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Agricultural Land Image Classification using Recurrent Neural Network and compare with KNN for Feature Extraction

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ABSTRACT

It's clear that agricultural research has been picking up steam and expanding rapidly during the last several years. The newest innovations, which make use of a variety of computational technologies, simplify the process of farming. We have utilized satellite imagery of land, including photographs of forests, farms, cities, and wilderness areas, to carry out this study. Very few research, including none that focus on the Sentinel-2 Multispectral Imager, have examined the performance of these classifiers with various training sample sizes on the same remote sensing pictures (MSI). Using Sentinel-2 satellite imagery, we analyzed the accuracy of the RF, kNN, and SVM classifiers in identifying different types of land use and cover. Training samples ranged from 50 to over 1250 pixels/class and were both balanced and unbalanced throughout a 30 x 30 km2 region in Vietnam's Red River Delta that had six distinct land use/cover categories. Overall accuracy (OA) was quite high, ranging from 90% to 95%, across the board for all categorization findings. SVM generated the greatest OA with the least sensitivity to the training sample sizes across the three classifiers and 14 sub-datasets. RNN and kNN followed in that order. When the training sample size was big enough, i.e., more than 750 pixels/class or representing an area of about 0.25% of the overall research area, all three classifiers exhibited a comparable and high OA. Both skewed and symmetrical datasets yielded the same high accuracy.

KEY WORDS: land use classification; supervised classification; nearest neighbors; agricultural land cover; crops.

1. INTRODUCTION

Within the scope of this research study, we investigated the use of high spatial and temporal resolution Sentinel-1 remote sensing data for a variety of agricultural land cover mapping applications and evaluated recent advances in deep learning methods. We suggested using two deep RNN techniques, both of which were applied on the Camargue area, in order to explicitly account the temporal correlation of Sentinel-1 data. These approaches were used to analyze the data. We showed that excellent classification performance could be obtained using Sentinel-1 SAR image time series using traditional methods such as KNN, RF, and SVM. These methods were proved by our work. We conducted an experiment to demonstrate that employing recurrent neural networks to process SAR

Sentinel-1 time series data results in a consistent improvement in agricultural classifications when compared with traditional machine learning approaches. This was demonstrated through the use of the term "consistent." The experiments demonstrate the utility of a particular category of deep learning models known as RNNs. These models take into account the temporal correlation of the data in order to differentiate between agricultural classes of land cover, which are typically characterized by similar but complex temporal behaviors.

2. LITERATURE SURVEY

2.1 Mapping and monitoring of rice crops via the use of ERS-1 data, based on the findings of experiments and models

T. Le Toan, F. Ribbes, and Li-Fang Wang are its authors: In order to conduct rice monitoring programs and research on the emission of methane from flooded rice fields, it is required to have information on the rice growing regions as well as the circumstances under which rice grows. This study's purpose is to evaluate the usefulness of ERS-1 SAR data in mapping rice growing regions and retrieving rice parameters. The technique begins with a synthesis of experimental findings obtained at two separate test regions. Next, a theoretical model is developed to explain the observations based on the synthesis. The analysis of experimental data gathered from two different test areas—one in a tropical climate with short cycle rice (Semarang, Indonesia) and another in a temperate climate with long cycle rice (Akita, Japan)—revealed that flooded rice fields have distinctive radar responses that increase in frequency over time. The influence of cultural practices and climate (long cycle vs short cycle) is mitigated when the radar backscattering coefficients are reported as a function of the rice biomass. The data have been analyzed using a theoretical model, which is based on an accurate description of rice plants and which takes into account the effects of backscattering amplification and clustering brought about by the scatterers. The experimental data and the theoretical findings have been found to accord with one another rather well. Rice fields show a significant amount of temporal variation in their radar responses because of the wave-vegetation-water interaction, which becomes more prominent when the crop transitions from the transplanting stage to the reproductive stage. The duration of the rice cycle or the rice types have demonstrated to have negligible influence on the temporal curve when simulated using the validated model. The temporal fluctuation of the radar response between two acquisition dates has inspired the development of a technique for mapping rice fields. This technique is based on the idea that the radar response changes over time. In addition to this, the inversion of SAR pictures into plant height and plant biomass has been carried out. The outcomes of this investigation seem to hold promise for the use of ERS-1 and RADARSAT data to the monitoring of rice.

2.2 Sentinel-2 is an Optical High-Resolution Mission for GMES Operational Services. This mission is operated by the European Space Agency.

