

# Tool for predicting energy consumption by electric artificial neural networks

## Abstract

In this research shows a tool to estimate the energy consumption in building a university student from of historical information from it and depending on a group of variables which are considered as major in the energy behavior. We have developed a tool based on Artificial Neural Network feed-forward back propagation that yielded excellent results in predicting energy consumption of the building type.

**Keywords:** artificial neural network, feed-forward back propagation, electric power consumption

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## Introduction

### Electricity and electricity market

Electricity is one of the main energy sources with which our civilization. Use covers a very wide range of activities extending from purely industrial uses to domestic household consumption. Moreover, in a global context of increasing competition, not an economy is seen growing and competitive at the global level without an electrical fluid quality and highly competitive prices. This high dependence has turned electricity into a strategic input that has some intense drag effects, not only economic but also social.<sup>1</sup> So we can say that we live in a world that runs on electricity.

### Artificial neural networks in economics

Since the mid-80s, leaning against the massive emergence of modern computing means, spread the use of artificial intelligence to find solutions to problems so far focused only Deterministic or

statistical methods.<sup>2</sup> Artificial intelligence and neural networks specifically, have the ability to determine patterns of behavior when they are subjected to proper training, even if the relationship between variables is not linear training.

With this document we present the ability of Artificial Neural Networks as a tool for prediction of energy consumption emphasizing the superiority shown by them in this field. We make a program implemented in *Matlab 7.0*, for planning electricity consumption based on statistical records of seven previous years and planned for the following year.

## Materials and methods

### Data acquisition and processing

The variables considered are: number of lamps (LAMPS), Burners (BURNER), Televisions (TELEVISIONS), Refrigerators (REFRIGERATORS) And fans (FANS). Historical data are: (Table 1).

**Table 1** Data university building

KWh	Lamps	Burner	Televisions	Refrigerators	Fans
702.3	174	19	8	2	49
786.75	200	21	10	3	40
541.5	100	15	5	5	37
555.45	150	14	9	6	29
488.7	130	12	14	4	35
740.1	120	20	12	10	3.4
800.1	110	2.3	7	7	28
898.05	140	25	6	13	30

Prior to the establishment of the network was placed in the work space necessary for training and validation of network variables. To this end a small program where these variables were created and normalized was designed.<sup>3</sup>

% Creating standardized variables  $KWhN = KWh / \max(KWh)$ ;  $LAMPASN = LAMPAS / \max(LAMP)$ ;  $BURNERS$

$HORNILLASN = \max(BURNER)$ ;  $TELEVISORESN = TVS / \max(TVS)$ ;  $REFRIGERADORESN = REFRIGERATORS / \max(REFRIGERATORS)$ ;  $VENTILADORESN = FANS / \max(FANS)$ ;  $VENT = [LAMPASN \ HORNILLASN \ REFRIGERADORESN \ TELEVISORESN \ VENTILADORESN]$ ;  $TARGET = KWhN$ ; % Of variables a section is selected to perform training:  $VESIMII = VIN(1: 5.1: 6)$ ;  $TARGETII = VOUT(:, 1: 6)$ .

## Neural network design

A neural network whose first information was obtained from the above table was designed: the network had five input variables given by the number of lamps, burners, televisions, refrigerators, fans (hidden layer 6 neurons activated by the function logsig)<sup>4</sup> and, as only want to know the electric power consumption in KWh, the last layer possessed a single output neuron with PURELINE function. The display of this network is shown in Figure 1 and the graph of network training is shown in Figure 2, where it was proposed to achieve results

with zero error (goal=0), among the variable TARGETII.

Target introduced as the training and the result of calculation of the net. As seen in the chart training after iterations scheduled training has converged showing behavior  $6.64255 \times 10^{-26}$  achieved on 5 times (Figure 1 & Figure 2). The rest of the program contains sections to observe the behavior of the network at all points of training and standardized training variables to simulate and predict behavior in the next year.<sup>5</sup>

