Political analysis of the peace process in Colombia: a simulation from artificial neural networks

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Abstract

This article presents an exercise in political science simulation applied via artificial neural networks software called Easy NN-plus 15.0, with reference to possible political scenarios that can emerge once conclude the dialogue between the guerrillas of the armed revolutionary forces of Colombia (FARC-EP) and Juan Manuel Santos's administration, whose aims to solve through negotiated via the internal armed conflict that is afflicting Colombia more than half a century ago. The political scenarios referred to as input layer for the Perceptron were: democratic stability, civil war, coup d'État, revolution, political reform and authoritarian modernization; the output layers were: democratic openness and the continuation of the conflict; while the interlayer was formed with the complex interrelationship of the six entry scenarios. The computer program was used to relate complex non-linear factors of the political challenge posed by the dialogue, to improve the analytical understanding of the situation.

Key words

political openness, conflict, political science simulation, artificial neural networks, reform, political transition

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1. Introduction

The aim of this article is to perform a simulation from artificial neural networks of six political scenarios that could arise once conclude the dialogues between the Government and the FARC - EP, in order to obtain a likely outcome.

The six scenarios that were used as "inputs" or political system entries were: democratic stability, civil war, military coup, revolution, political reform and authoritarian modernization. Each one of the scenarios is a type of analysis and at the time of be studied individually tend to interact each other generating confusion regarding which could be the results, providing a challenge to the formal logic of the social scientist.

Two outputs or "outsiders" were selected from the politic system under simulation, they were: democratic opening and then the internal armed conflict; while the hidden layer of the neural network, was the interplay of the six types described above.

It is necessary to note that some of the previously mentioned scenarios were analyzed in a first theoretical work done by sociologist Eduardo Pizarro led as title *"Escenarios posibles de Colombia en los 90"* [1], being part of a foresight exercise which took into account for its implementation, both historical and contextual elements and that for the purposes of this article are used as entry and exit data in learning neural network through a computer program.

The text has been organized as follows: first of all refers to three experiences of artificial neural networks applied to case studies in social sciences; Secondly it takes up the theoretical concept of "Transition policy" that allows to deploy the resulting scenarios of negotiation between the insurgency and the

Government of Santos; third shows how the variables and the weight were organized in the neural network before they become neural network programming data; in fourth place is the application in the computer program with the respective images produced in the processes of simulated analysis and finally put in consideration some conclusions

2. Precedents of the use of artificial neural networks in the social sciences

The work done by the authors: Germán Leonardo Acevedo, Eduardo Francisco Caicedo and Humberto Loaiza Correa [2], entitled *"Recruitment by means of neural networks,"* (*Selección de personal mediante redes neuronale)s*, intended to find a technological solution that would allow lower levels of attrition of officers as a non-commissioned officers in the national army of Colombia, posing as a aims: reducing subjective criteria in the selection phase, study in detail both income and dropout statistics and streamline administrative processes through the use of intelligent systems.

The results of the study showed that the permanence of students in the institution, depended not only on the psychological variables present at the time of entry but it should be exogenous variables considered requiring a new modeling.

A second work was carried out by Juan Vázquez, Julio Castillo, Maria Rojas and Marcelo Marciszack, who took as the title: *"Artificial neural networks applied to social sciences"* [3] (*Redes Neuronales Artificiales aplicadas a Ciencias Sociales)* . In this, estimated risks causing urban dwellings to human health, i.e. the social vulnerability, from a holistic approach where housing was taken as a whole, with its surroundings, the public servi-

ces available, the socio-economic aspects of its residents and the capacity of reaction to emergencies, among others.

The fundamental contribution of the study consisted in using a different alternative to formal logic represented in mathematics (algebraic or differential equations), since in the social sciences, it is impossible to make measurements of the impact on the health of a particular risk factor in the presence of all other variables constant, generating complex and non-linear relationships requiring the approach of neural networks to provide a solution.

A third work prepared by José Amozurrutia [4], entitled, *"fuzzy logic and neural networks applied to social sciences"* (*Lógica borrosa y redes neuronales aplicadas a las Ciencias Sociales)*, aims to show how the use of these two theories, one from of mathematics applied to industrial processes and other emerging biology combined with physics and mathematics whose purpose is the electronic modeling and simulation of neural brain operations, can be deployed in Sociology with a view to enriching he analytical study of societies.

