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Cognitive Computing For Sustainable Agriculture

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***Abstract* - Cognitive computing in agriculture is going to be a big revolution like the green revolution. Agriculture is a big step that accompanied the humanity to evolve from the ancient times to the modern days and has fulfilled the basic need for food supply. Today still remains it's at most importance. Cognitive computing uses cognitive technologies in agriculture that help to understand, learn from experiences and environment, reason, interact and thus increase the efficiency. Civilization has led to more urbanization. There are more people than available food. There is a great necessity to increase the per meter yield, So many techniques have been for seen in agriculture in terms of usage of pesticides and fertilizers, use of hybridization and green revolution to increase the production in agriculture. Now the use of modern technologies such as artificial intelligence and cognitive computation is going to bring a new big revolution for sustainable agriculture. The present paper focuses on the problems faced by the modern society in agriculture and how the cognitive computation provides an ultimate solution to the problems. We also discuss some illustrations for the usage of cognitive technologies and machine learning in the field of agriculture.**
***Keywords:* Cognitive Computing, Cognitive Technology, Sustainable Agriculture**

I. INTRODUCTION

Agriculture is the industry that followed the evolution of human beings from ancient times to modern times and fulfilled its basic need for food supply [1]. Even today this still remains its primary importance, but it is integrated with more complex mechanisms driven by multiple environmental, economic and sociological forces. This $5 trillion industry representing 10 percent of global consumer spending, 40 percent of employment and 30 percent of greenhouse gas emissions continues to keep pace with world's evolution, changing tremendously over the past years. Digital and technological advancements are taking over the industry, enhancing food production while adding value to the entire farm-to-fork supply chain and helping it make use of natural resources more efficiently.

Data generated by sensors or agricultural drones collected at farms, on the field or during transportation offer a wealth of information about soil, seeds, livestock, crops, costs, farm equipment or the use of water and fertilizer. Internet of Things technologies and advanced analytics help farmers analyze real time data like weather, temperature, moisture, prices or GPS signals and provide insights on how to optimize and increase yield, improve farm planning, make smarter decisions about the level of resources needed, when and where to distribute them in order to prevent waste. Efficiency and productivity will increase in the next years as precision agriculture grows bigger and farms become smarter and more connected. It is estimated that by 2020, over 75 million agricultural IoT devices will be in use, while the average farm is expected to generate an average of 4.1 million data points every day in 2050.

II. SUSTAINABLE AGRICULTURE

Always people would prefer the natural food that is free of chemicals and artificial enhancements. Unfortunately, the majority of food we consume is produced using industrialized agriculture, which is a type of agriculture where large quantities of crops and livestock are produced through industrial techniques for the purpose of sale. This type of agriculture relies heavily on a variety of chemicals and artificial enhancements, such as pesticides, fertilizers, and genetically modified organisms. This type of agriculture also uses a large amount of fossil fuels and large machines to manage the farm land. Although industrialized agriculture has made it possible to produce large quantities of food, due to the negative aspects of this technique, there has been a shift towards sustainable agriculture.

Sustainable agriculture is a type of agriculture that focuses on producing long-term crops and livestock while having minimal effects on the environment [2]. This type of agriculture tries to find a good balance between the need for food production and the preservation of the ecological system within the environment. In addition to producing food, there are several overall goals associated with sustainable agriculture, including conserving water, reducing the use of fertilizers and pesticides, and promoting biodiversity in crops grown and the ecosystem. Sustainable agriculture also focuses on maintaining economic stability of farms and helping farmers improve their techniques and quality of life.

There are many farming strategies that are used that help make agriculture more sustainable. Some of the most common techniques include growing plants that can create their own nutrients to reduce the use of fertilizers and rotating crops in fields, which minimizes pesticide use because the crops are changing frequently. Another common technique is mixing crops, which reduces the risk of a disease destroying a whole crop and decreases the need for pesticides and herbicides. Sustainable farmers also utilize water management systems, such as drip irrigation, that waste less water.

III. CHALLENGES FACED IN AGRICULTURE

While the growing number of connected devices represents a big opportunity for food and agribusiness players, it also adds more complexity for farmers and organizations [3] [4] [5]. Moreover, the explosion of unstructured data, like social media posts, imagery or video content drives the need to know more, to receive real time recommendations on close at hand devices, like smart phones or tablets. The solution is to use the cognitive technologies that help understand, learn, reason, interact and thus, increase efficiency.

Use of ICT imposes numerous hurdles among the major focus is on the owner of the data. ICT that records the input of resources and the output of products does raise questions of property rights and use of data. Business models might create added value by converting spatially explicit big data into information and advice not only for farmers but also for regulatory authorities who may use the data for surveillance and control. Governments must establish a regulatory architecture that guarantees high-quality data while at the same time fostering trust among all actors involved. The potential misuse of data creates additional legal and ethical challenges for regulation and monitoring.

In addition, ICT will intensify the challenges of responsibility and accountability of new technologies. There must be accountability for mismanagement or errors leading to economic and environmental consequences. For example, who is responsible for traces of fungicides left behind on harvested fruits when that fungicide has been applied too late? Is it the farmer, the provider of the software, or the producer of the sensor?

