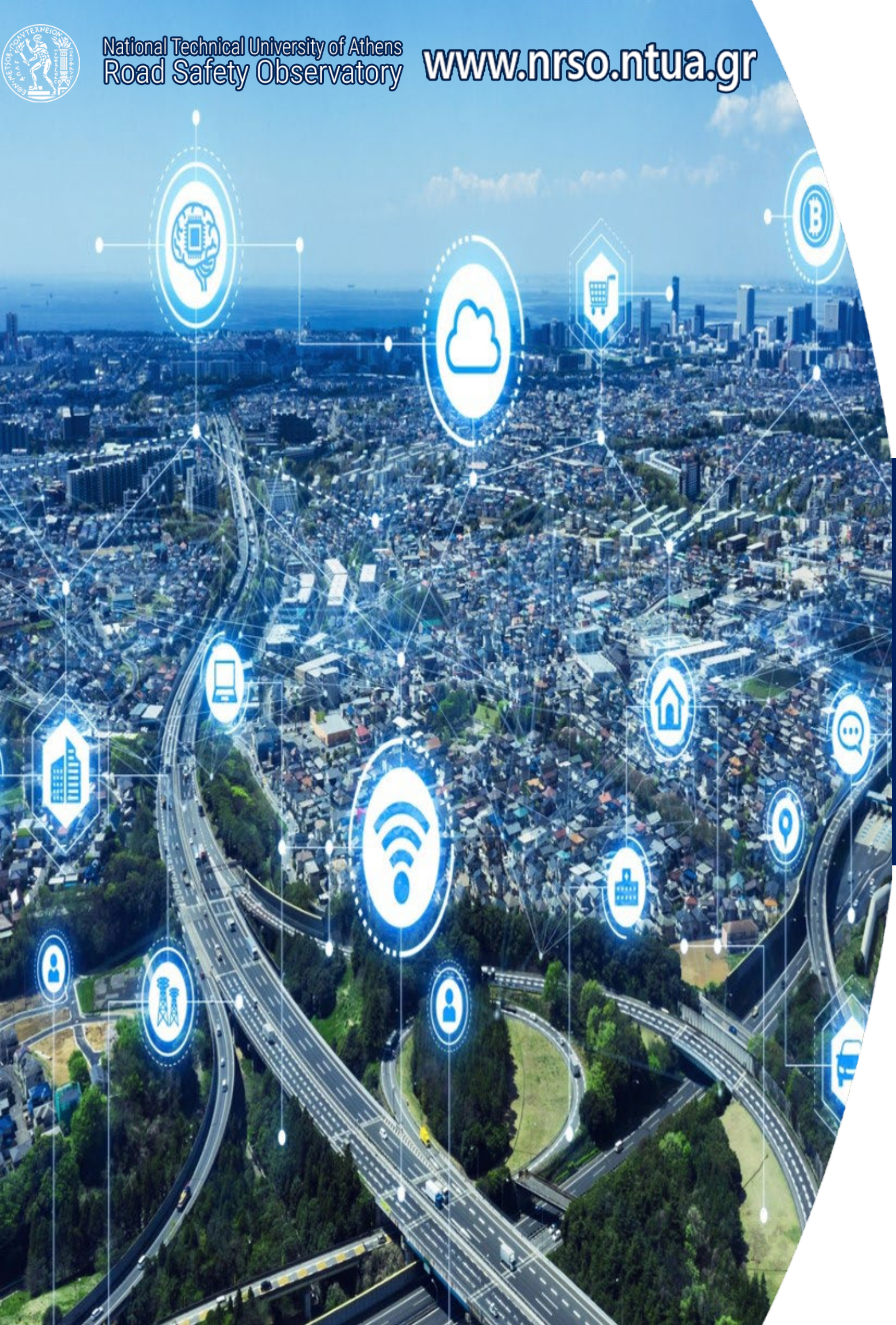

State of the art on spatial analysis and visualization tools for potential telematics applications – SmartMaps

Armira Kontaxi

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Together with:

Apostolos Ziakopoulos, Dimitrios Nikolaou, George Yannis

The SmartMaps project

- Project partners:
  - National Technical University of Athens, Department of Transportation Planning and Engineering www.nrso.ntua.gr
  - OSeven Telematics www.oseven.io
  - Global Link www.globallink.gr
- Duration of the project:
  - 30 months (June 2021 – December 2023)
- Operational Program:
  - "Competitiveness, Entrepreneurship and Innovation" (EPAnEK) of the National Strategic Reference Framework (NSRF) – 2nd iteration