Amozurrutia criticizes the way sociology, traditionally has relied on the theories of probability and statistics to build units of reasoning which fail to address the complex phenomena of the dynamics of a society in its entirety and that could be addressed better if it will take into account a systemic understanding of second order built based on the membership functions offered by fuzzy logic and the weighting of heterogeneities possible through the use of artificial neural networks.

The importance of fuzzy logic is that it enables building bridges between the numerical and linguistic variables to establish meanings and valuations correctable and operable

within a context of Boolean logic. At the same time neural networks develop further artificial intelligence, whose purpose is geared to improve the understanding of the cognitive processes of men and their levels of self-organization, allowing better knowledge of the context or environment in which cohabit.

Each of the three contributions made by previous studies have elements in common to point out that the contributions of the theories of probability and mathematics - formal science - to the analysis of society are insufficient since the behaviors of the societies are complex and unpredictable.

With positivization of science in general, particularly with respect to the social sciences, is important to hatch bridges between linguistic variables and numeric one, in order to build new analytical units or improve the old ones, that lead to a greater understanding of the facts, events or behaviors of the various societies and at the same time allow simulated representations in technological models to plot development policies aimed to create balance and wellness in human beings.

3. Political analysis of scenarios to emerge from the process of dialogue between the FARC-EP and the Santos Government

Colombian history has been marked during the last five decades by an internal armed conflict that has faced insurgency sectors, advocates multiple ideologies both Social Democrats and Socialists, against the security forces of the establishment, which supports the interests of the oligarchy and national bourgeoisie, generating a warlike situation that deepened over upon entering the theater of war the so-called paramilitary groups,

which are arms armed with an extreme right that operates with the consent of the class ruling, landowners, drug traffickers, ranchers, high-ranking military officers as well as Middle Sectors with significant income.

The outcome of this conflict has been reflected in issues such as the forced displacement of thousands of farmers, indigenous people and people of African descent, who form a significant mass of innocent civilian population, which has been forced to abandon their land to save their lives, becoming cheap labour, unemployed or homeless people arriving in the cities that host them, further aggravating the situation of poverty and misery in the metropolis.

The statistics show that you for the years 2002 to 2009 - term of office of former President Álvaro Uribe Vélez-, displaced Colombians were of the order of 2.412.834, representing a total of 49% of the 4.915.579 of Colombians who have been registered in the past 25 years, by the consultancy for human rights and the Desplazamiento - CODHES-, a non-governmental organization that promotes the realization and integral force of the human rights of displaced personsrefugee and migrant [5, p.1].

The military escalation of the internal armed conflict in Colombia presented its highest threshold during the period 2002-2010, in which applied the policy of *Democratic security* whose objective was the defeat the guerrillas militarily.

According to CODHES, - organization which takes as its reference the statistics of the Ministry of Defense and national security to submit its reports-, between 2002 and 2009 had been killed 11.388 FARC guerrillas, other 28.176 had been captured and 13.891 had demobilized individually, for a total of 52.740 of fighters who came out of the war, on the side of the insurgency, while on the side of the se-

curity forces, in the same period of time there were 4.427 deaths, 13.707 wounded, for a total of 18.134 [5, p. 24].

Despite military coups to FARC, infringed by the policy of *Democratic Security*, has been impossible for the establishment to militarily defeat the insurgency and vice versa, which again places more about sand policy, the discussion around the validity of renewing the dialogue between this insurgent force and the national Government currently headed by President Juan Manuel Santos to give a political solution negotiated the conflict.

Under this perspective, the guerrillas of the FARC, invited the Colombian Government to install a negotiations table, on 26 November of 2012, with headquarters in Havana, capital of Cuba, in order to find meeting points to achieve a negotiated political solution of the conflict, generating this way a *Transition Policy* scenario to the inside of the Colombian political system.

Authors such as O'Donnell and Schmitter [6, p. 19], text *"Transitions from authoritarian rule. Tentative conclusions on uncertain democracies"*, explained that a situation of *"Transition policy"* occurs when there are authoritarian forms parts of the ruling class and are the leading rulers, who, on its own initiative, decide to make a series of changes in the *Establishment* to ensure political rights of individual and group. In addition, the situation of democratic transition includes not only revolutionary dissolution of an authoritarian regime, but also the establishment of some kind of democratic figure or the step towards a revolutionary character alternative.

