

MR Acquisition-Invariant Representation Learning

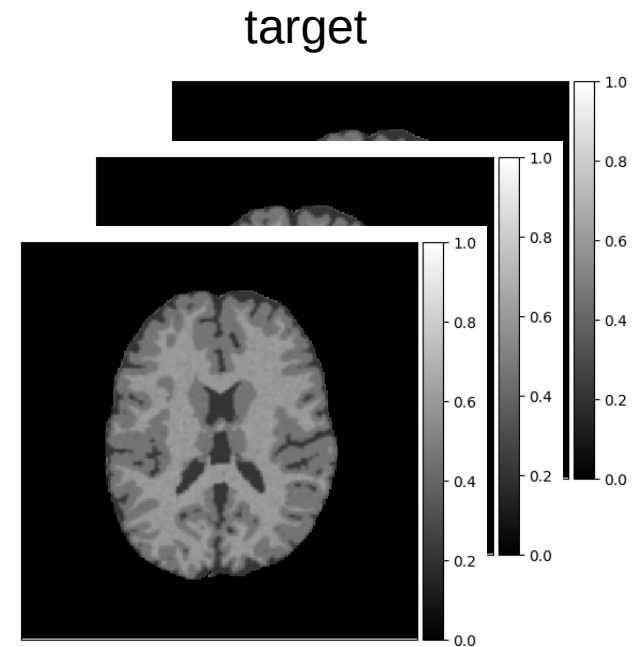
Wouter Kouw

29-05-2018

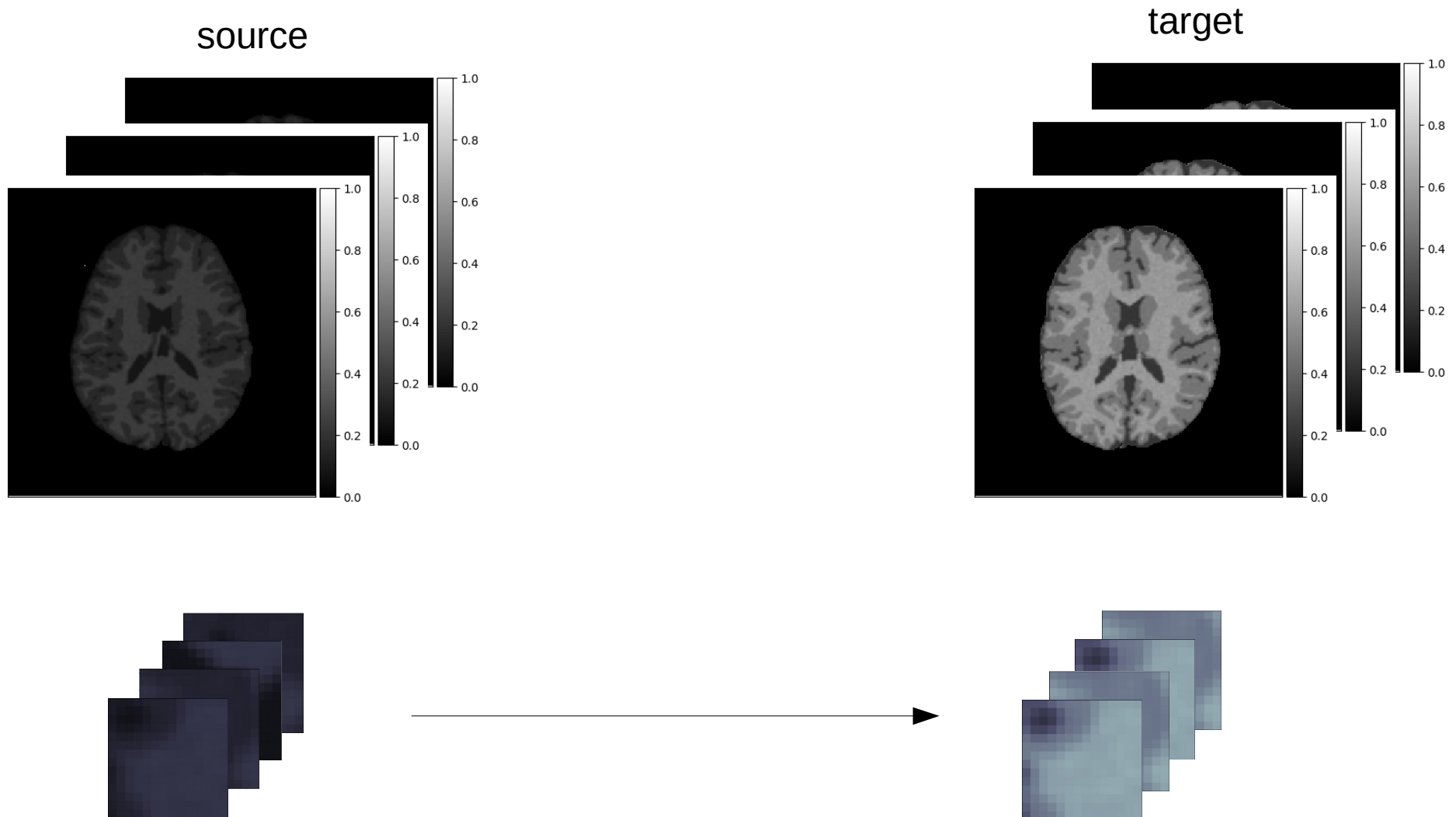
Data integration

- In order to create large data sets, data sets from multiple medical centers are often joined together.
- However, combining data sets without taking scanner variation into account is not a good idea.

