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Eclectic Method for Developing Optimum ANN's

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Abstract

Today one of the biggest problems found in developing and implementing Artificial Neural Networks (ANN) is the lack of a rigorous methodology that ensures the development of optimum ANN, because the performance of their function is measured by trial and error, leading to loss of time in training networks that are far away to reach the expected error rate and adequate performance. As a part of the investigation, a method for determining the optimal networks for prediction and function approximation networks with more than one output is proposed and developed. However, steps can be implemented in hard systems methodologies to analyze the characteristics of the variables required for training the ANN and the correlation between them to reduce the optimal search time. A methodology for the construction and development of an ANN is proposed and developed based on Checkland, Jenkins and Hall methodologies, obtaining a 14-step methodology grouped into three stages.

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Keywords: Artificial Neural Networks; Eclectic; Methodology; Optimal Network.

1. Introduction

It is difficult to identify the best way to solve a particular problem or the best method to use in Artificial Neural Networks (ANN). If the amount of used control or the time taken by different methods is correct, the solution may depend on the nature of the problem, its linearity and size [1]. This paper proposes and develops a methodology to establish and solve different problems using ANN under a systemic approach. Our work also supports taking decisions

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in a holistic and integrated environment. The proposed methodology was created from some stages of Soft Systems Methodology of Checkland [2][3], and methodologies Hall and Jenkins applied to systems of computer-based information, thus generating an eclectic methodology since implementation stage differs from its original condition, remembering that metamethodology combines ideas and methods from a family of methodologies [5]. The production forecast is a statistical technique that emerged in the nineteenth century and gained strength with techniques that are more complex and the introduction of computers in the following centuries [4]. Systems theory is the transdisciplinary study of systems in general with the aim of integrating the natural and social sciences, which includes living and non-living systems through early isomorphisms, leaving intact the individual relationships, studying the system as a whole and covering its complexity [6][7].

A number of systems methodologies have been developed, most of them qualitative models where the importance of the interpretation of the data under a hard system approach [8] is fundamental [9]. When a system refers to people, you need to focus on soft systems approaches. An artificial neural network can be considered as acyclic director nodes (neurons) organized in layers which generally employ learning algorithms [10]. However, a set of neurons is useless if not previously taught what to do; the learning process involves a lot of time because it has not yet been studied. Different methodologies have been adapted for use in the nature of companies and have been used in market research and its relationship to business activity [11]. The purpose of generating expert systems is to support decision-making, which is important a model or method to assist the analysis of efficiency and accuracy of the results obtained by Artificial Neural Networks [12]. Nevertheless, there are few studies of formal methodologies for interpreting and evaluating performance data on productivity expert systems [13], taking into account that these systems try to emulate human thinking and reasoning.

Training an artificial neural network is one of the major challenges in the use of a predictive model, without a clear study focused on work development algorithms and neural network training [14]. The use of artificial neural networks has been proliferating due to the mass use of the personal computer, big data and the emergence of tools increasingly versatile development. Building a dynamic model for forecasting allows alternative solutions with better levels of supplying conventional techniques of uncertainty [15]. Figure 1 shows the proposed methodology.

2. Development

Here is the correct development of each of the sub-phases of the system.

Phase 1. Planning system

The planning system is formed with the definition of the problem, which will provide the necessary information about the conflict is trying to solve, environmental analysis and market research that even though the two are separate steps serve to identify the system with its environment and the availability of the data network feed, gathering information, which starts from the definition of the problem, and the organization of the project, which takes into account various features of hardware and software to proceed to training network.

Subphase 1. Problem definition. One of the key problems for the construction of an artificial neural network is to identify proper handling and application, as although there is literature explaining their function, lack of experience in the management and application of ANN causes an improper development and erroneous data collection.

The aim of the ANN is to design machines with parallel processing neural elements, so that the overall behavior emulates, in the most faithful, natural neural systems [16], have been implemented as a response to approximate the behavior and human thought, to various systems, for the solution of certain problems in diverse areas [17]. This generates the need for activities to make decisions and generate measures that contribute to the solution to this problem. With the development of ICT is important to understand the whole context that exists at present to exploit areas of collaboration, human-computer interaction and human interaction through digital media to bring substantial improvement and transformation of organizations [18].

