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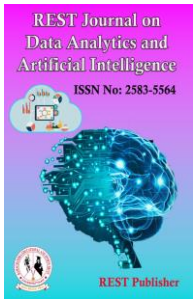

Advancements in Deep Learning: A Comprehensive Review

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Abstract: *Deep learning is a recent area of study in machine learning (ML). There are numerous hidden layers of artificial neural networks. High level model abstractions and nonlinear transformations are used in massive databases as part of the deep learning technique. Recent significant advancements in deep learning architectures in a range of fields have had a significant impact on artificial intelligence. This article provides a modern overview of the contributions and cutting-edge applications of deep learning. Deep learning techniques have been applied in major applications, as explained in the review that follows. Also reviewed and contrasted with those of more conventional algorithms in common applications are the advantages and drawbacks of the deep learning technique, as well as its hierarchy of layers and nonlinear operations. A detailed overview of the original concept and the expanding advantages and popularity of deep learning are also included in the state-of-the-art review.*

Keywords: *Machine learning, applied deep learning, and deep learning.*

1. INTRODUCTION

Artificial intelligence, sometimes known as AI, is a useful approach to simulate human learning and thought. Robots' displays of intelligence are known as AI. "The Turing Test" was proposed in 1950 as a plausible justification for how a machine may simulate human cognitive functioning. As a subject of study, AI is divided up into more focused research subfields. In certain settings, Natural Language Processing (NLP) can enhance writing, as an example. The most established branch of NLP is machine translation, commonly known as language translation. The results of machine translation algorithms include several applications that consider both spelling mistakes and grammatical structure. Additionally, when the machine suggests modifications to the writer or editor, a set of terms and language associated with the main theme is automatically used as the main source. Fig. 1 explains in detail how AI encompasses seven computer science subfields. Recently, the research community's focus and most popular topics have shifted to machine learning and data mining. These interdisciplinary disciplines of research analyses various database characterization options. Databases have been compiled over time for statistical objectives. Using statistical curves, it is possible to forecast future behavior by describing past and present actions. However, only traditional methods and algorithms have been employed in recent years to analyses this data, but an optimization of existing methods and algorithms could result in an efficient self-learning system. Based on existing values, a variety of criteria, and sophisticated statistical techniques, a better decision-making process can be established. As a result, one of the most significant applications of this optimization is in medicine, where enormous datasets of symptoms, causes, and medicinal remedies can be utilized to forecast improved therapies.

