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Information Veracity Detection with CNN and BERTScore

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Abstract

The spread of fake news and deceptive online content on social networks and other platforms pose a significant issue for end-users trying to find reliable information. This research project, "VeriTrue - Verifying the Veracity of Online Information with Cross-Encoders and BERTScore", aims to build a system to detect the veracity of online information. It has a twofold approach to enhance verification: text and image analysis. The text is verified using methods such as BERTScore and Cross-Encoders to analyse the content and its meaning, while images are verified using deep learning algorithms such as CNNs (convolution neural network) and EfficientNet-B0 to check for manipulated or misleading images. Data is preprocessed, including text cleaning, text normalization, feature extraction and image resizing. The proposed system uses a combination of text and image analysis to provide a veracity score and label the information as genuine or manipulated. Various steps like data preprocessing, feature extraction, semantic analysis, and classification are performed for reliable verification. The system is tested using the datasets of LIAR and LIAR-PLUS and verification metrics such as accuracy, precision, recall, and F1-score. It's been found that the text and image analysis improves false news detection and can be used to more accurately verify digital content.

Keywords:
Fake News Detection, Information Veracity Detection, Cross-Encoders, BERTScore, Deep Learning, Multimodal Analysis, Natural Language Processing, CNN, EfficientNet-B0, Semantic Similarity, Image Verification, Misinformation Detection, Artificial Intelligence, Fake Image Detection, Veracity Classification

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1.Introduction

With the growing use of social media and online platforms, the prevalence of fake news, misinformation and manipulation has risen. Misinformation can shape public sentiment and cause confusion, and it can decrease trust in the online media. Existing approaches to fake news detection primarily focus on natural language processing and are not capable of verification of multimodal information. So, it is important to have smart systems to verify information by analysing text and visual data.

This project aims to develop "VeriTrue - Cross-Encoder and BERTScore Text Veracity Detection" which is a multimodal fake news detection system for information verification using artificial intelligence and deep learning approaches. The system incorporates models like BERTScore and Cross-Encoders for text scoring and deep learning models like CNNs and EfficientNet-B0 for image verification to obtain better predictions of fake news.

Research Objectives and Methodology

The purpose of this research is to build a multimodal information veracity detection system to detect fake and real information. The research aims:

1. To detect lies or misinformation in text and image modalities.
2. To create fake news detection algorithms with **BERTScore, Cross-Encoders** and deep learning.
3. To enhance accuracy through multimodal searching.
4. To compute veracity scores and detect fakeness.

The system involves text processing, text semantics analysis, image feature extraction, feature mapping, and veracity determination. Benchmark datasets and the accuracy, precision, recall and F1 score are used to test the system.

2. Literature Survey

There has been some work on using machine learning and deep learning for fake news detection. Initial efforts primarily relied on textual analysis with conventional machine learning and natural language processing approaches to detect fake news. As advanced machine learning models like BERT emerged, researchers improved the understanding of semantics and context analysis for improved accuracy in fake news detection.In recent years, researchers used deep-learning models like CNNs and transformer models to detect fake images and multimedia content. Scientists also proposed datasets and approaches to detect fake images and deepfake videos based on visual

feature extraction methods. These methods achieved higher accuracy in detecting manipulated multimedia content than conventional methods.To achieve better detection results, recent studies have shifted towards multimodal fake news detection systems using both text and images. The use of models like Cross-Encoders, BERTScore and deep learning approaches to image verification have improved fake content detection performance. The proposed VeriTrue system adopted semantic textual analysis and image verification to enable reliable information veracity.

3. Methodology

The VeriTrue system is based on a multimodal approach for fake and real content identification. The system accepts text and image inputs from the user and applies preprocessing methods such as text cleaning and normalisation, and image resizing. Text analysis is done using the similarities and similarities in content using BERTScore and Cross-Encoder models, and image analysis is done for feature extraction and authenticity determination using CNNs and EfficientNet-B0 model. The features are then fed into a multimodal fusion layer and the system produces a veracity score to determine whether content is fake or real. The system's effectiveness is tested on standard datasets with metrics such as accuracy, precision, recall and F1-score.

4. Experimental Setup and Implementation

We implemented the experimental design for the proposed VeriTrue system using Python and deep learning frameworks such as Tensor Flow, PyTorch, OpenCV and scikit-learn. The implementation process includes the following steps:

1. **Data Collection:** Download texts and visual data sets like LIAR, LIAR-PLUS and fake image data.
2. **Data Preprocessing:** Clean and tokenize text, normalize text and images, extract text features.
3. **Feature Extraction:** Use BERTScore and Cross-Encoder models for obtaining semantic features, and CNNs and EfficientNet-B0 for visual features.
4. **Training and Classifying:** Detect fake or real news items and predict the veracity score of news articles.
5. **Multimodal Fusion:** Integrate text and image data for enhanced classification.
6. **Evaluation:** Test the system's performance using accuracy, precision, recall and F1-score.

