Has the Future Started? The Current Growth of Artificial Intelligence, Machine Learning, and Deep Learning

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ABSTRACT: In the modern era, many terms related to artificial intelligence, machine learning, and deep learning are widely used in domains such as business, healthcare, industries, and military. In these fields, the accurate prediction and analysis of data are crucial, regardless of how large the data are. However, using big data is confusing due to the rapid growth and massive development in public life, which requires a tremendous human effort in order to deal with such type of data and extract worthy information from it. Thus, the role of artificial intelligence begins in analyzing big data based on scientific techniques, especially in machine learning, whereby it can identify patterns of decision-making and reduce human intervention. In this regard, the significance role of artificial intelligence, machine learning and deep learning is growing rapidly. In this article, the authors decide to highlight these sciences by discussing how to develop and apply them in many decision-making domains. In addition, the influence of artificial intelligence in healthcare and the gains this science provides in the face of the COVID-19 pandemic are highlighted. This article concludes that these sciences have a significant impact, especially in healthcare, as well as the ability to grow and improve their methodology in decision-making. Additionally, artificial intelligence is a vital science, especially in the face of COVID-19.

Keywords: Artificial Intelligence; Machine learning; Deep learning; Sciences; Vision; Medicine; COVID-19.

1. INTRODUCTION

The terms artificial intelligence and robotics have become pervasive to the extent that people fear that machines will take control of their lives and the role of humans will diminish in many areas [1]. However, the reality is far from this perception. Humans are distinguished by their application of their talents, skills, and abilities, which other creatures cannot do. People are also differentiated from one another in terms of creativity and excellence, and those who stand out possess intelligence. Human intelligence is the ability and skill to solve problems [2]. The key reason for the development of artificial intelligence is to simulate the human mind by studying the behavior of human intelligence using computer programs that are capable of understanding human behavior. This fact indicates that computer and human intelligence will have a vast and evident influence on humans [3]. Artificial intelligence is described as the skill of machines and programs to simulate human mental experiences and their practice patterns, such as the ability to learn, judge, and react to situations

that are not programmed in the machine [4] [5]. Artificial intelligence is also the academic field involved with making computers and applications that are capable of understanding behaviors [6].

Scholars describe artificial intelligence as "the study and design of intelligent systems that include their environment and take measures that increase their chances of success." John McCarthy, who neologized this term in 1955, explains it as "the science and engineering of making intelligent machines" [7]. In recent years, the evolution of artificial intelligence technology has made great advancements [8], and deep learning technology is its most prominent manifestation. It is based on the development of artificial neural networks that mimic the way that the human brain works [9]; thus, the networks can experiment, learn, and grow themselves without human intervention. Deep learning technology has demonstrated its strength to recognize images, to communicate, and to translate from one language to another [10, 11]. In addition, companies such as Facebook, Google, and Twitter are investing huge amounts of money and intensifying efforts in developing deep learning skills and in making a model of artificial intelligence that can handle the complexity of the human brain. In the medical field, machine learning has a significant role especially in analyzing images of people with heart disease [12], chronic kidney disease [13], brain cancer [14], Coronavirus Disease of 2019 (COVID-19) [15–17], and analyzing ultrasound pictures of pregnant women to detect the gender of the fetus. Machine learning is the companion of specialists and doctors in analyzing patients' data and giving accurate results about diseases.
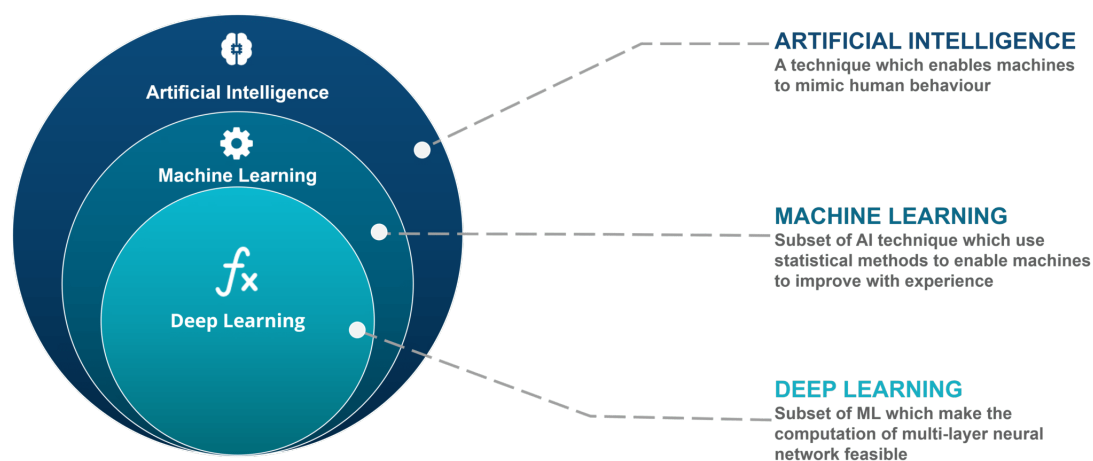
Hence, we live in a time when artificial intelligence is growing significantly. Soon, artificial intelligence will become an indispensable companion of man. Today, human capabilities are enhanced through the use of applications and technology in a significant way. Such progress is highlighted after Mark Zuckerberg, Chief Executive Officer of Facebook, launched the Metaverse platform, which is envisioned to materialize Zuckerberg's concept of a virtual world [18]. It is a 3D virtual world made with computer utilizing simulation software, and users will be able to connect to the virtual world through virtual reality glasses. We can interact and sit with one another in three dimensions without moving physically from one place to another. The goal of this platform is to move from one level of ordinary life to another level, in which humans are fully integrated with machines in the virtual world. If Metaverse is exploited correctly, then artificial intelligence will become a mate of man.

