POLITECNICO DI MILANO

PhD in DATA ANALYTICS AND DECISION SCIENCES - 39th cycle

Number of scholarship offered	4
Department	DIPARTIMENTO DI ELETTRONICA, INFORMAZIONE E BIOINGEGNERIA

Description of the PhD Programme

The PhD program in Data Analytics and Decision Sciences (DADS) aims at training highly qualified senior data analysts and data managers capable of carrying out research at universities, international institutions, tech and financial companies, regulatory authorities, and other public bodies. The program stems from the cooperation between three departments: Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB), Dipartimento di Ingegneria Gestionale (DIG), Dipartimento di Matematica (DMAT), and the Center for Analysis, Decisions and Society (CADS) at Human Technopole. It gives the enrolled students the opportunity to work in a highly interdisciplinary environment with strong connections to international research centers and private companies. The program provides successful candidates with the opportunity to acquire a high degree of professional expertise in specific scientific and technological fields. The program lasts three years: upon its successful completion and final exam, candidates will be awarded the title of PhD in Data Analytics and Decision Sciences. The first year is devoted to the courses that build the broad competence and the strong interdisciplinary set of skills required by data analytics. The next two years focus on the development of the Doctoral thesis. Students are required to spend at least one semester in a research institution abroad, taking advantage of the network of international collaborations of the three departments involved in the program. All the students enrolled in the DADS Doctoral Program are supported by scholarships from public institutions and private companies.

POLITECNICO DI MILANO

PhD in DATA ANALYTICS AND DECISION SCIENCES - 39th cycle

THEMATIC Research Field: CAUSAL INFERENCE IN ARTIFICIAL INTELLIGENCE WITH APPLICATION TO HEALTH DATA SCIENCE

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	Considerable progress has been made in predictive systems for healthcare following the advent of powerful machine learning (ML) approaches. In healthcare, clinical decision support (CDS) tools make predictions for tasks such as detection, classification and/or segmentation from electronic health record (EHR) data such as medical images, clinical text notes, blood tests and genetic data. These systems are usually trained with supervised learning techniques. However, most CDS systems powered by ML techniques learn only associations between variables in the data, without distinguishing between causal relationships and (spurious) correlations. CDS systems targeted at precision medicine need to answer complex queries about how individuals would respond to interventions.A major upstream challenge in healthcare becomes then how to acquire the necessary information to causally reason about treatments and outcomes. Modern healthcare data are multi-modal, high-dimensional and often unstructured. In addition, many diseases are progressive over time, thus necessitating that the temporal dimension is taken into account. Finally, any system must ensure that these predictions will be generalizable across deployment environments such as different hospitals, cities or countries. Causal Inference (CI) can help alleviate these challenges. ML allows causal models to process high-dimensional and unstructured data by learning complex nonlinear relations between variables. CI adds an extra layer of understanding about a

	system with expert knowledge, which improves information merging from multi-modal data, generalization and explainability of current ML systems.
Methods and techniques that will be developed and used to carry out the research	•Causal Inference •Graphical models •Structural Causal Models •Bayesian Networks
Educational objectives	To be able to critically analyse, model, ask and answer pertinent biological questions from data. To develop skills in statistical data analysis, machine learning, causal inference and their application to human genetics research and to epidemiological studies carried out over secondary databases.
Job opportunities	The profile proposed here are broadly relevant for a range of employers including (but not limited to): public and private healthcare institutions, hospitals, clinical and pharmaceutical companies, technology, and biotech companies, as well as Research institutes in healthcare domain.
Composition of the research group	1 Full Professors 3 Associated Professors 3 Assistant Professors 3 PhD Students
Name of the research directors	Prof. E. DiAngelantonio & Prof. P. Secchi

Contacts

•Prof. Emanuele DiAngelantonio (HT)
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•Dr. Claudia Giambartolomei (HT)
•Dr. Federica Nicolussi (DMAT)
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•Prof. Piercesare Secchi (DMAT)
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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	12

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Further support is available for students who engage in activities of teaching or additional lab duties coherent with their academic mission and doctoral training.The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

POLITECNICO DI MILANO

PhD in DATA ANALYTICS AND DECISION SCIENCES - 39th cycle

INTERDISCIPLINARY Research Field: HARNESSING ARTIFICIAL INTELLIGENCE TO TURN COMMERCIAL TRAINS INTO INFRASTRUCTURE MONITORING DEVICES

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	Interdisciplinary PhD Grant The PhD research will be carried out in collaboration with research groups of the PhD programme in "**MECHANICAL ENGINEERING**".
Methods and techniques that will be developed and used to carry out the research	We will *apply recent machine learning techniques, in particular deep recurrent and transformer-based neural networks, to analyse sequences of accelerometer data from sensors on commercial trains*. The aim is to learn models for estimating the rail geometry directly from the noisy sensor data, using measurements from dedicated track recording vehicles as ground truth. Once a valid model has been found, redundancy provided by data from an entire fleet of vehicles should enable continuous validation, and the possibility to carry out preventive maintenance. In developing the project, we will make use of a large amount of real data from a commercial fleet operator together with the ground truth geometry monthly measured by a dedicated vehicle. By facilitating near-continuous monitoring of track geometry through sensors on commercial fleet vehicles, we envisage *massive improvements in track monitoring and resulting economic benefits.*
Educational objectives	The research will be carried out in collaboration with an

