A Cost-Quantification Model for Local Itineraries in Urban and Peri-urban Areas using Open Data

ANTONIO CORREAS, SKYMANTICS EUROPE

ETC2022, MILAN, 8 SEPTEMBER 2022

EUROPEAN PARTNERSHIP

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 891166.

Co-funded by the European Union

Contents

- Background: Modus
- Objectives of the model
- Results
- Lessons learned from Open Data
- Conclusions and further work

Modus

An Exploratory Research project in SESAR ER4: 2020-2022, led by Bauhaus Luftfahrt

Modus

The high-level objective of Modus is to analyse how the **performance of the overall transport system** can be improved by considering the entire **door-to-door journey** holistically and considering **air transport within an integrated, intermodal approach.**

Motivation: the overall performance of the (future) European transport system will strongly depend on the alignment and improvement of multimodal transport

Constraints:

Transport's greenhouse gas emissions to reduce by 90% by 2050

- European Smart and Sustainable Mobility Strategy (European Commission, 2020)
- European Green Deal

Modus

WP4 “Passenger mobility modeling”

- Produces low-level, detailed mobility of passengers in Europe considering flight and rail modes
- Models impact of modal choice, airspace capacity load, unaccommodated demand, and passenger behaviours in long-distance travel
- Assesses intra and inter-modal competition between European city-pairs

Final goal of WP4: Develop a demand function of D2D transportation

- Derived from individual choice of modes
- Expressed in terms of market share
- Considering demand sensitivity drivers (e.g., price and performance)

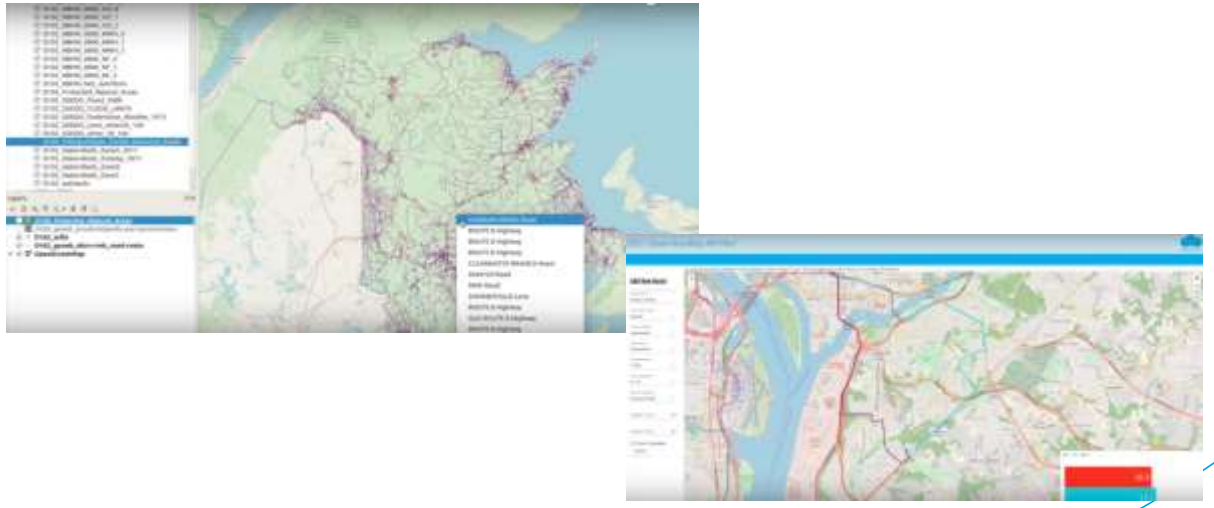
Objectives of the model

- “Fill the gap” of the Door-2-Kerb and Kerb-2-Door phases

- Make use of Open, publicly accessible data
- Consider complexities of urban mobility
- Define travel cost (time/length) dependent on input parameters: passenger type, city/airport, time of day

Objectives of the model

- Made use of Skymantics Universal Routing Engine (SURE)
  - Built on pgRouting stack
  - Implements OpenAPI OGC Routing API
  - Compatible with NSG, OSM, HERE and GTFS formats
  - Implements 6 different routing algorithms
  - Geospatial constraints (Max weight/height, routes around obstacles, road blockade, departure or arrival time)
  - Combines pedestrian and vehicle routes
  - Generates evacuation routes
  - Integrates AI models
    - Machine Learning – max speed assignment
    - Reinforcement Learning – network asset optimisation



