

## Artificial Intelligence

# Neural Networks in Exploration and Production of Hydrocarbons

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Human brain is a unique organ that can comprehend itself. Brain mechanisms are complex in nature and though much of research has been carried out by the scientists in this field, still it is a long way off from understanding these completely. Electronic computers that mimic structure of neural computation began a promising era in the eighties. Author discusses use of artificial neural networks that are and can be used in E&P activities.

**B**iological neurons share inputs and outputs from tens of thousands similar neurons which makes them fault resistant and powerful.

However the arithmetic ability of each neuron, the biological nerve cell is very primitive as compared to any digital computer which consists of a circuit to determine total of the sum of the products of inputs and corresponding weights. This total is compared with a preset threshold value. Neuron fires out an output if computed total exceeds the threshold or otherwise there is no output. (Refer Fig 1).

### Defining & Drawing Constituents of 3 Layered Neural Network

A three layer network consists of

Input nodes, Middle nodes and Output nodes. Each node connects to the other in the next higher layer and every connection has a weight attached to it. Once a known input pattern in the form of vector of numbers is applied to the network a weighted sum of the inputs is sent to the node in the next higher layer. Depending on initial conditions the nodes (weighted

sum accumulators) will fire which will further depend on whether threshold for that processor node is exceeded and the flow advances to the output nodes.

Using back error propagation, one can compare the value of the output vector with desired output for the given input and use error to change weights of connection.

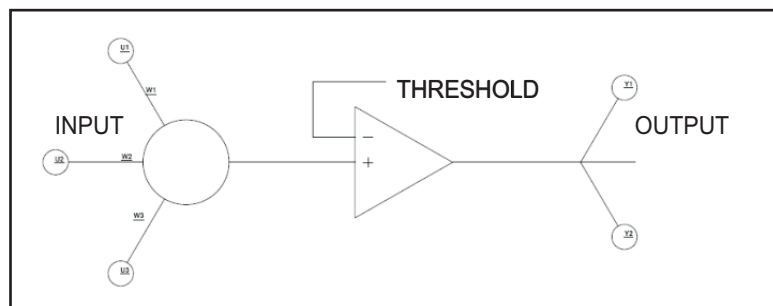


Fig.- 1 Artificial Neuron

Many sets of desired input output relationships are tried on the network in a process known as ‘training’, which helps the neural network understand desired input output relation. During late 1980s, the first text to speech network took 1-2 weeks of a VAX’s computer’s time to get trained. Modern computers are cheaper, smaller, less energy intensive, user friendly thus making artificial networks a matured field.

An artificial neural network made up of total of 309 neurons could convert English text to pronounced speech with an accuracy of up to 90 percent, which is a common feature in mobile phones and PDF documents.

## Applications in Hydrocarbon Industry

Formation evaluation through wire-line logging involves both active and passive recording of oil and gas well parameters. The study is supplemented by laboratory studies of rock samples collected by a core barrel, which is hammered into the sides of the well. Resistivity log and the Gamma Ray log are discussed below.

The simple method for determining the electrical resistivity of the rocks/

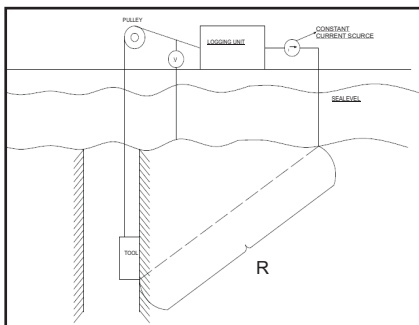


Fig.- 2 Resistivity Logging

formation around an oil/gas well is depicted in figure 2. One electrode of an electronically controlled and focused constant current source can be placed at the surface and the other at the seabed. The circuit through the wire line lowered into the well, leading to conductive pads of the logging tool touching the formation is completed. The potential difference between an electrode touching the sea bed and the

conductive pad of the tool will thus be proportional to the resistivity of the formation, by a simple application of Ohm’s law. Because oil and gas are insulators, in contrast to brine, which is also present in the formation, a high resistivity indicates a strong possibility of the presence of hydrocarbons. The formation rocks are of varying types like soft clays called shale and large grain rocks like sandstones. Shale is a natural source of gamma rays. It is believed that gamma ray signature of shale doesn’t change for centuries.