Drusch, M.; Bello, U.D.; Carlier, S.; Colin, O.; Fernandez, V.; Gascon, F.; Hoersch, B.; Isola, C.; Laberinti, P.; Martimort, P.; et al. The Global Monitoring for Environment and Security (GMES) program is a collaboration between the European Commission (EC) and the European Space Agency (ESA), with the goal of establishing a European capacity for the provision and use of operational monitoring information for applications related to the environment and security. Within the framework of GMES, the European Space Agency (ESA) is responsible for the specification and development of the space- and ground-related system components. The GMES Sentinel-2 mission ensures that services that depend on multi-spectral, high-resolution optical observations of the world's terrestrial surfaces will continue uninterrupted. The primary goals of the Sentinel-2 mission are as follows: (1) To provide systematic global acquisitions of high-resolution multi-spectral imagery with a high revisit frequency; (2) to provide enhanced continuity of multi-spectral imagery provided by the SPOT (Satellite Pour l'Observation de la Terre) series of satellites; and (3) to provide observations for the next generation of operational products such as land-cover maps, land change detection maps, and geophysical variables. Sentinel-2 is scheduled to begin operations in As a consequence of this, Sentinel-2 will provide an indirect contribution to the services of Land Monitoring, Emergency Response, and Security. The associated user needs have pushed the design in the direction of a reliable multi-spectral Earth-observation system. This system will include the Multi Spectral Instrument (MSI), which will contain 13 spectral bands ranging from the visible to the near infrared to the short wave infrared. With a field of vision of 290 kilometers, the spatial resolution may range anywhere from 10 meters to 60 meters, depending on the spectral band. In comparison to other multi-spectral missions, this one-of-a-kind combination of high spatial resolution, broad field of view, and spectrum coverage will constitute a significant advancement. The plan calls for the deployment of many satellites, each of which will have a lifespan of 7.25 years, over a span of 15 years, beginning with the launch of Sentinel-2A, which is anticipated to take place in 2013. During normal operations, two identical spacecraft will be kept in the same orbit with a phase delay of 180 degrees to provide a revisit period of five days near the equator. This will be done while the satellites will be operating at full capacity. In this document, an overview of the GMES Sentinel-2 mission is presented, which covers topics such as picture quality, Level 1 data processing, and operational applications.

2.3 An analysis and overview of several image classification methods and approaches for the purpose of enhancing classification performance

D. Lu and Q. A. Weng are the authors. The categorization of images is a difficult process that may be influenced by a wide variety of circumstances. The existing practices, challenges, and future possibilities of image categorization are investigated in this research. The primary focus is on providing a concise summary of the most important advanced classification methodologies as well as the methods that are used for enhancing the accuracy of categorization. In addition, a discussion is had on a few significant factors that influence the accuracy of categorization. According to the findings of this assessment of the relevant research literature, developing an appropriate image-processing technique seems to be a necessity for successfully classifying remotely sensed data into a themed map. For the purpose of increasing classification accuracy, it is particularly important to make efficient use of many characteristics included within remotely sensed data and to choose an appropriate classification strategy. The use of non-parametric classifiers like neural networks, decision tree classifiers, and knowledge-based classification is becoming an increasingly essential strategy for the categorization of multisource data. A new research field has emerged, and it involves the integration of remote sensing, geographical information systems (GIS), and expert systems. To increase the accuracy of classification, however, further study is required to identify and eliminate sources of uncertainty that are present in the image-processing chain.

2.4 *On-farm study of rice production variability and productivity disparities under Mediterranean climatic conditions comparing organic and conventional farming systems*

S. Delmotte; P. Tittonell; J.C. Mouret; R. Hammond; and S. Lopez-Ridaura are the authors of this study. Rice cultivation using organic methods is characterized by considerable yield variability and significant productivity gaps in comparison to rice production using traditional methods. In places with a changeable climate, such as the Camargue region of southern France, where the Mediterranean and the Atlantic oceans meet, variability may be exaggerated. Innovative farmers come up with techniques to produce high yields that are less susceptible to variation despite the fact that management guidelines for organic farming systems are not easily accessible. This research was conducted with the goals of determining the primary elements that influence yield variability as well as the management techniques that farmers use to maintain crop output while simultaneously minimizing input consumption. A database with more than 380 entries was produced as a consequence of participatory monitoring of farmer fields from 1992 to 2009. This monitoring focused on yields, yield components, soil condition, weeds, and management strategies. These data had both continuous and discrete variables, in addition to nominal ones. They were investigated by using classification and regression trees to describe management strategies under conventional and organic systems and to identify and categorize the main variables associated with rice yield variability. This was done in order to determine how much variability there is in rice yield. Under conventional management, rice yields were anywhere from 0.5 to 10 t ha-1, but under organic management, yields ranged anywhere from 0 to 9 t ha-1. The primary element that affected production in both conventional and organic farming systems was the presence of weed competition. Under conventional management, the difference between current average yields and the predicted yield potential of 10 t ha1 was on average 2.7 t ha1, but under organic management, the gap was 5 t ha1. This latter phenomenon may be traced, in large part, to the impact that weed competition has. The difference in production between conventional and organic management varied between about 1 ton per hectare per year under favorable circumstances and approximately 4 tons per hectare per year under unfavorable conditions (e.g., severe salinity problems). The following are some of the ways that conventional and organic farming use different methods to get high yields: In traditional management, a poor initial plant stand caused by early seeding was compensated for by high tillering rates produced via N fertilization. Weeds, on the other hand, were kept under control by herbicides. Because temperatures were greater throughout the emergence process when organic management was used, late planting made it possible to achieve a higher initial plant density. This increased density assured that there would be better competition with weeds and that there would be an adequate quantity of panicles per unit area when they were harvested. Such improvements should be backed by technological measures such as short cycle cultivars that are suitable to late planting in high latitudes if organic rice cultivation is to be further pushed in Mediterranean areas. Other options, such as managing irrigation water, rotating crops, or using cover crops, must also be investigated in order to eliminate the need for the use of herbicides. Weeds must be outcompeted and/or controlled without the use of herbicides. Based on these findings, it seems that innovative practices used by farmers may point to potential routes leading to an ecologically intensive kind of agriculture.

