DECISION SUPPORT SYSTEM FOR GAMEFOWL PERFORMANCE FORECASTING

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ABSTRACT

This study is directed towards the development of the Decision Support System for Gamefowl Performance Forecasting for RJT Cock Farm in Barangay Salvacion, Buenavista, Guimaras, Philippines. The software is provided with years' worth of data that include cock and hen profiles, breeding profile, health and medication, sparring records, and most importantly fight records as main input. The aforementioned data were gathered, processed, and analyzed in order to come up with reliable forecasts and efficient management of gamefowl records.

To realize its primary goal, Bayesian Algorithm was integrated in the system as an enabler for its data analysis component which will forecast the winning probability of gamefowls. As for the system's performance, the proponent used F-measure to evaluate the accuracy of the system's forecasting capability against actual cock performance in sparring and real fight.

Moreover, the system was evaluated based on the ISO 25010 International Quality Standards for computer software. The result revealed that the system highly conforms to international standards in terms of its functionality suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. During the accuracy test, the F-Measure value using the harmonic mean of precision and recall is 78.25% which implies that the accuracy of the forecasting capability of the system is Medium to High. Meanwhile, an over-all mean of 4.73 establishes that the system has "excellent" quality based on the ISO 25010 International Standards.

KEYWORDS – Forecast, F-measure, Gamefowls, Performance, Decision Support System

INTRODUCTION

Settling on choices concerning complex frameworks frequently strains our psychological abilities. Despite the fact that individual interactions among a system's variables may be well understood, predicting how the system will react to an external manipulation such as a policy decision is often difficult. A lot of constraints are involved in complex and often fine interdependencies and predicting the total outcome may be overwhelming. There is a substantial amount of empirical evidence that human intuitive judgment and decision making can be far from optimal, and it deteriorates even further with complexity and stress.

In the case of gamefowl breeding and cockfighting, in which in many situations the quality of decisions is important, aiding the deficiencies of human judgment and decision making has been a major focus of the breeding and gaming community. The tradition of cockfighting is widespread throughout the world; there is no doubt that the gamefowl has evolved together with the human culture of cockfighting for a long time. In Japan, there is a group of gamefowls called ''Shamo'' that are used specifically for cockfighting [1]. The cultural history of cockfighting chicken varieties is found not only in Japan but also in other Asian countries such as Indonesia and China. Through the examination of historical records, a description about fighting cocks was found in a book written by Zuo Zhuan in China in 517 BC. This implies that the cockfighting culture occurred in China more than 2500 years ago. [2].

In cockfighting, training (behavior modification and learning) is an important factor that must be considered in a conditioning program. Fitness must keep pace with increased learning in order to prevent fatigue and lameness from negatively affecting the ability or willingness to learn. Conversely, training must be adequate in order to channel the level of fitness toward the competitive activity [3]. In race horses, for instance, sprint work is essential in conditioning two-year-olds, but they are not mentally mature enough to handle very much of it [4].

As the saying goes, "Necessity is the mother of all inventions and humans have that propensity to create things that could make life easier". In this context, the existence of advance computer technology is considered as one of the best things to be harnessed to make things function automatically and bring convenience to a certain activity. The traditional practice could be improved with the aid of a computer system that has the capability of linking the past events with the current ones which can supply accurate information and a very reliable basis in decision making and forecasting.

The RJT Farm named after the three brothers Rommel, Japheth and Teddy Ken situated in Salvacion, Buenavista, Guimaras like all other small and developing game cock farm was challenged by not having an effective and efficient input recording. Aside from this, the owner-manager also finds it difficult to make sure that all facilitating and hindering factors from egg incubation, chick rearing to stag and derby cock conditioning are uniformly observed by all farmhands. A twenty-four seven close monitoring of the owner manager is needed. To compensate with the farm's record-keeping demands, the farm is practicing manual recording of virtually all areas of farm operation that are encoded via Microsoft excel. The challenge remains that this manually recorded data remains as raw data and are never processed to be used as scientific basis for crucial farm decisions that will influence their production of gamefowl breeds as well as forecasting of cock performance during fights.

