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Agriculture's AI Transformation: Blessing or Burden?

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Throughout history, the agriculture sector has continually seen advancements, ranging from improved management practices to the integration of cutting-edge technologies. One such transformative technology is Artificial Intelligence (AI). With the emergence of Information Technology (IT) and the continuous evolution of data science, the agricultural sector has harnessed the potential of AI to its advantage.

The roots of artificial intelligence can be traced back to the 1940s when philosophers endeavoured to explain human thought processes as the systematic manipulation of symbols. In 1956, the foundation for AI research was established during the Dartmouth Conference in the United States.

The introduction of artificial intelligence into the realm of agriculture occurred in 1985, spearheaded by McKinion and Lemmon. Their groundbreaking work led to the development of GOSSYM, a cotton crop simulation model. This innovative system utilized Expert Systems to optimize cotton production, taking into account various factors such as irrigation, fertilization, weed control, cultivation practices, climate conditions, and more.

History of AI

1943: "Logic Theorist" developed by Warren McCulloch and Walter Pitts.
1950: Alan Turing's "Computing Machinery and Intelligence" paper.
1956: John McCarthy coins the term "Artificial Intelligence" at the Dartmouth Workshop.
1956-1969: Early AI research, including symbolic reasoning systems.
1966: "ELIZA," the first chatbot, created by Joseph Weizenbaum.
1967: "Dendral" developed for expert system-based inference.
1970s: AI Winter, as funding decreases due to unmet expectations.
1980s: Dominance of expert systems and knowledge-based AI systems.
1997: IBM's Deep Blue defeats Garry Kasparov in chess.
2000s: Rise of Machine Learning, Neural Networks, and Big Data.
2010s: AI Spring, Technological Development, and AI Renaissance.
2011: IBM Watson wins Jeopardy!
2012: Deep Learning resurgence with ImageNet competition.
2015: "AlphaGo" defeats a human Go champion.
2018: Explosion of AI applications in various industries. World Health Organization reports big data analytics may support health policy decision-making.
2020s: Continued advances in AI, including GPT-3.

What is Artificial Intelligence?

AI is a set of technologies that are based primarily on machine learning and deep learning, used for-

- Data analytics
- Predictions and forecasting
- Object categorisation
- Natural language processing
- Recommendations
- Intelligent data retrieval

Languages preferred in AI-ML (Artificial intelligence and machine learning)-

- Python
- Java
- R programming
- C++
- Java script
- Julia
- LISP

The Transition from Microsoft Excel to AI in Agricultural Data Analysis

Before the emergence of AI, Microsoft Excel played a pivotal role in handling extensive data analytics and interpretation within the field of agriculture. However, using Excel for this purpose often consumed a significant amount of time and effort, particularly when it came to tasks such as data input, complex mathematical calculations, and logical reasoning.

As a result of these challenges, scientists and researchers in the agricultural sector have turned to AI as an indispensable analytical tool for processing vast datasets. AI has streamlined the process of managing data related to a multitude of factors, including climatic conditions, weather parameter forecasting, crop management practices, soil properties, production metrics, and overall productivity. Its adoption has not only alleviated the labour-intensive aspects of data analysis but has also empowered more efficient decision-making in agriculture.

Major applications of AI in agriculture are:

- **AI-Enhanced Crop Irrigation:** AI algorithms have made autonomous crop management a reality. When integrated with IoT (Internet of Things) sensors responsible for tracking soil moisture levels and weather conditions, these algorithms have the capability to make real-time decisions about the optimal amount of water required by crops. This powerful combination has led to the development of autonomous crop irrigation systems, with a primary focus on both water conservation and the encouragement of sustainable farming practices.
- **AI-Enhanced Nutrient Analysis for Optimizing Crop Health:** The improper balance of nutrients in the soil can have profound consequences on the well-being and development of crops. AI plays a crucial role in identifying these nutrient imbalances and assessing their impact on crop yields, equipping farmers with the tools to make necessary adjustments seamlessly. In practical terms, AI has demonstrated its exceptional ability to rapidly and accurately monitor the growth stages of wheat and determine the optimal ripeness of tomatoes—a level of speed and precision that surpasses human capabilities.

