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Analysis of deep learning techniques for the identification and classification of crops

Análisis de técnicas de deep learning para la identificación y clasificación de cultivos

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Abstract

The purpose of the study is to make known the importance of the use of computational techniques in agriculture, the use of deep learning allows artificial neural networks to perform data analysis through the use of preposition logic, this makes computers capable of to identify images or make predictions. The research methods used in the study were exploratory, bibliographical and descriptive research, they were very helpful to analyze these modern computational techniques. In the investigation it was determined that these methods are currently widely used in agriculture, being the convolutional neural network algorithm the most used for this objective. The use of these techniques is shown as one of the most important keys for the growth of precision agriculture.

Key words: Deep learning techniques, identification, crop classification, neural networks, agriculture.

Resumen

El estudio tiene como finalidad dar a conocer la importancia del uso de técnicas computacionales en la agricultura, el uso del deep learning permite que las redes neuronales artificiales puedan realizar análisis de datos mediante el uso de la lógica preposición, esto hace que las computadoras sean capaces de identificar imágenes o realizar predicciones. Los métodos de investigación empleados en el estudio fueron la investigación exploratoria, bibliográfica y la descriptiva, fueron de mucha ayuda para analizar estas técnicas computacionales modernas. En la investigación se determinó que estos métodos son muy utilizados actualmente en la agricultura, siendo el algoritmo de redes neuronales convolucionales el más utilizado para este objetivo. El empleo de estas técnicas se muestra como una de las claves más importantes para el crecimiento de la agricultura de precisión.

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Palabras clave: Técnicas de deep learning, identificación, clasificación de cultivos, redes neuronales, agricultura.

Introduction

After the sanitary emergency declared by the covid-19 disease at the beginning of 2020, the world has turned its attention to an important sector for our subsistence such as agriculture, because we have been used to everything going well in our daily lives, such as turning on the water faucet of our sink, turning on the electric light switch, going to the supermarket to buy vegetables and fresh fruit, without thinking about all the processes behind each result that seems so normal to us.

Agriculture, like many sectors today, has undergone profound changes such as the development of electronics and information and communication technologies that favor a term in diffusion such as precision agriculture. This technological advance has reached a level that allows the farmer to measure, analyze, and manage the variability within the plots and extensions of land of their crops. (Garcia, Martinez, & Garcia, 2018).

An important topic in precision agriculture is the identification and classification of crops through satellite images and images captured by unmanned aerial vehicles (UAV), for which different techniques and methods have been developed. In our study we will focus on Deep Learning, which is a computational model that allows artificial neural networks to perform data analysis through the use of preposition logic, this makes computers able to identify images or make predictions.

In the field of agriculture, Herrara (2016) states that Deep Learning is able to identify pests, fungi and other plant diseases. According to the data provided by this computer system, appropriate treatments can be given according to environmental factors such as weather, wind, floods, droughts that directly affect crop yields. Therefore, the technology allows the farmer to have accurate information which allows anticipating adverse conditions to achieve crops with high yields and consequent profitability.

The study on the analysis of deep learning techniques for crop identification and classification is important because it allows an efficient management of land extensions, for which we will divide this paper into 3 sections. Section 1 will introduce the reader to the main concepts and definitions involved in deep learning. In section 2 we will analyze the state of the art on the topic of study. In section 3 we will show the most widely applied deep learning techniques and algorithms for crop identification and classification. In section 4 we will present the conclusions and recommendations of the study.

Materials and methods

Machine learning is an evolving branch of computational algorithms that are designed to emulate human intelligence by learning from the surrounding environment. They are considered the workhorse in the new era of so-called big data. Machine learning-based techniques have been successfully applied in diverse fields ranging from pattern recognition, computer vision, spacecraft engineering, finance, entertainment and computational biology to biomedical and medical applications. (El Naqa, 2015)

In general, existing AI algorithms make use of computational power to solve certain types of problems, but they do so in a specific way. Through some input data, an algorithm learns to classify information or to make predictions through concrete patterns. It is something that gives the figure of being extraordinary, but what it does is to use that input data to refine its identification or prediction, being this prediction of the algorithm, which, instead of being static, is a dynamic learning process that varies as new data enters.

