Applying machine learning algorithms to fit shock-wave data with fluid dynamics simulations

Dyachkov S A[1,2,@] **and Grigoryev S Yu**[1]

[1] Dukhov Research Institute of Automatics (VNIIA), Sushchevskaya 22, Moscow 127055, Russia

[2] Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow 125412, Russia

[@] sergei.dyachkov@phystech.edu

Nowadays machine learning is applied in many fields of science and engineering. The aim of machine learning is to develop a model with a set of controllable parameters which would approximate data with the desired precision. By adjusting the model architecture and learning algorithm one may achieve an outstanding prediction capabilities for data of any complexity.

Computer simulations of high energy density physics problems, such as shock waves, explosions, interaction with intense laser pulses with fluid dynamics methods require both the specific numerical methods and high quality material models. The growing amount of experimental data for materials at extremes, on the one hand, allows to develop more comprehensive models, but one the other hand, it becomes more difficult to unite all the data within a model. Thus, the continuous improvement of material models require automated algorithms which adjust model parameters to fit both direct and indirect measurements.

In this study we developed a machine learning framework to adjust model parameters using wave profiles data obtained in plate impact tests. The optimization algorithm gradually changes the parameters of a material model with each continuum mechanics simulation of plate impact tests until all the wave profiles come into an agreement with experimental ones. The procedure is tested for adjusting the parameters of equations of state, elastic-plastic, failure, and spallation models. Such automated algorithm may be used with the shock-wave databases for continuous refining of material models.