- **Enhancing Crop Health Through Computer Vision and AI:** In addition to monitoring soil quality and crop growth, computer vision is a valuable tool for identifying the presence of pests and diseases. This process relies on AI to analyse images, pinpointing issues such as moulds, rot, insects, or any other threats to crop well-being. When integrated with alert systems, this technology enables farmers to respond promptly, either by eradicating pests or isolating affected crops to contain the spread of diseases. Notably, AI has demonstrated an impressive accuracy rate of over 90% in detecting apple black rot, underscoring its potential in safeguarding crop health.
- **Revolutionizing Livestock Health Monitoring with AI":** While identifying health issues in livestock might appear more straightforward compared to crops, it is, in fact, a notably challenging endeavour. Fortunately, AI has emerged as a valuable ally in this domain. One such example is the innovative solution offered by a company known as Cattle Eye. Their technology harnesses the power of drones, cameras, and computer vision to remotely monitor the health of cattle. It excels at recognizing deviations in cattle behaviour and can even identify significant events such as the birthing process.
- **Enhancing Crop Yield Analysis with Machine Learning:** The practice of yield mapping leverages the capabilities of Machine Learning (ML) algorithms to analyse vast datasets in real-time. This technology empowers farmers with valuable insights into the intricate patterns and attributes of their crops, facilitating more informed and strategic planning. Through a harmonious integration of methodologies like 3D mapping and data sourced from sensors and drones, farmers can predict soil yields for specific crops. The collection of data unfolds across multiple drone flights, enabling increasingly precise analysis with the application of advanced algorithms.
- **Advanced Weed Detection and Smart Automation in Agriculture:** Much like its prowess in identifying pests and diseases, computer vision serves as a formidable tool for detecting unwanted weeds and invasive plant species. When coupled with the capabilities of machine learning, computer vision assesses the size, shape, and color of leaves to effectively differentiate between weeds and cultivated crops. These innovative solutions pave the way for programming robots designed to execute Robotic Process Automation (RPA) tasks, including automated weeding. In fact, such robotic systems have already proven their effectiveness in practice. As these technologies become more accessible, the prospect of employing intelligent robots for both weeding and harvesting crops emerges on the horizon.
- **Empowering Crop Assessment and Grading with Computer Vision":** Computer vision technology proves its versatility in agriculture by not only identifying pests and diseases in harvested crops but also in accurately grading produce based on attributes such as shape, size, and colour. This capability allows farmers to efficiently categorize their produce, facilitating distinct pricing and distribution strategies for various customer segments. In contrast, traditional manual sorting methods can be exceptionally labour-intensive, underscoring the transformative impact of automation in crop assessment and grading.

Unveiling AI's Impact: Balancing Promise and Peril in Agriculture

- The burgeoning use of artificial intelligence in agriculture introduces significant but poorly understood and under-appreciated risks for farms, farmers, and food security.
- While AI holds immense potential to enhance crop management and agricultural productivity, addressing potential risks with responsibility is imperative. Robust testing in controlled environments is vital to ensure safety and security against unintended consequences, accidental failures, and cyber threats.

- The prospect of autonomous machines promises to alleviate farmers from arduous manual labour, thereby improving working conditions. However, without inclusive technology design, the deeply rooted socioeconomic inequalities seen in global agriculture, including gender, class, and ethnic disparities, are at risk of persisting.
- Some scientists suggest that AI's influence on crop productivity might be limited to the short term, potentially leading to environmental deterioration.

Conclusion

Undoubtedly, AI has seamlessly replaced manual and Excel-based data analytics, significantly enhancing the precision of data interpretation and decision-making. The results of AI-driven analyses consistently offer remarkable accuracy and utility, leading to improved aspects such as production, productivity, efficient management practices, minimized input costs, and heightened output efficiency. This technological revolution has paved the way for precision farming, ultimately transforming agriculture into a realm of "Smart Agriculture." However, it is imperative to bear in mind the crucial principle that guides us:

"**We should control AI; AI should not control us."**