PhD in Management, Production and Design

Research Title: Artificial Intelligence for Smart Manufacturing

Funded by	Ateneo/DIGEP

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Context of the research activity	Smart Manufacturing (SM) can be defined as the extensive application of computer-integrated manufacturing and advanced intelligence systems to enable rapid manufacturing of new products, dynamic response to product demand, and real-time optimization of manufacturing production and supply-chain networks (Kusiak 2018, Yao et al. 2017). The aim of SM is to respond to demand-dynamic economics, variability management, real-time materials engineering, and broad-based workforce involvement, thus reflecting the magnitude and impact of the smart technologies of the Industry 4.0 paradigm. Today, the amount of data generated continues to grow exponentially along with the digitalization of information, and the use of the Internet of Things (IoT) within factories (IIoT) to such an extent that manufacturing is identified as one of the five domains in which Big Data has transformative potential. For this reason, SM is now attracting a huge amount of interest in both academic and industrial communities, and will probably drive the manufacturing evolution in the next decade (Li et al. 2020). SM is considered as the evolution of Intelligent Manufacturing (IM), IM being knowledge-based, whereas SM is data-driven and knowledge-enabled. SM uses Artificial Intelligence (AI) techniques to learn directly from data and assist decision making, in contrasts with the "expert system" approach that aims to mimic the rules from human experts with

	the help of analysts who translate human rules and context expertise into software models (Tao et al. 2018). In SM, AI straightforwardly supports decisional systems and human operators by helping them to improve production and process control, to monitor continuous production flows, to prevent or detect equipment failures at an early stage, to minimize inefficiencies through the overall supply chain, and so on (Sharp et al. 2018). AI, in fact, combines a wide variety of advanced technologies to give machines an ability to learn, adapt, make decisions, and display new behaviors. *References* – *Kusiak (2018) Smart manufacturing, International Journal of Production Research, 56(1-2), pp.508-517.* – *K. Li, T. Zhou, B. Liu (2020) Internet-based intelligent and sustainable manufacturing: developments and challenges, The International Journal of Advanced Manufacturing Technology, 108(7411), pp.1767-1791.* – *M. Sharp, R. Ak, T. Hedberg (2018) A survey of the advancing use and development of machine learning in smart manufacturing, Journal of Manufacturing Systems, 48, pp. 170-179* – *F. Tao, Q. Qi, A. Liu, A. Kusiak (2018) Data-driven smart manufacturing, Journal of Manufacturing Systems, 48, pp. 157-169.* – *X. Yao, J. Zhou, J. Zhang, C. R. Boer (2017) From Intelligent Manufacturing to Smart Manufacturing for Industry 4.0 Driven by Next Generation Artificial Intelligence and Further On, 5th International Conference on Enterprise Systems.*

Objectives	The overall objectives of the research activity concern the appropriate deployment of new AI tools to contribute to the creation of competitive frameworks for manufacturing applications, with particular emphasis to the management of data generated by the network of sensors and devices at the plant level (Industrial Internet of Things - IIoT). One of the first aim of the research is to investigate on the AI capabilities for them to fulfill the expected tasks, along with the effective and efficient methodologies to develop AI systems for SM. Industrial AI systems should be able to manage the big amount of data generated by industrial sensors with the appropriate context knowledge, related to each control level of the manufacturing systems A second aim, strictly related to the first one, involves the management of the high degree of uncertainty underlying most of the manufacturing processes, to provide them the capability to react and recover from unexpected events in the most effective way. The research project includes: • Bibliographic research on manufacturing paradigm revolution caused by deep integration of AI techniques with manufacturing technologies. • Bibliographic research on structuring of and algorithms in manufacturing application. • Identification of preliminary case studies replicated on the available DIGEP Labs on mockups of IIoT implemented at the Collaborative Lab @Mind4Lab, the Manufacturing Lab that DIGEP

	is implementing within the frame of the governmental "Excellence Project". • Big Data Analytics for Smart Manufacturing: execution of the necessary experimental tests, gathering the big data from the process. develop and application of Machine Learning algorithms to extracted knowledge and information. • Study and applications in a real industrial case, at least, involved within the framework of a national or international research project. Validation of the machine learning algorithms for smart innovation, such as intelligence process monitoring, smart sustainability process and smart quality control.

Skills and competencies for the development of the activity	Master degree in class LM-25 LM-31 LM-32 LM 33 LM 44. Desirable skills of the candidate should include basic knowledge on Data acquisition and Data analysis, Statistics, Artificial Intelligence, Manufacturing processes, Methods and tools for the management of production processes.