3. PROPOSED SYSTEM

Using Sentinel-2 picture data, the RF, kNN, and SVM classifiers were put through their paces in the context of land use/cover categorization. The results of these tests were analyzed and contrasted. Within the Red River Delta in Vietnam, an area of 30 x 30 km2 including six distinct land use/cover categories was identified using 14 various training sample sizes, including balanced and unbalanced versions, ranging from 50 to over 1250 pixels/class. Every single set of categorization results had a high overall accuracy (OA) that ranged from 90% to 95%. SVM achieved the greatest OA while being the least sensitive to the training sample sizes, making it the clear winner among the three classifiers and 14 sub-datasets. RNN and kNN came in a close second and third, respectively.

4. RESULTS

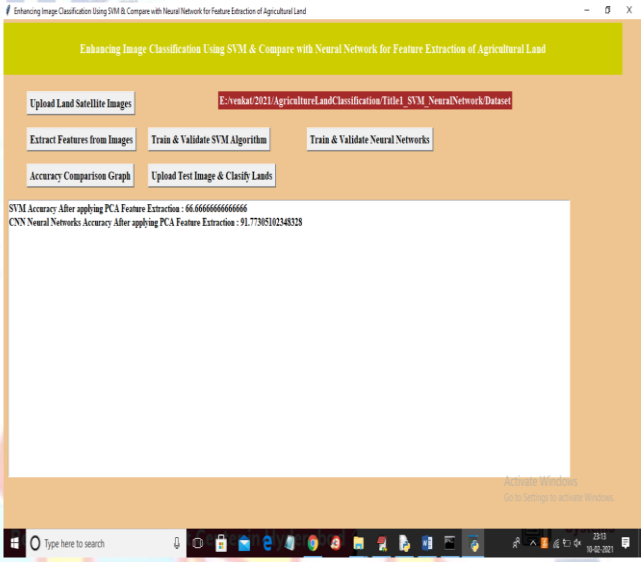

Figure 1: Accuracy of SVM and CNN

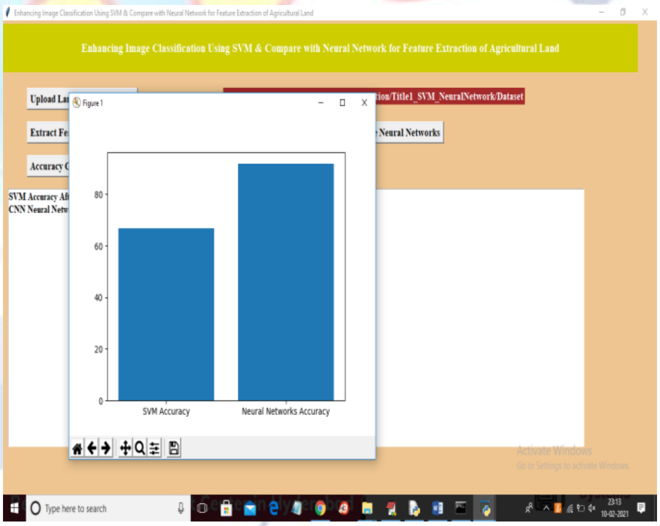

Figure 2: Graph for SVM and Neural Networks

5. CONCLUSION

The results of the categorization showed a high overall accuracy (OA) that ranged from 90% to 95%. SVM achieved the greatest OA while being the least sensitive to the training sample sizes, making it the clear winner among the three classifiers and 14 sub-datasets. RNN and kNN came in a close second and third, respectively.

In proportion to the amount of data collected, all three classifiers demonstrated an OA that was comparable and high.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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