Recent Advancement in Deep Learning: Open Issues, Challenges and A Way to Forward

Sakshi Purwar[1], Amit Kumar Tyagi[2[0000-0003-2657-8700]]
[1.2]School of Computer Science and Engineering,
[1.2]VelloreInstitute of Technology, Chennai Campus,
Chennai600127, Tamilnadu, India
sakshipurwar09@gmail.com, amitktyagi025@gamil.com

Abstract. In recent centuries, many nations have been declared as nations means "how its citizens are living their life with technology and living of standards", if living of standard of nation or the citizen that is high, and most of work is done by industry, called as a developed nation. But, in each types of nation, we always face several basic problems of several crimes like incidents, traffic accidents etc. Most of accidents are being occurred due to not having awareness or avoiding the rules. In this case, some example is visually impaired persons (citizen) who may face several problems in doing daily tasks, for helping them, we need to provide some different efficient solutions. A machine may (should) help a visually impaired citizen in doing his/her tasks. But, here problem is machine are not aware about natural language which is written over the side Boards. So, we need provide some efficient solutions with respect to Internet of Things (IoT)/ machines to the citizen of a nation. Hence, this article discusses several useful terms related to deep learning, its evolution, benefits and disadvantages (including popular tools/ software, in Appendix A) in detail.

Keyword–Deep Learning, Neural Networks, Computer Vision, Deep Neural Network, Machine Learning.

1. Introduction

Deep learning is a next level of machine learning, with the help of machine learning the computer or machine 'learns' from the given data so, that the programmer could 'teach' a computer to image of dogs, by giving it a teaching set of images: some of that carry dogs (these images would have to be labeled as 'dogs') and some that don't contain any dog (labeled 'not a dog'), and guiding the algorithm to different variables to discriminate cats and dogs. The computer then 'learns' from the instruction accepted and put in that knowledge to a new picture, getting better over time as it successfully identifies more pictures of dogs and cats and adds to its teaching set. If machine give wrong results, a programmer would help to adjust the code. It is a method that simulates the structure of the human brain [1]. This method is a series of algorithm for finding a hierarchical representation of the input data by simulating the way that human brain senses important part of a set of sensory data that it is exposed to at all-time [2]. This mechanization requirement enabled the creation of intelligent systems and provided an environment for the application of the systems which are called as artificial intelligence and machine learning [3]. The system can check by itself if its indicator is right or wrong. In this it is done by continuously assessing data via layers of artificial networks that mimic the decision-making processes in our human brains. In order to work well, deep learning algorithms require much larger data sets than traditional machine learning applications. In the future, machine will be used do everyday task, what human is doing now a days ,but human can understand sign/natural languages, but machine are not aware about such languages, which we need to sort out is our primary concern/work in our project that is machine should be able to understand some natural languages (used in our everyday life).
Hence, the remaining part of this article is organized as: Section 2 discusses evolution and history of deep learning. Further, motivation behind this work is discussed in section 3. Then section 4 discusses about popular applications using natural language processing or deep learning neural network. Also, benefits and pitfalls/weakness of deep learning tools/algorithms are discussed in section 5. Later, related work with respect to this work is being discussed in section 6. Finally, this article is concluded in section 7 with several future useful enhancements (in brief).

2. Evolution

Deep learning history dates back to 1943 [4] when Warren McCulloch and Walter Pitts developed a computer model based on the human brain neural networks. To simulate the thought process, Warren McCulloch and

Walter Pitts used a mixture of mathematics and algorithms that they called threshold logic. Deep learning has grown gradually since then, with two big breaks in its growth over the years. In 1960, Henry J. Kelley credits the development of the fundamentals of a continuous Back Propagation Model. In 1962; Stuart Dreyfus produced a simpler version based only on the chain rule. In the early 1960'sThe theory of back propagation existed but only became useful until 1985. The earliest attempts to develop deep learning algorithm date back to 1965, when models of polynomial (complicated equation) activation function were used by Alexey Grigoryevich Ivakhneko and Valentin Grigoryevich Lapa which were then analyzed statically. A brief delay in the creation Kunihiko Fukushima who developed the neural networks with multiple pooling and evolutionary layers, first used conventional neural networks (see figure1). In 1979, Kunihiko Fukushima created an artificial neural network called recognition, using multi-layered, hierarchical architecture.

