Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 218 (2023) 1132–1143

Procedia Computer Science

www.elsevier.com/locate/procedia

International Conference on Machine Learning and Data Engineering

Application of neural networks in the teacher selection process

Christian Ovalle[a], Wilver Auccahuasi[b*], Sandra Meza[c], Franklin-Cordova-Buiza[d], Karin Rojas[e], Miryam Cosme[f], Miryam Inciso-Rojas[g], Gabriel Aiquipa[h], Hernando Martin Campos Martínez[i], Alfonso Fuentes[j] and Aly Auccahuasi[k]

[a] *Universidad Tecnológica del Perú, Lima, Perú*
[b] *Universidad Privada Peruano Alemana, Lima, Perú*
[c] *Universidad ESAN, Lima, Perú*
[d] *Universidad Continental, Huancayo, Perú*
[e] *Universidad Tecnológica del Perú, Lima, Perú*
[f] *Universidad Científica del Sur, Lima, Perú*
[g] *Universidad Privada del Norte, Lima, Perú*
[h] *Universidad Tecnológica de los Andes, Apurímac, Perú*
[i] *Universidad Autónoma de Ica, Ica, Perú*
[j] *Universidad César Vallejo, Lima, Perú*
[k] *Universidad de Ingeniería y Tecnología, Lima, Perú*

Abstract

The information and communications technologies are revolutionizing the classic ways of carrying out the processes, in particular, for the teacher selection processes we have the classic form of evaluation, according to the criteria of each educational institution, in the present work it is presented a teacher selection model, using neural networks, using 3 criteria and 23 characteristics, which are entered into individual networks for each criterion and additionally a network for the final classification, is presented based on a prototype, an application developed with the computational tool Matlab, which is described in detail for its application and scaling, for purposes of measuring the performance of the network, evaluations were carried out with a group of 30 candidates, grouped into two groups, a group of 15 candidates with positive conditions complying with the policies of the educational institution and a second group with candidates who do not meet the policies of the educational institution, with which sensitivity values of 93% and a specificity level of 86% were obtained, we conclude that the model presented can be replicated and conditioned to the needs and policies of each educational institution.

Keywords: Selection, classification, network, sensitivity, specificity.

10.1016/j.procs.2023.01.092

1. Introduction

The neural network is considered the most used technique in the field of artificial intelligence, currently there are many works using this technique, to be able to start working with neural networks, it is necessary to know how its operating logic is as well as advantages and disadvantages [1]. When trying to work with neural networks, we have many options to put them into practice, which is characterized by the programming language, currently, most programming languages provide us with their artificial intelligence library, we can work with neural networks with Matlab, Python, R, Java, in others [2]. One of the applications where neural networks are most used is related to pattern recognition, where the characteristics of objects are analyzed by forming recognition patterns, these patterns can be images and signals, among others [3].

Another of the techniques used are the Deep Learning techniques, in this case to be able to classify, lesions in breast ultrasounds. Different Deep Learning architectures are presented for the classification of images and their different training strategies [4]. At present, neural networks are being applied in new areas of knowledge, among them in the financial area, where records of granted credits are analyzed, where rules or behaviors of clients are obtained, with which computational models are developed to be able to estimate the behavior of future clients, based on the approval or rejection of financial credits [5].

Health is one of the areas where artificial intelligence is being widely used, we find works where the nutritional status of people is analyzed and nutritional diets are recommended, with which the models of food consumption in people can be improved [6] Artificial intelligence is also being used in the area of education, we can mention models where solutions are designed based on Artificial Intelligence, for the appointment of academic hours in educational management processes, achieving optimal results compared to the classic processes of designation of academic hours. [7].

We found works where artificial intelligence is applied, in the vocational guidance process where each population group's own characteristics are analyzed, through which adolescents who are about to finish school are evaluated, managing to offer possible career lines that they can choose [8]. Continuing with the applications related to the educational area, we find works where teaching performance models are analyzed, as a measuring factor of educational quality, the worked model includes aspects such as economic, political, cultural, scientific and technological, as well as a important human factor, the results help in the process of educational quality [9].

We also find works where they try to use artificial intelligence, in applications related to the selection of applicants through the application of a survey to teachers in active service, achieving a model so that they can be compared with future candidates [10].