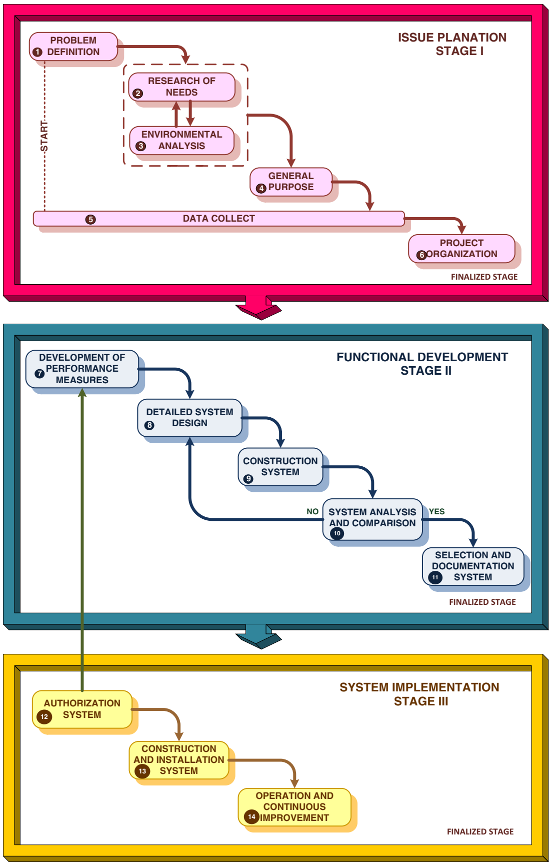

Figure 1. Methodology for the development of Artificial Neural Networks.
Source: Own source.

Subphase 2. Research of needs. This step is performed simultaneously with step 3, since investigating the needs of the system has to analyze the environment, which is explained in the next step. It should identify the needs of the affected agents of the problem, which will benefit from the ANN, to identify the variables that will serve as inputs and outputs. It is worth mentioning to be proposed variables that have a significant amount of data and access to them. Then you should choose the classification with respect to the type of problem and the area to be implemented. Table 1 specifies the types of classification with examples of structures and applications.

Table 1. Classification of ANN [19]

CLASSIFICATION	STRUCTURE EXAMPLE	EXAMPLE APPLICATION AREA
Data Mining. Groups without knowledge of the desired groups [20].	Kohonen self-organized map; Counter propagation.	Speech Recognition Fingerprint Recognition
Classification. Determine the group one class for each input pattern.	Neocognitron. Multilayer Perceptron	Classification in social environments, health, etc.
Function approximation. Determines a constant value for each input pattern.	Multilayer Perceptron Radial Basis Network	Elimination of experimental evidence diverse, developing material specification sheets and equipment.
Prediction. Determine time series values using past information.	Multilayer Perceptron; Recurrent; Hopfield	Prediction of financial variables

Source: Own source.

Figure 2 shows an example of the representation of the environment. The system consists of network models that can provide a solution to the problem and the required variables selected in step 2, and the environment is composed of agents that provide information for training and building the ANN and in turn, of those involved and benefit from the results that the network generates.

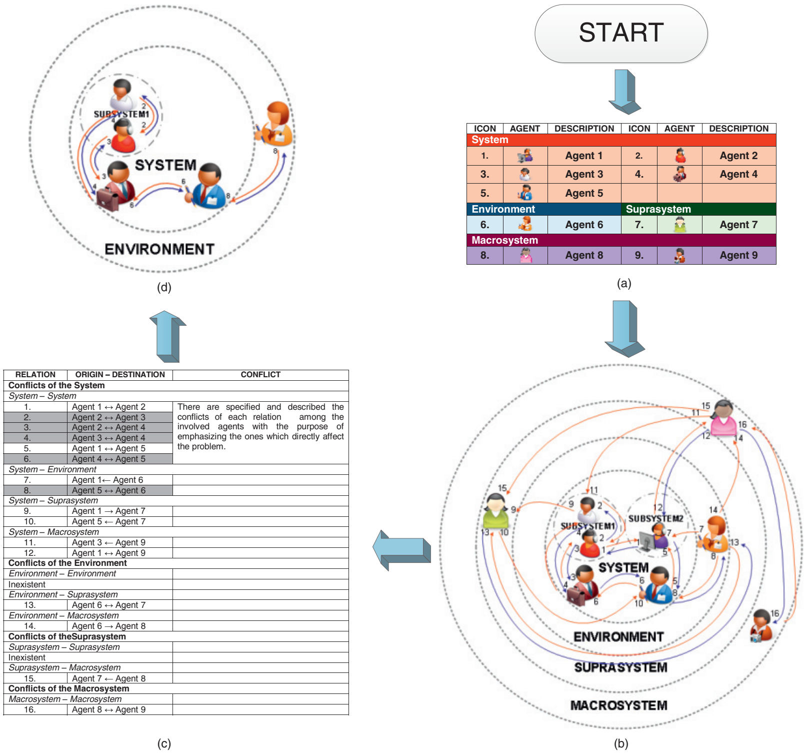

Figure 2. Diagram for Identifying the Environment.
Source: Own Elaboration.

