

reliabLE mAchine leaRning in iNdustry 4.0 (LEARN)

Title:	reliabLE mAchine leaRning in iNdustry 4.0 (LEARN)
Funding Institutions:	CNR / CNR-IEIIT
Scientific Responsible	<i>Stefano, Scanzio, stefano.scanzio@ieiit.cnr.it</i>
Main seat to carry out research	<i>Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), CNR, Torino or Milano (candidate can choose)</i>
Research Topic:	<p>Application of machine learning algorithms to next-gen industrial networks for the Industrial Internet of Things (IIoT) and Industry 4.0/5.0 paradigms. Research topics include the use of machine learning to improve reliability/determinism and reduce power consumption in industrial (wireless) networks. Given the specificities of industrial applications, particular attention is devoted to the implementation of reliable machine learning techniques, aimed at providing some guarantees on the predictions made by the related models.</p>
Description:	<p>Industrial applications and networks are characterized by tight requirements in terms of reliability, timeliness, and sometimes power consumption. These constraints make the research applied to factories a topic with quite peculiar interests and characteristics, in which any improvement has typically a chance to directly impact on industrial production, and hence on the National/European economic tissue.</p> <p>Artificial intelligence is impressing more and more momentum to many of the new paradigms that are pervading modern factories, like the Industrial Internet of Things (IIoT) and Industry 4.0/5.0. At the same time, the adoption of wireless technologies for connecting moving equipment without the burden of cables poses exciting new challenges. While ensuring unprecedented levels of flexibility and efficiency for production, the overall reliability and determinism demanded by this kind of applications must be fulfilled, in such a way to both meet safety constraints and achieve the desired quality for the final goods.</p> <p>Recently, Artificial Intelligence is being exploited in wireless networks to improve the quality of communication. It can be used, e.g., to predict the future behaviour of channels given their past, and this inference can be then exploited to adjust communication parameters so that performance requirements are satisfied. For instance, in whitelisting techniques only communication channels that meet specific criteria are exploited for communication. Basically, machine learning (ML) algorithms behind this research activity stem from those used for time-series forecasting. They are</p>

	<p>typically based on artificial neural networks like long short-term memory (LSTM) and resemble those used to predict the evolution of financial markets. The research group with whom the future PhD candidate will collaborate has a long-standing and solid experience in the analysis of IEEE 802.11 (Wi-Fi) and IEEE 802.15.4 (TSCH) technologies and their application to industrial scenarios. All the ML algorithms studied and developed in this PhD course will be tested and validated on databases acquired in the field on a real setup deployed in our lab, which can be categorized as big data. Several such data bases are already available and have been used as benchmarks in scientific papers.</p> <p>Besides industrial communication systems, ML is an enabling technology for several application contexts found in the factories of the future. Many of them have specific requirements in terms of prediction reliability. Not only erroneous predictions of ML models may have a significant impact on industrial production, in terms of the efficient use of machinery or the quality of goods, which could cause economic losses. In the worst cases, they may also lead to damages to machinery, constitute a source of risk for the safety of workers, or negatively impact on the environment. Consequently, particular attention must be paid to a family of techniques, referred to as reliable machine learning (RML), able to provide some guarantees about their predictions (or, at least, some hints about the reliability of the predictions they make).</p> <p>Examples that can take advantage of reliable machine learning are automated decision-making systems, control systems, quality control, and predictive maintenance, to cite a few. Consequently, the analysis and implementation of RML techniques applied to factory automation constitutes an essential part of the activities on which the PhD candidate will focus its attention.</p> <p>The activities related to this PhD research proposal will be performed with the Institute of Electronics, Computer and Telecommunication Engineering (IEIT) of the National Research Council of Italy (CNR). Research activities can be carried out in both the Turin and Milan IEIT sites, located at the Politecnico di Torino (Corso Duca degli Abruzzi, 24) and the Politecnico di Milano (Piazza L. da Vinci, 32), respectively. IEIT has offices and laboratories in both universities, and the candidate will be allowed to freely choose between them. Instead, all the other activities foreseen by the PhD course will be carried out at the Politecnico di Torino.</p>
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<p>Skills:</p>	<ul style="list-style-type: none"> - Very good programming skills with the Python programming language (most of the work will be done in Python). - Good skills about machine learning: Artificial Neural Networks (including FNN, LSTM, GRU, etc.), Keras, TensorFlow, PCA, LDA, GMM, etc. (it is not required to possess all of them when submitting the application).
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	<ul style="list-style-type: none">- Above-average skills about the Linux operating system (the platform used for experiments and ML training and test), including shell commands and bash.- Above-average programming skills about the C programming language.- Basic knowledge about communication networks.
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Supervisor(s)	<p><i>Stefano, Scanzio, stefano.scanzio@ieiit.cnr.it, Institute of Electronics, Computer and Telecommunication Engineering (IEIIT) and Adjunct Professor at Department of Control and Computer Engineering (DAUIN)</i></p> <p><i>Gianluca, Cena, gianluca.cena@ieiit.cnr.it, Institute of Electronics, Computer and Telecommunication Engineering (IEIIT) and Adjunct Professor at Department of Control and Computer Engineering (DAUIN)</i></p>
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Contact for further information	<i>For questions you can directly contact Dr. Stefano Scanzio.</i>
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