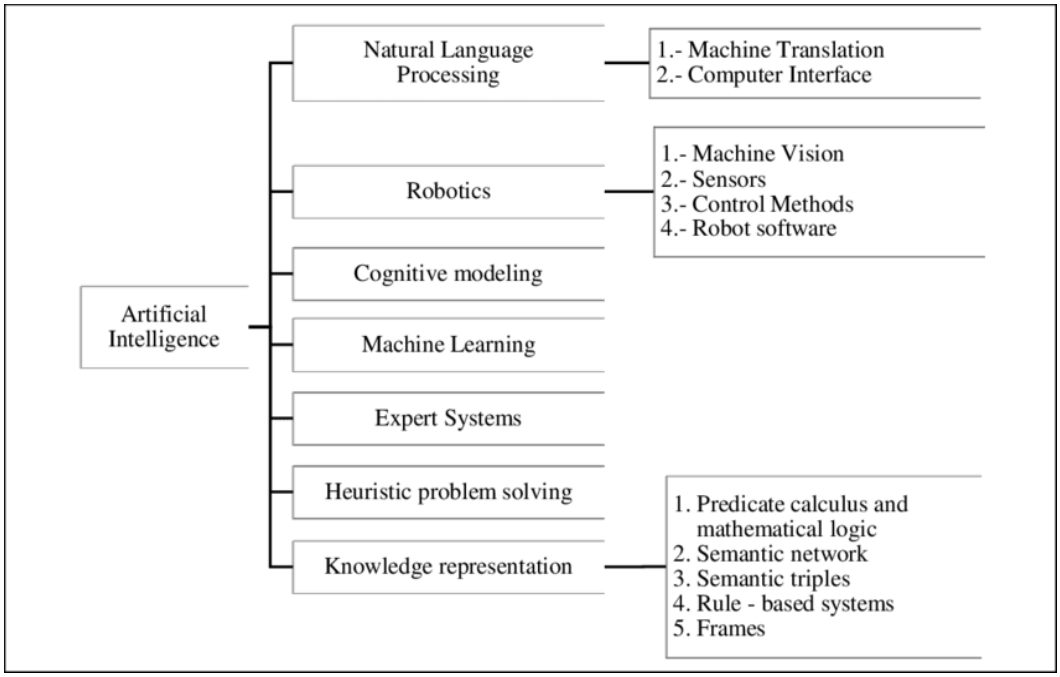

FIGURE 1. Artificial intelligence (AI) research Source

Since ML encompasses a broad field of study, numerous methodologies have been developed. A few of the methods include clustering, Bayesian networks, deep learning, and decision tree learning. The main focus of the review that follows is deep learning, including its fundamental ideas and both historical and current applications in various domains. Additionally, it includes a number of graphs illustrating the quick advancement of deep learning research as seen by publications in recent years in academic databases.

1. ***Background:*** The Deep Learning (DL) idea first surfaced in 2006 as a brand-new area of study in machine learning. It was first known as hierarchical learning at the time, and it frequently included numerous pattern recognition-related study topics. Deep learning primarily takes into account two important factors: supervised or unsupervised learning and nonlinear processing in numerous layers or stages. When an algorithm uses nonlinear processing in many layers, the output from the previous layer is used as the input for the current layer. To organize the importance of the data to be deemed as valuable or not, hierarchy is built among the levels. On the other hand, the class target label is a connection between supervised and unsupervised learning; its presence indicates a supervised system, while its absence indicates an unsupervised system.

2. ***Application:*** Hierarchical techniques and abstract layer analysis are implied by deep learning. It can, however, be applied in a wide range of real-world situations. As an illustration, grayscale image coloring from a picture used to be done manually in digital image processing, requiring users to select each color based on their own judgement. Coloring can be done automatically by a computer by using a deep learning algorithm. Similarly, utilizing recurrent neural networks (RNN) as a component of deep learning techniques, sound can be added to a drumming video that is currently silent. Deep learning can be viewed as a technique for enhancing outcomes and streamlining processing times in many computing processes. Deep learning techniques have been used in the field of natural language processing for the creation of handwriting and image captions. The following applications fall under the categories of biometrics, medical, and pure digital image processing. Processing of images Some applications had been carried out under the idea of pattern identification through layer processing before deep learning became a new research strategy. By combining Bayesian belief propagation with particle filtering, an intriguing example was created in 2003. The fundamental idea behind this application is that because a person can be recognized by their face after only seeing a half-cropped photograph of them, a computer could be able to recreate their face from a cropped image. Later in 2006, a programmer that could process handwritten digits was created by combining the greed algorithm with hierarchy. Deep learning has been used as the primary method for digital image processing in recent studies. Convolutional Neural Networks (CNN) can be more successful than conventional iris sensors, for example, when used to recognize iris patterns. The accuracy of CNN can be as high as 99.35%. Today's mobile location identification technology enables users to identify a specific address from a picture. When compared to Visual Hash Bit (VHB) and Space - Saliency Fingerprint Selection (SSFS), a Supervised Semantics - Preserving Deep Hashing (SSPDH) algorithm has shown to be a significant improvement. SSPDH is even 70% more accurate and efficient. Finally, facial recognition is a noteworthy use of deep learning in digital image processing. Microsoft, Facebook, and Google all have cutting-edge deep learning facial

