AI Hippocampal Volume Estimator for Alzheimer Progression Evaluation

Validation Plan

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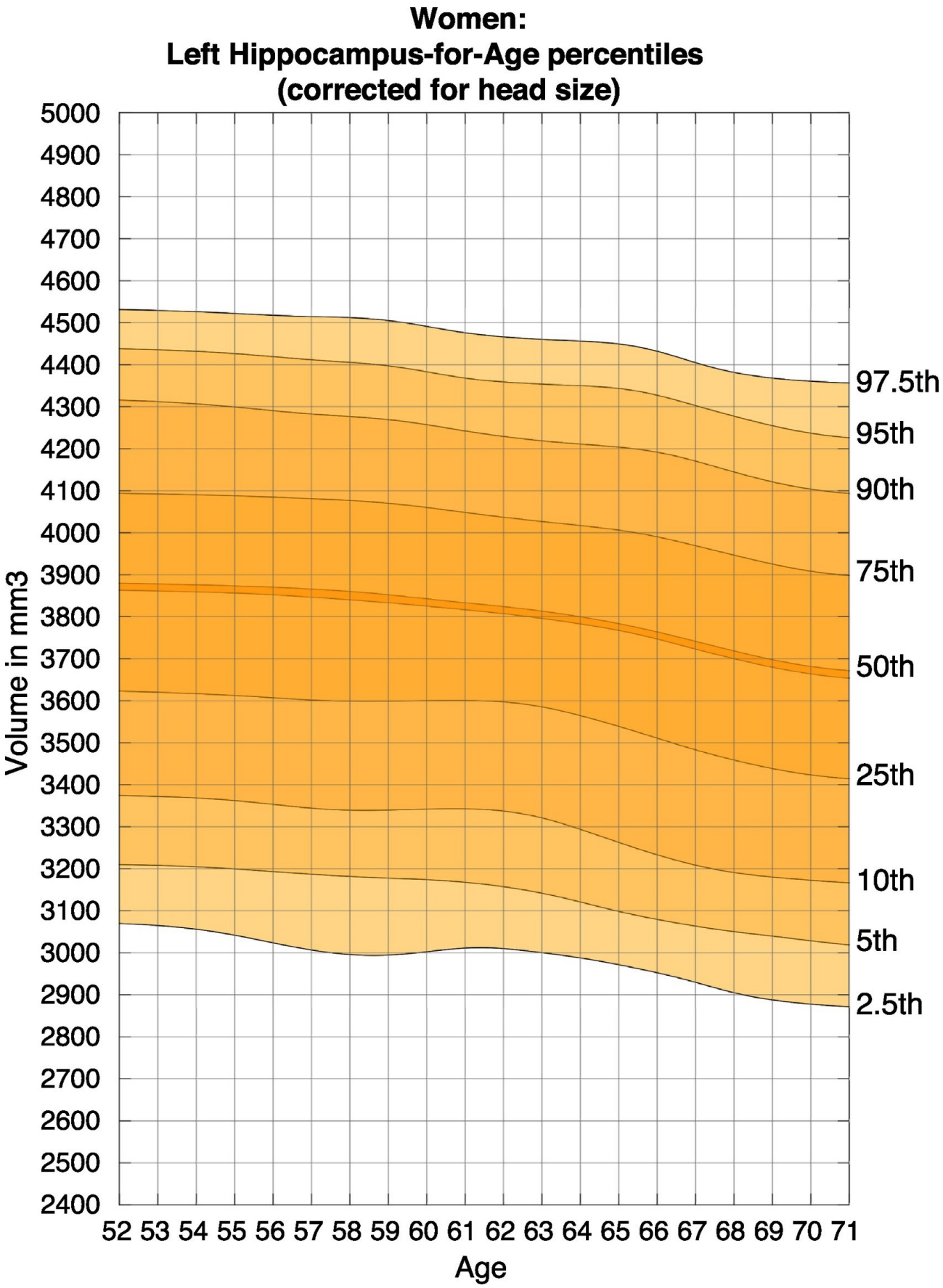
General Description:
The **hippocampus** is a major component of the human brain and it is composed by two parts one in each side of the brain. The hippocampus plays important roles in the consolidation of information from short-term to long-term memory.
It is located under the the cerebral cortex..

