ARTIFICIAL INTELLIGENCE IN ANIMAL BREEDING: A GAME CHANGER

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Abstract

The incorporation of Artificial Intelligence across various industries, including animal industry, has resulted in substantial progress. The field of Artificial Intelligence has seen extraordinary progress, including advancements in machine learning, deep learning and neural networks, showcasing impressive potential across various sectors. By utilizing advanced data analytics and machine learning algorithms, AI can more accurately forecast breeding outcomes, aiding in the selection of animals with desirable traits like disease resistance, enhanced productivity, and improved reproductive performance. As AI continues to evolve, its integration into breeding programs is expected to accelerate improvements in livestock genetics, making breeding processes more precise and sustainable. Therefore, by capitalizing on its benefits and exploring future possibilities, AI has the capacity to greatly improve animal breeding, facilitating more efficient and accurate genetic selection.

Keywords: Forecast breedings, Learning algorithms, Capitalizing

Introduction

Artificial intelligence (AI), which involves machines replicating human-like intelligence through techniques such as machine learning and deep learning, is playing a crucial role in driving this transformation (Garcia-Vazquez, 2024). These systems can process vast amounts of data much faster than humans, leading to more accurate predictions and more efficient breeding practices. Machine learning (ML) encompasses a variety of techniques, including classification and regression trees, random forests, kernel-based methods, and neural networks, among others. As a broad array of technologies, ML is poised to have a growing influence on animal breeding. In contrast, traditional animal breeding methods, which are highly parameterized, tend to require less data for analysis (Perez-Enciso, 2017). The extensive adoption of neural networks and AI has opened new avenues for research in biology, genetics and animal husbandry. Today, machine learning is actively employed to monitor the health and welfare of animals, identify individual animals with precision, and achieve various other objectives (Soloshenkov et al, 2024). Additionally, AI aids in analysing complex genetic interactions, optimizing breeding strategies, and enhancing the accuracy of performance predictions. These advancements not only streamline research efforts but also contribute to sustainable and ethical practices in animal management. By utilizing sensors, IoT devices and data analytics, AI systems can track and evaluate breeding data, animal behaviour, health indicators and production performance. The real-time analysis of this data facilitates the early identification of illnesses, accurate feeding schedules, and efficient resource management, ultimately enhancing animal welfare, boosting productivity and reducing costs (Hamadani et al., 2024).

Therefore, AI is revolutionizing animal breeding by enabling more precise, efficient and data-driven approaches to genetic selection and livestock management. By analyzing vast datasets, AI facilitates the identification of desirable traits, optimizes breeding strategies and enhances overall productivity in animal agriculture.

How Artificial Intelligence is transforming Animal Breeding

1.Enhancing genetic selection

Genetic improvement, through approaches such as selection between breeds, crossbreeding, and within-breed selection, has been extensively applied to farm livestock. Over the past 50 years, these methods have brought about remarkable advancements in the performance of dairy and beef cattle (Haskell et al., 2014). Production, reproduction, longevity and health traits are central to numerous breeding programs for dairy and beef cattle, with an increasing focus on behavioural traits. AI leverages machine learning algorithms to predict the heritability of desirable traits, such as milk yield, growth rate, and disease resistance. These predictions help breeders make informed decisions to enhance genetic gains. For example, AI-based genetic evaluations are now widely used to optimize breeding plans in Holstein and Angus cattle (Wittenburg et al., 2020). Genomic selection, combined with AI, accelerates the identification of superior breeding animals. AI processes genomic data to predict genetic merit, improving the accuracy and efficiency of selection (Meuwissen et al., 2018). AI helps in detecting optimal breeding times by analyzing physiological data, such as body temperature, hormonal levels, and activity patterns. This leads to higher conception rates and better reproductive efficiency (Choudhary et al., 2021).

