Master's Thesis: Offline Learning for RL Scheduling in Semiconductor Manufacturing

Are you passionate about AI, manufacturing, and optimization? In this master's thesis, you will help develop reinforcement learning methods for scheduling and dispatching in a semiconductor frontend fab. Training RL methods on a high-fidelity digital twin is computationally expensive - especially when combined with optimization - and credit assignment is challenging because actions have delayed and distributed effects across the fab. This thesis aims to mitigate these challenges through offline learning: building high-quality datasets from the simulation (and potentially real production data), training prediction models that approximate fab dynamics and KPIs, and integrating these models with RL to accelerate learning and improve final performance. You will identify promising methods, such as critic/value function pretraining, reward shaping aligned with global KPIs, or fully offline RL and perform a study to assess their applicability. Based on this analysis, you will explore the most promising offline strategies and assess their integration with novel RL algorithms. Working closely with domain experts, you will contribute to both cutting-edge academic research and real industrial impact. You'll gain hands-on experience with data engineering, model development and the integration of learned components with RL and optimization. The thesis will be conducted in collaboration with Infineon Technologies AG.

Job Description

- **Literature Review:** Review literature in the field to identify promising candidate strategies for offline learning strategies (e.g., critic/value-function pretraining, surrogate modeling, etc.)
- **Data Aggregation:** Define state, action, reward, and KPI features and build a robust data pipeline from the fab's digital twin and potentially real production data bases.
- **Model Development:** Develop and implement models for most promising identified candidate strategies
- **Feasibility Study:** Define decision criteria (e.g., data availability, fidelity needs, integration effort, etc.) and assess feasibility with small-scale pilots of developed models.
- **Scaling and Evaluation:** Scale feasible models and validate their performance in different testing scenarios and system conditions.
- **Integrate with Scheduling Models:** Integrate the framework with reinforcement learning and optimization methods for dynamic complex job shop scheduling.

Your Profile

- **Study Field:** You are currently enrolled in a master's program at TUM School of Management.
- **Experience:** You have strong programming skills in Python. Experience with data analysis libraries like Pandas and NumPy as well as machine learning frameworks like PyTorch or Scikit-learn is beneficial.
- **Focus:** You possess a solid understanding of machine learning concepts. Ideally, you have first experience with reinforcement learning, production science or scheduling problems.
- **Personality**: You exhibit strong problem-solving abilities, attention to detail, and the capacity for innovative thinking.
- **Way of Work:** You have the ability to work independently and as part of a project team. You can dive into complex problems while still maintaining a holistic overview of the problem scope.
- **Language Skills:** You are fluent in English; proficiency in German is a plus.

Begin: As soon as possible

Advisor: Niels Hayen