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SURVEY ON BRAIN – MACHINE INTERRELATIVE LEARNING

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Abstract - *With the rapid development from machine learning (ML) to deep learning (DL) there is closer connection between human brain-machine working. The purpose of this article is to provide survey on learning-based human–machine. We know how machine do work like brain. But how brain is consuming every data and do work like a machine? More specifically, first we will see how we learn something and after a period we do them as an involuntary action. Second we will see how the mathematical equations will work to define brain-machine functionality. Finally, we will briefly analyse how AI-ML and brain are interdependent.*

***Key Words*: Machine learning, deep learning, automation, perceptron.**

1. INTRODUCTION

1 Brain Automation

Brain makes judgments and decisions quickly and automatically. It continuously makes predictions about future events. It learns from past failures and eliminate those consequences in future decisions.

Nowadays lots of youths try to learn how to flip a pen in hand with help of fingers and palm. There are lots of tricks to do that and some are very hard. With time we learn those very fluently and even while reading a book we can flip a pen in fingers easily. How does our brain actually know to do this involuntarily? In starting off learning this our brain slowly collects data of when and where we have to change our finger and which finger while flipping. With lots of successful data, the brain tries to remove failure data, and after long term, the brain catches perfect probability and consequences to flip that pen without failure and fluently. Such lots of small data is collected in packets which is like when you'll change the size of pen brain will take very little time to handle it comparatively it took for the first time. It's all dependent on some algorithm that is used by our brain to act the same function on different parameters. A similar work function is used in ML by using AI.

From the day of birth, our Brain neurons start to collect data. As for a simple machine, there is no inbuilt data is present in such a way our brain is quite empty to learn things and functions. With reaching nearly age of 4-5 our brain makes such complexity of neuron networks which increase consumption of data that's why we start our school at the age of 4-5 years old. At the age of 18, we do not even think that we are actually walking on stairs and we do it involuntarily but when we were children, we learned it very toughly. Similar evolution we can see in machines with AI.

1.1 Neural network in ML which mimics Brain:

Neural Network in ML is just a carbon copy of our Brain system. A human brain have billions of neurons [5],they are connected to each other. Human neurons are cells so when one gets activated it send signals to other in its network.

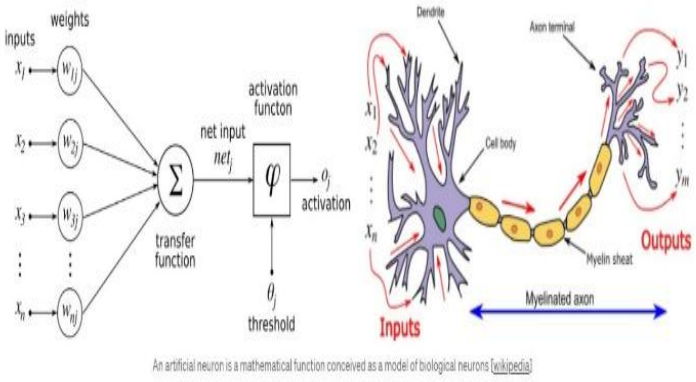
Like a human brain, the machine learning neural network also consists of interconnected neurons. When a neuron receives inputs, it gets activated and sends information to other neurons.

Due to the plasticity of our brain, we do tasks and become better at them and such thing is Machine learning. For example, when we look at a picture of a dog, we know that it is a cat because we have seen enough dogs in our lives. Likewise, if we provide our neural networks with enough dog images[1], they will start to recognize dogs.

1.2 AI and Neuroscience

Neural networks act as "virtual brains" [5] they do functions like our brain. Data is feed by giving lots of similar images to virtual machine to recognize some pattern which further helps neuroscientists to do their calculations and hypothesis.

However, the way artificial intelligence systems work is very different from our brain. As our brain [2] is a biological part that is very different than a piece of machinery. And using pattern recognition with help of an AI machine works like a neural network of the brain.



An artificial neuron is a mathematical function conceived as a model of biological neurons [wikipedia]

2 Mathematics of artificial neural network:

Artificial neuron (Perceptron):

An artificial Neuron is not a physical object [8] but it is a mathematical structure that mimics the function of actual brain neurons to some extent. It consists of lots of nodes as real neurons have Dendrites.

● Simple work of perceptron (an artificial neuron):

1) Nodes take N number of inputs.

2) Add all inputs.

3) Multiply each input with its weight.