Where do neural networks come in this oil and gas business? The proof of the pudding is when core samples have been taken and the rock type, and oil flow related permeability are determined in a laboratory. What is to be done to know the rock type and permeability where we could not take core samples while logging? Neural network is taken and it is trained with the data that gives lab determined rock type and permeability values as a function of the resistivity and gamma ray logs. When it is imperative to know the rock type and permeability of zones that correspond to depths where core samples could not be taken, then the values of the resistivity is presented. The expected rock type and permeability is read. A possible neural networks which is in the structural analysis of oil and gas platforms are used. A neural network can be trained at the dockyard where the platform is being designed and fabricated. This could have loading values at various places as input and the measured strains in members of the structure as the output.

Once a platform has been commissioned and loading pattern is feeded, it is expected to strain values at inaccessible places. Such an application could signal

unsafe structure status before any mishap or structural damage actually takes place. Another useful application is in enhanced oil recovery using carbon dioxide. This is possible because carbon dioxide mixes well with oil and can be used to propel it from those wells where the pressure has depleted. This is lucrative because up to 50 percent of the original oil in place could not be produced on ‘its own steam’. This method of pumping in carbon dioxide to push the oil out of the reservoir amounts to killing two birds with one stone. Not only oil production is increased but also the amount carbon dioxide released to the atmosphere thereby gaining carbon credits is decreased. In such situations, known oilfields are used to train a neural network with input parameters such as the volume and pressure of the injected carbon dioxide and outputs like volume of oil produced and the carbon credits earned. In nearby fields the neural network can be used to estimate the optimal level of oil production for a given volume and pressure of the injected carbon dioxide. Until now supervised learning was discussed. Furthermore, unsupervised learning networks will be discussed.

In unsupervised networks target values are not given for each input. By a process known as competitive learning an unsupervised network will take a large set of input data and classify it into finite type of patterns.. What happens is when units lying on the output or competitive layer, receive the sum of the products of the weights and the input levels they determine which one has the highest such sum and declare it the winner giving it an activation value of 1.0 and turning all the others to an activation level of 0.0. The weights are now changed in such a manner that they get increased for the winners

and decreased for the losers. Thus if a similar pattern is presented to the network the same winner will result, and the pattern gets classified. If other patterns are presented other output nodes will win and thus another brand is collected. Competitive learning in

the form of what are known as Self Organized Maps is being used in the interpretation of seismic data. Thus artificial neural networks have become an interesting and powerful tool for use in the exploration and production of hydrocarbons. ■



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## Haldia Petro in Talks to Rejig Debt Repayment



**Kolkata:** Haldia Petrochemicals Ltd (HPL), which has a debt burden of 2500 crore in its books, has sought a one-year moratorium on loan repayment from its lenders. The move has been prompted by a sharp increase in feedstock cost and a lower price recovery in polymers. HPL is also in active discussions with lenders, led by IDBI, to renegotiate interest rate on its loans. At present, the coupon rate on loans taken for the mother naphtha cracker plant is 10 percent. The coupon rate on loans taken by HPL for

Project Supermax, the second phase of company's expansion plan, is around 10.5 percent. HPL's outgoing on debt servicing is 600 crore annually. The company has not failed to service its debt after it went through a corporate debt restructuring exercise. However, FY11 has not been a very smooth year for HPL. Apart from prices of naphtha going up, Project Supermax failed to avail 100 percent capacity utilization. Uncertainty also looms over selection of a managing director for the company even though committees,

as well as an HR firm Spencer Stuart, have been appointed to find out a replacement for the present MD, Swapan Bhowmik, whose tenure comes to an end on March 31, 2011. In fact, the financial projections of HPL for FY11 have been recast. The profit after tax (PAT) estimates for the current year have been lowered by around 138 crore. HPL posted a net loss of 183 crore in the last fiscal, but that was largely because, the company had to suspend production to ramp up its manufacturing facility.