# TORCH-IO

A library for ?

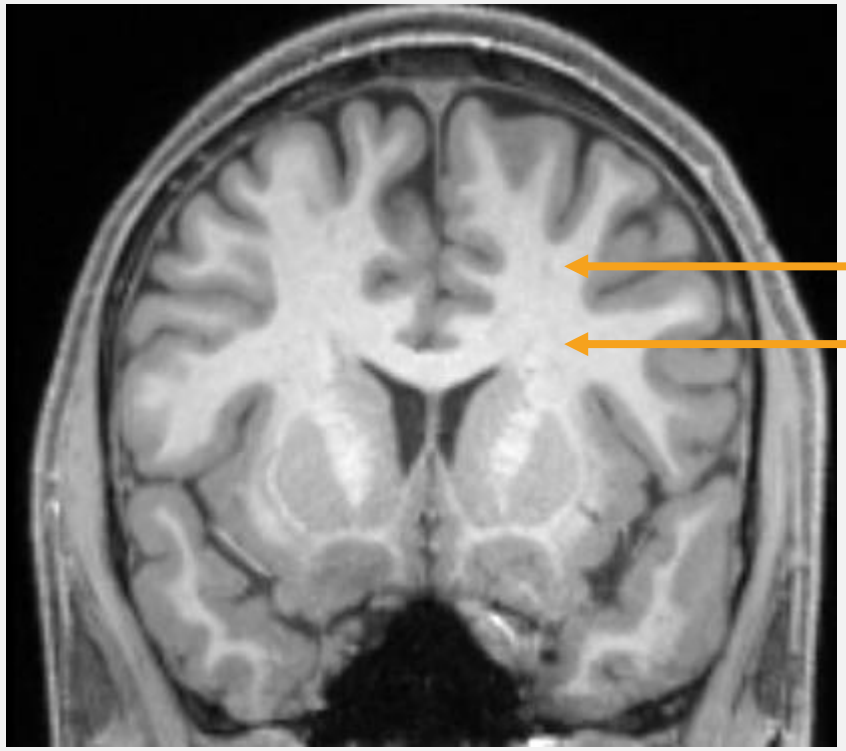
# INTRODUCTION

- Medical 3D imaging data cannot be processed like natural 2D images
- There is a lack of medical imaging data
- Tools exist for augmentation / preprocessing but are not usable in Pytorch
- Patch based method are important for memory efficiency but need special sampling for medical tasks

# DIFFERENCE 3D / 2D

Not next to each other

# DIFFERENCE 3D / 2D



Next to each other

# METADATA

- Encode physical size, spacing and orientation of voxels
- Determines spatial relationship

