Original Article

Credit Risk Analysis : Using Artificial Intelligence in a Web Application

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Abstract - The advantages of machine learning are not only in trying to reduce losses due to better prediction but there are also benefits related to the evaluation of risk profiles, whether they are clients or entities. It also adds to the savings in operating costs and resources that must be reserved to cover potential delinquency. The objective of the work is to imply that artificial intelligence can help measure the credit risk index of a financial institution to avoid loss and thus determine whether to access a loan or not. In the methodology, the Python programming language will be used with the necessary libraries for the analysis of Artificial Intelligence (AI), which, through the steps done in work, will proceed to make an application that demonstrates how useful it is. It is machine learning to avoid losses. Finally, the final result obtained will be the application which shows us if a client accesses a bank loan or if, on the contrary, it was rejected based on old clients.

Keywords - Artificial intelligence, Financial entity, Credit risk, Machine learning, Python programming language.

1. Introduction

Cooperatives and mutuals are non-profit institutions where their members support each other to benefit all. Each partner must assume its activities, as well as provide resources to achieve the achieved goal [1]. However, they suffer from problems that can affect their economic results to the point of being a disaster. One of the most common risks is credit risk, where there is a probability that debtors will not make their payments and cause capital losses [2]. Taking into account those mentioned above, the objective of this work is to be able to carry out an analysis model that uses artificial intelligence algorithms to minimize credit risk in cooperatives/mutuals [3]. The Peruvian economy has witnessed progressive economic growth, which has given way to a notorious growth of the credit risk faced by financial establishments [4], as Salvador explains in his thesis: Credit risk management and delinquency in a savings cooperative and credit Nuestra Señora del Rosario Ltda [5].

2. Literature Review

The author Fernández [6] defines that Within financial services, processes can be automated and analysis capabilities increased, all these thanks to the use of Artificial Intelligence, allowing better resource efficiency, cost reduction, improvements in customer satisfaction and in the quality of the product/service. According to what the author quoted, it can be said that through various methods, such as language processing natural or image recognition, companies' finances make the repetitive manual labor tasks much more automatic and have less duration; a clear example can be the answers to the frequently asked questions. It means a decrease in the face of possible human errors and, on the other hand, an increase in production and a considerable reduction in costs related to these activities. In conclusion, the advantages and disadvantages of using such technology should be carefully examined and considered, as well as an appreciation of how it should be used.

On the other hand, Del Carmen [7] states that Artificial Intelligence has been used in various activities, among them, in the area of finance, where it is oriented to the construction of information systems that integrate knowledge and provide organizations with a better decision making in business financial management.

It could be said that the main applications of algorithms in the financial area are: the ability to predict if a company will go bankrupt, evaluate and predict if the finance company can grant a loan in order to make a decision about granting the same, the deduction of the norms that indicate the best decision-making about the granting of resources based on the investigation of several years. From this quote, it could be concluded that this technology allows you to make timelier and more efficient decisions to meet the challenges imposed by a globalized world.

Cela and Cuenca [8] proposed Machine Learning techniques in companies beginning to appear more frequently since models and algorithms are required to determine reliable variables and predict irregularities in the life cycle of business processes.

Based on the algorithms they used, the authors explained the use of the logistic regression algorithm to classify customers into those who can respond to the credit granted and those with insolvency. In addition, the SVM algorithm is applied as a comparison to the previous algorithm that also serves to classify.

Obtaining the results, the authors concluded: in estimating credit risk with data from the Cooperative study, better results are obtained by machine learning algorithms based on logistic regression. However, the support vector machine model has a lower margin of error than the logistic regression model [21].

From this research work [9], it can be seen that machine learning techniques such as logistic regression and support vector machine (SVM) are useful for credit risk assessment; however, better performance with the former than the latter. Likewise, Peruvian cooperatives can use these techniques to create a predictive model to approve credit.

Meıa [11], in his research project, proposed the use of data mining and other artificial intelligence algorithms that are necessary to process large amounts of data and identify patterns in the behavior of partners that influence their delinquency.

According to the AI algorithms used, the author mentioned above, I concluded it was taken at decision trees as an algorithm for the data mining model that allowed the identification of patterns to predict the level of arrears in the members of the cooperative [3].

Regarding the results, the author concluded that the use of Talend and Pentaho Report tools Designer, and the decision tree algorithm, used in the prediction of the level of delinquency of the partners, was the more appropriate as a process for the application of searches for behavior patterns of the partners, managing to give more accurate information to the people in charge of approving the credits in the cooperative [12]. The research showed that data mining and the decision tree algorithm effectively detect partner behaviour patterns and predict defaulting partners. Based on this, the appropriate decisions can be made when approving the credit application.

Salazar [21] states that there are many applications for Artificial Intelligence, from little complex projects such as automation in programs to more laborious projects, with a large number of input signals, which would be more complicated to program without the help of Artificial Intelligence. The author affirms that a model elaborated from the investigations and the tests that are carried out can be beneficial to supervise the activity of a financial entity, acting progressively before a source of risk. This presented design considers an application in the most modern technologies of the last generation, in which the adaptation of the qualities that artificial intelligence offers us is proposed to achieve reliable and efficient solutions within a production process scenario.