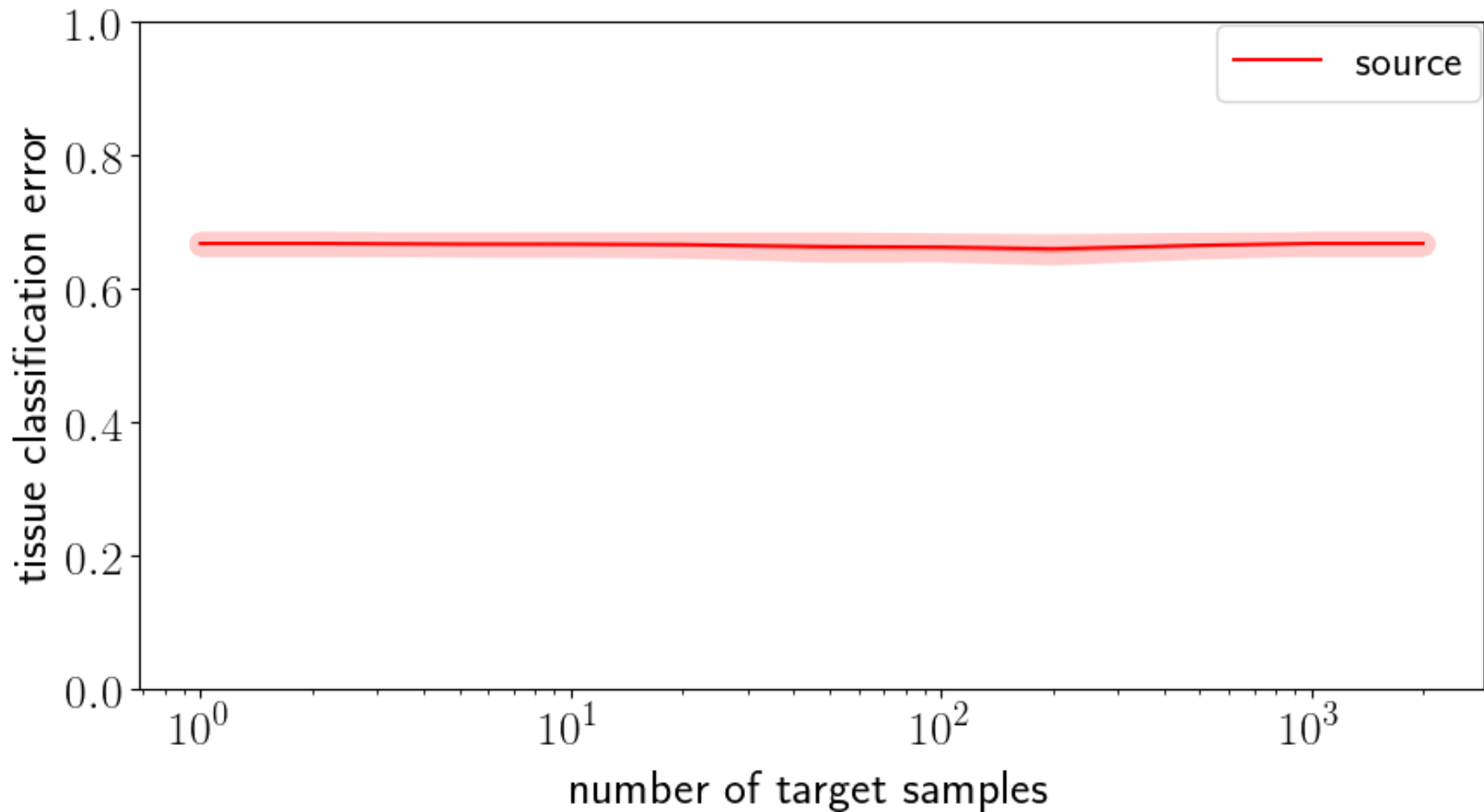
Generalizing across MRI scanners



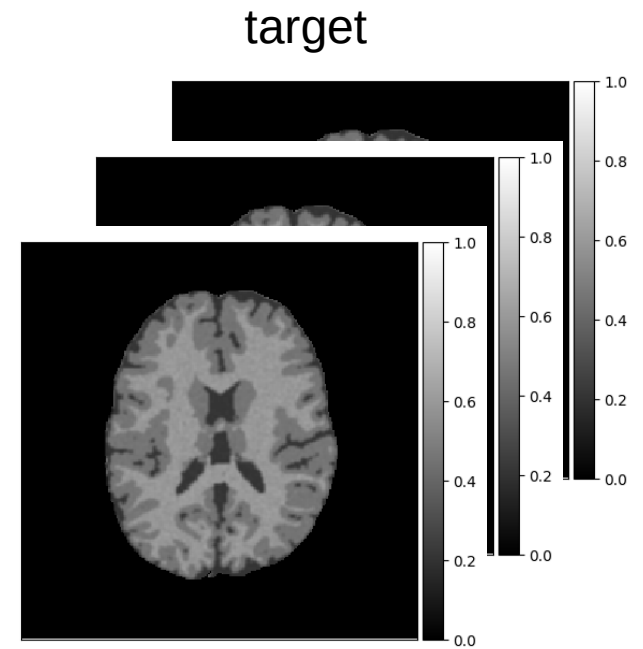