recognition algorithms. Recent advances have transformed facial image-based identification into automatic recognition by using age and gender as the starting parameters. For instance, Sighthound Inc. tested a deep convolutional neural network system that can identify emotions in addition to age and gender. Furthermore, using a deep multi-task learning architecture, a reliable system was created to precisely identify a person's age and gender from a single photograph. Medicine Unquestionably one of the key areas of research where a deep learning approach may be used is digital image processing. Clinical applications have therefore lately undergone testing. For example, a comparison of shallow learning with deep learning in neural networks resulted in improved disease prediction performance. A magnetic resonance imaging (MRI) scan of a human brain was processed to identify potential Alzheimer disease. Despite the procedure's early success, significant difficulties need to be taken into account for future uses. The restrictions include dependence on excellent quality and training. Although the integration of diverse data sources is a viable feature of deep learning architecture, the volume, quality, and complexity of data are hard issues. Another field where deep learning techniques are producing useful results is optical coherence tomography (OCT). Traditionally, convolutional matrices were manually developed to process images. Unfortunately, the deep learning approach is constrained by a paucity of training data. However, in a few years, improved training sets will be available that will accurately forecast retinal diseases and drive down the price of OCT technology. Biometrics in 2009, two distinct deep belief network topologies were used in an autonomous voice recognition application to reduce the Phone Error Rate (PER). In 2012, a Hybrid Neural Network-Hidden Markov Model (NN-HMM) was used in conjunction with the CNN approach. A PER of 20.07% was as a result attained. In comparison to a previous 3-layer neural network baseline technique, the PER produced is superior. Iris recognition has been tested on smartphones and their camera resolution. The accuracy of iris recognition on mobile devices created by various firms can reach up to 87% of effectiveness. Deep learning is utilized in conjunction with biometric traits in terms of security, particularly access control. Face Sentinel face recognition devices' development and optimization were sped up with the use of DL. This manufacturer claims that in nine months, its devices might change the identifying process from one-to-one to one-to-many. Without the introduction of DL, this engine development could have taken ten-man years. It hastened the equipment's production and introduction. These gadgets are in use at London's Heathrow Airport and could be utilized for time and attendance as well as in the banking industry.

2. OVERVIEW

TABLE 1. lists many deep learning applications that have been used in prior years. The most frequently stated topics are speech recognition and image processing. From the enormous amount of applications, this evaluation only takes a few into account.

Author	Application	Method/algorithm	Year
Tai Sing Lee, David Mumford	Inference using hierarchical Bayesian methods in the visual cortex	Filtering of particles and Bayesian belief propagation	2003
Hinton, Geoffrey E., Simon Osindero, Yee-WhyeTeh.	Digit Classification	Networks with complementary priors on belief	2006
Mohamed, Abdel-rahman, George Dahl, Geoffrey Hinton	Deep Belief Networks for phone recognition	Back propagation and the architecture of associative memory	2009
Abdel-Hamid Ossama, Mo-hamed Abdel-rahman,Jiang Hui, Penn Gerald	Multi-speaker speech recognition	Local filtering and maximum pooling are the do-main parameters.	2012
Kiran B. Raja, R. Raghavendra, Vinay Krishna Vemuri, Christoph Busch	Iris Recognition by using smartphones' cameras	Sparse deep filtering	2015
Silver David, et al	Mastering the Game of Go with Deep Neural Networks and Tree Search	Learning that is guided and reinforced	2016
Francesco Marra, Giovanni Poggi, Carlo Sansone,Luisa Verdoliva	Iris sensor model identi-fication	neural networks with convolutions	2017

Annual analysis of publications

Fig. 1 provides information on the number of articles in deep learning from the Science Direct database each year from 2006 to June 2017. Clearly, there has been a steady increase in the number of articles that depict exponential development.

Fig. 2 shows the annual total of Springer's deep learning publications from January 2006 to June 2017. Deep learning is clearly a current study focus for scientists, as evidenced by the sharp increase in publications in 2016 that increased to 706.

