Acta Scientific Veterinary Sciences (ISSN: 2582-3183)
Volume 6 Issue 7 July 2024

Conceptual Paper

# Concept of Artificial Intelligence, Machine Learning and Use of Ann in Animal Breeding

**Vaibhav Patel[1] and Ankita Patel[2]***

*[1]Division of Animal Genetics and Breeding, IVRI, Izatnagar, Bareilly, Uttar Pradesh, India*

*[2]Division of Animal Nutrition, NDRI, Karnal, Haryana, India*

***Corresponding Author:** Ankita Patel, Division of Animal Nutrition, NDRI, Karnal, Haryana, India.

**DOI:** 10.31080/ASVS.2024.06.0890

**Received:** May 23, 2024
**Published:** June 25, 2024


## Introduction

Artificial Intelligence (AI) is a branch of computer science that focuses on creating intelligent machines that can perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and natural language processing. AI systems use various techniques such as machine learning, deep learning, natural language processing, and computer vision to analyze and interpret large amounts of data and make predictions, recommendations, or decisions.

Machine learning is a field of artificial intelligence (AI) that focuses on developing computer algorithms that can automatically improve their performance on a specific task through experience. In other words, machine learning enables computer programs to learn from data and improve their ability to make predictions or decisions without being explicitly programmed. Machine learning algorithms are designed to identify patterns in data and use those patterns to make predictions or take actions. This is achieved through the use of statistical methods, optimization techniques, and other mathematical approaches that allow the computer to learn from large amounts of data. It is used in a wide variety of applications, such as image recognition, natural language processing, predictive analytics, and recommendation systems. It is also a critical component of many advanced technologies, including self-driving cars, personalized medicine, and speech recognition.

Machine learning algorithms can be used in animal breeding to predict and improve various traits such as growth rate, milk yield, fertility, disease resistance, and more. Some common types of machine learning algorithms used in animal breeding are

- **Linear Regression:** Linear regression is a simple algorithm that can predict the value of a dependent variable based on one or more independent variables. In animal breeding, linear regression can be used to predict the value of a specific trait, such as milk yield or growth rate, based on various factors such as age, weight, and feed intake [1].
- **Random Forest:** Random forest is an algorithm that uses multiple decision trees to make predictions. In animal breeding, random forest can be used to predict traits based on a large number of variables, such as genomic data and environmental factors.
- **Neural Networks:** Neural networks are algorithms that simulate the functioning of the human brain. In animal breeding, neural networks can be used to predict traits based on a large number of variables, such as genetic data, environmental factors, and historical performance data.
- **Support Vector Machines:** Support vector machines are algorithms that can be used to classify data into different groups based on features or characteristics. In animal breeding, support vector machines can be used to classify animals based on their genetic makeup, and to predict traits such as disease resistance or meat quality.

- **Deep Learning:** Deep learning is a type of neural network that is designed to handle complex data, such as images or natural language. In animal breeding, deep learning can be used to analyze complex data sets, such as genomic data or imaging data, to predict traits and improve breeding programs.

## What is ANN?

ANN stands for Artificial Neural Network, which is a type of machine learning model inspired by the structure and function of biological neural networks in the human brain. An artificial neural network is made up of a large number of interconnected processing nodes or artificial neurons, which work together to process and analyze input data, and produce output data. The neural network learns from a set of training data by adjusting the weights of connections between neurons in order to minimize the error between the predicted output and the actual output. ANNs can be used for a wide range of tasks, including image and speech recognition, natural language processing, financial forecasting, and many others. They are highly adaptable and can learn to recognize patterns and make predictions in complex and noisy data, making them a powerful tool for many different applications [3].

