Brain MRI Segmentation using PyTorch and U-Net

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Introduction

Brain MRI segmentation is a crucial task in the field of medical imaging, enabling the automatic detection and delineation of specific brain structures, such as tumors or lesions.

U-Net Architecture

The U-Net architecture is a convolutional neural network specifically designed for image segmentation tasks. It follows a symmetric encoder-decoder structure:

- The encoder progressively downsamples the input image, extracting hierarchical features.
- The decoder upsamples the features while combining them with corresponding features from the encoder through skip connections.

The skip connections allow the model to retain spatial information, improving segmentation accuracy. The figure below illustrates the U-Net architecture.

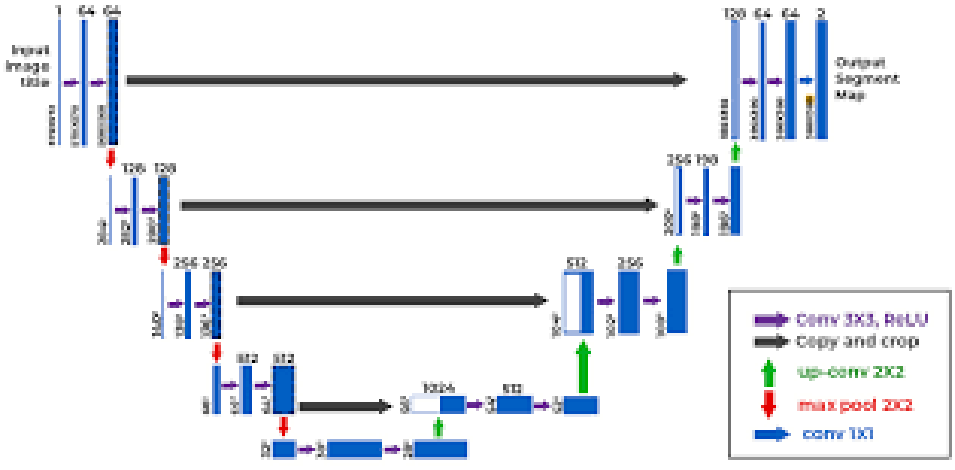

Figure 1: U-Net architecture: encoder-decoder structure with skip connections.

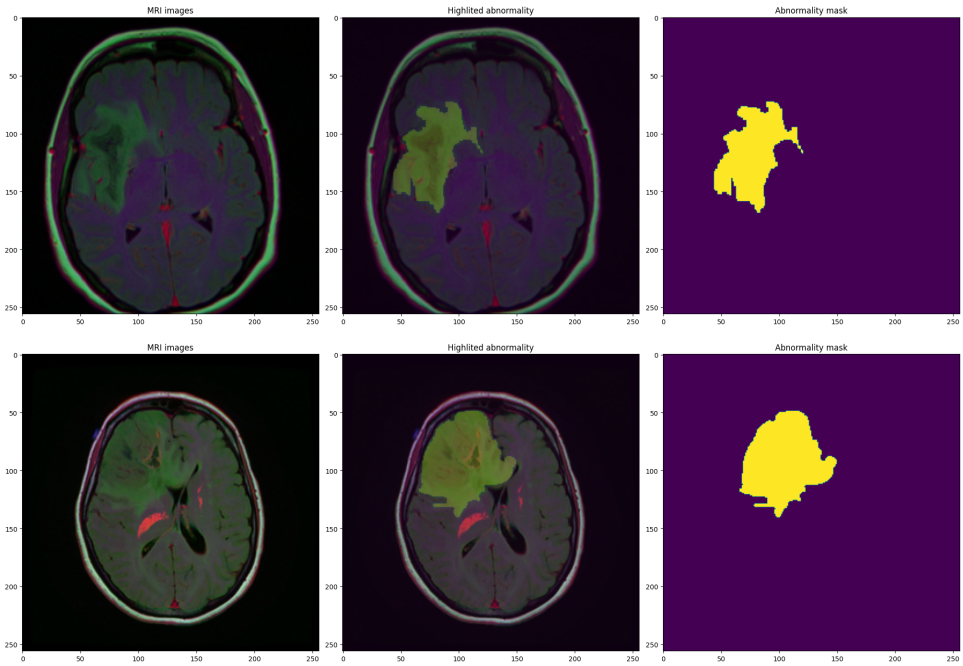

Figure 2: Examples of MRI images: (a) Raw image, (b) Highlighted anomaly, (c) Anomaly mask.