Objectives of the model

- Methodology:
  - Select list of representative city/airport archetypes
  - Generate multimodal catchment areas (cost function = travel time)
  - Map over population distribution
  - Generate travel time probability function per city/airport and access mode

City	Airport	Archetype
Paris	**CDG**	Arch-1 (main hub, HSR station at the airport, integrated in city/region transport network)
	ORY	Arch-2 (main hub, HSR station in the city, integrated in city/region transport network)
	BVA	Arch-5 (national/regional, no HSR station in the city, very loosely integrated in city/region transport network by shuttle)
Madrid	**MAD**	Arch-2 (main hub, HSR station in the city, integrated in city/region transport network)
Stockholm	**ARN**	Arch-3 (secondary hub, no HSR station in the city, loosely integrated in city/region network by shuttle and express train)
Brussels	**BRU**	Arch-2 (main hub, HSR station in the city, integrated in city/region transport network)
	CRL	Arch-4 (secondary hub, no HSR station in the city, loosely integrated in city/region network by shuttle to cities nearby)

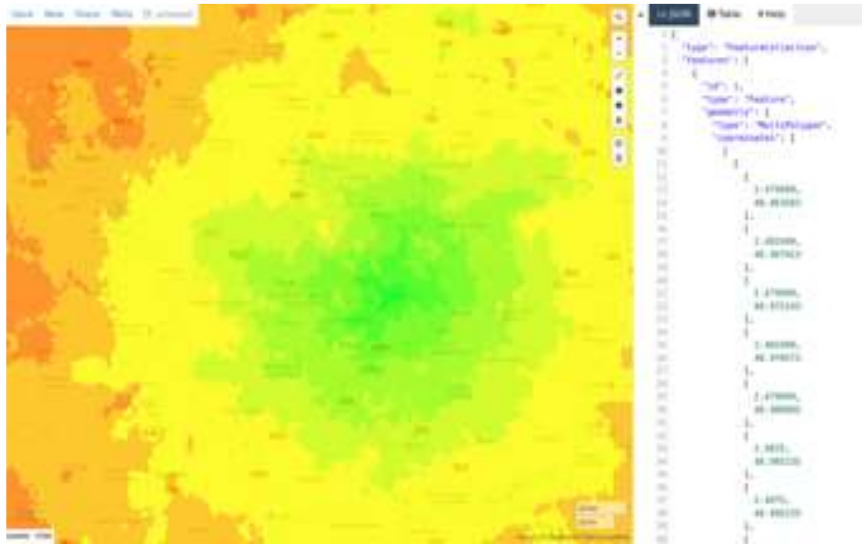
Objectives of the model

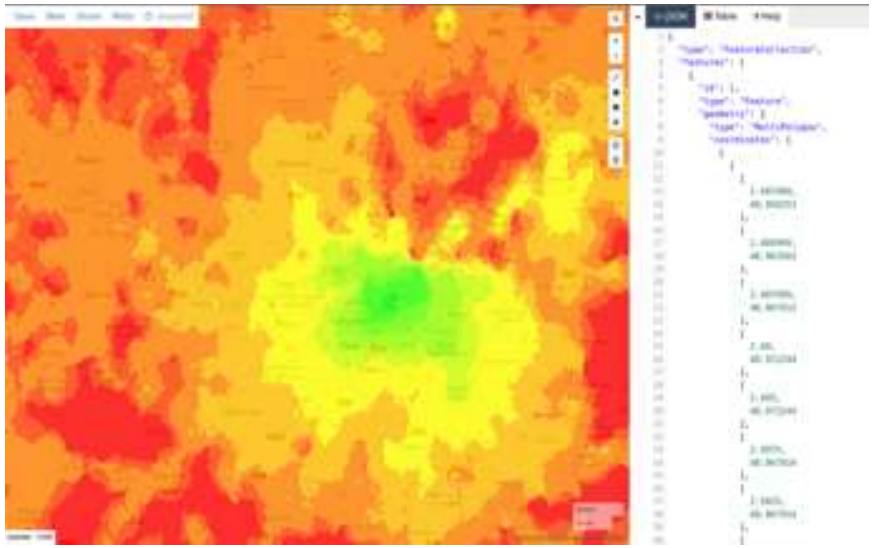
- Models entirely based on **Open Data**
  - Transparent
  - Publicly verifiable
  - No access barriers