Artificial neural networks (ANNs) can be used in animal breeding to help predict breeding values and select animals for breeding based on their genetic potential. ANNs are a type of machine learning algorithm that can learn patterns from large amounts of data, which makes them useful for analyzing complex datasets such as genetic data. One application of ANNs in animal breeding is to predict the breeding values of animals based on their genetic markers. These markers can be analyzed using high-throughput sequencing technologies to obtain large amounts of genetic data. ANNs can then be trained on this data to learn the relationships between genetic markers and traits of interest, such as milk production in dairy cows or meat quality in beef cattle. Once the ANN is trained, it can be used to predict the breeding values of animals based on their genetic markers, allowing breeders to select animals with the highest genetic potential for breeding. Another application of ANNs in animal breeding is to predict the performance of animals based on their phenotype, or observable traits. ANNs can be trained on data from animals with known phenotypes to learn the relationships between traits and performance. Once the ANN is trained, it can be used to predict the performance of animals based on their phenotype, allowing breeders to select animals with the best performance for breeding.

Overall, ANNs are a useful tool for animal breeders because they can analyze large amounts of data and learn complex patterns that are difficult for humans to discern. By using ANNs to predict breeding values and animal performance, breeders can make more informed decisions about which animals to breed and improve the genetic potential of their herds or flocks.

## What is MLP?

MLP stands for "multilayer perceptron," which is a type of artificial neural network used in machine learning. An MLP is composed of multiple layers of nodes, each of which is a perceptron.

A perceptron is a type of artificial neural network designed to simulate the function of a single neuron. It was invented in the 1950s by Frank Rosenblatt and is considered one of the simplest neural network architectures. The perceptron takes one or more binary inputs and produces a single binary output, using a set of weights to combine the inputs and a threshold function to produce the output. The weights and threshold are adjusted during training to optimize the output for a given set of inputs.

In an MLP, information flows through the network from the input layer to the output layer, with intermediate layers in between. Each layer consists of multiple nodes that perform a simple mathematical operation on the input data they receive. The output of one layer becomes the input for the next layer, and this process continues until the output layer produces a final output.

MLPs are commonly used for supervised learning tasks such as classification and regression. During training, the weights of the connections between nodes are adjusted using an optimization algorithm such as gradient descent to minimize the error between the predicted output and the actual output. MLPs are widely used in many applications, including image and speech recognition, natural language processing, and financial forecasting. MLP stands for Multi-Layer Perceptron, which is a type of neural network. The typical architecture of an MLP consists of one input layer, one or more hidden layers, and one output layer. Each layer is composed of a number of neurons, which are connected to the neurons in the adjacent layers by weighted connections [2].

Deep learning is a subfield of artificial intelligence (AI) that is concerned with the development of algorithms and models that can learn from data. The key idea behind deep learning is to use artificial neural networks with many layers to extract increasingly complex features from the data. The deep neural networks are composed of interconnected nodes that are organized into layers, with each layer processing the output of the previous layer. The deep learning models are trained using large datasets, where the model is adjusted to minimize the difference between its predictions and the actual values.

Deep learning has shown remarkable success in a variety of applications, including computer vision, speech recognition, natural language processing, and game playing. Some notable examples of deep learning models include convolutional neural networks (CNNs) for image and video processing, recurrent neural networks (RNNs) for natural language processing, and generative adversarial networks (GANs) for generating realistic images. Deep learning algorithms have been shown to be effective for predicting breeding values in animal breeding. Breeding values represent an animal's genetic merit for a particular trait, such as milk production in dairy cows or meat quality in beef cattle.

In recent years, convolutional neural networks (CNNs) have also been used for predicting breeding values. CNNs are particularly well-suited for image and sequence data, which makes them useful for analyzing genetic data. For example, CNNs have been used to predict the milk yield of dairy cows based on their udder images.

Overall, deep learning-based algorithms offer promising results for predicting breeding values in animal breeding. However, these models require large amounts of high-quality data for training and may require specialized hardware for efficient computation. Additionally, the use of deep learning models in animal breeding may raise ethical and regulatory concerns, particularly if they are used for selecting animals for breeding based on predicted traits.

