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BIG DATA APPLICATIONS IN CROP YIELD PREDICTION (ЗАСТОСУВАННЯ ВЕЛИКИХ ДАНИХ У ПРОГНОЗУВАННІ УРОЖАЙНОСТІ)

У публікації досліджується вплив баз даних на прогнозування врожайності, розглядається їх значення в сучасному сільському господарстві. Оскільки попит на продукти харчування зростає, інтеграція різноманітних джерел даних, таких як супутникові зображення, дані про погоду та показники стану ґрунту, стає життєво важливою для підвищення продуктивності. Були виділені передові методи аналітики, включаючи машинне навчання та статистичні моделі, які підвищують точність урожайності шляхом врахування факторів навколишнього середовища. Крім того, було розглянуто роль систем моніторингу в реальному часі з використанням датчиків Інтернету речей, що надає фермерам практичну інформацію.

Ключові слова: Бази данних, прогнозування врожайності, аналітика даних, машинне навчання, точне землеробство, супутникові зображення, датчики Інтернету речей, екологічні фактори, здоров'я ґрунту, моніторинг у реальному часі, системи підтримки прийняття рішень, історичні дані, стійкість сільського господарства, прогнозне моделювання, тематичні дослідження.

This publication explores the impact of big data on crop yield prediction, addressing its significance in modern agriculture. As food demand rises, the integration of diverse data sources, such as satellite imagery, weather data, and soil health metrics, becomes vital for improving productivity. There were highlighted advanced analytics techniques, including machine learning and statistical models, that enhance yield accuracy by considering environmental factors. Additionally, there was examined the role of real-time monitoring systems using IoT sensors, providing farmers with actionable insights.

Keywords: Big Data, Crop Yield Prediction, Data Analytics, Machine Learning, Precision Agriculture, Satellite Imagery, IoT Sensors, Environmental Factors, Soil Health, Real-time Monitoring, Decision Support Systems, Historical Data, Agricultural Sustainability, Predictive Modeling, Case Studies.

Data collection and integration are crucial steps in leveraging big data for crop yield prediction. This process involves gathering diverse datasets from multiple sources to create a comprehensive view of agricultural conditions. High-resolution satellite imagery provides valuable information on crop health, land use, and growth stages, allowing for monitoring changes in vegetation and assessing crop conditions. Accurate weather data, including temperature, precipitation, humidity, and wind speed, are essential for understanding how environmental

conditions affect crop growth, sourced from meteorological stations, weather satellites, and online databases. Collecting data on soil properties such as pH, nutrient levels, and moisture content is vital for assessing soil health and its capacity to support crop growth, with soil sensors and laboratory analysis providing this information. Analyzing historical yield data allows researchers to identify trends and patterns, facilitating more accurate predictions; this data can be sourced from agricultural databases, government reports, and local agricultural extension services. Once collected, integration techniques such as data warehousing and data lakes are employed to combine disparate datasets into a unified format, enabling comprehensive analysis and uncovering correlations between different data sources. Effective data collection and integration form the foundation for accurate crop yield predictions, empowering farmers and researchers to make informed decisions and enhance agricultural productivity.

Data analytics techniques play a pivotal role in crop yield prediction by transforming raw data into actionable insights. Advanced analytics approaches, particularly machine learning and statistical modeling, are utilized to analyze the vast amounts of data collected from various sources. Machine learning algorithms, such as regression analysis, decision trees, and neural networks, can identify complex patterns and relationships within the data, enabling more accurate predictions of crop yields based on a multitude of variables. Statistical models help in understanding the underlying distributions of crop yields and the influence of environmental factors, allowing for more precise assessments. These techniques can also incorporate real-time data, providing adaptive models that improve over time as more data becomes available. By applying these data analytics methods, researchers and farmers can gain valuable insights into how factors like weather conditions, soil health, and crop management practices affect yield outcomes. This enables them to optimize farming strategies, enhance productivity, and make informed decisions that contribute to sustainable agricultural practices. The integration of data analytics into crop yield prediction represents a significant advancement in agricultural science, offering the potential to meet growing food demands while ensuring environmental sustainability.