From the above can say that a system with AI allows development features with better performance and with the features of permanent optimization.

The author Ramírez [4] states that robotics with Artificial Intelligence is used in many areas, such as commerce or industry, some of the processes carried out are usually repetitive, exhausting, expensive and frustrating, but this does not apply to robotics that does not suffer of fatigue and has little or no margin of error. Likewise, he affirms the synergy of Artificial Intelligence with artificial intelligence, advancing very quickly with the design of robots that can perform tasks that are remarkable for humans. This is increasing much faster. Many countries and international organizations spend millions of dollars researching and developing robots with Artificial Intelligence.

It is concluded that Robotics with Artificial Intelligence positively influences international trade. Organizations have to put into operation this technology to replace some tasks that can be repetitive and fatiguing for people; in this way, there would be a reduction in costs, and they will be much more efficient and profitable.

In their Financial Credit Evaluation Model, Calvo et al. [16] proposed neural networks trained by backpropagation are a good instrument for financial evaluation; in this case, it will be oriented to the development of a model applied to entities oriented to credit provision. The authors mentioned above concluded that they seek to propose a Standard Credit Evaluation Model based on Neural Networks that maintains the level of risk for the delivery of loans within acceptable parameters.

Based on the results, the authors concluded that using neural networks is key to evaluating credits; these allow us to classify better the information that exhibits nonlinear behavior.

According to work examined, it is observed that the networks Neural networks allow a better classification of the information to evaluate credits, reducing the credit risk in clients. Similarly, these techniques can be used in cooperatives in the country to distinguish clients into groups and assess credit risk based on the results [13].
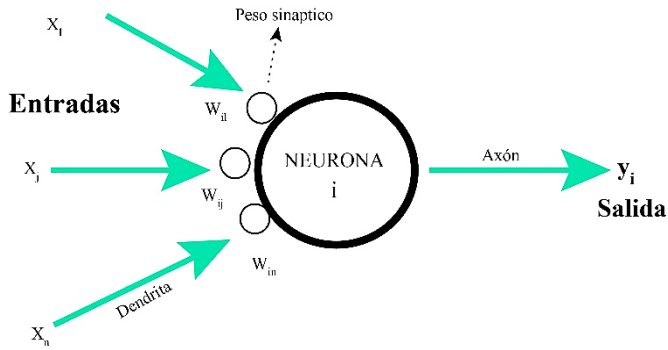
Fig. 1 Artificial Neuron Source: LAS REDES

3. Methodology

Neural networks allow a better classification of information to evaluate credits, reducing the credit risk in clients. In the same way, these techniques can be used in cooperatives in the country to distinguish clients in groups.

3.1. Research Method

Considering what was said by de Savant [22], this research is explanatory and, at the same time, descriptive. Descriptive projects are those whose function is to explain the properties that are valuable in systems, circuits, process responses, phenomena, or some way in which a system behaves, and that is taken to make measurements or tests in order to establish its operation.

For the process of evaluating data, Angulo's statement will be considered [15]; he says that descriptive statistics explains data and then performs a statistical analysis process to make their variables relate, that is, performs descriptive statistics analysis on all variables. Your variables and then see the relationship between the variables.

It is concluded that the neural network for pattern recognition and information classification can use both basic and standard models that consist of the choice of data, the creation and training of the network and the appreciation of its performance using, among others, the mean squared error.

3.2. Kind of Investigation

In this research, it is of an applied type. Zoila [11] states that applied research is a way to reveal effectiveness with a scientific test. The definition of Ezequiel Ander-Egg Hernández is that it is an effective resource with a detailed inconvenience base. Taking into account the aforementioned, the expectation is to obtain results that prove that Artificial Intelligence helps financial entities to innovate and, above all, to make processes more profitable and efficient for the public.

3.3. Research Design

The model used in this research is almost experimental [9], where there is no control of the variables; however, it is sought to be as large as possible in order to obtain a smaller margin of error. Because we do not choose the variables, this represents a significant cost reduction compared to experimental designs.

3.4. Variables
- Independent variable
- Artificial neural networks
- Dependent variables
- Credit risk

3.5. Population

The population to consider is the data of the people who make a loan since, based on them, a classification is made, and it is observed whether it is suitable to withdraw credits.

3.6. Sample

Certain data is taken from the people who make a loan, and these are used for research, such as: identification number, sex, age, city, income, disbursement date, monthly term, final date, amount disbursed, type of currency, debt balance, effective rate and nominal rate.

3.7. Data Collection Techniques

In this case, various techniques will be applied, such as the construction of a neural network, tests of the function of the network, and observation and analysis of the results. Everything will be necessary to test the efficiency of applying artificial neural networks for credit risk assessment.

3.8. Data Collection Instruments

For the data collection, the Python programming language will be used, which offers us a variety of tools for creating models, simulations and analysis of the results.

