Proceedings of the Canadian Society for Mechanical Engineering International Congress 2021
CSME Congress 2021
June 27-30, 2021, Charlottetown, PE, Canada

Parameter Estimation of Groundwater Virus Transport using Deep Neural Network

M. Shamsuzzaman[1*], M. G. Satish[2]
[1]Division of Engineering, Saint Mar's University, Halifax, Canada
[2]Department of Civil and Resource Engineering, Dalhousie University, Halifax, Canada
*md.shamsuzzaman@smu.ca

ABSTRACT

The fields of machine learning (ML) and artificial intelligence (AI) are rapidly expanding, impacting nearly every technological aspect of society. Fluid flow in porous media is ubiquitous and the study of this field is rapidly advancing, driven by unprecedented volumes of data from field measurements, experiments, and largescale simulations at multiple spatiotemporal scales. ML/AI offers a wealth of techniques to extract information from data that could be translated into knowledge about the underlying phenomena. Moreover, machine learning algorithms can augment domain knowledge and automate tasks related to flow control and of optimization. This article presents an overview of emerging applications of ML/AI in porous media flow. It outlines fundamental ML/AI methodologies and discusses their uses for understanding, modeling, optimizing, and controlling fluid flows in porous media. The strengths and limitations ML/AI methodologies are briefly addressed in this context related to modeling, experimentation, and simulation. To show the efficacy of this approach, parameter estimation of groundwater virus transport using different deep neural network models are considered.

There has been a recent surge of interest in applying deep learning using convolutional neural networks (CNNs) for machine learning problems in the areas of speech recognition, image and natural language processing. Deep CNNs have consistently outperformed baseline mathematical models with prediction accuracies and even surpassed human level performance. However, despite their excellent performance, CNN structures are not suitable to capture dynamical system (or, sequential and time-series data with dependencies), including groundwater transport problems. It is shown in the literature that the recurrent neural networks (RNN) types of structures are more suitable for the later type of problems but suffer from lower efficiency. Although, introduction to more recent addition to RNN resulting in long-short term memory (LSTM) improves the performance significantly, still it is not close to that of the CNNs. In this article, we convert the results from groundwater virus transport simulation to an image-like template and utilize CNN structure to estimate the parameters of the given problem. Our preliminary results show promising outcomes.