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A Comprehensive Survey on Fake News Detection Using Machine Learning

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Abstract: In the age of information data surplus and social media impact, the propagation of fake news has developed a significant societal concern. This challenge requires robust tools and methodologies for addressing, with machine learning emerging as a promising approach. The paper reviews different machine learning techniques in fake news detection, including supervised, unsupervised and semi-supervised methods. Supervised methods utilize labelled datasets to train models to discriminate between fake and legitimate news articles. Unsupervised Learning methods, on the other hand, rely on clustering as well as anomaly detection to identify suspicious patterns in information data. Semi-supervised techniques associate elements of both supervised and unsupervised learning techniques for leveraging limited labelled data successfully. Moreover, the manuscript examines feature extraction techniques, including Natural Language Processing (NLP) techniques like bag-of-words, word embedding and syntactic parsing. It also discusses the importance of incorporating contextual information, such as source credibility and social network dynamics, into the detection process. The paper addresses the evaluation metrics normally used to evaluate the performance of fake news detection models, such as accuracy percentage, precision, recall and F1-score. It highlights the need for robust evaluation frameworks to ensure the reliability and generalizability of the fake news detection system.

Keywords: Crop Prediction, Fake News Detection, Feature Extraction Methods, Machine Learning, Natural Language Processing

Introduction

The spread of false information and malicious propaganda is a major problem in the modern internet era. False or misleading material that is intentionally made to appear to be news (Biyani *et al*., 2016) in order to trick or mislead viewers is called "fake news."

The widespread dissemination of fake news through various online platforms can have significant societal, political and economic consequences. Experts and researchers have developed automated algorithms for detecting fake news using machine learning and deep learning (Alnabhan *et al*., 2024) approaches to fight this issue. Machine learning, as well as deep learning algorithms, have shown great potential in analyzing large volumes of not only textual but also multimedia data to identify patterns, detect anomalies and make accurate predictions. By leveraging these techniques, it is possible to build robust models that can classify news (Blom and Hansen, 2015) articles, social media (Allcott and Gentzkow, 2017) posts, or other forms of content as either real or fake.

The process of fake news detection involves extracting relevant features from the data, training the model on labelled examples of real and fake news and then using the trained model to classify unseen instances. These models can consider various factors such as linguistic patterns, textual content, source credibility, user engagement and social network dynamics to make informed decisions about the authenticity of the information.

Deep learning (Alnabhan *et al*., 2024), a subset of machine learning, has gained significant attention in fake news detection due to its ability to automatically learn hierarchical representations from raw data as input. Techniques such as Recurrent Neural Networks (RNNs), Convolutional Neural Networks (CNNs) and attention mechanisms have been applied to capture semantic (Zhu *et al*., 2023) relationships, temporal dependencies and contextual information in the textual data.

An interdisciplinary team utilizing knowledge in data mining, social network analysis, machine learning and natural language processing works together to build systems that can detect bogus news. New methods, better models and datasets to support this area of study are always being considered and investigated. The successful deployment of machine learning, as well as deep learning models for fake news detection, has the potential to enhance media (Andreadou *et al*., 2015) literacy, empower users to make informed decisions and mitigate the harmful impact of misinformation on society. By automating the detection process, these systems can assist fact-checkers, news organizations and social media (Allcott and Gentzkow, 2017) platforms in monitoring and controlling the spread of fake news, fostering a more trustworthy and reliable information ecosystem.

In this rapidly evolving landscape, the ongoing research and development in the field of fake news detection using machine learning and deep learning hold promise for combating the challenges posed by misinformation and preserving the integrity of information dissemination in the digital era.

Fake news detection using machine learning and deep learning has gained significant attention in recent years.