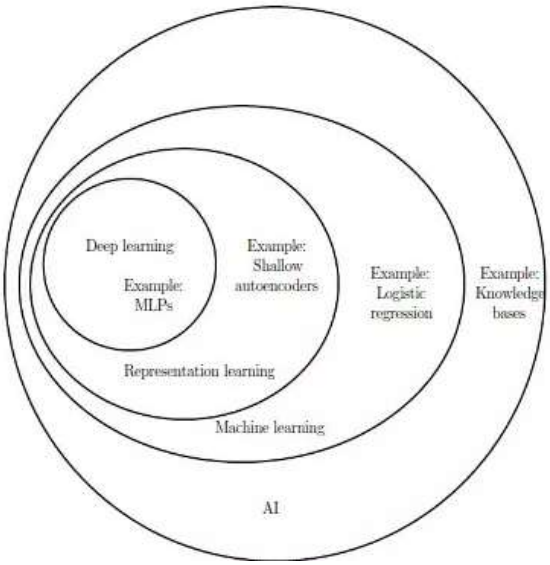

Figure1: Evolution of Deep Learning [4]

In 1950, Alan Turning published an article titled "machine and intelligence" which advertised which is now called the turning test as subfield of intelligence. Some beneficial and successful natural language systems were developed in the 1960's were SHRDLU, a natural language system work in bounded" blocks of words" with restricted vocabularies was written between 1964 to1966.Hence, this section discusses about evolution history of deep learning, its tools/algorithms. Now, next sections will discuss motivation behind writing this article towards this/deep learning area.

3. MOTIVATION

Identification natural language or hand-written language is a vital task, and require attention from computer science (deep learning) researchers to make human beings life easier and longer to live (in terms of communicating with machines). Deep learning can be used in following real world example with AI like computer vision, sentiment base news aggregation, bots based on deep learning, Autonomous vehicles, Coloring illustrations, Image analysis and caption generation, Text generation, Language identification. Today's Deep Learning (DL) is used to provide efficient services without making any hurdle using Artificial Intelligence/Robotics to users, which is also our main task (via designing an algorithm for natural language processing).

4. Popular Applications using Natural Language Processing (NLP)

There exist various applications where natural language processing is used like handwritten, speech and text recognition. Some of the popular (two) applications are listed here as:

- Finding for certain topic in a database.
- Draw out facts from a large record. Dialogue based application
- Solution arrangement
- Utility hand over a telephone.
- Text based application

Note that finding appropriate documents on certain topics from a database of text (for example finding relevant books on library) draw out facts from message. An article on certain topics, (for example building a database of all stock transaction describe in news on a given day). Translating documents from one language to another; for example, producing automobiles repair manuals in many different languages. Question solution arrangement system where natural languages are used to query a database, for example a query system to a personnel database handover customer service over the telephone (for example to perform banking transaction or order item from catalogue). a) search engines b) Advanced text editors c) commercial machine translation system d) Information extraction e) collaborative filtering f) Translation memories. Now, some deep learning libraries and popular tool used in such applications will be discussed in next subsections.

