Neural network implementation for optimization problem of the non-uniform duct shape

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There are situations in practical and research activities, when it's necessary to choose the most appropriate variant among a variety of alternatives using criteria called target function. In this case, we are talking about solving optimization problem.

The target function calculation in the non-uniform duct shape optimization is a resource-intensive procedure that requires CFD simulation. Feed forward neural network implementation for reducing optimization algorithm execution time approach is considered in this work. The neural network is used for estimation of the target function. The network was trained on dataset with the following structure: vector of unknowns (11 values) and vector of target values containing mathematical expectation and variance of Mach number distribution on axis and output. Adam algorithm [1] was used for training.

The target vector determination for the dataset was based on RANS-calculations results for gas flow using finite volume method in stationary formulation. The gas is perfect, viscous and thermally conductive. The channel wall was described using Bezier curve. The coordinates of reference points of the curve in a dimensionless form were used in the vector of unknowns.

The optimization problem was solved using differential evolution algorithm [2]. Numerical experiment shows that using this approach makes it possible to find optimal solution faster and with an accuracy comparable to using a complete gas dynamic calculation.

[1] Kingma D P and Ba J L 2015 *3rd Int. Conf. for Learning Representation*
[2] Randall M 2011 *IJMheur* **1**(4) 279–297