In the transition, there are no rules clear game presenting constant updates as well as an arduous struggle among political actors to redefine the political rules that benefit them

in the present and future, making the situation shows a complex tension, hindering the political analysis itself.

In view of the above, Colombia, would be going through a new situation of *Transition Policy* resulting from possible arrangements to reach the FARC-EP and the Government of Santos in the roundtable dialogue, whose political process, will depend on a series of agreements that will govern future democracy, to emerge in a series of political scenarios, that could be a side to sharpen the Colombian internal armed conflict or other side attenuate it to achieve a negotiated political solution.

In [7], which resulted from the political analysis of the situation at the beginning of the 1990s, in which were presented events as the delivery of weapons of the movement 19 April (M-19) in March 1990, The Constituent Assembly and The Constitution Of 1991. The study was titled: *Colombia: towards a democratic solution to the national crisis?* [7, p.46], there, the author prioritized six scenarios of saw it then, as manifestations of a *Transition Policy*, which were: civil war, confrontational continuum, authoritarian modernization, democratic opening, military coup and revolution, leaving aside the analysis of these last two as away from the political reality of the country at that time.

In this work, the six scenarios mentioned above, four of them were selected to feed layer entry or "Inputs" of the *Perceptron*, namely: civil war, authoritarian modernization, military coup and revolution, adding two more than they are: civil democratic stability and political reform.

While the outputs or "outsiders" constituted it: civil democratic stability and the reform of the political system democratic, by two more real stress scenarios to be considered living

Colombia today, and in which to play the possible exits to find a negotiated political solution to the internal armed conflict.

Here will then be a concise analysis of the possible political scenarios that allowed set by Artificial Neural network.

Civil democratic stability: consists of the continuous exercise of power by the elite - oligarchy - civil ruler, which was consolidated from the beginning of the Republic, which has wielded political power in Colombia for nearly two centuries, without making structural changes to overcome scourges such as economic, social and political inequality.

This scenario is not part of the analysis of Pizarro, however in one of his writings argues that in Colombian history, the political system has shown signs of great stability of civilian Governments because only on two occasions has been military dictatorships, in 1953 and 1957, consolidating the country as one of the most stable democracies in Latin America, [7, p.46].

Civil war: while the concept is difficult to define in the case of Colombia, for scholars of political science, is characterized broadly by the armed conflict of the almost all of the population, to the interior of the State, in terms of extreme polarization, due to ideologies or conflicting interests, generating huge amount of loss of life and infrastructure.

As shown in the political debate between Posada, Nasi, Ramirez and Lair [8, p. 157-159], Colombian society got used since the 1960s to live in a situation of internal armed conflict, but this has not led the population to a polarization on both sides as followers of a political project marked out by the insurgency and the other by the elite that controls the State.

Military coup: It is the political power by the military over the constitutional regulations and the legitimacy of a State.

Authors such as Bobbio, Matteucci, Pasquino, explained that a group of military or armed forces, who used rationally the use of physical violence by a surprise action planned and calculated, they act in a situation of military coup and seized the "organs and powers of political power", [9, p. 725].

Revolution: It is a radical change of all political, social, economic, cultural structures and others that organized a society until beginning of the revolutionary process, which can take some time.

According to sociologist Anthony Giddens in a revolution, at least must be present three criteria which are: "the political power generally by means of violence, by the leaders of a mass movement that, subsequently, used such power for great processes of social reform" [10, p.637].

In this scenario, the FARC would lead the mass movement would press violently political power to remove both the Colombian oligarchy and bourgeoisie, also would managers deep social reforms that change the social inequality in the country.

Political reform: The current political system has its historical roots in the National Front (1958-1974), which consisted of a political agreement between the ruling oligarchy of parties liberal and conservative, to repeatedly alternating power, establishing parity in public office and serve as a tool to contain sectarian violence present in the Colombian illiterate, after the assassination of Jorge Eliécer Gaitán, becoming in the formula saving which maintained the hegemony of the bipartisan political system, during this period of national history.

That agreement, resulted in the exclusion of third organized political forces opposed to bipartisanship, being outside the democratic system, bringing with them the formation of a political culture based on segregation and hatred of the opposition, particularly the one made by left-wing parties, leads to the militarization of the radical left in guerrillas inspired by the Cuban revolution which embraced Socialist and social-democratic ideologies.

