

Department of Numerical Analysis and Scientific Computing
Simula Research Laboratory
Oslo, Norway

Optimization in Oslo

A Seminar Series on Continuous Optimization

Date:

Wednesday November 9, 2022 at 14:00 (GMT+1, CET)

Speaker:

Prof. Lars Ruthotto
Emory University

Title:

Neural Network Approaches for High-Dimensional Optimal Control

Abstract:

This talk presents recent advances in neural network approaches for approximating the value function of high-dimensional control problems. A core challenge of the training process is that the value function estimate and the relevant parts of the state space (those likely to be visited by optimal policies) need to be discovered. We show how insights from optimal control theory and – in the stochastic case - the fundamental relation between semi-linear parabolic partial differential equations and forward-backward stochastic differential equations can be leveraged to achieve these goals. To focus the sampling on relevant states during neural network training, we use the Pontryagin maximum principle (PMP) to obtain the optimal controls for the current value function estimate. Our approaches can handle both stochastic and deterministic control problems. Our training loss consists of a weighted sum of the objective functional of the control problem and penalty terms that enforce the HJB equations along the sampled trajectories. Importantly, training is unsupervised in that it does not require solutions of the control problem.

We will present several numerical experiments for deterministic and stochastic problems with state dimensions of about 100 and compare our methods to nonlinear optimization approaches and existing approaches.

Brief Bio:

Lars Ruthotto is an applied mathematician developing computational methods for machine learning and inverse problems. He is an Associate Professor in the Department of Mathematics and the Department of Computer Science at Emory University and a member of Emory's Computational and Data Enabled Science Group. He also leads the Emory REU/RET site for Computational Mathematics for Data Science. Prior to joining Emory, he was a postdoc at the University of British Columbia and held PhD positions at the University of Lübeck and the University of Münster. He received an NSF CAREER award and is also supported by grants from the US Israeli Binational Science Foundation, the US Department of Energy's Advanced Scientific Computing Research program, the Air Force Office of Scientific Research, and contracts by Sandia National Laboratories.