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Data Automation with Deep Learning: A Systematic Review

Elvis Chacón-Pajuelo[1]; José Iglesias-Reyes[2]; Rosalynn Ornella Flores-Castañeda[3]
[1,2,3] Facultad de Ingeniería y Arquitectura, Universidad César Vallejo, Perú, *echaconpa@ucvvirtual.edu.pe, jiglesiasr@ucvvirtual.edu.pe, rfloresc@ucv.edu.pe*

Abstract– ***The instructions give the basic guidelines for This research addresses the application of Deep Learning techniques in data automation, highlighting its benefits and areas of implementation. A comprehensive search of academic databases was conducted using the PRISMA methodology, selecting relevant studies according to specific inclusion and exclusion criteria. The analysis focused on two main categories: predictive models and convolutional neural networks (CNN). In the area of predictive models, applications such as text sentiment analysis and IoT systems for predicting school dropout were evaluated. For CNNs, methods for 3D localization and smart factory management were explored. The findings indicate that Deep Learning significantly improves accuracy and efficiency in data automation, with applications in sectors such as technology, healthcare, agriculture and energy. Despite the limitations of the study, such as time coverage and database selection, future challenges are identified, including improving model scalability and efficiency, data security and privacy, and adaptability to new contexts with limited data. These findings provide a solid foundation for future research and practical applications in the field of Deep Learning.***

Keywords-- Deep Learning; Data automation; Predictive Modelling, Neural Networks; Data Security

I. Introduction

In today's digital era, institutions face the challenge of managing an increasing volume of data from diverse sources and in multiple formats. Efficient management of this data is crucial to maintain competitiveness, optimize internal processes and inform strategic decisions. However, traditional data processing methods have limitations in speed, accuracy and ability to extract valuable information from complex datasets [1].

The lack of a comprehensive data automation strategy exposes companies to risks such as data loss and unauthorized access. A survey by International Business Machines Corporation (IBM) revealed that 68% of chief data officers consider data security their primary responsibility yet lack a coherent strategy and dedicated resources. In this context, data governance is essential globally but faces challenges such as security risks and access control difficulties. An automated method for identifying sensitive financial data has proven effective in classifying sensitive data, contributing to international data management and security [2].

To meet these challenges, institutions must adopt solutions based on advanced technologies such as Deep Learning (DL). Here, artificial intelligence (AI) and machine learning (ML) open new opportunities in diverse sectors, enabling site monitoring, automatic detection and intelligent maintenance [3]. Furthermore, the integration of DL and rule-based systems facilitates visual inspection in production. [4]. In addition, sensor data fusion algorithms have been proposed that improve data fusion in wireless sensor networks [5].

In this context, data has emerged as a fundamental pillar in the digital transformation process of companies [6]. AI in data analytics enables companies to automate processes, improve real-time decision making and deliver personalized customer experiences [7]. In addition, the adoption of intelligent DL-based systems increases operational efficiency, promotes economic development and optimizes strategic decision-making.

By systematically analyzing and evaluating DL techniques applied in data automation, their benefits and applications in various sectors are highlighted. This comprehensive approach not only contributes to theoretical and practical knowledge but also sets a methodological standard for future research. Effective DL implementation is essential for improving the competitiveness and security of enterprises, optimizing operations and reducing costs in the information age.

II. LITERATURE REVIEW

To [8] presented a hybrid deep random neural network (HDRaNN) for cyber-attack detection in the Industrial Internet of Things, achieving 98-99% accuracy in classifying various cyber-attacks, outperforming other Deep Learning-based schemes.

According to [9] developed an IoT system to predict school dropout using ML techniques, achieving an accuracy of 99.34%. This IoT system proved to be a viable tool to identify students at risk of dropping out of school.

Also [10] proposed a DL model to classify occlusions in dentinal tubules, achieving an accuracy of 90.24%. This architecture proved to be effective for automatic classification of dentinal tubule images.

To [11] introduced an AI-based Intelligent Document Management System (IDMS), improving the accuracy of miscellaneous document management by up to 97%. This approach enabled the development of an efficient document management system.

