ADAM: Aneurysm Detection And segMentation Challenge
Unil – CHUV Team

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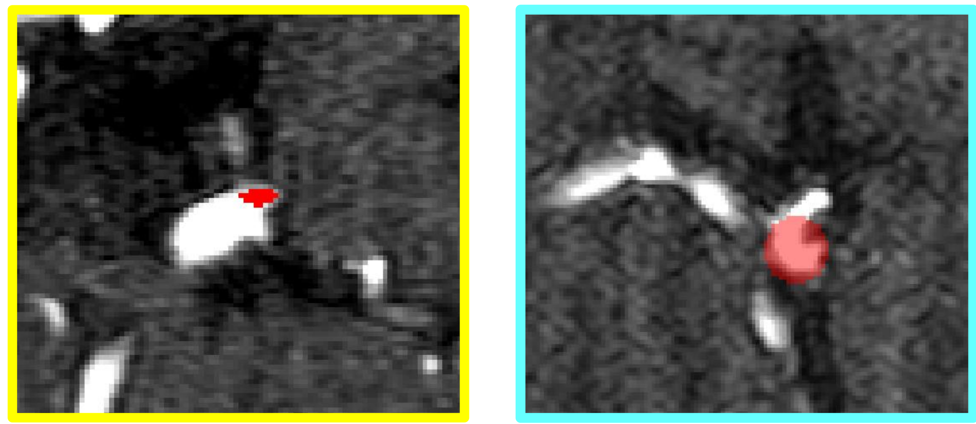
Background

- Diagnosis of unruptured aneurysms is a critically important clinical task. It occurs to 1% to 3% of the population and accounts for more than 80% of nontraumatic subarachnoid hemorrhages[1].
- Not only a CNN-like model capable of automatically detect brain aneurysms could improve clinicians' performances[2], but it could also help mitigate the steadily increasing workload of radiologists in the next decades, speeding up the diagnosis process.

Materials & Methods

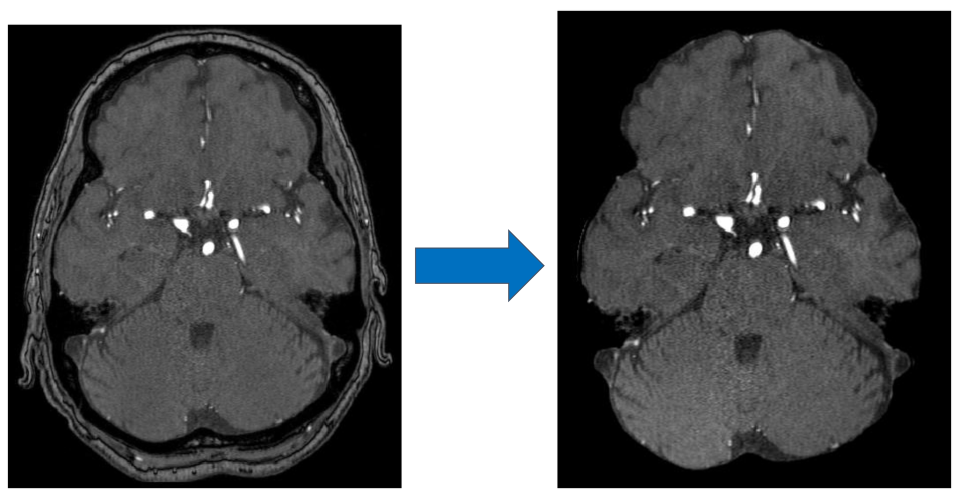
- **Dataset**
  - **ADAM**: 113 subjects (93 patients, 20 controls); 125 aneurysms
  - **CHUV**: 214 subjects (83 patients, 131 controls); 111 aneurysms

(a) (b)