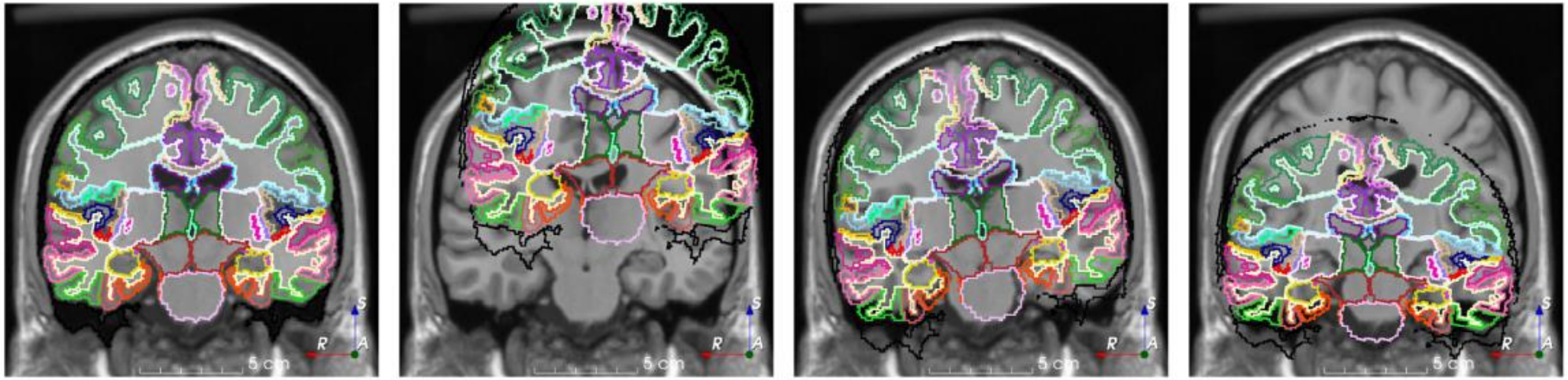


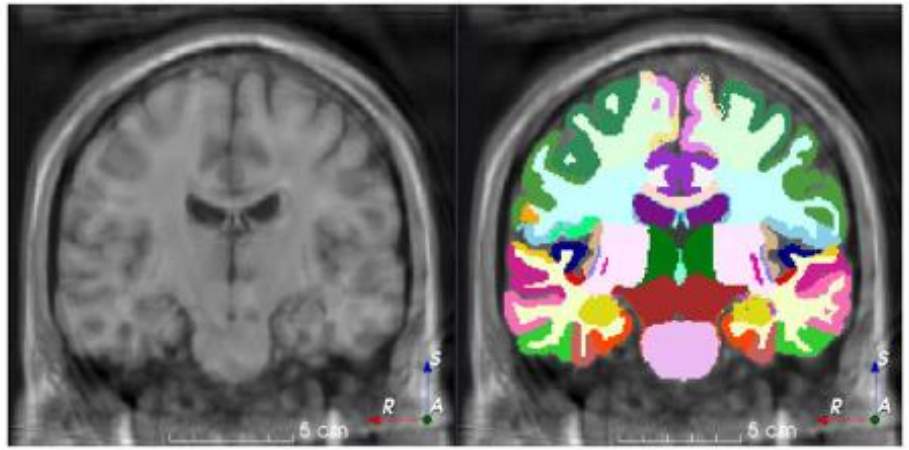

**Fig. 1.** Demonstration of the importance of spatial metadata in medical image processing. The size of both the MRI and the segmentation is 181 × 181. When spatial metadata is taken into account (a), images are correctly superimposed (only the borders of each region are shown for clarity purposes). Images are incorrectly superimposed if (b) origin, (c) orientation or (d) spacing are ignored.

# LACK OF MEDICAL DATA

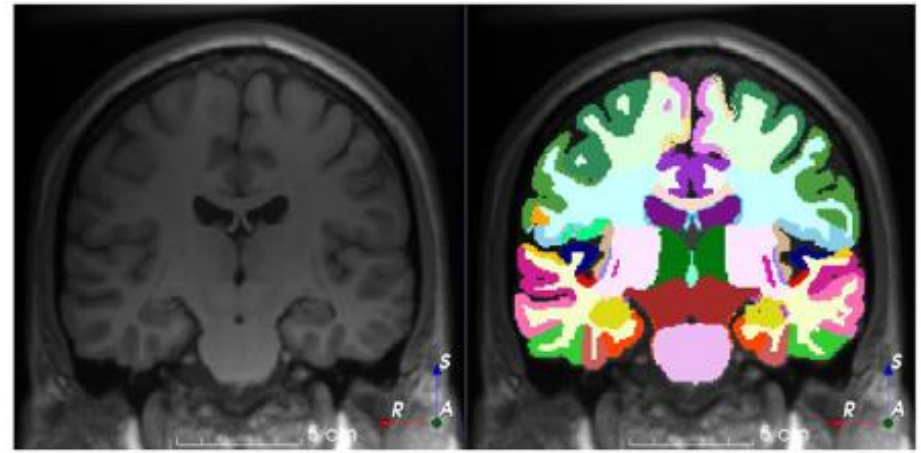
- Multiple tools exists but medical data cannot be augmented the same way as natural image
- Augmentation are needed to:
  - Simulate anatomy variation
  - Simulate acquisition artifacts

**Table 1**
Transforms included in TorchIO v0.18.0. Logos indicate the main library used to process the images. : NiBabel [15]; : SimpleITK [14]; : NumPy [30]; : PyTorch [8].

