1. **Introduction**

Conservation tillage management has been advocated for the purpose of soil preservation and sustainable crop production. Conservational tillage practice induces less surface disturbance and leaves more crop residues, which can decrease runoff rate, improve soil and water quality, and increase organic matter. The demand for the mapping of crop tillage practices has been brought up for precision agricultural management and appraisal. However, current methods for mapping massive crop tillage practices are mainly done with field investigations, which are labor costing, time consuming, subjective, and make it difficult to generate widely distributed survey data. Remote sensing technology provides a more rapid, accurate, and objective solution. Moreover, the vast data from remote sensing in agriculture require more efficient approaches in data analytics, including tillage mapping, in support of management decisions.

Recently, hyperspectral remote sensing has gained attention in the remote sensing application community. Hyperspectral imaging generates hundreds of images corresponding to different wavelength channels for the same area on the surface of the earth. A hyperspectral image is a 3-D cube of data with the width and length of the array corresponding to the spatial dimensions and the continuous spectrum of each point as the third dimension, which enables discrimination of materials based on their spectral characteristics. One of the most important applications of hyperspectral data is image classification, where pixels are labeled to one of the classes based on their spectral characteristics.

However, due to the large amount of data, high correlation between bands, directly conducting the classification not only results in slow classification speed but also low classification accuracy. Besides, hyperspectral data also present difficult challenges for supervised statistical classification, where labeled training data are used to estimate the parameters of the conditional probability density functions. In fact, the dimensionality of the data is high while the quantity of training data is often small. Taking into account of these factors, the feature extraction is often conducted to reduce the dimension of hyperspectral image prior to the classification.

1. Problem formulation

The hyperspectral image classification task is perfectly suitable to be modeled as a machine learning problem. Each pixel of the hyperspectral image is a sample in this problem. For each pixel, it contains 200 spectral bands, so there are 200 attributes for each sample. Consider the physical meaning of the spectrum, all the feature values are 0-1, and we scale them by multiplying 1000 so that all the feature values are integer.

The objective of this project is using different classifier for hyperspectral image classification. The problem is challenging because the feature space is high dimensional (200 dimensions) with limited number of labeled data. Furthermore, it is a multi-class (16 classes) classification problem.