To answer this challenge which remains hinging over the years, the researcher developed a Decision Support System for Gamefowl Performance Forecasting which could help process data scientifically. In this system, the game fowl farmer would no longer record data manually nor predict the chances of winning or losing of a gamefowl by mere intuition. Rather, he/she would be aided by the program which is scientifically made.

LITERATURE REVIEW

Decision Support System (DSS)

Decision Support System (DSS) is a computer program application that analyzes business data and presents it so that the users can make business or farm decisions more easily. It is an "informational operation" that collects data in the course of normal farm operations. Typical information that a decision application might gather and present would be Decision Support System application might gather and present be Decision Support System are computer-based information systems that provide interactive decision support to farm managers and business professionals particularly gamefowl breeders during decision-making process. Decision support system use (1) analytical models, (2) specialized databases, (3) a decision maker's own insights and judgments, and (4) an interactive, computer-based modelling process to support the making of semi-structured business decisions [19].

A decision support system may present information graphically and may include an expert system or artificial intelligence (AI). It may be aimed at business executives or some other group of knowledge workers. Whereas, a knowledge worker might be someone who works at any of the tasks of planning, acquiring, searching, analyzing, organizing, storing, programming, distributing, marketing, or otherwise contributing to the transformation and commerce of information and those who work at using the knowledge so produced. Such people also includes those in the information technology fields, such as programmers, systems analysts, technical writers, academic professionals, researchers, and so forth.

The researcher is aware that Decision Support Systems are gaining an increased popularity in various domains, including business, engineering, the military, and medicine. In this study a DSS is especially valuable in situations in which the amount of available information is prohibitive for the intuition of an unaided human decision maker and in which precision and optimality are of importance. Decision support systems can aid human cognitive deficiencies by integrating various sources of information, providing intelligent access to relevant knowledge, and aiding the process of structuring decisions. They can also employ artificial intelligence methods to address heuristically problems that are intractable by formal techniques. In the rarely explored field of game fowl breeding and cockfighting, proper application of decision-making tools increases productivity, efficiency, and effectiveness and gives a game farm such as RJT a significant advantage over their competitors, allowing them to make optimal choices for crucial processes and their parameters, business operations, logistics, or investments.

F- Measure

The F-measure can be viewed as a compromise between recall and precision. It is high only when both recall and precision are high. It is equivalent to recall when $\alpha = 0$ and precision when $\alpha = 1$. The F-measure assumes values in the interval {0,1}. It is 0 when no relevant documents have been retrieved, and 1 if all retrieved documents are relevant and all relevant documents have been retrieved [20].

According to Barbara Catania et al., the F –Measure values ranges from 68% - 95 % indicating a high effectiveness of the enrichment approach thus demonstrating its viability [21].

In this study the researcher used the F measure to test the accuracy of the system by computing the numbers of true positive, false positive, true negative, and false negative from the generated forecast and the game fowl's actual fight and sparring data.

On the use of Bayesian Algorithm

Bayesian refers to methods in probability and statistics named after Thomas Bayes (c. 1702–61), in particular methods related to statistical inference: Bayesian probability or degree-of-belief interpretation of probability, as opposed to frequency or proportion or propensity interpretations. On the other hand, an algorithm is a set of rules for doing a calculation. The Bayesian algorithm is a set of rules for using evidence (data) to change your beliefs. The Bayesian approach to inference, as well as decision-making and forecasting, involves conditioning on what is known to make statements about what is not known [22].

In this study, it is understood that in order to develop a decision support system and forecasting for game fowl, an appropriate algorithm is necessary. Looking at the study's application domain, since the system includes a feature on forecasting, the researcher determined the type of algorithm suited for the study. Of the algorithms, one specific type stood out from the rest- the Bayesian Algorithm.

