



PhD in BIOINGEGNERIA / BIOENGINEERING - 39th cycle

PARTENARIATO PNRR Research Field: DEVELOPMENT OF COMPUTATIONAL BRAIN-CIRCUITS-ON-CHIP

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	<p>The project aims to design and simulate computing functions in organoids. The bottom-up approach involves creating an in silico model of the in vitro network (Brain-on-chip or organoids) by connecting layers of neural populations and incorporating plasticity rules observed in experimental studies. The goal is to understand how modulation of neuronal activities within the organoids produces the desired input/output computational properties. Simplification strategies may be employed to capture essential electrophysiological features.</p> <p>This project research is in the framework EBRAINS INFRASTRUTTURE DI RICERCA -EBRAINSItaly European Brain ReseArch InfrastructureS-Italy (DEIB) CUP B51E22000150006 Decreto di Concessione D.D. 117 del 21/06/2022</p>
Methods and techniques that will be developed and used to carry out the research	<p>Neuron and microcircuit models employ a bottom-up strategy to construct networks. Biophysically detailed models form the heart of this bottom-up approach, representing active tissue models that faithfully replicate the biological properties of real neurons and microcircuits, from 3D morphology to ion channel gating and localization. The voltage- and time-dependent gating process of membrane ion channels yields a diverse array of functional states, including regular firing, bursting, oscillations, rebounds, and resonance, as evidenced by recent models of cerebellar neurons. The properties</p>



	<p>recent models of cerebellar neurons. The properties exhibited by these neurons manifest in local field potentials (LFPs), portraying the collective activity of neuronal populations. Maintaining detailed single neuron and synapse characteristics results in a fine-grained microcircuit model, allowing for the precise reconstruction of local neuronal dynamics, as initially demonstrated for the isocortex. The intricate process of network reconstruction and simulation demands specialized modeling platforms, such as the Brain Scaffold Builder (BSB) and powerful point-neuron models such as the Extended Generalized Integrate and Fire. The student will use point-neuron spiking neural network simulators (e.g., NEST) to develop bio-inspired and realistic short- and long-term plasticity rules, starting from existing phenomenological models and enriching them with biological features. The validated in silico organoid models will be made available to all users of the EBRAINS platform for future exploitation and enrichment. www.ebrains.eu</p>
<p>Educational objectives</p>	<p>We provide doctoral candidates with high-level scientific training, fostering and refining research and problem-solving abilities by focusing on both theoretical and experimental skills. A PhD in Bioengineering will be trained to layout, draft and carry-on original research, by leading a research group or working in a team. The didactic offer of the PhD in Bioengineering (https://www.phdbioengineering.polimi.it/) will be integrated by schools and workshops specific to the research topic.</p>
<p>Job opportunities</p>	<p>The skills and expertise developed during the PhD Program are suitable for national and international academic institutions, research organizations and SMEs committed to innovation, fundamental/applied research and technical development both in brain-inspired computing and AI.</p>
<p>Composition of the research group</p>	<p>2 Full Professors 2 Associated Professors 3 Assistant Professors 15 PhD Students</p>



Name of the research directors	Proff. Alberto Antonietti - Alessandra Pedrocchi
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Contacts	
<i>Alberto Antonietti</i> <i>alberto.antonietti@polimi.it</i>	
<i>Alessandra Pedrocchi</i> <i>alessandra.pedrocchi@polimi.it</i>	

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
<p>Educational activities: funding for participation in courses, summer schools, workshops and conferences.</p> <p>Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial of 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 regulation.</p> <p>A desk and a PC will be given to the student for the time needed to carry out research, with access to HPC resources (internal and external, e.g., from CINECA).</p> <p>This project research is in the framework EBRAINS INFRASTRUTTURE DI RICERCA - EBRAINSItaly European Brain ReseArch InfrastructureS-Italy (DEIB) CUP B51E22000150006 Decreto di Concessione D.D. 117 del 21/06/2022</p>