What differentiates Artificial Intelligence from other computer programs is that it does not have to be programmed specifically for each scenario. We can teach it things (Machine Learning), but it can also learn by itself (Deep Learning). While there are multiple variants of each, they can be broadly defined as follows. (Alonso, 2021):

- AI (Artificial Intelligence): a machine that is capable of imitating human reasoning.
- ML (Machine Learning): a subset of Artificial Intelligence where people "train" machines to recognize patterns based on data and make their predictions.
- DL (Deep Learning): a subset of ML in which the machine is able to reason and draw its own conclusions, learning by itself.

Deep learning is an artificial intelligence algorithm that seeks the recognition of images to identify complex patterns. One of its main characteristics is that it presents automatic learning, i.e. unsupervised. (Herrera, 2016). In this sense, Deep Learning artificial intelligence is based on neural networks inspired by human networks, which allow to make predictions according to the needs. All this allows the system to record the data obtained through images, taking into account variables such as climate, temperature and humidity of the crops, which can affect their production performance.

By means of Deep Learning, artificial neural networks can be designed, using an infinite amount of data for their training. It is important to note that this system can be implemented through computer programs to create artificial neurons and then use them to simulate the functioning of a biological neural network. (Parraga, Alcivar, Riascos, & Becerra, 2020). Neural networks are responsible for processing images through a computational model, which can identify the characteristics of plants, such as leaves, spots of different colors, which will

be very useful to identify or classify images and detect patterns or objects that will allow the identification and classification of crops.

Deep Learning has a wide use in agriculture since it allows performing many processes that are nowadays automated. With the help of this system it is possible to detect any type of diseases in crops, which is essential to obtain a good production and save money and labor. (Herrera, 2016).

Among the main advantages offered by Deep Learning in agriculture are:

- Improving crop yields
- Predicting crop production
- Knowing in advance about climate change, whether cold or heat waves. (Marengo, et al., 2020)

Deep Learning in agriculture, therefore, offers many advantages as it can control large agricultural plantations and improve crop yields and, of course, get the most out of the land.

Deep Learning techniques for the identification and classification of crops.

The Deep learning techniques most commonly used in agriculture are:

- **Random forest**

It is a supervised learning algorithm, it creates a forest and randomly takes several trees, which allows it to accurately predict the state of the crop.

- **Support Vector Systems (SVM)**

This vector system is used in classification and regression tasks, because it allows to obtain artificial vision images. One of the advantages of this system is that its error level is low and the results are easy to interpret.

- **Artificial neural networks**

This system is based on the structure of the human brain, which allows it to transmit information. In other words, artificial neural networks can recognize and send images and voice.

- **Convolutional networks.**

These networks are specialized for processing data to locate patterns in images, objects and scenes. The images can be classified and eliminate those that are not necessary to be more accurate with the data being searched.

Similarly through Deep Learning techniques, the farmer can predict crop yields accurately, because this system can provide important data about the crop, such as the quality of the product and the possible price in the market when the product is already harvested. This data allows the farmer to know in advance which products he can plant and whether or not they will generate profit when they are already cultivated. (Big Data Site, 2019).

The study on the analysis of Deep Learning techniques for the identification and classification of crops is qualitative in approach because its purpose is to investigate and interpret the topic of study through bibliographic sources, since it seeks to analyze how the technology can be used to identify and classify crops, through which the farmer can make timely decisions to avoid economic losses. *Authors such as Hernández, Fernández and Baptista* (2014)*mentioned that exploratory research allows to observe from the same actors in the research process, which has allowed to know closely the most important facts about the application of convolutional neural network technology to identify crops through satellite images such as Landsat-8, Sentinel-1 and Sentinel-2.*

Through bibliographic research it was possible to obtain information from several authors in order to find solutions to the problems posed by means of a two-way analysis, in which it has been related to existing data from different sources. That is to say that bibliographic sources allow the researcher to know the coherences that exist between the theory and the data referring to the study, so it is necessary for the researcher to use reliable sources and be able to carefully compare with the data of similar authors.

The study is descriptive, since it will allow a detailed description of the analysis of *Deep Learning* techniques for the identification and classification of crops. *In this regard,* Gutiérrez and Rosas (2014)point out that descriptive research makes it possible to analyze or describe the phenomena under study, in order to learn more about the problem.

