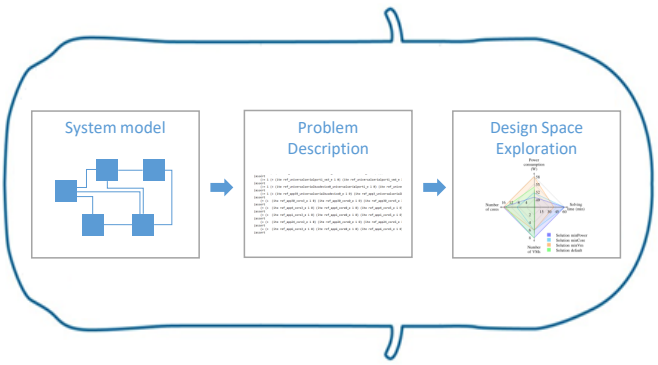
Automated Design Space Exploration for Automotive Resource Allocation

Description

With the increasing number of automotive software and evolving hardware architecture, the design of modern automotive systems has become increasingly complex. To tackle this complexity, the automotive industry is turning to model-based system engineering, which employs formally described system information to enable automated system analysis, including verification and validation. This study focuses on design space exploration for automotive resource allocation [1], which is a challenging task involving various system properties and automotive requirements. Currently, engineers encode this resource allocation problem manually or through pre-defined templates of specific scenarios into mathematical formulations and use state-of-the-art solvers to identify design alternatives [2]. However, the process of writing mathematical formulations is complex and prone to errors. In this study, we propose an automated approach by generating mathematical formulations from formal system model descriptions, enabling engineers to explore design alternatives in a more efficient and accurate way.

Tasks

Your main task is to develop a transformation that automatically generates Mixed-Integer Programming (MIP) optimization problems from formal model descriptions (e.g., EMF/UML models, OCL constraints). You will select suitable optimization engines to solve the generated problems. Furthermore, you will design artificial scenarios to test your implementation. In our previous work, we employed SMT as the problem formulation. A thorough comparison of the previous SMT-based approach and your MIP-based approach should be covered in your thesis.



References

[1] Fengjunjie Pan, Jianjie Lin, Markus Rickert, and Alois Knoll. Resource allocation in software-defined vehicles: ILP model formulation and solver evaluation. In *Proceedings of the International Conference on Intelligent Transportation Systems (ITSC)*, pages 2577–2584, 2022.

[2] Uwe Pohlmann and Marcus Hüwe. Model-driven allocation engineering: specifying and solving constraints based on the example of automotive systems. *Automated Software Engineering*, 26:315–378, 2019.

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Advisor:
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Research project:
MANNHEIM-CeCaS

Type:
BA/MA

Research area:
System engineering, optimization, automotive resource allocation

Programming language:
Java

Required skills:
Object-oriented programming with Java (must have); Experience with Gurobi solver and Eclipse EMF environment (nice to have).

Language:
English

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