Transformers for Ischemic Stroke Infarct Core Segmentation from Spatio-temporal CT Perfusion Scans

Lucas de Vries[1], Bart Emmer[1], Charles Majoie[1], Henk Marquering[1], and Efstratios Gavves[2]
[1] Department of Radiology and Nuclear Medicine, Amsterdam UMC, Amsterdam, The Netherlands
[2] University of Amsterdam, Amsterdam, The Netherlands
Contact: lucas.devries@amsterdamumc.nl

Motivation

- Ischemic stroke is one of the deadliest diseases worldwide
- Obstruction of blood supply to the brain
- Infarct core size is an important biomarker for treatment selection
- Spatio-temporal (3D + t) CT perfusion (CTP) imaging is used to determine the infarct core size via parameter maps

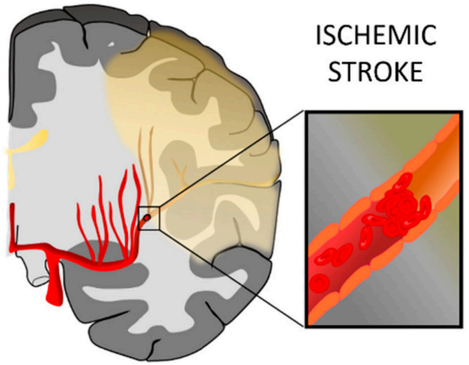
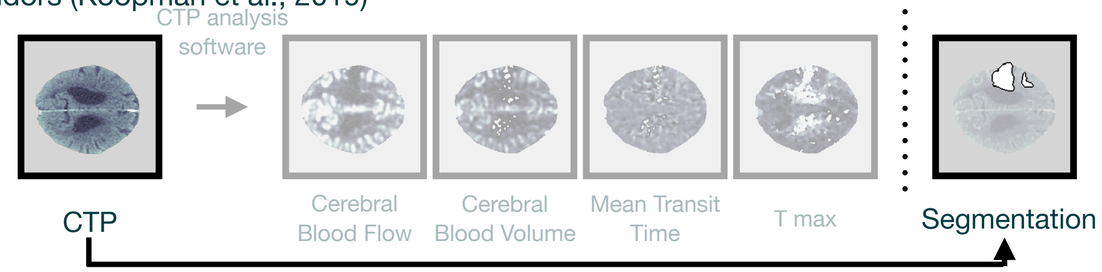


Figure: Correa-paz et al. (2021)