Continuing on the area of being able to evaluate the performance of teachers, we find works where the performance of teachers is evaluated according to their work carried out, in a certain period, with the purpose of being able to characterize the competences, the influence on the students, professional development, in order to obtain a model of teacher evolution [11]. Continuing with work related to the application of artificial intelligence in educational management and teacher selection processes, through which surveys are applied to teachers and teachers themselves, with the intention of being able to know the qualities and skills that are required. in their educational institutions, as well as the qualities and skills they possess so that they can be considered in a future teacher selection process [12]. Found works where the level of knowledge of teachers with respect to the learning of information technologies applied to education is predicted, using artificial intelligence techniques with optimal results [13].

Present a method to carry out the selection process of teachers, by recording values corresponding to criteria related to the selection process carried out in person, such as writing exercises, group interviews and demonstration classes, through which 33 characteristics are captured, These are entered as inputs to a neural network, which is trained to predict whether a teacher meets the criteria of the institution, to be hired or otherwise not to pass the selection process, as a mechanism of evaluation we present a calculation of the levels of sensitivity and specificity.

2. Methods

For the demonstration of the proposal, three fundamental processes are considered, in order to understand the model, we begin with a description of the problem that governs the teacher selection processes, from an overview. We continue with the model of criteria that we can find, in such a way that we present a way of organizing the data and finally we present the computational model based on the organization of the data, as can be seen in figure 1, below we describe each one of the processes:

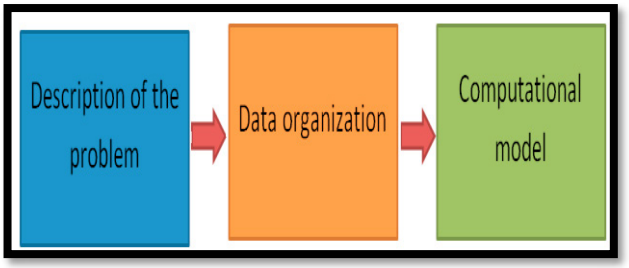

Fig. 1. (a) Proposal block diagram

2.1. Description of the problem

The problem that commonly arises is the teacher selection processes, it is related first to the recruitment process and then to selecting them, these processes can be carried out by the same institutions or they can hire companies dedicated to being able to carry out the selection, in both options, Candidates are presented for a final evaluation, which is normally an interview.

In the different stages, tests of general use are used, as well as procedures and policies of common use, which causes that in the interview stage candidates with poor conditions are presented or in the worst case, teachers are hired who are not aligned to the needs of the educational entity.

As a mechanism to be able to carry out a selection process with a greater degree of personalization, a computational model is presented based on selection criteria through which the criteria and qualities of the model teachers of an institution are analyzed through, in the particular case, 3 criteria and 23 qualities, which is presented in Figure 2.

The criteria and qualities are obtained from a particular institution, the criteria and qualities may change according to the policies and requirements of the educational institutions, in the particular case, the criteria are those used in a recruitment process defined by the institution.

CRITERIA VALUES	Writing Exercise	Group Interview	Demostrative Class
	Introduction	Credentials	Class organization
	Developing	Interest Level	Class Preparation
	Organization	Interpersonal approach	Clarity
	Cohesion	Communication Effectiveness	Critical thinking stimulation
	Grammar	Assessment systems	Presentantion style
	Analysis	Methodology	Domain of the subject
	Content		Use of materials
	Conclusion		Avaliability to answer questions
			Use of time

Fig. 2. Organization of data by criteria.

2.2. Data organization

According to the criteria, the data is grouped into 3 groups, each with its qualities that each applicant must meet, in order to be able to demonstrate the method, an application was designed using the Matlab computational tool, in order to verify the logic and the data model, below we present the 3 groups organized by means of the developed application.

