Artificial Intelligence and Traditional Machine Learning to Deep Neural Networks: A Study for Social Implications

Mahesh Babu Pasupuleti

Data Analyst, Department of IT, Iminds Technology Systems INC, 1145 Bower Hill Rd, Pittsburgh, PA 15243, **USA**

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Email: maheshbp.gs@gmail.com

ABSTRACT

There are intriguing opportunities on the road to broad usage of artificial intelligence, as well as challenges that must be solved in order to use machine learning and artificial intelligence technology in industries. On the basis of Google Scholar data, this work systematizes artificial intelligence sections and analyzes the dynamics of changes in the number of scientific papers in machine learning sections. The process of data collection and calculation of dynamic indicators of changes in publication activity, such as the growth rate and acceleration of growth of scientific publications, is presented in detail. Particularly evident in the analysis of publishing activity was the high level of interest in current transformer models, the production of datasets for specific industries, and a significant growth in interest in explainable machine learning approaches. As indicated by the negative correlation between the number of publications published and the number of articles published in a given year, relatively minor study topics are gaining an increasing amount of attention. Results demonstrate that, despite the method's limitations, it is possible to (1) identify rapidly expanding fields of research, irrespective of the number of papers published, and (2) anticipate publication activity in the short term with sufficient accuracy for practical purposes. Results for more than 400 search queries relating to designated study topics and the application of machine learning models to industries are presented in this article in a single document. The suggested method assesses the growth and fall of scientific areas that are related with specific key phrases in terms of their dynamics of growth and decline. It does not necessitate access to huge bibliometric archives and enables for the generation of quantitative estimates of dynamic indicators in a reasonably short time frame.

Keywords: Machine learning, deep learning, explicable machine learning, transfer learning, convolution neural networks, artificial intelligence

INTRODUCTION

The developed countries require new technologies that are not only related to extractive, processing, and manufacturing technologies, but also to the collection and analysis of data that is generated as a result of these processes in order to achieve economically justified development of traditional and new industries, increasing production volumes, and increasing labor productivity. Without a doubt, artificial intelligence is one of the most promising instruments in this area of development (AI). Already, artificial intelligence (AI) is providing considerable economic benefits in fields such as healthcare, commerce, transportation, logistics, automated manufacturing, banking, and other fields of application (Haseeb et al., 2019). AI policies for use and development are being developed or have already been embraced in a number of countries (Garfield, 1972). The widespread usage of artificial intelligence (AI) is accompanied by both exciting prospects and some difficulties, which must be overcome in order for AI to advance technologically and to expand its application horizons in a new round (Pasupuleti & Amin, 2018).

In each scientific direction, including artificial intelligence, there is a rise or decline in the attention of researchers, which is reflected in the change of bibliometric indicators as the field develops. There are several indicators of success, including as the number of publications, citation index, and the number of co-authors, in addition to the Hirsch index. We can gain a better understanding of the current state of science by identifying "hot" regions in which these indicators are more essential. We can then concentrate our efforts on areas that are likely to provide breakthroughs.

The field of machine learning (ML) and artificial intelligence (AI) is characterized by a diverse range of methods and tasks, some of which have already been successfully implemented in software, while others require extensive research.

In this regard, it would be useful to evaluate how researchers' interests have evolved over time and, if feasible, to identify those areas of research that are currently receiving more attention and to concentrate our efforts on these areas of research. The number of publications in several fields of artificial intelligence is increasing at the same time. Because of this, a simple declaration of an increase in the number of publications is insufficient. As a result, bibliometric indicators (BI), such as the number of publications, the citation index, the number of co-authors, and other similar measures, are frequently employed to estimate the productivity of scientists. It has also been used to evaluate universities and research topics, among other applications. In the sphere of scientific research, business intelligence is used to evaluate policy decisions and the impact of published databases. According to the authors of (Daim et al., 2005), bibliometric data is used to construct prediction models that are informed by both bibliometric indicators and models of system dynamics. The previously mentioned approach is integrated with patent analysis in a publication published by Daim et al. (2006). Especially in times of rapid technological development, the work of forecasting is critical. As a result, the variations in the Hirsch index over time are investigated, and the concept of a dynamic Hirsch index is proposed.