Finally, the study [12] created an intelligent management system for sand factories using DL and edge computing, achieving 98% accuracy in automatic sand identification and improving the efficiency of operations compared to traditional management.

III. METHODOLOGY

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodological approach was used for this article. This approach provides numerous advantages for authors, editors and reviewers alike, as it establishes a clear guide for the synthesis of information from articles and other research sources. The main objective of the PRISMA methodology is to increase the transparency, completeness and accuracy of publications, which facilitates decision-making based on robust evidence [13].

PRISMA offers a structure that acts as a set of guidelines for a more systematic and comprehensible development. The following are the relevant steps according to the PRISMA method:

- Incorporate documents relevant to the research.
- Eliminate duplicate documents.
- Conduct an eligibility analysis.

A. *Research questions*

- What Deep Learning techniques are commonly used in data automation?
- RQ2: What are the reported benefits of using Deep learning in various media?
- RQ3: In which sectors is Deep Learning applied?

B. *Search strategy*

The sequence used to search for articles addressing the subject of this research is shown in Fig. 1.

"deep learning" AND data AND management AND automation

Fig. 1 Search chain

After searching the databases using the search sequences described above, articles that met the research objectives were reviewed, as illustrated in Table I and Fig. 2, with the largest number found in ScienceDirect.

TABLE I
SEARCH STRATEGIES

Database	Strategy
Scopus	TITLE-ABS-KEY ("deep learning" AND data AND management AND automation) AND PUBYEAR > 2019 AND PUBYEAR < 2025 AND (LIMIT-TO (OA , "all")) AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "ENGI")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Deep Learning") OR LIMIT-TO (EXACTKEYWORD , "Automation") OR LIMIT-TO (EXACTKEYWORD , "Machine Learning")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re"))
ScienceDirect	qs="deep%20learning"%20AND%20data%20AND%20management%20AND%20automation&years=2020%2C2021%2C2022%2C2023%2C2024&articleTypes=REV%2CFLA&accessTypes=openaccess&subjectAreas=1700%2C2200&publicationTitles=280203%2C271304%2C777250%2C271521%2C779210&show=100&offset=400
Taylor & Francis Online	[All: "deep learning"] AND [All: data] AND [All: management] AND [All: automation] AND [All Subjects: Computer Science] AND [All Subjects: Engineering & Technology] AND [Article Type: Article] AND [in Journal: Applied Artificial Intelligence] AND [Publication Date: (01/01/2020 TO 12/31/2024)]
Web of Science	"deep learning" AND data AND management AND automation (All Fields) and Open Access and Review Article or Article (Document Types) and 2024 or 2023 or 2022 or 2021 or 2020 (Publication Years) and Automation Control Systems or Computer Science Information Systems or Computer Science Artificial Intelligence (Web of Science Categories)

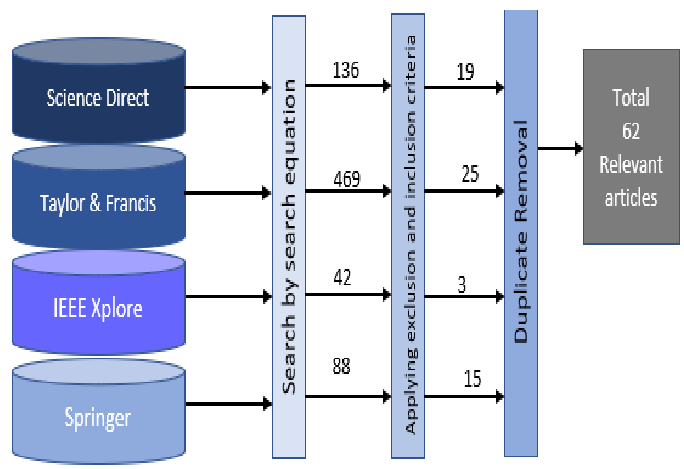

Fig. 2 Article inclusion matrix

C. *Inclusion and exclusion criteria*

For the systematic review study, the following inclusion and exclusion criteria were applied, as shown in Table II.

