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Artificial intelligence in geography and its use in agricultural activity

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Abstract:

The world has a rapid developments in various fields, including technology. This has enabled humanity to innovate and create new technological applications, or to update and utilize existing ones, integrating theory and practice, and applying the practical aspects in various fields, including agricultural geography, which is the focus of this study. This research aims to study the role of geographic artificial intelligence in agricultural activity. Agricultural activity is one of the most important economic sectors, upon which other economic sectors (industrial and commercial) depend. This is due to its significant importance in achieving food security for the population. Therefore, recently, the importance of artificial intelligence has been highlighted, because of its clear impact on the agricultural sector, as it could revolutionize the field of agriculture. This research explores the components and applications of artificial intelligence (AI), and how they can be applied in the agricultural sector. The research also addresses the importance of using geographic AI in improving the agricultural sector, such as data representation and analysis, and identifying problems affecting agricultural crops.

Keywords: Artificial intelligence (AI), Geography, Agricultural activity.

الذكاء الاصطناعي الجغرافي واستخدامها في النشاط الزراعي

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الخلاصة:

شهد العالم موجة تطورات متسارعة في مختلف المجالات ومنها المجال التقني ، مما جعل الانسان اكثر تقدماً لابتكار تطبيقات تكنولوجية جديدة او العمل على تجديدها وتوظيفها ليتلأم فيه الجانبين النظري والعملي وتطبيق الجانب العملي في مجالات مختلفة ومنها المجال الجغرافي الزراعي الذي نحن بصدد الحديث عنه الان في هذه الدراسة. يهدف هذا البحث إلى دراسة دور الذكاء الاصطناعي الجغرافي في النشاط الزراعي. اذ يعد النشاط الزراعي من أهم القطاعات الاقتصادية التي ترتكز عليها قطاعات الاقتصادية اخرى (الصناعية، التجارية) ولما له من اهمية كبيرة في سبيل تحقيق الامن الغذائي للسكان لذلك وفي الآونة الأخيرة تم تسليط الضوء على اهمية الذكاء الاصطناعي لما له من تأثيراً واضح في القطاع الزراعي اذ يمكن ان يشكل ثورة في مجال الزراعة. يستعرض البحث مكونات والتطبيقات المرتبطة بالذكاء الاصطناعي وكيفية تطبيقها في القطاع الزراعي ويتناول البحث ايضاً اهمية استعمال الذكاء الاصطناعي الجغرافي في تحسين القطاع الزراعي، مثل تمثيل وتحليل البيانات وتحديد المشكلات التي يعاني منها المحصول الزراعي.

الكلمات المفتاحية: الذكاء الاصطناعي، الجغرافي، النشاط الزراعي.

Introduction:

AI has become widespread across all sectors and fields. It is relied upon in various industries as the world moves towards digital transformation. This is due to its significant importance in solving many problems and rapidly achieving desired results. AI is considered one of the most important achievements of the technological revolution. As a result of the smart applications that have emerged from it, impacting various aspects of life, it has contributed to creating opportunities for limitless innovation, leading to further advanced technological revolutions, in all fields.

This research study focuses on the following:

First: The Research Problem: The problem was represented by the following:

1. How can geographic artificial intelligence be applied in agricultural activity?

2. What are the uses of geographic artificial intelligence in agricultural activity?

Second: Research Hypothesis: Based on the research questions, the following hypotheses are proposed:

1. Artificial intelligence plays a significant role in all branches of physical and human geography, including agricultural geography.

2. Geographic artificial intelligence has multiple applications in agricultural activity, particularly in water resources

and irrigation, crop selection, and crop health monitoring.

Third: The Importance of the Research:

Given the importance of geographic artificial intelligence in agricultural activity, and its effective contribution to it, the idea arose to study the applications of geographic artificial intelligence, particularly researching its importance to agricultural activity.

Fourth: Research Objective:

This research aims to demonstrate the importance of artificial intelligence in geography, in the field of agricultural geography, and to clarify its applications in agricultural activity.

Fifth: Research Methodology:

The research adopted a descriptive approach to describe the importance of using geographic artificial intelligence to achieve desired results in the field of agricultural activity.