The foremost contribution of this article is the delivery of brief and straightforward information about artificial intelligence, machine learning, and deep learning. We present how they are utilized in various fields that benefit humanity, especially in the analysis of big data. Furthermore, we discuss the most important algorithms, techniques, and applications applied.

This article is outlined as follows. Section 2 briefly introduces artificial intelligence, machine learning, and deep learning, what functions they provide, and how they are employed. Section 3 presents the importance of artificial intelligence in the medical fields. Finally, Section 4 provides the conclusions of the article.

2. THE SCIENCES

This section reviews the gains in artificial intelligence, machine learning, and deep learning. The information presented is valuable especially for those interested in these sciences. Figure 1 illustrates the main differences between the three sciences.

ARTIFICIAL INTELLIGENCE
A technique which enables machines to mimic human behaviour

MACHINE LEARNING
Subset of AI technique which use statistical methods to enable machines to improve with experience

DEEP LEARNING
Subset of ML which make the computation of multi-layer neural network feasible

FIGURE 1. Differences between the three sciences

2.1 ARTIFICIAL INTELLIGENCE

Artificial intelligence is a core of computer science [19, 20]. It is a scientific development through which a machine is developed to perform actions that fall within the scope of human intelligence, such as teaching, logic, self-correction, and self-programming. The principal aim of artificial intelligence is to make computers do the work that humans do [21]. Artificial intelligence is vital to some scientific and applied fields. Today, artificial intelligence has pervaded people's daily activities , including industry, agriculture, and medicine. For example, physicians use a robot to perform surgeries with high accuracy. The abilities that artificial intelligence can advance are learning, pattern-recognition, reasoning, problem solving, visual perception, and language comprehension. Furthermore, artificial intelligence investigation is highly technical, specialized, and relies heavily on logic, knowledge, planning, education, communication, imaging, and the ability to move and handle objects. This science is divided into two types:

- **Applied**: It is the more common type that includes intelligent systems capable of accomplishing one task, such as driving a car without a driver. This type is termed weak or narrow artificial intelligence.
- **Generaliz ed**: This is the less common type and involves systems that can handle any assignment because they have sufficient capacity to solve any obstacles or unusual situations. This type is called robust. To date, no example of robust artificial intelligence is available, because it is in a stage of evolution and growth.