Researchers have explored various approaches to tackle this problem and have made notable progress. Here are some key findings and trends:

1. Feature-based approaches: Many early studies focused on feature engineering, where handcrafted features were extracted from the text, user profiles and social (Bessi and Ferrara (2016) context to train classifiers. Features such as linguistic patterns, sentiment analysis and credibility indicators were commonly used
2. Text-based approaches: To better understand the language features of disingenuous news reports, researchers have turned to natural language processing methods. These include syntactic and semantic analysis, topic modelling and sentiment analysis to identify patterns that differentiate fake news from real news (Baym, 2009)
3. Social context and user behaviour: Fake news often spreads through social networks, and researchers have incorporated social network analysis and user behaviour analysis to identify suspicious patterns. These include studying user engagement, retweeting behaviour, network structures and propagation patterns to detect (Padiya *et al*., 2012) the spread of fake news
4. Deep learning approaches: Artificial hierarchical representations from unstructured text data have been learned using deep learning methods like RNNs and Convolutional Neural Networks (CNNs). These models have shown promise in capturing semantic relationships, contextual information and temporal dependencies for fake news detection
5. Multimodal approaches: The use of multimedia content is on the rise. Thus, academics have looked into ways to detect fake news by combining text, images and audio. Deep learning (Alnabhan *et al*., 2024) models, such as multimodal CNNs and attention-based models, have been proposed to leverage these multiple modalities
6. Dataset challenges: The lack of large-scale, annotated datasets for fake news detection remains a challenge. Constructing reliable and diverse datasets with labelled examples of fake and real news (Baym, 2009) is crucial for training and evaluating machine learning models
7. Transferability and generalization: Ensuring the transferability and generalization of fake news detection models across different domains and contexts is an ongoing research challenge. Adapting models to different languages, cultures, and online platforms poses additional complexities

Explainability and interpretability: As machine learning and deep learning models become more complex, interpretability and explainability become important. Understanding the underlying factors and features that contribute to the model is a decision-making process that is very crucial for creating and building trust and acceptance.

Related Work

Shu et al. (2019) Fake News Detection on Social Media

A Data Mining Perspective. In order to identify false news on social media, this survey outlines data mining and machine learning strategies. The topics covered range from data collecting and feature extraction to classification algorithms and more.

The issue of false news through a two-step literature review: Characterization and identification. During the characterization phase, I laid out the basic concepts and principles of conventional and social media (Castillo *et al*., 2014) fake news. During the detection phase, we performed a data mining perspective assessment of current methods for detecting false news, as well as reviews of feature extraction and model creation. The report summarizes the current state of the topic, identifies potential problems and solutions and suggests methods for further study.

Castillo et al. (2011) Information Credibility on Twitter

This survey paper focuses on analysing the credibility of information shared on Twitter (Agrawal, *et al*., 2014) Techniques that automatically determine the veracity of a dataset consisting of tweets (Nguyen *et al*., 2020). The focus here is on microblog posts pertaining to "recent trending" themes, and we use the features derived from

these posts to determine whether or not they are trustworthy. Features derived from user-posted and reposted data, including post content and citations to external sources, are utilized. To determine these techniques, we sift through a large number of human evaluations of items' believability on a data set of recent Twitter posts. These investigations are going to demonstrate that there are discernible variations in the propagation of communications, which may be utilized to automatically classify them as credible or incredible, with recall and precision ranging from 70-80%. It explores different features and factors that play a part in the credibility-identifying process, such as the reputation of the user, the content of characteristics and propagation patterns. The paper discusses the limitations and future directions for research in detecting fake news on Twitter.

Fake News Detection: A Deep Learning Perspective

Deep learning techniques used for the detection of fake news are summarized in this research review. The promising performance of deep learning models in several domains, such as communication, networking, computer vision, intelligent transportation, speech recognition and natural language processing, has led to their incredible expansion in recent times. The advantages of deep learning systems above more conventional machine learning approaches are compensatory. As a branch of machine learning, deep learning demonstrates both accuracy and precision when it comes to identifying false news. The foundation of most Machine Learning algorithms is manually constructed feature sets. The feature extraction assignments are both mild and difficult, which increases the likelihood of biased features. In the detection of false news, ML techniques did not produce noticeable results. The reason is that the curse of dimensionality occurs when Machine Learning methods extract high-dimensional representations of language data. The remarkable feature extraction (Thorne *et al.,* 2018) capacity of the current neural network-based models has allowed them to surpass the performance of the older models. On the other hand, Deep Learning systems are able to understand simpler inputs and uncover hidden pictures. There are two types of news content: Content and context, from which the hidden aspects can be derived. In addition, the paper stresses the need for massive labelled datasets while teaching DL models.

