CNN-LSTM Architecture for Detection of Intracranial Hemorrhage on CT scans

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Motivation

- Classifying Intracranial Hemorrhage (IH) is challenging:
  - 3D representation of the data
  - Transfer learning on Imagenet ignore 3D contextual information
  - 3D CNN consume huge memory

- Efficient training strategy for 3D medical imaging:
  - Long short-term memory (LSTM) + convolutional neural network (CNN)
  - **Trained end-to-end**
  - Take advantage of **ImageNet pretrained models**
  - **Modeling the spatial dependencies between adjacent slices** in 3D space

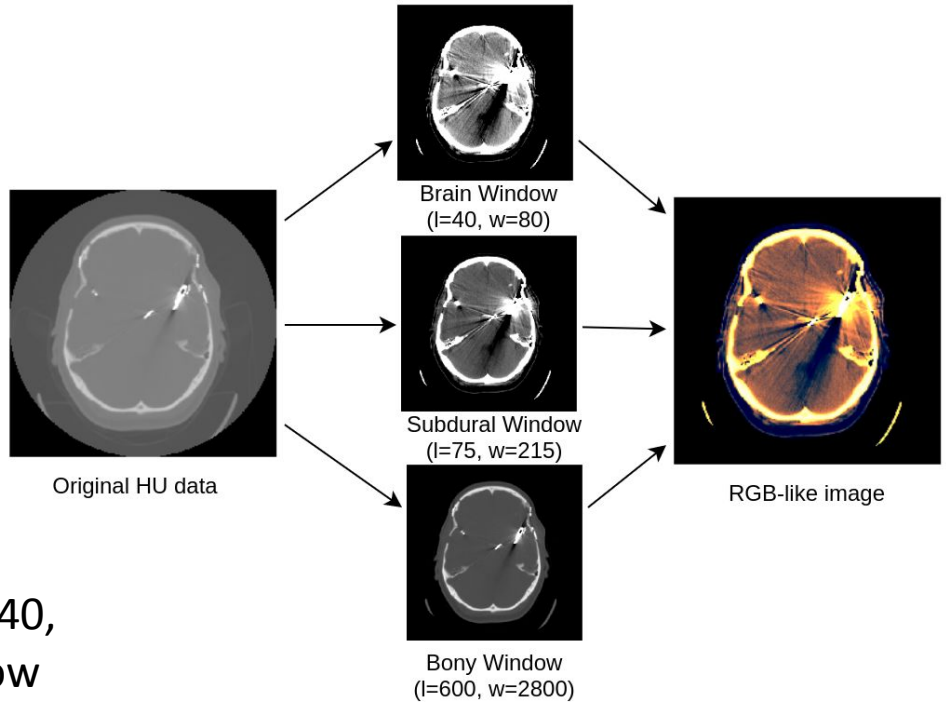
- Validate the method:
  - RSNA Intracranial Hemorrhage Detection challenge
  - CQ500 dataset

Dataset

- RSNA dataset:
  - 25,000 non-contrast brain CT studies
  - 20 to 60 slices each
  - Manual **slice-level label** for 5 IH subtypes: intraparenchymal, intraventricular, subarachnoid, subdural and epidural
  - Split into a public train, a public test, and a private test

