APPLICATION OF AI TOOLS IN MANUFACTURING

Maria Grazia Marchesano – Advisor: Prof. Guido Guizzi

Curriculum: Tecnologie e Sistemi di Produzione/Tecnologica Srl

The problem of configuring production and logistic systems to satisfy a more and more personalized market demand in a shorter time and minimizing costs is widely investigated. The introduction of the Industry 4.0 paradigm helps in satisfying these tasks. In the current situation, therefore, it is necessary to exploit even more these tools to face every adversity. Modern manufacturing systems have smaller lot sizes, a wider product variety, and more complex material flow systems, necessitating high manufacturing versatility and the ability to deal with the complexities of such scenario. Humans find it difficult to make appropriate decisions in these circumstances, so adaptive and efficient control is required. Control systems are mostly based on static and model-based heuristics, which necessitate extensive human domain knowledge and, as a result, do not match the dynamic environment of manufacturing companies.

One of the tools that could help in achieving a more resilient production system and coping with the dynamic of the manufacturing systems is Reinforcement Learning (RL). RL is one of the frameworks of Machine Learning (ML) which, together with Deep Learning (DL), has been investigated in these recent years in the field of production control.

Even though there is much more to learn about the subject, some works can already be identified to demonstrate the benefits that the implementation or inclusion of such technologies could provide. The problem of scheduling and production control has been approached in a variety of ways, utilizing various frameworks and ML algorithms.

To overcome issues that may occur in the production control many authors propose the ML, DL, or RL approach.

Concerning the control of the production, Hopp and Spearman(2011) have proposed a solution to counteract the inefficiency in manufacturing, that is to say controlling the Work-In-Process (WIP) in the system and protect the throughput from variance. To the best of our knowledge, no one has yet addressed the issue of controlling the throughput (TH) and the WIP using RL to make the system more efficient and self-controlled.

We want to address the problem of configuring a learning agent using Deep Q-network (DQN), a combination of deep NN and RL, to regulate a Flow Shop line. The processing time are stochastic and the learning agent allows to reach a target throughput level while controlling the WIP. The current study, in particular, aims to contribute to the development of a novel control approach that evaluates the current state of the production system and its set of possible actions. With this information, the system can determine the best policy to achieve a given goal. Furthermore, we compare the results obtained with the known results of an analytical model from the literature to validate the efficacy of the proposed approach.

The Industry 4.0 and emerging technology offer new possibilities for dynamic scheduling strategies using Machine Learning (ML) techniques and algorithms. This brings with it a number of significant new challenges and planning opportunities.

Since different rules can be applied to different situations, it can be difficult for the decision-maker to select the best rule at any given time.

Moreover, dispatch rules are limited to their local information horizons, so, there is no rule that exceeds others by different goals, scenarios and conditions of the system.

Many approaches have been taken in the literature to address the problem of scheduling and production optimal control. The method of Deep Reinforcement Learning (DRL) is the proper way to produce a self-optimization scheduling policy, so that the accurate simulation and high performance data provided by a simulation tool can be used.

The aim is to create an "intelligent" tool that updates its choices in response to changes in the production line's situation.

References:

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