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ASPECTS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN AGRICULTURAL INDUSTRY

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Abstract

The pressure to produce more food has led to the need for identification of applicable solutions, to solve, to improve the sustainability of production processes and accelerate innovation in the agriculture. These solutions based on the technical revolution can be characterized by the Farming 4.0 concept.

This concept is primarily based on the application of precision agriculture methods with the help of new technical achievements such as IoT (Internet of Things), AI (Artificial Intelligence), Big Data, Cloud and battery modernization. Among the important technological achievements, we list the automatic steering based on GPS, autonomous tractors and agricultural machines, the replacement of the thermal motors with electric motors, using batteries as the main source of energy, robots and drones for agriculture, direct communication between agricultural machines and centralization of all information in Cloud-based software applications.

This article gives a brief overview of the achievements based on artificial intelligence and machine learning for agricultural industry and tries to synthesize the main future directions.

Key words: artificial intelligence, machine learning, Farming 4.0, IoT, precision agriculture, robots for agriculture.

INTRODUCTION

The Department of Economic and Social Affairs, Population Division, of the United Nations, (United Nations, 2017) has predicted that the global population will reach 8.55 billion people by 2030 and almost 10 billion people by 2050. In order to feed this growing population, according to FAO, food production must increase with 70 percent by 2050 and a 60 percent increase in demand for high quality protein such as milk, meat and eggs.

Agriculture is energy intensive and the pressure to produce more food requires more energy, an increasingly costly input to the production process.

The early part of the past decade saw the rise of data-driven technologies and insights, going from basic analytics tools to the significantly more powerful business intelligence (BI) suite, which boasts the ability to aggregate an organization's data and display it, in an easily digestible format. The massive leap in analytics capacity meant that data became a valuable asset, and organizations are happy to invest millions into applications and tools if it means they can use it successfully for ROI acceleration.

Artificial Intelligence (AI) is a broad field of research at the intersection of several disciplines, among which Computer Science, Statistics, Neuroscience, Mathematics, Cognitive Science, Information Engineering with aim to design intelligent computer systems.

Machine Learning is about programming the computer to learn from the given input automatically and improve through experience without being explicitly programmed. It has been evolving and has gained importance because of the ability to predict and have a crucial role in decision making and real time actions. Machine learning algorithms consumes large voluminous amount of data from which learning happens by considering different entities, drawing relationships and correlating them. The learning is better when there is large and diverse data integrated from various sources.

Machine learning (ML) has emerged together with big data technologies and high-performance computing to create new opportunities to unravel, quantify, and understand data intensive processes in agricultural operational environments. Among other definitions, ML is define as the scientific field that gives machines the ability to learn without being strictly programmed.

Deep Learning (DL) is a subset of Machine Learning that relies on *multi-layered neural networks* or *deep neural networks*. In particular, it is a formalism to represent the relationship between an observation and the desired behaviour. It was inspired by neuroscience, and borrows rough intuitions from how neurons in the brain are supposed to process information. (Patraucean, Pascanu, 2019).

MATERIAL AND METHOD

AI and Machine Learning are emerging technology in agriculture domain. AI-based equipment and machines, has taken today's agriculture system to a different level.

This technology's has enhanced crop production and improved real-time monitoring, harvesting, processing and marketing. The latest technologies of automated systems using agricultural robots and drones have made a tremendous contribution in the agro-based sector. Various new computer based systems is design to determine various important parameters like weed detection, yield detection and crop quality and many other techniques (Liakos et al., 2018).

The most popular applications of AI in agriculture appear to fall into three major categories:

• Agricultural Robots and complex machinery's – Companies are developing and programming autonomous robots to handle essential agricultural tasks such as harvesting crops at a higher volume and faster pace than human labourers.

• Crop and Soil Monitoring – Companies are leveraging computer vision and deep-learning algorithms to process data captured by drones and / or software-based technology to monitor crop and soil health.

• Predictive Analytics – Machine Learning models are being developed to track and predict various environmental impacts on crop yield such as weather changes.

• Water management and planning – the best solutions can be determined based on information on crops, soil and weather forecast.

Blue River Technology has developed a solution for optimize use of pesticides by using advanced machine learning algorithms to enable robots to make decisions, based on visual data about whether or not a plant is a pest, and then deliver an accurate, measured blast of chemical pesticides to tackle the unwanted pests. John Deere seeing the potential of this development acquired the start-up and added it to the catalogue of high tech, data-powered services it already offers its customers (Marr, 2019).

Blue River LettuceBot2 are the perfect tools for farmers and their lettuce crops. With its imaging system, the LettuceBot2 is a popular tool in the agriculture world that attaches itself to a tractor to thin out lettuce fields as well as prevent herbicide-resistant weeds, it uses 90% less herbicide on crops. Already the firm enables automated farm vehicles to plough and sow, under the control of accurate GPS systems. On top of that, its Farmsight system is designed to enable data-driven insights to inform agricultural decision making, based on shared user data from subscribers all around the world.

