Optimizing Cement Production by Employing Physics Informed Machine Learning

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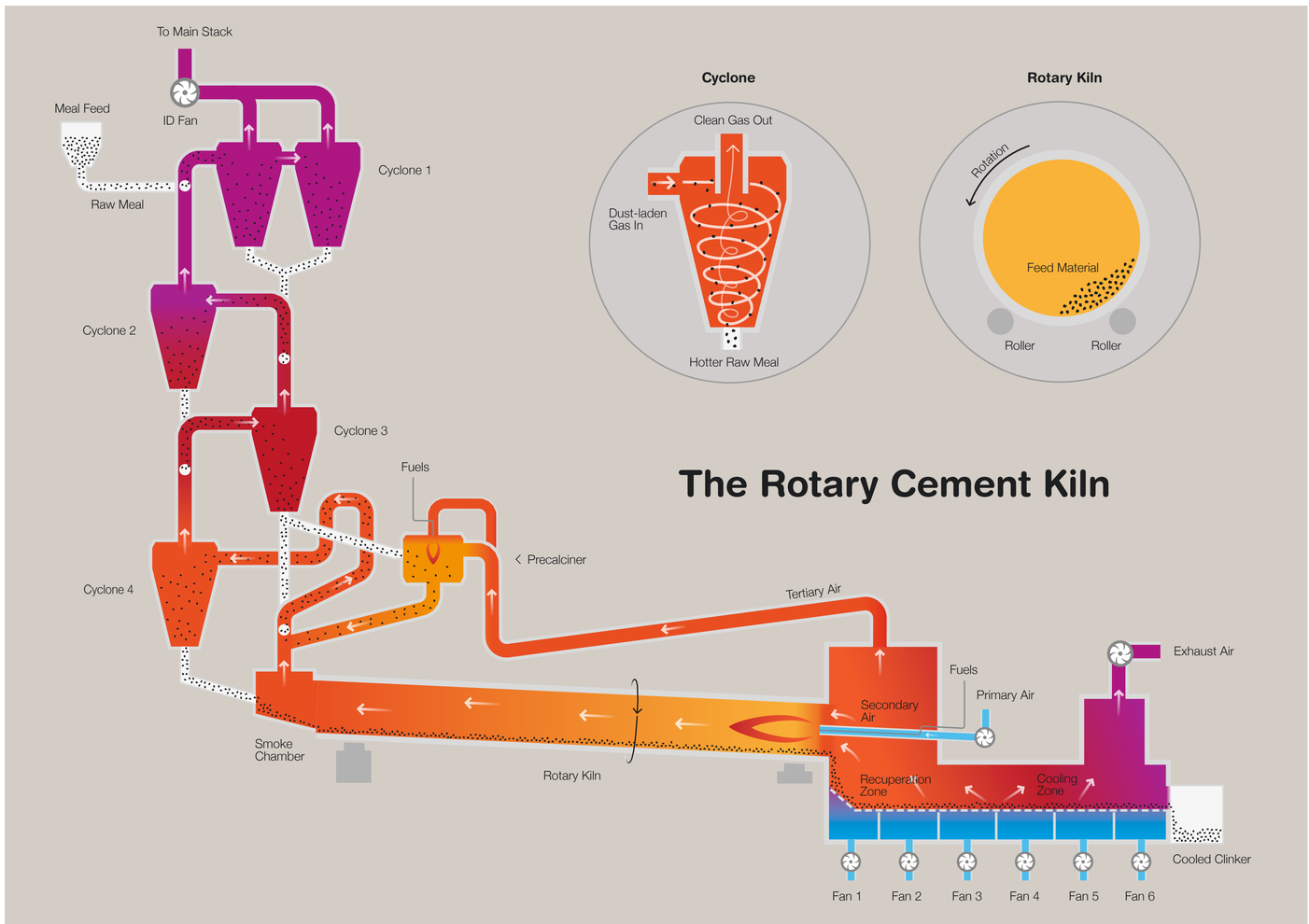
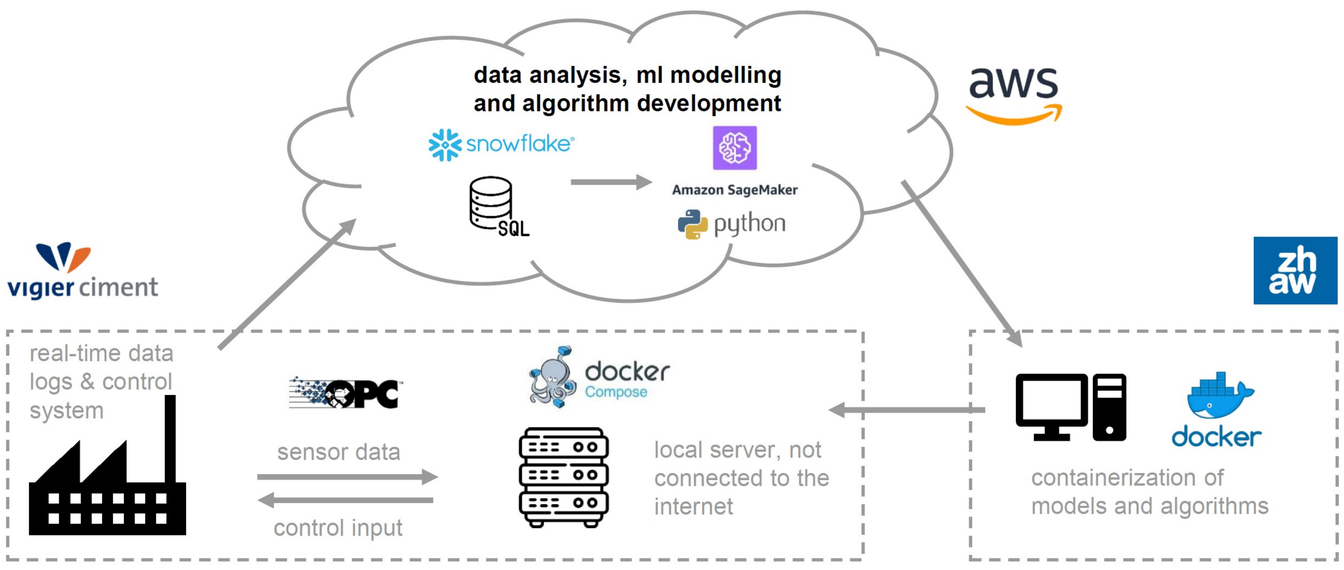
Problem Statement