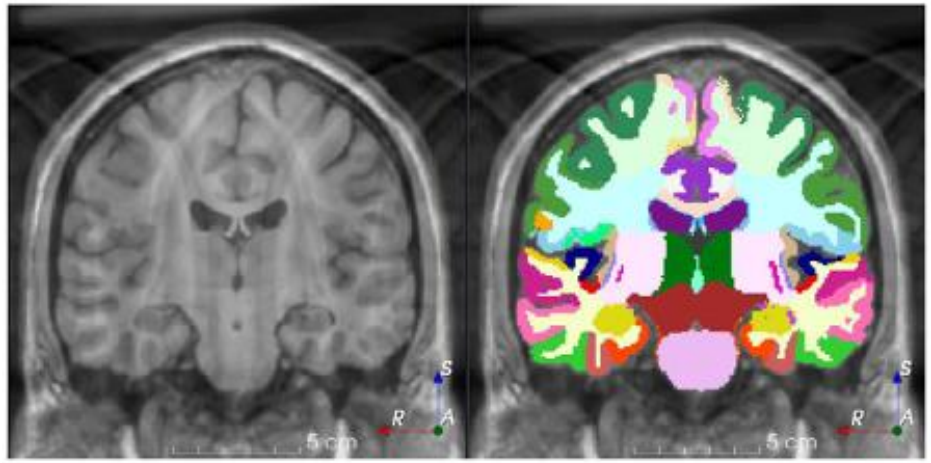
| | Spatial | Intensity |
|---|---|---|
| **Preprocessing** | `ToCanonical`<br>`Resample`<br>`Crop`<br>`Pad`<br>`CropOrPad` | `HistogramStandardization` [29]<br>`RescaleIntensity`<br>`ZNormalization` |
| **Augmentation** | `RandomAffine`<br>`RandomElasticDeformation`<br>`RandomFlip` | `RandomMotion` [42]<br>`RandomBiasField` [43]<br>`RandomGhosting`<br>`RandomSpike` [44]<br>`RandomBlur`<br>`RandomGamma`<br>`RandomNoise`<br>`RandomSwap` [45]<br>`RandomLabelsToImage` [46]<br>`RandomAnisotropy` [47] |



