



CHIST-ERA Projects Seminar 2021



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April 13, 2021

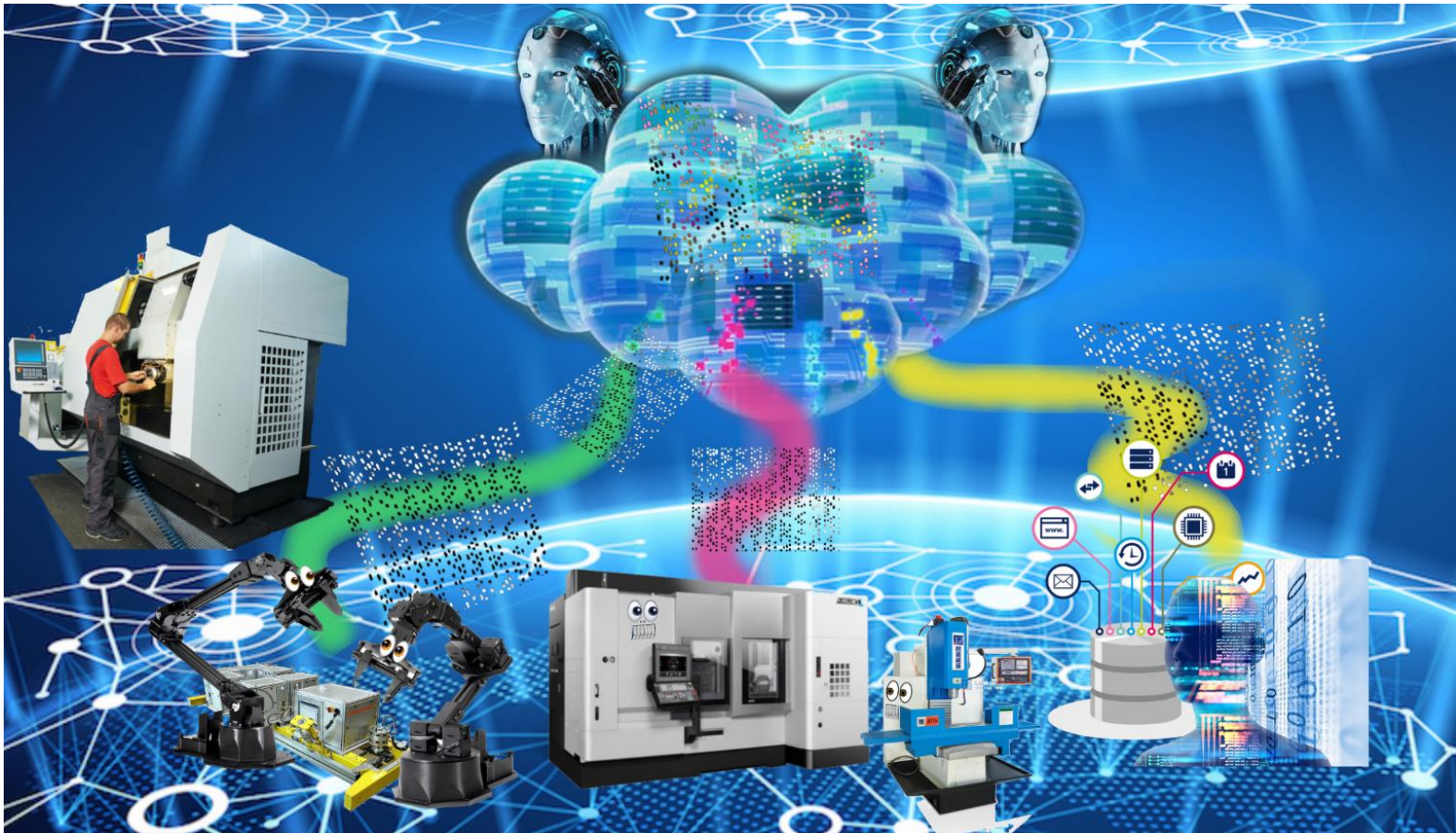




chist-era

Scientific background

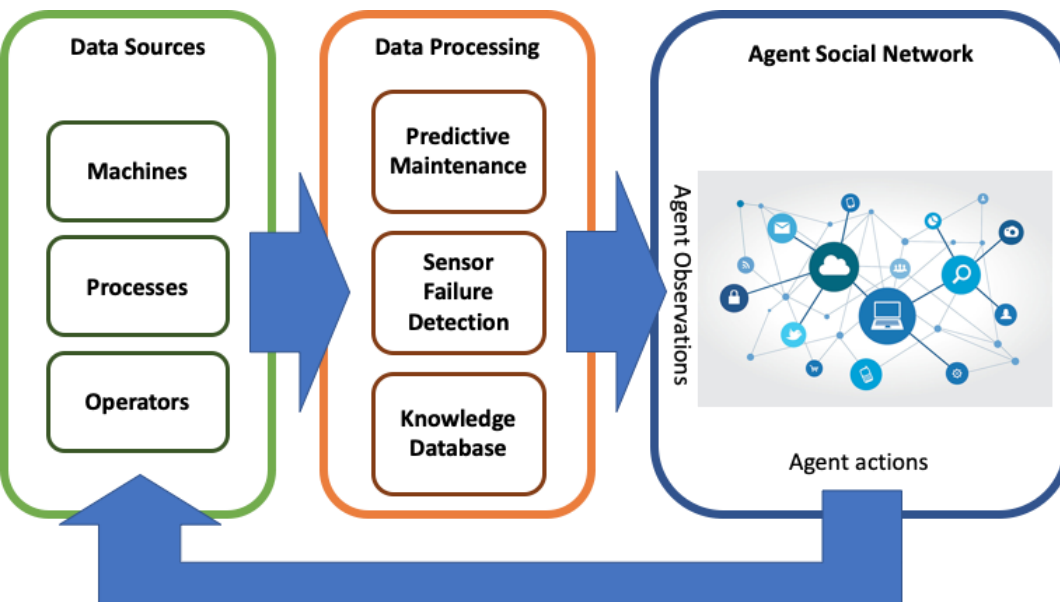
SOON: Social network of machines



- **Context: Industry 4.0**
- **Goal:**
 - Optimization of production flows and processes
 - Reduce impact of failures
 - Design of evaluation benchmark
- **How**
 - Social Multi-Agent System (MAS)
 - **Machines, sensors and operators seen as Agents**
 - Big data technology and Machine Learning
 - Models for *predictive maintenance*
- **3 applied industrial scenarios**
 - Tooling machines: precision mechanics
 - Recycling industry: plastics recycling
 - Steel-making: wire rod and hot strip mills



Key challenges and potential impact of the project



Challenges:

- MAS design
- Predictive and smart maintenance
- Early failure detection
- Efficient failure mitigation (knowledge database)
- Acceptability

Impacts:

- Reduction of unplanned production downtime
- Intelligent guide for human operators
- Production lines autonomization

4 Academic partners



Universidad de Oviedo



UNIVERSITATEA DE MEDICINĂ,
FARMACIE, ȘTIINȚE ȘI TEHNOLOGIE
„GEORGE EMIL PALADE”
DIN TÂRGU MUREȘ

3 Industrial partners

TORNOS



ArcelorMittal



HE-Arc (HES-SO) - Project Coordinator

- Data analytics group: AI & Machine learning
- Experience with AI applied to tooling machines processes, predictive maintenance algorithms
- Industrial Partner: Tornos



Institute of Informatics of the Slovak Academy of Sciences

- Research Groups: Parallel and Distributed Computing & Modelling and Control of Discrete Processes
- Expertise: AI, intelligent agents, data collection & aggregation
- Industrial Partner: Mat-Obaly Ltd.



