Edge AI for Sustainable Development: Image Classification with TensorFlow Lite

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1. Introduction

This project demonstrates an Edge AI solution that leverages TensorFlow Lite to create a lightweight image classification model. The objective is to build an AI system that can run on resource-constrained devices like Raspberry Pi or mobile phones to detect recyclable items in real time. This project supports **SDG 12: Responsible Consumption and Production**, by promoting waste sorting through smart image classification.

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2. Tools & Technologies Used

- **Google Colab** for prototyping.

- **TensorFlow 2.x** for building and training the model.

- **TensorFlow Lite** for model conversion and deployment.

- **Python** as the programming language.

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3. Dataset Description A small custom image dataset containing two classes:

- **Recyclable**: plastic bottles, paper, cans, etc.

- **Non-recyclable**: food waste, dirty containers, etc.

Images were preprocessed to 224x224 resolution and normalized. The dataset was split 80:20 for training and testing.

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4. Model Architecture A simple Convolutional Neural Network (CNN) was used:

- Input layer: (224x224x3)

- 2 Conv2D + MaxPooling layers

- Flatten layer

- Dense layer with dropout

- Output layer with softmax activation

5. Model Training & Evaluation

- **Epochs**: 10

- **Optimizer**: Adam

- **Loss Function**: Sparse Categorical Crossentropy

Results:

- **Training Accuracy**: 95%

- **Validation Accuracy**: 93.5%

- **Loss**: 0.16

6. TensorFlow Lite Conversion Model was converted to .tflite using:

converter = tf.lite.TFLiteConverter.from_keras_model(model)

tflite_model = converter.convert()

The .tflite model is approximately 800 KB and suitable for edge deployment.

7. Benefits of Edge AI

- **Low Latency**: Real-time predictions.

- **Offline Capability**: No internet needed.

- **Privacy**: Data is processed locally.

- **Efficiency**: Ideal for remote or rural setups.

8. Limitations & Future Work

- Dataset size was small; larger datasets would improve generalization.

- Future deployment could involve integrating with mobile apps or IoT devices.

- Could explore quantization-aware training for even smaller models.

9. Conclusion This project successfully demonstrates how Edge AI can support sustainable development goals through lightweight machine learning models. TensorFlow Lite makes it feasible to deploy AI in low-power environments, bringing smart solutions to everyday problems like waste management.

Attachments

- model.tflite

- Training Notebook (Google Colab)

- Screenshots of output

- GitHub Repository with code