There are other research appoint agents as nodes (users, entities) who also studied in large-scale social networks as they remain soft systems [21], in combination with stochastic and probabilistic methods creating hybrid methodologies in order to propose better solutions [22].

Subphase 4. General purpose. To begin step three above points and must have been well defined in order to define clearly the scope of the ANN. In the case of the targets coincide all methodologies which should be clear and specific. Even there are ways to make good targets such as Smart method among others. However, this methodology is indispensable that the main objective is to solve the problem.

Subphase 5. Data collection and information. It should consider the time of data collection that will serve to make the samples that will train and validate the network since one of the features to cover the set of samples is to be significant; it must be a considerable number of samples. This step starts with step 1, since from the time presents a problem, it is essential to begin to identify the variables that can be used for the development of the network because of the conflicts in this area the constraints and the difficulty can be found by the designer to obtain the data samples generated.

Subphase 6. Project organization. In the organization of the project are considered some important points before starting the functional design of the ANN, which are described below: equipment characteristics, homogenize data, representative samples and homogenize scale

Phase 2. Functional development

To start Functional Development phase is entirely necessary to complete the steps in the planning stage of the system, and that at this stage there is constant feedback from step 10 to 8 to find the net covering the performance measures established in step 7.

Subphase 7. Development of performance measures. In order to develop performance measures of ANN should establish a convergence criterion [23], based on information gathered and analyzed in phase 1, which is the point when the learning period ends and depends on the type of network used or the type of problem to solve. This can be determined by three different situations: in a fixed number of cycles, when the modification of the weights is irrelevant or when the error in the validation of the ANN falls below a preset amount.

Note that the average error generated in the ANN, for more than two outputs, not guaranteed to be the most appropriate, and to consider the range of error generated by each of the output variables have to be minimal or be below the proposed error for the entire network.

Subphase 8. System design. It is essential to start this step having been completed in full the above. In the design of the ANN addresses: layers and number of neurons, the learning scheme, propagation rule, and activating function.

While the number of hidden neurons may influence the behavior of the network, usually, the number of hidden neurons is not significant parameter, as a problem, there may be a large number of computer systems that can adequately solve the problem [24]. On the other hand, the random selection of a number of hidden neurons can cause overfitting problems, so that are still studying methods for the calculation of the binding of hidden neurons in neural networks to provide the minimum error [25].

After setting, the above proceeds to generate the ANN design. Figure 3 is an example of designing a MLP, before choosing the tool for building.

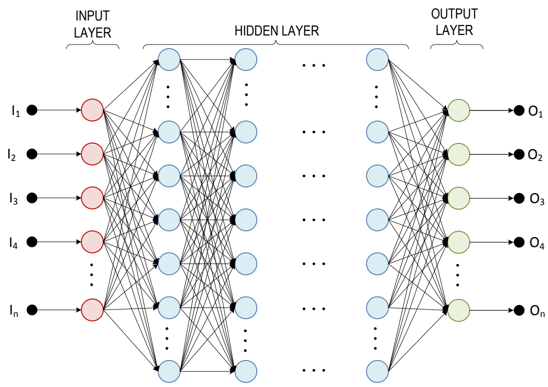

Figure 3. Preliminary Design of the System.
Source: Own Elaboration

Subphase 9. System construction. There is different software to create and develop ANN, some bring specific network models only allow you to choose the number of layers and elements in each, other, allow the creation of new models or the combination of existing ones, and there is also the ability to be programmed in different languages. However, it is essential to mention that it is important to master the technique then knowing how to choose the tool that allows us to create the ANN according to the characteristics defined in the previous steps.

Subphase 10. Systems analysis and comparison. It is important to assess the total performance of the ANN and performance in each of the output variables, should be more than two. The information obtained in this step, assessing whether the operation of the ANN is expected, if not fed back to step 7, where he will propose a new design, which can be different in number of elements and layers hidden or with respect to model ANN. Feedback end until the functioning of ANN than the one proposed.

