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Neuroevolution Based on Adaptive Ensembles of Biologically Inspired Optimization Algorithms Applied for Modeling a Chemical Engineering Process

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Abstract : Neuroevolution is a subfield of artificial intelligence used to solve various problems in different application areas. Specifically, neuroevolution is a technique that applies biologically inspired methods to generate neural network architectures and optimize their parameters automatically. In this paper, we use different biologically inspired optimization algorithms in an ensemble strategy with the aim of training multilayer perceptron neural networks, resulting in regression models used to simulate the industrial chemical process of obtaining bricks from silicone-based materials. Installations in the raw ceramics industry, i.e., bricks, are characterized by significant energy consumption and large quantities of emissions. In addition, the initial conditions that were taken into account during the design and commissioning of the installation can change over time, which leads to the need to add new mixes to adjust the operating conditions for the desired purpose, e.g., material properties and energy saving. The present approach follows the study by simulation of a process of obtaining bricks from silicone-based materials, i.e., the modeling and optimization of the process. Optimization aims to determine the working conditions that minimize the emissions represented by nitrogen monoxide. We first use a search procedure to find the best values for the parameters of various biologically inspired optimization algorithms. Then, we propose an adaptive ensemble strategy that uses only a subset of the best algorithms identified in the search stage. The adaptive ensemble strategy combines the results of selected algorithms and automatically assigns more processing capacity to the more efficient algorithms. Their efficiency may also vary at different stages of the optimization process. In a given ensemble iteration, the most efficient algorithms aim to maintain good convergence, while the less efficient algorithms can improve population diversity. The proposed adaptive ensemble strategy outperforms the individual optimizers and the non-adaptive ensemble strategy in convergence speed, and the obtained results provide lower error values.

Keywords : optimization, biologically inspired algorithm, neuroevolution, ensembles, bricks, emission minimization
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