	interdisciplinary team of computer systems and mechanical engineers. Knowledge of the data and current analysis techniques are specific to the rail context and require expertise from mobility and mechanical engineering, while knowledge of advances in deep learning requires a machine learning expert from this subfield of data analytics. Within this lively and stimulating academic research environment, the doctoral student will be educated to become a skilful researcher in data science, deep learning, and mobility engineering.
Job opportunities	The profile of data scientist and deep learning engineer with expertise at the PhD level are in short supply and highly sought after by industry. Moreover, the technological solutions proposed in this project will be of interest to a range of actors, including transportation companies and policy makers.
Composition of the research group	0 Full Professors 2 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	0

Contacts
Prof Mark Carman (DEIB) Prof Claudio Somaschini (DMECC) Prof Alan Facchinetti (DMECC) Contact: Prof. Mark Carman E-Mail: mark.carman@polimi.it Voice: 0223993628 Web https://www.deib.polimi.it/eng/people/details/1439980

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There are various forms of financial aid for activities of support to the teaching practice. The Ph.D. student is encouraged to take part in these activities, within the limits allowed by the regulations.

POLITECNICO DI MILANO

PhD in DATA ANALYTICS AND DECISION SCIENCES - 39th cycle

THEMATIC Research Field: IN-SITU BIG DATA MINING FOR 3D PRINTING PROCESS MONITORING, CONTROL AND ADAPTIVE OPTIMIZATION

Monthly net income of PhDscholarship (max 36 months)
€ 1300.0 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	Industry 4.0 is fostering a new generation of enabling technologies driving digital and smart manufacturing. Among these technologies, Additive Manufacturing, 3D printing and bioprinting are very promising solutions to target the green and digital goals that industry and society have to meet in the near future. Thanks to smart sensing, a new generation of big data (images, video- images and signals) are available to aid decision-making and define new solutions for in-situ monitoring, control and optimization. https://www.ic.polimi.it
Methods and techniques that will be developed and used to carry out the research	•Spatio-temporal modeling •Image and thermal video image data modeling •Multistream data reduction •Statistical quality monitoring and transfer learning •Metamodeling for process optimization
Educational objectives	The PhD candidate will develop skills and core competencies to face data mining, modeling, control to aid defect prediction and prevention in-situ and in-line in additive manufacturing and 3D bioprinting.
Job opportunities	•Industry 4.0 specialist •Data scientists for industry 4.0

	•Quality experts in Additive manufacturing and bioprinting •Scientist in data mining for zero-waste advanced manufacturing
Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 5 PhD Students
Name of the research directors	Bianca Maria COLOSIMO

Contacts
Prof.ssa Biancamaria Colosimo Email: biancamaria.colosimo@polimi.it Voice: +390223998530

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	650.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
List of Universities and Companies cooperating in the research: 1. Massachussetts Institute of Technology (MIT) 2. Georgia Institute of Technoogy 3. European Space Agency 4. Siemens (Erlangen) 5. Fraunhofer (IPA) 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.

POLITECNICO DI MILANO

PhD in DATA ANALYTICS AND DECISION SCIENCES - 39th cycle

THEMATIC Research Field: LARGE-SCALE HISTOLOGY FOR THE UNDERSTANDING OF INFLAMMATORY BOWEL DISEASE (IBD)

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	Inflammatory Bowel Disease (IBD) is commonly diagnosed through histological assessment of multiple GI biopsies. Additionally, disease progression and response to treatment are also monitored via biopsy and histology throughout the patient's life. In this project, we would like to design, develop, and apply machine learning models to aid in the diagnosis, prognosis and disease understanding of IBD using histology, prospective clinical data as well as genetics (genotyping). In addition, understanding the molecular basis of IBD histopathological characteristics will be determined via the use of large-scale spatial transcriptomics, for novel subtype discovery and biomarker identification.
Methods and techniques that will be developed and used to carry out the research	•Supervised and unsupervised machine learning method development (multiple instance learning, segmentation, cell classification, detection, and localisation). •Digital pathology/Whole Slide Image analysis. •Spatial Transcriptomics.
Educational objectives	To be able to critically analyse, model, ask and answer pertinent biological questions from data. To develop one's skills in statistical data analysis, machine learning and the application of computation to human genetics research.
Job opportunities	

	The profile of machine learning researcher and the applications proposed here are broadly relevant for a range of employers including (but not limited to): public and private healthcare institutions, hospitals, clinical and pharmaceutical companies, technology, and biotech companies.
Composition of the research group	1 Full Professors 1 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Dr C.A. Glastonbury and Prof. P. Lanzi

Contacts
•Dr C.A. Glastonbury craig.glastonbury@fht.org https://humantechnopole.it/en/people/craig-glastonbury/ +393662532728 •Prof. P. Lanzi pierluca.lanzi@polimi.it +390223993472 DEIB - Politecnico di Milano

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	12

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
List of Universities, Companies, and Institutions cooperating in the research •Population &Medical Genomics, Human Technopole

Further support is available for students who engage in activities of teaching or additional lab duties coherent with their academic mission and doctoral training.The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.