



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 1 - Computer Science and Engineering

**PNRR 117 Research Field: COMPUTATIONAL AND DATA INTEGRATION APPROACHES
FOR CHRONIC PAIN PATIENT STRATIFICATION**

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**

Chronic pain, one of the most common non-communicable disorders, is a distinct clinical entity caused by a large variety of underlying aetiologies and influenced by multiple factors. Its genetic predisposition is likely determined by a continuum of genetic risk determinants, acting cumulatively and in combination with clinical factors, driving an overall individual risk. Despite many candidate gene studies have been performed in the last years, much of its heritability is apparently unexplained and no unbiased approaches have been performed to search for the missing genetic susceptibility of such complex disease. In this context, a genotype-first approach, based on genome-wide genotyping of common single and copy number variants and gene-wise aggregation approaches, would allow to identify novel disease genotype-phenotype associations.

The study aims to address computational and data integration approaches for patient stratification based on a shared genetic susceptibility to characterize the different subtypes of the heterogeneous phenotypic spectrum. The identification of genetic predisposition would optimize the diagnosis despite the phenotypic heterogeneity, supporting clinicians in the subtypes classification and giving a chance for an effective personalized treatment.



Methods and techniques that will be developed and used to carry out the research	Genomic and deep phenotype data will be available for the study. The considered patients have an in-depth phenotypic characterization including demographics, symptoms, pain features and distribution, familiarity, comorbidities, drug response, nerve conduction study, intra-epidermal nerve fiber density quantification at skin biopsy and blood sample collection for genetic analysis. The study is based on a genome-wide two-stage approach, including discovery and validation datasets, each composed by 150 Italian chronic pain patients and 150 healthy controls for a total of 600 samples. An independent cohort from the Netherlands, including 200 cases and 200 controls will be used as replication sample. Target (N=800) and exome (N=100) next generation sequencing data will be also achievable. Categorical and quantitative association analyses will be performed to investigate the impact of common single nucleotide polymorphisms, rare mutations, haplotypes, and copy number variations on chronic pain phenotypes. Multiple bioinformatics, data science and information engineering data integration and computational techniques will be considered for the development and use of computational approaches for patient stratification. Different unsupervised and supervised machine learning algorithms will be investigated and optimized to the addressed research and available dataset. Computational systems biology approaches will be also considered. The outputs of the computational processing will be analyzed with the support of biological knowledge and clinical expertise to interpret the results on the basis of the state of the art of the pathology.
Educational objectives	We are aimed at developing specific competence, autonomy, research methodology and skills, in an interdisciplinary environment. The strong connection with the Fondazione IRCCS Istituto Neurologico Carlo Besta (https://www.istituto-besta.it/english-version) makes one of the strength of our PhD. In fact, this PhD is fully developed within the Joint Research Center “NEUROTECH” between Politecnico di Milano and Fondazione IRCCS Istituto Neurologico Carlo Besta, in support to the activities of the Computational Multi-omics



	of Neurological Disorders (MIND) joint lab.
Job opportunities	Career development is possible both in research, academic and private institutions, and in production, in Italy and abroad. Start-ups from research results are also encouraged. Employment in this area provides several opportunities.
Composition of the research group	0 Full Professors 2 Associated Professors 4 Assistant Professors 6 PhD Students
Name of the research directors	prof. Marco Masseroli; Erika Salvi, Besta

Contacts	
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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)	Department of Clinical Data Science, Faculty of Health, Medicine and Life Sciences, Maastricht University
By number of months at the company	6



Institution or company where the candidate will spend the period abroad (name and brief description)	Fondazione IRCCS Istituto Neurologico Carlo Besta
By number of months abroad	6

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

EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.

TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student 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.

COMPUTER AVAILABILITY: individual use.

DESK AVAILABILITY: individual use.