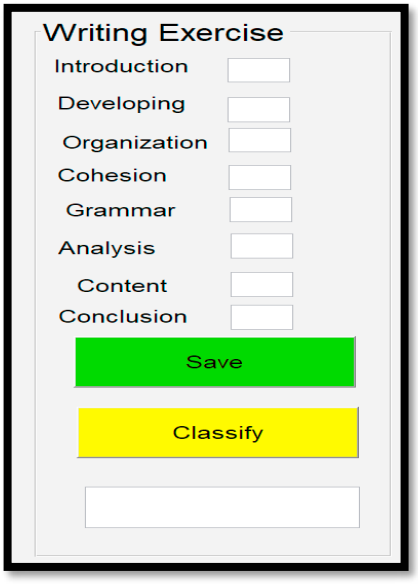

Fig. 3. Organization of data of the writing exercise

The first criterion corresponds to the writing exercises, which is made up of 8 qualities as can be seen in Figure 3, where values from 0 to 100 are entered in the evaluation process, where each value corresponds to the percentage of the level of satisfaction achieved. in the evaluation, “0” corresponds to not satisfied and “100” corresponds to the satisfied level. In execution mode, when the entry of the 8 values is finished, the data is saved with the save button, we can carry out a partial classification of the criterion with the classify button, which returns us the level of satisfaction of the writing exercise criterion.

Similarly, the second criterion corresponds to the group interview criterion, where 6 qualities are evaluated, according to figure 4, in an analogous way the data corresponding to the percentage achieved are entered, having to save the entered data, we can also have a partial result of the criterion with the classify button, which returns us the level of satisfaction reached in the group interview.

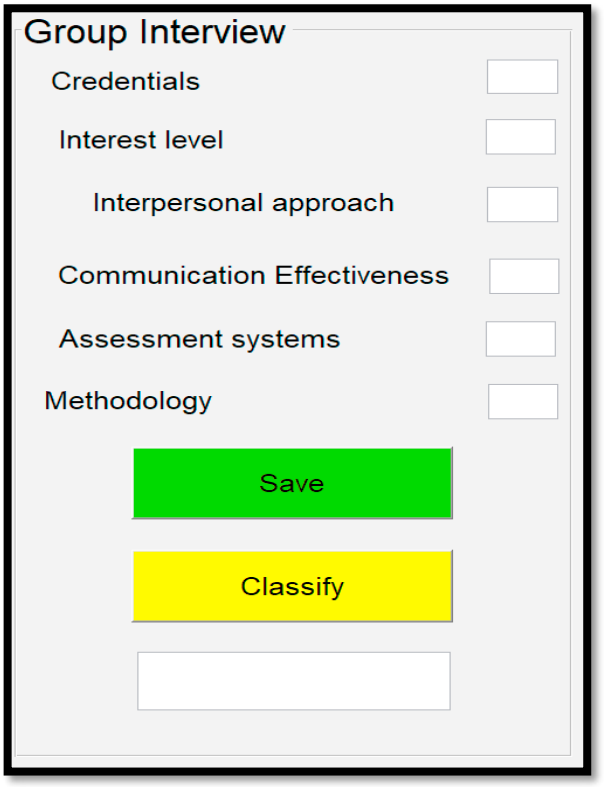

Fig. 4. Organization of group interview data

Finally, we conclude with the 9 qualities of the third demonstrative class criterion, where the values can be entered in a similar way in the previous criteria, with also the option of saving the data and having a level of satisfaction reached in the group interview criterion.

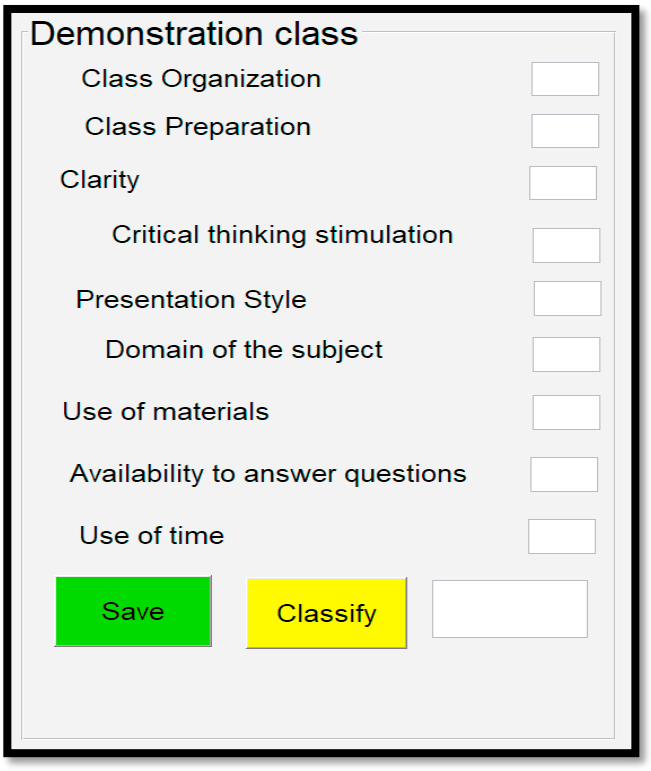

Fig. 5. Demo class data organization

2.3. Computational model

The computational model is composed of an arrangement of 4 neural networks, which are integrated in each of the processes, according to figure 6, where we have as the first layers, which correspond to the 23 qualities, these inputs correspond to the 3 networks networks, one for each criterion, having a network that classifies the writing exercise, a dedicated network to classify the group interview and finally a network to classify the demonstrative class.

