# ADVANCES IN CONTROL AND MODEL ORDER REDUCTION FOR SIMULATION SCIENCE

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## ABSTRACT

Advancements in computational science and simulation have revolutionized our understanding and ability to predict complex systems across diverse domains such as engineering, physics, biology, and finance. In particular, *control theory* and its numerical applications are powerful tools to model the dynamic behaviour of complex systems, providing a framework to predict their responses under various conditions and to design strategies that guide these systems towards stabilized and beneficial configurations efficiently and reliably. However, numerical simulations for complex and real-life scenarios often come with a substantial computational cost, creating the need for efficient methods to balance accuracy and performance. *Model order reduction* (MOR) has emerged to address this challenge, allowing efficient system solutions by using low-dimensional representations [1,3].

This mini-symposium aims to bring together experts and researchers working in the fields of numerical methods for control problems [4] and MOR to discuss recent developments, applications, and open challenges in the context of simulation science. Topics of interest include, but are not limited to:

- theoretical advances in reduced-order modeling, including projection-based methods, data-driven techniques, and machine learning surrogate modeling;
- exploration of hybrid approaches combining traditional numerical methods with modern artificial intelligence-driven techniques;

- applications of MOR in large-scale control systems and optimal control strategies, such as fluid dynamics, structural mechanics, climate modeling, and industrial processes;
- numerical methods for *optimal control* problems, including *model predictive control* [2] and general feedback control strategies;
- challenges ensuring stability, robustness, and interpretability in reduced order models and control systems.

By fostering dialogue and collaboration, this mini-symposium aims to identify synergistic opportunities between the numerical issues of control problems and MOR strategies to accelerate computational workflows without compromising accuracy. It seeks to showcase the potential of these methodologies in simulation science, from real-time optimization to scalable solutions for multiphysics problems.

## REFERENCES

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