Chapter 4 Machine learning in the detection of gender violence in digital job offers in the technological sphere

Capítulo 4 Aprendizaje automático en la detección de la violencia de género en las ofertas digitales de empleo en el ámbito tecnológico

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Abstract

Gender violence is a social problem that continues to affect women in various sectors and areas, specifically in the workplace, where their right to equal employment is undermined by the existing gender discrimination, which is evident in the selection process of candidates observed in the publication of digital job offers, which can result in one of the many unfair practices, which result in a negative impact, hindering equal opportunities, diversity and even innovation. This research work presents a qualitative analysis of different Machine Learning algorithms, classified into supervised and unsupervised machine learning. A literature review is established, where the information obtained allows an evaluation of the advantages and disadvantages of the algorithms, Decision Trees, Naïve Bayes Classification, Ensemble Methods, Support Vector Machines (SVM) and Unsupervised Deep Learning (Autoencoders): Neural Networks, to determine the best and most relevant characteristics of each one, which can be implemented in the proposal of an algorithm that allows identifying patterns of gender violence in the field of digital job offers.

Gender violence, Discrimination, Digital job offers, Diversity, Machine Learning, algorithms

Resumen

La violencia de género es un problema social que sigue afectando a las mujeres en diversos sectores y ámbitos, específicamente en el ámbito laboral, donde su derecho a la igualdad laboral se ve menoscabado por la discriminación de género existente, que se evidencia en el proceso de selección de candidatos que se observa en la publicación de ofertas de trabajo digitales, lo que puede resultar en una de las muchas prácticas desleales, que se traducen en un impacto negativo, dificultando la igualdad de oportunidades, la diversidad e incluso la innovación. Este trabajo de investigación presenta un análisis cualitativo de diferentes algoritmos de Machine Learning, clasificados en aprendizaje automático supervisado y no supervisado. Se establece una revisión bibliográfica, donde la información obtenida permite evaluar las ventajas y desventajas de los algoritmos, Árboles de Decisión, Clasificación Bayes Naïve, Métodos de Ensamble, Máquinas de Vectores de Soporte (SVM) y Aprendizaje Profundo No Supervisado (Autocodificadores): Redes Neuronales, para determinar las mejores y más relevantes características de cada uno, las cuales pueden ser implementadas en la propuesta de un algoritmo que permita identificar patrones de violencia de género en el ámbito digital ofertas de trabajo.

Violencia de género, Discriminación, Ofertas de empleo digitales, Diversidad, Machine Learning, Algoritmos

Introduction

Gender-based violence in the selection process of candidates continues to be a practice carried out by some organizations on a recurring basis, causing a negative impact on equal opportunities, diversity and innovation. It is important to analyze the problem, with the intention of detecting the negative consequences, in turn, in future work to find solutions that allow detecting and preventing gender violence in the technological workplace.

This research paper presents different Machine Learning algorithms, where their characteristics and advantages are explained. In addition to a literature review that allows us to address the problem of gender-based violence in the technological workplace, raising the central hypothesis that Machine Learning can be used to detect patterns of gender-based violence in digital job offers. The methodology used, through the literature review, allows a qualitative analysis of Machine Learning algorithms for the detection of patterns of gender-based violence in digital job offers, evaluating the advantages and disadvantages of each algorithm, as well as its ability to identify patterns of gender-based violence in the field of digital job offers.

Previous research that has applied these algorithms was reviewed, with the intention of determining their efficiency in the detection of gender-based violence in digital job offers, allowing an evaluation of their effectiveness. Additionally, the inherent limitations of algorithms, such as Decision Trees, Naïve Bayes Classification, Ensemble Methods, Support Vector Machines (SVM) and Deep Unsupervised Learning (Autoencoders): Neural Networks, were explored.

In the discussion section, the proposal of an algorithm with a hybrid approach is shown, which contains the strengths of each algorithm analyzed above, this, to correctly address the detection of patterns of gender violence in the technological field, together with the presentation of the operation and possible results of the algorithm in the data analysis. The conclusions show the main findings of the study together with some recommendations for future research in this field.

Literature Review

1. Gender-based violence in the technological field

We are currently living in a digital era, where the technology sector has experienced exponential growth, transforming life in different environments, such as: social, educational, business, work, to mention a few. However, this situation has highlighted some social issues, such as gender-based violence, which still persists in the technological workplace. According to Hernández (2022), between 2012 and 2021, there is a 42% increase in women who decided to study careers related to science, technology, engineering and mathematics, known as STEM (for its acronym in English), however, the gender gap continues to be an obstacle for women seeking to develop in these areas, emphasizing that gender discrimination is present from childhood to participation in the labor market.