Private vehicle routes and walking routes	Data source
Open Street Map (OSM)	Geofabrik download – https://download.geofabrik.de/
Public transit routes	
Madrid and surrounding area	https://data-crtm.opendata.arcgis.com
Paris and surrounding area	Paris/Ile de France https://data.iledefrance-mobilites.fr/pages/home/ Hauts-de-France, Bourgogne, Normandie, Grand-Est, Centre-Val de Lore https://transport.data.gouv.fr/datasets/ Shuttle service to BVA https://www.aeroportparisbeauvais.com/passagers/
Stockholm and surrounding area	https://www.trafiklab.se/api/trafiklab-apis/gtfs-sverige-2/
Brussels and surrounding area	Brussels, Wallonie, Flanders https://hello.irail.be/gtfs/ Nord, Grand-Est https://transport.data.gouv.fr/datasets/ Luxembourg https://data.public.lu/fr/ Germany (part) https://gtfs.de Netherlands https://gtfs.ovapi.nl Shuttle service to CRL and other cities
Population distribution	
JRC-GEOSTAT 2019	https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/population-distribution-demography/geostat

Results

- Catchment area per airport, access mode (private vehicle or public transportation) and time of day (6AM – 9PM)





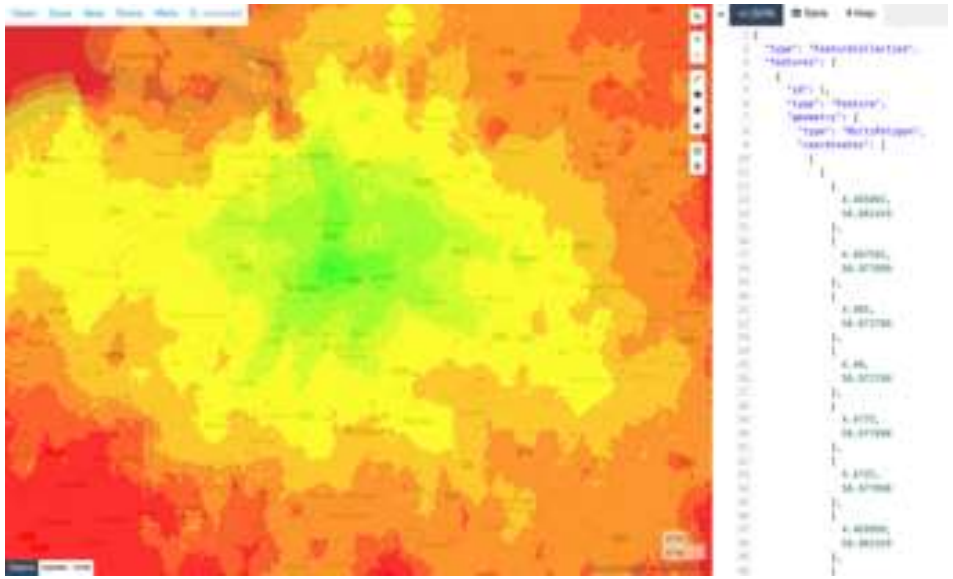
e.g. CDG

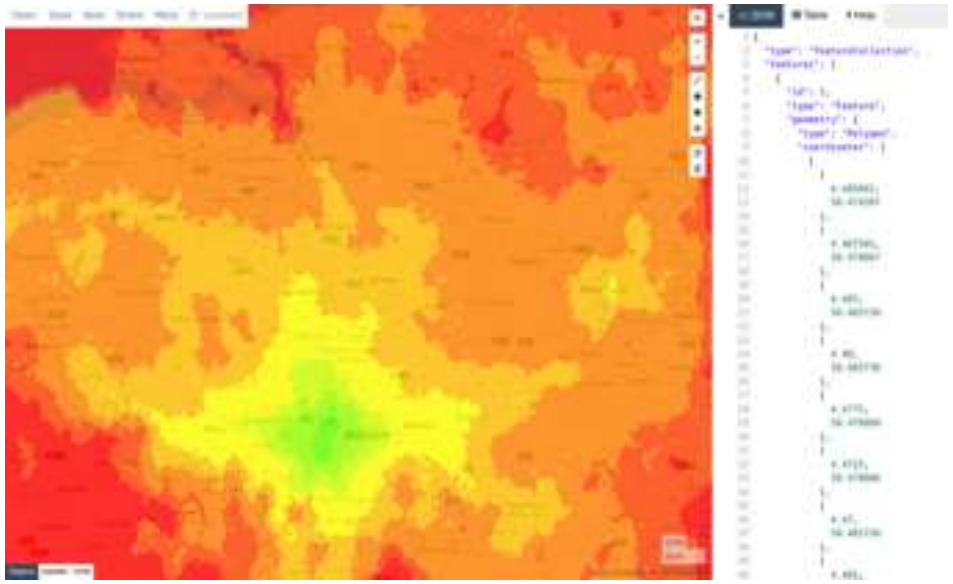
a) Private vehicle

b) Public tansportation

Results

- Overlapping catchment areas for cities with more than one airport





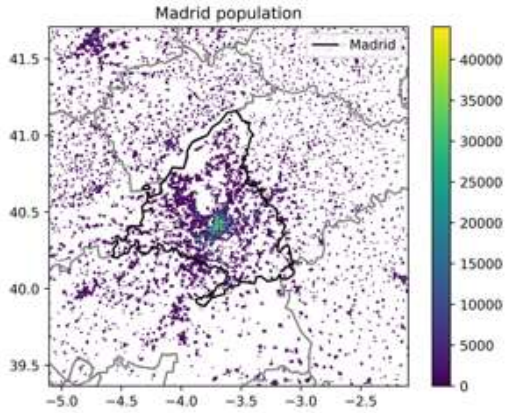