The political Constitution of 1991 despite their regulatory framework failed to ensure a true political opposition to parties defeated in the different electoral contests, currently subsisting mechanisms that call into question the legitimacy of the State, such as; patronage, co-optation, electoral fraud, the financing of campaigns with money from drug trafficking, the impediment so that opposition parties access to public office, the murder and political persecution by the paramilitary groups, inequality in the management of the media and impartiality in information [11, p. 137].

As [11] proposed, the democratic reform should eliminate all the elements described above, that question the legitimacy of the Colombian State, starting with regulation of a statute of the political opposition, the restructuring of the electoral system, the political control of Congress, the administration of elections, the strengthening of real political parties, a review of the financing of the elections and the change of the political regime that replaces the presidentialism whose burden falls in power Executive by a parliamentary system or semi-parliamentary where the legislature is strengthened with multiparty representation that expand the borders of democracy [11, p.205].

Authoritarian modernization: from the Government of Virgilio Barco Vargas (1986-1990), the Colombian oligarchy adopted a development model focused on the implementation of the neoliberal economic policies that put an end to protectionism and industrialization by import substitution.

In an intensive way, from the 1980s to the present, all Governments have been concerned to emphasize more and more the neo-liberal recipe that defines the modernization as economic growth through economic openness, the reduction of tariffs on imports, free trade, the slimming of the State because of privatization, political and administrative decentralization and the holding of trade integration agreements, as free trade agreements.

In the field of trade policy, Colombia has signed multiple agreements since 1969, when was created the Andean Community of Nations (CAN), with Bolivia, Ecuador, Peru and Venezuela, in the form of free trade zone, adding to this year, approximately 48 trade agreements that consolidate Colombia as the country of the region, with more trade agreements, highlighting recently treaties of free trade (agreement FTA) signed with the United States and Canada in 2012 and 2013 South Korea.

The current President, Juan Manuel Santos, elected for the period (2010-2014), defined through the National Development Plan called *"Prosperity for all",* large focus of economic growth in five "locomotives" which are: innovation; Agriculture and rural development; transport infrastructure; mining development and energy expansion; housing and development of "friendly" cities, with a view to promoting social equality, generate employment and extreme poverty, [12, p.7].

Of the five locomotives, the most controversial has been the mining development and energy expansion, as it affords regulatory frameworks very flexible to transnational mining corporations, so they exploit natural resources to the length and breadth of the country without worrying about the great environmental impact that large-scale mining can generate, and without having in mind that the economic dividends today received the country for exports of minerals in the long term constitute a loss of natural resources which will not be counted to establish the future development policies.

The mining of low added value - oil, coal, and ferronickel - represented 72% of exports, which for 2012 totaled 58,000 fully billion [13], contrasting with the statistics of inequality generated by the World Bank, which placed the country as the seventh most unequal in the world and the second in Latin America, after Bolivia, situation which must be resolved if a negotiated political solution of the conflict, wants to achieve peace with social justice.

Democratic opening: Carlo Nasi argues that the 2001 Caguán negotiating agenda, failed partly because the weight of the negotiating process focused on economic aspects aside from politicians [14, p.89], for this reason is necessary to analyze the issue of the democratic opening that involves the current political regime and the rules of the game so the insurgency can access to public office. In terms of restricted democracy – points out Nasi - a way that can give you access to the internal armed conflict is the Federalism which consists in giving autonomy to each administrative division so that the political parties of the insurgency have influence in those geographical locations of military predominance, so they can continue making political legally consolidated locally, given the scenario of ha-

ving lost the chance to contest political power nationwide [14p 99], with the traditional parties of the oligarchy.

You may also develop other mechanisms to ensure a Democratic Opening, from electoral reforms to establish that from obtaining a certain percentage of votes in the elections by the parties from the insurgency; they can access the Congress, as occurred in Nicaragua in 1984 with 1.19% or Guatemala with 19% of the vote [14, p.101].
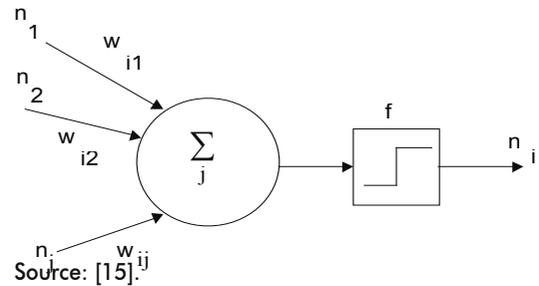
There is also the possibility of expanding the number of congressmen to leftist political parties entering improving proportionality in representation.