A study published by Grant Thornton's International Business Report (IBR) shows that in management positions in global mid-matket companies, the integration of the female gender has grown slowly, with only 32.4%, which is just half a percentage point (pp) increase for the year 2022, while compared to its study carried out in 2004 it only increased by 13 pp, In addition to the above, the World Economic Forum (WEF) Global Report mentions that with this growth until 132 years from now, the gender gap can be corrected worldwide (Guerra, 2023). In addition to the above, the United Nations Population Fund (2023), mentions the type of gender-based violence triggered through technology, known as digital violence, which is exercised through the use of information and communication technologies, in digital spaces against a person for gender reasons.

Statistical data reveal a worrying reality in the technological field, regarding gender-based violence, despite the growth in women's participation, the gender gap persists in various areas, from education to the world of work. The slow progression in the integration of women in managerial and executive roles manifests a challenge for women to be able to access management positions in the business world. Moreover, the forecast that it will take more than a century to close the global gender gap, as noted by the World Economic Forum's Global Report, emphasizes the need for effective action to address this problem. This information shows the importance of using technology, in particular, machine learning, to analyse gender-based violence in the technological workplace, with the aim of focusing efforts to advance towards gender equality in this sector.

Technology is not only an area of professional development, as well as a labor one, it also helps to carry out a hiring process, thus revolutionizing the way in which job offers are sought as part of the process to obtain a job. Currently, searching for jobs on the internet through social networks is one of the most popular ways to look for a job, two clear and most used examples are: Online Career Center (OCC Mundial) and LinkedIn. Within these, more and more people are going through the job search process, due to the convenience, accessibility and a wide variety of options offered by online job search, this modality is increasingly predominant due to digitalization in the globalization of the economy.

2. Gender-Based Violence in Digital Job Offers

Job offers on digital platforms represent an opportunity to enter the world of work, where people manage to find important professional jobs. However, even today, gender-based violence is still present within job search processes, a problem that is of urgent concern, because it remains in digital job offers. It is necessary to analyze this phenomenon, with the aim of exploring its scope, its manifestations, which help to determine the importance of using technologies to detect its components that continue to cause the lack of inclusion of women in high-ranking jobs.

The language with which a candidate is applied for a job position, according to Piras *et al*. (2023), can act as a barrier to aspiring to a job, since the advertisement may show explicit or implicit language indicating a preference for a specific gender. The Inter-American Development Bank (IDB) conducted the first large-scale research on the impact of inclusive language, addressing biases in job advertisements, finding that the way job searches are conducted can be a barrier to entry for women in highly masculinized sectors. In turn, Cortina *et al*. (2019), conducted an experiment that addresses gender discrimination in job offers, where women between the ages of 37 and 39 are on average 30% less likely to be called to a job interview than men, with the same professional preparation.

Gender-based violence is a problem that is implicit in different areas of society, from gender discrimination in job offers in the candidate selection process, affecting equal opportunities in the workplace. This not only represents an unfair practice, but also has a negative impact on diversity, innovation and the economic progress of organizations and societies as a whole.

In addition to the above, access to employment for women in the 21st century is not only an odyssey, but at the same time, a risky activity, some job offers on digital platforms, ask women, without children or without family dependents, even a type of height, weight or even breast size, without such characteristics being decisive for the correct development of the work offered (Burriel, 2020). Therefore, addressing gender-based violence in job offers is essential not only from an ethical perspective, but also to promote a more productive and equitable work environment.

3. Machine Learning in the Detection of Gender-Based Violence

According to Jiménez and Díaz (2021), Machine Learning (ML) belongs to a type of artificial intelligence (AI), which, according to its name, performs the action of "learning", that is, it can adapt over time, by identifying programmed patterns, resulting in algorithms that evolve over time. ML provides several options for applying machine learning to help detect patterns, becoming a valuable tool in the fight against gender-based violence in the technological workplace. ML makes it possible to analyze large data sets to identify patterns that indicate the presence of gender-based violence in job offers. There are different types of machine learning algorithms, which are located, from classification to neural networks, which learn to recognize indicators of gender violence in texts published within job offers, such as gender bias, offensive language or implicit discrimination, with the aim of identifying early job advertisements that may perpetuate gender stereotypes or discriminate against candidates based on their gender.

