Early Forest Fire Detection Using CNN

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Introduction

- Forest fires cause significant environmental and economic damage.
- Early detection is crucial to minimize these impacts.
- This project utilizes Convolutional Neural Networks (CNNs) and YOLO (You Only Look Once) for early fire detection.

Problem Statement

Forest fires can spread rapidly, causing widespread damage.Traditional methods of fire detection are often slow and inefficient.The goal is to develop a fast and accurate system for early detection of forest fires using advanced machine learning techniques.

Data Collection

D-Fire: an image dataset for fire and smoke detection
Authors: Researchers from Gaia, solutions on demand (GAIA)

About
D-Fire is an image dataset of fire and smoke occurrences designed for machine learning and object detection algorithms with more than 21,000 images.

All images were annotated according to the YOLO format (normalized coordinates between 0 and 1). However, we provide the yolo2pixel function that converts coordinates in YOLO format to coordinates in pixels.

Data Preprocessing

- Data cleaning involved removing duplicate and irrelevant images.

- Image augmentation techniques, such as rotation and scaling, were applied to increase dataset size and variability.

- The dataset was split into training, validation, and test sets.

Model Architecture

- A Convolutional Neural Network (CNN) was chosen for its effectiveness in image recognition tasks.

- The network consists of convolutional layers, pooling layers, and fully connected layers.

- Specific configurations and parameters were selected based on performance optimization.

YOLO Framework

- **YOLO (You Only Look Once)**YOLO is a state-of-the-art, real-time object detection system.

- It divides the image into a grid and predicts bounding boxes and probabilities for each grid cell.

- Integration with CNN allows for efficient detection of fire in images.

Training the Model

- The model was trained using the annotated dataset with parameters like learning rate, batch size, and epochs.

- Data augmentation helped prevent overfitting and improved generalization.

- Challenges included tuning hyperparameters and managing computational resources.
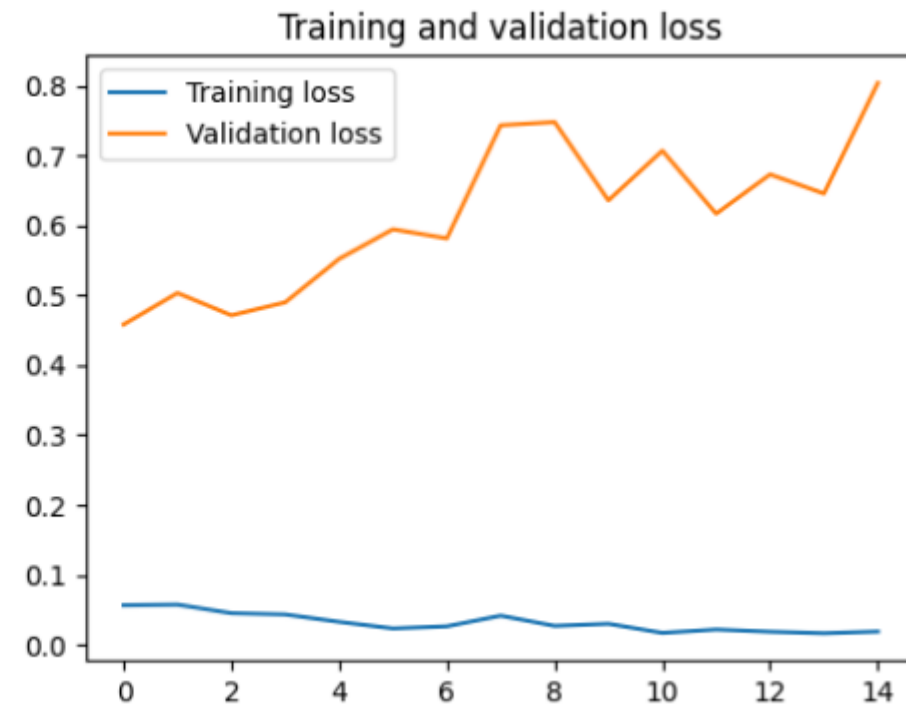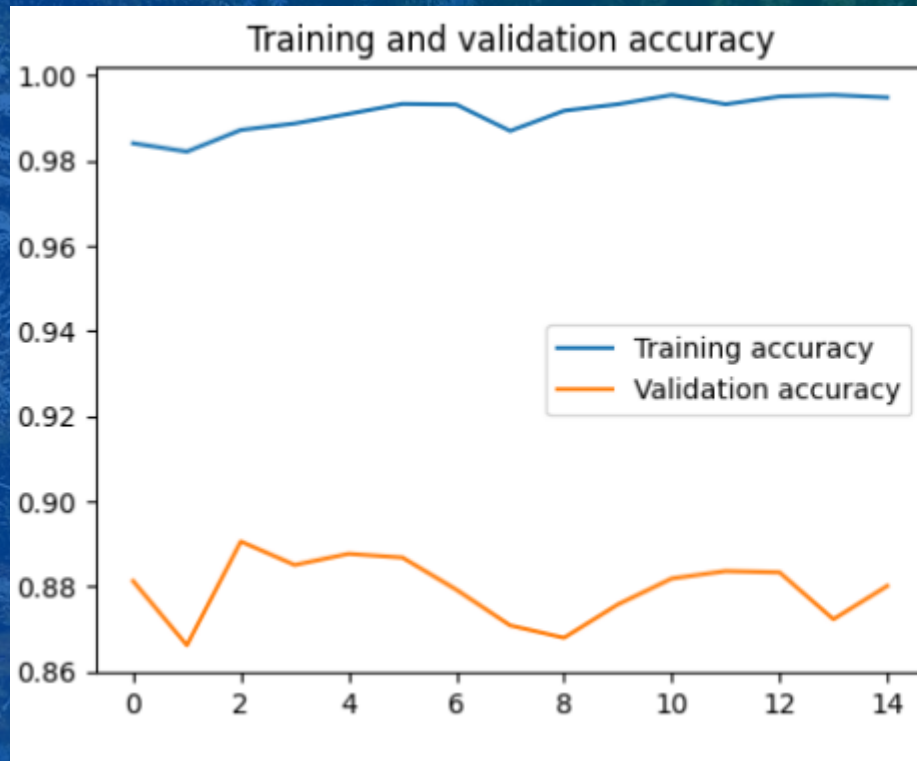
Evaluation Metrics