According to **Nobis et al., 2019**, the volume of hippocampus varies in a population, depending on various parameters, within certain boundaries, and it is possible to identify a "normal" range taking into account age, sex and brain hemisphere.

From the study above the distribution of the hippocampal volume for women of age between 52 and 71.


Women:
Left Hippocampus-for-Age percentiles
(corrected for head size)
Volume in mm3
5000
4900
4800
4700
4600
4500
4400
4300
4200
4100
4000
3900
3800
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71
Age
97.5th
95th
90th
75th
50th
25th
10th
5th
2.5th

It clearly shows how the volume decreases with age.

Measurement of hippocampal volume has proven useful to diagnose and track progression in several brain disorders, most notably in Alzheimer's disease (AD)

The algorthm developed has this objective as described in the next session.

Intended Use

The algorithm is intended to help radiologist to have direct measure of the estimated hyppocampal volume (in mm3) and to have the segmentation of the hyppocampal, which would instead require an analyis to be performed slice by slice of the MR.

It can be used for longitudinal studies comparing how the volume evolves in time.

Traning Data Collected:

The Training Data has been taken from the Hippocampus **Medical Decathlon competition**. This dataset is stored as a collection of NIFTI files, with one file per volume, and one file per corresponding segmentation mask. The original images here are T2 MRI scans of the full brain.

The images have been cropped by our departement “CropTools” to make a first selection of the area under investigation.

This tecnique allows to save considerable amount of time for the Training of the Model.

The Dataset has orginally been cleaned in order to remove outliers (volume outside the range [2200-4500].

One volume has been removed since there was no correspondence between the image and the associated label.

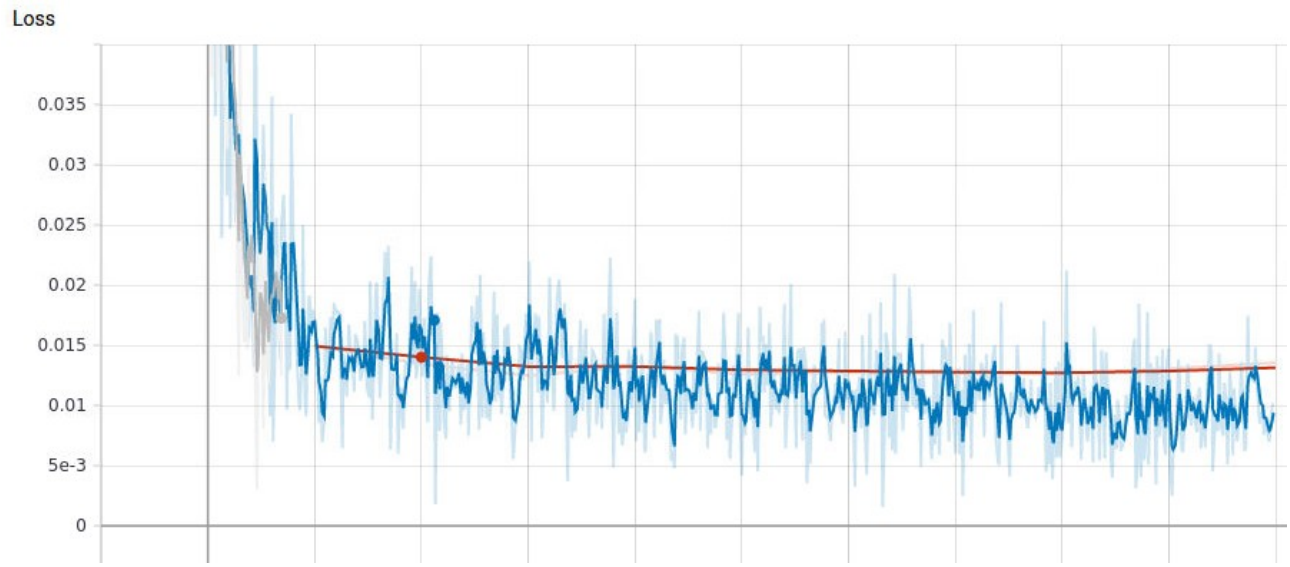
One model consisted of slices of dimension 512x512 and has been removed.