Scholars believe that artificial intelligence techniques will not cause any risk to the human race. Yoshua Bengio, a Canadian professor of computer science at the Université de Montréal, thinks that intelligent technologies should not be a cause of concern, as they require many years of slow and gradual improvement before they can be improved [22]. It reaches the extent that analysts fear, because it is based on its influence on sciences and ideas that are currently in their early beginnings. Artificial intelligence has entered unlimited applications and fields. Among these areas are the development of computer applications in medical diagnosis, the effect of a search device on a computer via the Internet, and the growth of stock trading operations. Another impressive application is the impact of cognitive stimulation, in which computers are used to test theories on how the human brain works and the functions it performs, such as recognizing faces and activating memory. Artificial intelligence gives machines the ability to "reason and learn" [23, 24]. These two capabilities are beneficial in clinical diagnosis. For example, a computer program can analyze the lung's X-ray image, match it with its database, and establish the probability that the patient is infected with a virus, such as COVID-19 [25, 26]. Similar applications are being developed for many other diseases; thus, artificial intelligence could complement and strengthen physicians' diagnoses of diseases. Practice planning is another great advantage of artificial intelligence; as the most suitable treatment could be drawn on the basis of patients' information and that of thousands of previous similar cases.

2.2 MACHINE LEARNING

With the technological developments in recent years, new terms have begun to emerge. Big data [27] [28], Industry 4.0 [29], and artificial intelligence are the most popular ones. Although machine learning is not as popular as these terms, it is a concept that has been on the rise. However, , many questions surround machine learning. Machine learning is applied in different sectors and applications today, and its use is increasing gradually. Machine learning is a sub-area of artificial intelligence [30, 31]. Information technology systems automatically learn patterns and relationships from data and gain without being explicitly programmed. Machine learning has been successfully supported in business, investigation, and improvement for many years [32–35]. Furthermore, machine learning can automatically produce knowledge, train algorithms, identify relationships, and recognize unknown patterns. These identified patterns and relationships can be utilized to a new, unknown data set in order to make predictions and optimize processes. Machine learning algorithms can be categorized into three main divisions:

- **Decision Process:** Machine learning techniques are utilized to create predictions or classifications of specific data, which can be labelled or unlabeled. The outcome of these techniques is to estimate a pattern in the data, which assists in decision making.
- **Error Function:** This function judges a model's prediction and whether it gives actual or false effects. Additionally, this function has the ability to make a comparison to judge the functioning of the model and verify the functioning of machine learning techniques.
- **Model Optimization Process:** If the proposed model for implementation fits well with the training data set, then the weights will be adjusted to reduce the discrepancy between the proposed work and the model estimation. The technology will repeat this assessment, improve the implementation process, and improve the weights independently until the accuracy is met.

Unlike traditional software development, machine learning focuses on independent learning from data and information. Thus, machine learning technologies learn from data and create their own approach code on their own. These techniques will live in a particular situation and train themselves depending on the circumstances in which they will be.

Machine learning is categorized into three, namely (see Figure 2):

- **Supervised learning:** In general, this type includes most of the problems in machine learning, which is characterised by looking at training samples. Each sample is entered as X so that it corresponds to a specific result, which is y. We need to train a model (mathematically is x→y relationship mapping f) in unknown samples x after giving, then we can obtain y predictions. If the prediction is a discrete value (often category types, such as spam/snail mail in the mail classification problem, such as whether a user will/will not buy a particular product), then it will be termed a classification problem. If the prediction result is a continuous value (e.g., apartment prices, stock prices, etc.), then this state will be termed a regression problem.
- **Unsupervised learning:** It is a form of learning in which information is categorized or not. Unsupervised learning finds hidden patterns in data. It uses them to infer from datasets entered into the system, without labelled data. Given that no classification has previously been done, the system can classify using data sets.
- **Reinforcement learning**: It is a form of learning that takes place between supervised learning and unsupervised learning. It is used for the same applications as supervised learning. Large amounts of unlabelled data and small amounts of labelled data are commonly used.
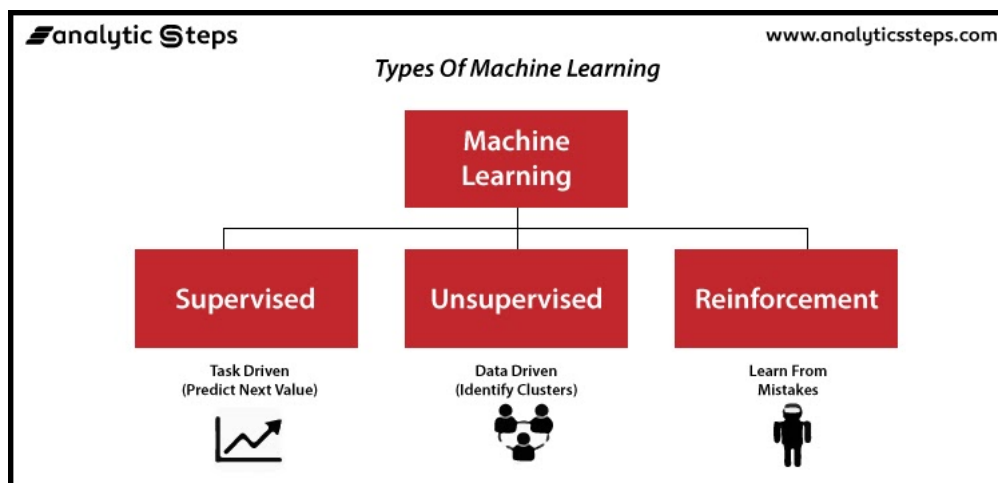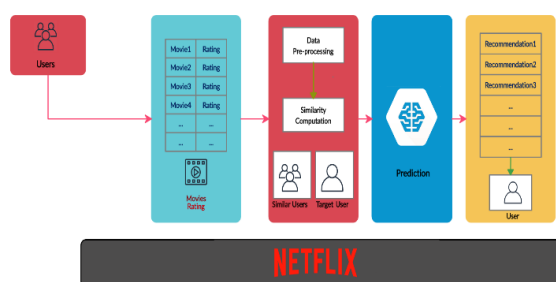