3.9. Description of the Methodology

The structure of an artificial neural network is made up of a fundamental element, the artificial neuron, configured as an essential calculation component, which in turn receives information from the outside or from other neurons, and becomes a single exit. The artificial neuron has an input composition through which information is accessed by the cellular organism, which is processed and responds to the stimulus received, depending on the intensity assigned between the input junction and the neuron. In response, the neuron will produce an output through the so-called axon. Depending on the procedure that a neuron makes of the information it receives, it may send a response to the next, or it may not. It will depend on the level assigned to each input, that is, the importance of the stimulus received (see Figure 1).

3.9.1. Pre-processing

The data, whether input or output of an artificial neural network, are usually heterogeneous in terms of their

placement, their variability and the range of values. To ensure that the inputs and outputs are relevant based on their importance, and this does not depend on the presentation to the neural system, a pre-processing of the information collected will be done. This is based on the evolution of the inputs and outputs of the neural network so that they can be treated in the correct way by the system [17].

3.9.2. Learning Phase and Generalization Test

The processing of the data from the previous phase is carried out with the help of an algorithm. To do this, the system must be supplied with the necessary examples to describe the situations that will later arise in reality. In some models, such as the perceptron, the learning data sample is usually used, and something similar for checking the level of learning.

This stage will end when the errors are minimal, and the model is adapted to the problem presented. To do this, it is advisable to try different topologies and learning algorithms until the most suitable ones are found.

Finally, once the previous stages are finished, if the desired outputs are not obtained, it would be best to review them since it is likely that this technique will not solve this problem, or the inputs may not be adequate or not have been well pre-processed.

3.9.3. Operation Phase

The network is available to use the knowledge it has acquired about new cases not presented so far. In this way, it will be possible to evaluate if the results have an acceptable margin of error. If this happens, the neural network model could be used to solve the problem.

- Evaluate credit processes.
- Qualify obligations.
- Analysis of capital markets.
- Credit risk models.
- Prediction of the volatility of options.

3.9.4. Analysis Phase

The results obtained are observed, and based on them, the necessary arguments are obtained to make the correct decisions.

3.9.5. Steps to develop an Artificial Intelligence in Python

First, have Sublime Text downloaded; this can be downloaded from the official page (see Figure 2).

Choose the operating system that wants to work with; in my case, it is Windows-64bit. Once installed, create a new project with the name "risk.py" (see Figure 3).
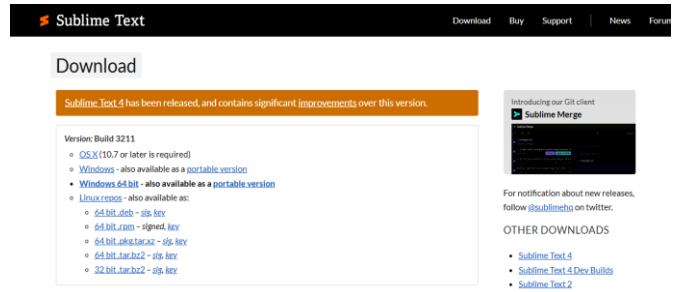

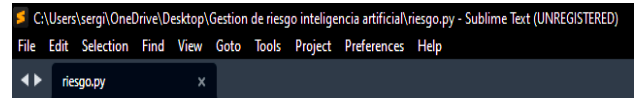**Fig. 2 Sublime Text official page**
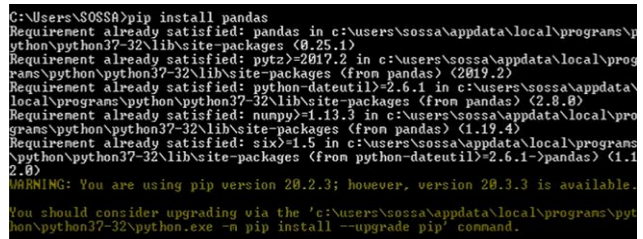

Fig. 3 Nuevo proyecto Sublime Text

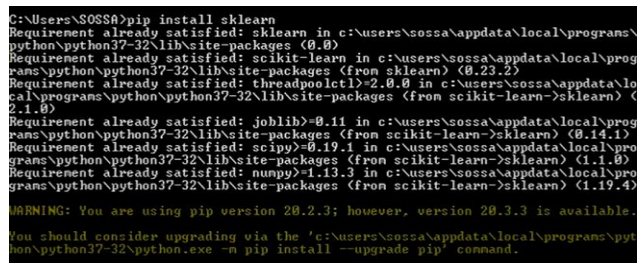**Fig. 4 Installation of the Pandas library**

Fig. 5 Installation of the Sklearn library

Then import the Liberia Pandas; this library works with the data and large-scale can-do analysis. Then install the Sklearn library used to do the artificial intelligence calculations.

Open CMD and then type the command "pip install sklearn" as well as the command "pip install pandas" (see Figures 4 and 5).

Now open a notepad to enter the data of previous clients; based on that, the algorithm will determine if it is safe to give the loan or not. The data entered will be open debt, a delinquent client, a client who has a job and finally, the result of whether he returned the loan or not. Save the document with the .csv extension (see Figure 6).