4) then add up all the products of input and weights which gives a weighted sum.

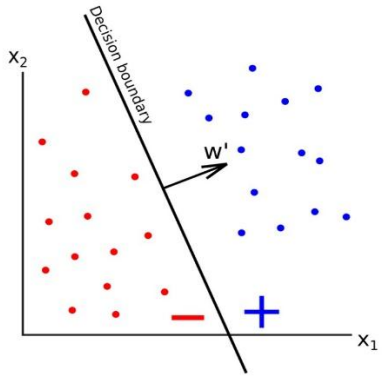
5) If the weighted sum is greater [9] than some threshold value returns a decision of 1 and otherwise returns a decision of 0, similar to neuron firing and not firing.

$$z = \sum_{i=1}^{n} x_i w_i$$

$$\Phi(z) = \begin{cases} -1, & z \leq w \\ 1, & z > w \end{cases}$$

In the graphical representation, for 2 inputs decision boundary is a line similarly for 3 inputs boundary will be a 2-D plane such that for N inputs (N-1)-D decision boundary will exist.

Let's see simplification by using 2 inputs:



(Work of perceptron on 2 inputs)

w' represents weight vector without bias term (Parameter used to represent patterns that do not pass through the origin.). This vector represents the slope of the decision boundary.

We've seen how perceptron takes decisions based on different inputs but how actually it learns new things? How did it find the right parameters?

$$\text{If } y(x \cdot w) \leq 0 :$$
$$w = w + yx$$

y= Label (either -1 or +1), x= current data point, $(x \cdot w)$ =dot product (Weight vector).

If expression $y(x \cdot w)$ is less than or equal to zero then label y is different than the predicted label let say $z(x \cdot w)$ so we update weights as w = w + yx.

How update rule works?

$$y(x \cdot w_i) = y(x \cdot (w + yx))$$
$$= y(x \cdot w + y||x||^2)$$
$$= y(x \cdot w) + y^2||x||^2$$
$$= y(x \cdot w) + ||x||^2$$

As $||x||^2 \geq 0 \Rightarrow y(x \cdot w_i) \geq y(x \cdot w)$

Due to square factors, new value will be near to positive value and hence it is correctly classified.

Drawback:

Perceptron fails to show the result on XOR [3]. It can only classify linearly separable sets of vectors. It just gives output values like 0 or 1, True or False. For more complex problems we required more than one perceptron to get an output.

3. Interdependence between an AI and brain

The revolution of AI systems can help drive neuroscience forward and unlock the secrets of the brain. It allows researchers to build better models and theories of the human brain. Similarly, our recognition system helps machines to learn things through AI. Probabilistic modelling [7] also has advantages over traditional normative theory in terms of learning in AI system.

With the help of AI, we can solve lots of problems that we are not able to solve by simple thinking. As we have made calculators solve long problems in short term. The "Tower of Hanoi" [10] is an example of that. Actually, it is impossible to solve this problem with lots of disks. But with help of data structures, we are able to solve it.

So, with help of AI, we are helping neuroscience to cross the boundaries to achieve lots of things and with our daily problems, we are enhancing the capacity of AI.

Literature Review

1.Mathematics of Neutral Network paper by Gabriel Peyré et al [3] explains the algorithm and mathematics behind the learning process. In order to explain this, two types of neural networks are mentioned and considered here i.e 1]Discriminative Neural Network, 2]Generative Neural Network. In Discriminative Neural Network parameters in terms of dimensions are set to define an object and then later to identify an unknown object, the parameter of that object are considered and probability is calculated using mathematical expressions, based on this probability of the unknown object is identified. In the case of the Generative Neural Network parameter in terms of color and feature and further using this parameter the unknown object is identified.

2.BrainOS: A Novel Artificial Brain-Alike Automatic Machine Learning Framework paper by Newton Howard et al [5] explains the hypothesis regarding creating artificial human intelligence in a machine learning framework. The BrainOS system mimics the human thinking process which is much different than the other ML algorithms and tools. Due to its ability to think like humans, it can solve high-level problems.

3.Commonly used Machine Learning Algorithm an article by Sunil explains some of the algorithms of machine learning and also explains it works. Some of these algorithms are linear regression, logistic regression, decision tree, SVM, Naïve Bayes, k-means, random forest, dimensionality reduction algorithms, gradient boosting algorithms.