Background

- **Technological advancements** during recent decades have led to the development of a **wide array of tools and methods** to record driving behaviour and measure various aspects of driving performance

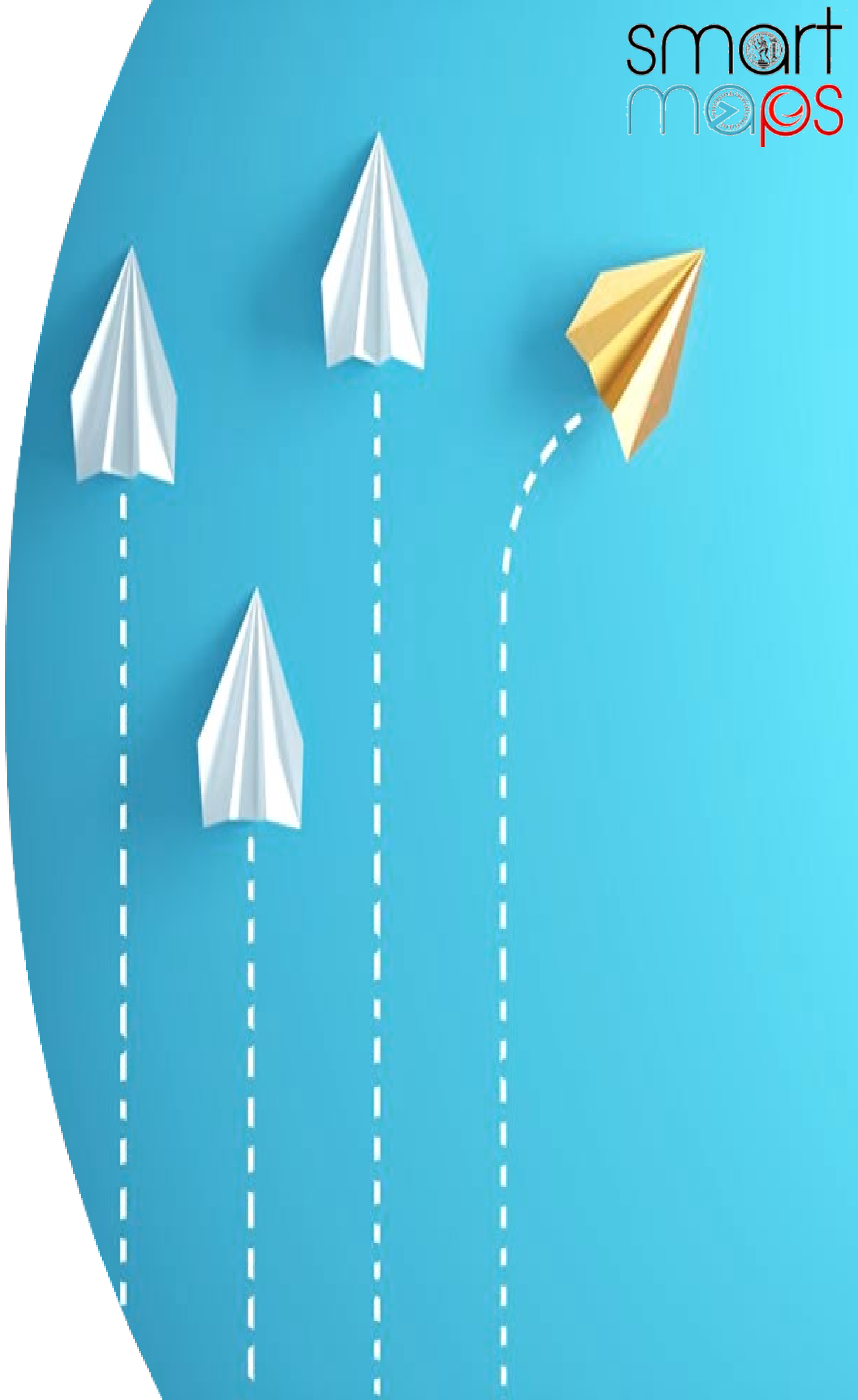
- **Smartphones** and data obtained from their sensors are increasingly used as informative devices for **monitoring driver behaviour**

- In order to effectively integrate **road network distances** and to precisely estimate **crash risk** in each location, several **spatial statistical approaches** and **visualization tools** have been implemented in the literature

Objective

➢ The objective of this presentation is to provide a **review of the scientific literature** regarding:

- **spatial approaches** and spatial analyses in road safety
- **visualization tools** of driving behaviour