The impact of environmental factors on crop yield is a critical aspect of agricultural science, as these factors significantly influence plant growth and productivity. Key environmental variables include temperature, precipitation, soil quality, and sunlight. Temperature affects physiological processes in plants, such as photosynthesis and respiration; extremes can lead to heat stress or frost damage, both of which can reduce yields. Precipitation is equally important, as it determines water availability for crops. Insufficient rainfall can lead to drought conditions, while excessive rainfall can cause flooding and soil erosion, negatively impacting crop health. Soil quality, encompassing aspects such as nutrient content, pH levels, and organic matter, directly affects a plant's ability to absorb essential nutrients and water. Additionally, sunlight plays a vital role in photosynthesis, with inadequate light exposure limiting plant growth and yield. Understanding the complex interactions between these environmental factors is essential for accurate crop yield predictions. By analyzing historical data and using advanced analytics, researchers can assess how these variables have affected past yields and predict future outcomes under varying conditions. This knowledge helps farmers make informed decisions about crop selection, irrigation practices, and soil management strategies, ultimately enhancing agricultural productivity and sustainability in the face of changing climate conditions.

Real-time monitoring and decision support systems play a transformative role in modern agriculture, particularly in crop yield prediction. By utilizing Internet of Things (IoT) technology, farmers can deploy sensors in the field to continuously monitor various parameters such as soil moisture, temperature, humidity, and crop health. This real-time data collection allows for immediate insights into current growing conditions, enabling farmers to respond quickly to potential issues. For instance, if soil moisture levels drop below a certain threshold, farmers can initiate irrigation to prevent drought stress on their crops. Moreover, integrating this real-time data with big data analytics enhances the predictive capabilities of crop yield models. By analyzing live data alongside historical datasets, farmers can make more informed decisions regarding planting schedules, fertilization, and pest management. Decision support systems can provide recommendations based on predictive

analytics, helping farmers optimize their practices for better yields. Additionally, mobile applications and platforms can deliver these insights directly to farmers in the field, making it easier to implement recommendations on the go. The use of real-time monitoring and decision support not only improves the accuracy of crop yield predictions but also fosters more sustainable agricultural practices, as farmers can make proactive adjustments based on the most current data available. This approach ultimately leads to increased efficiency, reduced waste, and enhanced productivity in the agricultural sector.

Case studies and success stories in the application of big data for crop yield prediction illustrate the significant benefits and advancements achieved in agriculture. Numerous agricultural enterprises and research institutions have successfully implemented big data analytics to enhance yield outcomes and optimize farming practices. For instance, some farms have adopted precision agriculture techniques, utilizing data from satellite imagery and sensors to make informed decisions about planting, fertilization, and irrigation. In these cases, farmers have reported substantial increases in crop yields and reductions in resource usage, demonstrating the effectiveness of data-driven strategies. Additionally, case studies highlight how large-scale agricultural organizations have integrated data analytics into their operations, enabling them to forecast crop yields with greater accuracy and manage risks associated with climate variability. These success stories often showcase collaborative efforts between technology companies and agricultural experts, leading to the development of innovative tools and platforms that facilitate data collection, analysis, and decision-making. Furthermore, the sharing of these experiences through agricultural extension services and industry conferences helps disseminate knowledge and best practices, encouraging more farmers to adopt big data solutions. Overall, these case studies serve as compelling evidence of the potential of big data to transform agriculture, providing insights into effective methodologies that can be replicated across different regions and farming systems, ultimately contributing to improved food security and sustainability.

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STRATEGIC GUIDELINES FOR TOURISM DEVELOPMENT OF TERRITORIAL COMMUNITIES OF MYKOLAIV REGION
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