POLITECNICO MILANO 1863

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Doctoral Programme in Mechanical Engineering

Automated Generation and Exploitation of Discrete Event Simulation Models for Decision Making in Manufacturing

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Manufacturing and Production Systems, XXXIII Cycle

Introduction

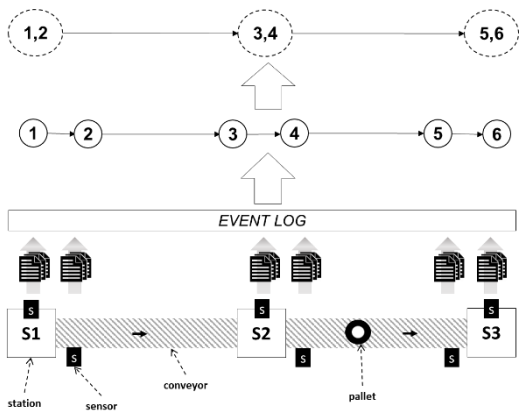
The latest developments in industry have involved the **deployment of digital twins for both long- and short-term decision-making**, such as production planning and control. The ability to take appropriate decisions online is based on the assumption that digital models are properly *aligned* with the real system.

As modern production environments are frequently subject to disruptions and modifications, **the development of digital twins of manufacturing systems cannot rely solely on manual efforts**. If a model could be generated from the available data in a manufacturing system, the development phase may be significantly shortened.

Practical implementations of automated model generation approaches remain scarce. Also, automatically built representations may be **excessively accurate** and describe activities that are not significant for estimating the system performance. Hence, the **generation of models with an appropriate level of detail** can avoid useless efforts and long computation times, while allowing for easier understanding and re-usability.

Objectives

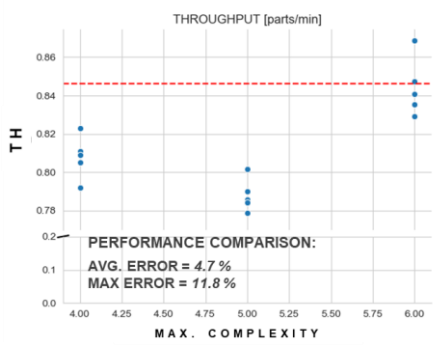
- Development of **automated model generation techniques** for obtaining simulation models starting from the data logs of manufacturing systems.
- Development of **methods to adjust the models toward a desired level of detail**, exploiting the properties of manufacturing systems such as buffer sizes.
- Development of a **testing platform** for real-time decision-making approaches within digital twin architectures.

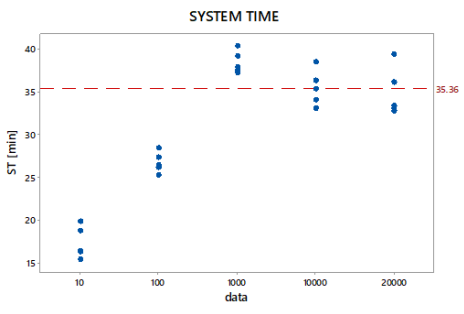


Results

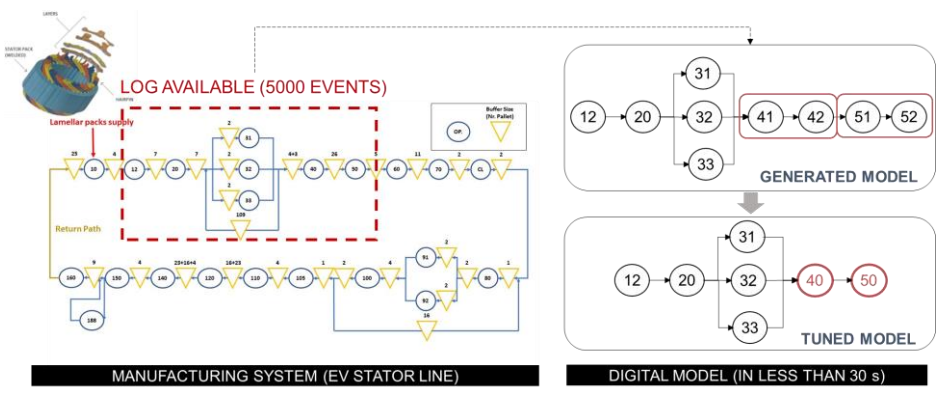
The method has been applied to test cases, verifying that the loss in performance with a reduced model is acceptable.

Test Case: 6-station Production Line

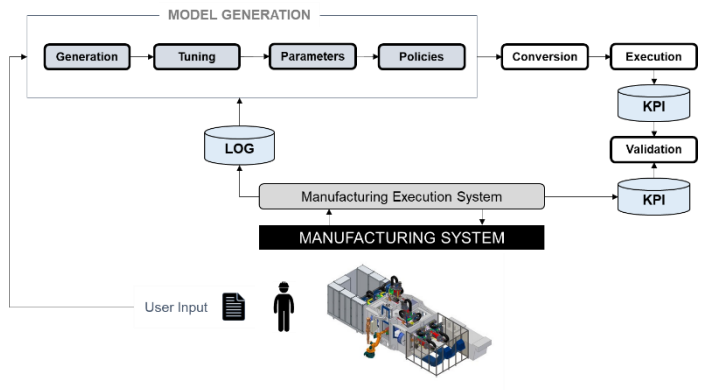




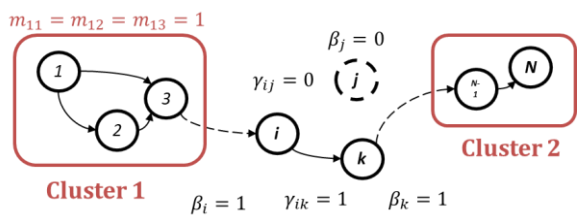
Industrial Use Case: EV Motors Production Line



Method

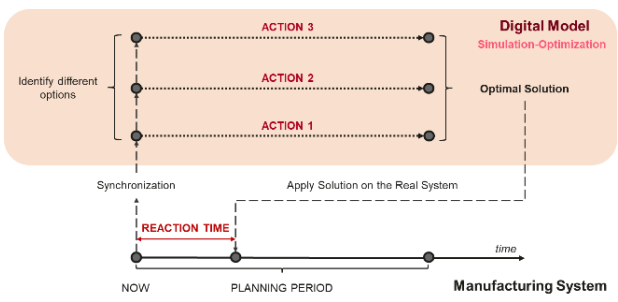


- **Problem formalization**: mathematical programming can represent the *model tuning problem*.
- **Objective function**: sum of scores that represent the system properties (e.g., buffer sizes, machine capacity).
- **Solving method**: heuristic algorithm that starts from an initial model (complete representation), generates neighbor models until it reaches the required size.



Conclusions

The capability to generate an accurate model in a short time can **enable Real-time Simulation applications**. Indeed, the online application of the proposed methodology allows for adapting simulation models to the real system counterpart, potentially at any time a modification occurs. This way, decisions taken online are guaranteed to be referring to the current state of the physical system. Manufacturing enterprises can reach a higher production flexibility, together with higher responsiveness to technological changes and market demand fluctuations.



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