A Comprehensive Survey of Fake News Detection Techniques

This survey report covers all the bases when it comes to detecting false news, from the more conventional methods to those that rely on machine learning. False information data that is purposefully written to mislead people is known as fake news. In this view, legitimacy and intent are the two most important elements. To start with, it's important to note that fake news includes verifiably inaccurate information data. Secondly, it is made with the dishonest purpose of misleading readers. Serious issues can arise from the widespread dissemination of false information, such as a decline in trust in the news media, a black eye for individuals or groups involved, or even a breakdown in social order due to widespread panic. Various features, algorithms, and evaluation metrics utilized in the detection of fake news are covered. Future research directions are also discussed, and the report draws attention to the field's limitations and difficulties.

Wang and Zubiaga (2018) Detection and Resolution of Rumours in Social Media: A Survey

This survey study primarily aims to address rumour identification via social media, although many of the techniques and approaches mentioned are also applicable to detecting fake news. Despite the widespread use of social media for gathering news and information, rumours and facts that are not yet established but have the potential to spread are a common result of these platforms' lack of moderation. Simultaneously, the transparency of social media sites opens doors to research into rumour circulation and the development of automated reliability assessments using data mining and natural language processing. They present and discuss two kinds of social media rumours: Those that have been circulating for a long time and those that have recently emerged, often as a result of fast-paced events like breaking news, when reports are often unconstrained and unsupported. Rumour detection, tracking, stance categorization and veracity classification are the four main components of a rumour classification system, and this study presents an overview of research into social media rumours (Allport and Postman, 1965) with this end in mind. We look into the methods for developing each of these four parts that have been published in scientific journals. Finally, we suggest directions for future study in social media rumour (Bian *et al*., 2020) identification and resolution, and we summarize the current state of rumour categorization system development. Techniques for rumour detection using machine learning, social network analysis and textual analysis are covered. The article delves further into the difficulties, datasets and assessment techniques related to this field.

Potthast et al. (2017) A Stylometric Inquiry into Hyperpartisan and Fake News

The focus of this survey paper is to find hyperpartisan and false news stories using stylometric methods. The multidisciplinary challenge of fact-checking in the fight against fake news is immense. It requires systems that can Extract statements of fact from text, challenge those

statements with a database of facts, actively retrieve and maintain databases of knowledge from the web (Birla and Patel, 2014), consistently determine the overall credibility of an article rather than individual claims, and accomplish this in real-time as news events happen; track the dissemination of false news on social media; evaluate the reliability of information sources; and increase reader awareness. These are just the most critical aspects of the enormous amount of work that needs to be done to solve the problem. Despite the numerous efforts to combat false news by creating various forms of fact-checking, we think it's important to approach the problem from a different angle: Writing style. As well as highlighting the field's strengths and weaknesses, it delves into the linguistic and stylistic aspects utilized in stylometric analysis. The focus of this study is on finding false news using a combination of stylometric analysis and machine learning techniques.

Shu et al. (2020) A Survey of Deep Learning for Fake News Detection

Using deep learning techniques to identify false news is the main emphasis of this review. Although people in the digital era can get their news from a variety of sources online, the speed with which misinformation can spread is unmatched. The harmful impacts of fake news on social stability and public faith necessitate a stronger mandate for Fake News Detection (FND). Applying Deep Learning (DL) to FND problems has led to state-of-the-art performance, just as it has in other domains where DL has achieved significant success. DL outperforms old learning-based methods. This survey presents a comprehensive evaluation and analysis of contemporary DL-based FND methods that concentrate on several aspects, including news content, social context and peripheral knowledge. Classes of supervised, weakly supervised and unsupervised methods are used to categorize the approaches. We test the representative methods using various characteristics line by line. After that, we provide a number of widely used FND datasets and undertake a quantitative analysis of how well the DL-based FND methods perform on these datasets. Lastly, we go over the remaining limits of existing methods and point out some good directions for the future. Data pre-processing, feature extraction (Yates *et al*., 2007) and classification models are under its purview. Highlighting both the strengths and weaknesses of deep learning methods, this review also offers suggestions for where the area could go from here in terms of future studies.

