Discrete fractional-order plant absorption of carbon dioxide: Analysis by artificial intelligence

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Abstract: A nonlinear mathematical model is proposed to examine the role of plants with varying abilities to absorb atmospheric carbon dioxide (CO_2) and its broader ecological impacts. Different plant species exhibit distinct CO_2 absorption capacities, which can significantly influence the overall reduction in atmospheric CO_2 levels. The study aims to analyze how disparities in plant absorption capacities affect atmospheric CO_2 concentrations, with a particular focus on the influence of plant growth and harvesting rates. The model is formulated using a discrete difference operator, facilitating a numerical exploration of the system's dynamics. A hybrid computational framework is employed, namely, the Discrete Numerical Iterative Method integrated with the Levenberg–Marquardt neural network algorithm (DNIM-LM). Artificial intelligence techniques are used to assess model performance, including training progress, error distribution, regression accuracy, and overall fitness. The dataset is partitioned into 70% for training, 15% for validation, and 15% for testing. The results reveal that plant species with higher CO_2 absorption capacities lead to more rapid decreases in atmospheric CO_2 as their growth rates increase. Conversely, higher harvesting rate coefficients are associated with increased atmospheric CO_2 concentrations. The study concludes that differences in plant absorption abilities significantly shape the dynamic behavior of atmospheric CO_2 reduction. These findings underscore the critical role of plant growth and harvesting practices in regulating CO_2 levels, offering valuable insights for ecosystem management and carbon sequestration strategies.

Keywords: Plants model; Discrete operator; Neural networks; training performance; Regression.