POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

PARTENARIATO PNRR Research Field: HOMOLOGATION OF AUTONOMOUS VEHICLES THROUGH CAUSAL INFERENCE TECHNIQUES

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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	One of the primary challenges in achieving effective implementation of autonomous driving is to provide efficient, fast, and cost-effective tools for validating the developed systems. It is worth mentioning that even a modification of a control parameter necessitates re-approval of the entire system. Particularly, the extensive number of simulation tests and subsequent experimental tests required impede the swift deployment of such systems. In light of this, our project aims to develop a methodology based on statistical analysis tools to minimize the reliance on simulations and the need for physical prototype testing. In detail, the utilization of causal inference is deemed essential as it enables us to understand the cause-effect relationships among the variables involved. This understanding assists in identifying the direct and indirect influences of various factors on the effectiveness of the driving system, thereby enhancing the ability to predict and manage complex situations safely and efficiently. The project encompasses two main phases: the initial creation of a simulation tool for the vehicle-control-environment system through experimental test data to establish a digital twin, and the subsequent development of statistical methodologies to reduce the significant number of tests required for validating the examined system. Finally, the developed methodology will be applied to diverse working conditions (vehicle-control-environment) to assess its generality.

	The research activity is financed and developed within the Sustainable Mobility Center (Centro Nazionale per la Mobilità Sostenibile - CN - MS) - Spoke 6 (Connected and autonomous vehicle - Guida autonoma e veicolo connesso) CN00000023, as part of the National Plan for Recovery and Resilience (PNRR, M4 C2 Dalla Ricerca all'impresa, Investimento 1.4), finanziato dall'Unione Europea - Next GenerationEU. Norms of reference: CUP D43C22001180001 - D.D. 1033 del 17/06/2022; D. D. 3138 del 16/12/2021 rettificato con D.D. 3175 del 18/12/2021 Avviso pubblico per presentazione Proposte di intervento per il Potenziamento di strutture di ricerca e creazione di "campioni nazionali" di R&S su alcune Key Enabling Technologies da finanziare nell'ambito del Piano Nazionale di Ripresa e Resilienza, Missione 4, Componente 2, Investimento 1.4 "Potenziamento strutture di ricerca e creazione di "campioni nazionali di R&S" su alcune Key Enabling Technologies" finanziato dall'Unione Europea - Next GenerationEU.
Methods and techniques that will be developed and used to carry out the research	To carry out the research, various methods and techniques will be developed and utilized. Statistical analysis tools, particularly causal inference, will be employed to understand cause-effect relationships among system variables. This will help in predicting and managing complex situations efficiently. The project will start with the creation of a simulation tool using experimental test data to establish a digital twin of the vehicle-control-environment system. Subsequently, statistical methodologies will be developed to minimize the need for extensive simulation and physical prototype testing, thereby reducing the overall number of tests required for system validation. The methodology will then be applied to different working conditions to assess its general applicability.
Educational objectives	The PhD candidate will: •develop a proficiency in statistical analysis tools and methodologies, particularly causal inference; •gain hands-on experience in developing simulation tools and establishing digital twins of vehicle-control-

	environment systems; •enhance his/her ability to develop and apply statistical methodologies to minimize the need for extensive testing in system validation.
Job opportunities	Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary compared MSc holders in the same field. These job opportunities span various disciplines such as engineering, sustainability, material science, and project management, offering diverse career paths for individuals interested in advancing sustainable practices in the field of electric vehicle technology. Some partner universities are: Scuola Superiore Sant'Anna - Italy, and ETH Zurich - Switzerland.
Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 2 PhD Students
Name of the research directors	Prof. Francesco Braghin

Contacts
Phone: 02 2399 8306 *Email*: francesco.braghin@polimi.it, marta.gandolla@polimi.it For questions about scholarship/support please contact phd-dmec@polimi.it

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	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 6.114,50. Our candidates are strongly encouraged to spend a research period abroad, joining high-level

research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 750 euro/month- net amount).
Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.