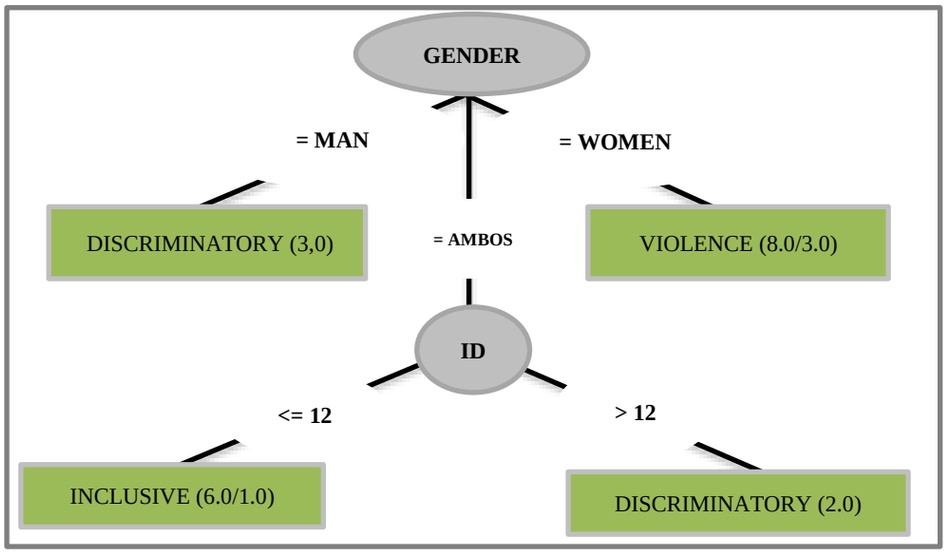
ML contains algorithms classified into two modalities: supervised and unsupervised learning, which are described below.

Supervised Learning: It allows the training of an algorithm, through the application of questions, as well as the implementation of certain characteristic labels, in obtaining answers. The algorithms that belong to this modality are categorized by: classification, where digits, diagnoses, or detection are identified, commonly used in problems such as identity theft. Regression, to obtain continuous or immediate response values, commonly used for climate predictions, or growth projections.

The algorithms belonging to the machine learning modality are:

1. Decision Trees: This algorithm is a prediction algorithm, which works, showing results based on a series of related decisions. There are three important elements to take into account, the integration of decision-making nodes (decision moments), random nodes (events) and branches (associated probabilities). Figure 1.1 shows the graph obtained from Three's algorithm, J48.

Figure 1.1 Decision Tree Chart

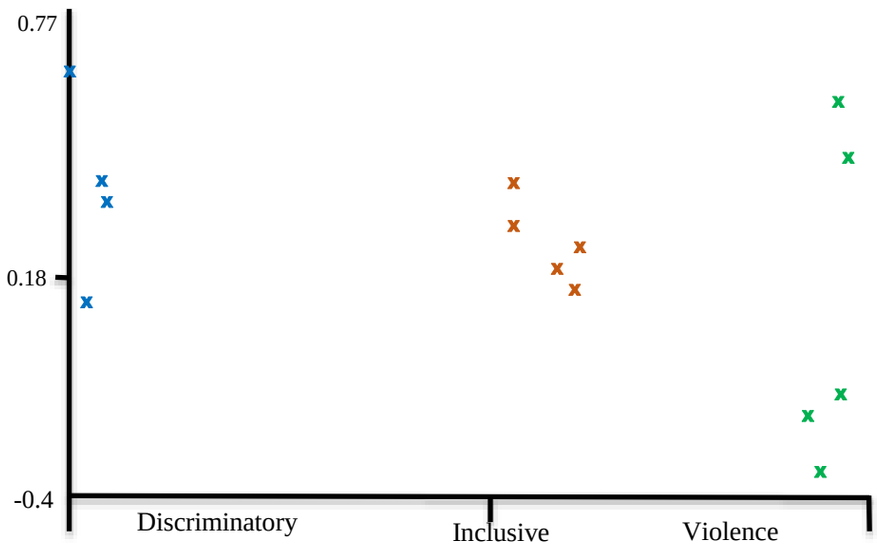


Source: Own Work

The figure above shows a decision tree graph, where a classification, as well as decision-making, is used to identify patterns of gender-based violence in the digital workplace. The decision tree is made up of nodes that represent the characteristics of the data and branches that represent the decisions based on those characteristics, in this case it classifies digital job offers as inclusive or discriminatory based on a delimitation of words within those ranges.

2. Naïve Bayes classification. Simple probabilistic classification algorithm with strong independence assumption. On the a priori basis of each class, a frequency calculation is made of the class labels in the training set, together with the conditional probabilities of each given attribute in each class. Figure 1.2 shows a graph corresponding to the Naïve Bayes algorithm.

Figure 1.2 Naïve Bayes Chart

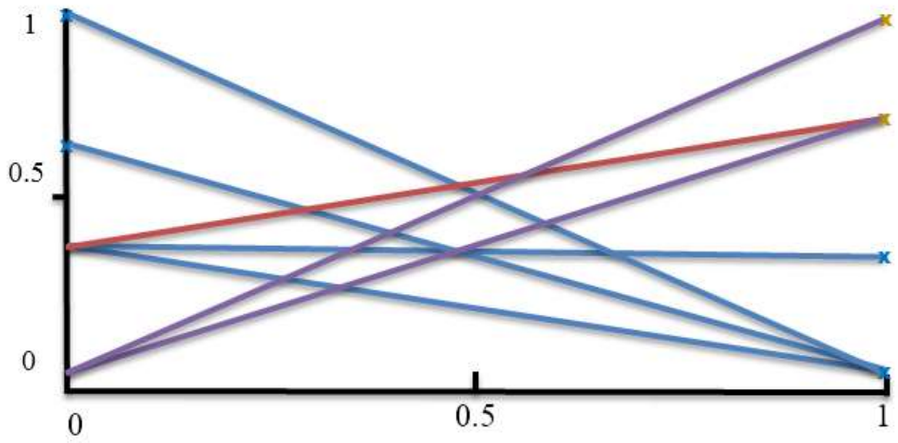


Source: Own Work

Figure 1.2 illustrates an example of gender classification, which can take data such as age and inclusion or discrimination in the job offer, to name just one example. The chart shows how the conditional probabilities of each given attribute in each class (in this case, gender) are calculated to classify new data.

