



PhD in DATA ANALYTICS AND DECISION SCIENCES - 40th cycle

**THEMATIC Research Field: PHYSICS-INFORMED DEEP LEARNING ARCHITECTURES FOR
REAL-TIME NUMERICAL APPROXIMATION OF PARTIAL DIFFERENTIAL EQUATIONS**

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	
<p>Motivation and objectives of the research in this field</p>	<p>The goal of this project is the mathematical and computational setting of accurate and efficient reduced order models (ROMs) for the numerical approximation of systems governed by parametrized partial differential equations (PDEs) in real-time. New ROMs for nonlinear unsteady parametrized PDEs will be introduced combining projection-based ROMs such as the reduced basis methods and deep learning (DL) algorithms to train deep neural networks, with particular emphasis on the exploration of physics-informed architectures and recent paradigms emerged in deep learning. The rigorous construction of DL-ROMs will be the core of the project, with their complexity, and error analysis. Additional research topics will involve model discovery, latent dynamics modeling, as well as uncertainty quantification in DL-ROM architectures. Applications in computational mechanics, dealing with both single-physics and multi-physics problems, will be considered for the numerical verification of the proposed techniques.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>Computational strategies developed in the research project will leverage on both numerical approximation techniques and recent learning paradigms like, e.g., online and progressive learning from multiple sources to sequentially incorporate diverse data types. Physics-informed operator learning, together with latent dynamics learning, will also represent core strategies the research</p>



	learning, will also represent core strategies the research project will rely on.
Educational objectives	The candidate will have the opportunity to collaborate with a wide research group across several Departments of Politecnico di Milano (e.g., Civil and Environmental Engineering, Mechanical Engineering) as well as with worldwide recognized research groups.
Job opportunities	Besides Universities, Research Institutes, and DeepTech companies in Europe and all-over the world, job opportunities are related to fields where experts in computational methods, data science, Engineering, as well as machine and deep learning, are requested.
Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Andrea Manzoni

Contacts	
Andrea Manzoni: mail: andrea1.manzoni@polimi.it tel. +39 02 2399 4638 www.mate.polimi.it mox.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	700.0 €
By number of months	6

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



List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

1. Prof. Nathan Kutz and Prof. Steven Brunton, University of Washington, Seattle, US
2. Prof. Karen Willcox, ICES, University of Texas at Austin, USA
3. Dr. Mengwu Guo, University of Lund, Sweden

Additional support

Educational activities (purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences):

financial aid per PhD student per year:

1st year: max 1.902,38 euro per student

2nd year: max 1.902,38 euro per student

3rd year: max 1.902,38 euro per student

Teaching and lab assistantship: availability of funding in recognition of supporting teaching and lab activities by the PhD student.

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.

Computer availability:

1 st year: individual use

2 nd year: individual use

3 rd year: individual use

Desk availability:

1 st year: individual use

2 nd year: individual use

3 rd year: individual use