4. Possible scenarios of political transformation in an artificial neural network

An Artificial Neural Network (ANN) is a learning system designed by man to simulate neural processes that take place in the brain where it is involved the interconnection of different neurons to process information and develop a series of decisions . Systems engineering uses of knowledge in a field called Artificial Intelligence, which aims to provide reasoning to a non-living system, for example a robot.

In an Artificial Neural Network usually divided into three layers: An input or inputs; an intermediate layer interface with inputs already developed and a final or "outsiders" layer with a throughput representing reasoning, as represented by the following figure 1 [15].

Figure 1. Neural network structure

Source: [15].

As shown in equation (1)

$$n_i(t+1) = f\left(\sum_j \left(w_j\, n_j(t)\right) - u_i\right) \qquad (1)$$

Where, w_{ij} is the weight of the connection between neuron j and the neuron i

$n_j(t)$ It is the output produced by neuron j

u_i is the threshold of the neuron i

$$f(x) = \begin{cases} 0 & f & x < u \\ 1 & \text{Otherwise} \end{cases}$$

Is the threshold function, [15].

The present work have opted to make a multilayer neural network, where they mix different connections between neurons that belong to various levels or layers, producing activities of association since the information entered through an input layer, through a hidden layer and ends with a layer of output.

The inputs in the network the six political scenarios resulting from the process of dialogue between the Government and the insurgency are: civil democratic stability, civil war, coup, revolution, reformation in the demo-
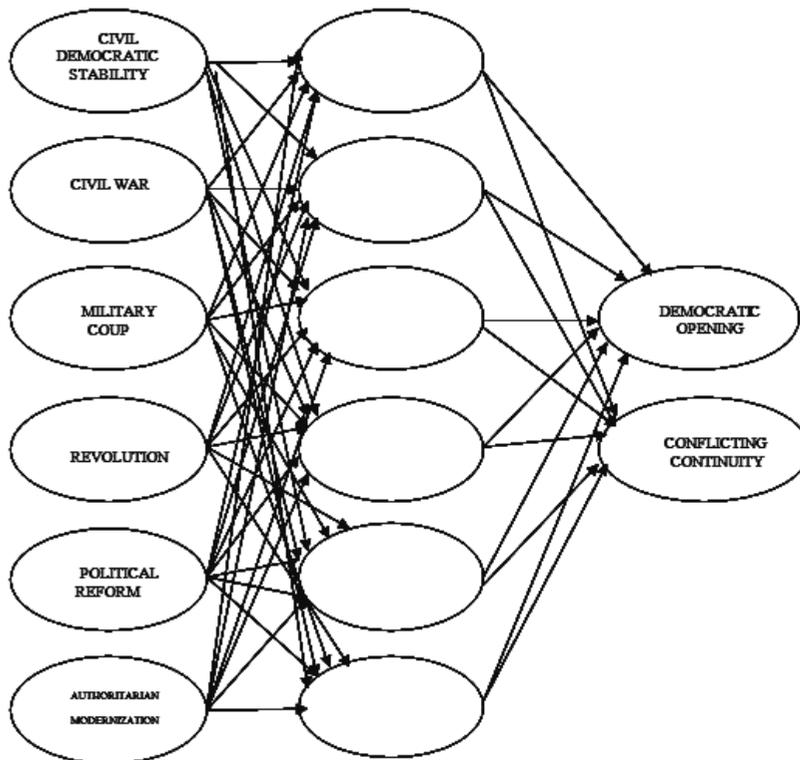
cratic political system and authoritarian modernization, which are interwoven with each other. For example, if there are authoritarian modernization cannot be showing democratic reforms that benefit the majority of the population, so it could lead to a civil war that would endanger democratic stability maintained by Colombia in what has been their historical construction as a nation-State.