Labels

The labels corresponding to each volume have been classified in terms of hyppocampal voxels by a team of Radiologists.
The labels contains values 0 for the background, 1 for the anterior hyppocampal and 2 for the posterior hyppocampal

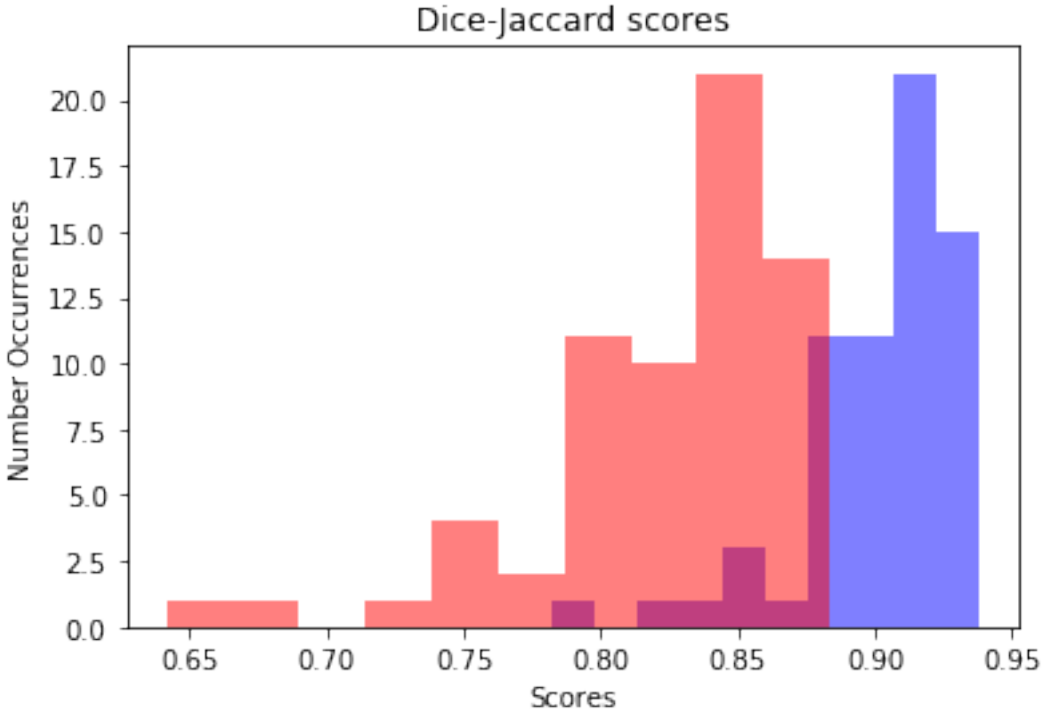
Performances

The algorithm uses a Unet Architecture using the images and labels provided in the dataset for training.
During the training process, the loss has been logged and can be visualized for through tensorboard application as shown below:



After 10 epochs the loss can be quantified in the order of 0.01

Once the model has been trained using a section of the original dataset, its performance on the estimation of the Hyppocampal volume has been tested through another section of the dataset.
The predicted image is then compared with the label and different metrics have been evaluated.
The results from Testing 65 volumes are presented below:
Dice 3D Metrics: Mean 0.903
Jaccard 3D Metric: Mean 0.82
Sensitivity and specificity have also been measured for each volume.



One test volume has clearly the lowest value in terms of metric scores:

`hippocampus_199.nii.gz`

CLINICAL WORKFLOW

In the real world the algorithm is interfacing with the hospital PACS.

It receives the MR studies, elaborate the volumes and provide the predicted hippocampal volume to OHIF server sending a complete report.