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LEVERAGING LARGE MODELS FOR CROP PRODUCTION INDEX PREDICTION THROUGH REMOTE SENSING DATA: A NEW CHAPTER TOWARDS SUSTAINABLE AGRICULTURE

Abstract

As global population growth intensifies and the impacts of climate change on agricultural production become increasingly evident, the need for precise monitoring and forecasting of agricultural production indices has never been more critical to ensuring food security and advancing sustainable agricultural practices. This paper introduces a novel approach through the development of large models derived from remote sensing data, aimed at accurately predicting and monitoring pivotal agricultural indices. Drawing inspiration from advanced model training techniques in language processing, we pioneered the pre-training of a large model utilizing data reconstruction on an extensive dataset of unlabeled remote sensing imagery. Specifically, our approach leverages a Transformer-based model, renowned for its superior feature extraction capacity and proficiency in managing long-range dependencies. Owing to its self-attention mechanism, the model adeptly discerns the intricate spatial and temporal correlations within the remote sensing data, establishing a robust groundwork for precise future predictions. Following the pre-training phase, the model was carefully fine-tuned for various agricultural index subtasks. These subtasks included crop area delineation, crop area and yield estimation, and reservoir water level monitoring. We validated our methodology through an experimental analysis using various remote sensing datasets from South Dakota in 2020. This dataset included Sentinel-1 radar and Sentinel-2 imagery, ERA5 temperature and precipitation data, and elevation and vegetation indices. The performance of the method was underscored by the classification of different land covers, including corn and soybeans, with F1 scores for these crops reaching 87.04% and 86.06%, respectively, demonstrating the potential of the large remotely sensed model in predicting and monitoring agricultural production indices. This research illuminates the powerful role of advanced remote sensing technologies and big data analytics in providing new insights and tools for the global monitoring and prediction of agricultural output. Beyond offering scientific validation and technical support for improving agricultural productivity and sustainability, our findings pave new avenues for research and strategic decision-making in the domain.