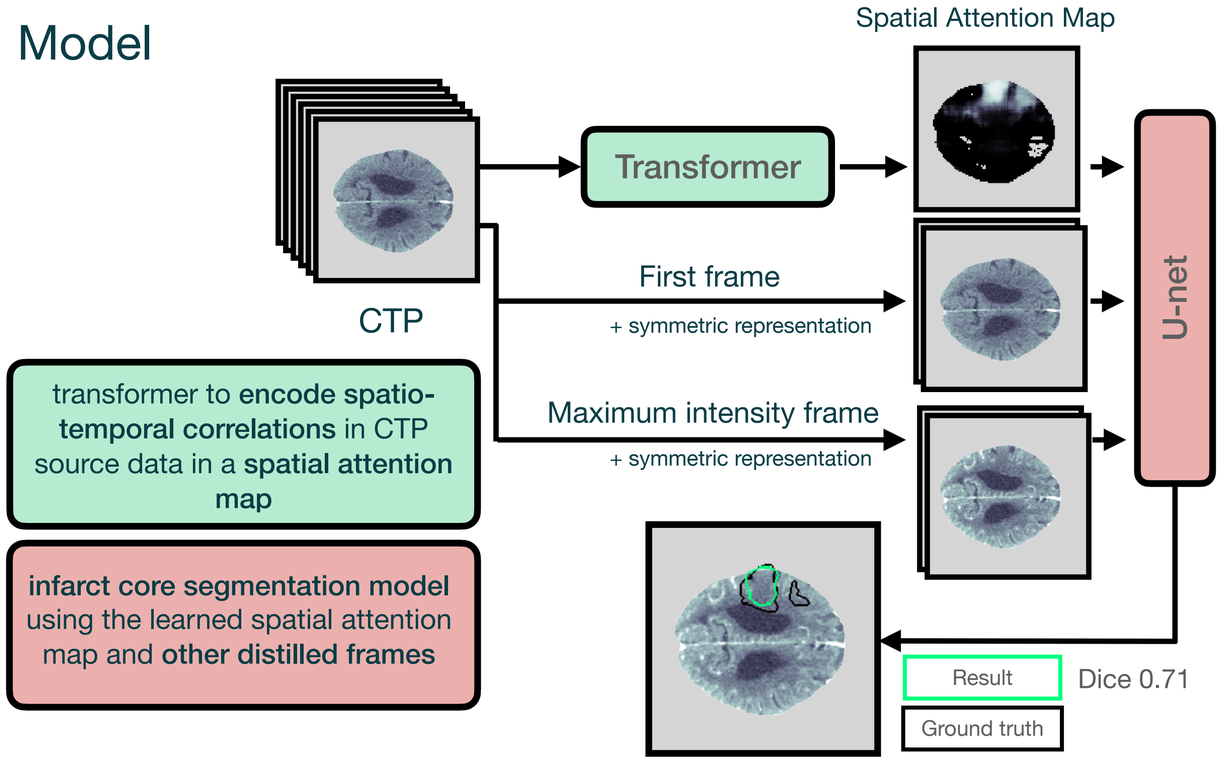
Problem and proposed solution

Problem: discrepancy in the output of different CTP analysis software packages from vendors (Koopman et al., 2019)



Solution: direct core segmentation from CTP source data
Intuition: sequential CTP data triggered us to investigate the use of state-of-the-art sequential models, namely transformers, for capturing spatio-temporal correlations

Model



A simple patch-wise **transformer-based model** is able encode spatio-temporal correlations in CTP source data. Consequently, this provides a **data-driven alternative to CT perfusion analysis software.**

Transformers for Ischemic Stroke Infarct Core Segmentation from Spatio-temporal CT Perfusion Scans

Lucas de Vries[1], Bart Emmer[1], Charles Majoie[1], Henk Marquering[1], and Efstratios Gavves[2]
[1] Department of Radiology and Nuclear Medicine, Amsterdam UMC, Amsterdam, The Netherlands
[2] University of Amsterdam, Amsterdam, The Netherlands
Contact: lucas.devries@amsterdamumc.nl

