Machine learning methods for wastewater hydraulics

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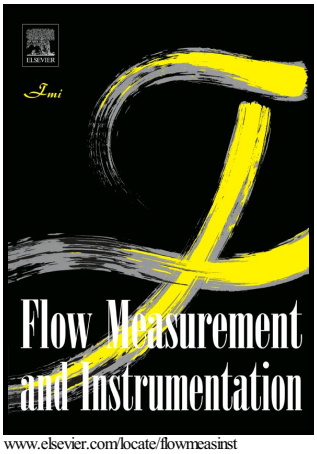

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Abstract

Wastewater hydraulics problems are frequently addressed by investigation on physical models. Dimensional analysis is a powerful tool that allows discovering essential information about the investigated phenomenon, but in some cases it is affected by significant limitations. In such cases, many issues can be addressed by means of machine learning algorithms, resulting from the theories on pattern recognition and computational learning. In order to show the potential of such an approach, in this study Regression Tree M5P model, Bagging algorithm and Random Forest algorithm were applied to the solution of some complex problems of wastewater engineering: the prediction of energy loss, the pool depth, the air entrainment in a drop manhole, and the forecasting of the lateral outflow in a low crested side weir. The algorithms were trained and tested on data obtained from experimental tests that were carried out at the Water Engineering Laboratory of the University of Cassino and Southern Lazio. In most of the considered cases, regression trees and ensemble methods were able to provide very accurate predictions.

Keywords: machine learning, tree model, Bagging, Random Forest, wastewater hydraulics, drop manhole, side weir, experimental research

Introduction

The hydraulic engineering problems can be addressed by different approaches: by theoretical models, by experimental studies or by experience on similar problems [1]. From an analytical point of view, the equations used in hydraulic calculations arise from three principles of conservation. The complexity factors affecting many practical cases of motion of fluids limit the effectiveness of a purely theoretical approach. Therefore, physical models are needed to achieve reliable solutions. Scientific investigation on physical models is based on the theory of similarity between the