ECOLE DOCTORALE IAEM LORRAINE

Contribution to the Formalisation of Data-driven Invariant Modelling Constructs of Cyber-Physical Systems

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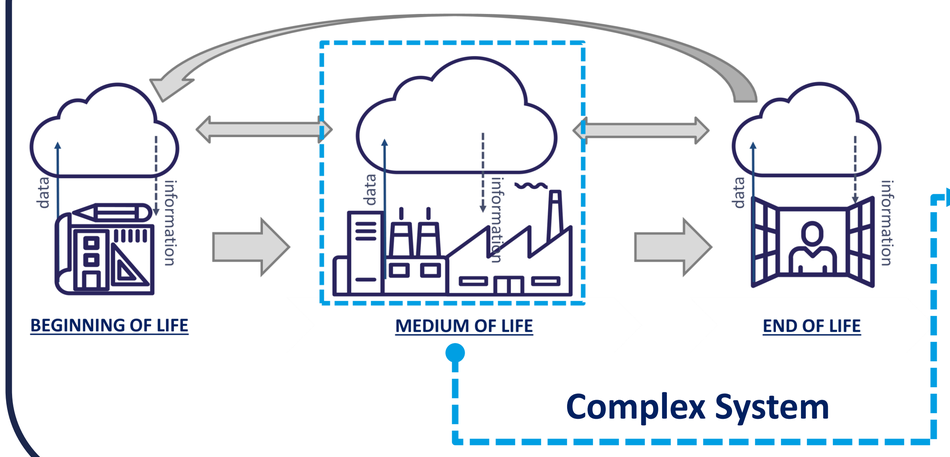
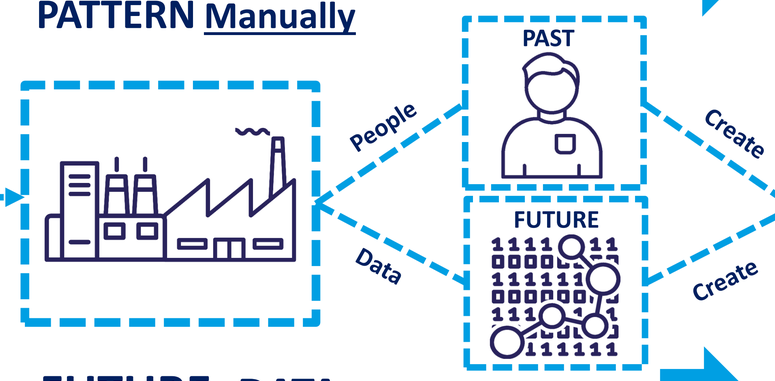
Université : Université de Lorraine and Politecnico di Bari

Collaboration industrielle : Master Italy s.r.l.

Research Context



PAST: PEOPLE for detecting **PATTERN** Manually



FUTURE: DATA for detecting **PATTERN** Automatically

GAPS:

- ❖ Rely on the experience of people.
- ❖ Not easy to develop and to keep updated during the system life-cycle.

RESEARCH CONTRIBUTION:

Formalization of data driven modelling constructs for realizing an INVARIANT APPROACH

Issues

QUESTIONS:

1. How it is possible to **discover** and formalize **data-driven modelling constructs?**
2. How to **implement an invariant approach** through data-driven pattern constructs?

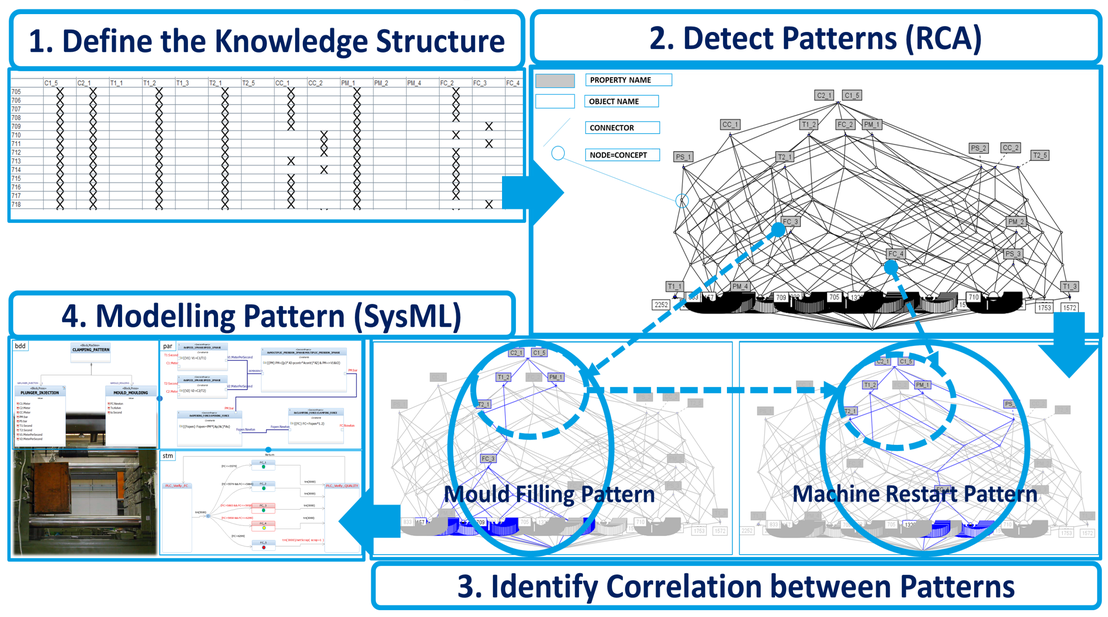
HYPOTHESIS:

- ❖ The idea behind **the invariant approach is to use, and especially re-use, predefined functional patterns for building digital models based on the specific application.**
- ❖ The invariant approach is based on the **combination of data-driven approaches with model-based approaches**.

Proposed Approach

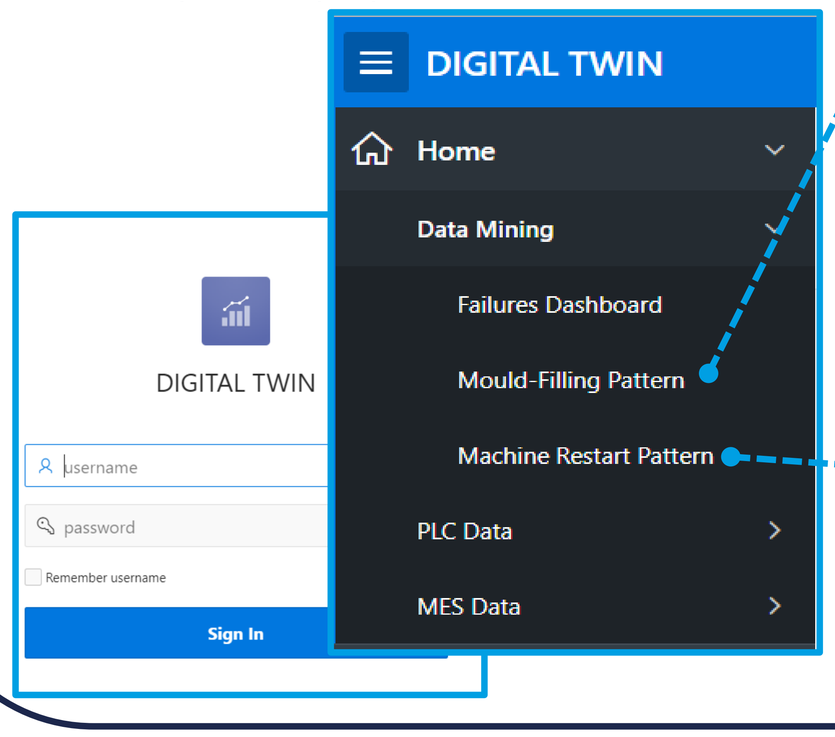
The invariant approach developed is articulated in four different stages:

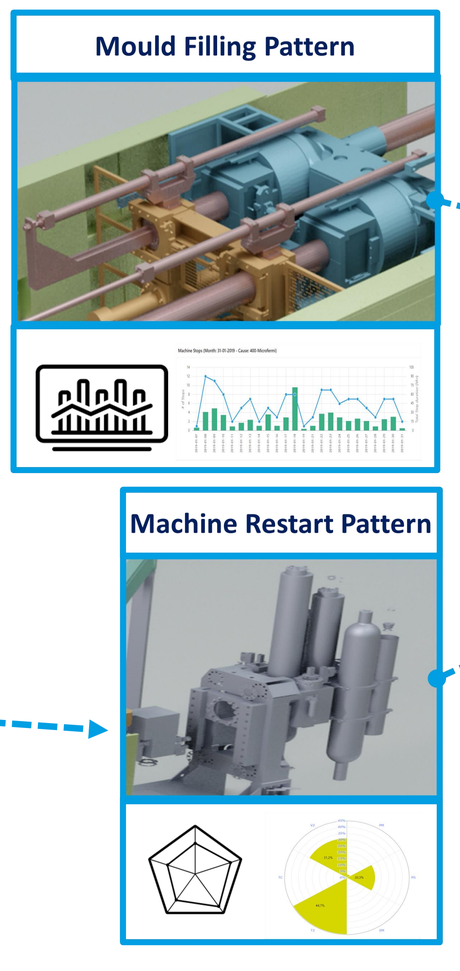
1. The first stage is to define the knowledge structure in a data table. The cross indicates that exists a relation between an object (rows) and an attribute (columns).
2. In second stage, RCA (relation concept analysis) converts automatically the data table into a lattice.
3. The third stage is to extract the patterns from the lattice and to identify the relationship between patterns.
4. The last stage is to generate the model of a pattern in SysML diagrams, based on the features defined in the previous step. The block definition (bdd), internal block definition (ibd), state chart (stm) and parametric (par) diagrams enable to represent the structure and the behaviour of a pattern.