2.Improving Animal health and Welfare

Artificial intelligence (AI) algorithms have demonstrated remarkable capabilities in detecting diseases by analyzing medical imaging, enabling veterinarians to identify and classify illnesses with enhanced precision and efficiency. Additionally, predictive analytics leverage diverse data sources, including electronic health records and genetic profiles, to identify patterns and predict disease outbreaks. This allows veterinarians to remotely monitor vital signs and respond promptly, facilitating preventative care

and personalized treatment approaches (Ali and Al-Zubi, 2023). AI technology is transforming our capacity to identify and interpret animal behaviour, providing significant advantages for animal welfare, conservation efforts, scientific research, and farm management (Fuentes et al., 2022). Along with visual algorithms, gathering data on animal behaviour using sensors and training AI models with this information is a widely adopted approach to enhance animal welfare and improve the efficiency of farm management (Carslake et al., 2020).

3.Predicting Breeding Outcomes with Precision

Through the use of machine learning algorithms, AI can analyze vast datasets, including genetic information, performance records and environmental factors, to estimate the potential genetic merit of animals. This allows breeders to identify individuals with desirable traits, such as high milk yield, faster growth rates, or enhanced disease resistance, and make informed decisions about mating strategies. Predictive AI models, powered by genomic selection, have significantly improved the accuracy and speed of genetic evaluations, surpassing traditional breeding methods. For example, studies have demonstrated that AI-driven predictions can enhance the selection of superior sires and dams, ultimately accelerating genetic progress and improving productivity in livestock systems (Meuwissen et al., 2018; VanRaden, 2020). Furthermore, these technologies reduce the need for extensive trial-and-error in breeding programs, saving both time and resources. By integrating AI into breeding strategies, the livestock industry is moving toward more efficient, sustainable and data-driven genetic improvement practices.

4.Improving Breeding Efficiency

In order to improve the breeding efficiency, sustainable breeding practices should be adopted. AI contributes to sustainability by identifying animals that are more efficient in resource utilization, such as feed and water. This efficiency reduces the environmental footprint of breeding programs and promotes sustainable livestock production. AI's ability to analyse complex datasets aids in developing breeding strategies that balance productivity with environmental considerations. Moreover, combining AI with other advanced technologies, such as CRISPR gene editing, holds transformative potential for animal breeding. AI

can analyse large datasets to identify target genes for editing, while CRISPR can make precise genetic modifications (Doudna, 2024).

The Future of AI in Animal Breeding

1. Customized Breeding Programs

AI enables the development of personalized breeding strategies tailored to specific farm objectives, such as disease resistance, milk production, or beef quality. By analyzing genetic data, AI can identify animals with desirable traits, facilitating precision breeding based on individual genomics. This approach allows for more efficient selection, accelerating genetic improvement and enhancing productivity.

2. Advanced Health Monitoring and Predictive Analytics

AI-powered sensors and monitoring systems provide real-time data on animal health, behaviour and performance. This continuous monitoring allows for timely interventions, improving animal welfare and breeding outcomes. For example, AI

has been used to enhance the success rates of IVF treatments by matching the strongest sperm with the highest quality eggs, demonstrating its potential in reproductive management.

3. Ethical Considerations

As AI adoption grows, ethical discussions will intensify. Breeders must consider animal welfare, environmental impact and community engagement. Transparency about AI use and genetic modifications is essential to maintain public trust and ensure responsible implementation. Engaging with stakeholders and adhering to ethical guidelines will be crucial in navigating the future of AI in animal breeding.

Therefore, the future of AI in animal breeding holds immense potential to transform traditional practices, leading to more efficient, precise and sustainable livestock management. By embracing AI technologies, breeders can address global challenges such as food security and environmental sustainability, paving the way for a more resilient agricultural future.

Conclusion

AI is undoubtedly a game changer in animal breeding, offering unparalleled opportunities to improve the efficiency, health and productivity of livestock. By harnessing the power of AI, breeders can make data-driven decisions that lead to healthier animals, better breeding outcomes and more sustainable practices. AI stands as a transformative force in animal breeding, offering innovative solutions to traditional challenges. By embracing AI technologies, the agricultural sector can achieve more sustainable, efficient and ethical breeding practices, meeting the growing global demand for animal products while ensuring the well-being of livestock.

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