POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 40th cycle

THEMATIC Research Field: TRUSTWORTHY ARTIFICIAL INTELLIGENCE FOR PREDICTIVE MAINTENANCE OF INDUSTRIAL EQUIPMENT

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	The increased availability of data from industrial equipment and the grown ability to treat these data by artificial intelligence (AI) methods have opened the doors for the development and application of predictive maintenance in several industrial sectors, like nuclear, oil and gas, energy, electronics and transportation. Predictive maintenance is a great opportunity for reducing unforeseen failures, and operation and maintenance costs, and for increasing components and machines usage. Practical implementation of predictive maintenance entails trustworthiness of the AI model outcomes. This brings some key challenges of AI: *i*) data collected from degraded and failed equipment are scarce; *ii*) AI models must capture the inherent uncertainty of the degradation and failure processes; and *iii*) the AI models are of black-box nature and their outcomes are difficult to explain physically. The research of the proposed PhD thesis aims at developing new AI analytics for predictive maintenance based on the powerful emerging techniques of Deep and Transfer Learning, Physics-Informed Neural Networks and Generative Adversarial Networks for improving prediction accuracy, especially in case of imbalanced data, i.e. dew degradation and failure data (challenge *i*); Deep Ensembles and Bayesian Neural Networks for treating the uncertainty in AI models (challenge *ii*) and eXplainable Artificial Intelligence

	algorithms for enhancing model transparency and explaining AI model outcomes (challenge *iii*).
Methods and techniques that will be developed and used to carry out the research	Artificial Neural Networks, Bayesian Neural Networks, Physics-Informed Neural Networks, Deep Ensembles, Autoencoders,Convolutional Neural Networks, Generative Adversarial Networks, Transfer Learning, eXplainable Artificial Intelligence
Educational objectives	To prepare a RAMS (Reliability, Availability, Maintainability and Safety) professional expert and competent researcher with multidisciplinary technical skills, algorithmic knowledge and system analysis capabilities, with domain expertise in the energy and transportation fields.
Job opportunities	RAMS, reliability, maintenance, safety, risk engineer and manager, data analyst for nuclear, chemical, transportation and energy generation and distribution sectors.
Composition of the research group	2 Full Professors 1 Associated Professors 1 Assistant Professors 13 PhD Students
Name of the research directors	Prof. Enrico Zio

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	750.0 €
By number of months	6

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

Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc.. The amount is about Euro 3.100,00.

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.