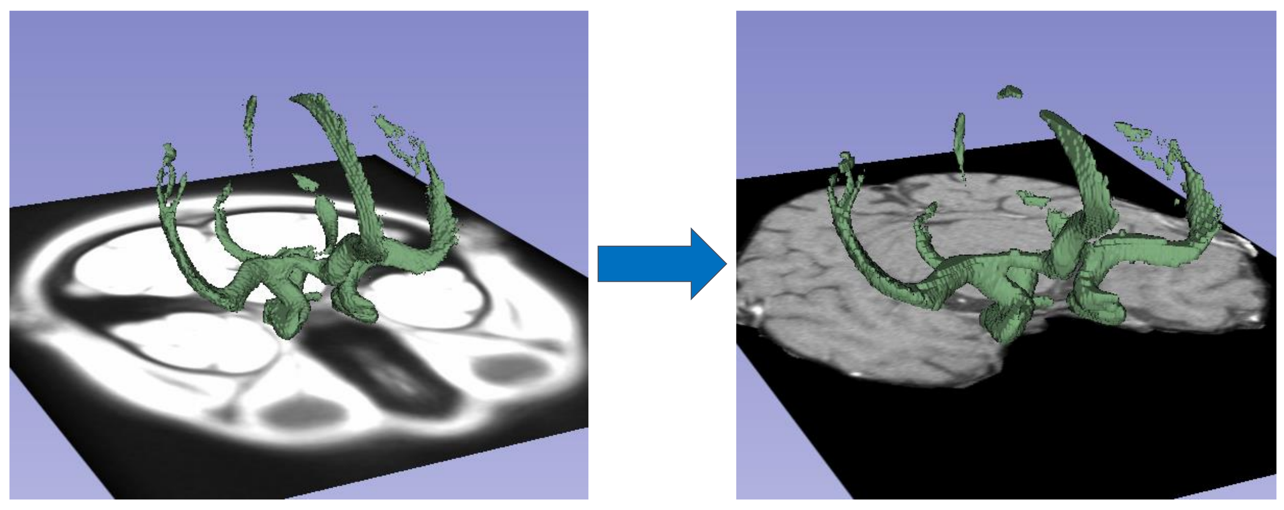


Axial slice of two manual masks. (a) «voxel-wise» mask of the ADAM dataset; (b) «weak» mask of our CHUV dataset. Weak labels correspond to spheres enclosing the aneurysms.

- **Pre-processing**
  - FSL Brain extraction[3]

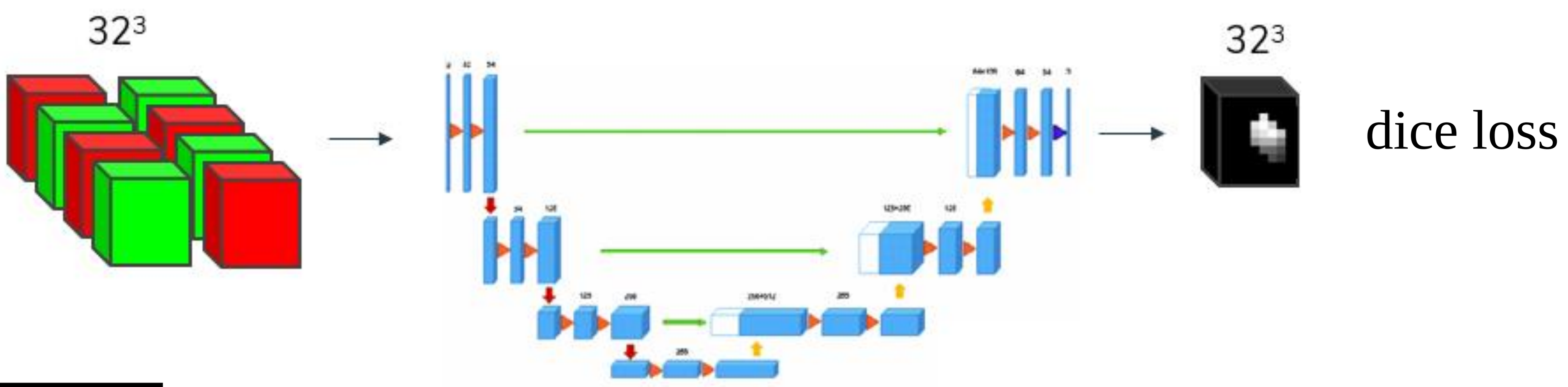


  - Registration of probabilistic vessel atlas[4] from MNI to TOF space with ANTs[5]