4. Mathematics of artificial neutral networks article on Wikipedia explains the artificial neural network's principle, structure, algorithm, and working. It also explains neural networks in mathematical expression by making a function of them.

5.Fascinating Relationship between AI and Neuroscience article by Hong Jing explains us the role and contribution played by neuroscience in AI development by giving some real-life examples, but along with it explains how A helps to understand how the human brain works

6.The Brain's Autopilot Mechanism Steers Consciousness article by Steve Ayan talks about the brain's ability to take a decision unconsciously and its mechanism behind this unconscious decision making power and learning of various actions and performing them involuntarily, is explained by referring to various theories in of neurobiology, one of them is the theory of predictive mind. According to the theory of predictive mind, there are various automatic processes and thoughts going on in the brain and with the help of this involuntary process, the brain is able to predict a situation and event quickly and accurately.

7.Probabilistic machine learning and artificial intelligence paper by Zoubin Ghahramani depicts the importance of probabilistic programming in the fields of Artificial Intelligence and Machine Learning. Probabilistic programming uses the theory of probability and probability distribution either to identify a pattern, object, structure, etc or to extract unknown information about it or to carry out the task assigned to it, on the basis of chances of the feature, shape, size (in order to identify image), or the type of the condition given to it (in order to analyze data and find its application or to solve problems and bugs). A probabilistic approach is way more efficient than that of the traditional normative theory, as the probabilistic approach is way more flexible and along with that it is also capable of producing data from any model or subject irrespective of its domain.

8. Maths in a minute : Artificial Neuron article by Marianne gives us information regarding the statistical data regarding neuron. By understanding the mathematics, structure and mechanism behind the functioning of the brain. And by using this understanding, the concept of artificial neuron is introduced here.

9. Perceptron: Explanation, Implementation and a Visual Example article by Dorian Lazar explain the concept of perceptron. Perceptron is the term which refer to the artificial neural network. It is an algorithm which actually mimics the process of the biological neuron i.e. to take input, compute the weight of the sum and then pass it through a threshold function, finally displaying result as a output. Now on the basis of this result the machine can plot/place a decision boundary. Along with the mechanism and the mathematics of this algorithm, writer has also explained its application and implementation of it along with some examples.

ID	Related work	Algorithm	Result	Advantages	Limitations
[1]	Invention of machine learning	Supervised learning	It starts to give idea about machine doing work itself without a handler.	A new way of making mechanical works, calculation, and various activities with artificial brain.	There are lots of difficulties about algorithms, structure, price, processing capacity.
[2]	Mathematics of artificial neural network	ANN	The proposed model shows mathematical proposition of an artificial neuron.	The artificial neural network learns by itself and can store information within it instead of on database.	We can't claim that it is more efficient than statistical method.
[3]	Commonly used machine learning algorithms	Linear regression, SVM, KNN, etc.	In various apps, software, games machine learning uses algorithm based on choices, probability which improve itself by gathering the data and making further process well oriented.	We don't have to spend any more time after making algorithm full-fledged it can improve itself.	As it is making choices by itself, we have slight chance of error due to its lack of knowledge or less data available.
[4]	AI and neuroscience, building neural network that will mimic brain.	NLP	We made neural network that will resemble to brain. And can make decisions and learn through it.	Google able to build an AI equivalent to a 55.5 IQ human.	It cannot match brain's high dimensional matrix. Scientist trying to understand how billions of neurons work together and makes a complex structure.
[5]	Unconscious decisions	Predictive mind	There are some automatic processes which leads the mind to the specific decision.	Mechanism like this will be able to predict a situation as react so quickly and accurately.	Uncontrolled processes.
[6]	Probabilistic machine learning	HMM	Probabilistic programming uses theory of probability and probability distribution.	More efficient and flexible approach. Producing data from any mode; irrespective of its domain.	Non-probabilistic problems are required different approach.
[7]	Perceptron	perceptron	Mathematical representation of artificial neuron	nonlinear problems and complex patterns in data are possible to process.	Still not efficient to process thousands of inputs and 10-degree polynomials.

3. CONCLUSIONS

Machine Automation plays an important role in the global economy and daily lifestyle. Scientists trying to modify automated devices with mathematical tools to create complex neural systems for a rapidly expanding range of applications and human activities. This survey tries to explain the mathematics and the mechanism behind the machine learning and its relation with brain. The upcoming technology has potential to process high dimensional data and thousands of inputs.

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