Fig. 6 Creating past customer data

Fig. 7 Importing libraries

Fig. 8 Typing the algorithm

Fig. 9 Continuing with the algorithm

Fig. 10 Result

Fig. 11 Doing another example

Fig. 12 Approved result

Now turn to the Sublime Text, and the first thing that will do will import the libraries (see Figure 7).

Then we have to extract the data obtained from notepad with the ending .csv previously created to be later taken to a DataFrame which is a data intelligence for work on Python and Artificial Intelligence. In X, it will put the data such as open debt, delinquent customer or a client who has worked. In the Y, it will be whatever you want to predict, in this case, the result (see Figure 8).

Then we call the extracted Data Frame with train and test. We indicate that model is equal to Logistic Regression to indicate the type of algorithm. With "model.fit", the intelligence machine is trained artificially. Then the data is entered with new data; for example, we are saying that the person has an open debt, is not delinquent and has a job. Later we make a Data Frame with the new clients, and at the end, we will get the prediction (see Figure 9).

As we can see from the result, artificial intelligence does not give us loans (see Figure 10).

Now another example, this time, we are going to say that the client does not have an open debt, is not delinquent, but does have a job. As we can see, the result is that you are approved for the loan (see Figures 11 and 12).

4. Results and Discussion
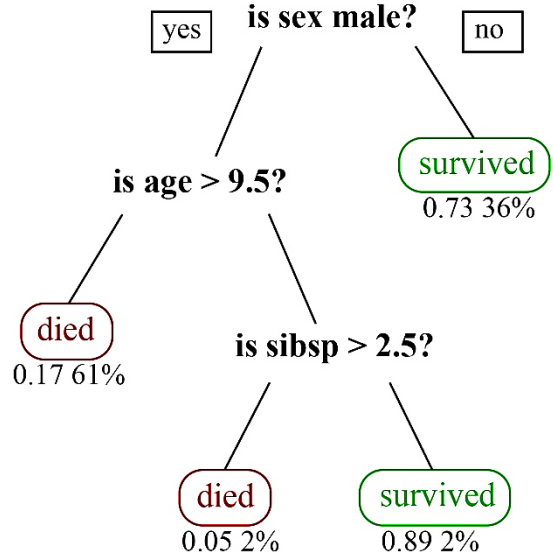### 4.1. Results
4.1.1. Learning based on Decision Three

Fig. 13 Structure of a decision tree.

How to do machine learning that is used algorithms such as a prediction model that observes an article and draws conclusions about the value of the objective. It is one of the most used predictive models in statistics, data mining and

machine learning. Flores Guadalupe [20] states that tree models where the target variable can take a finite set of values are called classification trees. It means that trees are a structure, leaves are represented as class labels, and branches are features that carry the class. In decision trees, the destination takes continuous values, these are usually real numbers, and they are called regression trees. Decision tree analysis can be used to represent decisions visually explicitly. In data mining, a decision tree describes the data, not the decisions. (See Figure 13).

4.1.2. Algorithms for Decision Trees

Decision tree learning is the construction of a tree from training. The tree is similar to a flowchart, in which each node is a test of an attribute, and each branch is the final result. Paky Chinchay [3] defines the following most used decision tree algorithms:

ID3 (Iterative Dichotomiser 3)
C4.5 (Successor to ID3)
ACR (Classification and Regression Trees)
CHAID (Chi-Square Interaction Automatic Detector).
MARS: Extends decision trees to control better numerical data.

Conditional Inference Trees: Tests are used non-parametric such as split criteria, which are corrected for different tests. An example of a decision tree based on this research would be first to see the client's credit history, in both cases, whether he has a good history or not, proceed to see the amount of the loan, if he qualifies to have a loan with an amount of considerable money, or if the amount of money is minimal (see Figure 14).
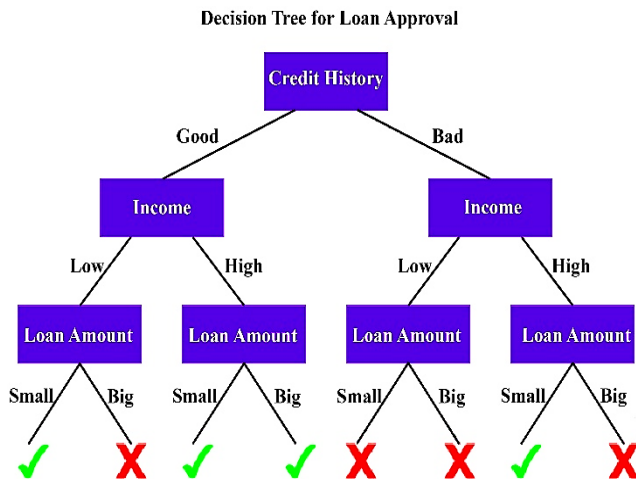

Fig. 14 Decision tree based on credit history

Fig. 15 Importing classification tree

4.1.3. Developing an Algorithm Based on a Decision Tree

For the development of this algorithm, have to have installed Sublime Text as well as the library Sklearn (see figures 5 and 8).