But there are considerable drawbacks to bibliometric approaches as well. Numbers indices, in particular, are non-linearly depending on the size of the country and the organization in question. "Quick and dirty" impacts are produced when indicators are used without a thorough comprehension of the topic matter. For the most part, the BI is a one-time evaluation (Pasupuleti, 2016a). Bibliometric indices must be taken into account while attempting to measure the progress of scientific subjects.

To measure the effectiveness of this paper's indicators, the number of articles published that contain specific key terms is assessed. With the help of differential metrics, it is possible to analyze changes in the frequency with which certain key terms are used by authors of scientific publications, which can be used to determine whether or not researchers are becoming more or less interested in the scientific field denoted by this term (Adusumalli & Pasupuleti, 2017).

The examination of the scientific field in order to discover the key phrases that characterize the lines of research and applications is a significant challenge while doing this type of research. The following is a quick overview and systematization of scientific directions incorporated in ML, which we conducted for this purpose: (Pasupuleti, 2016b). Also included in this study was an attempt to determine the applicability of deep learning technology across a variety of businesses. It goes without saying that the informal analysis that was carried out has a significant impact on how the results are interpreted.

In this study, the following are the primary objectives:

- Systematization of the AI&ML portions in accordance with existing literature.
- Research and development of methods for collecting data from open sources and measuring changes in publication activity through the use of differential indicators
- Evaluation of changes in publishing activity in AI&ML using differential indicators to identify research topics that are rapidly developing and those that are "fading."

LITERATURE REVIEW

Artificial intelligence (AI) is the ability of a digital computer or a computer-controlled robot to do tasks that are typically performed by intelligent beings, such as reasoning and problem solving (Adusumalli, 2016b; Pasupuleti, 2015; Pasupuleti & Adusumalli, 2018). In other words, artificial intelligence (AI) refers to any software or hardware technology that is designed to emulate human behavior and reasoning. Machine learning, natural language processing (NLP), text and speech synthesis, computer vision, robotics, planning, and expert systems are some of the applications of artificial intelligence (Adusumalli, 2017a; Adusumalli, 2019; Pasupuleti et al., 2019). Figure 1 depicts a schematic illustration of the components of artificial intelligence.