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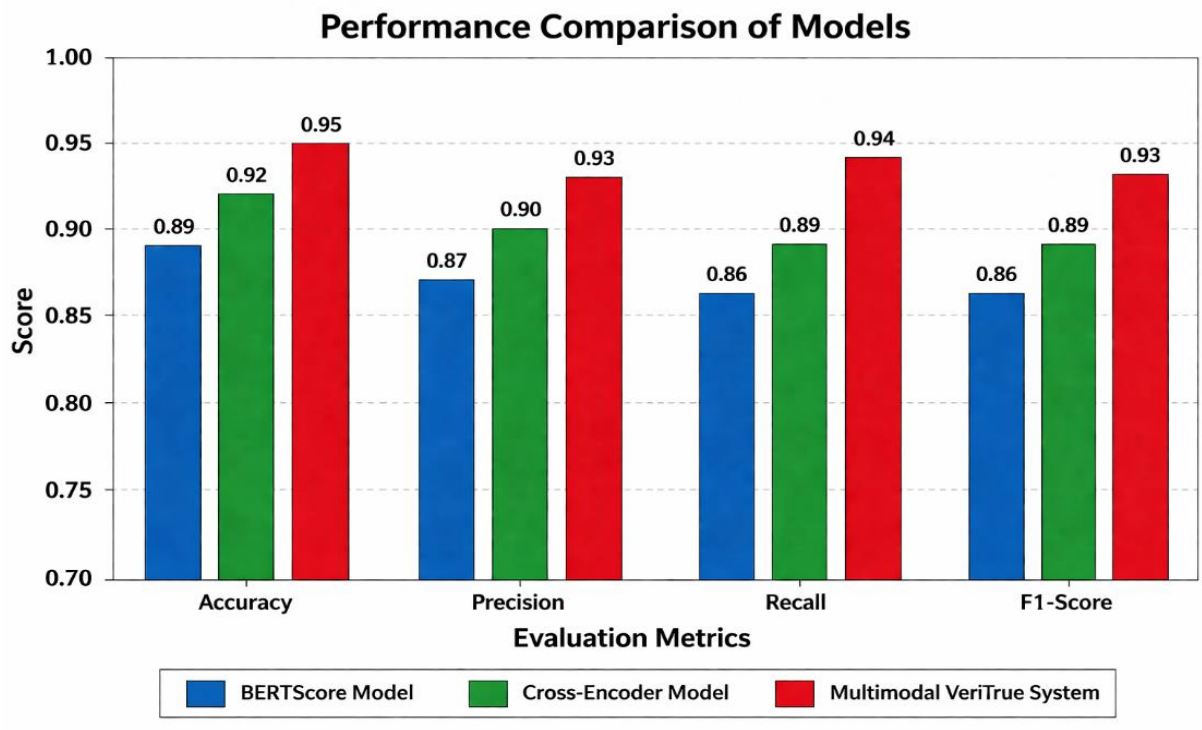
5. Result Analysis

Our analytics on the results show a comparison of the different models used in our VeriTrue system for identifying fake vs genuine media content. The metrics are accuracy, precision, recall and F1-score. The test results demonstrate that the use of textual semantic analysis and visual verification results in better performance for misinformation detection than using either approach alone. The experiments have shown that the proposed multimodal VeriTrue system performance than other text-based models alone, which involved semantic analysis and image verification. The architecture has been depicted in Fig 1.

Table 1. Performance Metrics

Model	Accuracy	Precision	Recall	F1-Score
BERTScore Model	0.89	0.87	0.86	0.86
Cross-Encoder Model	0.92	0.90	0.89	0.89
Multimodal VeriTrue System	0.95	0.93	0.94	0.93

Fig1. Performace Analysis



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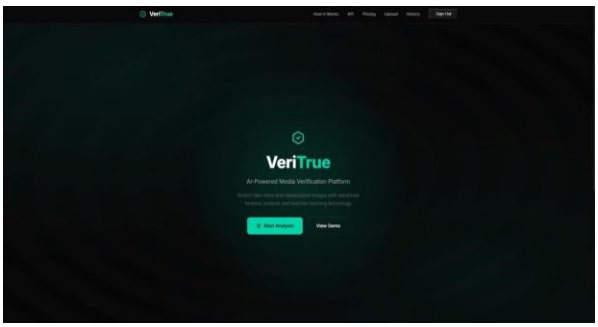