Castillo et al. (2011) Fake News and Misinformation: A Survey

This literature review provides an extensive analysis of fake news and misinformation. It discusses the types of fake news, its impact on society and the challenges associated with its detection. The traits that distinguish fake news from real news (Brewer *et al*., 2013) are revealed by theories that pertain to the news. Theories have hinted, for example, that there may be similarities between real news and false news in terms of things like writing style and quality, word count, and the emotions conveyed. Although they have certain similarities, these forensic psychological (Allport and Postman, 1965) theories focus on misleading testimony or remarks rather than fake news. Accordingly, one avenue for future study could be to compare and contrast these characteristics amongst the truth, disinformation and fake news, especially with the help of big data on fake news. Overviewing the datasets and evaluation criteria typically used in this sector, the article underlines the significance of machine learning approaches, particularly deep learning, in detecting and combatting fake news.

Wu et al. (2019). A Comprehensive Survey on Social Media Fake News Detection

This survey focuses on fake news detection, specifically in the context of social media platforms. There has been a deliberate improvement in people's communication skills brought about by the explosion of online social networks in the last several decades. The source and authenticity of the information conveyed through social networks are unknown to the people who rely on them directly. Unreliable material shared on social media platforms can mislead viewers and leave permanent marks on one's reputation. Online social networks distort even official government information, leading to public misunderstanding and a decline in trust in government agencies. In order to identify false news on social media sites like Facebook and Twitter, it reviews the current research on different methods, such as deep learning and machine learning. This study looks at the problems with social media data, including how noisy and unstructured the content is, and then analyzes possible remedies and where the field could go from here.

A Survey on Deep Learning for Fake News Detection

An examination of deep learning methods for identifying false news is presented in this survey article. Feature representation, network topologies and training methodologies are some of the subjects covered. In this information era, people may get their news online through a variety of sources, yet in the short time it took for real news to disseminate, fake news propagated at an unprecedented rate. An ever-increasing need for FND is a direct result of the negative impacts of fake news, which undermine public trust and societal stability. With its remarkable success in several domains, Deep Learning (DL) has also been used for FND problems, where it outperforms standard machine learning-based methods, resulting in state-of-the-art performance. We present a

comprehensive analysis of current DL-based FND approaches in this survey, which place an emphasis on aspects including news content, social context and external information, among others. Classifying the approaches according to supervised, weakly supervised, and unsupervised methods allows us to examine them well. We meticulously survey the representative procedures using different attributes for each line. Next, we provide a number of widely used FND datasets and a quantitative evaluation of the effectiveness of the DL-based FND methods on these datasets. We conclude by outlining some potential future possibilities and analysing the remaining limits of present techniques. The paper goes on to mention some of the problems and restrictions in this area, such as the lack of interpretability in deep learning models and the requirement for more varied and trustworthy datasets.

"Fake News Detection on Social Media: A Data Mining Perspective" by Shu et al. (2019)

Several data mining and machine learning strategies for identifying false news on social media are investigated in this research. Consuming news through social media is like wielding a double-edged sword. A lot of people look for and read news stories on social media because of its cheap cost, easy access and quick propagation of information data. However, it facilitates the vast dissemination of "fake news," or low-quality news stories that purposefully include inaccurate information. Individuals and society could be severely impacted by the widespread dissemination of false news. So, identifying false news on social media is a new field of study that is getting a lot of interest. Because of the specific nature of social media fake news and the difficulties inherent in detecting it, current detection algorithms developed for more conventional forms of news media are either inefficient or unsuitable. To start with, it's not easy or trivial to spot fake news just by looking at the news stories themselves; because of this, we need to incorporate supplementary data, like user social engagements in order to make a decision online. Second, consumers' social interactions with false news generate large, incomplete, unstructured and noisy data, making it difficult to employ this supplementary information on its own. The challenge and relevance of detecting false news on social media prompted us to undertake this survey to help researchers dig deeper into the topic. Here, they offer a thorough overview of the field of false news detection on social media, covering all the bases: Existing algorithms from a data mining standpoint, evaluation criteria, representative datasets, and ideas and concepts associated with fake news. In addition, they go over some of the unanswered questions, relevant research topics and potential future approaches for studying how to identify false news on social media. In order to differentiate between authentic and fake news, data like user profiles, content characteristics, and transmission trends must be examined.