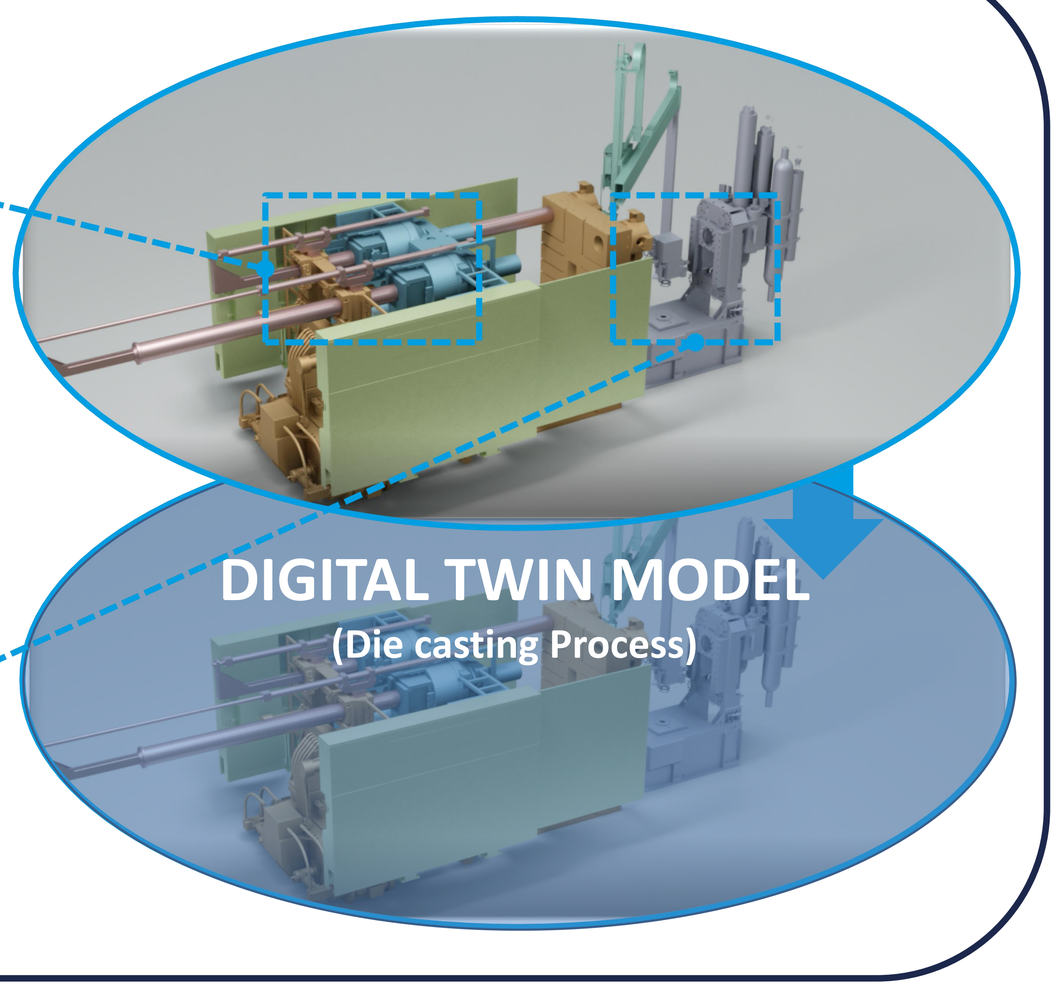


Preliminary Results

- ❖ A **WEB PLATFORM** has been developed. It contains all **DISCOVERED PATTERNS**.
- ❖ A set of Patterns have been used to realize a **DIGITAL TWIN MODEL** of die casting aluminium process for Master Italy s.r.l company.







PUBLICATIONS:

- ❖ *Concetta Semeraro, Mario Lezoche, Hervé Panetto, Michele Dassisti,* **"Digital Twin Paradigm: A Systematic Literature Review",** *Survey IFAC World Congress 2020 in Berlin, Germany, "Submitted";*
- ❖ *Concetta Semeraro, Mario Lezoche, Hervé Panetto, Michele Dassisti, Stefano Cafagna,* **"Data-driven pattern-based constructs definition for the digital transformation modelling of collaborative networked manufacturing enterprises",** *Scientific International Conference PRO-VE 2019- Turin, ITALY 20th Working Conference on Virtual Enterprises;*
- ❖ *Concetta Semeraro, Mario Lezoche, Hervé Panetto, Michele Dassisti, Stefano Cafagna,* **"Monitoring Strategy for Industry 4.0: Master Italy s.r.l Case Study",** INSIGHT, *Wiley, Décember 2019, 22 (4);*
- ❖ *Michele Dassisti, Hervé Panetto, Mario Lezoche, Pasquale Merla, Concetta Semeraro, Antonio Giovannini, Michela Chimienti,* **"Industry 4.0 Paradigm: The Viewpoint of The Small and Medium Enterprises"** *Scientific International Conference ICIST 2016 - Kopaonik, Serbia, 7th international conference on information society and technology;*