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A Hybrid-Evolutionary Optimizer for Modeling the Process of Obtaining Bricks

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Abstract : Natural sciences provide a wide range of experimental data whose related problems require study and modeling beyond the capabilities of conventional methodologies. Such problems have solution spaces whose complexity and high dimensionality require correspondingly complex regression methods for proper characterization. In this context, we propose an optimization method which consists in a hybrid dual optimizer setup: a global optimizer based on a modified variant of the popular Imperialist Competitive Algorithm (ICA), and a local optimizer based on a gradient descent approach. The ICA is modified such that intermediate solution populations are more quickly and efficiently pruned of low-fitness individuals by appropriately altering the assimilation, revolution and competition phases, which, combined with an initialization strategy based on low-discrepancy sampling, allows for a more effective exploration of the corresponding solution space. Subsequently, gradient-based optimization is used locally to seek the optimal solution in the neighborhoods of the solutions found through the modified ICA. We use this combined approach to find the optimal configuration and weights of a fully-connected neural network, resulting in regression models used to characterize the process of obtained bricks using silicon-based materials. Installations in the raw ceramics industry, i.e., bricks, are characterized by significant energy consumption and large quantities of emissions. Thus, the purpose of our approach is to determine by simulation the working conditions, including the manufacturing mix recipe with the addition of different materials, to minimize the emissions represented by CO and CH_4. Our approach determines regression models which perform significantly better than those found using the traditional ICA for the aforementioned problem, resulting in better convergence and a substantially lower error.

Keywords : optimization, biologically inspired algorithm, regression models, bricks, emissions
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