Each of the outputs of the 3 neural networks become inputs of the fourth neural network that allows us to obtain the final classification, where it classifies whether the candidate has similarity to the institution's teaching model, which in an analogous way returns values of "0" when it does not resemble the model at all, a value of "1" when the candidate resembles the model 100%, decimal values indicate the percentage of similarity.

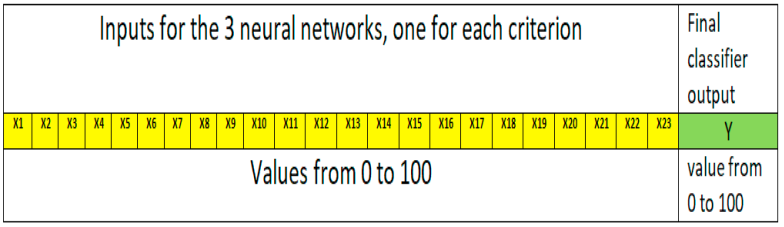

Fig. 6. Feature Vector

Figure 6 shows the feature vector made up of the 23 qualities and the final output of the classifier.

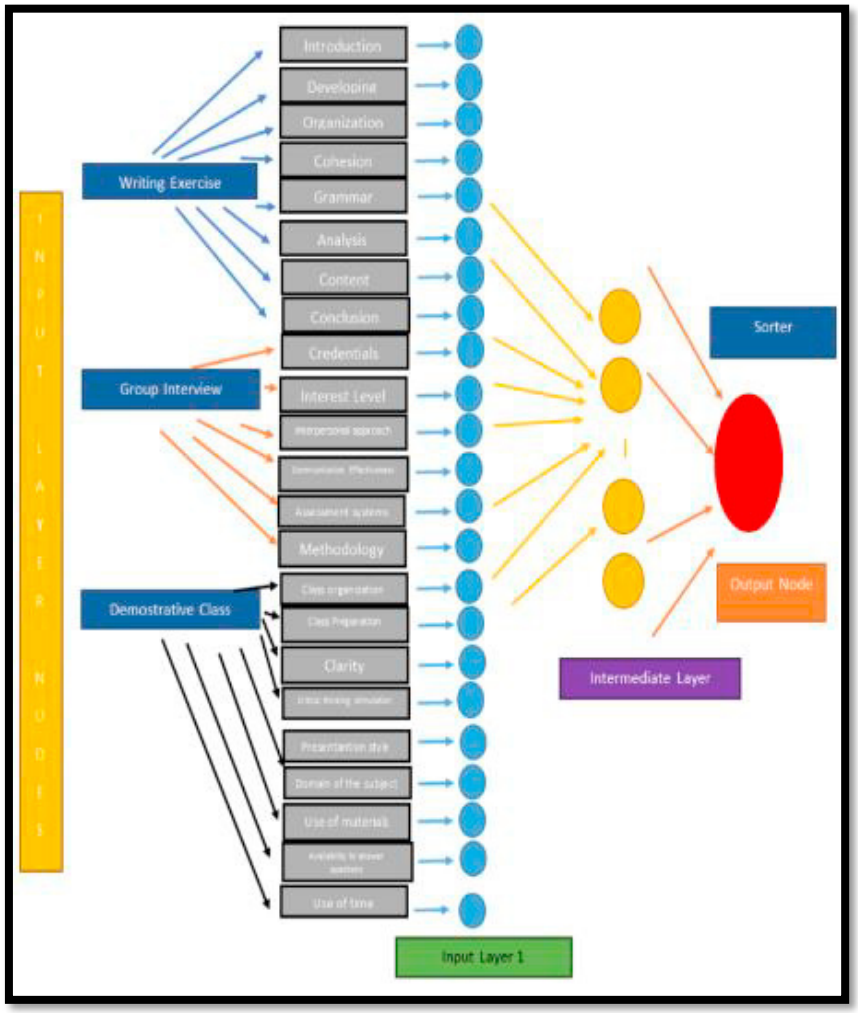

Fig. 7. Computational model architecture

Figure 7 presents a computational model, represented by the architecture of the neural networks, organized one for each criterion, which are 3 neural networks and a final neural network.