e.g. Brussels (public transport)

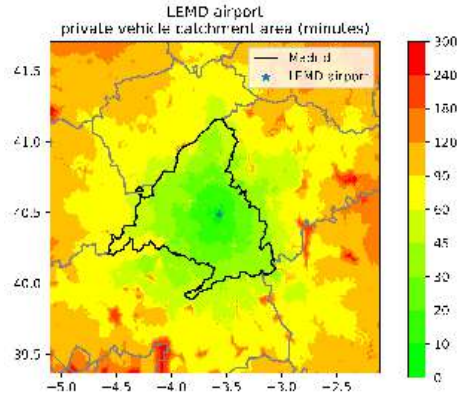
a) BRU

b) CRL

Results

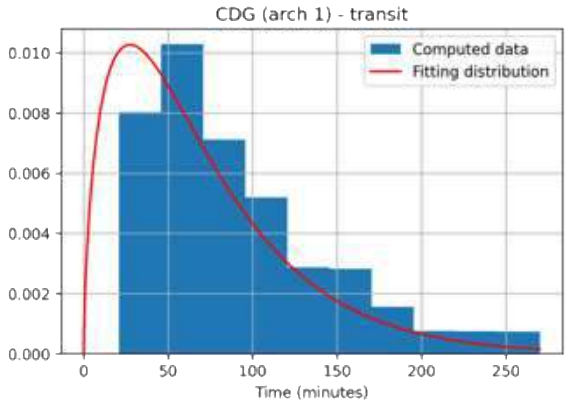
- Calculation of travel time probability distributions

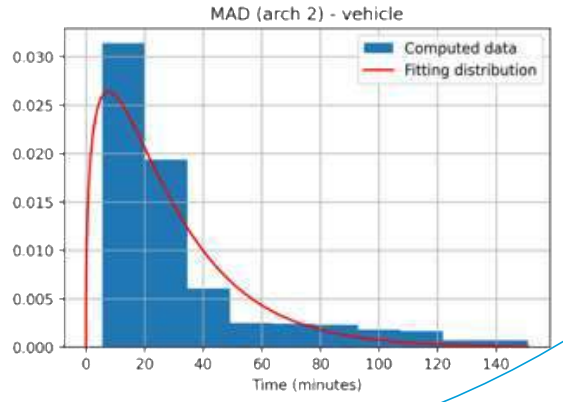




Spatial sampling with GEOSTAT population distribution

Fitting function (gamma)





Lessons learned from Open Data

- Searchability
  - OSM (centralized) vs GTFS (fragmented dataset publication policies)
- Data integrity and accuracy
  - Actual speed calculation on OSM (missing max speed, missing traffic elements)
  - GTFS with incorrect or missing data (directions, frequencies)
  - Scope inconsistent among regions
  - Element IDs not unique
- Data format consistency
  - Not all GTFS implement same parameters
  - “Parent station” parameter used inconsistently

Conclusions and further work

- A detailed quantitative model of travel cost functions in urban/peri-urban areas is feasible using Open Data
- Challenges found in data accuracy and consistency, which require either
  - Preparation algorithms (stochastic, Machine Learning)
  - Manual data cleaning
- Features to be added to model
  - Expand to other European cities
  - Add other cost functions (emissions, safety, convenience)
  - Model freight use cases

THANK YOU FOR YOUR ATTENTION

https://modus-project.eu/

EUROPEAN PARTNERSHIP

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 891166.

Co-funded by the European Union