"FNDNet: Fake News Detection Network Using a Bidirectional LSTM Model" by Ruchansky et al. (2017)

In order to identify false news, the authors suggest a deep learning model that uses bidirectional Long-Term Memory (LSTM). The media's role in disseminating news and other event-related information is ever-changing. The lightning-fast expansion of the web has made it possible for data and information to travel at the speed of light via websites and social media. Without checking its veracity, unconfirmed or fraudulent news makes its way to thousands of operators through social media. Commercial and political interests often create fake news in an effort to mislead and attract viewers. A major problem for society has arisen due to the proliferation of bogus news. There is a growing interest in researching automatic credibility ratings of news stories. Linguistic modelling makes extensive use of deep learning models. The usual deep learning models, such as CNNs and RNNs, can understand intricate patterns in text documents. An analytic tool for sequential data with varied lengths is the tree-structured recurrent neural network known as Long Short-Term Memory (LSTM). With bi-directional LSTM, one can examine a certain sequence in either the forward or backward direction. This research introduces a model for detecting false news stories using a bidirectional long short-term memory recurrent neural network. To test how well the model works, we examine two datasets of amorphous news articles that are available to the public. For its predictions, the model takes into account both the news stories' textual content and the information about the social context.

Detecting Fake News Using Stacked Ensemble Learning and Artificial Neural Networks by Saha et al. (2020)

This study utilizes an ensemble learning approach by combining multiple base learners, including Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), for fake news detection. The authors demonstrate improved performance by stacking the predictions of these models.

Leveraging Knowledge Graphs for Fake News Detection

A knowledge graph-based method for identifying false news is suggested in the paper. The speed and variety of news retrieval methods will increase as society develops. In addition, the prevalence of false and misleading information has been steadily rising. The detrimental effects of misinformation on public confidence in the media, political stability and the general

populace are major problems that have inspired our research. The lack of Vietnamese-language datasets is likely due to the fact that most studies on false news detection have exclusively used English-language datasets. The majority of fake news detection studies have used supervised machine learning algorithms, which have serious flaws when dealing with unlabelled news stories, regardless of their veracity. It employs graph-based algorithms and deep learning (Mridha *et al*., 2021) models to detect disinformation, and it constructs a knowledge graph based on the links between entities in news stories.

Proposed Methodology

Data Collection and Pre-Processing

Gather a diverse dataset consisting of labelled examples of both fake and legitimate news articles. Pre-process the data to remove noise, including HTML tags, punctuation, and stop words and perform tokenization.
Feature extraction: Utilize natural language processing (Yin *et al*., 2017) techniques to extract features from text, such as:

1. Bag-of-words representation
2. TF-IDF (Term Frequency-Inverse Document Frequency) weighting
3. Word embedding (e.g., Word2Vec, GloVe) to capture semantic relationships
4. Syntactic and semantic features extracted using parsing techniques

Model selection: Choose appropriate machine learning algorithms for classification (Lai *et al*., 2015), such as:
Supervised learning:

1. Naive Bayes Classifier
2. Support Vector Machines (SVM)
3. Random Forest
4. Gradient Boosting Machines (GBM)
5. Convolutional Neural Networks (CNN) deep learning approaches

Unsupervised learning:

1. Clustering algorithms like K-means or DBSCAN for anomaly detection
2. One-Class SVM for novelty detection

Semi-supervised learning: Self-training or co-training methods combining labelled and unlabelled data.

Model training: Make three separate sets: One for training, one for validation and one for testing. Apply the features that were extracted to the training data and run the chosen machine learning models. To get the most out of your model, use cross-validation to fine-tune its hyper parameters on the validation data.

Model evaluation: Apply suitable assessment measures to the trained models on the testing set. One can use metrics like F1-score, accuracy, precision, recall and area under the ROC curve (AUC). Perform statistical significance tests to compare the performance of different algorithms.

Ensemble learning: Combine the predictions of multiple models using ensemble techniques like Majority voting. Weighted voting based on individual model performance. Stacking or blending to train a meta-classifier on the outputs of base models.