- Metrics used include accuracy, precision, recall, and F1-score.
- Accuracy measures the overall correctness of the model.
- Precision and recall assess the model's ability to detect fires accurately.
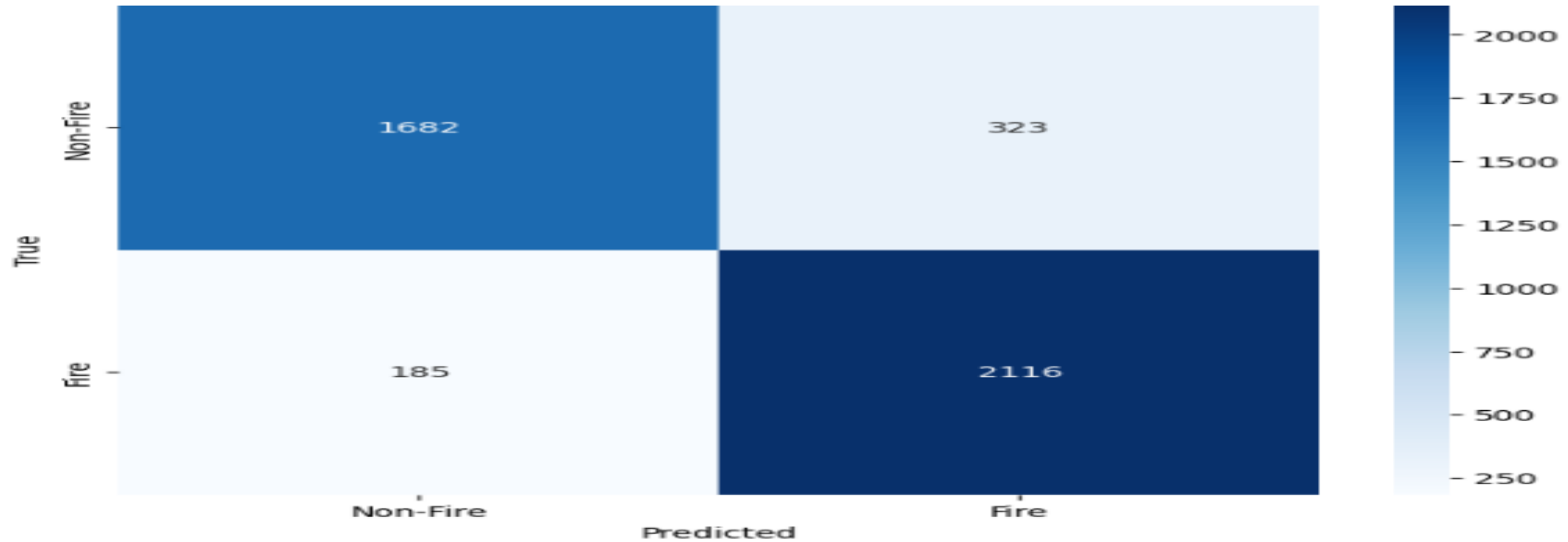- F1-score balances precision and recall.

Results

- The model achieved an accuracy of 88% on the test set.
- Precision and recall values indicate the model's effectiveness in detecting fires.
- Results are compared with baseline models to demonstrate improvement.

Results

Results

Confusion Matrix

Results

Prediction: Fire

Prediction: Non-Fire

Discussion

- The model shows promising results in early fire detection.
- Some limitations include false positives and the need for more diverse data.
- Potential improvements involve further tuning of the model and exploring additional data sources.

Conclusion

- The project successfully developed a system for early forest fire detection using CNNs and YOLO.
- Early detection can significantly reduce the impact of forest fires.
- Future work will focus on improving accuracy and expanding the dataset.