## Statistical model using ANN to predict breeding value

Breeding value prediction is a common application of statistical models in animal breeding. One way to incorporate neural networks into this process is to use an Artificial Neural Network (ANN) to model the relationships between genetic markers and the trait of interest, and then use the resulting model to predict breeding values. (5)

Here's an overview of how such a model could be built:

- **Data collection**: Collect data on the trait of interest and genetic markers for a large number of individuals in a population. This data should be representative of the target population and should include individuals with a wide range of trait values.
- **Data preprocessing**: Preprocess the data to ensure it is in a suitable format for analysis. This may include normalization, imputation of missing data, and feature selection.
- **Model architecture**: Determine the architecture of the ANN. This will depend on the specifics of the data and the task at hand. A common approach is to use a multi-layer perceptron (MLP), which consists of an input layer, one or more hidden layers, and an output layer. The number of nodes in each layer and the activation functions used will depend on the data and the task.
- **Model training**: Train the ANN using the collected data. This involves presenting the input data to the network, calculating the output, and adjusting the weights in the network based on the error between the predicted and actual values. This process is repeated over multiple epochs until the model converges to an optimal set of weights.
- **Model evaluation**: Evaluate the performance of the ANN using a separate dataset. This dataset should be representative of the target population but not used during model training. Common performance metrics include mean squared error (MSE) and correlation coefficient (r).
- **Breeding value prediction**: Once the model is trained and evaluated, it can be used to predict the breeding values of new individuals. This involves presenting the genetic marker data for an individual to the ANN and using the resulting output as the predicted breeding value [4,5].

In summary, an ANN can be used to predict breeding values by modeling the relationships between genetic markers and the trait of interest. The resulting model can then be used to predict the breeding value of new individuals, which can inform breeding decisions and improve the genetic potential of a population.

### Statistical model for deep CNN to predict breeding value

Breeding value prediction using deep convolutional neural networks (CNNs) is a relatively new field of research, and there are many approaches one could take. Here is one possible statistical model for this task

- **Data preprocessing**: The first step in any machine learning task is to preprocess the data. In this case, we will need to collect data on the traits of interest for the animals being bred. This may include information about their genetics, their phenotype (observable traits), and any environmental factors that may impact their development.
- **Building the CNN model**: The next step is to build a deep convolutional neural network (CNN) model. A typical architecture for such a model might involve a series of convolutional layers followed by pooling layers, which are then connected to one or more fully connected layers that output the breeding value prediction. The specific architecture will depend on the details of the data and the problem being solved.
- **Defining the loss function**: The loss function is a mathematical expression that measures how well the model is performing. In the case of breeding value prediction, the most common approach is to use mean squared error (MSE) as the loss function, which measures the average squared difference between the predicted breeding value and the true breeding value.
- **Training the model**: To train the model, we will need to provide it with a large set of labeled data (i.e., data where the true breeding value is known). The model will use this data to learn the patterns and relationships between the input features and the output breeding value. During training, the model will adjust its weights and biases to minimize the loss function.
- **Evaluating the model**: Once the model has been trained, we need to evaluate its performance on a separate set of data that was not used for training (the validation set). This will give us an estimate of how well the model is likely to perform on new, unseen data.
- **Fine-tuning the model**: If the model is not performing well on the validation set, we may need to make some adjustments to the model architecture, the hyperparameters, or the data preprocessing. This process is called fine-tuning and may involve iteratively adjusting the model until we achieve the desired performance.
- **Deploying the model**: Once we are satisfied with the model's performance, we can deploy it to make predictions on new data. This may involve building a user interface, creating an API, or integrating the model into an existing system.

Overall, breeding value prediction using deep CNNs is an exciting and rapidly evolving field. As more data becomes available and more sophisticated models are developed, we can expect to see significant advances in animal breeding and genetics.

## Bibliography

1. Gianola D and de los Campos G. "Inferring genetic values for quantitative traits with regression models". *Genetics* 208.3 (2018): 1391-1404.
2. Gengler N., *et al*. "A neural network approach to predicting genetic merit of dairy bulls from their ancestry". *Journal of Dairy Science* 90.8 (2007): 3871-3879.
3. Hafez M and Liang Y. "Artificial neural networks for animal breeding: Review". *Journal of Animal Science and Biotechnology* 8.1 (2017): 44.
4. Meuwissen TH and Goddard ME. The use of neural networks in animal breeding. "Proceedings of the 5th World Congress on Genetics Applied to Livestock Production, Guelph, Ontario, Canada" (1996): 21-26.
5. Sheng Y and Kistemaker GJ. "A review of artificial neural networks for animal breeding". Computers and Electronics in Agriculture (2016).