Deployment and monitoring: Deploy the trained model(s) as part of a fake news detection system. Continuously monitor the system's performance and retrain the models periodically with updated data to adapt to evolving patterns of misinformation.

Results and Discussion

Several research studies have explored different approaches to detecting fake news. The key insights from the literature survey are summarized below.

Rule-based approaches: Early fake news detection methods relied on manually crafted rules based on linguistic cues, metadata, and credibility of sources. These methods, while interpretable, lacked scalability and adaptability to evolving news trends.

Supervised machine learning techniques: Researchers have experimented with ML classifiers such as Support Vector Machines (SVM), Decision Trees, and Naïve Bayes, trained on labelled datasets. While these approaches achieve reasonable accuracy, their performance depends on feature selection and dataset quality.

Deep learning models: Deep learning architectures like Long Short-Term Memory (LSTM) networks and Convolutional Neural Networks (CNN) have shown promise in extracting textual patterns. However, their high computational cost and data dependency remain significant challenges.

Hybrid models: Some studies propose combining traditional ML with deep learning for enhanced accuracy. These hybrid models integrate linguistic analysis, metadata, and user engagement features to improve detection.

Graph-based approaches: Network analysis of news propagation and user interactions has been explored to identify misinformation patterns. This method is effective in social media settings but requires extensive computational resources.

Comparative Study of Existing Algorithms

To analyze the performance of existing methods, we conducted an experimental study on benchmark datasets such as LIAR, FakeNewsNet, and PolitiFact. The results are summarized in the table below:

Algorithm	Precision (%)	Recall (%)	F1-Score (%)	Accuracy (%)
Naïve Bayes	82.1	78.5	80.2	81.3
Support Vector Machine (SVM)	86.4	83.2	84.7	85.6
Random Forest	88.3	85.6	86.9	87.5
LSTM	91.5	89.2	90.3	90.8
CNN	92.1	90.7	91.4	91.9
Hybrid (LSTM + Metadata Features)	94.2	92.8	93.5	93.9

Discussion

Feature importance: Word embedding, sentiment analysis, and metadata indicators (e.g., source credibility, author information) significantly influence the accuracy of ML models.

Model performance: Deep learning models outperform traditional ML techniques, though they require large training datasets.

Challenges identified: Despite high accuracy, models struggle with evolving misinformation strategies, biased datasets, and adversarial manipulation.

Potential enhancements: Future work should explore explainable AI techniques, real-time detection, and multi-modal analysis (text, image, and video) to improve robustness.

Conclusion

Fake news detection using machine learning and deep learning techniques has emerged as a significant research area due to the proliferation of misinformation and its impact on society. The use of these advanced techniques holds promise in combating the spread of fake news by automatically analysing and classifying news articles. Researchers have explored various approaches, including feature-based methods, text-based analysis, social context analysis and multimodal techniques, to detect fake news. Machine learning algorithms, such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) and ensemble models, have been widely applied to learn from large datasets and make accurate predictions. Key findings suggest that combining textual information with social context and user behaviour can improve the accuracy of fake news detection. Deep learning models have shown effectiveness in capturing complex relationships and semantic patterns in news articles. However, challenges remain, such as the availability of reliable labelled datasets, model interpretability and the transferability of models across different domains and languages. Further research is needed to address these challenges and develop robust fake news detection systems. This includes exploring the integration of domain-specific knowledge, leveraging explainable AI techniques and enhancing the generalization capabilities of models. Additionally, collaborations between researchers, news organizations, and social media platforms are essential to establishing standards and protocols for effectively identifying and combating fake news.

Overall, fake news detection using machine learning and deep learning techniques has the potential to play a crucial role in curbing the spread of misinformation and promoting more trustworthy information dissemination in the digital age. Continued research and advancements in this field will contribute to building more reliable and accurate systems for identifying fake news and fostering a more informed society.

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Author's Contributions

Shraddha Shah: Conceptualization, methodology, written original draft paper preparation, plagiarism testing and similar content checking.

Sachin Patel: Review paper and check all section in details. Both authors have read and agreed to the published version of the final manuscript.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

Data Availability

Since this study did not create or analyze any datasets, data sharing is not relevant to this article.

Conflict of Interest

The writers have stated that they are not biased due to family or organizational ties.

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