- The cement production contributes to about 8% of the global anthropogenic CO_2 emissions and in addition is a significant source of NOx pollution. Optimizing cement production is therefore crucial.
- The intensive use of alternative fuels (used oils & solvents, sludge, fluff, animal meal) with strongly varying calorific values makes it very challenging for a human operator to stabilize the burning process.
- Machine Learning algorithms that exploit the many hundreds of data sets that are recorded every moment can help to improve the process due to predictions of key process parameters and active control of important set points.
- However, the very rough environment with temperatures up to 2000°C, corrosive gases, dust and vibrations leads to sensors drifts and discontinuities in the measurement and even makes the measurement of some key temperatures impossible. Thus, the development of ML algorithms is very demanding.

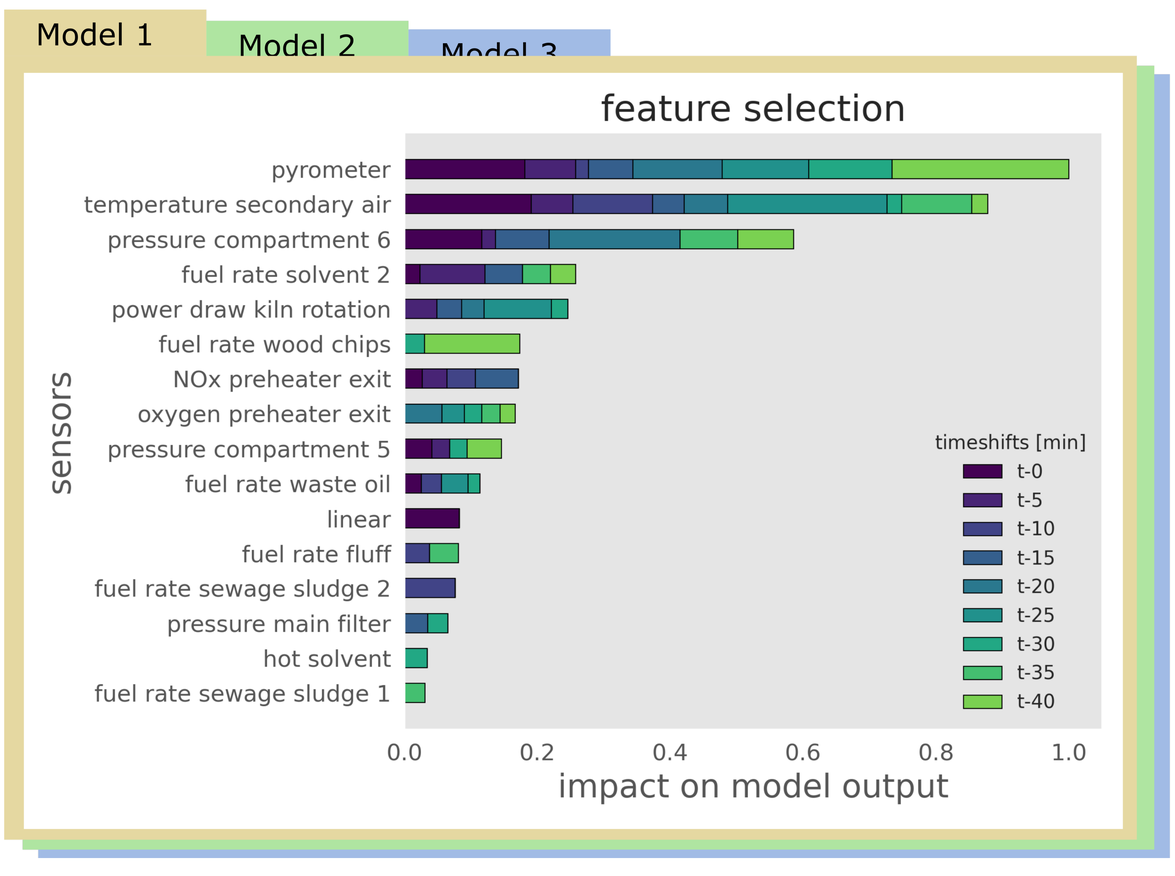


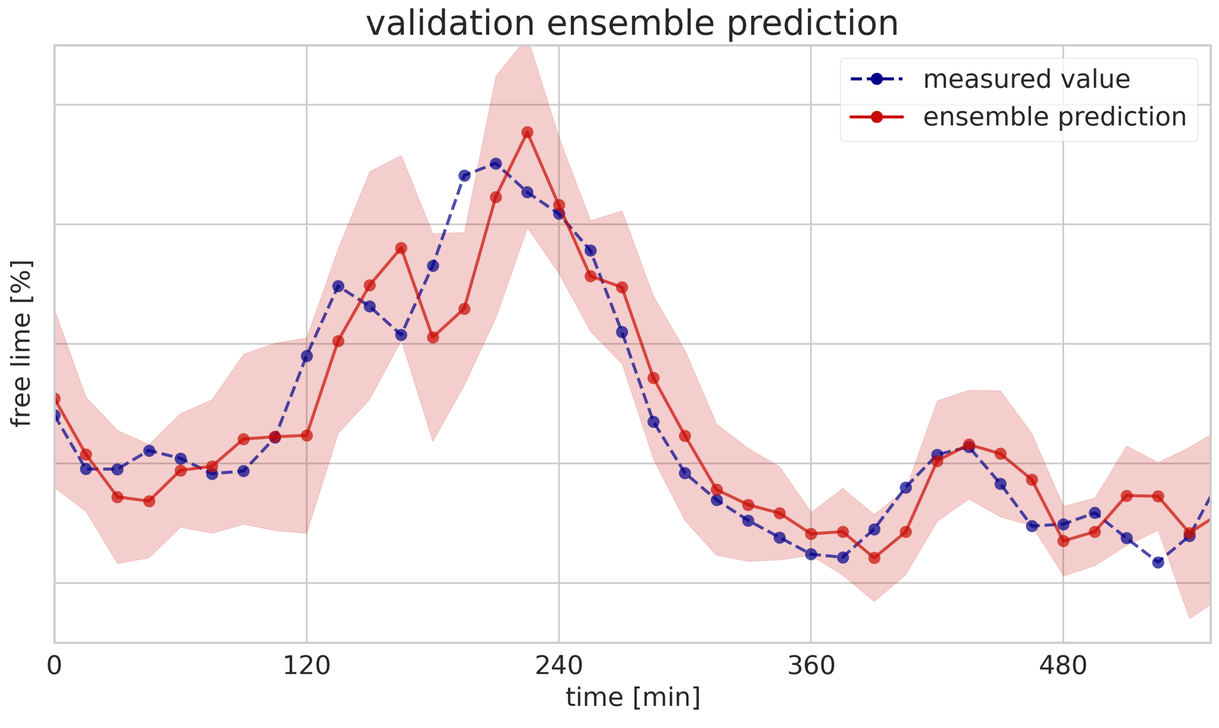
Data Platform & Deployment

- A data platform based on AWS has been set up, which allows for storage and real-time analysis of sensor data as well as development of algorithms and models in the cloud.
- The developed algorithms are tested locally at ZHAW and containerized using docker.
- The final application is running in multiple containerized (micro)services on a local server at the cement plant.
- Long-term vision: model training and containerization are completely done in the cloud.



Free Lime Prediction





The free lime content of the burned clinker, the main ingredient of cement, is an important quality parameter. A free lime prediction model can be used by the kiln operator or a ML algorithm to stabilize the burning process, to improve the product quality and to reduce emissions.

This work is supported by Innosuisse Innovation project 54692.1 1P-ENG.