Contribution ID: **44** Type: **Student Talk**

Utilizing Machine Learning-optimized Piecewise Polynomial Models in Mechatronics

Tuesday, February 6, 2024 9:30 AM (20 minutes)

The success and fast pace of Machine Learning (ML) in the past decade was also enabled by modern gradient descent optimizers embedded into ML frameworks such as TensorFlow. In the context of a doctoral research project, we investigate how these optimizers can be utilized directly, outside of the scope of neural networks. This approach holds the potential of optimizing explainable models with only few model parameters allowing to derive properties for direct, physical explanation and interpretation, like velocity, acceleration or jerk. This is highly beneficial for use in the field of mechatronics. However, while modern gradient gradient descent optimizers shipped with ML frameworks perform well in neural nets, results show that most optimizers have limited capabilities when applied directly to PP models. Domain-specific model requirements like C^k-continuity, acceleration or jerk limitation as well as spectral or energy optimization pose the need for developing appropriate loss functions, novel algorithms as well as regularization techniques in order to improve optimizer performance.

In this context, we investigate piecewise polynomial models as they occur (and are required) in 1D trajectory planning tasks in mechatronics. Utilizing TensorFlow optimizers, we optimize our PP model towards multi-targeted loss functions suitable for fitting of C^k-continuos PP functions which can be deployed in an electronic cam approximation setting. We enhance capabilities of our PP base model by utilizing an orthogonal Chebyshev basis along with a novel regularization method improving convergence of the approximation and continuity optimization targets. We see a possible application of this approach in Deep Reinforcement Learning applied to Control Theory. By exchanging the black box that is a neural network with an explainable PP model, we foster utility of Reinforcement Learning in designing cyber-physical control systems.

Possible contributed talk

Yes

Are you a student?

Yes

Authors: Mr WACLAWEK, Hannes (osef Ressel Centre for Intelligent and Secure Industrial Automation); Dr HUBER, Stefan (Josef Ressel Centre for Intelligent and Secure Industrial Automation)

Presenter: Mr WACLAWEK, Hannes (osef Ressel Centre for Intelligent and Secure Industrial Automation)

Session Classification: Student Session