Based on a set of variables or parameters such as the game fowl's breed and conditioning, it's possible to predict fight outcomes based on probabilities. These variables are connected in such a way that the resulting value of one variable will influence the output probability of another, hence the use of networked nodes. The algorithm was used to generate forecasting by combining evidence using Baye's Rule and deriving the following formula:

$$\frac{P(W) * P\left(\frac{Wb}{W}\right) * P\left(\frac{Wc}{W}\right)}{\left(P(W) * P\left(\frac{Wb}{W}\right) * P\left(\frac{Wc}{W}\right)\right) + \left(P(NW) * P\left(\frac{Wb}{NW}\right) * P\left(\frac{Wc}{NW}\right)\right)}$$

The important part of Bayes' Theorem is the observation of previous events, or the degree of belief that something will occur. If there is a degree of belief of one event happening, it can be applied to new data and make an informed calculation to its probability.

Precision Agriculture and Farming

In precision agriculture, real time and historically generated data is collected in structured and unstructured datasets. As precision agriculture generates more data in the unstructured form and current research trend is to find knowledgeable information from them [23]. In the agriculture sector, ICT plays an important role to provide new technologies for data generation, transformation, and management [24]. New technology provides a framework for finding insights from data to give decisions regarding improve productivity and unwanted investment in advance.

The researchers in [27] present preliminary experimental results from a system to predict the onset of disease in feedlot cattle. Working in conjunction with the Alberta Research Council and two industrial partners, they developed an intelligent system that receives sensor data from a live animal-mounted platform, and classifies the animals into two groups: those requiring medical intervention within the next k days, and those that do not. Their discussion revolves around a single sensor, which records watering events in a feedlot setting using a proprietary design. They use time-series prediction methods to analyze the sequence of watering events for individual cows, and relate them to interventions by the producer. It is found that livestock disease management is thus a process of loss

minimization: the farmer will isolate an infected animal as early as possible to minimize the spread of disease, and attempt to treat the animal.

In this study, the principles of Precision Livestock Farming will still be applied but will be further enhanced by the use of a Decision Support System. One of the areas of the PLF that needs monitoring is the health, conditioning, and performance of game fowls. As the demand of quality game fowl production increases, the owner of RJT game farm have lesser time in monitoring the many features that would demand correlation of game fowl performance with its breeding, feeding, health, weight and growth profiles.

Forecasting

Planning is an integral part of a manager's job. If uncertainties cloud the planning horizon, managers will find it difficult to plan effectively. Forecasts help managers by reducing some of the uncertainty, thereby enabling them to develop more meaningful plans. A forecast is a statement about the future. Forecasting is a popular numerical prediction method for modeling nonlinear dynamic systems, such as climate [28], agriculture [29], ecological [30], and hydrological [31] systems. Specifically, the future states of the systems are predicted using computer models that simulate the physical processes governing the behavior of such systems. Furthermore, multi-task learning is an approach designed to improve predictive performance by learning from multiple related tasks simultaneously, taking into account the relationships and information shared among the different tasks.

In this study, forecasting for the performance of gamefowls is not an exact science. Instead, successful forecasting would also require a skillful blending of art and science. Experience, judgment, and technical expertise all play a role in developing useful forecasts. Along with these, a certain amount of past experience and expert's judgments can be helpful. Current forecasting techniques range from the mundane to the exotic. Some work better than others, but no single technique works all the time. In the case of this study, the responsibility for preparing breeding decisions and fight performance predictions for a game farm operator lies with historical data rather than day-to-day operations. Nonetheless, current operations data are also put into consideration to make certain forecasts and to help others prepare forecasts. In addition, because forecasts are major inputs for many operations decisions, operations managers and staff must be knowledgeable about the kinds of forecasting techniques available, the assumptions that underlie their use, and their limitations. It is also important for the game farm owner to consider how forecasts affect overall operations.

METHODOLOGY

Project Description

The development of the Decision Support System for Gamefowl Performance Forecasting is the main deliverable of the proponent's study conducted at RJT Cock Farm in Barangay Salvacion, Buenavista, Guimaras, Philippines.