4.1 Deep learning libraries and framework

Deep learning enables multi-layered computational models to learn data representations with multiple abstraction levels. Both methods have greatly improved the state of the art in speech recognition, visual object identification and object detection. Deep learning is more advanced then machine learning. When system is trained with a large amount of data, it is simply in terms of accuracy. In fact, when a situation challenges the human brain, it plays an important role in filling the gap. We now have open source, deep learning frameworks which are easy-to-use, that aimed at simplifying the implementation of complex and large-scale deep learning models. We can introduce complex models such as convolution neural networks using these incredible frameworks. A deep learning framework is a library, interface or tool that makes it easier and faster for us to build deep learning models without going into the underlying algorithm specifics. By using a collection of pre- built and optimized components, they provide a clear and concise way to define models. Most of the Deep Learning frameworks are evolved with the aid of the arena's biggest software program corporations inclusive of Google, Facebook, and Microsoft. These corporations own huge amounts of information, high overall performance infrastructures, human intelligence and funding resources. Such tools encompass Tensor Flow, Microsoft CNTK, Caffe, Caffe2, Torch, PyTorch, and MX Net (refer table 2, in appendix A). Apart from them, other Deep Learning frameworks and libraries including Chainer, Theano, Deeplearning4J, and H2O from different groups and research establishments are also thrilling and appropriate for business use. The key points for a good deep learning framework [6]: Performance optimized, Good support to the community, Comprehensible and quick to code, Calculate radients automatically, and to reduce computations, processes are parallelized.
Few of the deep learning frameworks and libraries are discussed in [7].

4.1.1 Tensor Flow

It was introduced by engineers and researchers of Google Brain team. It is the popular software library used in the deep learning field. It is open source software which supports multiple languages (such as C++, R, Python) to create deep learning models. Already code is written for most of complex deep learning models. This framework is issued by Gmail, Uber, Nvidia and many others. TF not only take into account computing collection, but also the ability to run applications on mobile platforms such as iOS and android.It is useful to build and experiment with architectures of deep Learning, and its formulation is helpful for the integration of data such as input graphs SQL tables and images together.

4.1.2 PyTorch

After Tensor Flow, the primary tool for deep learning applications is PyTorch. This framework is designed for Facebook services, used by twitter and sales force. It is most flexible frame work. PyTorch is a port to the deep learning frame work of Torch that can be used to develop deep neural networks and compute tensors. Torch is a framework based on Lua, while PyTorch is running on Python. Unlike Tensor Flow, a dynamically updated graph is used in the PyTorch library. It means you can make changes in the process to the architecture. Data parallelism and distributed learning model are supported by PyTorch and it has many pre –trained models. It is well-suited for short-term project sand proto typing. PyTorch autocrat software constructs computational graphs from tensors and computes gradients automatically. Using PyTorch, we can work on all kinds of deep learning challenges,

including: images (Detection, Classification etc.), NLP, Reinforcement Learning.

4.1.3 Keras

Keras is a Python wrapper library that connects to other DL tools such as Tensor Flow, CNTK, Theano, Monet beta and Deep learning 4j announced (Keras2018). It is let grounder MIT license. Keras is an open source, rapidly evolving, with backend software from dominant technology companies such as Google and Microsoft. It has popular Deep Learning API with excellent documentation. It runs on python 2.7 version to 3.6 versions. It was developed and managed by Francois Chollet. Keras model Serialization / Deserialization, APIs, call-backs, and data stream using Python generators.

4.1.4 Sonnet

It is built on top of Tensor Flow, Sonnet deep learning platform. It is designed by the world-famous company Deep mind to create neural networks with a complex architecture. High-level object-oriented libraries that trigger complexity when designing algorithms for the creation of neural networks (NN) or other Machine Learning (ML). Sonnet's main advantage is that we can use it to replicate with greater ease the research shown in Deep Mind's papers than Keras, as Deep Mind will use Sonnet itself.

4.1.5 MXnet

MXnet is deep learning tool that is highly scalable and can be used on a wide range of devices. This framework supports a large number of languages (C++, python, R, Julia, JavaScript, Scala, Go and even Perl). It works parallel on multiple GPUs (with optimized computations and fast context switching). It has a quick ability to solve a problem.

