Artificial Neural Networks as Predictive Tools in Machining

Sai Manish Mekarthy and **Harish P. Cherukuri**

Department of Mechanical Engineering and Engineering Science
The University of North Carolina at Charlotte
Charlotte, NC 28223-0001, USA

In machining, prediction of specific cutting forces and maximum tool temperatures are essential for process planning and increasing tool life. These quantities depend on many parameters, such as the cutting speed, rake angle, tool-tip radius,uncut chip thickness. The finite element method (FEM) is the tool of choice for understanding the effect that these parameters have on the forces and temperatures. However, the simulations, even in the context of a two-dimensional orthogonal machining model, are time-consuming and thus, it is difficult to generate sufficient data that covers the entire parametric space of practical interest. The purpose of this work is to present, as a proof-of-concept, a hybrid methodology that combines the finite element method and machine learning to predict specific cutting forces and maximum tool temperatures for a given set of machining conditions. The finite element method (FE method) was used to determine specific cutting forces and maximum tool temperatures for several different combinations of uncut chip thickness, cutting speed and the rake angle. This data was then used to build a predictive model using artificial neural networks (ANNs). The neural network modeling was performed using Python with Adam as the training algorithm. Both shallow neural networks (SNNs) and deep neural networks (DNNs) were built and tested with various activation functions. The optimal neural network architecture along with the activation function that produced the least error in prediction was identified. Validation of the model was carried out by comparing the predictions with experimental data. The sensitivity of the output parameters to the input features was also studied.