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Popular Article

Revolutionizing animal breeding: artificial intelligence takes the lead

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Abstract

In recent years, the rapid advancement of technology has permeated various industries, and the field of animal breeding is no exception. This article investigates the revolutionary impact of Artificial Intelligence (AI) and Machine Learning (ML) on enhancing animal genetics, improving breeding programs, and optimizing productivity across diverse species. AI and ML exhibit immense potential by effectively processing vast amounts of data and extracting valuable insights, propelling animal breeding into a new era of precision and efficiency. The integration of AI-powered systems facilitates automated data collection, real-time monitoring, and decision support systems, streamlining the overall breeding process and reducing labor-intensive tasks. Moreover, AI-based image recognition and behavioural analysis algorithms contribute to non-invasive and efficient phenotyping, enabling comprehensive evaluation of animals. As AI continues to evolve, the future of animal breeding holds immense promise for sustainable agriculture, improved animal welfare, and increased food security.

Introduction

Artificial intelligence (AI) has emerged as transformative technologies across various domains, revolutionizing the way we approach complex problems. AI algorithms, such as machine learning and deep learning models, are used to analyse vast amounts of genomic data and accurately predict an animal's genetic value. AI is a valuable tool which leverages the ability to process vast amounts of data and extract valuable insights. It involves the development of algorithms that allow computers to learn and make predictions or decisions without being explicitly programmed, and focuses on creating intelligent machines capable of mimicking human cognitive processes. Machine learning techniques have opened new avenues in animal breeding by enabling the analysis of



extensive datasets encompassing genetic, phenotypic, and environmental factors. ML algorithms can uncover hidden patterns, detect non-linear relationships, and identify genetic markers associated with desirable traits. This knowledge empowers breeders to make more informed decisions regarding selection, mating, and breeding strategies. By accurately predicting the breeding values of animals, ML facilitates the identification and propagation of superior genetic traits, leading to faster and more effective genetic progress. AI has found significant applications in functional genomics within the genomic domain. These applications primarily involve predicting the sequence specificity of DNA- and RNA-binding proteins, methylation status, gene expression, and splicing control. In particular, deep learning (DL) has demonstrated notable success in the field of regulatory genomics. DL models leverage architectures that have been adapted from computer vision and natural language processing applications, allowing for effective analysis and interpretation of genomic data in regulatory contexts.

Enhanced Genetic Selection

Traditionally, animal breeders have relied on selective breeding methods to improve desirable traits in livestock, pets, and even endangered species. AI and ML algorithms are taking this process to new heights by analysing vast datasets and identifying hidden patterns that contribute to superior genetic traits. For example, in dairy cattle breeding, AI-based systems analyse data from multiple sources, including production records, pedigrees, and genomic information, to predict the genetic potential of individual animals for milk production, fertility, and disease resistance (Hickey and Gorjanc, 2020).

Example: A study conducted on dairy cattle breeding utilized AI and ML algorithms to analyse a large dataset comprising production records, genomic information, and pedigrees of thousands of cows. By applying machine learning models, researchers accurately predicted the genetic potential for milk production in individual cows, allowing breeders to selectively breed animals with higher milk yields and improved genetic traits. This resulted in significant improvements in milk production and overall herd productivity (Hickey and Gorjanc, 2020).

Disease Detection and Prevention

One of the most significant challenges in animal breeding is combating genetic diseases. AI and ML algorithms excel at identifying genetic markers associated with various disorders, allowing breeders to detect and mitigate these risks at an early stage. For instance, researchers have used ML



algorithms to analyse genome-wide association studies in pigs and identify genomic regions associated with disease resistance.

Example: In pig breeding, ML algorithms were employed to analyse genomic data from a large population of pigs. By identifying specific genetic markers associated with disease resistance, breeders were able to selectively breed pigs with enhanced resistance to a particular disease. This approach significantly reduced the incidence of the disease within the population, improving animal welfare and overall productivity (Guo et al., 2021).

Optimal Breeding Pairing

Pairing animals for breeding has traditionally relied on breeder expertise and intuition. However, AI and ML are revolutionizing this process by introducing data-driven methods for optimal pairing. For example, in poultry breeding, ML algorithms analyse pedigree, phenotypic, and genomic data to predict the breeding value of individual birds and identify the most suitable mating pairs for improving desired traits such as growth rate, egg production, or disease resistance.

Example: In a poultry breeding program, ML algorithms were utilized to analyse the pedigree and genomic information of individual birds. By considering various factors, including genetic potential for growth, egg production, and disease resistance, the ML algorithms accurately predicted the breeding value of each bird. This information enabled breeders to select the most optimal pairs for mating, resulting in improved growth rates, increased egg production, and enhanced resistance to diseases.

Precision Livestock Farming

AI and ML technologies are also transforming the management and monitoring of livestock farms. Smart sensors, wearable devices, and computer vision algorithms enable continuous monitoring of animal behaviour, health, and productivity. For instance, AI-powered systems can analyse video footage of pigs to detect abnormal behaviours indicative of health issues such as lameness or respiratory problems (Ahmad et al., 2020).

Example: In a pig farming facility, computer vision algorithms were employed to monitor the behaviour of pigs using video cameras. By analysing the pigs' movements, eating patterns, and interactions, the AI system could identify abnormal behaviours associated with lameness or respiratory issues. Early detection allowed farmers to provide timely veterinary care, resulting in improved animal welfare and reduced economic losses (Ahmad et al., 2020).



REML (Restricted Maximum Likelihood) and AIREML (Average Information REML) are statistical methodologies that leverage AI and ML techniques for bull selection in animal breeding. These approaches consider multiple factors, such as performance records, pedigree information, and genetic markers, to estimate the breeding value of a bull. For example, a study conducted on beef cattle breeding used REML to estimate the genetic parameters related to growth and carcass traits. The findings helped identify high-performance bulls for breeding programs, ultimately improving meat quality and production efficiency.

Machine Learning for Breed Identification

AI and ML algorithms have proven to be valuable tools for breed identification, particularly in cases where visual inspection alone may be challenging or unreliable. For example, researchers have developed ML models that analyse images of dog breeds to accurately classify them based on visual features. This capability aids breeders in verifying and maintaining breed purity, especially in situations where crossbreeding may be a concern.

Conclusion

Artificial Intelligence and Machine Learning are revolutionizing animal breeding, enabling breeders to make informed decisions, optimize genetic selection, prevent diseases, and enhance productivity. With the ability to process vast amounts of data and uncover hidden patterns, these technologies, including REML and AIREML, are propelling the field into a new era of precision and efficiency. Additionally, machine learning for breed identification aids in maintaining breed purity and promoting specific traits. As AI and ML continue to evolve, we can expect even greater advancements in animal breeding, ensuring healthier, more resilient, and genetically diverse populations for the future.

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