4.1.6 DL4j (Deep Learning for Java)

Deep learning 4j or DL4J differs from different ML/DL frameworks in its API languages, rationale and integrations. It is a current open-supply, allotted, DL library carried out in Java (JVM) aimed to the commercial Java development atmosphere and Big Data processing. DL4J framework comes with built-in GPU help, that is an important function for the education method and supports Hadoop and Spark (DL4J 2018; Sky mind 2017). The library consists of numerous sub-initiatives together with uncooked records transformation into function vectors (DataVec), equipment for NN configuration (DeepLearning4j), 3rd model import (Python and Keras fashions). Deeplearning4j has Java, Scala and additionally Python APIs. It helps to diverse sorts and formats of input information without problems extendable by other specialized types and codecs. The DataVec toolkit accepts uncooked information inclusive of pictures, video, audio, text or time collection on enter and allows its ingestion, normalization and transformation into feature vectors. It also can load statistics into Spark RDDs. DL4J includes a number of the important NLP gear together with Sentence Iterator (for feeding textual content piece by using piece right into an herbal language processor), Tokenizer (for segmenting the textual content at the extent of single words or n-grams), Vocab (cache for storing metadata). Specialized codecs may be brought by means of enforcing custom enter formats similarly as in Hadoop through Input Format. Moreover, this, we have discussed many deep neural network implementations with various software packages in table 2 (refer Appendix A).

5. Benefits and Pitfalls of Existing Algorithms

Deep learning and neural network are used in many applications in this current era. Applications like image, text, audio, video, etc., recognition deep learning is used. Deep learning solves some recognized characters (printed or handwritten) very efficiently. But together thus we face several challenges, disadvantages also with deep learning and variants of neural networks. In overall, we also get several benefits with deep learning and its tools with solving real world's problems. Hence, advantages and disadvantages of deep learning are discussed here as:

Advantages: Deep mastering has become application that previously required imaginative and prescient knowledge into engineering challenges solvable by way of non-vision professionals. Deep mastering transfers the logical burden from a software developer, who develops and scripts a regulations-based algorithm, to an engineer training the gadget. It additionally opens a brand-new variety of possibilities to remedy packages which have in no way been tried without a human inspector. In this manner, deep getting to know makes device vision less difficult to work with, whilst expanding the bounds of what a computer and digital can as it should be inspecting. On other side, historically no need to design the features, they are automatically learned to be suitable for task at hand, robustness to natural data variability is automatically learned. The same neural network path can be used for many different applications and data types. Performance improves with more data; method is massively parallelizable.

Disadvantage: Deep learning studying requires a huge data set, as a result lengthy practice period, in term of cost, device mastering methods like SVMs and other habits are very effortlessly deployed even by relative gadget mastering beginners and can normally get you courtesy right result. Deep learning studying approach generally tends to study the entirety. It's higher to encode prior information approximately structure of deep learning technique generally tends to examine everything. It's better to encode earlier expertise about structure of photo (or audio or text) the found-out characteristics are often difficult to understand many imaginative and prescient capabilities are also now not simply human–understandable instance concatenations and combos of different capabilities.

Hence, this section discusses several advantages and disadvantages of deep learning and neural networks. Also, we have discussed several deep learning models (including key features, as benefits and weaknesses) in table 1 (refer appendix A). Now, next section will discuss some work related to deep learning and its open issues (emerged in this current era).

6. RELATED WORK

According to technologies applied, namely computer-vision and range sensor technology, Electronic travel aid (ETA)can be divided into two groups. Sense of sight can be replaced for visually impaired persons by using computer vision (CV) technology. In [8] new techniques are applied to computer vision (CV)to detect static obstacles and moving objects while walking on the way for visually impaired. The system analyzes picture pixels from a camera installed on the user's chest to determine the border path and obstacles with in the border. In [9], a camera used edge detection and planar motion tracking methods to detect stairs in the scene. In [10], authors developed an EYE Cane, camera-embedded white cane device to help to identify the direction of walk using CV and neural network algorithm. Few ETAs use stereo vision technology to detect obstacles in depth from the scene [11,12]. Researchers have used Smartphone to develop ETAs. [13] A Smartphone- based system was developed and a catadioptric stereo system was developed and installed on the Smart phone to acquire stereo image pairs from the Smartphone camera. In [14], authors proposed on-floor CV- based obstacle detection algorithm that was implemented using a Nokia Smartphone.

