



**Project Name:** Feedforward Neural Network  
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## Summary

An artificial neural network (ANN) can be used to predict the technical states of gas pumping units (GPU) in real time, and thus prevent them from being damaged during operation. An analysis of real vibration and acoustic processes generated by the operation of the GPU type GTK-25-i (Nuovo Pignone, Italy) was carried out. The developed ANN has been trained for a deep fully connected feed-forward ANN, trained on the back propagation algorithm.

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# 1 Introduction

Artificial neural networks have been successfully applied to many diverse fields. Pattern classification/recognition system modeling and identification, signal processing, image processing, control systems and stock market predictions are some of those main fields of engineering and science. Feed-forward neural networks are the mostly encountered and used in many diverse applications, therefore they are chosen to exemplify the artificial neural networks.

There are two main categories of network architectures depending on the type of the connections between the neurons, “feed-forward neural networks” and “recurrent neural networks”. If there is no feedback from the outputs of the neurons towards the inputs throughout the network, then the network is referred as a feed-forward neural network. In case there is a feedback then the output then the network is called a recurrent neural network. Feed-forward neural networks fall into two categories depending on the number of the layers either single layer or multi-layer.

## 1.1 Methodology

Back-propagation algorithm is the most popular and mostly used one for the training of feed-forward neural networks. It is a means of updating networks synaptic weights by back propagating a gradient vector in which each element is defined as the derivative of an error measure with respect to a parameter. Error signals are usually defined as the difference of the actual network outputs and the desired outputs. Therefore a set of desired outputs must be available for training making back propagation a supervised learning rule.

# 2. Findings

## 2.1 Feed forward neural network

The error signal error signal at the output of the neuron  $j$  for  $n$ th iteration is:

$$e_j(n) = d_j - y_j(n)$$

Where  $d_j$  is the desired output for neuron  $j$  and  $y_j(n)$  is the actual output for neuron  $j$  calculated by using the current weights of the network at iteration  $n$ . For certain input there is a certain desired output, which the network is expected to produce. Each training example from the training set is defined as an iteration.

Instantaneous value of the error energy for the neuron  $j$  is given in Equation:

$$\varepsilon_j(n) = \frac{1}{2} e_j^2(n)$$

Since the only visible neurons are the ones in the output layer, error signals for those neurons can be directly calculated  $\varepsilon(n)$ , of the total error energy is the sum of all  $\varepsilon_j(n)$ 's for all neurons in the output layer as given in this equation:

$$\varepsilon(n) = \frac{1}{2} \sum_{j \in Q} e_j^2(n)$$

Where Q is the set of all neurons in the output layer.

## ***2.4 Experiments***

it is impossible to make a decision based only on the spectral composition of acoustic noise and vibration signals, as the spectrum is fairly uniform over a wide frequency range. The architecture of the neural network proposed in this study turned out to be effective for solving the problem. A proposed neural network architecture that uses only two information parameters, such as noise and vibration, greatly simplifies data processing and reduces the complexity of the model. The closest to the approach described in and are based on the use of classical probabilistic neural network architectures, as well as on advanced learning algorithms. A key feature of the proposed architecture is the application of batch normalization between all layers of the neural network, which speeds up data processing and improves network stability.

### **3. Conclusion**

Feed-forward neural networks are the mostly encountered type of artificial neural networks and applied to many diverse fields. The main used algorithm is back-propagation which is used for learning and training algorithm of feed-forward neural networks.

#### 4. Reference List

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