Spatial analyses (1/2)

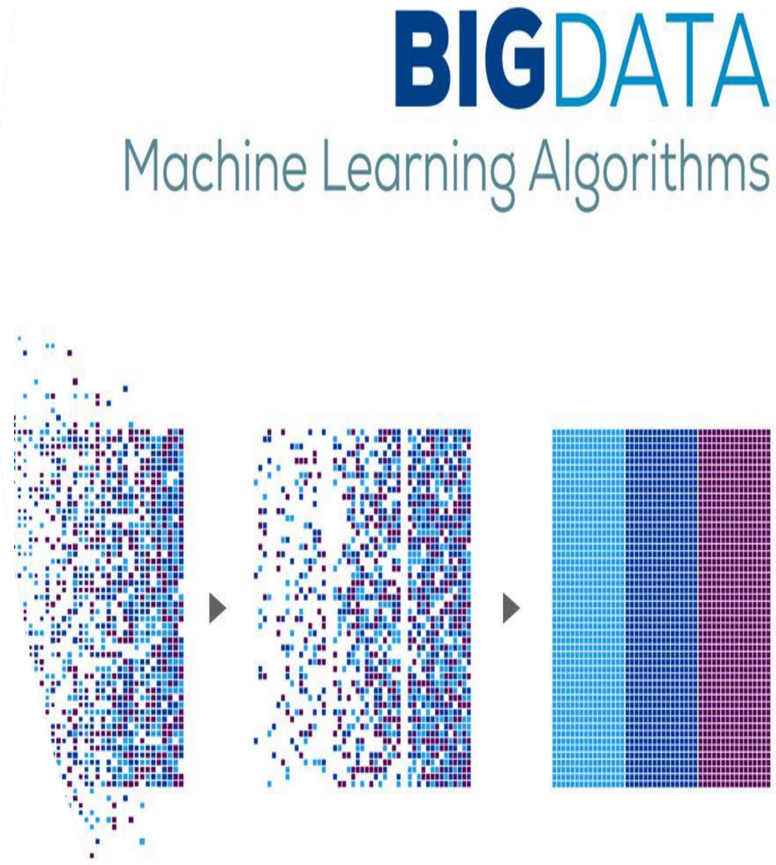
Thorough review of international scientific studies of spatial analysis applications in road safety

- **Available methodologies:**
  - Geographically Weighted Regression (GWR)
  - Bayesian Conditional Autoregression (CAR)
  - Full/Empirical Bayesian Analyses
  - Machine learning approaches
  - Kernel density approaches etc.

- **Wide array of parameters related to:**
  - Road traffic (speed, traffic volume, vehicle-kilometers)
  - Road environment (gradient, curvature, lane number/width, intersection number/density etc.)
  - Demographic characteristics (population, road user age)
  - Socio-economic characteristics (income, employment)
  - Land use (commercial, industrial, residential)

Spatial analyses (2/2)

- The majority of studies analyze crash frequency specially with count-data models (GWPR/CAR Poisson)
- Additional issues:
  - Boundary problem
  - Modifiable areal unit problem
  - Lack of common working framework
  - Most research done in modernized countries
- All variables are examined and analyzed on a spatial unit basis (AADT/zone, average speed/road section)
- Methodological advantages and disadvantages:
  - Frequentist models (e.g. GWPR): Intuitive interpretation, reduced fit capabilities
  - Bayesian models (e.g. CAR): Wide applications & adaptation to new data trends, lack of informative priors for initialization
  - Machine learning (e.g. SVM/CNN): Flexibility & handling of big data, harder interpretation – occasional 'black box' effect



Knowledge gaps

- Spatial analysis objectives are dictated by data availability:
  - No research was found in urban road networks due to lack of data
- Dependent variables:
  - Limited analyses regarding crash injury severity
  - No research pertinent with spatial analysis of harsh events was found
- Despite precise hotspot location capabilities, there is a lack of transferability of spatial analysis results:
  - No predictions are conducted for different study areas
- Large margins for exploitation of new technological advancements for spatial analyses:
  - Enhancement of existing data – production of new datasets

Meta-regressions (1/2)

- Parameters of **exposure to danger**
  - Serve for the creation of a **common baseline** between models and results
  - Most **prevalent parameters**: roadway length, vehicle-miles/kms, AADT

- Meta-regressions: **Original research**
  - **Quantitative investigation** of factors which systematically influence exposure parameters
  - A means of investigating **heterogeneity** of scientific study results
  - Conducted with the **inverse variance technique**

