Neural network-based IV curves analysis: A Fast Hybrid Method for Extracting One-Diode Model Parameters

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This communication aims to present the objectives and preliminary results of a student project focused on developing an artificial intelligence (AI)-based tool for fast and accurate extraction of key parameters from current-voltage (IV) curves of photovoltaic cells using the one-diode model.

Objectives: The project is based on a hybrid approach combining machine learning and numerical optimization. The AI is used to perform a near-instant pre-fit of the IV curve, which is then refined through gradient descent using optimal initial conditions. This method targets the estimation of four key parameters of the one-diode model: the series resistance (Rs), the shunt resistance (Rsh), the diode saturation current (J_0), and the diode ideality factor (n). The approach enables near-instantaneous parameter extraction, meeting a real need for scalable and real-time photovoltaic performance analysis.

Preliminary results: On synthetic datasets generated from the one-diode model, the relative error is below 0.75% for each of the four parameters. Tests on experimental IV curves show results that are highly consistent with those obtained using classical fitting methods, while drastically reducing computation time. A web platform is currently under development, allowing users to input IV curves and automatically retrieve the four parameters, along with a detailed analysis of prediction quality and data consistency. The current model is trained on a specific type of solar cell, but the next step is to offer a flexible tool enabling each laboratory to train its own tailored AI, adapted to their specific technologies and measurement conditions.