Fig2. Home Screen

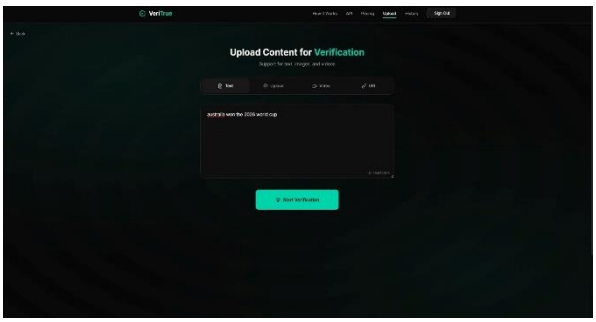

Fig3. Text Uploading

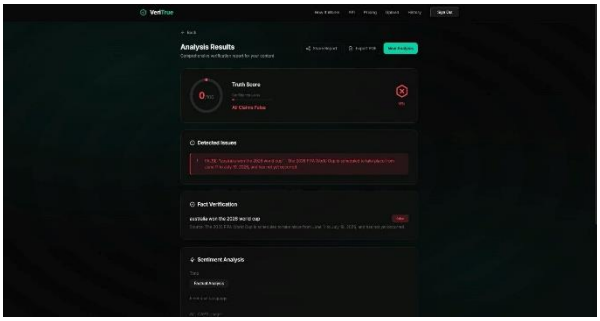

Fig4. Content Detected False

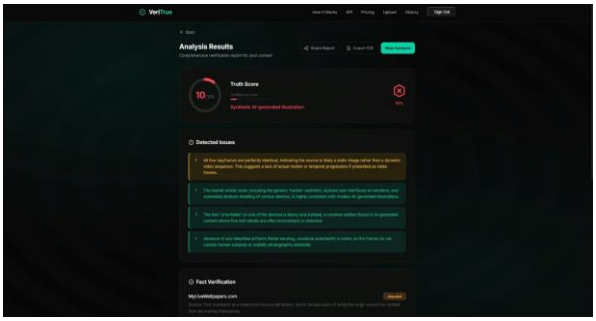

Fig5. Explanation

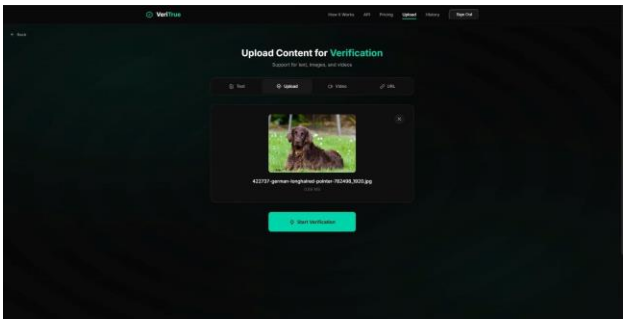

Fig6. How Content is Uploaded

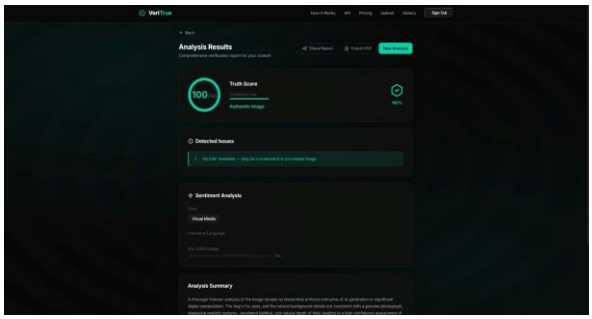

Fig7. Content Detected True

Conclusion

This project showcased "VeriTrue - Veracity of Information using Cross-Encoders and BERTScore", a multimodal fake news detector that aims to determine if a piece of information is fake or not. This approach integrates semantic analysis of text using BERTScore and Cross-

Encoders with deep learning-based image verification to enhance fake news detection. The integration of text and image analysis in the system offers accurate veracity scores and good classification outcomes for the verification of digital content. Experiments show that the multimodal system outperforms single-modal detection methods. The system's performance was enhanced by employing state-of-the-art deep learning and natural language processing approaches, allowing for better detection of misinformation and manipulation. This “work -underscore” the benefits of multimodal analysis for fake news detection and sets the stage for future developments in real-time verification systems, increased training data and powerful transformer models.

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