3. "Ensemble" methods: An algorithm that performs the combination of multiple classifiers, with the intention of improving performance and accuracy to make the best decision, contribute to significantly improving performance in a variety of machine learning applications. Figure 1.3 shows the representation of the RandomForest algorithm.

Figure 1.3 RandomForest chart

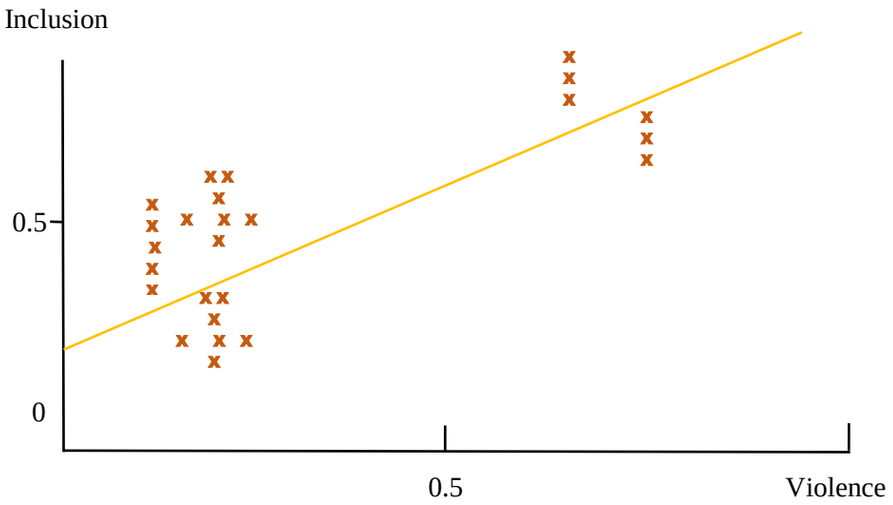


Source: Own Work

The figure above shows the graph of the RandomForest algorithm, which is an "Ensemble" method of classification that combines multiple classifiers to improve performance and accuracy in decision-making. The graph shows an example of classification, which can be in relation to gender, age or some other elements that allow determining inclusion or discrimination in the labor offer.

4. Least squares regression: Based on two variables, dependent and independent, in which it models a relationship between them, using a set of data, with the intention of predicting numerical values based on independent variables. Figure 1.4 shows the graph corresponding to the least-squares regression algorithm, showing that it can be obtained from a prediction using numerical values based on independent variables.

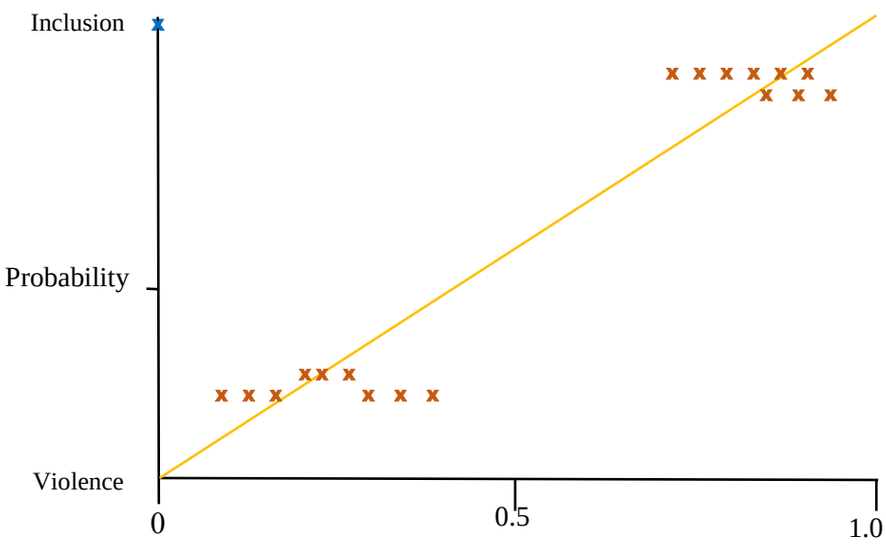
Figure 1.4 Least-squares regression chart



Source: Own Work

5. Logistic Regression: Classifies data in a binary and multiclass way, used for classification problems. It uses logistics to model the relationship between a dependent variable and a set of independent variables. Figure 1.5 contains the representative graph of the logistic regression algorithm.

