POLITECNICO DI MILANO

PhD in DATA ANALYTICS AND DECISION SCIENCES - 39th cycle

PNRR 118 PNRR Research Field: DATA-DRIVEN LEARNING-BASED APPROACHES FOR DESIGN AND ACTIVE MONITORING OF SMART AND SUSTAINABLE MOBILITY SYSTEMS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Greenhouse gases (GHG) emissions are one of the main causes for the steep increase of our planet's temperature. Government and policymakers have set goals and taken measures to minimize air pollution and achieve climate neutrality. However, while sectors such as agriculture and industry have substantially reduced their carbon footprint in recent years, emissions in the transport sectors have been constantly increasing and currently account for approximately 27% of the total. Changing the current mobility paradigm by encouraging the uptake of sustainable solutions can substantially help reduce transport's environmental impacts. Besides electrifying the fleet, though, it is crucial to improve the so-called 'modal shift', i.e., encouraging people to use a combination of transportation systems that replace the private vehicle to satisfy their mobility needs. This will in turn reduce the number of circulating vehicles, which is fundamental to meet the environmental goals. To do so, the design of sustainable mobility systems needs a systemic approach, which allows to consider many different aspects, which comprise users' mobility patterns, vehicle characteristics and related energy demands and supporting infrastructures. This research will focus on data-driven and learning-based holistic design of such systems, with a specific attention on multimodality, i.e., on the conception of solutions for addressing the mobility requirement of individuals, expressed as the need of moving from origin to destination that merge different sustainable solutions,

	both public and private, composing a multi-modal trip. In doing so, attention will be paid to provide also monitoring capabilities of the overall system, which can allow us to both quantify the performance of the system and to detect in advance from data early warnings of potential mis-functioning that could lead to cost increase and safety hazards. Thus, especially for safety-critical systems, it is crucial to design evaluation and monitoring capabilities that can work in real-time, requiring a minimal amount of a-priori information, and which can be robust to noise and to (possibly time-varying) uncertainties. As they must work with huge amount of data that describe the different components life cycles and capture their interaction modes, effective data analytics tools are needed to solve this problem successfully. The proposed PhD research will address this very relevant and timely problem combining a methodological approach that will design data-driven approaches for damage detection and residual-life prediction of safety-critical components in transport systems, considering different case studies related to different mobility scenarios with particular reference to Smart Cities contexts.
Methods and techniques that will be developed and used to carry out the research	It is clear from the above discussion that the design of such innovative multimodal mobility solutions and the related monitoring systems requires a multidisciplinary approach, combining system dynamics with data-analytics, in order to design effective algorithms that optimally blend signal processing, optimization and Machine-Learning competencies with context-based knowledge. Note also that the considered applications ask for very high performance levels, reachable only with a true integration of the aforementioned competencies. This will lead to novel results of high scientific value, with strong repercussions on the reference industrial sectors, thus enabling a valuable technological transfer.
Educational objectives	The candidate will have a unique opportunity to work on a multidisciplinary research project, combining all the aspects needed to address the challenging and timely topic presented above. This entails a growth path for the candidate that will make her/him acquire different

	competencies – mainly technical and technological, in the disciplines mentioned in the methodology description, which is key to proposing effective solutions. The research outputs will target publishing in international conferences and journals, with specific attention to all the venues of interest for the different facets of the research.
Job opportunities	Expertise in data analysis, machine-learning and dynamic decision making certainly makes the PhD candidates very appealing for a wide range of high-end positions. Further, the technical knowledge on smart mobility is also of interest for a wide array of stakeholders. These range from the more contro-oriented ones to those more related to policy design. Thus, our candidates might apply for positions both in technology companies and in public institutions or academia.
Composition of the research group	2 Full Professors 3 Associated Professors 32 Assistant Professors 25 PhD Students
Name of the research directors	Prof. Mara Tanelli

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Non richiesto
By number of months at the company	0
Institution or company where the candidate will spend the period abroad (name and brief description)	To be determined, we aim at finding a research partner to support the methodological development of multimodal mobility solutions.

By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Attinenza alla tematica prescelta del bando Questa ricerca è in pieno accordo con la missione del PNRR legata alla "Infrastrutture per una mobilità sostenibile" e di "rivoluzione verde e transizione ecologica", in quanto si occuperà di studiare sia il progetto di sistemi di mobilità sostenibile e multimodale, unitamente anche a sistemi di monitoraggio del sistema di mobilità nel suo complesso, considerando dunque anche aspetti infrastrutturali. Disporre di metodi di progetto e supporto alle decisioni che sappiano trattare in modo quantitativo ed integrato questi sistemi sia ex-ante sia ex-post sono cruciali sia per la pubblica amministrazione sia per il settore privato (SDG16), e si coniugano a tutte le tematiche oggetto di politiche di incentivi, fortemente connesse alla mobilità sostenibile, alle tematiche climatiche ed energetiche (SDG 7, 11 e 13).