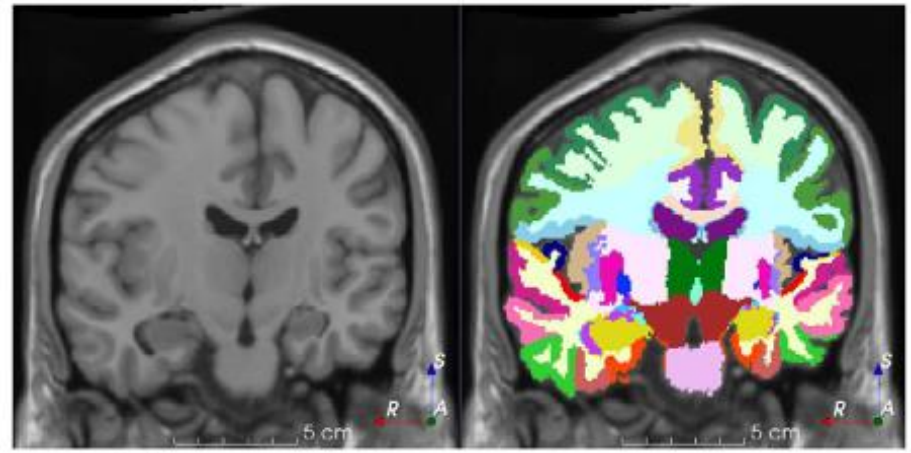

(h) Random motion artifact




(g) Random bias field artifact

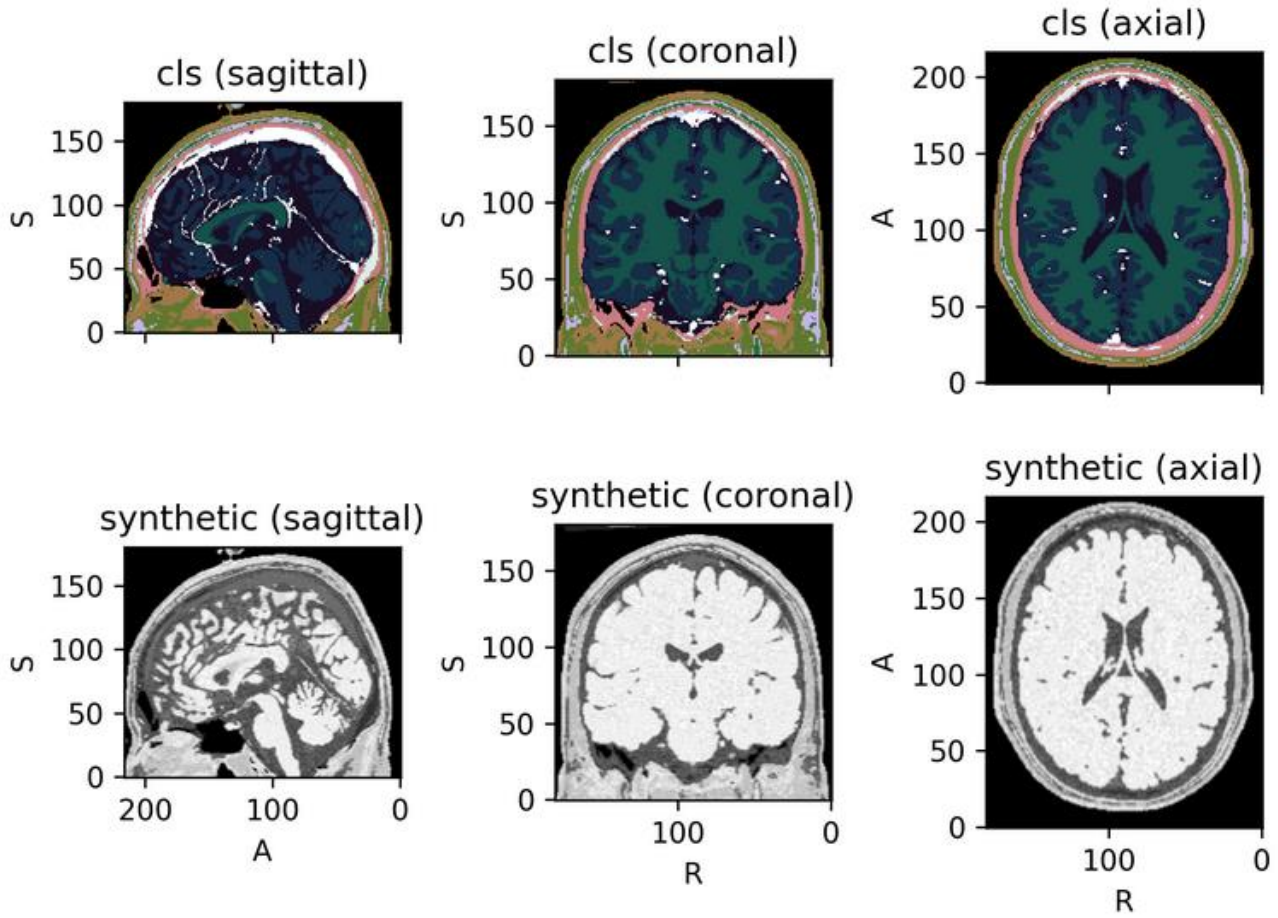



(j) Random ghosting artifact




(f) Random elastic transformation