TABLE II
INCLUSION AND EXCLUSION

Inclusion Criteria	Exclusion Criteria
- Studies that address the use of DL and data automation in various fields.	- Studies that do not deal with DL or AI.
- Articles published in peer-reviewed journals between 2020	- Publications not peer-reviewed or published before 2020

and 2024	
- Papers available in English or Spanish that provide empirical data and detailed analysis on the benefits and challenges of DL.	- Articles in languages other than English and Spanish that do not provide data on AI branches.

D. Prism methodology

A total of 735 articles found in the databases related to the research topic were analyzed. Of these, 47 duplicate articles and those that did not contribute similar themes were discarded. Following the review, 283 articles were selected, excluding 221 that did not meet the exclusion criteria or did not contribute to the requested research. This resulted in 65 articles for the systematic review. Fig. 3 shows the selection process following the PRISMA methodology.

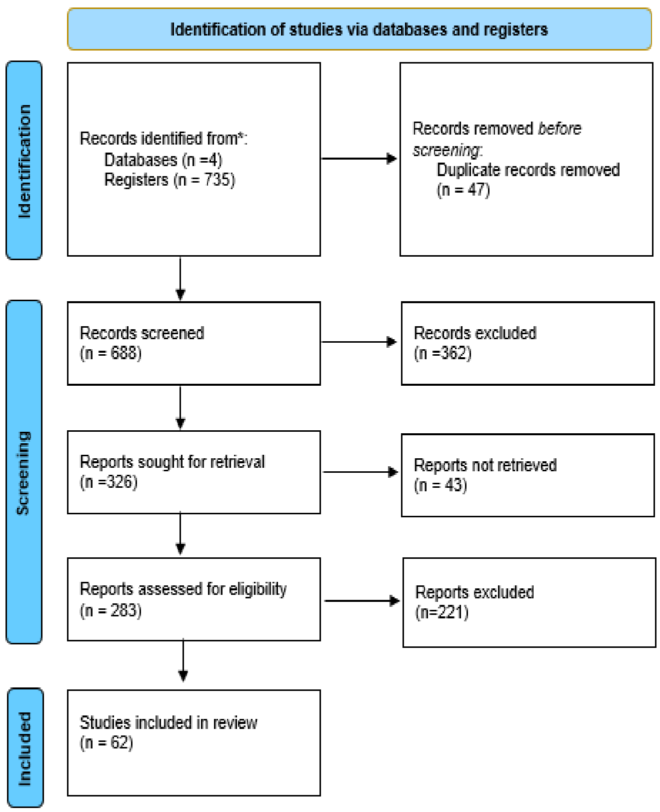

Fig. 3 Prism matrix

IV. RESULTS

Fig. 4 shows the distribution of articles by database in the systematic review. Scopus and ScienceDirect account for most publications, with 19 and 25 articles respectively, while Taylor & Francis Online and Web of Science contribute 3 and 15 articles. Together, Scopus and ScienceDirect comprise the largest number of articles reviewed, underlining their importance in DL and data automation research.

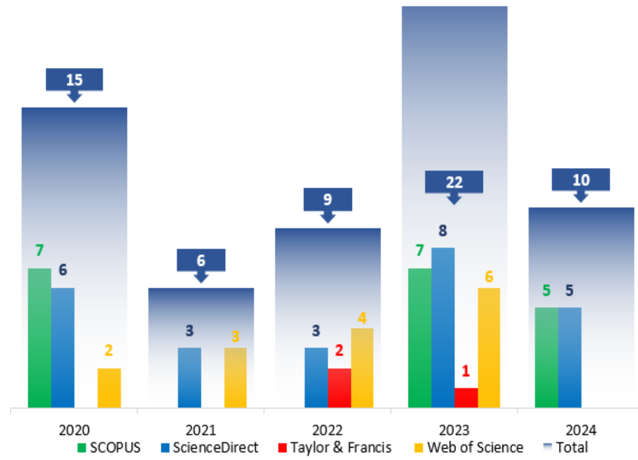

Fig. 4 Articles by year database

Fig. 5 shows the distribution of articles by country. Most publications come from Asia, North America and Europe, with India (12 articles), the United States (10 articles) and China (10 articles) as the largest contributors. This reflects the geographical diversity in Deep Learning and data automation research, highlighting its global relevance.