Figure 1.5 Logistic Regression Graph

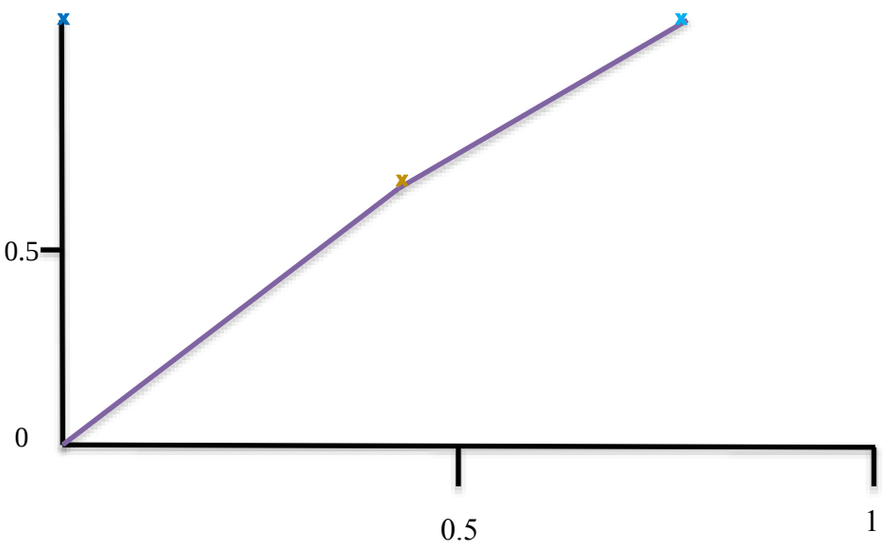


Source: Own Work

As shown in the figure, the data to be obtained can be binary and multiclass in classification problems. The graph shows an example of how the relationship between a dependent variable and a set of independent variables is modeled using the logistic function.

6. Support Vector Machines (SVM): Used in classification and regression problems, it maximizes the distance between classes in feature space, in a linear fashion, used in applications such as text classification, image detection, and bioinformatics. Figure 1.6 shows the graph of the SMO algorithm, representing a variable, in this case, discrimination.

Figure 1.6 Support Vector Machines (SVM)



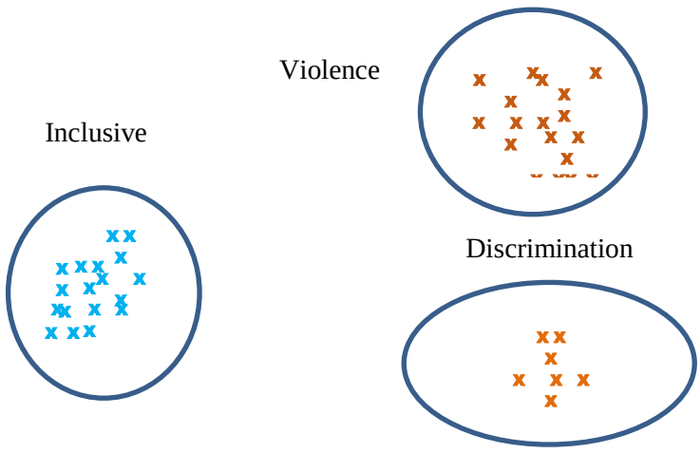
Source: Own Work

Figure 1.6 shows a graph corresponding to the Support Vector Machines (SVM) algorithm used in classification and regression problems. The graph shows an example of how the distance between classes is maximized according to certain characteristics, in a linear way, to classify new data based on the independent variables.Unsupervised Learning: The algorithm is developed with the ability to autonomously assimilate various characteristics and data elements classified in input, where it returns them for output in a coded form.

Two unsupervised algorithms are shown below.

1. Clustering: A model of grouping a set of similar objects or data into groups, with the aim of finding patterns to understand a situation to make informed decisions, used as a technique for customer segmentation, content recommendation, anomaly detection, among others. As an example, there is K-Means: where data is grouped into K, i.e. clusters, where K is a user-predefined value. Hierarchical Clustering: Creation of a hierarchical clustering tree, to observe the clustering structure at different levels of granularity.

