COMPUTER AND CONTROL ENGINEERING

DAUIN - Leveraging Machine Learning Analytics for Intelligent Transport Systems Optimization in Smart Cities

Funded By	Dipartimento DAUIN Centro Interdipartimentale SmartData@PoliTO
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Context of the research activity	The availability of large amounts of data collected by black boxes for insurance/safety opens innovative challenges and opportunities to improve transportation systems and reduce carbon footprints. The research will focus on effective machine learning pipelines for multiple purposes including proposing new policies, optimizing fleets, and designing electrified systems, with a focus on comparing the impact of the transition from Internal Combustion vehicles to Electric vehicles.
	This PhD research seeks to harness the power of machine learning and big data analytics to understand and optimize mobility through the analysis of data collected by black boxes in fleets of vehicles. This proposal outlines a comprehensive plan to use big data analytics for intelligent transportation systems in smart cities. The impact of electric vehicle mobility and its comparison with previous habits will be a core part of the study. The research objectives aim to contribute valuable insights to mobility planning and optimization and the work plan ensures a systematic approach to achieve these objectives. The PhD student will be involved in research activities with companies and funded research projects. Data could also be provided by companies. Outline of the research work plan: 1st year- Investigate state-of-the-art data analysis techniques for transportation and mobility. Data collection, exploration and preprocessing to understand and pre-process raw data from black boxes, to ensure data quality and compatibility for further analysis. Develop techniques to deal with missing or incomplete data. Explore and implement privacy-preserving methods to ensure ethical use of mobility data while still gaining valuable insights.

Objectives	2nd year- Apply machine learning algorithms to recognize patterns in mobility data and gain insights into traffic flows, congestion, and usage patterns. Implement anomaly detection mechanisms to identify unusual events and improve system resilience. Develop predictive models to forecast traffic conditions, to enable proactive measures to mitigate congestion and improve overall traffic management. Explore adaptive algorithms for real-time adjustments based on dynamic traffic patterns. 3rd year - Integrate the developed algorithms into a cohesive system for intelligent transportation systems. Validate the system against real-world scenarios and fine-tune the algorithms for optimal performance. References: - Ciociola, A., Cocca, M., Giordano, D., Mellia, M., Morichetta, A., Putina, A., & Salutari, F. (2017, August). UMAP: Urban mobility analysis platform to harvest car-sharing data. In SmartWorld/(pp. 1-8). IEEE. - Cocca, M., Giordano, D., Mellia, M., & Vassio, L. (2019). Free-floating electric car sharing: A data-driven approach for system design. IEEE Transactions on Intelligent Transportation Systems, 20(12), 4691-4703. - Cocca, M., Giordano, D., Mellia, M., & Vassio, L. (2019). Free-floating electric car sharing design: Data-driven optimisation. Pervasive and Mobile Computing, 55, 59-75. List of possible venues for publications - IEEE Transactions on Intelligent Transportation Systems - IEEE International Conference on Data Science and Advanced Analytics - IEEE International Conference on Big Data - IEEE International Smart Cities Conference - IEEE Transactions on Vehicular Technology - Elsevier Cities - Elsevier Transportation Research - ACM Transactions on Spatial Algorithms and Systems

Skills and competencies for the development of the activity	The candidate must have excellent knowledge of Object-Oriented programming languages, geographic information systems (e.g., with Geopandas tool) and simulation environments (e.g., SimPy). Other appreciated skills are data analysis, knowledge of statistics and modelling, web crawling, database and big data tools.