Regarding the outputs were selected two possibilities which were: the opening democratic, consisting of changes to the inside of the political system to allow the return to the legal political scene of the insurgency of the FARC, with a view that this organization be-

comes a legal political party and participate in the elections to reach political power, as well as offer another kind of economic, social and cultural guarantees. It should be noted here that the democratic opening scene is open not only to the insurgency to rejoin civilian life, but also to all the members that make the Colombian civil society.

The second output corresponds to the continuation of the internal armed conflict product of a rupture in the dialogues between the insurgency and the State, giving once again ruined the political negotiation that could end military actions, see Figure 2.

Figure 2. Artificial neural network multilayer with 2 entries, 14 nodes, representing the political scenarios resulting from the process of dialogue between the FARC-EP and the Santos Government

Source: own elaboration.

5. Modeling of the artificial neural network in a computer program

To model the neural network, was chosen the computer program called Easy NN-plus 2012 version 15 developed by Neural Planner Software Company, which offers users a version of free use for 30 days to be evaluated and if you prefer you can buy.

This program has the characteristic of producing multilayer neural networks combining linguistic and numerical variables, accepting sheets from text, Excel, graphics and many more applications.

Procedure:

1. open the application *Easy NN*

2. proceed to select the *Insert* option

3. enable *Input Column*, where are placed numerical values, in this case linking the six scenarios of transition policy in each of the columns is enabled.

4. Again, in the *Insert* option we choose *Output Column*, where the columns of output of the system, which in the case of the present application are two are enabled, these enters the numerical values corresponding to the output of the *Perceptron.*

5. Then in the option *Insert* select the alternative *Training example* row, which allows to start the training of the neural network process.

6. Then in the option *Action* enables the alternative *New Network* whose function is to create a new network.

7. In the same option *Action* enabling the option *Start Learning*, so the program starts internally to begin the process of learning of the neural network

8. Finally, evaluates the learning process, by selecting the *Insert* option and also the option of *Querying example row* proceed to query the data processed by the system.

To enter the data the program proceeded to assign binary numerical rating (0-1), calling all those tickets close to the opening democratic with 0, and conversely, the inputs next to the continuation of the internal armed conflict were assigned 1. It should be noted here that, as there were relationships between some and others were decreasing in percentages 3%, according to the degree of less intense or more intense towards the situation of conflicting continuity; for example, a stage of reform of the political system was awarded a weight of 0.0097, being closer towards the democratic opening that towards armed conflict.

The percentages and the weights resulted from the intuition of the researcher, privileging the following arguments in the variables:

- If there is a situation of civil democratic stability (weight = 0.0000), a civil war is not feasible (weight = 1.0000), nor a military coup (weight = 1.0000), as it is unlikely a revolution (weight = 1.0000), therefore the likely output is a democratic opening (weight = 0.000) the noncontinuation of the internal armed conflict (weight = 1.0000).

- If a civil war is filed (weight = 1.0000), is very likely that to maintain social order will go to a military coup (weight = 1.0000), which gives derail civil democratic stability (weight = 0.0000), with reforms to the political system (weight = 0.0000), imposing authoritarian modernization in neo-liberal economic policies (weight = 1.000), probably leading to the continuation of the internal armed conflict (weight = 1.0000) and not the democratic opening (weight = 0.0000).