Figure 1.6 Clustering

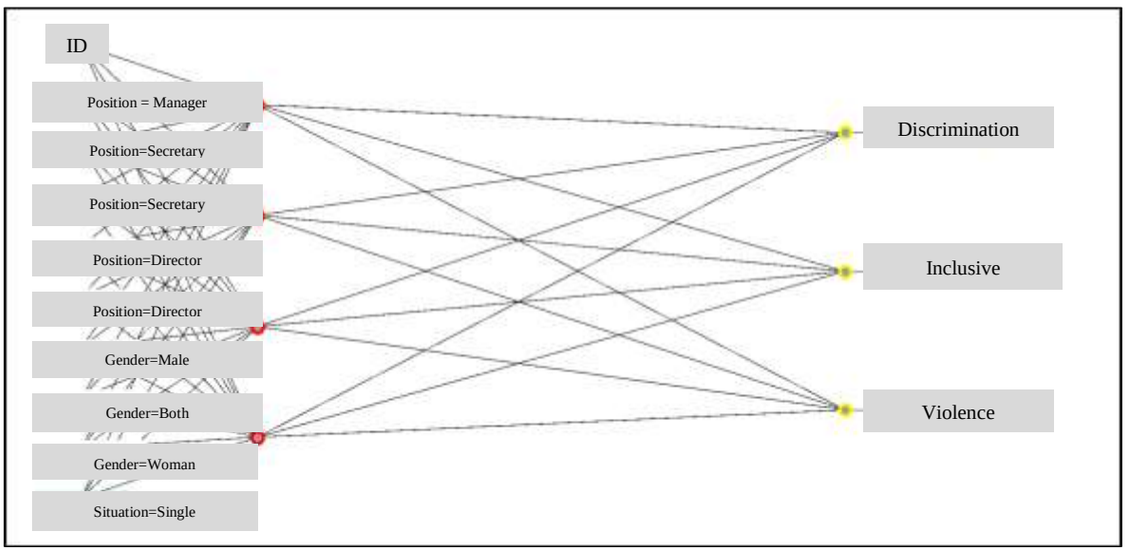


Source: Own Work

The figure above illustrates the grouping of similar data into groups, allowing us to find patterns to understand a given situation. It looks at the different data points grouped into different clusters, some examples of use are: customer segmentation, content recommendation for anomaly detection, among others.

2. Deep Unsupervised Learning (Autoencoders): It uses neural networks to learn latent representations of data, which can help in feature extraction and data generation, being neural networks, the ones that learn continuously by corrective feedback to improve the prediction analysis it performs, the data flows from the input node to the output node through many different paths in the neural network, as shown in Figure 1.7.

Figure 1.7 MultilayerPerceptron



Source: Own Work

Figure 1.7 shows an example of a neural network called Multilayer Perceptron, which makes use of autoencoders, which allow the representation of latent data, with the intention of extracting certain characteristics for the generation of data, which are flowing from the initial node to the output node, following several different paths in the neural network. where learning is done through corrective feedback, which allows improving the prediction analysis carried out by the neural network.

To address the detection of gender-based violence in digital job offers, some specific algorithms have been identified for the analysis of the information. These algorithms include: Decision Trees, Naïve Bayes Classification, "Ensemble" Methods such as Classifier Sets, Support Vector Machines (SVM) and Deep Unsupervised Learning, specifically the use of Neural Networks. They allow a visual representation, which helps to understand the patterns of gender-based violence in the data, through the representation of the information through specific graphs, with the intention of identifying and understanding hiring trends in digital job offers.

Methodology

Through a qualitative analysis, the advantages and disadvantages of each algorithm are established, as well as its ability to identify patterns of gender-based violence in the field of digital job offers.

The analysis consists of a review of previous research that has applied these algorithms, with the intention of determining their efficiency in the detection of gender-based violence in digital job offers, allowing an evaluation of their effectiveness. Additionally, the inherent limitations of algorithms are explored: Decision Trees, Naïve Bayes Classification, Ensemble Methods, Support Vector Machines (SVM) and Deep Unsupervised Learning (Autoencoders): Neural Networks, which help to determine a possible existence of biases in the data, allowing to determine the strengths and weaknesses of the algorithms.

Table 1.1 shows a comparative table of the algorithms proposed for the analysis of information in the detection of gender-based violence in digital job offers.

Table 1.1 Analysis of Machine Learning Algorithms

Id	Algoritmo	Ventajas	Desventajas	Ejemplos de aplicación
1	**Decision Trees**	Effective decision-making. Easy to use and understand. Implement usability. Fast. Constantly updated. Simple graphic design. Intuitive reading. Handles alphanumeric data.	The more training information, the more unstable. It does not guarantee that the tree generated with new data is optimal. Skewed trees. It has drawbacks when generating new data.	According to Dueñas (2020), it mentions the development of a predictive Machine Learning model, using decision trees, to classify HTTP requests classified as normal and anomalous, with 100% accuracy in the classification of HTTP requests.
2	**Naive Bayes Classification**	Perform operations faster. Requires a small amount of training data to estimate parameters. It is extremely fast.	Its attributes depend on others to continue learning (variable independence). You may observe a probability of 0 (zero).	Mostly used for spam detection in emails. García and Guevara (2023) analyzed Phishing, using Naive Bayes, where they obtained 99.04% confidentiality, precision and effectiveness in detecting poisoning attacks on DNS servers.
3	**Ensemble Methods (RandomForest)**	Combine multiple models to improve performance. Functional in hyperparameter adjustments in classification and regression problems. Reduces the risk of overfitting.	Hyperparameter tuning, that is, setting specific values. It comes to present overfitting with high costs. Too much training time. Does not work with small datasets. Difficulties in implementation.	According to Deborah *et al*., (2020), it combines different classifiers, offering better generalization performance, where it minimizes the expected error with respect to the trained data set. Mostly used for web applications, such as: Ecommerce, banking apps, medicine, to name a few.