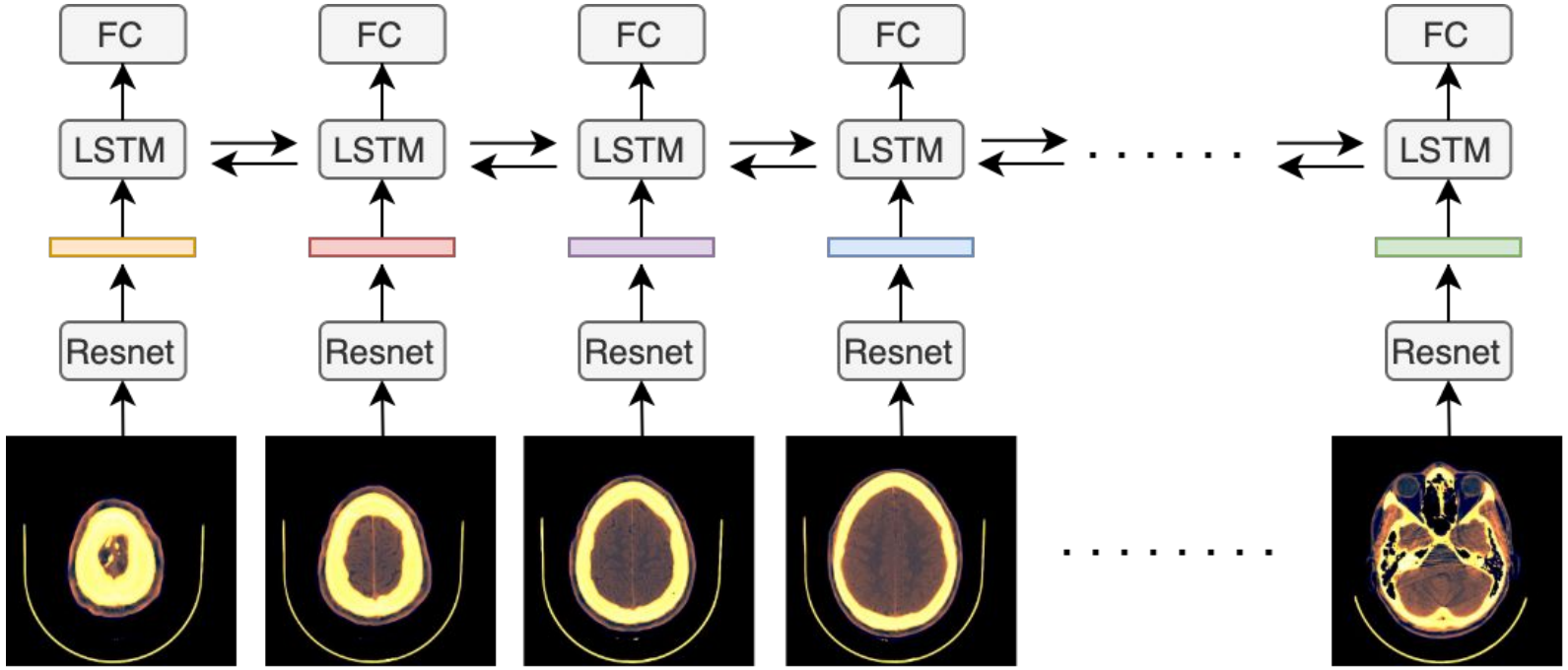
- CQ500 dataset:
  - 491 studies that has between 15 to 128 slices each
  - Manually **scan-level** label for 5 IH subtypes

- Windowing:
  - For each slice of the CT scan, we apply brain window (l=40, w=80), subdural window (l=75, w=215), and bony window (l=600, w=2800) and stack them to obtain the RGB-like image



Method

- The model consists of an CNN backbone follow by a bi-LSTM:
  - CNN extract the feature vector for each input slice
  - Feature vectors to bi-LSTM by spatial order
- Train end-to-end: 30 epochs, Adam optimizer with initial learning rate of 1e-3 and cosine annealing scheduler with linear warm-up



Result

Models	Weighted Log Loss
ResNet-50	0.05289
SE-ResNeXt-50	0.05218

Performance on private test set of RSNA Challenge
These single model is on par with **top 3%** on Kaggle

AUC (Area Under Curve)			
Finding	Qure.ai	ResNet-50	SE-ResNeXt-50
Intracranial Hemorrhage	0.9419	0.9597	**0.9613**
Intraparenchymal	0.9544	0.9616	**0.9674**
Intraventricular	0.9310	**0.9901**	0.9858
Subarachnoid	0.9574	0.9662	**0.9696**
Subdural	0.9521	**0.9654**	0.9644
Extradural (Epidural)	0.9731	**0.9740**	0.9731

Performance on CQ500 in comparison with the method of Qure.ai.

Thank you for your attention, VinBDI for supporting this research, and the MIDL 2020 Organisers!

Source code: https://github.com/VinBDI-MedicalImagingTeam/midl2020-cnnlstm-ich

Paper: https://arxiv.org/abs/2005.10992