Successful conditioning of game fowls depends on several factors. Game fowls differ in ability, behavior, and strength, and cockfight events vary enough in duration and intensity to require specialized training programs. Regardless of the competition or the game fowl, there are several important concepts that should be employed to develop a well-conditioned game fowl. As cockfighting communities adopt principles based on experience and thorough observation, a well-founded approach based on scientific methods is believed to be a more reliable guide. For breeders, it is crucial that every aspect of a game fowl's breeding, medication, and conditioning should be recorded. Such data will be invaluable when it comes to the production of breeds that are highly desirable and sought by cockfighters. On the part of the researcher, it is argued that sufficient data of said nature can be used for the prediction of game fowl performance during a cockfight. As such, years' worth of breeding, conditioning, and fight data have been the most important aspect of the system's conceptualization and development. To aid with the forecasting, Bayesian Algorithm is used to determine the winning probability of a game fowl based on its breed, conditioning method, and fight record.

Based on the recommendation of domain experts, the researcher identified the necessary data, components, and functionalities which established the architecture of the system as shown in Figure 1.

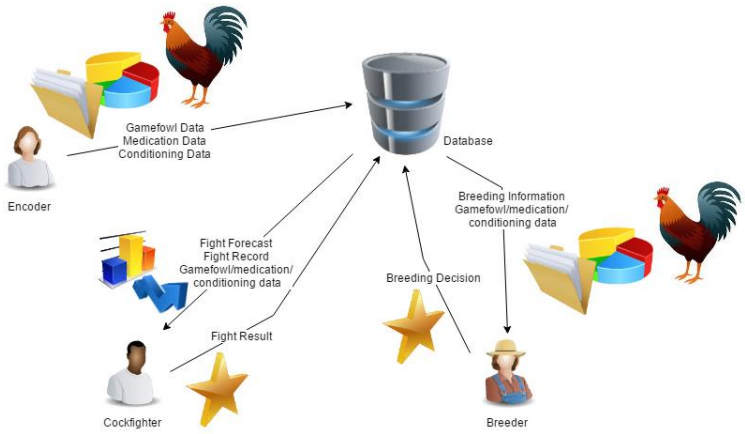

Figure 1. The System Architecture

Table 1. Hardware Specification

CPU Type Model	Dual Core 2.3 GHz or Higher
Storage Type	500 GB Hard Disk or Higher
Input	Mouse, Keyboard
Output	Monitor, Printer

Table 2. Software Specification

Operating System	Microsoft Windows 7 or Higher
Programming Software	Borland Delphi
Database	Absolute DB

CONCLUSIONS

The system was implemented and evaluated in terms of its accuracy by comparing it with actual fight data as well as its quality through evaluation by domain experts. Hence, the following conclusions are drawn:

1. The "Decision Support System for Gamefowl Performance Forecasting" presented in this study was able to:
    a. Record game fowl profiles through the game fowl information module;
    b. Record the health status of game fowls through the health, vaccination and medication module;
    c. Record the breeding profile of game fowls through the breeding module;
    d. Record game fowl performance profile through the fight record module;
    e. Record gamefowl data through the data analysis module which forecasted the winning probability of gamefowl using Bayesian Algorithm.
2. The accuracy of the system's forecasting capability against actual cock performance in sparring and real fight was evaluated using F-Measure. The F-Measure value was 85% which implies that the accuracy of the forecasting capability of the system is Medium to High.
3. Based on the result of ISO 25010 survey for quality software, the system is of high quality and value in terms of its functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability. An over-all mean of 4.73 shows that the system has "excellent" quality based on the ISO 25010 International Standards.

RECOMMENDATIONS

These recommendations are intended for future researchers who would want to further enhance the system:

1. The amount of data should be increased and updated in order to improve the forecasting capability of the system; moreover, the completeness of the input data should also be strictly observed.

In this current research, the accuracy of the forecasting was affected by the amount of historical data. The recommendation for future researchers is to increase the amount and enhance the consistency of the input data.

2. The system can be deployed in the cloud in order to enable collaboration among breeders and cockfights all over the world. A larger database would mean a highly improved forecasting capability to the system due to the abundant amount of training data.
3. Future versions of the system may consider other parameters and/or attributes of gamefowls that were not used in this study, the results would be interesting.
4. The system can also be implemented using other machine learning techniques such as Artificial Neural Networks, Genetic Algorithm, Support Vector Machines, and the like. Comparing the accuracy of the said algorithms against the current implementation would also be worth studying.

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