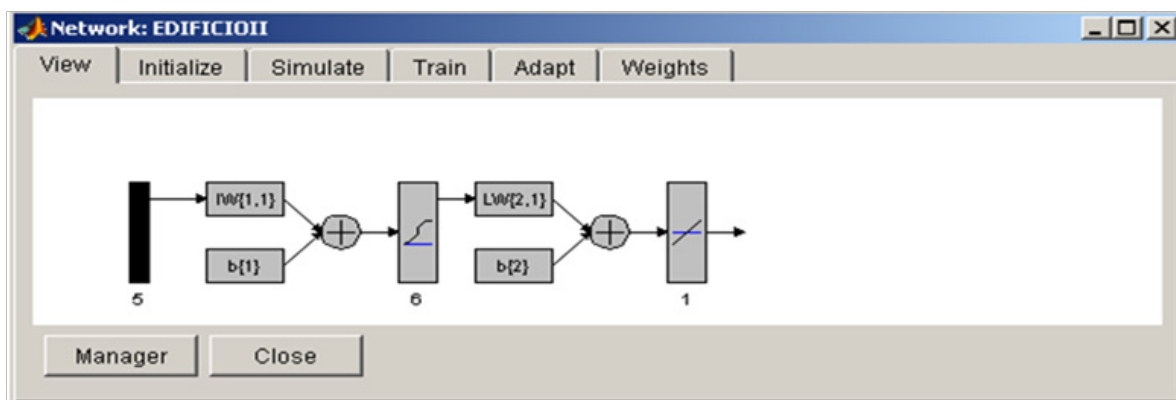


Figure 1 Viewing the neural network designed "BUILDING II".

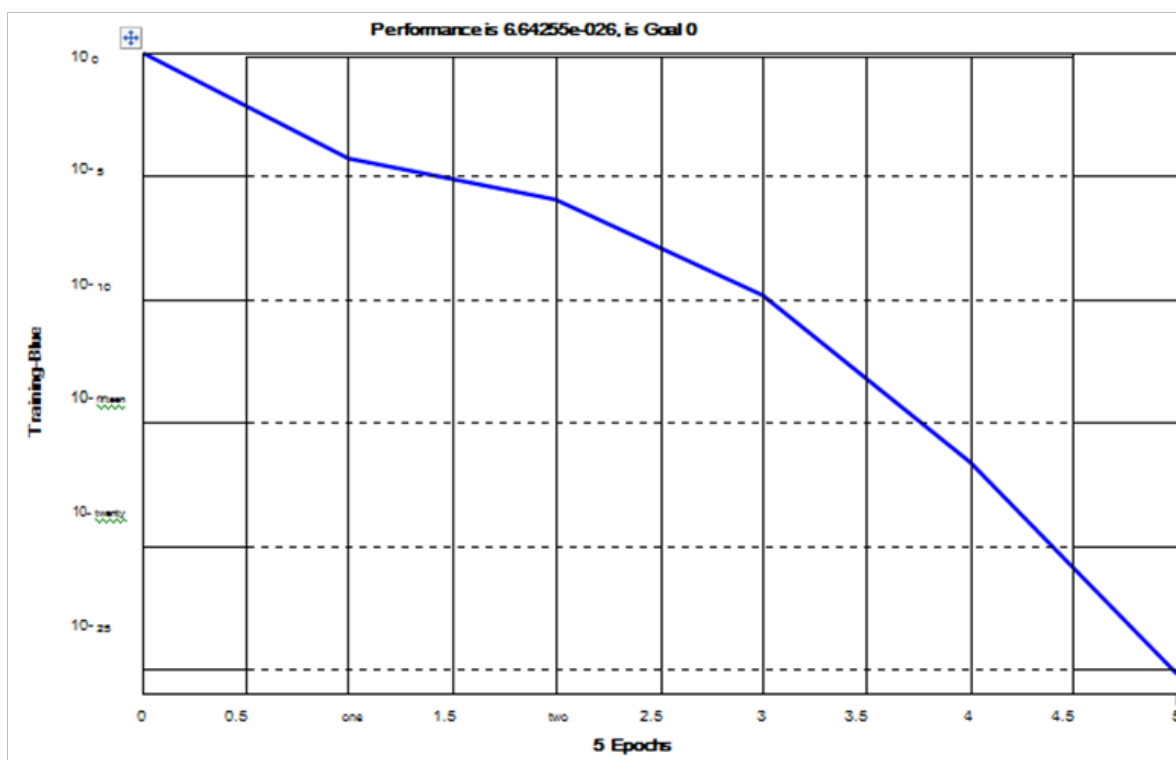


Figure 2 Graph of network training.

