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Harness Satellite Observations and Deep Learning to Identify the Irrigated Fields

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Project title: Harness Satellite Observations and Deep Learning to Identify the Irrigated Fields

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Project Summary: Irrigation in Alabama even with limited acreage could be a substantial water consumer. As irrigated acreage grows, assessing and managing the increased water demand is likely to be one of the largest and most important challenges facing water resource management in the State.

While the Alabama Water Use Reporting Program provides Alabama with a system for registering agricultural water users and collecting annual water use data, a good inventory of irrigated acreage in Alabama is somewhat limited. As part of Alabama's efforts to both promote irrigation AND protect our water resources; detailed information about water users (and their locations) is critical. The current survey has highly relied on the visual interpretation of center pivot systems and the delineation of the irrigated cropland from high-resolution airborne imagery, such as the National Agriculture Imagery Program (NAIP) (Fig.1). However, the interpretation process is usually time-consuming and labor-intensive. Great efforts have been made in promoting the accuracy of automatically detecting the center pivot systems from the spectral features of irrigated and non-irrigated cropland. Challenges exist, particularly in the southern States. The similar signals from irrigated areas and its adjacent non-irrigated field (e.g., lower-left corner of the image) largely contribute to misclassification errors by using the traditional semi-automatic classification approaches from the satellite images.

Figure 1 Clearly visible center pivot systems using NAIP, and the results of visual identified irrigated field

The primary goal of this project is to implement a Deep Learning approach (DL), e.g., convolutional neural network over different regions of Alabama from vegetation signature, such as enhanced vegetation index (EVI) from existing NASA products. We will use the temporal anomaly of EVI values to identify the irrigated field, typically the irrigated crops show a higher EVI (healthier) under the normal and drought conditions. The initial experiment over two counties in Alabama have shown a promising result. The project will test and implement the existing models to other counties over entire Alabama. The outcome of this project will be possible to be used to enhance the future Alabama irrigated acreage survey, which can improve the efficiency of investigation over a large area and help the State manage the water demand in the agriculture system. This proposed project can benefit the student from understanding the real-world challenge, and we provide she/he a vehicle to learn and implement multidisciplinary techniques to solve the problems.

Student Duties, Contributions, and Outcomes

The project consists of three specific research activities during the 10-week summer term, which will combine the basic training of literature review, satellite data manipulation, implementation of the proposed methods, and assessment of the results.

Task 1: The student will under the supervision of Dr. Hu to get familiar with the principle of satellite observations and remotely sensed vegetation properties through literature review (~10 papers). Through this learning process, the student will also be trained to display and manipulate the satellite images and prepare the data for the DL application. The student will feel comfortable working with the raster and vector geographic data.

Task 2: The student is expected to implement the DL model in a programming environment. Dr. Zhang and his graduate student will assist the student to learn how to run the existing case and apply the trained model to other counties in AL. Through the experiment, the study will have a deeper understanding of the structures and parameters of one or two DL approaches.

Task 3: The student will gain quantitative and qualitatively analysis skills to validate the model output with the "ground-truth" (independent survey) data. Finally, the student will summarize the assessment and document the results in a report.

Student Selection Criteria:

Students who are interested in this topic and have basic knowledge of math (statistics) and programming skills (e.g., Python, R, or equivalent programming languages), and some basic experiences of raster data are encouraged to apply.

Mentor Supervision and Interaction:

Drs. Hu, Zhang, and Handyside will co-supervise the participant on this project and will have weekly or biweekly meetings with the student (depending on the stage of the project) to discuss the project progress and help solve specific problems. Through the summer project, the student will work in a collaborative environment and interact with faculty members and graduate students. She/he will gain basic research experience in collecting, processing and analyzing data. Dr. Hu will provide guidance on scientific writing, critical thinking, and other assistance that is pertinent to her/his career development. The student will have opportunities to present the results in a group meeting and scientific conference. A final report that summarizes research activities and related research results are required at the end of the term.