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Optimization of Agricultural Management for Soil Carbon Sequestration UsingDeep Reinforcement Learning and Large-Scale Simulations

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Soil carbon sequestration in croplands has tremendous potential to help mitigate climate change; however, it is challenging to develop the optimal management practices for maximization of the sequestered carbon as well as the crop yield. We aim to develop an intelligent agricultural management system using deep reinforcement learning (RL) and large-scale soil and crop simulations. To achieve this, we build a simulator to model and simulate the complex soil-water-plant-atmosphere interaction, which will run on high-performance computing platforms. Massive simulations using such platforms allow the evaluation of the effects of various management practices under different weather and soil conditions in a timely and cost effective manner. By formulating the management decision as an RL problem, we can leverage the state-of-the-art algorithms to train management policies through extensive interactions with the simulated environment. The trained policies are expected to maximize the stored organic carbon while maximizing the crop yield in the presence of uncertain weather conditions. The whole system is tested using data of soil and crops in both mid-west of the United States and the central region of Portugal. Our study has great potential for impact on climate change and food security, two of the most significant challenges currently facing humanity.