Data and Preprocessing

The images used to train the model include raw MRIs and their associated masks. These masks highlight abnormalities.

The preprocessing steps include:

- Normalizing pixel intensities to a range between 0 and 1.
- Data augmentation to improve robustness.

Results

The training process was monitored by observing loss curves for both training and validation datasets. The curve below shows a progressive decrease in loss, indicating improved model performance.

The U-Net model accurately detected and segmented brain anomalies. The figure below illustrates predictions overlaid on ground truths (in red).

Conclusion

The U-Net model successfully segmented MRI images with high accuracy, as shown above. This approach can be extended to identify various brain pathologies with minor adjustments.

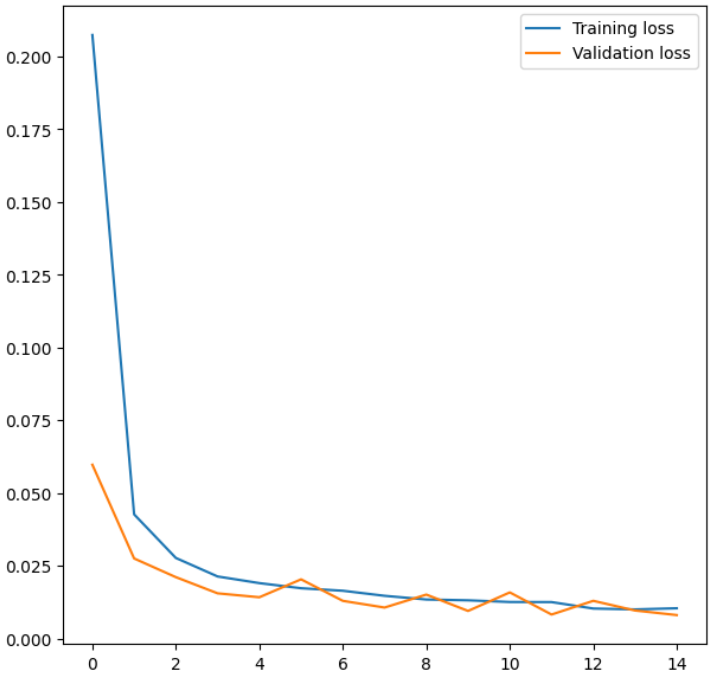

Figure 3: Loss curve: training and validation.

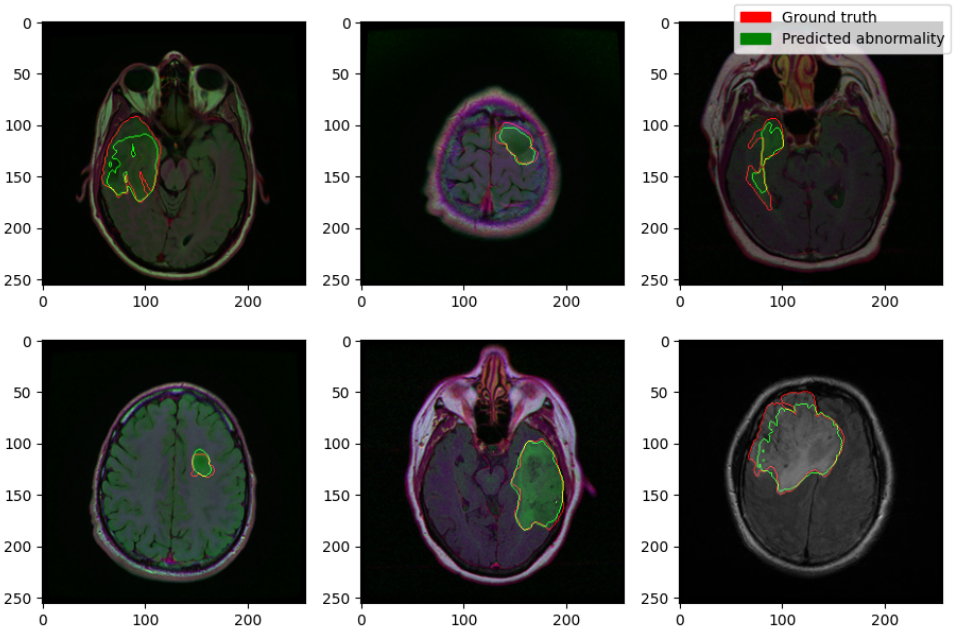

Figure 4: Examples of model predictions: ground truths in red, predicted anomalies in green.