In ETA, range sensors for example, ultra-sensors are widely applied to intimate the users about detected obstacles. In [15] using ultrasonic echoing technology, author implemented a device called as smart guide (SG) which is used to inform the obstacles on the path. So, that the user can avoid the obstacles, A Bluetooth communication module is integrated in Smart Guide(SG) device, it is used to send messages to any Bluetooth-enabled mobile phone. In [16], authors proposed a prototype of an Electronic Long Cane (ELC) for sensing barriers above the knee. Vibration actuators and ultrasonic sensors are fixed in the handle of the ELC. In [17], authors developed device with ultrasonic sensors connected to a white cane to discover boundaries. Those sensors are placed at excessive level and coffee level with one of a kind heading instructions as a way to without problems discover limitations. To gain three-D pix from environment machine uses a time-of-flight camera with infrared (IR) illumination. In three-D photo the gap information is converted and rendered to the user using 10 array of self – retractable pins ultrasonic sensors are noticeably vulnerable to ghost echoes.

In result, hurdle is often considered to be closed than they actually are, thereby reduces the ultrasonic Sensor's powerful range. Therefore, the extensive ultrasonic beam projection attitude further compounds the problem of ghost echoes. In ETAs, laser variety finders are mounted. For example, one device was developed in [18]. Many sensors, which consist of IR and Ultrasonic sensors and gyroscope, had been embedded in [19] to discover the pinnacle level and a head level implement. To differentiate the sweeping mode and the pointing mode of the white cane, gyroscope is used. User gets the statistics with the aid of two haptic feedback systems, specifically an impulse to imitate the knock of an actual cane so that a distant impediment may be diagnosed and a vibrating tactile manage to provide a feel of distance via the person's obvious motion. User can generate a representation of environment and achieve context remark with the aid of the use of CV-based ETAs. Moreover, there are drawbacks to using cameras. These issues may be solved by way of smart phones. Though, maximum present day smart telephones have constrained area-of-view cameras, which can also permit the person to carefully keep and goal the Smartphone within the course in which obstacles can arise [14]. Compared to CV-based ETAs, ETAs the usage of range sensor generation, together with IR and ultrasonic sensors, are particularly cheap. Such ETAs can be designed to be self-contained with microcontroller systems. Though, the facts supplied by way of those ETAs are constrained as best the presence and approximate location of the obstacles may be stated to the user. Researchers stated that, feedback-rendering strategies are utilized in ETAs. Feedback information that needs to be introduced to the person is converted through actuating vibration vehicles into haptic. Signals in maximum recorded ETAs. To order to avoid overloading the person's auditory channels that are commonly required to

discover approaching motors, listen to ambient sounds and so forth, auditory information turned into less used. To prompt the tactile sensation, vibration vehicles were used even as no longer interfering with other sensing channels. ETAs deploy the vibration cars on apparels [12], gloves [20] with wearable feedback rendering gadgets. Few ETAs fixed the feedback gadgets at the white cane to allow the consumer to experience the feedback records while catching the cane [12, 19, and 21]. Hence, this section discusses associated paintings or literature paintings related to deep getting to know and neural network (and its open problems). Now, next segment will finish this work in brief (with numerous future enhancements**).**

7. CONCLUSION

The use of deep learning or neural networks comes with various short comings (also some advantages). A lot of research has been raised towards issues by many (several) researchers in the previous decades. Issues like generation of huge data, not handling of this (big) data, non-availability of efficient analytic tools, etc., are few problems in today's era. Also, area (for more applications, refer table 3 in appendix A) like medical algorithm, self-driving cars, investing financial assets, Deep Neural Networks (DNN) can be used to reduce complexity in the same applications. It is important to researchers to add some security features (in deep learning algorithm) to avoid many serious issues like security, privacy, etc. Hence, this article provides a complete detail with respect to deep learning and neural network (including popular tools). Now, for future work, we can extend our work in solving several real-world problems through new deep learning techniques/tools, which have not been solved yet (like black box problem, data is too hungry and being produced at very large scale, etc.).

