

Analysing Hucul Horses by AI

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The neural classification system in form of a multi-layered artificial neural network suggested in this paper was implemented in the programming environment MATLAB. MATLAB is a useful tool focused mainly on scientific and technical calculations. It boasts of a wide spectrum of software solutions/libraries, the so-called Toolboxes that can be used, for example to create and optimize neural networks. It is fully compatible with other programming environments. Matlab is a tool for rapid prototyping that enables a wide range of learning algorithms, the selection of optimal neural network architecture, the selection of the most efficient neuron activation functions as well as optimal learning parameters.

The design of the network is of key significance both for the learning process, and the quality of its operation in later stages. The set of input data, purpose, and results do have significant impact on the they configuration. A key assumption is taking cognizance of factual links between the set of explanatory variables (input) and the output.

The artificial neural networks enable the capture of relationships and dependencies between the data in circumstances where the application of traditional analytical methods would not have yielded satisfactory solutions.

The use of ANN enables objective assessments of individual animals by taking into account only factors essential for determining horses' performance and breeding values.

Preliminary results of the application of artificial neural networks in predicting the utility value of Hucul horses, relying on a specific set of features seem rather promising.

It offers potential possibilities of evaluation, relying on available information about the animals.

artificial neural networks, horses, performance,

classification,

breeding

1. Introduction

The application of artificial neural networks (ANN) has already become commonplace in modelling as well as in the optimization of several processes in technical studies ^{[1][2]}. It is also increasingly becoming a subject of interest to scientists engaged in issues concerning animal breeding and use and optimal nutrition ^{[3][4][5][6][7][8]}. This has been due, partly though, to the need to seek alternative methods with high potentials of application and offer reliable information (data) that enhances forecasting. The designing of an appropriate model that takes account of measurable and immeasurable features offers possibilities for, amongst others, forecasting the occurrence of lameness in horses ^[3], assessing animal behaviors while estimating their levels of welfare ^[9], analyzing the factors impacting on milk yield in cows ^[4] and goats ^[10], susceptibility to mastitis in cattle ^{[6][11]} as well as the risk of occurrence of complications in parturition ^[12], predicting the occurrence of African horse sickness ^[13], in genomic selection in cattle ^[14], and including research in the field of evolution ^[15]. Data analysis with the use of artificial

neural networks would pave the way for precise classification and adjustments to the expected pattern, clustering, modelling, and forecasting. Their undisputed leverage over traditional methods is their ability to process, learn, and generalize information simultaneously. This offers the opportunity to exploit a variety of information, including incomplete data.

Hucul horses are one of the oldest horse breeds consolidated in mountainous areas of several countries in Central Europe. Reports, where many of its advantages were emphasized, date back to 1874. These primitive horses are characterized by remarkable resilience and strength, not being picky in terms of feed and feed use, high fertility, and longevity ^{[16][17]}. These features have made Hucul horses very popular, not only in mountain tourism, but also in hippotherapy, therapeutic riding ^{[18][19]}. Despite their increase in numbers, the population of Hucul horses is yet to attain the size considered safe for the preservation of genetic variety, this being the reason why the breed is covered by the Genetic Resources Conservation Program. One of the program's assumptions is to assess the breeding and utility values in order to preserve the pattern of small but valiant mountain horse ^[20]. Moreover, measures are needed to preserve all female families as well as the male lines. Traditional methods for evaluating horse performance and breeding value are time-consuming and expensive, while covering only a fragment of the active population. Besides, the results may be impaired by errors accruing to the influence of both external and environmental factors. Such limitations call for the necessity to research alternative methods that allow the analysis of multiple variables covering several years. Hence, this study that relies on artificial neural networks can become a crucially interesting tool which will allow the identification and analysis of features that significantly influence the utility values of Hucul horses and also significantly shorten the time necessary to obtain such information. The approach proposed for the manuscript is novel, as previous works using ANN on equines had focused on singular problems, for example lameness (3), colic (5), and African horse sickness (13).

2. Materials and Methods

The study exploits the results obtained during 2009–2015 final competitions of the National Breeding and Utility Championships for Hucul horses. The program for breeding Hucul horses ^[20] stipulates that the test for utility value for horses aged 4 and above is for them to successfully complete the National Utility Championships, which covers assessments of the exterior (breeding championships), the Hucul path and endurance.