When we refer to the data model where we compare the similarity, we refer to a set of data organized in a similar way to the qualities that are evaluated in a selection process, in figure 8, we present the database that contains information of the 23 qualities of 40 teachers, where 20 teachers correspond to the suitable teachers class and 20 teachers correspond to the unsuitable class. This database was created with information from teachers who have participated in previous evaluations, this information is used in the network training process. With which the neural networks are trained with this data so we can indicate after the training process that the final neural network is trained to classify a candidate if it can be suitable, otherwise not suitable.

```
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,1,80,70,70,80,90,80,75,76,78,76,88,84,79,74,78,98,85,85,85,78,78,75,85
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,40,40,50
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
,0,40,50,60,65,41,25,36,25,45,52,65,41,42,52,45,62,41,52,63,41,45,25,45
```

Fig. 8. Training database

In figure 8, the data model is presented with the 23 qualities that correspond to 40 teachers, these data are loaded with the application to be able to train the neural network. In the results section, we present the controls, which make possible the training and execution of the neural network, the working mechanism consists of loading the training data, through which the network is trained and ready to be used in the classification processes.

3. Results

The results presented in the present work are grouped into two stages, the first consists of the presentation of the application where the proposed model is demonstrated, where the candidate can be registered, as well as each of the qualities of the 3 criteria. , the application also provides buttons for the creation and training of the network, then we describe the implemented application, according to figure 9.

In Figure 9, the form that corresponds to the final application is presented, developed with the Matlab tool, where the main processes of a system can be seen, as well as the administration processes of the neural network and the registration of data from entry that corresponds to the qualities of each of the criteria. The input data loading processes are described in figures 4, 5 and 6, where it corresponds to the input data record, below we present figure 10, where the intelligent processes are described, which corresponds to the data loading, where the 23 characteristics of the 40 teachers are presented, these data are used in the training process of the neural network. We also have the neural network creation button, where it returns the created networks, having the training networks and data, the next

procedure is to train, for which we have the train networks button, this process trains the networks being ready for be able to work in teacher selection processes.

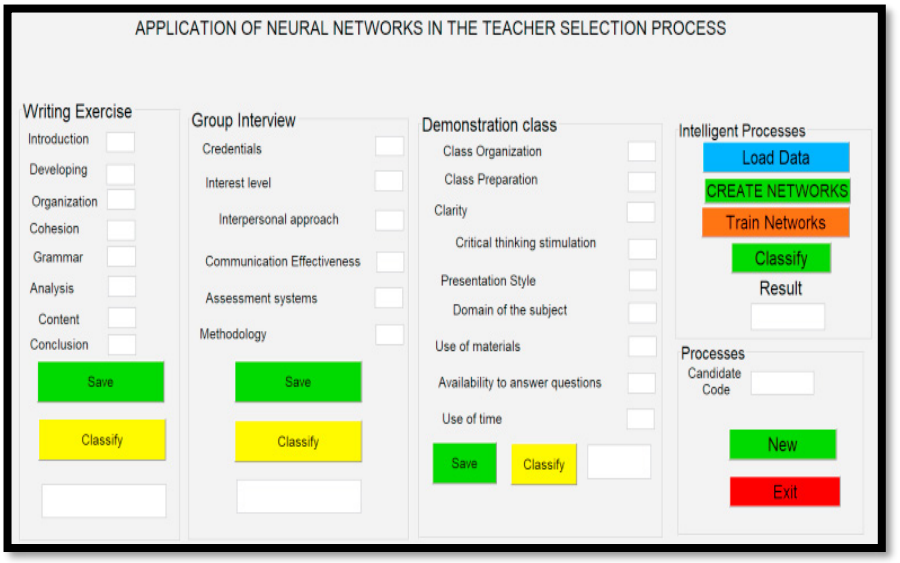

Fig. 9. Main application form

After having the neural networks created and the data loaded that correspond to the 23 characteristics, we proceed to classify where it returns the following values:

- “0” when it is not suitable
- “1” when it is 100% suitable
-“Decimal value” that corresponds to the percentage of similarity.

