Smartphone exploitation for event spatial analysis & mapping – SESAME –

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Together with George Yannis
PhD Research Identity

- **Research organization**
  - National Technical University of Athens, Department of Transportation Planning and Engineering - [www.nrso.ntua.gr](http://www.nrso.ntua.gr)

- **Supporting organizations**
  - OSeven Telematics - [www.oseven.io](http://www.oseven.io)
  - Traffic Management Centre of Athens - [www.patt.gov.gr](http://www.patt.gov.gr)

- **Duration of the project:**
  - 30 months (April 2018 – September 2020)

- **Research framework**
  This research is co-financed by Greece and the European Union (European Social Fund- ESF) through the Operational Programme «Human Resources Development, Education and Lifelong Learning» in the context of the project “Strengthening Human Resources Research Potential via Doctorate Research” (MIS-5000432), implemented by the State Scholarships Foundation (IKY)»
Road Safety Background

- Road safety casualties have platooned during the past 18 years worldwide (largely stable numbers)

- More targeted interventions are required, alongside informed road network evaluation and assessment

- The Internet of Things (IoT) and smartphone sensors provide a wealth of information of driver behavior
  - More effortless and wide-range data collection
  - Increased coverage/network completeness
  - Big Data analysis approach
  - Several emerging open-source platforms offer uncharted capabilities
Scientific literature findings

- Spatial analyses of crashes have been adopted in road safety for decades, however there is no research conducting spatial analyses of driver behavior on a road network level.

- Several zonal levels have been explored, such as regional, zonal or road segment level approaches. Network investigations are demanding and uncommon.

- A plethora of spatial and spatio-temporal statistical models has been implemented for crash investigation.

- Meta-regression techniques were applied to the impact of 3 common exposure parameters on their reported coefficients on crash counts:
  - Road length (affected by examining fatality crashes only)
  - Traffic volume (affected by speed limit and road user age)
  - Vehicle distance travelled (affected by the size of study zones examined)
Objectives - Research Questions

➢ Can smartphone sensors provide concise trip data for road network formulation and evaluation?

➢ What are the characteristics of the best and worst-performing road segments based on driver behavior?

➢ How can personal driver behavior metrics be statistically analyzed while taking spatial – network effects into account?

➢ Is there a way to predict road segment performance based on driver behavior without available past driver data?
Implementation Framework

- Description of network through several data sources and map-matching harsh events and trips to road segments

- Separation of road segments in three categories, based on their available data:
  1. Full-info segments (all information available)
  2. Sparse-info segments (trip information with no events)
  3. Zero-info segments (neither trip nor harsh event information)

- Calibration of advanced statistical models while considering spatial effects from neighboring segments using full-info segments

- Prediction of harsh event rates in sparse- and zero-info segments (Bayesian inference for sparse-info segments with priors set to zero)

- Complete network assessment/road score allocation and possible harsh event hotspot identification
Methodological Challenges

- Combination of several diverse data sources
  - OSeven Telematics: driver trip/behavior data
  - OpenStreetMap: geometrical parameters
  - USGS/NASA SRTM: precise altitude data
  - Traffic Management Centre: traffic data

- Manipulating and analyzing very large datasets
  - Initial testbed area in Chalandri: 527 road segments
  - Trip info file contained 1,980,628 trip seconds, of which 336,070 in the testbed area
  - 14 month range yielded 638 harsh events in testbed

- Solving the riddle of road safety performance prediction: Integration of several statistical models
  - Geographically Weighted Regression (GWR models)
  - Conditional Autoregressive Priors (CAR models)
  - XGBoost – Extreme Gradient Boosting (machine learning)
Scientific and Social Impact

- Development of a highly useful **complete spatial road safety assessment tool**
  - In road safety, driver behavior is **innovatively** analyzed spatially on a network
  - Identification of **critical parameters** for each road segment and overall
  - Identification of road safety **event hotspots** on developed maps
  - **Increased transferability** of results and methodology due to its concept
  - **Final result is comprehensive** to individual drivers and road management authorities alike
Future Challenges

- Identification of the degree that harsh events hotspots match with crash hotspots and quantification of that relationship
- Investigation of the possibility of temporal effects within the data after separation in different time-periods
- Exploration of the impacts of examining different road types (e.g. a full urban network vs. a solely urban highway network)
- Exploitation of the limitless potential of road safety map creation, enhanced by open-source capabilities
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