According to Guevara, Verdesoto, and Castro (2020)through descriptive research, the researcher can know in depth the subject under study, since he can explain step by step the research process in order to analyze the how and why of the problem under study. Such is the case of the study on the analysis of Deep Learning techniques for the identification and classification of crops.

In this regard, Hernández and Mendoza (2019)mention that in a descriptive study several concepts and variables can be selected, to measure them independently, with the purpose of describing the causes and consequences that originate the phenomena. According to the

aforementioned, descriptive studies offer the possibility of making predictions, to obtain an estimate of how the phenomena will affect in the future.

The methods used in the study on the analysis of Deep Learning techniques for the identification and classification of crops were the *deductive* method*, since it allows the* analysis of postulates, theorems, laws, principles, among others. Taking into account that this method is based on the universal application of facts or solutions to apply them to particular solutions. While the deductive method was used to elaborate conclusions by means of particular sections, which are accepted as valid.

Result

According to Baruffaldi's results (2019)Deep Learning techniques allow the farmer to observe the state of the crops through a video. For example, he can identify where weeding is required in the planting, as well as whether the crop growth is adequate. The study shows that Deep Learning techniques offer many advantages for agriculture because they can identify climatic changes, whether hot or cold. Another important fact presented in this study is that these techniques can predict the quality of crops, so the farmer can take advantage of these benefits to optimize the production of different crops.

In this research it was possible to show that Deep Learning, allows farmers to yield much more production of their crops and significantly lowering the economic losses that can generate crop failures. In fact, by using Deep Learning, the farmer can supervise the entire planting process up to the moment of harvesting.

In this regard, Jácome (2021)states that the most widely used crop prediction systems are those that learn based on image and text data, in order to guarantee adequate learning.

Deep Learning systems allow crop predictions to be made in 25%, based on data obtained through image and text, 21% is done by means of audio and video, 17% is performed by means of images and optical flows, 10% is performed based on soft tissue studies also known as MRI, PET. 9% is performed by gene expression, 5% is performed by medical imaging, 4% is performed using multispectral imaging and 2% is performed by gene expression.

According to the study presented by Banchón Fajardo and Soriano Navas (2021)they point out that by using Deep Learning in crops, the farmer can know in advance the weather predictions such as winter or summer and which product may be the most suitable for planting, to achieve greater profitability in both crop and economic terms. In this sense, Bonilla et al. (2021)mentions that the machine learning system can be applied in various types of crops such as sugar cane plantations, vegetable crops, tubers and other agricultural products.

According to these data it can be seen that the application of the Deep Learning system in sugar cane cultivation is represented by a total of 41%, while in the cultivation of vegetables is used 14%, in what has to do with the cultivation of tubers this system is used in 12%, while in other crops is used in 33%. These data show that Deep Learning is a technological tool that brings many advantages for agriculture, because through videos and digital photographs the farmer can maximize crop yields, achieving greater economic profitability. Similarly, he can control crop diseases and act in time to reduce losses. For this and many other reasons, Deep Learning has become indispensable in agriculture.

Therefore, Deep Learning is widely used in agriculture around the world, because it can predict with a high degree of accuracy on the yield and needs of crops, through visual data and text that can improve the conditions and profitability of crops.

The literature is largely based on the processing of satellite images, but currently we have a growing number of studies applying UGV (Unmanned Aerial Vehicles) images as a remote sensing platform and classical machine learning algorithms with classification, clustering and detection logics.

The most widely used technique for this type of detection and classification are convolutional neural networks, which show better results than a traditional multilayer feedforward network.

The main drawback to improve the results with images from unmanned aerial vehicles is that these devices have little memory and storage capacity, studies could be conducted to send data to cloud platforms, but there would be a drawback in the transmission of data from the device to the database in the cloud. As a recommendation for future work, studies could be conducted to implement Deep Learning Techniques in agriculture in order to obtain benefits in crops, because in Ecuador this technique is rarely used.

Conclusions

The use of Deep Learnig techniques allows the farmer to obtain better yields in agriculture and achieve greater profitability. In addition, the techniques can be applied to make weed control more efficient, especially in large areas, which simplifies costs and reduces the use of herbicides. Automatic crop classification using new deep learning techniques is one of the most important keys to the growth of precision agriculture. It allows reducing the number of workers, the amount of chemicals applied, among others.

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