As an example we can indicate that a value of "0.25" indicates that the candidate has a 25% similarity with the training data of being a suitable teacher, thus a value of "0.75" is interpreted with 75% of being a teacher. suitable, in an analogous way the result must be interpreted, depending on the policies the result can be interpreted, it is recommended to have a classification threshold, where values above 75% are considered suitable and lower values can be considered unsuitable, this interpretation is at the discretion and policies of the entity that performs the selection process.

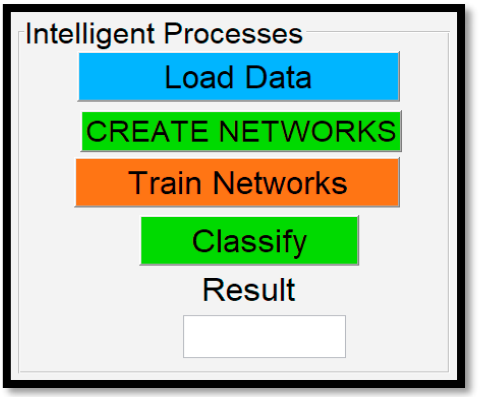

Fig. 10. Smart process form

To improve the administration of the developed application, we have the classic processes, such as the candidate's registration where we can place the code, in this way the evaluation can be carried out anonymously without knowing the candidate's personal data, we also have the process again , where after finishing the classification of a candidate, we proceed to clean all the data entry fields for a new evaluation and finally we have the process of closing the application, with which we end the use of the application, we must consider that if closed the application, requiring new selection processes to be carried out, it is mandatory that the network training process be carried out, for which we carry out the process of creating a network, loading data and training.

In figure 11, the candidate processes are presented, to evaluate a new one and to close the application.

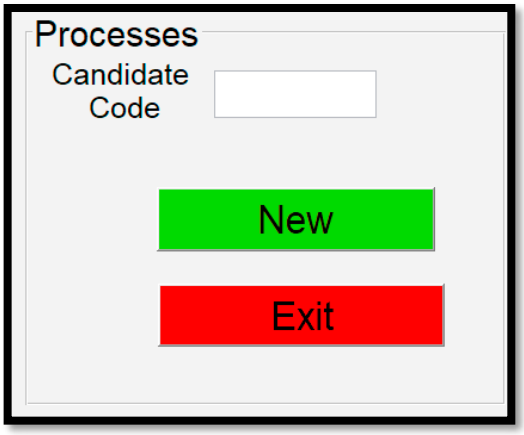

Fig. 11. Basic process form

A second group of results is carried out by evaluating a group of candidates, who are grouped into a group of 15 suitable candidates and a second group that correspond to 15 unsuitable candidates, we must clarify that these 30 candidates are new candidates and none correspond to candidates considered in the candidates used in the training stage.
After having made the evaluations to these 30 candidates, we evaluated the performance of the application based on the calculation of the sensitivity and specificity according to the following detail:

	Apt teacher	Unfit teacher
Apt teacher result	true positive (VP)	false positive (FP)
Unfit teacher result	false negative (FN)	true negative (VN)

Fig. 12. Criteria for evaluating performance

In figure 11, the detail for the measurement of sensitivity and specificity is presented, where we define four estimated values, such as true positives, false negatives, false positives and true negatives, for which the following results were obtained , after evaluating the 30 candidates, grouped into 15 fit and 15 unfit:

	Apt teacher	Unfit teacher
Apt teacher result	true positive (VP) **14**	false positive (FP) **2**
Unfit teacher result	false negative (FN) **1**	true negative (VN) **13**

Fig. 13. Performance appraisal results

Sensitivity = VP / VP + FN = 14 / 14 + 1 = 0.93
Specificity = VN / VN + FP = 13 / 13 + 2 = 0.86

From the values obtained, we calculated the sensitivity and specificity. The sensitivity value represents the proposal's ability to classify an unfit candidate as unfit; and specificity represents the ability of the proposal to classify an unfit candidate to be classified as unfit. The sensitivity of the proposal is 93%, we can indicate that if we provide 10 suitable candidates, the model correctly classifies 9, being able to make mistakes in at least 1 candidate. For specificity, the value obtained is 86%, which can indicate that we provide the proposal with 10 unsuitable candidates, the model correctly classifies at least 8 candidates, making mistakes in at least 2 candidates.