First topic: Geographic Artificial Intelligence (Concept, Components, Importance)

First: The Concept of Artificial Intelligence

1. Intelligence:

It is the ability to adapt to new circumstances [1]. In 1935, identical, randomly generated questions would be posed to a computer and a hidden human. If the computer succeeded, the person answering would be unable to distinguish between the machine and the human [2]. Intelligence was then applied to devices that could mimic the thinking process. Humanitarian account. The term "artificial intelligence" was first used in 1956 by John McCarthy. AI research centers such as Carnegie emerged, AI also appeared in the 1970s in several fields, and its use expanded to include banking [3].

The history of artificial intelligence and geography is an evolving one, with the roots of artificial intelligence in geographical sciences being documented in the works of Cuckles (1986) and Smith (1984). In 1997, Stan and Christine Openshaw authored the first book entitled "AI in Geography"[4].

2. AI Concept:

The creation of advanced technologies based on AI, to integrate with efficient computer programs to solve problems through multiple techniques, to enable them to plan, understand, and act in a way that mimics humans [5].

AI is a unique and groundbreaking leap in the world of software, a technological and informational phenomenon that has permeated all aspects of life. It is a modern branch of computer science [6]. AI concept refers to the technological ability to design and develop specialized systems and programs capable of performing tasks similar to human intelligence [7].

3. AI geographic:

The old school of geography, which relied on theoretical and field studies, evolved to incorporate software in the

1960s. The development of geography has been rapid, driven by advancements in methods and tools. These advancements have greatly facilitated the application of geography in various fields, beginning with the use of computers, followed by the use of Geographic Information Systems (GIS) software and aerial imagery, culminating in the information revolution, numerous analytical and statistical tools have been introduced, capable of processing, organizing, classifying, and sequencing very large datasets. This data can then be represented on electronic maps, statistical tables, and graphs, a process known as AI Geographic [8].

Geo-AI is the computer's ability to visualize geospatial data, for analysis and interpretation to inform decision-making, relying on remote sensing [9]. Goe-AI is an AI application that integrates geographic data, including spatial data, sciences, and modern technologies [10].

Second: AI Components:

AI is based on two fundamental principles [11]:

The first principle: Data Representation: Understanding how to represent data helps identify the problem. The computer then solves it appropriately.

The second principle: Searching: The computer solves problems in the appropriate ways.

AI consists [12]:

1. Knowledge Base: It is a set of hypothetical mathematical rules, it has logical relationships between elements and concepts, it is based on experience and practice, it demonstrates multiple ways to solve problems. There are several ways knowledge is represented in an expert system:

A. Rule-based knowledge systems

B. Framework-based knowledge systems

C. Clarity-based knowledge systems

D. State-based knowledge systems

2. Software Resources: These are programmed procedures. These resources facilitate user interaction with the expert system by allowing the input of information and instructions.

3. User Interface: This is a set of procedures that provides the user with suitable tools for interacting with the system during the development and usage phases.

Third: The Importance of AI Agricultural Geographic:

Geo-AI assists in visualizing complex patterns and relationships within a diverse and ever-expanding dataset. Organizations leveraging geographic artificial intelligence (Geo-AI) are revolutionizing the way data is transformed into information, along with models that adapt to evolving data. Features of geographic AI include improved data quality, consistency, and accuracy; streamlined data generation workflows for

increased efficiency and reduced costs; and the ability to monitor and analyze events for faster response times and proactive decision-making [13]. In recent years, AI has become a crucial tool for improving the agricultural sector in ways never before possible. Through predictive analytics, precision agriculture, robotics, and smart water management, farmers can maximize their resource utilization and minimize waste. Furthermore, AI helps address major challenges such as climate change, water scarcity, and population growth, making agriculture more sustainable and efficient in the future [14].

Second topic: Applications of AI Geographic in Agriculture:

Geo-AI is used in various sectors and applications to overcome obstacles and better capitalize on opportunities. It is an application designed to improve agricultural productivity, by leveraging technological advancements. It comprises services, data analysis, and the use of cameras and remote sensing. AI is more efficient in predicting production by studying the environment and soil. This contributes to identifying risks in agriculture. The important applications of AI in agriculture are discussed as follows:

1. AI in geography is applied in geography in general and agriculture in particular, in analyzing and interpreting aerial images captured using drones (Image 1). This technology is used to determine the number of trees and the type of crops in a cultivated area and to identify different agricultural regions [15].

Image (1) Pest control using AI. (Source; www.noonpost.com/35941)

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. It is used in monitoring agricultural crops and soil by integrating artificial intelligence into agriculture. Special devices can be placed inside the farm to monitor insects and determine their type, whether they are harmful or beneficial to the crop. Aerial images can be analyzed and converted into

data to provide a clear view of the health of agricultural crops, soil quality, growth stages, and to detect diseases and insects that agricultural crops are exposed to. This can help farmers take timely measures to prevent the spread of diseases and reduce damage to agricultural crops [16].