4	**Support Vector Machines (SVM)**	Learn through features. Extracts large amounts of data, to reduce dimensionality and generate synthetic data. Effective in high-dimensional spaces. Efficient memory management.	Its effectiveness depends on the chosen kernel They are inefficient with large datasets (the kernel calculation can be very slow) The greater the characteristics, the greater the number of samples, causing overtraining.	It builds one or several hyperplanes in a very high-dimensional space that separates groups, used in classification or regression problems (Moreno *et al*., 2020). Examples: medical applications of signal processing, natural language, image and speech recognition.
5	**Deep Unsupervised Learning (Autoencoders): Neural Networks**	Capture complex relationships. Fault tolerant. Recognizes patterns that have not been learned. They correctly capture complex features, for high-precision results.	It requires adjusting the architecture and prolonged training. Greater data preprocessing. Prolonged time and complexity in learning acquisition.	Castillo *et al*., (2022), analyzed data on the Internet through Web Mining, to identify suicidal traits in students, finding suicidal tendencies, with 98% accuracy, coupled with validation, aggregation, data analysis, prevention and detection of failures in complex software systems. Creation of autonomous systems and robots.

Source: Own Work

Discussions

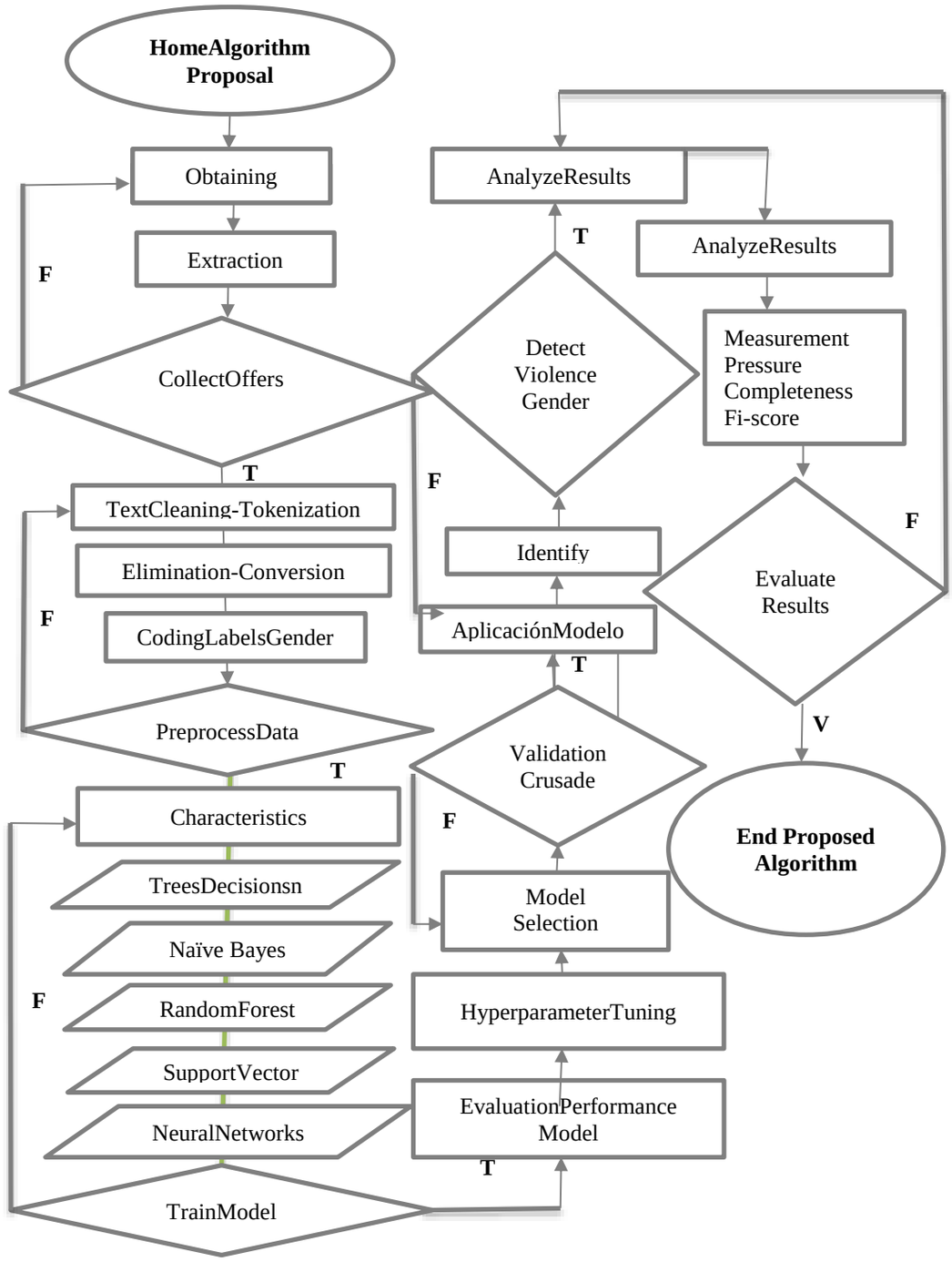
A comparison of different machine learning algorithms is conducted to address gender-based violence detection in digital job postings in the technological domain. Each algorithm presents distinct advantages and disadvantages based on its operational nature. Decision Trees prove to be more efficiently faster, coupled with their easy understanding during implementation. However, their stability is compromised with large training sets. Naïve Bayes classification is fast with small datasets but exhibits variable independence, limiting its effectiveness in more complex scenarios.