4. Conclusions

We can indicate as conclusions that when making predictive models, we must consider the characteristics that make possible the execution of the model, in the case presented we performed an analysis of a particular case, which is to predict whether a teacher candidate meets the conditions required by the institution, the model presented includes 33 characteristics that are considered as inputs to the neural network, As a result, we present a trained model that has the ability to predict whether a candidate is suitable for the educational institution, compared to a similar model, we have a computational mechanism to predict the level of learning of teachers with respect to knowing the management of information technologies.

At the end of the research, we come to describe the conclusions based on three pillars made in the research: first with the possibility that the methodological proposal can be applied and scaled, which will depend on the criteria that each educational institution has, to be replicated it is necessary to evaluate the requirements and policies in such a way that the entries that correspond to the vector of characteristics are updated. The second pillar is related to being able to be implemented in different programming languages, such as Python, R, C, C++, Matlab, among others. In our case, the Matlab computational tool was used, where we were able to implement the proposal, run it with 30 candidates and evaluate the sensitivity and specificity. And finally the third pillar is related to the values obtained in the performance of the proposal, by evaluating the sensitivity and specificity with values of 93% and 86% respectively, which represents that the model can be improved by increasing the number of cases for the training data as well as the cases used to evaluate the performance and recalculate them.

References

[1] Acevedo, E., Serna, A., & Serna, E. (2017). Principios y características de las redes neuronales artificiales. Desarrollo e innovación en ingeniería, 173.
[2] Antona Cortés, C. (2017). Herramientas modernas en redes neuronales: la librería Keras (Bachelor's thesis).
[3] Asanza, W. R., & Olivo, B. M. (2018). Redes neuronales artificiales aplicadas al reconocimiento de patrones. Editorial UTMACH.

[4] Chanampe, H., Aciar, S., Vega, M. D. L., Molinari Sotomayor, J. L., Carrascosa, G., & Lorefice, A. (2019). Modelo de redes neuronales convolucionales profundas para la clasificación de lesiones en ecografías mamarias. In XXI Workshop de Investigadores en Ciencias de la Computación (WICC 2019, Universidad Nacional de San Juan)
[5] Koo, J. J. P., May, O. A. C., & Almeida, C. D. C. B. (2018). Sistema experto en apoyo a toma de decisiones para aprobación de líneas de crédito. Pistas Educativas, 39(127)
[6] Zafra, D. F., & Landeo, I. M. (2019). Sistema experto para mejorar la salud nutricional mediante la evaluación y recomendación de dietas nutricionales. Tlatemoani: revista académica de investigación, 10(32), 19-30
[7] Aviles Cortez, E. P., & Cedillo Duchicela, M. A. (2020). Sistema Experto para la Optimización de la Gestión Académicos en la Subdirección de la Universidad Técnica de Cotopaxi-Extensión La Maná (Bachelor's thesis, Ecuador: La Maná: Universidad Técnica de Cotopaxi (UTC))
[8] Maucaylle Leandres, D. (2018). Desarrollo de un sistema experto para apoyar el proceso de la orientación vocacional de los estudiantes egresados del nivel secundario.
[9] Escribano Hervis, E. (2018). El desempeño del docente como factor asociado a la calidad educativa en América Latina. Revista Educación, 42(2), 717-739.
[10] León Cajiao, A. X. (2018). Selección de aspirantes a docentes en el cantón Pujilí (Bachelor's thesis, Latacunga: Universidad Técnica de Cotopaxi; Facultad de Ciencias Humanas y Educación; Licenciatura en Educación Mención Educación Básica).
[11] Padilla-Hernández, A. L., & Vanesa, M. (2018). Selección de categorías para el estudio de la evolución de la competencia digital docente del profesorado en Educación Superior. Revista Interuniversitaria de Investigación en Tecnología Educativa.
[12] Marcelo, A., & Natali, Y. (2018). Gestión educativa y selección de personal docente en IE San Juan de Lurigancho. 2017.
[13] Verma, C., Stoffova, V., & Illés, Z. (2020, June). Feature selection to identify the residence state of teachers for the real-time. In 2020 International Conference on Intelligent Engineering and Management (ICIEM) (pp. 17-22). IEEE.