The **Institute of Information Systems Engineering (IISE)** and the **Institute of Mechanics and Mechatronics (IMM)** at **TU Wien** invite applications for a **Master Thesis on parameter learning, data-driven modeling and AI-based control** embedded in an ongoing **research project "FurnAIce"** involving multiple research and industry partners.
The research project FurnAIce broadly develops **AI-enhanced modeling and control** of industrial tunnel kilns in roof tile / brick production to improve **energy efficiency and sustainability**. The brick firing process in such tunnel kilns is highly complex (distributed in space and time, nonlinear, coupled flows, uncertainties) which is addressed by a hybrid combination of physics-based and data-driven modeling and control approaches.

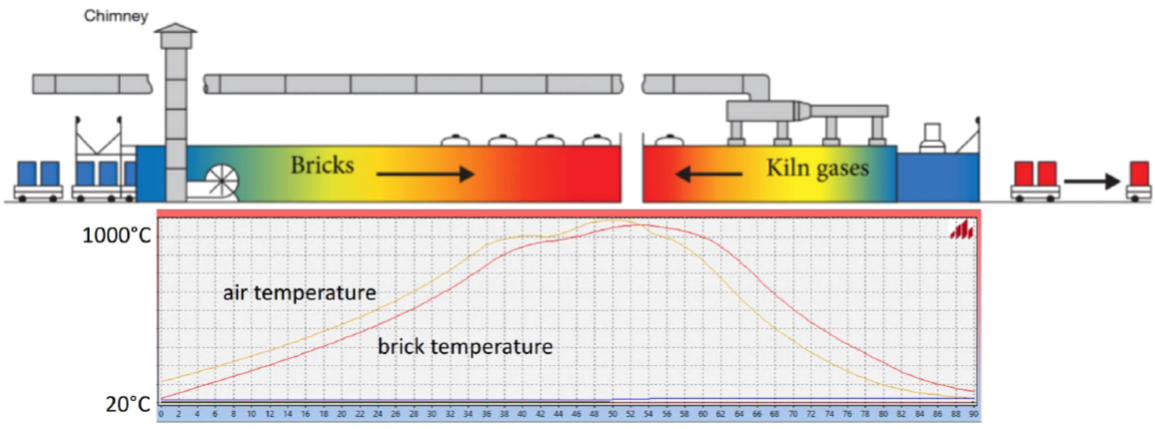
Master Thesis in AI-enhanced Modelling & Control:

Parameter Uncertainty Quantification, Model Extension and Uncertainty-Aware Agent-Based Control of a Tunnel Kiln Process for Brick Production

In this research context, the offered master thesis should help **parametrize a high-fidelity process simulation model**, including estimating and quantifying multiple coupled parameter uncertainties and their cross-correlations, based on actual measurement data of the real industrial plant.
These findings serve as the basis for two subsequent tasks in the thesis:

(1) extending the model by data-driven/AI model components and their parametrization to improve model accuracy and adaptation capabilities, and
(2) demonstrating the use of quantitative uncertainty descriptions in the design, training, and deployment of a reinforcement-learning-based control policy for efficient tunnel kiln control. The so-called "sim-to-real" gap should be significantly reduced by explicitly exploiting the quantified uncertainties.

Methods from data science and statistics, machine learning, and control will serve as starting points, which should be combined, extended and applied as appropriate. The student is thereby involved in an active research project with in-depth scientific guidance and helps solve high-impact real-world control tasks. For the development and elaboration of the research content under academic supervision, a position as a student research assistant (20 hours per week, fixed term of 6 months) is foreseen. The completion of a master's thesis on the topic is intended.



Schematics of the tunnel kiln process to produce bricks by accurate and energy-efficient control

Your profile:

- Advanced undergraduate studies in **computer science, mathematics, physics, engineering**, or related fields.
- Solid background in **system theory, modeling, and control**.
- Beneficial prior experience:
  - **statistics and data science, experimental (data-based) modeling, simulation**
  - **machine learning (Bayesian learning, reinforcement learning), control**
  - **programming (MATLAB, Python, Julia)**
- **Motivated to learn & do actual research in a real-world industrial setting**, with a structured approach.

Planned work / thesis aspects:

- **On-ramping** into the team & research topic (overview/big picture, literature studies)
- **Literature research** focusing on parameter learning / parameter identification methods (such as Bayesian learning) to characterize parameter sensitivity and quantitative uncertainty descriptions of *multiple coupled relevant parameters*
- Implementing and carrying out **parameter learning** and **uncertainty quantification** of an available parametrized simulation model via **real-world measurement data** of an operating tunnel kiln plant to obtain a calibrated tunnel kiln simulation model with interpretable quantitative knowledge of relevant uncertainties (including their couplings and cross-correlations).
- Assess and **explore specific model extensions** by e.g. AI-based data-driven components to improve model quality where needed.
- Set up, develop, train and demonstrate a **reinforcement-learning-based control policy for tunnel kiln control** which explicitly exploits the uncertainty quantification results to reduce the sim-to-real gap.
- Clearly **document** your findings, program codes and results. **Scientific publication** of the results is foreseen.

Contact

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