The Hucul path contest was in 2009–2015 held over distances ranging from 3150 m (2010) to 5215m (2009), with the number of obstacles along the route ranging from 21 (2009) to 35 (2013). The test for fitness took place over a distance ranging from 15 km (2012) to 23 km (2011).

The research material collected enabled the creation of a set of input data (for the artificial neural network), out of which independent learning and testing sets were isolated. The explanatory variables were selected relying on the expert's knowledge and indications.

Each horse was described using features in three models:

1. Model 1 – with 21 explanatory variables that include sex, age, father, lineage, family, breeder, owner and the attributes being assessed during the championships.
2. Model 2 – with 18 explanatory variables similar to model 1 except for the breeder, forms of ownership and inbreeding coefficient.
3. Model 3 – with 19 explanatory variables similar to model 2 but with information about the number of participations of the individual within the study period being included. The ANN structure (framework) for model 2 is illustrated in Figure 1.

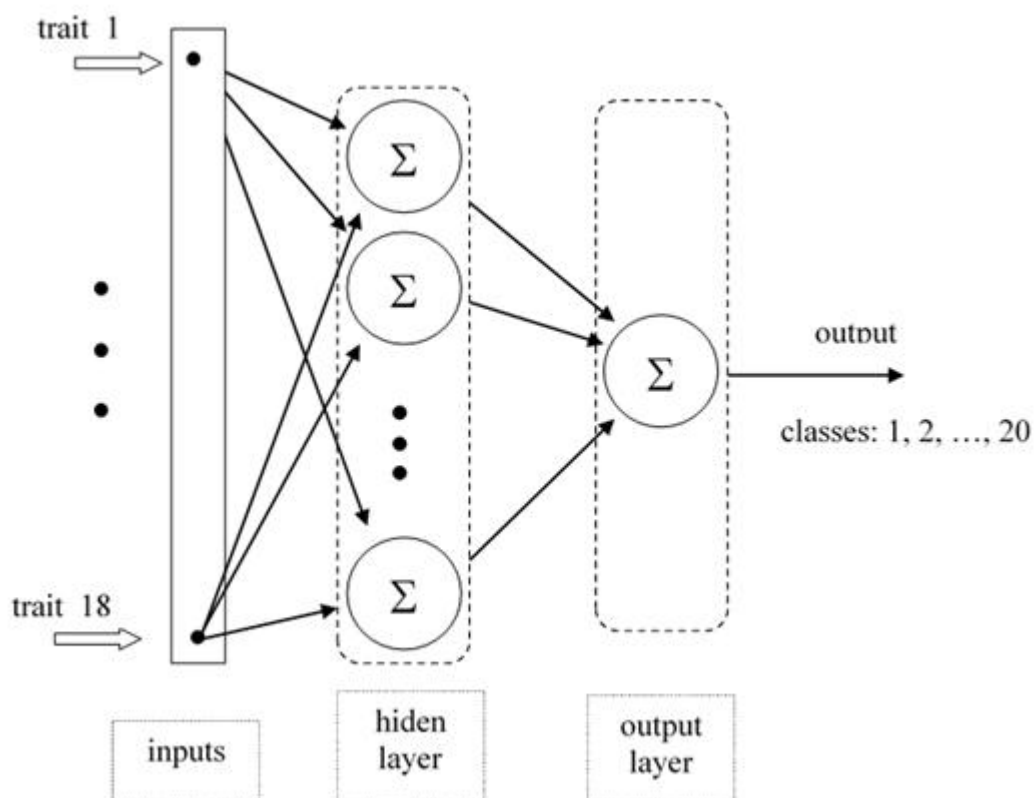


Figure 1. The artificial neural networks (ANN) structure.

3. Conclusions

The three models tested differed in their numbers of explanatory variables as well as the number of proposed classes for the classification of Hucul horses. It has been demonstrated that the best results in the form of compliance between the expert's indication and the neural network were obtained for 18 explanatory variables and 20 classes. Such explanatory variables as sex, age, and genealogy turned out to be significant, while the breeder, ownership type, level of inbreeding coefficient, as well as the number of horse starts were less significant.

Preliminary results of the application of artificial neural networks in predicting the utility value of Hucul horses, relying on a specific set of features seem rather promising. It thus offers potential possibilities of evaluation, relying on available information, and a larger group of horses rather than individual horses partaking in utility

championships. The results obtained can also serve as a good tool in search of individual animals for optimal matchmaking.

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