% Simulating a University Building Using Neural Networks  
LAMP=input ('Number of Lamps, LAMP ='); HORN = input ('Number of burners, HORN='); TV = input ('Number of televisions, TV='); REFRIG = input ('Number of Refrigerators, Refrig='); FAN=input ('Number of fans, blowers='); KWhN = KWh / max (KWh);

LAMPASN=LAMP/max (LAMP); BURNERS  
HORNILLASN=/max (BURNER); TELEVISORESN=TVS/

max (TVS); REFRIGADORESN=REFRIGERATORS/max (REFRIGERATORS); VENTILADORESN=FANS/max (FANS); VENT=[LAMPASN HORNILLASN TELEVISORESN REFRIGADORESN REFRIGADORESN]; TARGET=KWhN'; % Variable section is selected to perform training: VESIMII=VENT (1: 5.1: 6); TARGETII=TARGET (:, 1: 6); % Variables and simulation output. Red FFB predictor LAMPARASS=LAMP/max (LAMP); HORNILLASS=HORN/

```
max (BURNER); TELEVISORESS=TV/max (TVs);
REFRIGERADORESS=COOLING/max (REFRIGERATORS);
VENTILADORESS=FAN/max (FANS); VSIM=[LAMPARASS
HORNILLASS TELEVISORESS REFRIGERADORESS
REFRIGERADORESS]; % VENT, from first to fifth row and the sixth
column to VESIMII low=VENT (1: 5.1: 6); TARGETII=TARGET
(:, 1: 6); Historical Simulation EDIFICIOII% by OUTPUT=sim
(EDIFICIOII, VENT) * max (KWh); Y = [OUT (1: 8)] '; % Graph
bar (Y, 'r') grid on
```

```
xlabel ('years')
```

```
ylabel ('Consumption KWh')
```

```
title ('Annual Energy Consumption University Building')
```

```
Values=[OUT (1) OUTPUT (2) OUTPUT (3) OUTPUT (4)
```

```
OUTPUT (5) OUTPUT (6) outlet (7) OUTPUT (8)]'; disp ('')
```

```
disp ('historical performance') disp ('') disp ('consumption in
KWh') disp ('')
```

```
Results=Values' disp ('') disp ('') disp ('')
```

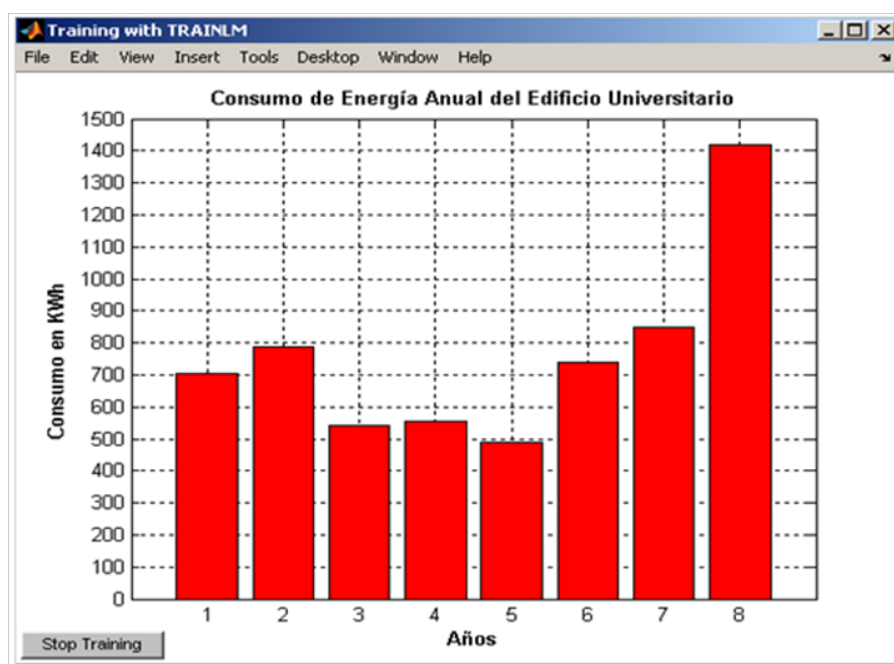
```
disp ('RESULT EXPECTED BY EDIFICIOII RNA') disp ('')
```

```
disp ('Consumption KWh') disp ('')
```

```
% Prediction by ANN EDIFICIOII
```

```
PREDEEDIFII=sim (EDIFICIOII, VSIM) * max (KWh)
```

Finally, the results of total simulation are shown in the bar chart, where the behavior of energy consumption reflected for years in the university building. The prediction for the year, eight resulted from 1419.2KWh (Figure 3).



**Figure 3** Annual consumption of electricity.

## Results and discussion

It was possible to implement a tool based on a neural network of the type Feed forward back propagation able to estimate with adequate precision the energy consumption of seven previous years and predict next year in a university building from historical data variables influencing installation.<sup>6</sup>

Given the uncertainty surrounding the value to be assigned to the parameters that define the neural network (number of hidden units, learning rate, etc), it could study the possibility of optimizing these values using genetic algorithms. Along the same lines it would also be interesting to investigate to what extent this type of procedure reduces the risk of local minima associated with training methods based on gradient.

## Acknowledgements

None.

## Conflict of interest

The author declares there is no conflict of interest.

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