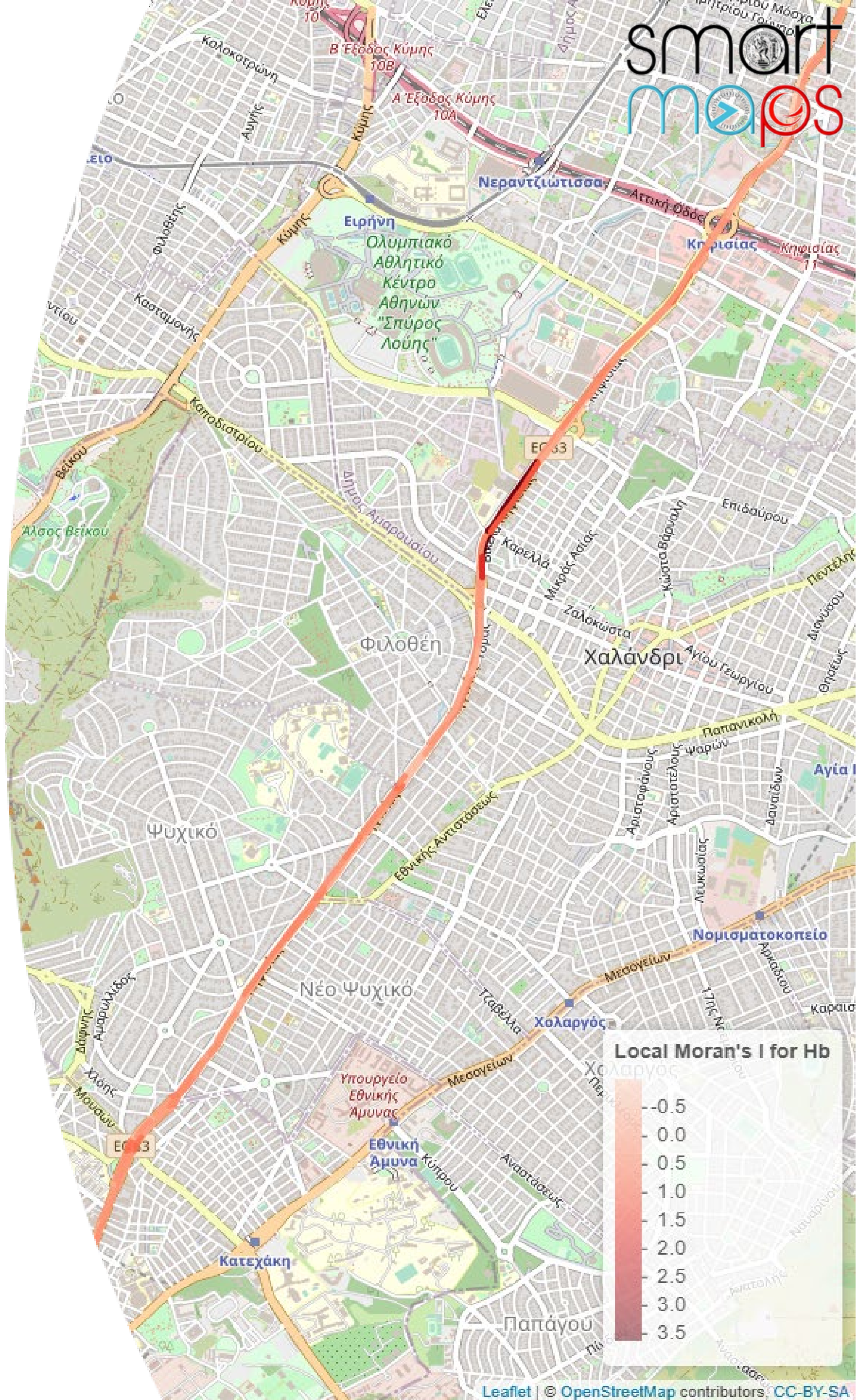
Meta-regressions (2/2)

➢ Results for road safety spatial analyses:

- AADT coefficients are positively correlated with taking speed limit and road user age into consideration

- Roadway length coefficients are positively correlated with analyzing only fatal crashes compared to total crashes

- AADT coefficients are positively correlated with analyzing crashes on a county level compared to TAZ level