Universidad de Oviedo

University of Oviedo

- Project Engineering Research Group: multidisciplinary research group (project management / sustainable engineering / data modelling)
- Expertise: process modelling and data analysis for the industrial sector
- Industrial Partner: ArcelorMittal



UNIVERSITATEA DE MEDICINĂ,
FARMACIE, ȘTIINȚE ȘI TEHNOLOGIE
„GEORGE EMIL PALADE”
DIN TÂRGU MUREȘ

University of Medicine, Pharmacy, Science and Technology of Târgu Mureș

- Research group: Industrial Informatics, Industrial Processes Modeling and Control
- Expertise: Computational Intelligence, Data Acquisition and Signal Processing
- Involved in Cyber-physical model and testbed development.

TORNOS

Tornos is a Swiss machine-tool manufacturer. Tornos uses a range of machining technologies with swarf removal capabilities to produce parts requiring extreme precision and quality.



MAT-obaly is a Slovak plastic trading and recycling company. It operates its own LDPE plastic sorting and recycling plant. It's products are symbolized by high quality and reliability delivered to domestic and foreign partners. It emphasizes environmental protection practices by fair recycling of plastic.



ArcelorMittal is the world's leading steel and mining company. Guided by a philosophy to produce safe, sustainable steel, it is the leading supplier of quality steel products in all major markets including automotive, construction, household appliances and packaging. ArcelorMittal is present in 60 countries and has an industrial footprint in 18 countries.



Main scientific results, dissemination and other output

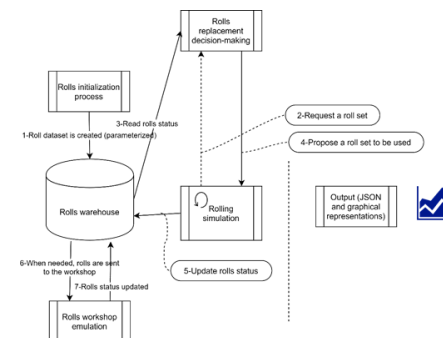
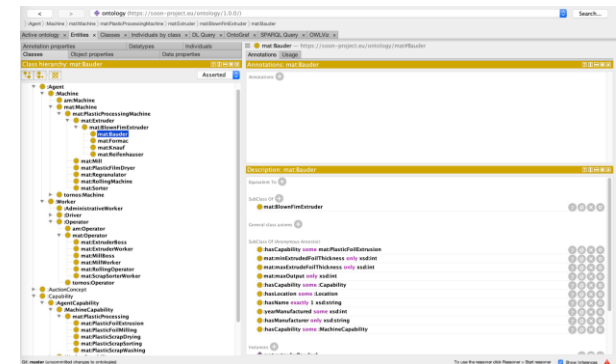
Main scientific results

- **Requirements** specification & **Scenarios**
- **Multi-agent architecture**
- **Predictive maintenance algorithms** based on social **multi-agents** approach
- **Open dataset** with failure data to share with the scientific community.
- An **evaluation framework** to ensure repeatability and validate the resilience of the proposed approach.



Main scientific results (details)

- Auction approach for maximizing the factory production
- SOON Ontology (Core + 3 Domain Specific Extensions for Use Cases) Social Concepts Ontology
- Machining quality prediction using inertial sensors, acoustic emissions and AI
- Digital Twin for the simulation of rolls replacement process
- Wire rod mill rolls replacement model using a modified asynchronous backtracking algorithm (ABT) approach
- Testbed for electric motor fault detection
- Automatic sensor failure detection algorithm
- Analysis of past maintenance interventions to forecast future needs
- 3-level evaluation framework





Main scientific results, dissemination and other output

Dissemination and other output

- Scientific publications
- MDPI Mathematics - Preparation for special issue
 - https://www.mdpi.com/journal/mathematics/special_issues/Industrial_Big_Data_Process_Modelling_Smart_Manufacturing
- RATIONALITY International workshop (2020)
 - Workshop 2021 (in organization - want to participate?)
 - <https://bit.ly/3sYpPTo>
- Consortium creation for a Horizon Europe call loosely based on the SOON project results and ideas