3. Creating detailed maps of agricultural crops and their types using aerial photographs taken by drones to capture high-resolution images of cultivated areas [17].

4. Using geographic artificial intelligence to analyze weather data and predict future weather conditions, thus enabling farmers to make better agricultural decisions (Image 1) [18].

AI predicts weather and plant diseases. Plant health is monitored through soil and plant sensing using satellites or drones, by applying increasingly complex algorithms, AI learns. This increases production and reduces losses [18].

5. AI can be used to analyze land and predict the water needs of agricultural crops, thus enabling better irrigation control and improved water management, reducing water waste and enhancing agricultural yields. Smart irrigation systems regulate water distribution more effectively, minimizing losses and conserving natural resources. (Table 1) [20].

Table (1) Smart Irrigation Systems.

Technical type	Water savings rate (%)
Drip irrigation	25
Automated irrigation	20
Humidity sensors	30

Source: Abdul Rahman Al-Salem, Artificial Intelligence in Agriculture: How It Will Change the Future of Agricultural Production, Najd Journal of Agricultural Technologies, 2025.

The systems described above rely on real-time sensor data to automatically adjust water quantities, making the process more precise and simpler for farmers. They also contribute to reduced long-term costs and become even more effective with the application of artificial intelligence technologies in the field.

6. AI uses Geographic Information Systems (GIS) to automatically classify and separate crops from weeds and other plants (Figure 2). This reduces manual labor, thus increasing production efficiency by identifying weeds and diseases and determining how to control them [21].

Image (2) The use of artificial intelligence in agriculture. (Source; https://economy-news.net).

7.

Increased Agricultural Yields: Artificial intelligence helps improve planting and harvesting timing, leading to increased agricultural yields. For example, AI can predict crop productivity with high accuracy by monitoring overall crop health and suggesting best practices based on collected data (Table 2)[22]:

• Continuous analysis of weather and soil data.

• Determining the optimal time for planting and harvesting.

• Monitoring plant health with the help of cameras and sensors.

Table (2) shows some techniques and the percentage increase in agricultural yield.

Technical type	Increase in agricultural yield (%)
Remote sensing	20
Digital soil analysis	15
Smart irrigation systems	25

Source: Abdul Rahman Al-Salem, Artificial Intelligence in Agriculture: How It Will Change the Future of Agricultural Production, Najd Journal of Agricultural Technologies, 2025.

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. Empowering farmers to achieve effective results: AI is changing the perception of modern agriculture by reducing effort. This is transforming traditional farming into modern agriculture. Many believe that AI is merely a digital world, overlooking its potential to assist agriculture [23].

9. Employing AI for Plant Health Monitoring in Modern Agriculture: Monitoring plant health is crucial for productivity and minimizing losses.

The FlyPix AI system offers effective solutions with advantages including:

A. Early detection of plant health changes.

B. Indicating soil suitability for cultivation.

C. Optimizing irrigation practices.

D. Identifying risks in large fields.

Integrating AI with FlyPix reduces waste and improves sustainability, resulting in higher productivity [24].

10. Monitoring and Managing Livestock and Dairy Health: Artificial intelligence (AI) is becoming increasingly important in agriculture, revolutionizing livestock management and monitoring by improving animal health, welfare, and productivity. AI is being implemented in livestock health management through the adoption of diverse and innovative technologies and methods designed to monitor, diagnose, and predict animal health problems. In the dairy industry, AI can be used in the milking process to help identify problems with cows that may affect milk production, thus maximizing milk production efficiency [25].

Conclusions:

Artificial intelligence plays a clear and prominent role in various fields, including agriculture, given its pivotal role in determining cultivated area, crop type, and pest control. Research has shown that artificial intelligence mimics human intelligence by equipping electronic devices with specialized software that simulates human intelligence. The research highlighted the applications of geographic artificial intelligence in the agricultural sector (plant and animal).

Recommendations:

Conducting introductory and guidance seminars on the importance of geographic artificial intelligence (GIS) and its role in agricultural activity. Identifying GIS programs that specialists working in the agricultural sector can adopt. Explaining how to use GIS and training farmers to adopt AI programs as a smart technology that mimics human intelligence.

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