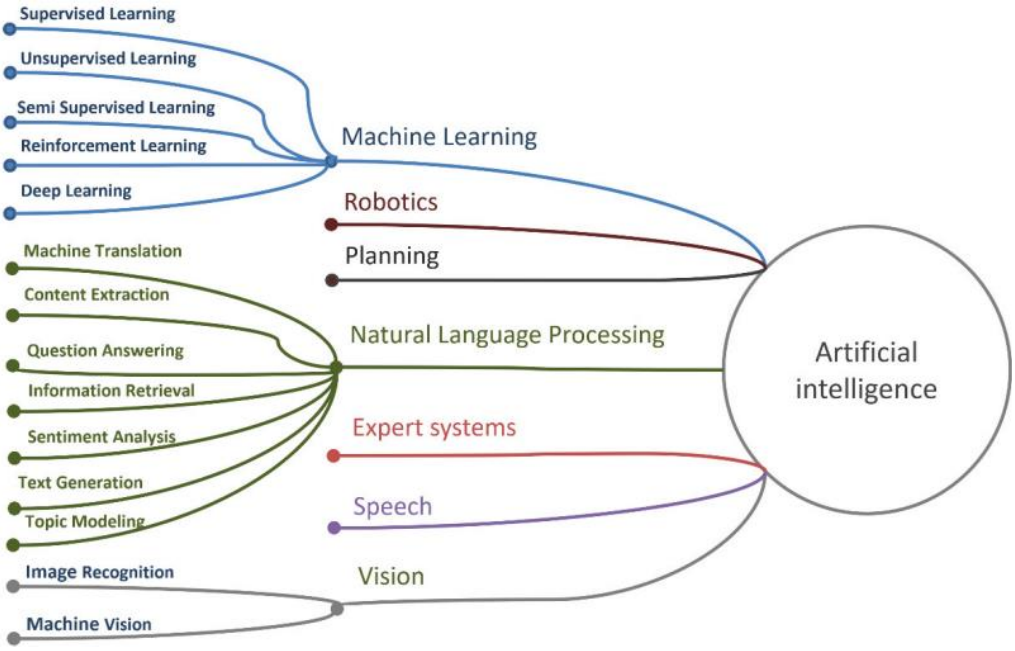

Figure 1: Artificial intelligence is divided into divisions.

Muhamedyev and colleagues (Muhamedyev et al.) established differential indicators in order to discover the logic of variations in publication activity (2018). Using their application, it is possible to assess the speed and acceleration of changes in bibliometric indicators in a given period of time. Accordingly, the indicators that have been established can more clearly demonstrate the growth or drop in the researchers' interest in specific portions of artificial intelligence and machine learning that are characterized by specific key words. According to our findings, the use of dynamic indicators in conjunction with full-text analysis allows us to more correctly assess the potential of research fields than previously possible.

Machine learning contributes considerably to the realization of the potential contained in the concept of artificial intelligence. The most important expectation connected with machine learning is the development of algorithms or computational approaches that are flexible, adaptive, and "teachable." As a result, new functions for systems and programs are made available as a result. According to the definitions provided in (Adusumalli, 2016a; Adusumalli, 2018; Fadziso et al., 2018) the following is true:

- ML is a subset of artificial intelligence approaches that allows computer systems to learn from previous experience (i.e., from data observations) and improve their behavior in order to fulfill a certain task.
- Neural networks (NNs), also known as artificial neural networks (ANNs), are a subset of machine learning (ML) methods that have some indirect resemblance to biological neural networks. They are typically described as a collection of interconnected pieces known as artificial neurons that are arranged in orderly layers.
- Deep learning (DL) is a subset of neural networks (NN) that provides computation for multilayer neural networks (MLNN). Deep neural networks (DNN), convolutional neural networks (CNN), recurrent neural networks (RNN), generative adversarial networks (GAN), and other types of DL architectures are examples of typical DL architectures.