Main scientific results, dissemination and other output

- ❖ Iantovics, L.B.; Kovacs, L.; Rotar, C.: MeasApplInt - a novel intelligence metric for choosing the computing systems able to solve real-life problems with a high intelligence, *Applied Intelligence*, 49(10), 2019, 3491-3511.
- ❖ Gligor, A., Vlasa, I., Dumitru, C. D., Moldovan, C. E., & Damian, C. (2020). Power demand forecast for optimization of the distribution costs. *Procedia Manufacturing*, 46, 384-390.
- ❖ Iantovics, L.B.; Kountchev, R.; Crişan, G.C.: ExtrIntDetect-A New Universal Method for the Identification of Intelligent Cooperative Multiagent Systems with Extreme Intelligence, *Symmetry*, 11(9), 2019, 1123.
- ❖ Iantovics, L.B.; Rotar, C.; Morar, F.: Survey on establishing the optimal number of factors in exploratory factor analysis applied to data mining, *Wiley Interdisciplinary Reviews- Data Mining and Knowledge Discovery*, 9(2), 2019, e1294.
- ❖ Kenyeres M.; Kenyeres J.: Data Aggregation in Mobile Wireless Sensor Networks Represented as Stationary Edge-Markovian Evolving Graphs, Volume 25, Issue 1, 24 June 2019, 25th International Conference on Soft Computing, MENDEL 2019; Brno; Czech Republic. Code 150403
- ❖ Kenyeres M.; Kenyeres J.: On Performance Evaluation of Distributed System Size Estimation Executed by Average Consensus Weights, Volume 25, Issue 1, 24 June 2019, 25th International Conference on Soft Computing, MENDEL 2019; Brno; Czech Republic. Code 150403
- ❖ Junquera, A. M. V., González, J. G., Balsera, J. M. V., & Montequín, V. R. (2020). A Wire Rod Rolling Mill Digital Twin for the Simulation of the Rolls Replacement Process. In *Multidisciplinary Digital Publishing Institute Proceedings* (Vol. 63, No. 1, p. 13).
- ❖ Bustamante Arias, L., Rodríguez Montequín, V., Villanueva Balsera, J., Mones Bayo, A. (2020). Methodology for the Integration of Data-Based Models in Production Environments. In *Dortmund International Research Conference 2020 Proceedings (in press)*
- ❖ Carrino, S., Guerne, J., Dreyer, J., Ghorbel, H., Schorderet, A., & Montavon, R. (2020). Machining quality prediction using acoustic sensors and machine learning. In *Multidisciplinary Digital Publishing Institute Proceedings* (Vol. 63, No. 1, p. 31). <https://www.mdpi.com/2504-3900/63/1/31>
- ❖ Iantovics, L.B. Black-Box-Based Mathematical Modelling of Machine Intelligence Measuring, *Mathematics* 2021, 9(6), 681.
- ❖ Vlasa, I.; Gligor, A.; Dumitru, C.D.; Iantovics, L.B.: Smart Metering Systems Optimization for Non-Technical Losses Reduction and Consumption Recording Operation Improvement in Electricity Sector, *Sensors* 2020, 20(10), 2947;
- ❖ R. Kumar, I. Budinska, Z. Balogh, E. Gatial and T. Matejka, "Discrete event simulation approach for evaluation and estimation of various production parameters," 2020 IEEE 20th International Symposium on Computational Intelligence and Informatics (CINTI), Budapest, Hungary, 2020, pp. 91-98, doi: 10.1109/CINTI51262.2020.9305850.
- ❖ E. Gatial, Z. Balogh and L. Hluchý, "Concept of Energy Efficient ESP32 Chip for Industrial Wireless Sensor Network," 2020 IEEE 24th International Conference on Intelligent Engineering Systems (INES), Reykjavík, Iceland, 2020, pp. 179-184, doi: 10.1109/INES49302.2020.9147189.

Valorisation & Exploitation

- Direct exploitation by the Industrial partners
 - ArcelorMittal, Mat-Obaly & Tornos
- Creation of the *Micro-lean lab* in Switzerland
 - microleanlab.ch/en
- Digital Innovation Hubs (participation in progress)
- General public datasets
- Related teaching activities (student projects, etc.)

Thank you!

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Or <https://soon-project.eu/contact.html>