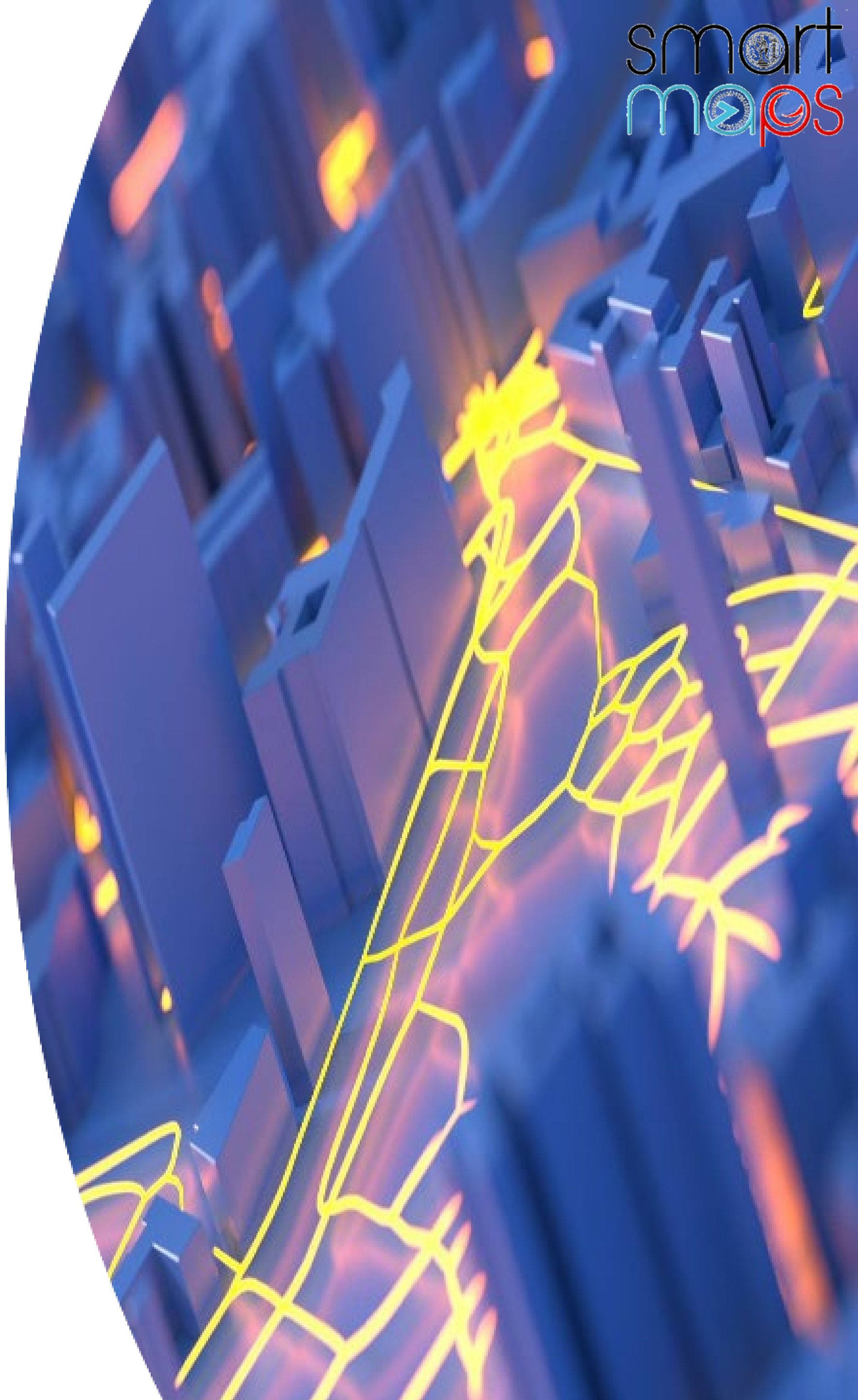


Visualisation tools - Background

- **Advanced methods** based on spatial visualization of driving behaviour provide:
  - simple visualization of **high-risk road segments**
  - possibilities to analyze spatial impact and **spatial interactions** with other geographical factors

- An **emerging research direction** is the interdisciplinary approach to:
  - **integrate and leverage** different types of data (including mobile data and big data)
  - **analyze** them (meaningfully) with a set of advanced analytical spatial visualization tools

- **Six open source spatial visualization tools** that can also be used to visualize driving behaviour are presented

