A Friend in Need — A Friend Indeed: Successful AI Applications in Ironmaking by a Transparency Approach




For integration of artificial intelligence (AI) into critical decision-making processes, transparency is crucial. AI and other data-driven methods offer powerful alternatives to first principles modeling of complex metallurgical processes. However, they tend to be black boxes, leading to unreliable guidance especially in critical operational situations. This can be overcome by a transparency approach using explainable AI and considering meta information. This work demonstrates how advanced AI-based applications for sinter plants, blast furnaces and direct reduction plants can be seamlessly integrated into state-of-the-art decision support systems.

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Introduction

While artificial intelligence-based tools provide a powerful approach to generate models of complex systems, their black box behavior is a grave drawback. This is especially relevant if the results should be used within the decision-making loop of critical processes, as within the ironmaking plants. Therefore the development of methods to enhance the transparency of these black box models is essential for practical applications.[1]

Discussion

Transparency Approach

Transparency is a big challenge[9] and is the premise for acceptance of data-driven methods in production. This is especially prominent in mission-critical processes and use cases where process stability is crucial, such as ironmaking operations. Increase in the transparency of machine learning (ML) models allows for a better understanding of the model, the interdependencies of process variables and to augment the control strategies and process knowledge base. As shown in a previous study,[17] involvement of end applicants of the ML models and domain experts in the development process is decisive for increasing acceptance of these models. To bridge the gap in the acceptance of ML models in production systems and increase transparency in algorithmic decision-making, a multiphase approach has been proposed. The developed approach aims for integration of domain expert knowledge and insight in ML model development and evaluation process, ensuring ML model stability in the deployment phase and providing insight into reasoning during the model operation.

The Cross Industry Standard Process for Data Mining (CRISP-DM)[18] (Fig. 1) is the most widely used analytical model and de facto industry standard for the development of data-driven solutions. The approach discussed in this work aims to integrate domain experts in the ML development process through utilization of selected methods in the final three steps of the CRISP-DM process, namely Modeling, Evaluation and Deployment. In the CRISP-DM process, domain experts are predominantly involved in the initial stages such as Business Understanding and Data Understanding, which often results in lack of insight in later stages of development, consequently, alongside other identified challenges, culminating in low acceptance of overly complex, nontransparent predictive models.