Unlike the other example, more data will be used, such as open debt, delinquent client, if he is in a job, sex, age, amount, and type of currency if it is in dollars or soles. Once inside Sublime Text, import the Sklearn library with the tree instance and put the classification tree (see Figure 15).

Unlike the previously shown algorithm, creating the data in a .csv extension will no longer be necessary since the data from previous clients will now be inside the algorithm. Section X has the data of previous clients such as open debt, delinquent clients, if they are in a job, sex, age, amount, and type of currency if it is in dollars or soles. While the Y part corresponds to whether the requests were approved or denied (see Figure 16).

The data is then passed to the classification tree, where fit means that the algorithm has to learn from the given data. then it enters the data to be predicted; for example, let's say that the client has a debt open, is delinquent, but has a job, is for a sex female, is 18 years old and wants a loan are 2000 soles (see Figures 17 and 18).

Fig. 16 Entering old customer data.

Fig. 17 Entering old customer data

Fig. 18 Result
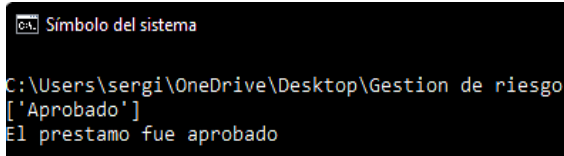

Fig. 19 Approved result

Fig. 20 Approved result

Now another example this time, let's say that the client has no open debts, is not delinquent, has a job, is female, is of the age 19 years old and needs an amount of 1000 dollars (see Figures 19 and 20).

4.1.4. Making the Flowchart
Based on the previous activities, the flow of the "Customer Data Request" processes and "Credit Evaluation".
• Customer data request process
• Credit Evaluation Process

4.1.5. Customer Data
Data collected from the author's client Wong Susan [22], were obtained from some questionnaires; these data were entered into the CSV document in which the following input data:
• Age
• Marital status
• Gender
• Employment situation
• Degree of instruction
• Income
• Economic activity
• Type of Housing
• Amount of the last credit
• Credit destination
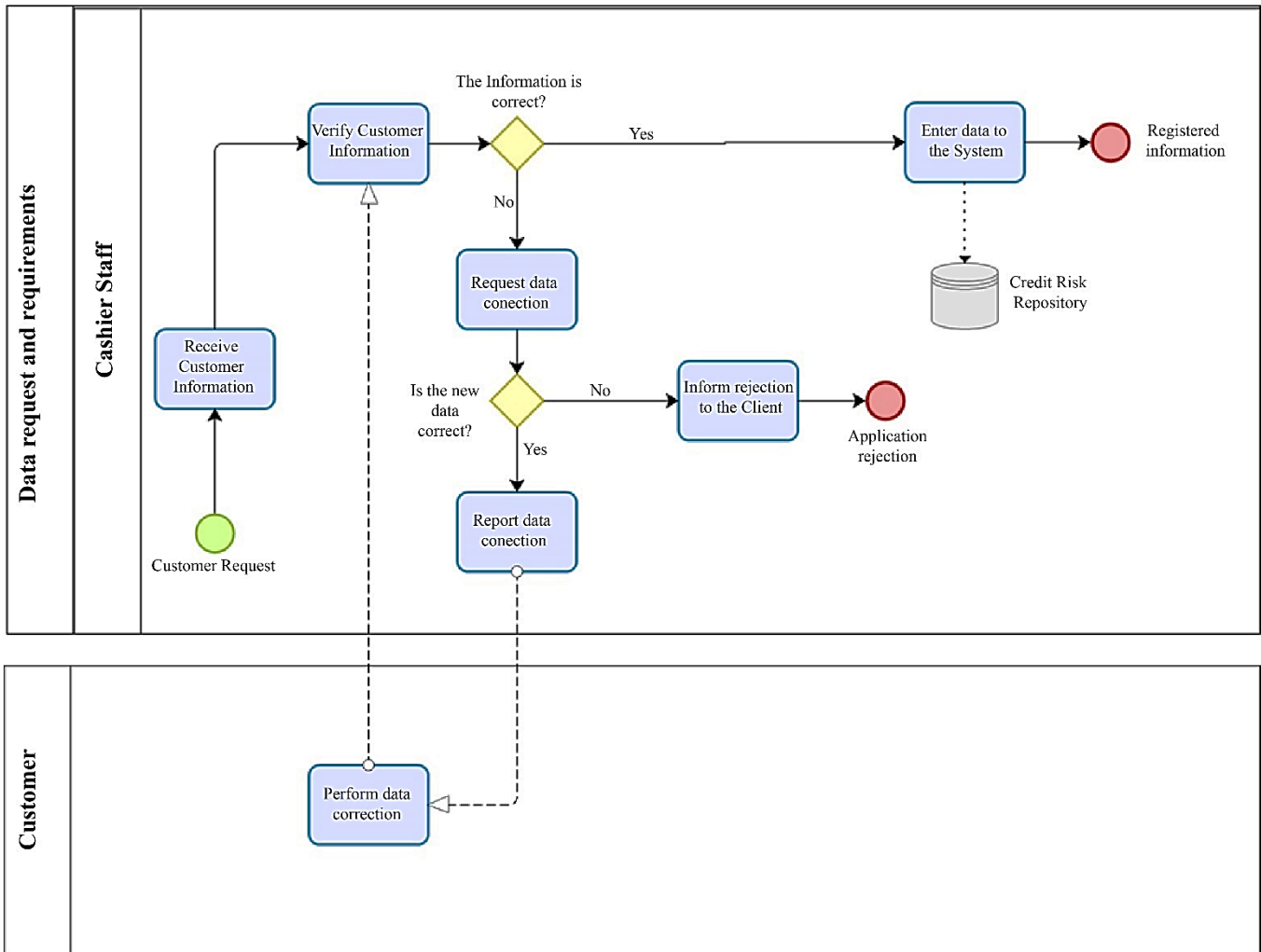• Warranty
• Type of guarantee
• Type of currency