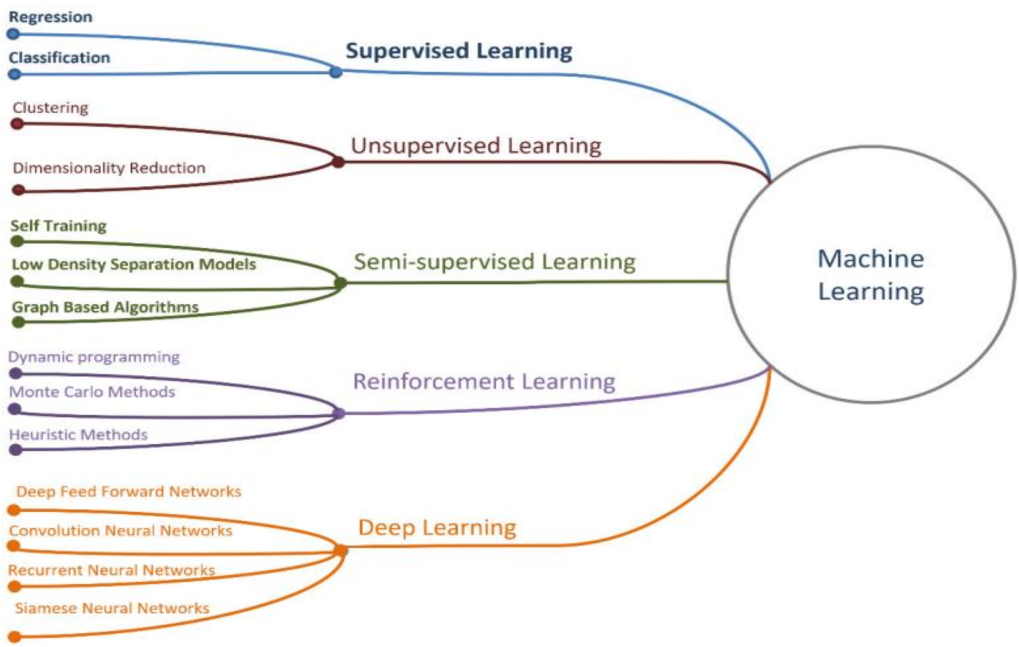

Figure 2: The most fundamental types of machine learning models

Machine learning is currently being used to solve problems in a variety of fields, including medicine, biology, robotics, urban agriculture and industry, agriculture, modeling environmental and geo-environmental processes [29], developing a new type of communication system, astronomy, petrographic research, geological exploration, natural language processing, and a variety of other fields (Ayodele, 2010; Ibrahim et al., 2012).

In this chapter, the classification of machine learning models was discussed (Muhamedyev, 2015). According to Nassif et al. (2019), machine learning approaches can be classified into five categories (Figure 2):

- Unsupervised learning (UL) or cluster analysis.
- Supervised learning (SL).
- Semi-supervised learning.
- Reinforcement learning.
- Deep learning.

In the fields of regression, classification, clustering, and data dimensionality reduction, machine learning approaches are used to address problems.

UL techniques are used to solve the tasks of clustering and dimensionality reduction. When a set of unlabeled objects is sorted into groups by an automatic procedure based on the properties of these objects, the tasks of clustering and dimensionality reduction are solved (Schmidhuber, 2015). K-means, isometric mapping (ISOMAP), local linear embedding (LLE), t-distributed stochastic neighbor embedding (t-SNE), kernel principal component analysis (KPCA), and multidimensional scaling are some of the clustering approaches that can be used (MDS).

By utilizing these methodologies, it is possible to uncover hidden patterns in data, as well as anomalies and imbalances. The final decision on how to tune these algorithms, however, must be made by a trained professional.

SL provides a solution to the classification or regression problems. When finite groups of some selected objects are singled out from among a potentially endless set of objects, a classification problem occurs as a result. Most of the time, an expert is responsible for the formation of groups. The classification algorithm, using this initial classification as a pattern, must assign the following unmarked objects to either this group or that group depending on the attributes of these objects, as determined by the properties of these objects.

Deep learning is a term that refers to a collection of methods that make use of deep neural networks. A deep neural network is an artificial neural network that has more than one hidden layer and is regarded to be more complex than a simple neural network. A shallow neural network is one that has less than two hidden layers and is used for machine learning applications. When dealing with vast amounts of data, the benefits of deep neural networks are immediately apparent.

After reaching a certain point, the quality of classical algorithms no longer improves in proportion to the amount of data that is accessible. Deep neural networks, on the other hand, can extract the features that provide the solution to the problem, so that the more data there is, the more subtle dependencies can be exploited by the neural network to improve the quality of the solution, and the more data there is, the better the quality of the solution (Hochreiter and Schmidhuber, 1997).

The application of deep neural networks facilitates the transition from issue-solving to End-to-End problem solving. It indicates that the researcher pays significantly less attention to the extraction of features or characteristics from the input data, such as the extraction of invariant facial traits when recognizing faces or the extraction of individual phonemes when doing speech recognition, for example. Instead, it merely feeds a vector of input parameters, such as an image vector, to the network's input and waits for the network to provide the desired classification result on the output. As a result, by selecting an appropriate network architecture, the researcher is able to allow the network to extract those features from the input data that are most useful in solving a particular problem, such as the classification problem. The greater the amount of data collected, the more accurate the network will be. Deep neural networks were predetermined to be successful in tackling classification and regression problems because of the behaviour described above.