The determination of weights to the variables that fueled both inputs and outputs to the program Easy NN-plus were conducted in the following manner, figure 3:
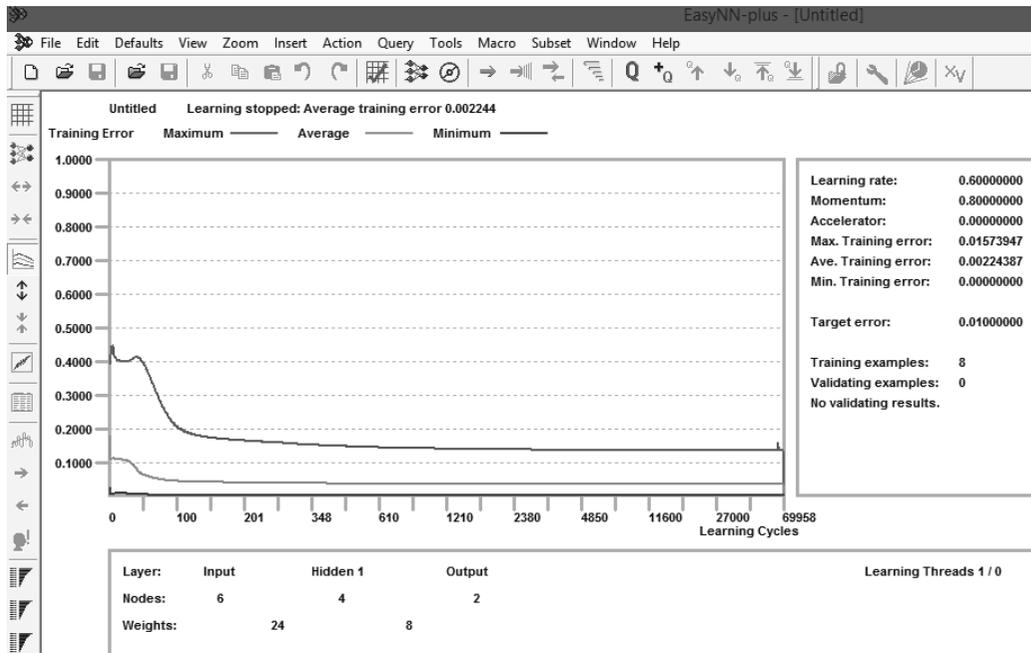
Figure 3. Weights of the variables used in the neural network, awarded by the intuition of the author

Day 1	Civil demo+	Civil war	Military c+	Revolution	Political +	Authoritar+	Democratic+	Conflictin+
T:0	0.0000	1.0099	1.0098	1.0000	0.0000	1.0000	0.0097	1.0099
T:1	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
T:2	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
T:3	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	1.0000
T:4	0.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000
T:5	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000	0.0000	1.0000
T:6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
T:7	1.0000	1.0000	1.0000	0.0000	1.0000	0.0000	0.0000	1.0000

Source: own elaboration.

The selected program internally conducted complex mathematical operations, mixing linguistic variables with numerical variables processing the following learning curve, a simulation to the process of synapses that make human neurons in the brain.