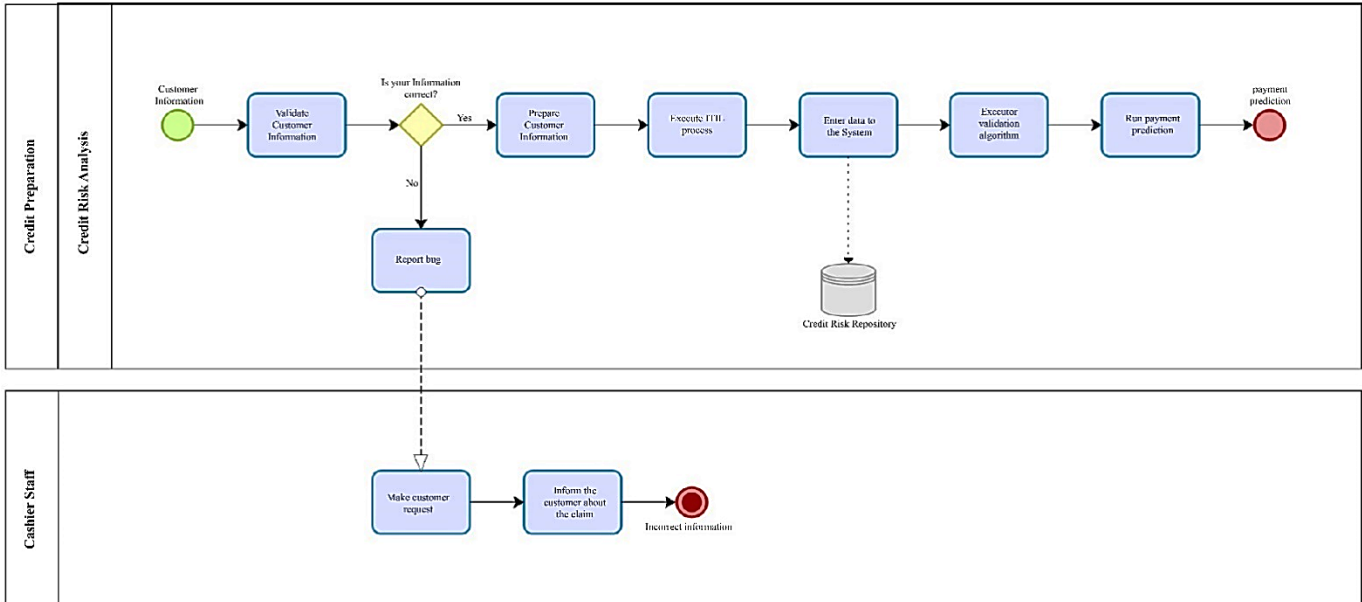**Fig. 21 Customer data flow diagram.**

Fig. 22 Credit evaluation flowchart

4.1.6. Developing the Software and Prototype

Table 1. Management validates if a customer accesses a loan or not

| MANAGEMENT VALIDATE IF A CUSTOMER ACCESSES A LOAN OR NOT	
Precondition:	The client opens the web application to make an inquiry to see if you can access a loan.
Postcondition:	The system manages to capture The Requirements of the client
Basic Flow – request	1. The process begins when a request is made in the web system 2. The system displays the search option 3. The system manages the form that is filled out by the client 4. The system captures the requirements of the loan requested by the client 5. Use case is finished.
Alternative Flows Incorrect data	In step 4 capture requirements, if an error is verified or a failure to fill out the form displays an error notification and request to complete the data.
Subflows	None
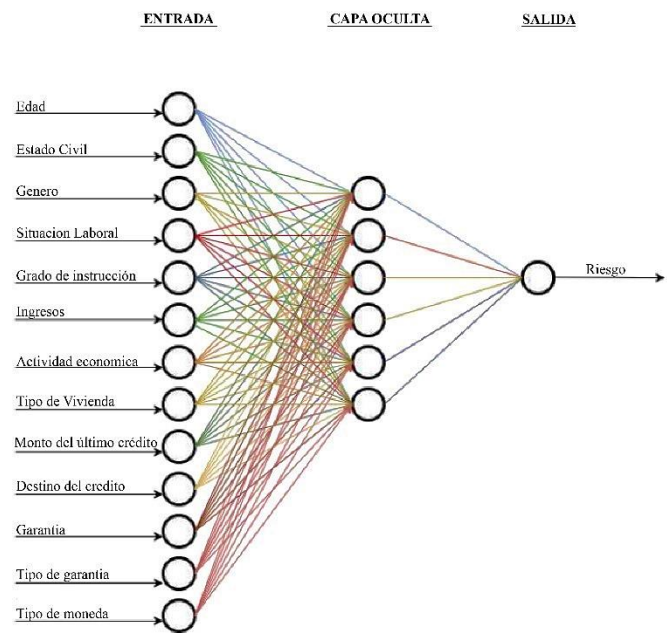
Fig. 23 Customer data entry and exit process.

Fig. 24 Validad si se accede al préstamo

Tabla 2. Data register

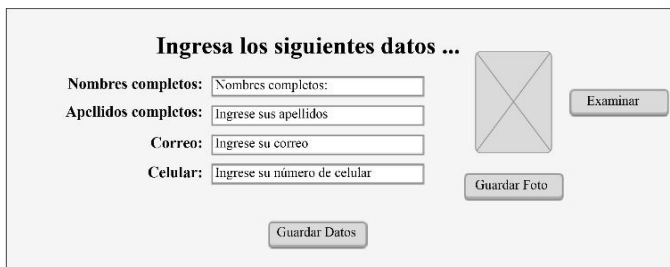| DATA REGISTER	
Precondition:	The application allows the filling in the customer data form
Postcondition:	The system manages to save the data of the applicant in a database and so on, complete your registration
Basic Flow – request	1. The process begins when the client enters the registration option 2. The system displays the form to be filled out by the customer 3. The system manages the form that is filled out by the client 4. The system captures the customer data and saves it in the database 5. Use case is finished.
Alternative Flows Incorrect data	In step 4 of data capture of the client, if an error is verified or missing when filling out the form displays an error notification and request to complete the data