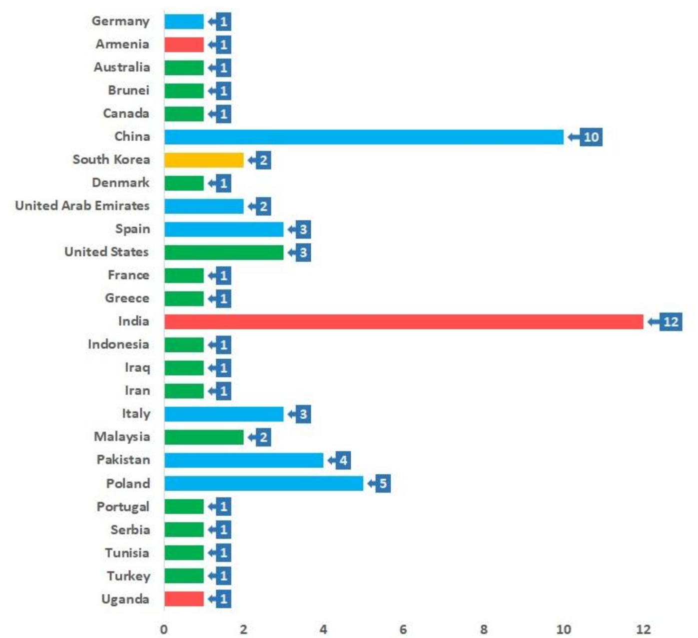

Fig. 5 Number of articles published by country

Fig. 6 shows the distribution of articles by continent. Asia leads with 38 publications, followed by Europe with 17 and the Americas with 4. Africa and Oceania are less well represented with 2 and 1 article respectively. This distribution highlights the high research activity in Asia and Europe in the field of DL and data automation, while other regions show opportunities for further development and collaboration.

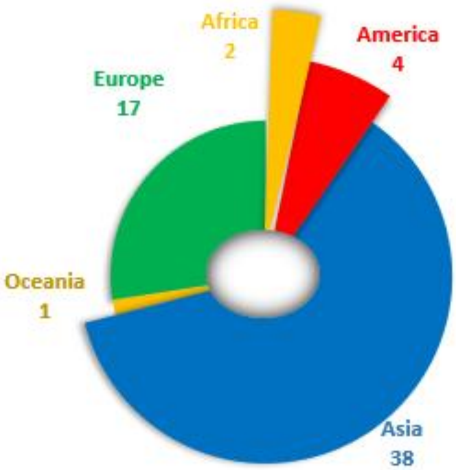

Fig. 6 Articles by continent

A. *Bibliometric analysis*

The bibliometric analysis was conducted using VOSviewer software to visualize relationships and trends in DL and data automation research. This approach provides a deeper understanding of collaborations between authors, institutions and countries, as well as the predominant thematic areas in this field.

Fig. 7 shows a network visualization of the bibliometric analysis, highlighting the connections between authors and keywords in deep learning and data automation research. The different colors represent different thematic groupings: blue, predominantly 'deep learning' and related to agricultural management and bankruptcy prediction; red, including 'machine learning' and 'artificial intelligence' associated with energy management and sentiment analysis; green, related to 'model prediction' and 'demand response'; yellow, focused on 'big data' and 'smart city'; orange, including 'classification' and 'accuracy' focused on object identification and activity recognition; and purple, addressing 'anomaly detection' and defect prediction.

