Assessing Time-Weighted Dynamic Time Warping as a method for Land Cover Classification utilizing NASA Satellite Imagery

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Overview/Introduction
Food security is a global concern due to a changing climate, which has increased uncertainties with regard to weather patterns and water availability. As a result, there is a focus on monitoring agricultural fields to determine if there is an optimal amount of food production, and quantifying change over time. In this study, I assess time-weighted dynamic time warping (TWDTW) as a method to classify land cover, utilizing normalized difference vegetation index (NDVI) composites created from NASA’s Landsat 7 satellite imagery. This method is scalable over area, time, and location. These results can be used to differentiate between vegetation classes in a supervised classification framework.

Methodology

The figure above shows the aspects of phenology that are used to distinguish different vegetation types. The phenology of the land cover types in this analysis were determined by taking the average NDVI values from the ground truth points representing each land cover.

Ground truth points with land cover info
Landsat 7 8-day NDVI composites
Timeline for time series imagery
Phenology for each land cover

Apply temporal patterns to time series NDVI composites taken from Landsat

Time-weight function

Land Cover Classification

The left figure shows a land cover classification created by the TWDTW method over a study area of Grinnell, Iowa. The urban area was correctly identified, and the method also distinguished the natural grassland on the west side of town from the agricultural land east of town. The center figure is a Landsat 7 satellite image of the study area for reference. The right figure is a heat map for likeliness to be developed land over the study area. Red areas indicate a high likeliness to be developed land, and blue areas are unlikely to be developed.

Key Findings

- Developed areas, grassland areas, and cropland areas are well distinguished by the method within the selected study area.
- The major source of error with the TWDTW classification method is between crops with similar phenology, in this case study corn and soybeans.
- The result from this method were compared to the NASS Cropland Data Layer by creating random points over the study area and extracting the land cover values. Approximately 2/3 of the points were classified as the same land cover by both methods.

Impact/Future Research

- Grassland to cropland conversion, a major area of study due to its climatological effects, can be studied using this method because of the strong differentiation in phenology between grassland and cropland.
- Time series imagery from space borne satellites is an integral component for supervised land cover classifications.
- Future research will include incorporating additional indices into the method as opposed to just using NDVI, and exploring using NASA satellites with higher spatial resolution for more accurate results.

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