Chair of Computational Modeling and Simulation
TUM Department of Civil, Geo and Environmental Engineering
Technical University of Munich

Master Thesis Proposal

Reinforcement Learning-Based Optimization of Machining Operation Sequences and Parameters for Automated Computer-Aided Manufacturing

Description

In modern manufacturing, the increasing demand for customized products and complex geometries necessitates sophisticated approaches to computer-aided manufacturing (CAM). While traditional CAM systems rely on predefined rules and human expertise for tool path planning and parameter selection, they often fall short in optimizing the complete manufacturing process, particularly for complex workpieces. **Recent advances in artificial intelligence, specifically reinforcement learning (RL), offer promising opportunities to automate and optimize machining decisions.** However, current research primarily focuses on optimizing individual machining parameters rather than addressing the holistic challenge of sequential decision-making in manufacturing processes, including tool selection, operation sequencing, and parameter optimization simultaneously.

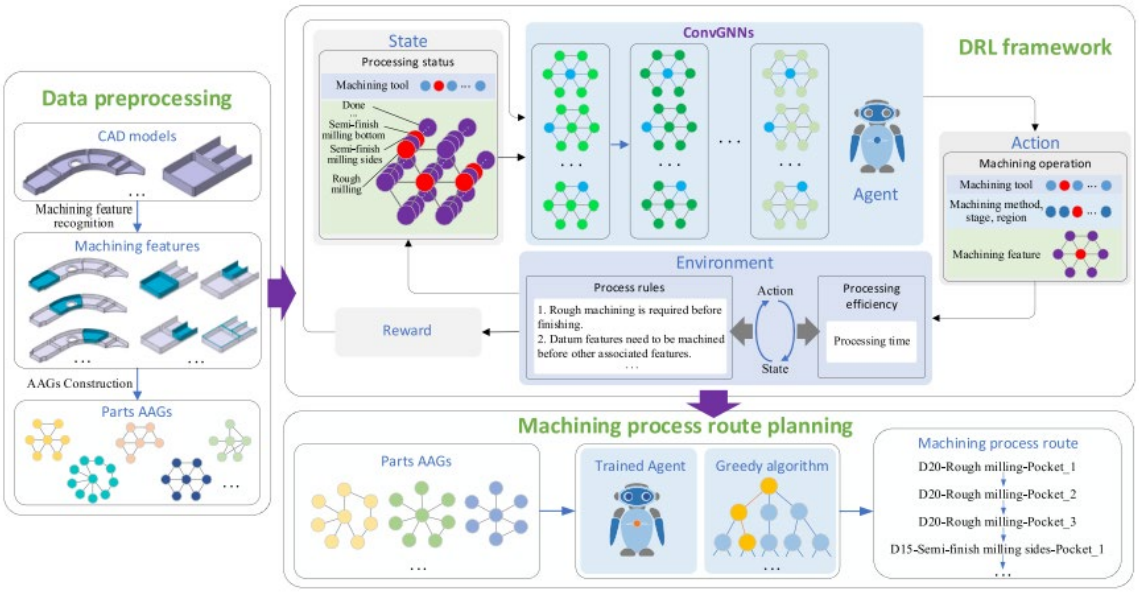

Figure 1 Machining route planning paradigm (Zhang et al. 2024)

This thesis aims to **develop framework paradigm for a novel RL-based approach for identifying appropriate machining operation sequences and parameters**, considering both the geometric complexity of workpieces and manufacturing constraints. Specific research tasks include: **(1)** developing a suitable state and action space representation for machining operations, **(2)** designing an effective reward function that balances multiple objectives including surface

quality, production time, and tool wear, **(3)** implementing and evaluating various RL algorithms for the machining domain, and **(4)** validating the approach through simulation and real-world experiments.

Fusion 360 (Willis et al. 2020) and **ABC** (Koch et al. 2019) datasets will be used for the development of the RL algorithms.

You have

- strong programming skills (Python),
- understanding of machine learning fundamentals,
- basic knowledge of manufacturing processes, and familiarity with CAD/CAM software
- analytical thinking,
- problem-solving abilities,
- writing skills

Supervisors

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References

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