Even younger companies in the field of agricultural machinery production began to produce robots. Jacto from Brazil made Arbus 4000 JAV an autonomous solution for precision spraying.

In the field of agricultural robotics, companies not related to agriculture are also involved. For instance, Google finances Abundant Robotics, which BayWa picking robot suck ripe fruit from branches with vacuums (Claver, 2019).

Perfect for those in the citrus fruit business, the Energid Citrus Picking System are fast and efficient harvesting systems. The systems can pick a fruit every 2 to 3 seconds. Even more so, the robot is cheap to build, making it significantly cheaper than human labour.

Several companies such as PEAT (with Plantix), CropDiagnosis and Trace Genomics, has developed deep learning application that reportedly identifies potential defects and nutrient deficiencies in soil. Analysis are conducted by software algorithms, which correlate particular foliage patterns with certain soil defects, plant pests and diseases. The image recognition application identifies possible defects through images captured by the user's smartphone camera.

Satellites have been used for a decade to monitor large croplands and forestry but a new level of precision and flexibility has been obtained with the use of UAVs. For example, Sen4CAP software is an advanced solution for agriculture monitoring, commissioned by the European Space Agency, gives a direct access to the complete Copernicus Sentinel satellite data repository and dynamically scalable processing opportunities (European Commission, 2018).

Drones however can monitor crops much more accurately, frequently and affordably, delivering higher quality data that are updated regularly to provide insight into crop development and highlight inefficient or ineffective practices. The ability to assess the health of a crop quickly and precisely can be invaluable for farmers. If a bacterial or fungal infection are identified, early detection allows quick action to be taken in order to remedy the issue

Predicting the crop yield in advance of its harvest would help the policy makers and farmers for acting appropriately for marketing and storage.

For increase and improve the crop yield and the quality of the crops by analysing all problems like weather, temperature and several factors, in (Champaneri et al., 2020) was uses Data mining techniques. Data mining is the process of analysing data from various viewpoint and summarizing it into important information. Random forest is the most popular and powerful supervised machine learning algorithm capable of performing both classification and regression tasks, that operate by constructing a multitude of decision trees during training time and generating output of the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees.

The most applied deep learning algorithm for crop yield prediction is Convolutional Neural Networks (CNN), and the other widely used algorithms are Long-Short Term Memory (LSTM) and Deep Neural Networks (DNN) algorithms (Klompenburga et al., 2020).

Agriculture accounts for the vast majority (70%) of water used in the world. Drones equipped with special monitoring equipment can used to identify parts of a field experiencing “hydric stress” (inadequate of water of sufficient quality). They use infrared and thermal sensors to provide snapshots of entire fields, allowing targeted diagnosis of areas receiving too much or too little water.

Vegetation indices such as normalized difference vegetation index (NDVI), normalized difference red edge (NDRE), chlorophyll-based indices (“chlorophyll map”), and other indices (SAVI, OSAVI, etc.) can be used to detect and quantify variability in the field. Digital surface models (DSMs) are digital representations of the elevation of the field and crop. They can be used for water management and planning, water flow analysis, and crop optimization based on slope direction (Saad, 2020).

FIWARE is one of the open-source cloud platforms through which programmers can execute their applications. The cloud platform provides users with services to determine how to adjust the irrigation solution so as to keep the composition of the soil within desired parameter values. FIWARE was born in Europe from the Future Internet Public Private Partnership (FI-PPP), which aimed at accelerating the development and adoption of Future Internet technologies in Europe, advancing the European market for smart infrastructures, and increasing the effectiveness of business processes through the Internet. The European Commision has funded 2 projects to continue the FIWARE Accelerator Programme: Impact Growth and FrontierCities.

RESULTS AND DISCUSSION

As an emerging technology in agriculture, Artificial Intelligence and Machine Learning must earn users' trust: it is certainly worth making them effective, but first and foremost they must be sure and safe. It is about demonstrating the seriousness of the issues surrounding safety, in order to meet the challenge of performance and sustainability

All over the world is a growing concern for the development of intelligent machines for agriculture. This concern is given on the one hand by the increasing need for food to feed the population but also due to the decrease in the workforce in agriculture and the need to protect the environment.

This concern has materialized through the emergence of precision agriculture technologies and Digital Farming or Smart Farming concepts, which has transformed into Farming 4.0, the fourth revolution in agriculture.

CONCLUSIONS

We can conclude that the agricultural industry is about to be disrupted and will transform into a high-tech industry and will need a high skilled farmers.

Each of the applications and technologies presented is continuously improved both in terms of performance and environmental protection capabilities but also the reduction of prices to be available to all.

These maturing technologies are paving the way for the fifth agricultural revolution. They are supported by research in the university environment, by the achievements of the companies involved but also by government policies to support digitalization in all countries.

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