

# Hybrid Xception-ViT for Automatic White Matter Lesion Diagnosis with Explainable AI

Fatana Jafari

Supervisor: Zuzana Černeková

## Motivation and Problem

**White Matter Lesions (WMLs)** [1] are regions of abnormal tissue in the brain's white matter. These lesions can cause neurological issues such as cognitive issues, vision problems, balance difficulties. Early diagnose of WML is crucial.

## Dataset & Methodology Pipeline

**Source:** Cyril and Methodius Hospital.

**Size:** 559 MRI scans (382 positives and 177 negative) in DICOM format.

## Solution or Contributions

ML and DL models detect WMLs well but struggle with small lesions and lack explainability. **Our contributions are :**

1. Expand dataset to solve the imbalance issue.
2. Detecting small WMLs is challenging; we propose a hybrid Xception-ViT with a modified Vision Transformer [2] for accurate detection.
3. Apply deep learning algorithms for WML diagnosis from MRI using XAI methods to ensure transparency and trust.

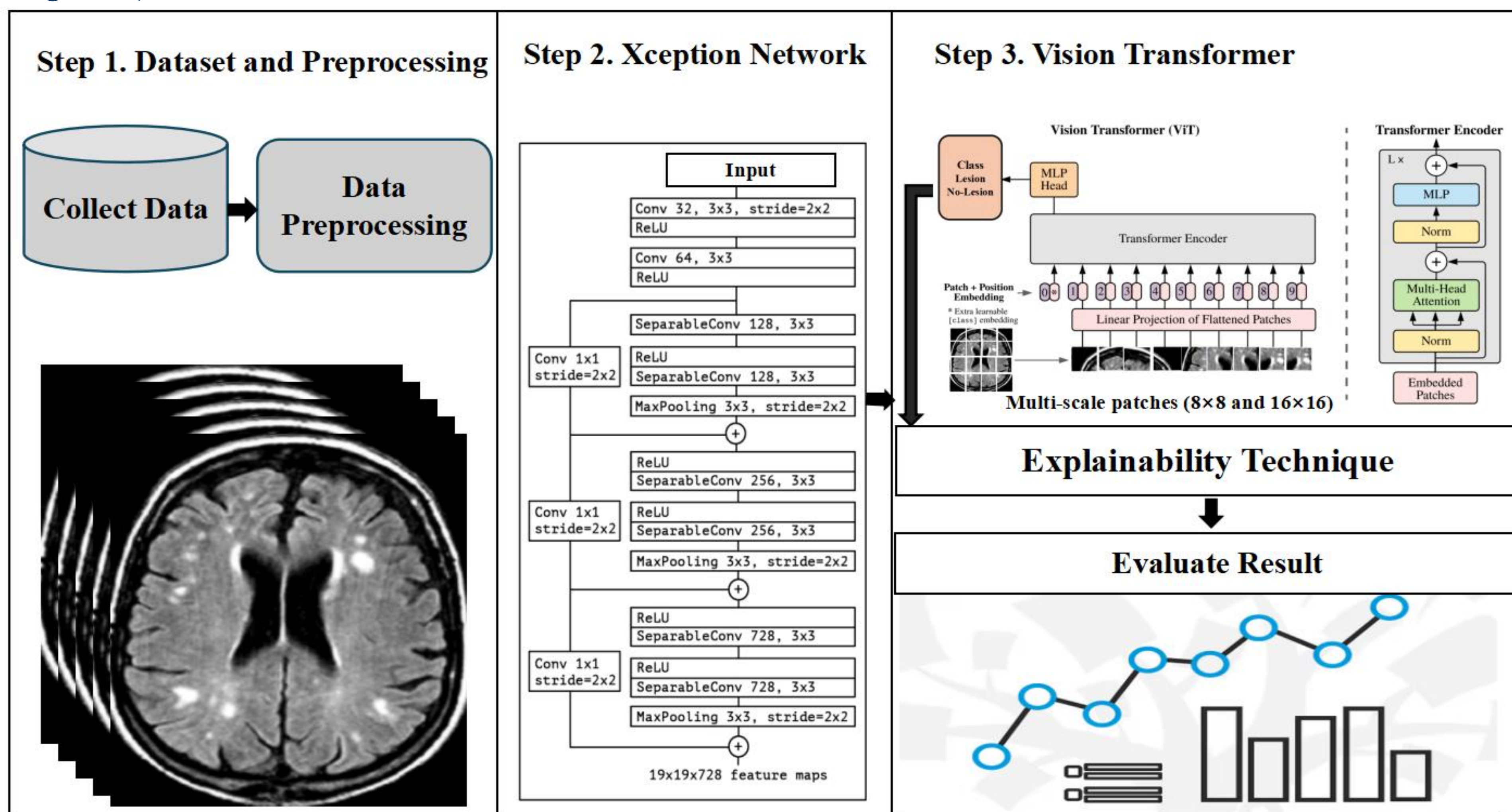


Figure 1: Proposed method

The proposed method mainly has three steps:

**Step 1.** Data collection and preprocessing operations are applied.

**Step 2.** The Xception model is used to extract local features.

**Step 3.** The extracted features are fed to the ViT model to capture global dependencies. Finally, Explainable AI methods are applied.