# RANDOM LABEL TO IMAGE



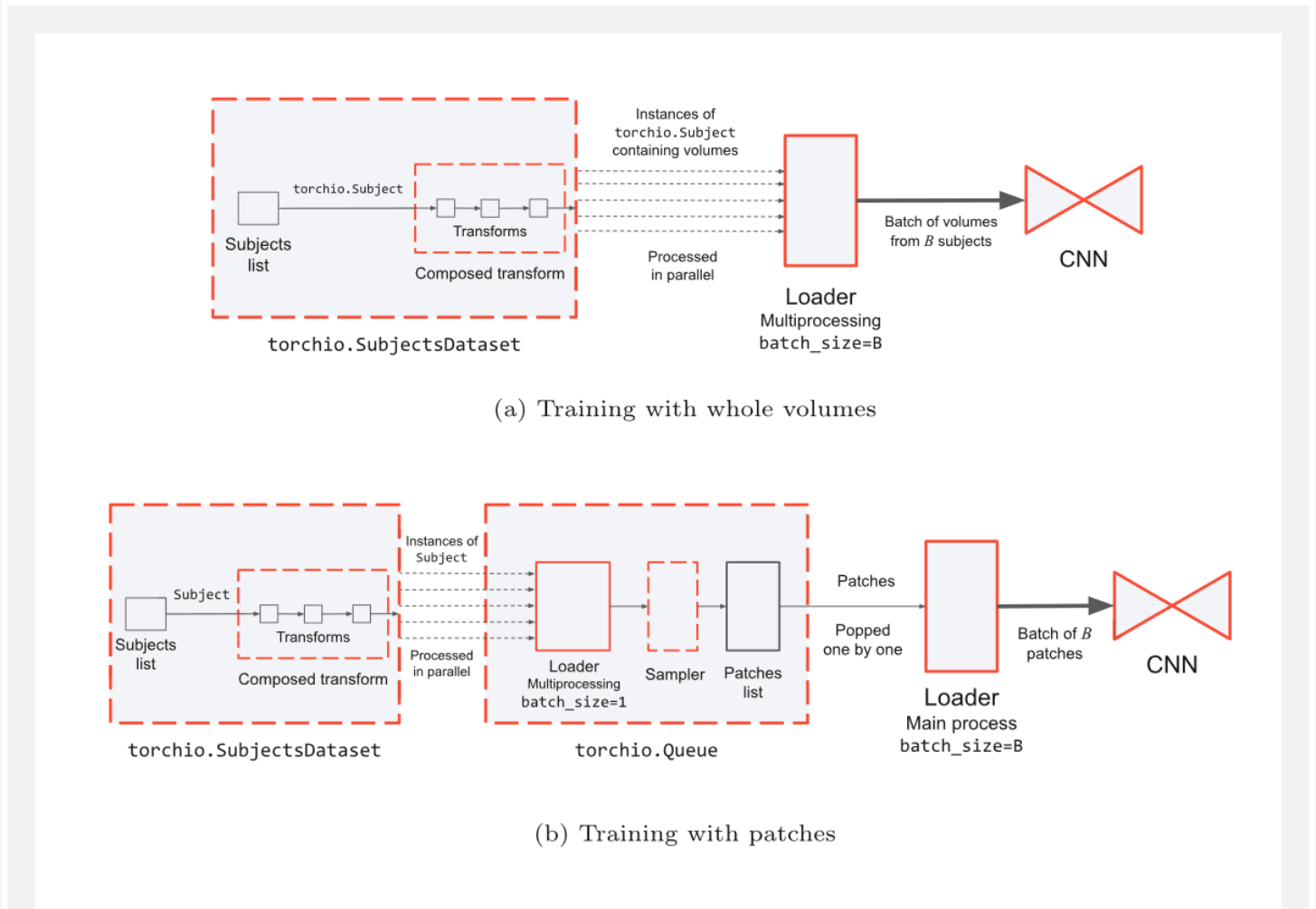
# PATCH BASED TRAINING

- 224 × 224 × 3 = 150 528 pixels
- 512 × 512 × 1069 = 280 231 936 voxels (high resolution lung CT scan)