Subflows	None

Table 3. Validate DATA

VALIDATE DATA	
Precondition:	The application must verify that the customer data exists in the database
Postcondition:	The system confirms that the client is already registered
Basic Flow – request	1. The process begins when the receptionist manager validates the data 2. The system displays the customer data 3. The system validates that the client's data has been registered 4. Use case is finished.
Alternative Flows	None
Subflows	None

Fig. 25 Data Register

Fig. 26 Validate DATA

Fig. 27 Download DATA

Tabla 4. Download of previously entered data

DOWNLOAD OF PREVIOUSLY ENTERED DATA	
Precondition:	The client fills out the form with the information requested.
Postcondition:	The system sends the data filled in by the client to a database
Basic Flow – request	1. The process begins when the client fills out the form 2. The system saves the customer data in the database 3. The system allows the client to download the entered data. 4. Use case is finished.
Alternative Flows	In step 1 of capturing the form, if an error is verified or missing in filling out the form, an error notification is displayed, and a request is made to complete the data
Subflows	None

4.1.7. Database Design

Next, the design of the tables and their relationships will be done for the correct functioning of the application.

Fig. 28 Validation if the loan is accessed

Fig. 29 Database

4.1.8. Organize Necessary Information

To design a database, you must first identify that there will be two types of users that differ in their privileges and access. Each client will have personal data such as ID, names and surnames, and marital status, among others, allowing the client to be identified. Lastly, there must be a report showing

the client's data, approved amount and data related to the credit (see Figure 28).

