STROKE LESION OUTCOME PREDICTION BASED ON 4D CT PERFUSION DATA USING TEMPORAL CONVOLUTIONAL NETWORKS

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1 BACKGROUND

- **Acute ischemic stroke (AIS)** is a major cause of death and disability worldwide [1].
- To date, perfusion parameter maps are typically calculated from **spatio-temporal (4D) CT perfusion (CTP) imaging** data and then thresholded to localize and quantify the stroke lesion core and tissue-at-risk [2].
- A few studies have recently developed advanced machine learning techniques, such as **deep learning**, to automatically predict stroke tissue outcomes from perfusion maps [3].

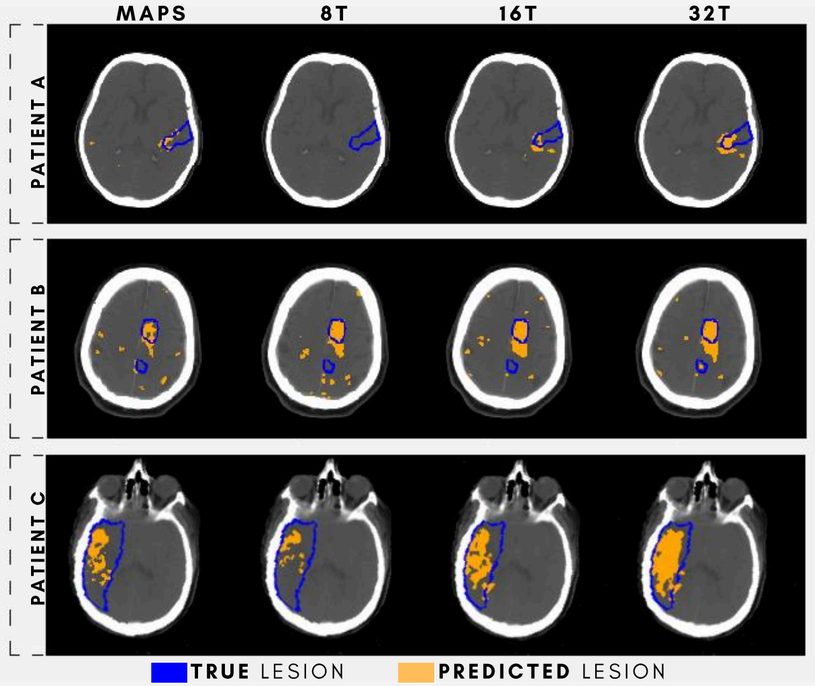
Original 4D CTP data might contain valuable information not directly represented in perfusion parameter maps.

2 OBJECTIVE

We aimed to develop and evaluate a **novel, high-level deep learning model** that directly utilizes 4D CTP data to predict the stroke tissue outcome as a spatial output (lesion segmentation).

3 METHODS

A temporal convolutional network (TCN) was designed for this work, as it has shown promising results in other medical image analysis problems [4] but has never been applied in AIS. **This TCN aims to build a hierarchy in a tree-like fashion for combining temporal information from neighboring images.** Briefly explained, we trained the proposed model, using the original 4D CTP datasets and their corresponding follow-up images, to automatically estimate the future outcome in new patients.



4 RESULTS

Model	Dice		Absolute Volume Error
MAPS	0.2387 ± 0.18	(*)	49.50 ± 27 ml
8T	0.2564± 0.20	(*)	32.25 ± 27 ml
16T	0.2836 ± 0.21	(**)	64.48 ± 54 ml
32T	**0.3361 ± 0.21**		52.04 ± 46 ml

Table 1 -- Evaluation metrics *are reported as mean ± standard deviation. A paired t-test was used to compare the 32T model and its variants, with (*) indicating P<0.05 and (**) indicating P<0.001.*

→ Using longer CTP sequences improves the stroke tissue outcome predictions.

→ The proposed model can make better use of the 4D information available in CTP scans, especially when compared to using perfusion maps.

EXPERIMENTS

Using a multicenter dataset of 176 CTP scans, we:

- Explored the **impact of the time window size** by training the proposed model on various CTP lengths: 8, 16, and 32 time points.
- Investigated the added predictive potential of 4D CTP data **compared to using perfusion maps**.

5 FUTURE WORK

Our future projects will focus on improving the model performance while generating **treatment-specific predictions.** This could potentially assist in clinical decision-making and thus enhance the long-term prognosis of acute ischemic stroke patients.

References:
[1] Feigin et al. *The Lancet Neurology*, 2019.
[2] Laughlin et al. *Practical Neurology*, 2019.
[3] Clerigues et al. *computers in Biology and Medicine*, 2019.
[4] Krebs et al. *Lecture Notes in Computer Science*, 2020.

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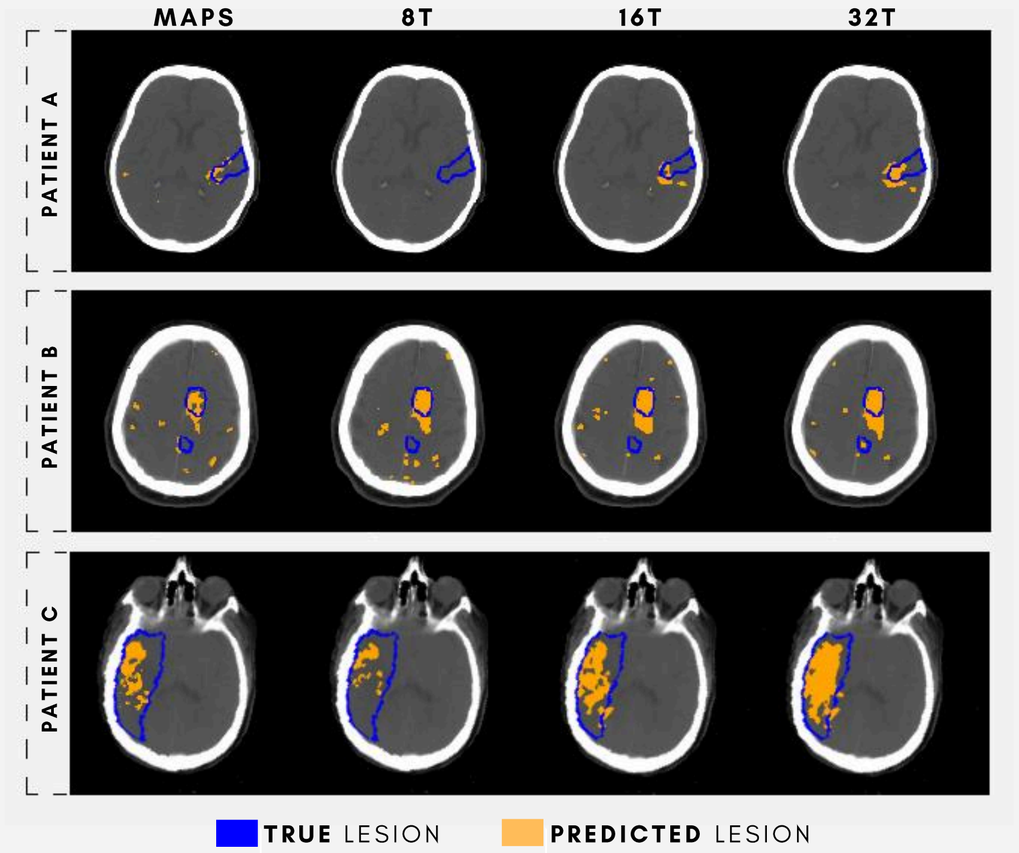

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