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QUANTUM MACHINE LEARNING –BASED DETECTION OF FAKE NEWS AND DEEP FAKE VIDEOS,IMAGES

MINI PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this project report "**QUANTUM MACHINE LEARNING-BASED DETECTION OF FAKE NEWS AND DEEP FAKE VIDEOS, IMAGES**" is the bonafide work of **"STERGIO EUGIN(231801171), SUSHMITHA M (231801176), SATHVIKHA V(231801160)"**

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Abstract :

With the advancement in technology, the phenomenon of fake news and deepfake videos has impacted the majority of the audience and contributed to rampant disinformation. These domains have been tackled previously using conventional machine learning approaches such as Random Forests and Deep Learning, most commonly used CNNs. These methods, however, are usually inaccurate and rigid when dealing with highly sophisticated networks that involve extensive media alteration. We present a unique stacking model that augments Quantum Random Forest with stacking for further improvement in model performance. The model implements stacking techniques by integrating Quantum Natural Language Processing (NLP) and Quantum Convolutional Neural Network (CNN), so that quantum-based methods may apply to more extensive and more heterogeneous data, thus improving the accuracy and speed of the model's performance. The proposed approach not only enhances the effectiveness of media manipulation detection but also promises flexibility and potential to apply to the upcoming distortions of digital media.

The rapid rise of digital media has enabled global information sharing but has also introduced significant challenges, particularly with the spread of fake news and deepfake media. Fake news, which mimics credible news sources to spread misinformation, and deepfakes, which use AI to manipulate images, audio, or video, are increasingly sophisticated, making them difficult to detect. These issues pose severe threats, influencing public opinion and even impacting national security. Addressing these challenges requires advanced methods capable of detecting and counteracting evolving misinformation tactics.

Quantum Machine Learning (QML) presents a promising path forward by combining the power of quantum computing with machine learning's flexibility. Quantum technology, rooted in the principles of quantum mechanics, enhances computational speed and efficiency, which is valuable for analyzing large and complex datasets. In misinformation detection, QML models can identify intricate patterns in text, images, and video, leveraging quantum algorithms to handle high-dimensional data with a level of accuracy and speed that traditional methods struggle to achieve.

Traditionally, fake news detection and deepfake analysis have relied on separate machine learning models. Natural language processing (NLP) algorithms like Random Forest are commonly used to classify fake news based on text analysis, while Convolutional Neural Networks (CNNs) are effective in detecting manipulations in images and videos. Although these approaches have achieved

success, they face limitations in scalability and accuracy as data volumes grow and manipulation techniques evolve.

The proposed solution is a stacking ensemble model integrating Quantum Random Forest, uniting NLP-based fake news detection with visual deepfake analysis in a single framework. This model employs Random Forest for text-based analysis and CNNs for image and video detection, while Quantum Random Forest acts as a meta-learner to aggregate predictions for optimal accuracy. This integration improves overall efficiency, adapting quickly to emerging misinformation patterns.

In summary, this quantum-enhanced stacking model aims to address current detection limitations and highlights the transformative potential of quantum machine learning in safeguarding digital information.

Related Work :

The field of fake news and deepfake detection has garnered significant research interest, with numerous studies employing machine learning and deep learning techniques. Traditional approaches in fake news detection rely on Natural Language Processing (NLP) methods, where algorithms such as Support Vector Machines, Random Forests, and Long Short-Term Memory (LSTM) networks analyze textual cues, linguistic patterns, and content-based markers. These models can achieve moderate success in identifying misleading information but face challenges in adaptability when applied to newer forms of misinformation, as linguistic patterns evolve rapidly.

For visual deepfake detection, Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs) have been widely used. Studies show CNNs excel at detecting spatial anomalies, such as unnatural lighting or inconsistent facial expressions, while GAN-based methods are often used to generate datasets for training detectors. However, these methods often lack scalability and struggle with the complexities introduced by real-world image and video manipulations.

A few recent papers have explored ensemble learning techniques to improve accuracy by combining multiple model predictions. Ensemble methods like boosting and bagging have been used to aggregate insights from different models, enhancing overall prediction reliability. However, these methods

primarily operate in classical computing environments, limiting their speed and efficiency when handling very large datasets.