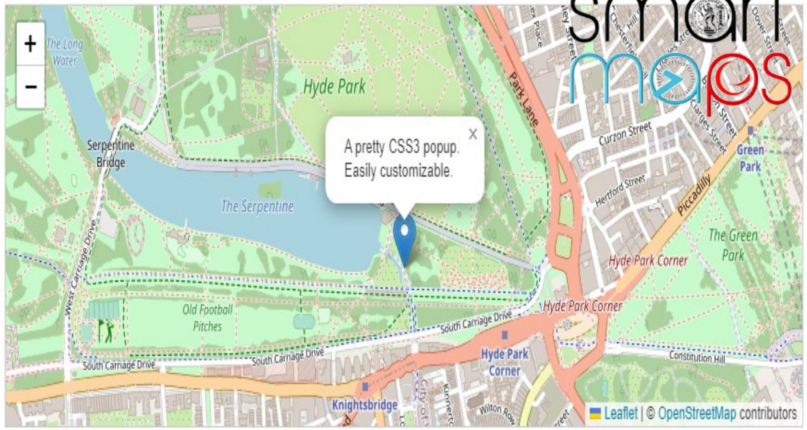


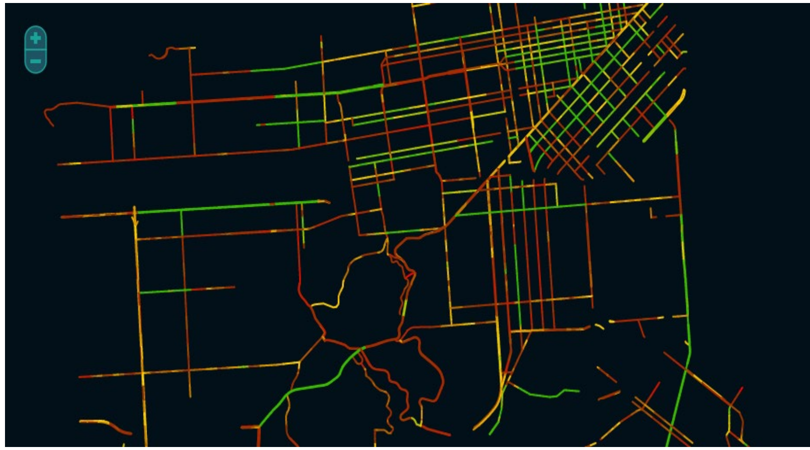
Visualisation tools (1/2)

- **Leaflet** is one of the most popular options for creating interactive **JavaScript maps**, and it is designed with simplicity, high performance and usability at the same time

- **Open Layers** makes it easy to insert a **dynamic map** into any web page, while it can display tile map, vector data and markers loaded from any source

- **Polymaps** is a **free JavaScript mapping library** used to create interactive maps and utilizes scalar vectors and is ideal for displaying information at country, city and even individual street level



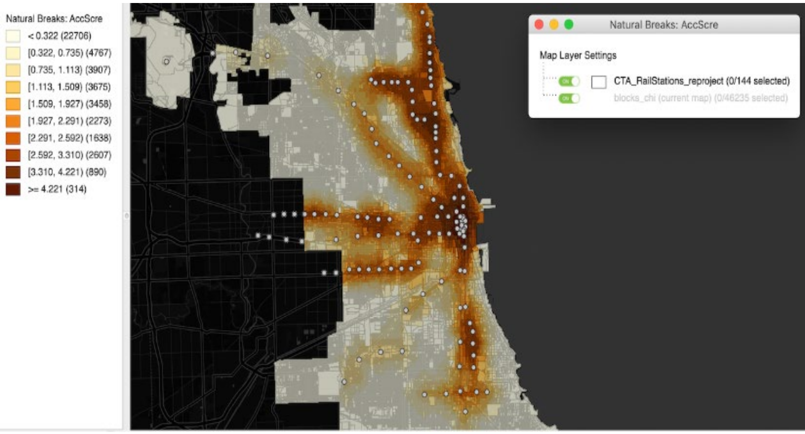


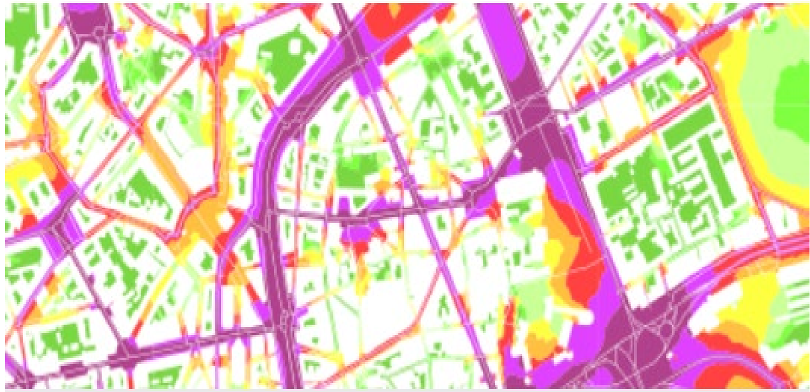
Visualisation tools (2/2)