High costs to adopt technology for individual farms and limited knowledge and skills can be significant adoption hurdles, especially in developing countries. Thus, the access to the latest technology may remain restricted to big and industrialized farms. The benefits of ICT might be limited to industrialized countries and focused on the production of well-known and widely grown crops, such as wheat, maize, and rice. This also increases the risk of unsustainable intensification practices. In an industrialized setting, disease outbreaks may be delayed by fungicides, but this comes with an increased risk of generating resistant fungal strains that can then act even more devastatingly once they have overcome prevention measures.

IV. USE OF AI IN AGRICULTURAL INDUSTRY

Hypothetically, it is possible for machines to learn to solve any problem on earth relating to the physical interaction of all things within a defined or contained environment by using artificial intelligence and machine learning.

The principle of artificial intelligence is one where a machine can perceive its environment, and through a certain capacity of flexible rationality, take action to address a specified goal related to that environment. Machine learning is when this same machine, according to a specified set of protocols, improves in its ability to address problems and goals related to the environment as the statistical nature of the data it receives increases. Put more plainly, as the system receives an increasing amount of similar sets of data that can be categorized into specified protocols, its ability to rationalize increases, allowing it to better “predict” on a range of outcomes.

The rise of digital agriculture and its related technologies has opened a wealth of new data opportunities [6]. Remote sensors, satellites, and UAVs can gather information 24 hours per day over an entire field. These can monitor plant health, soil condition, temperature, humidity, etc. The amount of data these sensors can generate is overwhelming, and the significance of the numbers is hidden in the avalanche of that data.

The idea is to allow farmers to gain a better understanding of the situation on the ground through advanced technology (such as remote sensing) that can tell them more about their situation than they can see with the naked eye. This is not only more accurate but also quicker than seeing it walking or driving through the fields.

Remote sensors enable algorithms to interpret a field’s environment as statistical data that can be understood and useful to farmers for decision-making. Algorithms process the data, adapting and learning based on the data received. The more inputs and statistical information collected, the better the algorithm will be at predicting a range of outcomes. And the aim is that farmers can use this artificial intelligence to achieve their goal of a better harvest through making better decisions in the field.

Based on our research, the most popular applications of AI in agriculture appear to fall into three major categories: Agricultural Robots, Crop and Soil Monitoring and Predictive Analytics. Agricultural Robots are used for many agricultural applications. 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 laborers. Another type of agricultural application is 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 are most useful to handle the uncertainty faced in agriculture. Machine learning models are being developed to track and predict various environmental impacts on crop yield such as weather changes.

V. AGRICULTURAL ROBOTICS

The use of cognitive technology began in the Agriculture with the extensive usage of robots. This resulted in a separate branch of study known as Agricultural Robotics. There are many existing robots which are effectively used for various agricultural tasks worldwide. A few illustrative examples are provided in the following discussions.

Blue River Technology has developed a robot called See and Spray which reportedly leverages computer vision to monitor and precisely spray weeds on cotton plants. Harvest CROO Robotics [8] has developed a robot to help strawberry farmers pick and pack their crops. Berlin-based agricultural tech startup PEAT, has developed a deep learning application called Plantix that reportedly identifies potential defects and nutrient deficiencies in soil. Analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pests and diseases. Similar to the Plantix app, California-based Trace Genomics, provides soil analysis services to farmers.

Sky Squirrel Technologies Inc. [8] is one of the companies bringing drone technology to vineyards. a Where, a Colorado based company uses machine learning algorithms in connection with satellites to predict weather, analyze crop sustainability and evaluate farms for the presence of diseases and pests. Based in Raleigh, North Carolina, Farm Shots is another startup focused on analyzing agricultural data derived from images captured by satellites and drones. Specifically, the company aims to detect diseases, pests, and poor plant nutrition on farms.

VI. USE OF COGNITIVE TECHNOLOGY

Cognitive computing can enhance our human ability to take better decision for the entire environmental sustainability. With its ability to understand, learn from experiences and environment, reason, interact and thus increase the efficiency. Cognitive technology could be great ally in protecting our planet [9]. Physics-based prediction models already exist for forecasting things like weather, pollution, and drought. But with machine learning, we can systematically understand which model performs better when, where and under what circumstance. Through machine learning and video analytics, cognitive technology can help us understand what the norms are and discover anomalies or problem areas. This will help us minimize deforestation, track urbanization, mitigate diseases and better understand and control ecosystems.

VII. CONCLUDING THOUGHTS

AI-driven technologies are emerging to help improve efficiency and to address challenges facing the industry including, crop yield, soil health and herbicide-resistance. Extensive testing and validation of emerging AI applications will be critical as agriculture is impacted by environmental factors that cannot be controlled unlike other industries where risk is easier to model and predict. We anticipate that the agricultural industry will continue to see steady adoption of AI and will continue to monitor this trend. In most cases, the problem is not that the technology does not work, the problem is that industry has not taken the time to respect that agriculture is one of the most uncontained environments to manage. For technology to truly make an impact in the field, more effort, skills, and funding is needed to test these technologies in farmers' fields. There is huge potential for artificial intelligence and machine learning to revolutionize agriculture by integrating these technologies into critical markets on a global scale. Only then can it make a difference to the grower, where it really counts.

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