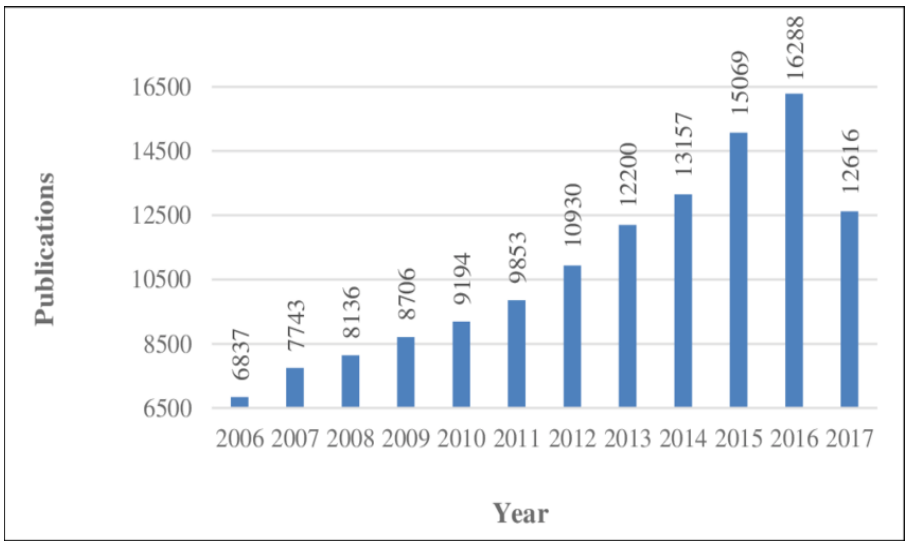

FIGURE 1. Increase in the quantity of publications in the Science direct database on deep learning (Jan. 2006–Jun. 2017)

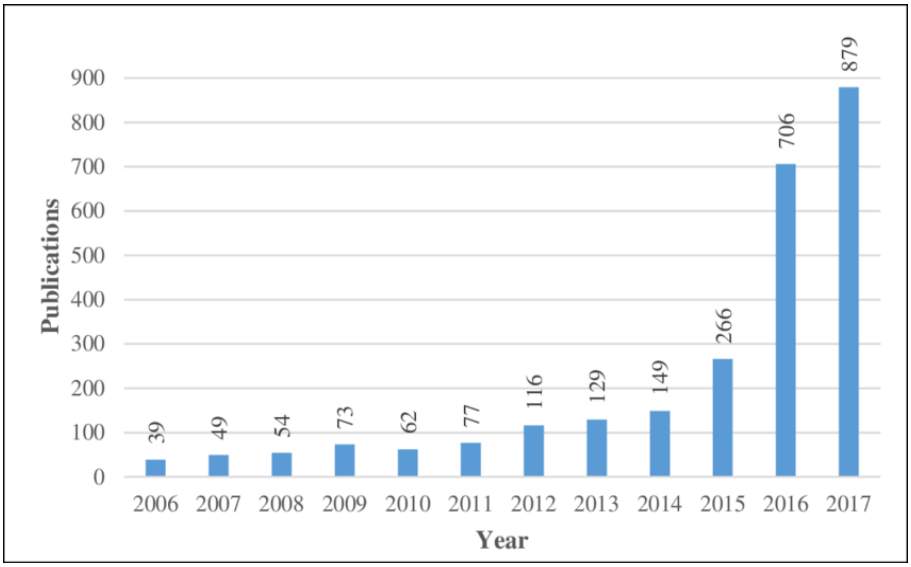

FIGURE 2. Increasing amount of Deep Learning publications from the Springer database (Jan. 2006–Jun. 2017)

3. CONCLUSION

In fact, deep learning is a rapidly expanding machine learning application. The multiple applications listed above demonstrate its quick development in a short period of time. These algorithms' adaptability is demonstrated by the various sectors in which they are used. The publishing analysis carried out in this study provides a clearly depicts the growth of deep learning and the tendency regarding the future research in this subject. It also clearly demonstrates the usefulness of this technology. It's also important to remember that supervision in learning and the hierarchy of layers are crucial elements in creating a successful deep learning application. The proper classification of data requires hierarchy, but supervision views the significance of the database as an integral component of the process. Due to its novel approach to hierarchical layer processing, deep learning mostly benefits from the optimization of machine learning applications that are already in use. Speech recognition and digital

picture processing both benefit from deep learning. The improvement over tried-and-true approaches is amply supported by the drop in mistake percentage (10 to 20%). Due to the combination of facial recognition and speech recognition, deep learning can produce a helpful security tool both now and in the future. In addition, the research topic of digital image processing has numerous potential applications. Deep learning is a current and intriguing area of research in artificial intelligence since it has demonstrated a true optimizations and because it has been proven to be effective.

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