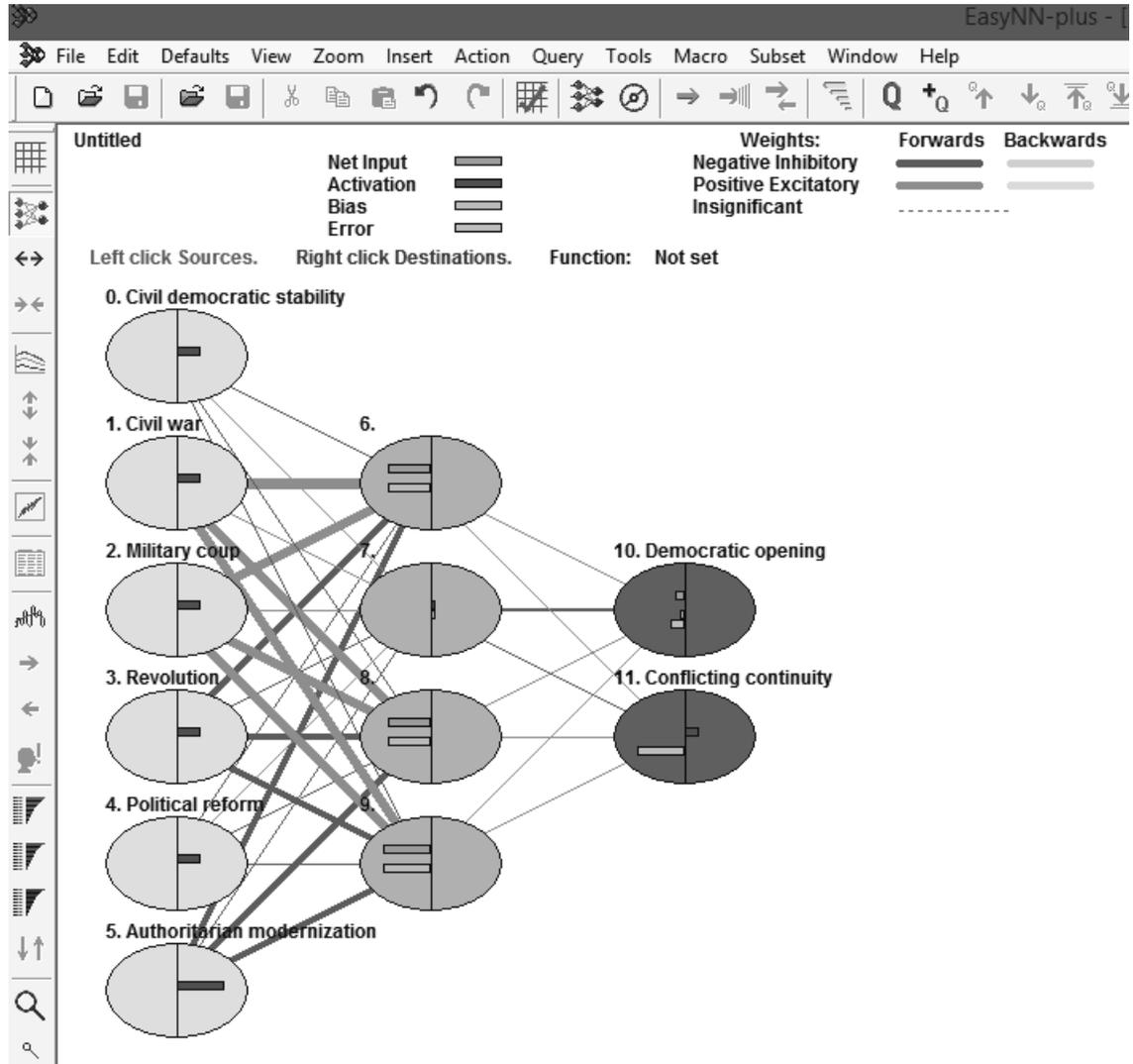## Figure 4. Representation of the learning curve of the program
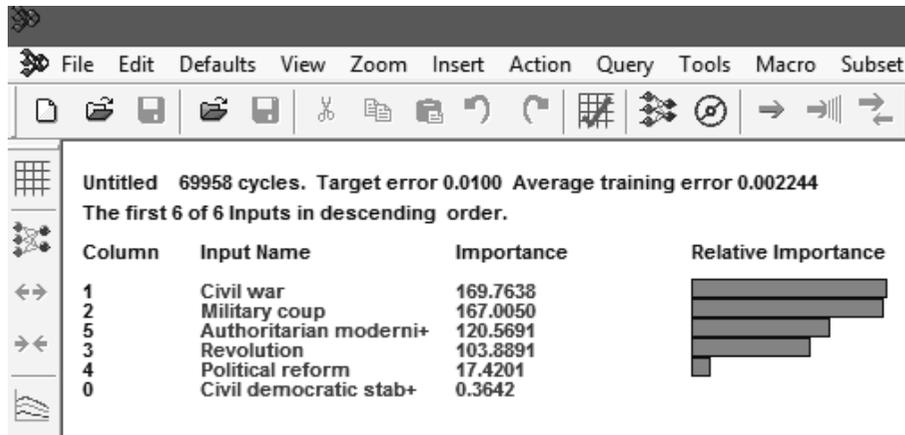

Source: own elaboration.

The graphical modeling of artificial neural network which produced the program shows how in the mid-layer intermingle different variables in a kind of non-linear logic, resulting in the following way, figure 5.

In addition, Easy NN-plus program, allows you to visualize the data consulted, as shown below the figure 6.

Figure 5. Graphical modeling of network neuronal

Source: own elaboration.

Figure 6. Data processed by the System

Source: own elaboration.

5. Conclusions

The simulation exercise of an artificial neural network based on possible political scenarios resulting from the dialogues between the FARC-EP and the Santos Government was very fruitful since it allowed the use of numerical and linguistic variables in the political analysis of a situation of political transition that was not presented since 1990, offering new methods of study both for political as for Social Sciences science.

In the same way offers alternative solutions in a complex situation where intersect different types, variables, or analytical units that explain the behavior of a society and which have been treated traditionally by employing mathematical theories or probabilistic characteristic of formal logic, which turn out to be insufficient in view of a changing reality as that offered by a democratic transition characterized by constant changes and fluid political situation.

Finally, it should be noted that against all odds of the scenarios that may await you to Colombia before the end of the insurgency-government dialogues, the least expected was the civil war and was the latter which threw the artificial neural network as seen in Figure 6.

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