An Automated Machine Learning and Tuning (AutoML)-Physics Informed Neural Network (PINN) for Predicting Nanofluid Flow and Thermal Characteristics

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ABSTRACT

Accurate prediction of nanofluid transport integrating thermal boundary layer characteristic is vital for enhancing the performance of advanced cooling systems and energy transport technologies. Motivated by these applications, the current investigation proposed an automated machine learning and tuning (AutoML)-based hyperparameter optimization integrated with physics informed neural network (PINN) to analyse nanofluid flow over a rotating disk geometry. The modelled coupled problem describing the momentum and heat transfer are transformed into a system of ordinary differential equations (ODEs) via suitable similarity transformation. The resulting system is handled using AutoML-optimized PINN model through Python and trained with the Adam optimizer. The optimal network model is identified as seven hidden layers with a tangent hyperbolic activation function, a learning rate $6.0933*10^{-4}$, and a batch size 47 over 4804 training epochs. The predictive results show excellent agreement with the classical Runge-Kutta technique, validating the correctness of the proposed approach. The analysis of error reveals a low deviation in the order of 10^{-5} to 10^{-8} across the parametric range.

Keywords: Nanofluid flow; rotating disk; Physics informed neural network; Hyperparameters optimization