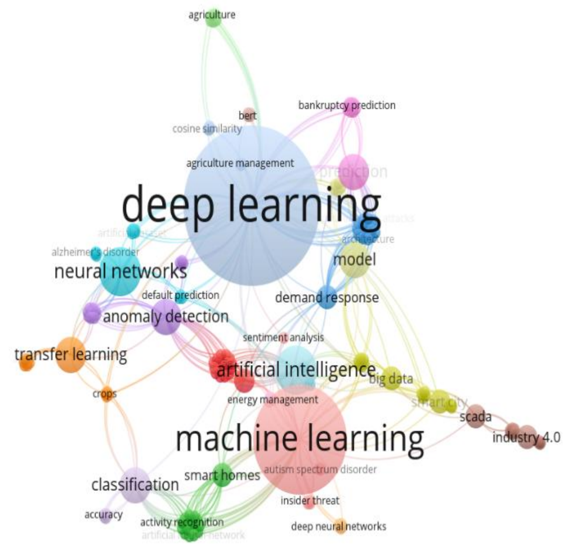

Fig. 7 Network visualization of bibliometric analysis

The word "data" is plural, not singular. In American English, periods and commas are within quotation marks, like "this period." A parenthetical statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.) A graph within a graph is an "inset," not an "insert." The word alternatively is preferred to the word "alternately" (unless you mean something that alternates). Do not use the word "essentially" to mean "approximately" or "effectively." Be aware of the different meanings of the homophones "affect" and "effect," "complement" and "compliment," "discreet" and "discrete," "principal" and "principle." Do not confuse "imply" and "infer." The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen. There is no period after the "et" in the Latin abbreviation "et al." The abbreviation "i.e." means "that is," and the abbreviation "e.g." means "for example." An excellent style manual for science writers is [8].

IV. DISCUSSION

A. *What Deep Learning techniques are commonly used in data automation?*

Data automation using DL techniques is a rapidly evolving field with significant applications in various industries. Table III shows that in the field of Predictive Modelling [14] highlight the importance of balancing accuracy and efficiency in the analysis of sentiment in texts, using a hybrid approach that combines linguistic rules with DL networks. This approach finds parallels in the study of [9], where an IoT system was developed to predict school dropout with an accuracy of 99.34%, demonstrating the effectiveness of predictive models in critical education applications. On the other hand, in the field of Convolutional Neural Networks (CNN) [15] present a three-dimensional localization method based on RFID, significantly improving the accuracy and stability of the system. This study is contrasted with the work of [12] which created an intelligent management system for sand factories using DL and edge computing, achieving 98% accuracy in automatic sand identification and optimizing operations compared to traditional management. In summary, these studies illustrate how Deep Learning techniques, through predictive models and CNNs, are revolutionizing data automation, improving efficiency and accuracy in various applications. The integration of advanced methodologies and continuous adaptation to the specific challenges of each sector are essential to maximize the potential of these emerging technologies.

TABLE III
TECHNIQUES USED IN DATA AUTOMATION

N	DL techniques	Manuscripts
1	Autoencoders	[16], [17]
2	Predictive Models	[4], [5], [14], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31]
3	Convolutional Neural Networks (CNN)	[15], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47]
4	Graph Neural Networks (GNN)	[48]
5	Deep Neural Networks (DNN)	[49], [50], [51], [52], [53], [54]
6	Recurrent Neural Networks (RNN)	[55]
7	Long Short-Term Memory (LSTM)	[56], [57], [58], [59], [60], [61]
8	Transformers	[62]
9	Deep Q-Networks (DQN)	[63], [64], [65]

B. *What are the reported benefits of using Deep Learning in various media?*

After analyzing the reported benefits of using DL in various environments, it is evident that high precision and accuracy and improved decision making are the most prominent categories, reflecting a significant trend in the current literature. Table IV shows that high precision and accuracy is fundamental in critical applications; for example, [63] achieved an accuracy of over 98% in complex pattern recognition, which is consistent with [8], who achieved between 98% and 99% in cyber-attack detection using a hybrid random deep neural network. This demonstrates the potential of DL to significantly improve performance on highly complex tasks. Improved decision-making is another key benefit [57] demonstrated that the implementation of DL in healthcare systems optimizes diagnostic efficiency, while [11] increased document management accuracy by up to 97% with an intelligent AI-based system. These findings suggest that DL not only increases accuracy, but also facilitates more informed and timely decisions. Other benefits, such as automation and efficiency [50], the ability to learn and adapt, fraud detection and scalability, although less mentioned, also contribute positively. In other words, DL adoption in various sectors is essential to address today's challenges, and its ability to improve accuracy and decision-making is particularly valuable in contexts where accuracy is critical.

