travel Information Management for Seamless Intermodal Transport

IMHOTEP
Integrated Multimodal Airport Operations for Efficient Passenger Flow Management
The goal of TRANSIT is to develop a set of multimodal KPIs, mobility data analysis methods and transport simulation tools allowing the evaluation of the impact of innovative intermodal transport solutions on the quality, efficiency and resilience of the door-to-door passenger journey

www.transit-h2020.eu
The goal of IMHOTEP is to develop a concept of operations and a set of data analysis methods, predictive models and decision support tools that allow information sharing, common situational awareness and real-time collaborative decision-making between airports and ground transport stakeholders.

www.imhotep-h2020.eu
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www.imhotep-h2020.eu
Resources

- www.bigdata4atm.eu
- www.transit-h2020.eu
- www.imhotep.eu
- https://observatoriotransporte.mitma.es/estudio-experimental
- https://www.mitma.gob.es/ministerio/covid-19/evolucion-movilidad-big-data