## Plimentry Experiment & Results

Depth	Ac	P	Recall	FP	F1
30 Slices	0.67	0.75	0.75	0.46	0.75
50 Slices	0.76	0.75	<b>0.94</b>	0.56	<b>0.84</b>
100 Slices	0.67	0.71	0.83	0.63	0.77

Table 1: ResNet50

Depth	Ac	P	Recall	FP	F1
30 Slices	0.69	0.70	0.87	0.61	0.78
50 Slices	0.77	0.74	<b>0.97</b>	<b>0.57</b>	<b>0.84</b>
100 Slices	0.77	0.76	0.92	0.48	0.83

Table 2: A custom 3D-CNN

Depth	Ac	P	Recall	FP	F1
30 Slices	<b>0.87</b>	0.82	1.0	0.36	<b>0.90</b>
45 Slices	0.82	0.83	0.86	<b>0.01</b>	0.82
60 Slices	0.86	<b>0.88</b>	0.88	<b>0.01</b>	0.86

Table 3: A custom CNN+LSTM

## Explainable AI Results

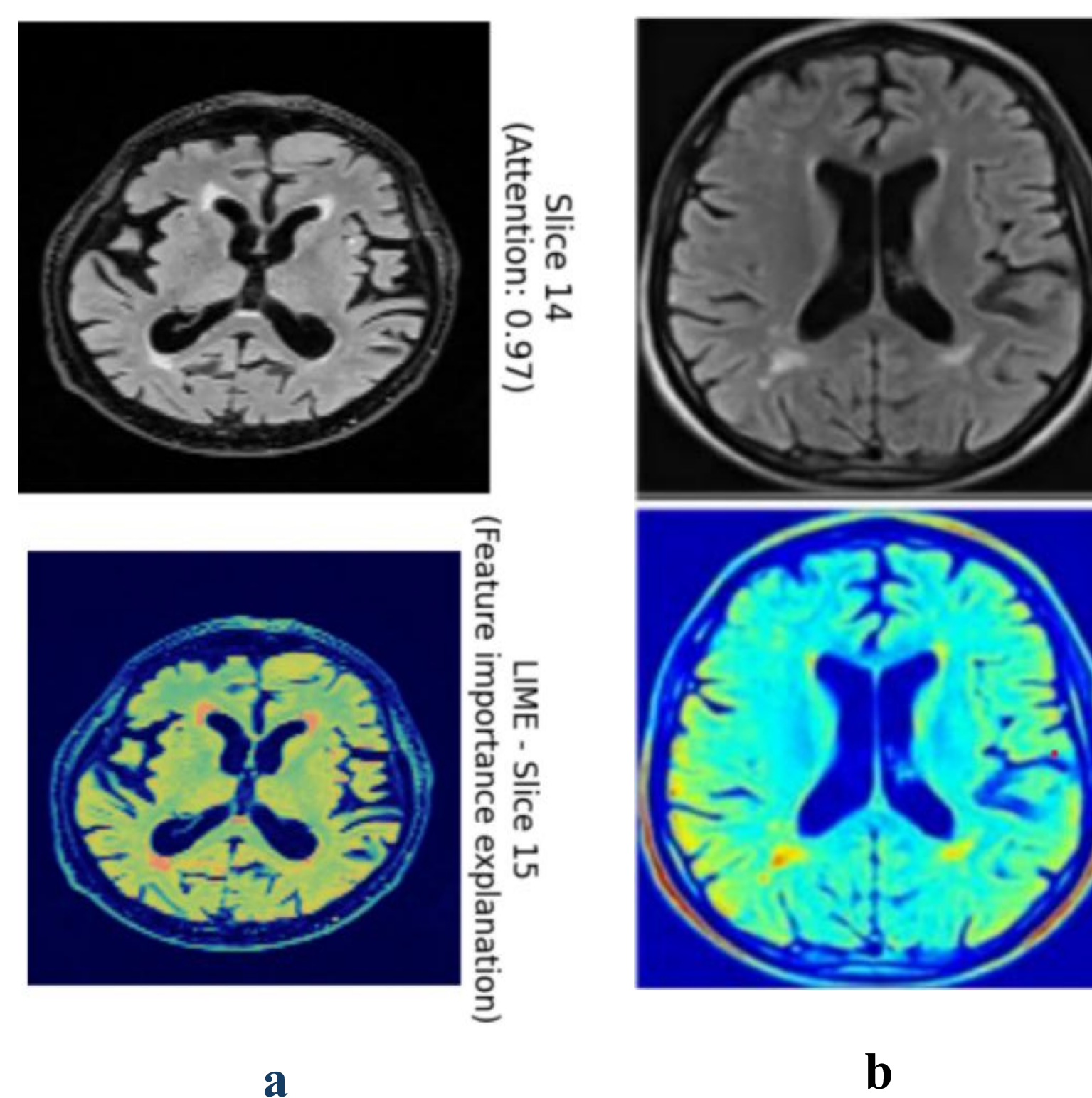


Figure 2: (a) LIME on 3D-CNN, (b) Grad CAM on ResNet-50 Visualizations

## Future work

1. Resolve the imbalanced data .
2. Implement the proposed X-ViT method to detect small lesions.
3. Retrain the dataset with deep learning networks and XAI techniques.

## References

- [1]. Prins, Niels D., and Philip Scheltens. "White matter hyperintensities, cognitive impairment and dementia: an update." Nature Reviews Neurology 11.3 (2015): 157-165.
- [2]. Dosovitskiy, Alexey. "An image is worth 16x16 words: Transformers for image recognition at scale." arXiv preprint arXiv:2010.11929 (2020).