FIGURE 2. **Categories of machine learning [36]**

People ask if artificial intelligence is the same as machine learning. In this division, the difference between them can be reviewed as follows: artificial intelligence aims to enhance the chances of success, not accuracy. By contrast, machine learning does not care about success; it aims to improve accuracy. Artificial intelligence is an intelligent computer program, whether machine learning is a concept that the machine receives (collects) data and learns in line with this data. In addition, artificial intelligence aims to simulate natural intelligence to solve complex problems. The goal of machine learning is to learn from the data collected for a specific task in order to maximize the machine's performance. Thus, machine learning is the system of learning new things from collected data. Artificial intelligence works to decide and to obtain the most suitable solution; whereas machine learning considers only one answer, whether it is optimal or not. Artificial intelligence leads to intelligence or wisdom; whereas machine learning leads to knowledge. Artificial intelligence works to decide and get the most suitable solution; while machine learning considers only one answer, whether it is optimal or not. Artificial intelligence leads to intelligence or wisdom, on the other hand, machine learning leads to knowledge. In essence, machine learning is a set of algorithms and statistical models that computers utilize to perform a specific assignment without using explicit instructions. Machine learning algorithms build a scientific model that relies mainly on a sample of data that provides training data. The model is directed to make predictions or make decisions without explicitly programming it to perform the assignment. It concludes from the behavior of the data. Thus, machine learning models can provide reliable decisions or valuable correct predictions.

2.3 DEEP LEARNING

Do you know that deep learning helps in investigations to fight COVID-19 [37, 38]? What is deep learning? Is it part of the big picture of artificial intelligence? Deep learning is a branch of machine learning that aims to develop a model that matches the level of the human brain in solving complex problems in the real world by utilizing artificial neural networks and simulation learning [39–41]. Each created model must achieve two primary deep learning assignments tightly; mining semantic information from input and producing meaningful output. The human brain consists of a group of neurons [42, 43], and deep learning tries to reach the level of these neural connections by simulating the human brain through artificial neural network techniques, which is the core of deep learning. It consists of an input layer, an output layer, and one or more extra hidden layers, each of which involves a collection of weighted nodes or neurons that are attached to one another. Deep learning requires the use of high levels of cognitive skills such as analysis (compare, contrast) and synthesis (integrate knowledge in a new dimension). Moreover, deep learning improves the understanding and application of lifelong learning [44–46]. The main features of deep learning are the intrinsic motivation that encourages learning as a source of satisfaction, meaning-centered learning, linking new knowledge with other subjects, merging expertise and real life, and promoting a critical spirit and analysis. Deep learning is characterized by the speed of learning, as it has the ability to learn from large amounts of data, which humans cannot handle. Therefore, deep learning may draw ideas and conclusions that humans cannot reach. Deep learning takes advantage of image recognition, weather forecasting, and agriculture. It has also been utilized in automotive technology and medical fields. Hence, artificial intelligence has been essential in supporting and enriching the lives of people and society.