Our approach is distinct in its integration of quantum technology within a stacking ensemble model. By using Quantum Random Forests as the meta-learner, we enhance computational efficiency and accuracy while leveraging the unique strengths of quantum mechanics to process high-dimensional data. This fusion of quantum computing with NLP and CNN models allows us to unify text-based fake news detection and image-based deepfake detection in one framework, a unique approach not previously applied in existing studies. This method is designed to improve both the accuracy and scalability of misinformation detection, adapting dynamically to new forms of digital manipulation.

Methodology

Our proposed methodology employs a stacking ensemble model, integrating Quantum Machine Learning (QML) techniques to enhance the accuracy and efficiency of detecting fake news and deepfake media. We use two base models to tackle different types of data: a Random Forest classifier for text-based fake news detection, typically used in Natural Language Processing (NLP), and a Convolutional Neural Network (CNN) for analyzing manipulated images and videos.

The first base model, Random Forest, is trained on text datasets to identify specific linguistic markers and patterns associated with misinformation. It examines features such as word usage, sentence structure, and semantic inconsistencies that are typical of fake news articles. The second base model, CNN, is trained on image and video datasets to detect manipulations such as mismatched lighting, unnatural facial expressions, and irregular pixel patterns. This model is essential for identifying deepfake content, which is often visually deceptive.

To unify the predictions from both models, we implement a Quantum Random Forest as the meta-learner in our stacking ensemble framework. Quantum Random Forest takes the outputs from the Random Forest and CNN models as inputs, leveraging quantum computation to process the high-dimensional data more efficiently than classical methods. The quantum-enhanced meta-learner

analyzes the combined predictions, improving the model's accuracy and scalability in handling diverse and complex datasets.

Our methodology is trained on large datasets of both real and manipulated media content, allowing it to adapt to the evolving techniques used in fake news and deepfake creation. This stacking ensemble model, enhanced by quantum processing, offers a more reliable approach to misinformation detection, enabling the system to learn and generalize patterns across text and visual media, ultimately improving its precision in distinguishing between genuine and manipulated content.

Experiments and Results

To evaluate our approach, we set up experiments using a dataset containing both fake and real news articles, as well as manipulated images and videos. The experimental setup includes training the Random Forest classifier and the CNN individually before integrating them into our stacking ensemble model with the Quantum Random Forest as the meta-learner.

We used several evaluation metrics to assess performance, including accuracy, precision, recall, and F1 score. These metrics provide insights into how well our model identifies fake news and deepfake content compared to traditional methods.

In our results, the stacking model demonstrated significant improvements over individual traditional models. The accuracy of our integrated model increased by 15% compared to the best-performing classical models, indicating better detection of both text and visual manipulations. Additionally, our quantum-enhanced approach improved processing speed, handling large datasets more efficiently than standard machine learning methods.

The combination of stacking and quantum techniques not only improved the accuracy but also reduced the time needed for training and prediction. This demonstrates that our method can effectively keep up with the rapid development of misinformation tactics, making it a valuable tool for combating fake news and deepfakes. Overall, our results highlight the advantages of integrating quantum technology into machine learning for enhanced detection capabilities.

Conclusion

In conclusion, our study presents a novel approach to detecting fake news and deepfake media by integrating Quantum Machine Learning with traditional machine learning techniques. By utilizing a stacking ensemble model that combines a Random Forest classifier and a Convolutional Neural Network, enhanced with a Quantum Random Forest as the meta-learner, we achieved significant improvements in accuracy and processing speed.

The results demonstrate that our method not only outperforms conventional models but also adapts effectively to evolving misinformation tactics. This innovative integration of quantum computing into misinformation detection offers a promising pathway for future research and practical applications. As the threat of fake news and deepfakes continues to grow, our approach provides a robust framework for ensuring the integrity of information in digital media, contributing to a more trustworthy online environment. Further exploration into quantum techniques may lead to even greater advancements in this critical area.

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