To choose the most appropriate ANN and determine the final feedback intends to develop comparison chart, Figure 4, which is generated according to the error obtained in each of the outputs of the ANN that is created for the difference of Total Error (DET_{R_i}) as a result of:

$$DTE_{R_i} = \sum_{j=1}^{m} DE_{R_i S_j} \qquad j = 1,2,3,\dots,m \quad i = 1,2,3,\dots,n \tag{1}$$

Where $DE_{R_iS_j}$ is the difference of error in each of the outputs of the network $E_{R_iS_i}$ respect to the proposed error limit (EL), shown in the following equation.

$$DE_{R_iS_i} = \begin{cases} E_{R_iS_i} - E_L, & E_{R_iS_i} > E_L \\ 0, & E_{R_iS_i} \le E_L \end{cases} \tag{2}$$

Subphase 11. Selection system. After selecting the appropriate ANN must be developed documents containing information about its features and operation, graphical comparisons between the data generated by the ANN with the actual data for the training set, validation and production of data and the data demonstration generated by the network are meeting the objectives and performance measures indicated.

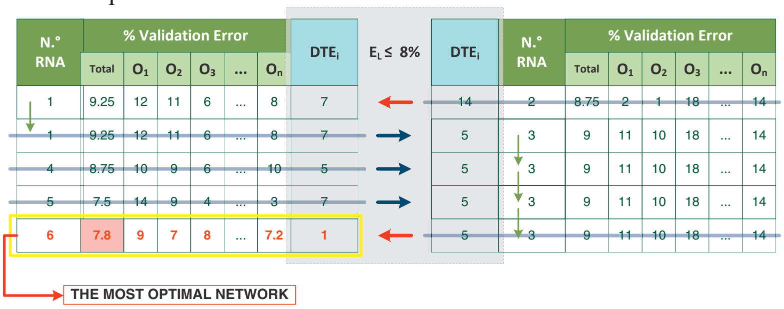

Figure 4. Comparison Chart to choose the most appropriate ANN
Source: Own Elaboration

Phase 3. System implementation

To be able to finish a project is essential to start it, it is for this reason that the third phase is of high relevance. To use a project should consider submitting system authorization documentation and performing the necessary interface for the interpretation of the results.

Subphase 12. Authorization system. In this step, you must present the results so that the concerned agents or those responsible for project approval evaluate the performance of the network according to the needs identified in stage 1. If it is rejected the project is considered a feedback to the objectives in step 7, to stake the convergence criteria in the performance measures. If the project is approved, consider relevant evidence in the necessary infrastructure to ensure successful results. Then you have to test the operation of the new system to ensure good performance.

The way that students, readers, and researchers are trying to establish whether the proposed interventions are beneficial and applied, is through a process of scientific research, evaluations or experimental studies in the case studies [26].

Subphase 13. System installation. The ease of installation of the ANN depend on the area and function that will be given, for example, is not the same implement a software based on ANN where you need programming languages for the user interface with the computer as is the case some financial software, to implement a system of ANN in some kind of digital control device as a mechanical arm. This section considers it pertinent to collect the material used along with prices; it will support future improvements, and system failures.

Subphase 14. Constant operation and monitoring. After the ANN implanted, it should monitor the operation of the new system and collect new data for subsequent updates, this does not imply that each new sample generated immediately feedback ANN, as the principle of artificial neural networks is the training from a significant number of samples. Improvements should also be considered in the design, access to variables previously had denied, environmental changes and continued assistance.

3. Conclusions and Future Directions

A systemic methodology to develop optimal ANN was proposed and developed. The application of the methodology described, to the system can result in an extensive design process, resulting in an exploration of system requirements and system designed to adapt to these requirements. Although the ANN is not a modern art, there is no literature to indicate the correct construction of an existing ANN and the performance evaluation is trial and error. In our proposed methodology, the environment components that will be used to develop ANN are studied such that there is a point of comparison between each network that is constructed, thereby avoiding erroneous results and loss ANN training time. The results obtained when ANN development was based on the methodology were favorable to both documents, presentation of results, and choosing the optimal network. As a part of the research work, a method for determining the optimal networks for prediction and function approximation networks with more than one output was proposed and developed. Importantly, in the step of comparing the networks, if there are two networks with a difference of almost equal total error, the network's designer will elect the network with more number of zeros in the difference error for each output. If the number of zeros also were equal, then the network with the lowest error rate should be chosen. More research is needed to offer concluding results.

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