TABLE IV
BENEFITS OF USING DL

N	Benefits of using DL	Manuscripts
1	High Precision and Accuracy	[63], [56], [15], [16], [32], [33], [34], [66], [17], [35], [36], [39], [40], [67], [14], [18], [68], [69], [21], [70], [51], [41], [59], [52], [43], [44], [45], [61]
2	Automation and Efficiency	[50], [22], [23], [28], [29], [60], [60], [65]
3	Learning and Adaptive Capability	[71], [24], [19], [25], [5], [55]
4	Fraud Detection	[49], [53]
5	Scalability	[31]
6	Improved Decision Making	[57], [37], [38], [58], [20], [64], [48], [4], [26], [27], [54], [46]

C. *In which sectors is Deep Learning applied?*

Examining the sectors in which DL is applied in Table V identifies technology, agriculture and healthcare as the most prominent areas, reflecting a significant trend in current research. In technology [15] implemented DLs to improve pattern recognition in complex systems, which is consistent with the work of [8] who used a hybrid random deep neural network to detect cyberattacks on the Industrial Internet of Things, achieving accuracies of 98-99%. The application of DL in this sector drives innovation and optimizes processes, strengthening the security and efficiency of systems. On the other hand, in agriculture [50] applied DL to predict crop yields, improving accuracy and facilitating decision making for farmers; this approach is aligned with the study by [12] where a smart management system for sand factories was developed using DL, achieving 98% accuracy and improving operational efficiency. The integration of DL in agriculture has the potential to revolutionize farming practices, promoting sustainability and increasing productivity. In the healthcare sector [16] used DL for early diagnosis of diseases, increasing the accuracy and speed of medical diagnoses; this is consistent with [10] who proposed a DL model to classify occlusions in dentinal tubules with an accuracy of 90.24%. As such, the application of DL in healthcare is crucial to improve patient care and optimize clinical outcomes. Furthermore, DL is also applied in sectors such as energy, finance, transportation, ecology and business, according to several studies, demonstrating its versatility and broad impact.

TABLE V
SECTORS WHERE THE DL WAS APPLIED

N	Sectors where DL is used	Manuscripts
1	Health	[16], [17], [18], [39], [43]
2	Education	[24], [44]
3	Technology	[5], [14], [15], [22], [26], [28], [31], [46], [62], [71], [72]
4	Energy	[29], [37], [56], [57], [60], [61], [63], [64]
5	Finance	[21], [30], [59]
6	Agriculture	[33], [34], [36], [41], [45], [47], [50], [51], [68]
7	Transport	[23], [55], [66], [67]
8	Ecology	[20], [32]
9	Business	[4], [27]

V. CONCLUSIONS

Data automation using techniques has proven to be a powerful tool in a variety of DL industries, providing significant improvements in accuracy, efficiency and decision making. This systematic review has identified and categorized the main techniques used, such as predictive modelling and convolutional neural networks, as well as the sectors where they have been successfully implemented, including technology, healthcare, agriculture and energy. The reported benefits range from high accuracy in classification and prediction to improved process management and automation. For example, in agriculture, yield and product quality have been improved through IoT and UAVs, while in healthcare, automatic image segmentation has improved diagnostic accuracy and therapeutic planning.

This study has some relevant limitations. First, the use of Deep Learning models, especially those based on transformer-type architectures, entails a high demand of computational resources and long training times, which may limit their implementation in environments with reduced technological capabilities. In addition, the quality and reliability of the results depend heavily on the availability of accurate, unbiased and large-volume data, which is not always feasible in all contexts.

For future research, it is recommended that the challenges of implementing Deep Learning in contexts with limited technological infrastructure, as is the case in various regions of the world, be explored in greater depth. It is crucial to explore strategies to reduce the digital divide and promote equitable access to these technologies, which would help democratize their benefits. It would also be relevant to study the social and economic implications of data automation, including its impact on the labor market, the reorganization of professional roles, equity in access to technological benefits, and the effects on organizational sustainability. A contextualized critique of these aspects would strengthen the ethical and social dimension of the use of Deep Learning in automation processes. Finally, it is suggested to investigate new directions and emerging applications of this technology, such as its integration with green technologies, edge computing, or its role in the creation of sustainable digital ecosystems. These approaches can not only boost efficiency but also offer innovative solutions to global challenges.

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