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Appendix A

Table 1: Deep Learning Models and Its Variants (including key features)

Description of Models	Key Features
Deep Neural Network **a)** General deep framework usually used for classification or regression **b)** Made of many hidden layers (more than 2) **c)** Allows complex (non-linear) hypotheses to expressed	**Benefits** **a)** Widely used with successes in many areas **Weaknesses** **a)** Training is not trivial because once the error is back- propagated to the first few layers they become minuscule **b)** The learning process can be very slow
Deep Autoencoder **a)** Aim to recreate the input vector **b)** It has same number of input and output nodes **c)** It is an unsupervised learning method	**Benefits** **a)** Does not require labelled data for training **b)** Many variations have been proposed to make the representation more robust; Sparser autEnc.[6], DenoisingAutEnc.[7], Contractive AutEnc.[8], Convolutional AutEnc.[9] **Weaknesses** **a)** Require a pre-Training stage **b)** Training can also suffer from vanishing of the error
Deep Belief Network **a)** In this composition of RBM where each sub –network 's hidden layer serves as the visible **b)** layer for the next **c)** Has undirected connection just at the top two layers **d)** Allows unsupervised and supervised training of the network	**Benefits** **a)** Proposed a layer-by -layer greedy learning strategy to initialize the network **b)** Inference tractable maximizing the likelihood directly **Weaknesses** **a)** Training procedure is computationally expensive due to the initialization process and sampling
Convolutional Neural Networks **a)** It is well suited for 2d data such as images **b)** Every hidden convolutional filter transforms its input to a 3D output volume of neuron activations **c)** It is Inspired by the neurobiological model of the visual cortex	**Benefits** **a)** Few neurons connections required with respect to typical NN **Weaknesses** **a)** It may require many layers to find an entire hierarchy of features **b)** It usually requires a large dataset of labelled images

Recurrent Neural Networks	Benefits
a) It is a NN capable of analyzing stream of data **b)** Useful in application where the output depends on the previous computations **c)** Share the same weights across all steps	**a)** Can memorize sequential events **b)** Can model time dependencies **c)** It shows great success in Natural language processing applications **Weaknesses** **a)** Learning issues are frequent due to vanishing gradient problem

Table 2: Deep Neutral Network Implementation (Software -Wise)

Name of Tools	License	Platform	Interface	OpenMP Support	Supported Techniques			Cloud Computing
Caffe	Free BSD	Linux, Win, OSX, Andr	C++, Python, MATLAB	NO	YES	YES	NO	NO
CNTK	MIT	Linux, Win	Command Line	YES	YES	YES	NO	NO
Deep learning 4Jk	Apache 2.0	Linux, Win, OSX, Andr	Java, Scala, clojure	YES	YES	YES	YES	NO
Wolfurm Muth	Propriet ary	Linux, Win, OSX, Cloud	Java, C++	NO	NO	YES	YES	YES
Tensor flow	Apache 2.0	Linux, OSX	Python	NO	YES	YES	YES	NO
Thenno	BSD	Cross-Platform	Python	YES	YES	YES	YES	NO
TORCH	BSD	Linux, Win, OSX, Andr, iOS	Lua, LuaJIT, C	YES	YES	YES	YES	NO

Table 3: Application of Deep Learning

Author	Applications	Method /Algorithm	Year
Tai Sing Lee, David Mumford	Hierarchical Bayesian inference in the visual cortex	Particle filtering and Bayesian- belief Propagation	2003
Hinton,Geoffrey, E.Simon Osindero, Yee-Whyeteh.	Digit Classification	Complementary priors on Belief networks	2006
Mohammed, Abdel- Aramean, George Dahl, Geoffrey Hinton	Deep Belief networks for phone Recognition	Back propagation and associative memory architecture	2009
Abdel-Hamid Ossama ,Mohamed Abdel-rahman, Jiang Hui,Penn Gerald	Multi -speaker speech recognition	Local filtering and max pooling infrequency domain	2012
Kiran B. Raja , R. Raghavendra, Vinay Krishna Vemuri , Christoph Busch	Iris Recognition by using smartphone cameras	Deep sparse filtering	2015