



# Enhancing Crop Classification and Yield Estimation through Satellite Imagery and Machine Learning

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## DESCRIPTION

Satellite imagery and machine learning are two powerful technologies that can be used for crop classification and yield estimation, which are important tasks for agricultural management and food security. Crop classification is the process of identifying and mapping different types of crops in a given area, while crop yield estimation is the process of predicting the amount of crop production per unit area. Both tasks can benefit from the use of satellite imagery and machine learning, as they can provide large-scale, high-resolution, and timely information that can complement or replace traditional methods such as field surveys and statistical models.

Satellite imagery is the collection of images of the Earth's surface taken by satellites orbiting the planet. Satellite imagery can provide various types of information about crops, such as spectral, spatial, temporal, and angular characteristics. Spectral information refers to the reflectance or emission of electromagnetic radiation by crops at different wavelengths, which can indicate their physiological and biochemical properties. Spatial information refers to the size, shape, and arrangement of crops on the ground, which can indicate their type and density. Temporal information refers to the changes in crop characteristics over time, which can indicate their growth stage and phenology. Angular information refers to the viewing angle of crops from the satellite, which can affect their appearance and reflectance.

Machine learning is the branch of artificial intelligence that deals with creating algorithms and models that can learn from data and perform tasks such as classification, regression, clustering, etc. Machine learning can be used to analyze satellite imagery and extract useful information for crop classification and yield estimation. Machine learning algorithms can be divided into two main categories: Supervised and unsupervised. Supervised algorithms require labeled data, i.e., data with known outputs or targets, to train and test their models. Supervised

algorithms can be used for crop classification, as they can learn to assign labels (e.g., crop types) to satellite images based on their features (e.g., spectral, spatial, temporal, angular). Unsupervised algorithms do not require labeled data, but rather try to find patterns or structures in the data without any prior knowledge. Unsupervised algorithms can be used for crop yield estimation, as they can learn to predict outputs (e.g., crop yields) from satellite images based on their features.

There are many examples of how satellite imagery and machine learning have been used for crop classification and yield estimation in different regions and contexts. For instance presents a review of deep learning techniques applied to UAV imagery for crop classification. Deep learning is a subfield of machine learning that uses neural networks with multiple layers to learn complex and nonlinear relationships from data. The authors review various CNN-based (Convolutional Neural Network) methods applied to UAV-based remote sensing image analysis for crop classification, such as ResNet, DenseNet, U-Net, SegNet, etc. They also discuss the challenges and potential solutions for improving the performance of deep learning-based algorithms for crop classification from UAV imagery.

Another example is, which proposes a method for crop yield estimation using decision trees and random forest machine learning algorithms on data from Terra (EOS AM-1) and Aqua (EOS PM-1) satellite data. Decision trees are simple yet powerful machine learning algorithms that use a tree-like structure to split the data into smaller subsets based on certain criteria or rules. Random forest is an ensemble method that combines multiple decision trees to reduce overfitting and improve accuracy. The authors use DSSAT (Decision-Support System for Agrotechnology Transfer) simulation model to estimate crop yield for the period from 1981 to 2025 using datasets from India Meteorological Department (IMD) and National Oceanic and Atmospheric Administration (NOAA). They then use decision trees and random forest algorithms to predict crop yield from MODIS data from Terra and Aqua satellites. They validate their

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results by comparing them with NDVI (Normalized Difference Vegetation Index) values, which are indicators of vegetation health and biomass.

In conclusion, satellite imagery and machine learning are valuable tools for crop classification and yield estimation, as they

can provide accurate, timely, and scalable information that can support agricultural management and food security. However, there are also challenges and limitations that need to be addressed, such as data availability and quality, computational complexity and cost, algorithm selection and evaluation, etc.