Transformer design

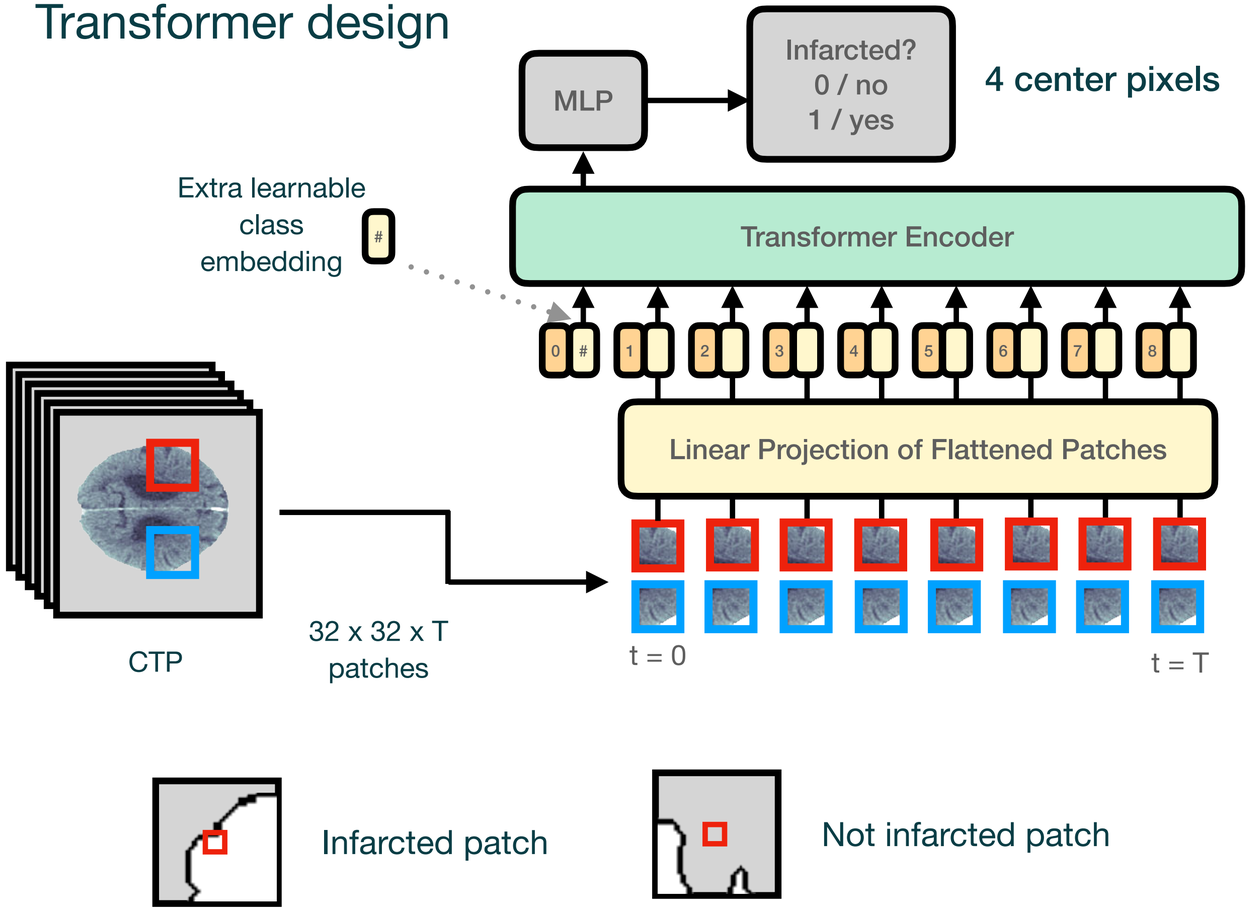


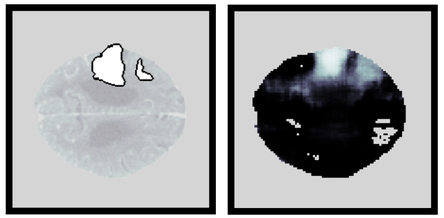
Image and set-up inspired by Dosovitskiy et al. (2020)

Results

- Thresholding the transformer attention map can result in a fragmented segmentation mask, due to our local patch-wise method
- Training a U-net with additional inputs, such as the first frame and frame at maximum intensity, increases performance with around 8%

Our transformer-based model achieves the **top DICE score of 0.42 (+10% improvement)** on the test data set for methods **using CTP source data**

- We do not yet achieve the results of models using spatial maps from CTP analysis software
- Core assessment independent of vendor's CTP software
- Our results provide a primary benchmark



Transformer spatial attention map, easily interpretable and potentially valuable in a clinical setting

Correa-paz et al. New Approaches in Nanomedicine for Ischemic Stroke. Pharmaceutics. 13. 757, 2021
Koopman et al. Comparison of three commonly used ct perfusion software packages in patients with acute ischemic stroke. Journal of NeuroInterventional Surgery, 11(12): 1249–1256, 2019.
Dosovitskiy et al. An Image is Worth 16x16 Words: Transformers for Image Recognition at Scale. 2020