It is possible to restrict the range of neural network topologies to four fundamental architectures (Figure 3):

1. A feed forward neural network in its most basic form.
2. A recurrent neural network is used.
3. Neural network with convolutional layers.
4. Hybrid architectures, which include aspects of the first, second, and third basic architectures, such as Siamese networks and transformers, as well as elements of the fourth fundamental architecture.

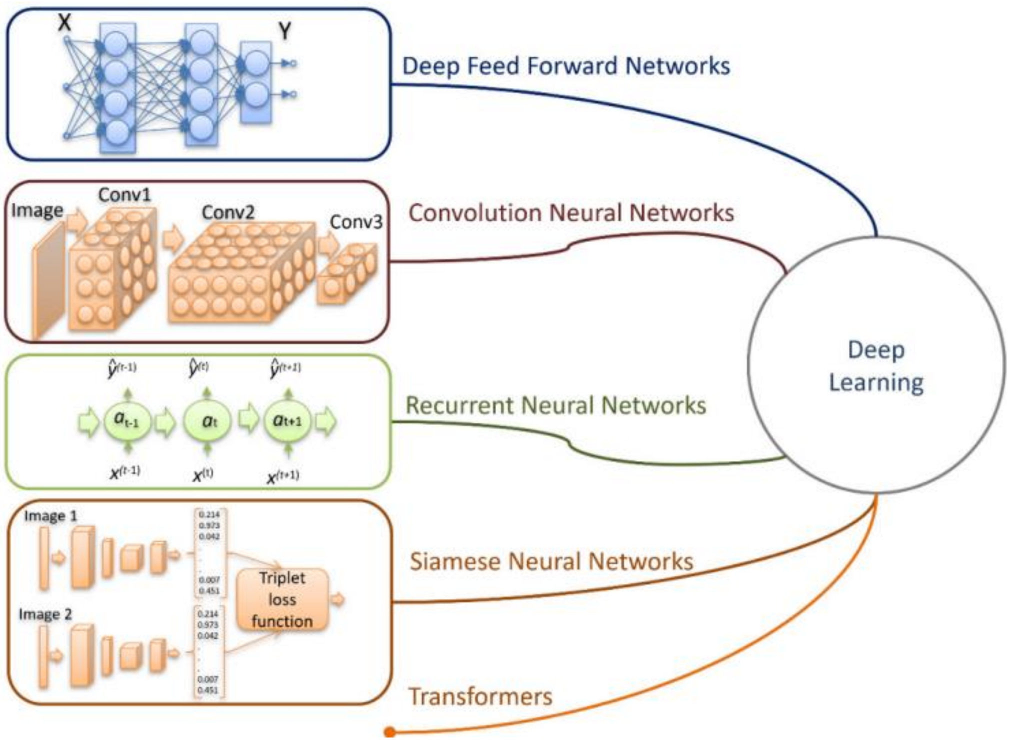

Figure 3: Deep neural networks

DISCUSSION

Several terminology (robotics, supervised learning, machine vision, regression, and so on) are becoming increasingly infrequently used as a result of the regularities of publication activity. The fields of topic modeling, text generation, and question answering are seeing substantial growth in the field of natural language processing (NLP). At the same time, according to the data currently available, the rate of growth in the field of sentiment analysis is decreasing significantly. The domain expert system, on the other hand, is characterized by a significant slowdown in the decline in the number of publications, in contrast to the domain recurrent neural network, which, while showing an observed increase in the number of articles, is nonetheless characterized by a significant slowdown in the rate of increase in the number of articles. It can be assumed that the focus of recurrent network research is changing toward new neural network topologies, explanations of outcomes, and other related topics. For example, we can witness a significant increase in the number of publications relating to the phrases Siamese neural networks and convolutional neural networks in recent years. The goal of scientific publications is to overcome the limits of artificial intelligence and machine learning technology. These algorithms, on the other hand, make it easy to determine which noun sets of algorithms are most frequently used in practice. In instance, Mukhamedyev et al. (2019) discovered that deep learning technologies, when applied to healthcare, result in a significant rise in the amount of published work. According to the most recent research, healthcare is one of the most popular application domains for deep learning algorithms. When combined with the phrase healthcare, models of transformers (BERT) and generative adversarial networks (GAN) show extremely high rates of D1 and D2 occurrences. BERT, when applied to a wide range of industries (development, production, manufacturing, communication, electricity, supply chain, and so on), exhibits a rapid increase in the number of publications. Meanwhile, the search keywords "electricity deep learning" and "social services" were chosen for inclusion in the search results. Deep + Learning has had a significant slowdown in the number of publications (Adusumalli, 2017b). According to one interpretation, this phenomena represents a probable shift in the researchers' interest in new words that describe recent deep learning models. In light of the negative association between the number of articles published and the indicators, we may conclude that domains with a high number of publications have lower dynamics of publication activity and model error.

Research Contribution

According to Google Scholar, we systematized the sections of artificial intelligence and examined the dynamics of changes in the number of scientific articles produced in the machine learning domains. This study demonstrates that it is possible to identify quickly developing and "failing" study topics for any "good" number of publications (>100), and that it is also possible to predict publication activity in the short term with enough accuracy to be useful in practical applications.