The most popular types of artificial neural networks are convolutional neural networks (CNNs) [47] and recurrent neural networks (RNNs) [48]. On the one hand, CNNs are characterized by utilizing filters to extract features and then correlating features in its different layers by utilizing convolutions rather than general matrix multiplication. Image processing, computer vision, and pattern recognition are applications of CNNs. On the other hand, RNNs are an updated version of CNNs with an internal memory that stores all computations necessary for sequential data problem. However, RNNs have poor ability to process long data sequences and have limited tables; hence, long short-term memory [49] has been recommended as an extension of RNNs for training data that are long-term. Moreover, deep learning needs substantial effort in providing large amounts of classified data; for instance, developing a driverless car requires millions of images and thousands of hours of video. The effort of deep learning is unrivalled, and it requires high computing power. High-performance graphics processing units have a parallel architecture that is effective for this science. When deep learning is combined with clusters or cloud computing, community teams can reduce training time for a deep learning network from weeks to hours or less.

FIGURE 3. Netflix recommendation system [50]

A lot of people ask us why the term "*deep*;" what does it signify? The term "deep" refers to the number of hidden layers in a neural network. In a conventional neural network, the number of hidden layers is two to three, whereas in deep learning, the number of hidden layers in a neural network reaches 150. This amount indicates that deep learning has the ability to train extensive data in a structure neural network. It is used in many fields, including recommendation systems. For example, companies such as Amazon and Netflix have popularized the recommendation system in their applications, through which they can understand what shows or products might appeal to a user. The recommendations are based on the search or viewing behavior of a user. Figure 3 shows how the recommendation system works in Netflix. Deep learning frameworks such as Tensorflow, Pytorch, Caffe2, MXNet, CNTK, and PaddlePaddle are available. Tensorflow's other

famous wrapper is Keras, and a model can be built with it in a few lines of code. Although it lacks the flexibility that Tensorflow provides, it is convenient and easy to use, controlling almost every detail.

3. THE IMPORTANCE OF ARTIFICIAL INTELLIGENCE IN HEALTHCARE AND MEDICINE

Artificial intelligence has made tremendous and remarkable progress in the health field [51], as it facilitates many of the problems related to filling out forms for admission in hospitals or clinics and preventing the surge of discounts at the reception desk. In recent times, the science of artificial intelligence has been able to contribute to the development of the healthcare system to be more effective in detecting diseases such as cancer [52], infections [53–56], and other diseases, in addition to the development of robots that perform surgeries and accurate diagnosis [57, 58]. Recent statistics indicate that artificial intelligence developers have arrived at the stage of providing effective solutions to complex obstacles in healthcare management systems, thereby revolutionizing the medical field to eliminate inefficient systems prevailing in societies. The uses of artificial intelligence in the healthcare sector are manifold, from diagnosis and drug development to workflow management in hospitals or clinics [59]. Specifically, artificial intelligence is used for diagnosis and detection of diseases, cancer detection, management of chronic conditions, drug discovery, robot-assisted surgery, delivery of health services, and scientific tests and experiments [60, 61].

One of the best examples of the benefits of artificial intelligence in combating diseases is COVID-19. Since March 2020, the world has been struggling from the COVID-19 pandemic, which has caused significant morbidity and mortality rates [62] [63]. This disease has pushed countries to implement strict response measures to suppress its infectivity rates, including countrywide lockdowns, curfews, border closures, social distancing, travel restrictions, school closures, prohibition of public gatherings, mandatory quarantine of asymptomatic contacts, and hospital isolation of patients [64–67]. This pandemic and its associated health protocols have caused multiple health, psychological, financial, social, and cultural effects of varying levels on all people, but especially among COVID-19 patients, students, and healthcare workers [68–72]. Hence, experts have been scrambling to use artificial intelligence to mitigate the effects of the pandemic. To date, different artificial intelligence and deep learning applications and techniques have helped fight the COVID-19 pandemic [73] [74]. These applications are involved in rapid and accurate detection and diagnosis of the infection through practical algorithms and medical imaging technologies, automatic monitoring and prediction of the spread of this virus, contact tracing of clusters, identifying high-risk patients, and predicting the number of COVID-19 cases and mortality rates in any region by adequately analyzing patients' data [73]. Furthermore, artificial intelligence has been utilized in social control by using thermal imaging to scan public spaces for people who are potentially infected and by enforcing social distancing and lockdown measures [75] [76].