- **QGIS** is an easy-to-use **mapping and spatial analysis tool** used for creating, editing, visualizing and efficiently analyzing **geospatial information** on Windows, Mac and Linux

- **GeoDa** serves as an introduction to spatial data science and is designed to **facilitate new insights** from data analysis by exploring and modeling spatial patterns

- **OrbisGIS** is a **multi-platform** geographic information system (GIS) that proposes new methods and techniques for modelling, representing, **processing and sharing spatial data**



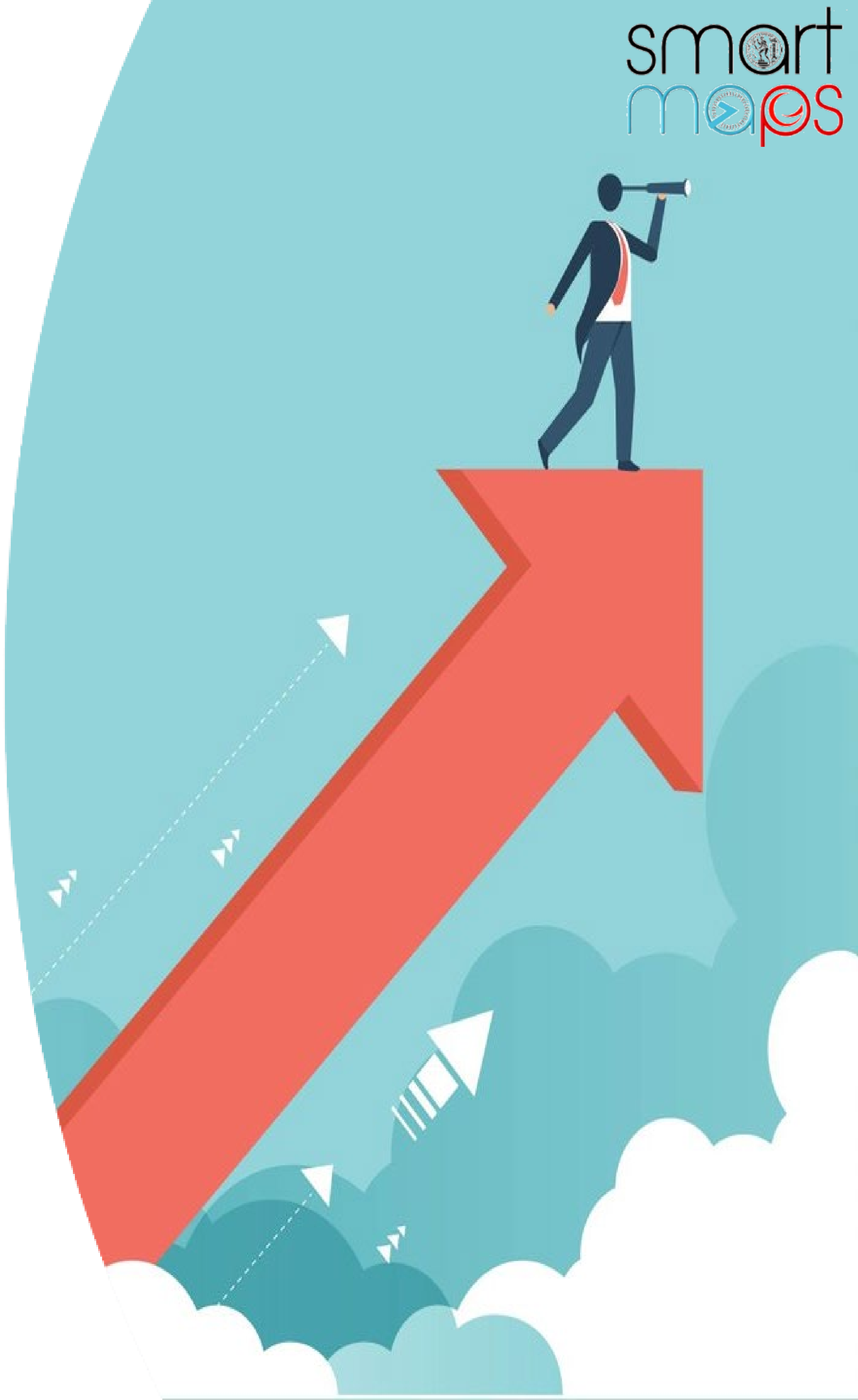


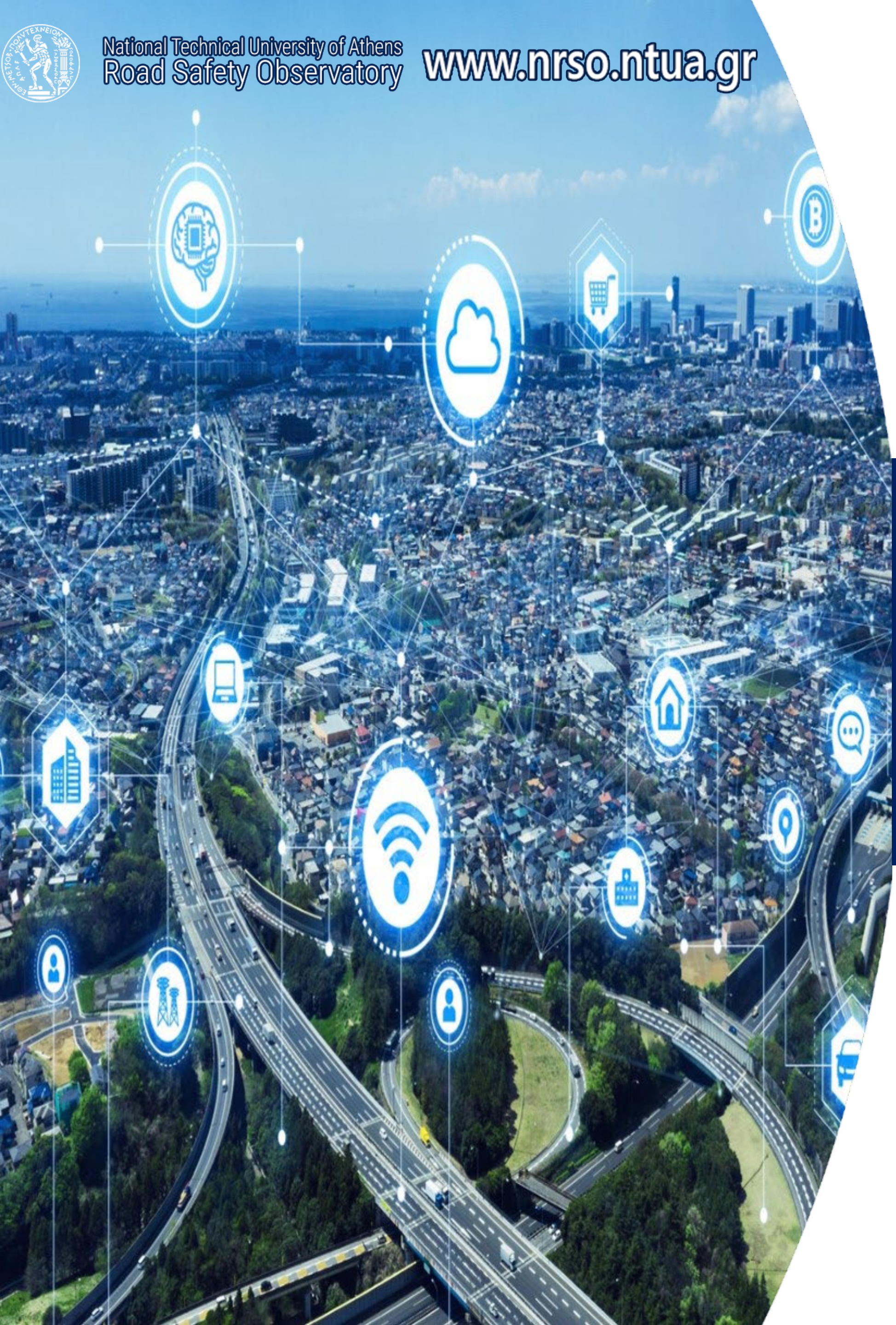
Impact on Telematics Applications

- **Spatial analysis tools** allow telematics companies to identify **patterns and trends** in vehicle data, such as routes taken, driving behavior, and fuel consumption and thus promote **safer and greener driving**

- **Visualization tools** offer the opportunity to present telematics data in a more user-friendly and accessible way; **dashboards and interactive maps** for easy and informative use by all

- By **combining spatial analysis and visualization tools** with other data sources, such as weather and traffic data, telematics applications can provide more **accurate and predictive insights** to their customers





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