Tabla 5. Validate if you access the loan

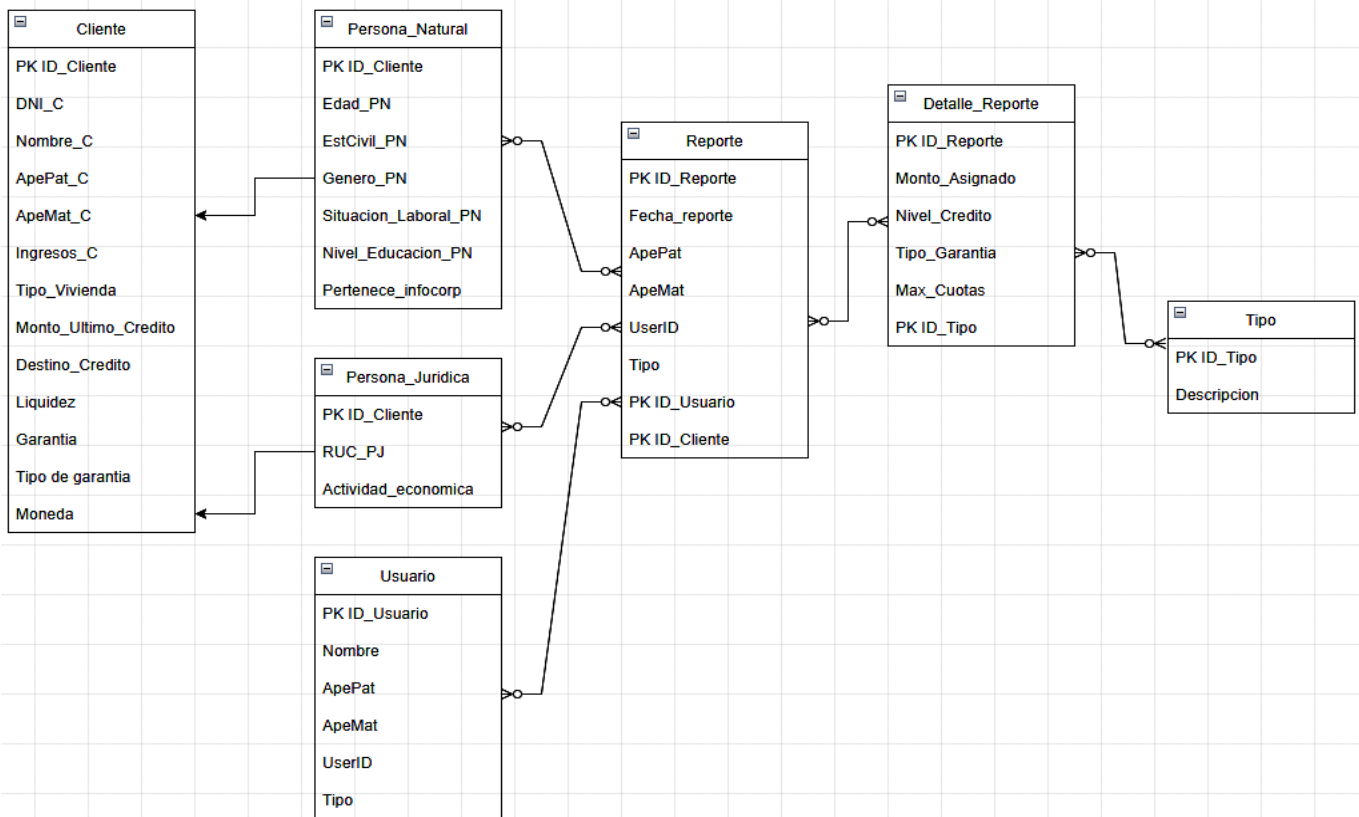| VALIDATE IF YOU ACCESS THE LOAN	
Precondition:	The receptionist gives the final result to the client to see if he accepts the loan or not
Postcondition:	The system allows you to view the total amount requested.
Basic Flow – request	1. The process begins when the receptionist informs the client about the final result 2. The system calculates the total amount 3. The system allows the visualization of the amount 4. The client decides whether to accept the loan or not 5. Use case is finished.
Alternative Flows	In step 4, if the client does not accept the loan, then the registration data is deleted.
Subflows	None

Fig. 30 Database design

4.1.9. Split Information Into Tables

To design the database, the following tables have been considered as main:

• User: Administrator and risk analyst user data is stored.
• Client: Stored data of the financial company's clients.
• Report: The customer's user data and credit report will be saved.

4.1.10. Convert Items to Columns

The tables with their respective attributes are created.

4.1.11. Elaborate Database Design

The database is structured based on the information required for credit risk analysis (see Figure 29).

4.2. Discussion

AI is a very extensive topic, as it contains many aspects of current trends. On this aspect, [19] I mention in his research work that the vast majority of citizens are in a situation that does not favor AI technology and that the risks to which they are exposed to this advance are unknown. It goes at a very fast pace. But in my opinion, the aforementioned is not only understood from the socioeconomic risk or possible disasters by computers in a dystopian future related to AI as some tend to think, but artificial intelligence technologies are not necessary in the future. to impact this globalized world. According to the thesis of [20], he states that the consequences of this process are sustained by many of the technologies that carry out various activities. The criteria for using AI are very diverse, and currently, it is mainly used in computing and robotics [13], adds in his article. In my opinion, it does not end here because the possibilities extend to various areas, such as the case of social sciences and business sciences, where a large amount of processed data requires implementing systems based on artificial intelligence. In addition, [8] it should be mentioned that the current development of artificial neural networks and processing systems to predict credit risks are increasingly common in banks to prevent future losses.

5. Conclusion and Future Work

In recent times, technology has allowed people to enter the digital age. Currently, it has been shown that banks use AI to prevent losses; in this work, the characteristics and requirements requested by the bank were defined. The mapping of the processes helped to identify the attributes of the tables and the input data that were considered in order to design the application interface. Managing to obtain interest on the part of the banking entities to opt for better decisions based on the information of previous users, a need arises to conduct investigations to analyse highly dangerous users. To conclude, it would be recommended that for future work, you take into account that the Python programming language, together with the Pandas and Sklearn libraries, which are used to make artificial intelligence calculations, will be very useful if you want to carry out work based on artificial intelligence.

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