Ensemble methods, such as RandomForest, help mitigate risks like overfitting, but their hyperparameter configuration results in long training times on massive datasets. Support Vector Machines (SVM) excel in high-dimensional spaces due to memory management efficiency, dependent on the chosen kernel's capabilities. However, in large datasets, SVM can become slow. Deep Unsupervised Learning (Autoencoders) in neural networks is useful for complex relationships and capturing previously unlearned patterns with high precision. Still, it requires specific architecture for careful training, along with extensive data preprocessing. The above observations demonstrate that there is no one-size-fits-all approach, highlighting the importance of creating technological solutions that integrate the best features of different algorithms.

Given these observations from the comparison, a hybrid approach is proposed that capitalizes on the strengths of each algorithm. This involves using decision trees for efficiency and ease of use, employing ensemble techniques like RandomForest to mitigate overfitting, and incorporating SVM skills to handle large datasets and capture complex patterns. Additionally, elements from deep neural networks, such as Autoencoders, can be utilized. Figure 1.8 illustrates a flowchart depicting the operational process of the proposed algorithm for gender-based violence detection in digital job postings. The flowchart begins with job posting collection, feature extraction, and text cleaning through tokenization, allowing gender label encoding.

Subsequently, data preprocessing involves the removal of conversions. Following that, model performance evaluation is carried out using cross-validation and hyperparameter tuning, if necessary. Finally, the model is applied to detect gender-based violence in digital job postings, coupled with result analysis to assess model accuracy and completeness.

Figure 1.8 Flowchart, Proposed Algorithm



Source: Own Work

To better address the detection of gender violence in digital job offers in the technological field, the algorithm allows combining the positive elements of each algorithm, with the intention of improving the precision in the identification of patterns of gender violence, to contribute to mitigate the risk of overfitting in complex data sets, and thus efficiently manage large volumes of information. In addition, an ability to capture complex patterns is required, due to the subtlety of the language to be analyzed, such as the detection of more discreet or direct manifestations of gender violence.

The expected results through the implementation of the proposed algorithm for the detection of gender violence would allow working from:

- Data Collection, with a total number of digital job offers collected greater than 500.

- Data Preprocessing, a number of offers with clean text resulting in a tokenization of 450, with a minimum of 50% of stop words removed, and 100% conversion to lowercase: 100%, for gender coding: Male (0), Female (1), Not Specified (2).

- Model Training: the characteristics taken from the Decision Tree must have a minimum training precision of 85%, for the Random Forest, a minimum of 90%, in SVM, there must be a minimum of 88%, for the Neural Network (Autoencoders) of 92%.

- Cross Validation, the percentages to be taken must be the same as the training.

- Detection of Gender Violence, the number of job offers with and without indications of gender violence must be counted to determine the percentage.

- Evaluation, the analysis of the detection results is carried out, the measurement of precision, completeness and F1-score is carried out, as part of the feedback for continuous improvement of training, the hyperparameters of the SVM model must be adjusted to improve the exhaustiveness.

Conclusions

Machine Learning provides tools that allow gender violence to be detected in digital job offers in the technological field. Where through different algorithms, such as Decision Trees, Naïve Bayes Classification and Neural Networks, patterns in text within web pages can be analyzed. It is necessary to look at the advantages and disadvantages of each algorithm, to choose the best approach to measures that can be taken to reduce the gender gap in the STEM sector.

Gender violence in society indicates gender discrimination in the candidate selection process, affecting equal opportunities in the workplace, which represents an unfair practice with a negative impact on diversity, innovation and progress. economic of organizations with societies as a whole. Access to employment for women is still a challenge that results in a risky activity in the 21st century, since the gender gap persists in various areas, from education to the world of work, therefore, effective actions are needed to address it.

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