Aside from herd immunity and a cure drug for this virus, the best hope for ending this crisis is vaccination, which is one of the most cost-efficient health interventions to prevent infectious diseases [77]. Artificial intelligence is a valuable tool for drug delivery design and vaccination development by analyzing the available data on COVID-19. Moreover, this technology is a powerful tool for accelerating real-time testing, where standard testing takes much time and hence helps speed up this process, which may not be possible for a human. Artificial intelligence may help counter vaccine hesitancy, which is one of the significant challenges in the COVID-19 fight [78]. A recent study from France indicated that interacting with people using a chatbot could significantly decrease vaccine hesitancy by encouraging more people to get vaccinated [79]. However, artificial intelligence systems are at a preliminary stage and are not yet playing a significant role in the fight against COVID-19. The use of this technology is constrained by missing data and too much outliers and noisy data [80, 81].

In recent times, artificial intelligence has made remarkable progress with high expectations in the field of early detection of diseases. Many wearable applications and tools also utilize artificial intelligence techniques that monitor the body's vital signs disturbances. They can predict the possibility of a health crisis before it occurs. Now, companies are seeking to grow their products by using artificial intelligence techniques. For instance, the American platform *CarePredict* has developed a wearable tool that tracks small changes in the behavioral patterns of the elderly that precede falls, malnutrition, and depression. The tool also sends urgent distress signals when needed and at great speed. Precision medicine depends on knowing the most effective drug for patients according to their genetic makeup, lifestyle, and drug response. In this context, current investigations prove an apparent positive influence when physicians' work is integrated with artificial intelligence to pave the way for precision medicine, where deep learning techniques can analyze genetic data from large numbers of individuals, identify individual variation in response to drugs, and assist in clinical decision- making in real-time. As a result, physicians can recommend the most suitable medication for each person. Deep learning and computer vision techniques are primarily used to analyze medical images, whereas CNNs are the most popular techniques for identifying, classifying, and detecting diseases. Thus, deep learning and computer vision technologies are able to

outperform radiologists in detecting malignant tumors through images. In fact, researchers have begun building clinical scientific trials with the help of artificial intelligence techniques.

Official authorities and international health organizations will take years before they adopt artificial intelligence as a reliable medical partner. This technology can be applied in matters such as data analysis, which requires the machine to learn natural language processing. One of the most famous artificial intelligence tools employed in the medical field is contextflow, which is a search engine based on 3D medical images. The engine can specify a region to review reference cases according to the type of disease detected. Additionally, contextflow can limit results to age groups, gender, or pathological results mentioned in the reports via text search and linking to related medical references.

4. CONCLUSIONS

This article sheds light on artificial intelligence, machine learning, deep learning, their role in humans' lives, and how they can be practiced in the future. The growth in artificial intelligence since Alan Turing "cracked the Nazi code" is on the rise. This science has become universal and is present in every device. It has entered into many industries, including the automobile industry and film production, and this prevalence indicates that artificial intelligence has no limits. Today, as the world lives in the era of big data, healthcare workers rely heavily on artificial intelligence algorithms to analyze patients' data. However, a lack of data, unbalanced data, computational requirements in general, and executing data are challenging to analyze. In machine learning and deep learning, unbalanced and/or missing data cause an algorithm to leave the test data due to incomplete knowledge of the model. This case is called "overfitting," and it could lead to a wrong model with low accuracy. Machine learning and deep learning are growing and continuously progressing for the modernization and service of humans, yet we do not know the extent of this development and where it will lead us. This article recommends utilizing machine learning and deep learning models because of their high ability to predict and make decisions. Such ability speeds up the fulfilment of assignments—the more data, the greater the ability of these models to analyze. In the future, a set of studies that employ artificial intelligence techniques to analyze data of people infected with COVID-19 disease will be addressed.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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