Research Limitations

There are some drawbacks to the method we utilized, in particular:

- Despite the in-depth nature of the informal analysis, the researcher retains control over the collection of terms used. As a result, some articles that are relevant to the section under consideration may be overlooked, while some publications that are not relevant to the issue under consideration may be wrongly assigned to it. Also, we cannot guarantee that the empirical evaluation conducted will be exhaustively complete and consistent in its findings.

- The fact that the importance of a particular scientific topic is determined not only by the number of articles published, but also by the volume of citations, "weight" assigned to individual characteristics of authors, and the quality of journals published, among other factors, is not considered in this analysis.
- The strategy does not take into consideration word change processes or the semantic proximity of scientific areas.

Research Implications

These estimates, despite some limitations of the methodology used, corroborate empirical findings about the growth of deep learning models in applications, the development of explainable artificial intelligence systems, and the increase in both quantity and variety of datasets for many machine learning applications. The findings of the study indicate that the scientific community's efforts are focused on overcoming the technological limits of machine learning. The development and application of methods for creating datasets, explaining the outcomes of machine learning systems, and speeding up learning have all been accomplished, with some of these methods having already been effectively implemented. New solutions, on the other hand, are required to overcome the restrictions stated above for the majority of AI applications. As soon as this occurs, we will be witness to the beginning of a new stage in the evolution of artificial intelligence applications.

Future Research

The use of topic modeling and text embedding analysis to overcome the inadequacies of the proposed approach of evaluating publication activity, in our opinion, is the key to overcoming the shortcomings of the method. Classical topic modeling (David et al., 2003) and the embedded topic model (Friedman, 2001) are two approaches that we will employ to automatically cluster scientific publications and find related terms in a large corpus of scientific publications. Furthermore, a more complex scraper will provide information on the amount of citations received by publications as well as the quality of scientific journals published.

Conclusions

The field of artificial intelligence is vast. Machine learning, particularly deep learning models within it, are the fastest-growing areas of research today, according to the National Science Foundation. New findings, as well as applications of previously proposed networks, are published on a nearly daily basis. It encompasses a vast family of networks for text recognition, speech recognition, and handwriting recognition as well as networks for picture alteration and stylization, as well as networks for processing temporal sequences. Siamese networks are a relatively new direction of deep neural network applications, and they produce excellent results in recognition tasks. Other deep neural network applications include networks for object identification that provide confident object identification, transformer models that solve the problems of recognition and text generation, and so on.

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