- Smaller batches => reduce efficiency of Batch Normalisation
- Longer training time

# PATCH SAMPLERS

- UniformSampler: select patch center randomly
- WeightedSampler : select patch center according to probability map
- GridSampler: Ensure all pixels are processed at least once
- GridAggregator : Merge results of GridSampler



# INTERESTING DATASET STRUCTURE

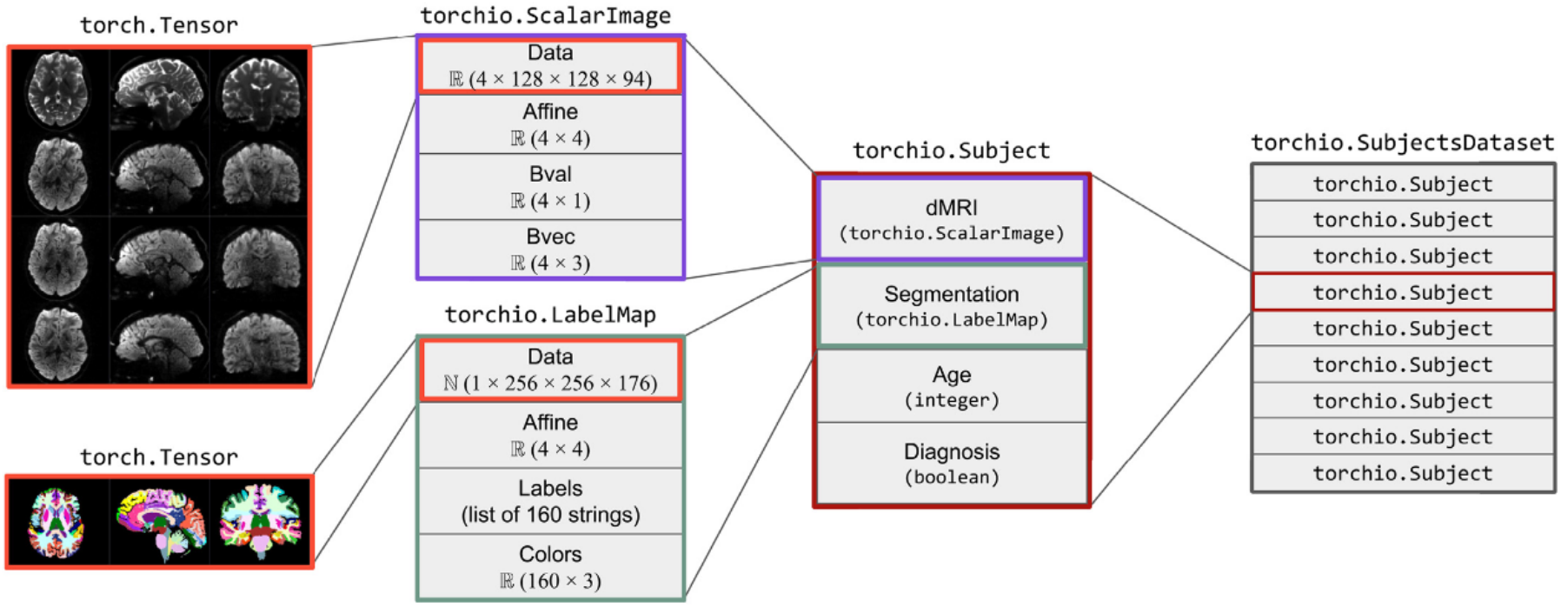



**Fig. 3.** Usage example of `ScalarImage`, `LabelMap`, `Subject` and `SubjectsDataset`. The images store a 4D dMRI and a brain parcellation, and other related metadata.

# CONCLUSION

- Interesting Tool to create synthetic samples
- Nice Dataset structure that seems easy to expand

- Mainly focus on Brain MRI
- Poorly named