

## **From Robot-Assisted Mechanical Experiments to Machine Learning Based Constitutive Models**

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Machine learning offers a data-driven approach to the development of constitutive models as an alternative to classical physics-based modeling. Here, several applications of machine learning in the context of sheet metal forming are evaluated. At the same time, the feasibility and benefits of robot-assisted high through-put experiments in mechanics are discussed. The first application is concerned with the modeling of the rate- and temperature dependent strain hardening of DP steels. It is shown that a neural network model can capture all effects seen in the data on the stress-strain response of a DP800 steel obtained from low, intermediate and high strain rate experiments at temperatures ranging from room temperature to 600°C. In particular, the non-monotonic effect of the temperature on the strain hardening is accurately described by the neural network model. For the second application, a wealth of virtual experimental data on the effect of non-linear strain paths on FLCs is generated through FE-based M-K-simulations. Using a standard backpropagation algorithm, a compact neural network model is trained and tested based on the results from virtual experiments. Even though the experimental data base includes only a finite number of random loading paths, the results show that the neural network model is able to predict the FLCs for a wide range of pre-straining histories. In a third application, a neural network based ductile fracture model is presented to describe the effects of temperature, strain rate and stress state on the fracture strains of aluminum alloys during hot stamping.