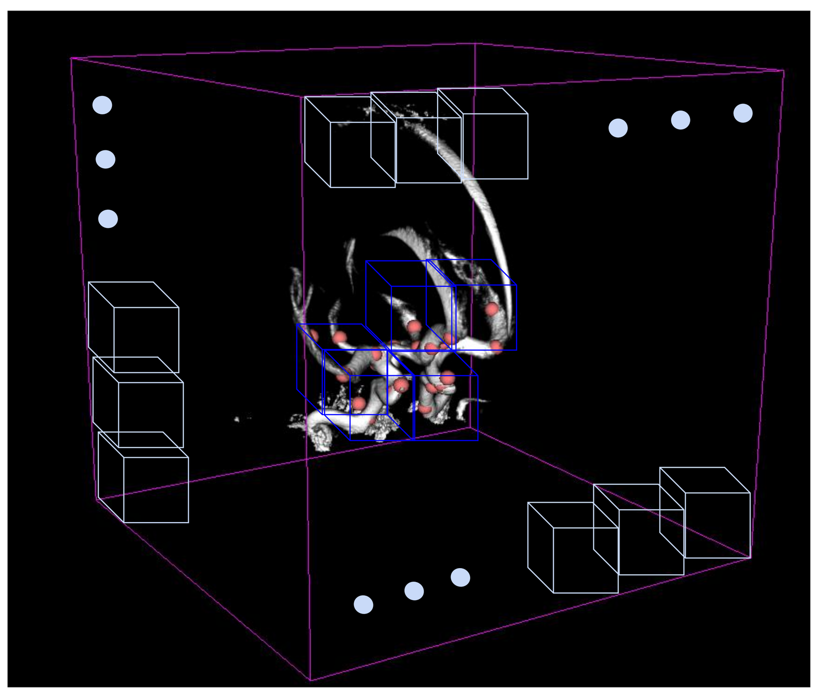


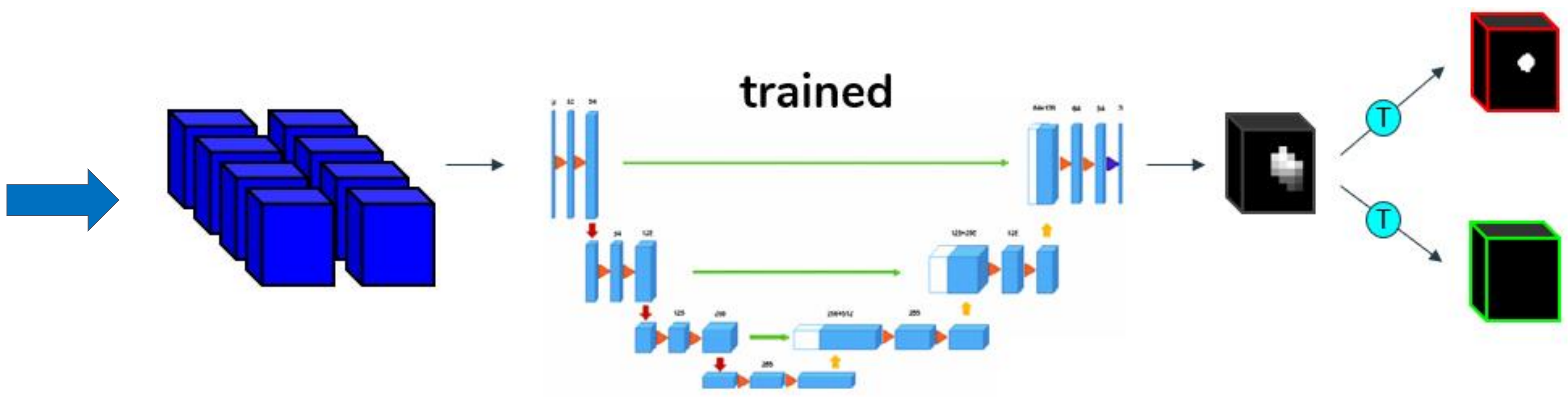
- **Train dataset creation:** for every subject, we extract 30 **negative (i.e. without aneurysms)** patches: 24 in correspondence with landmark points where aneurysms are recurrent and 6 in correspondence with other vessels. Moreover, for patients with aneurysms, we extract 5 **positive (i.e. with aneurysm)** patches with random shifts around the lesion. All patches have shape 32^3.

- **Patch-wise training 3D-Unet:** the model is trained to distinguish background voxels from aneurysm voxels through the Adam optimizer, with adaptive learning rate and 500 epochs.



- **Patient-wise inference:** at test time, every subject is scanned with a sliding-window approach. White patches in the figure are discarded because unlikely to contain aneurysms.





Instead, we retain the anatomically-plausible patches. These are then fed to the trained U-Net which outputs a prediction and thresholds it. If after the threshold there are still some non-zero voxels, the biggest connected component is considered a candidate aneurysm and its center of mass is used to compute the voxel coordinates of the aneurysm center.

- **FP reduction:**
  1. Max 4 FP per patient (most probable)
  2. Merge predictions of adjacent patches

Detection Results

Team: unil_chuv	Task 1 Rank: 0.4	Task 1 Place: 9 th

(lower rank is better)

Task 1	False Positives	Sensitivity
Average	1.45	0.2
Rank	0.06	0.73

References:
1. Jaja et al., (2013), *Neurocritical Care*
2. Park et al., (2019), *JAMA Network, Health Infor.*
3. Smith, (2002), *Human Brain Mapping*
4. Mouches et al., (2019), *Scientific data*
5. Avants et al., (2011), *Neuroimage*

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