Generalizing across MRI scanners



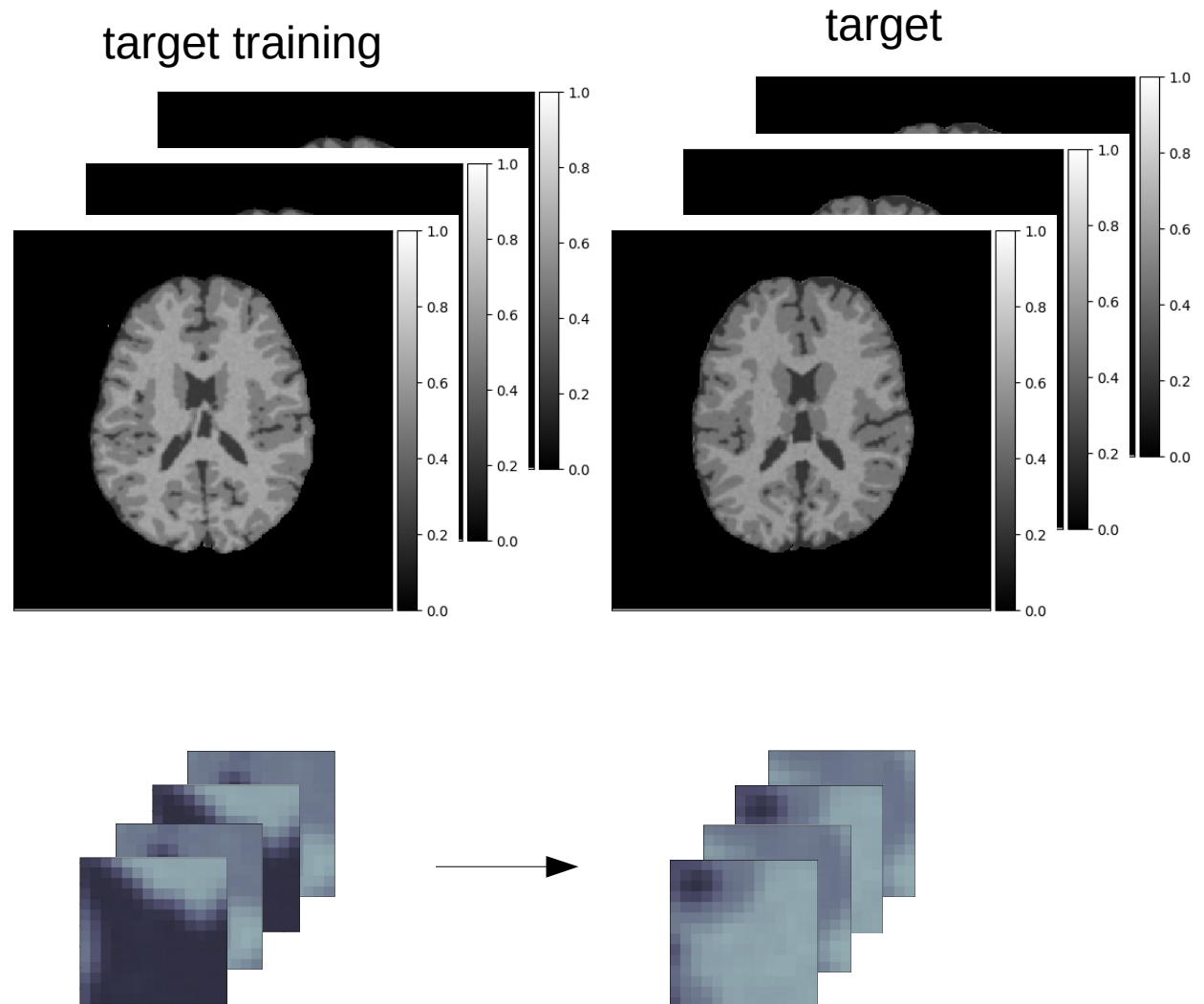
Generalizing across MRI scanners



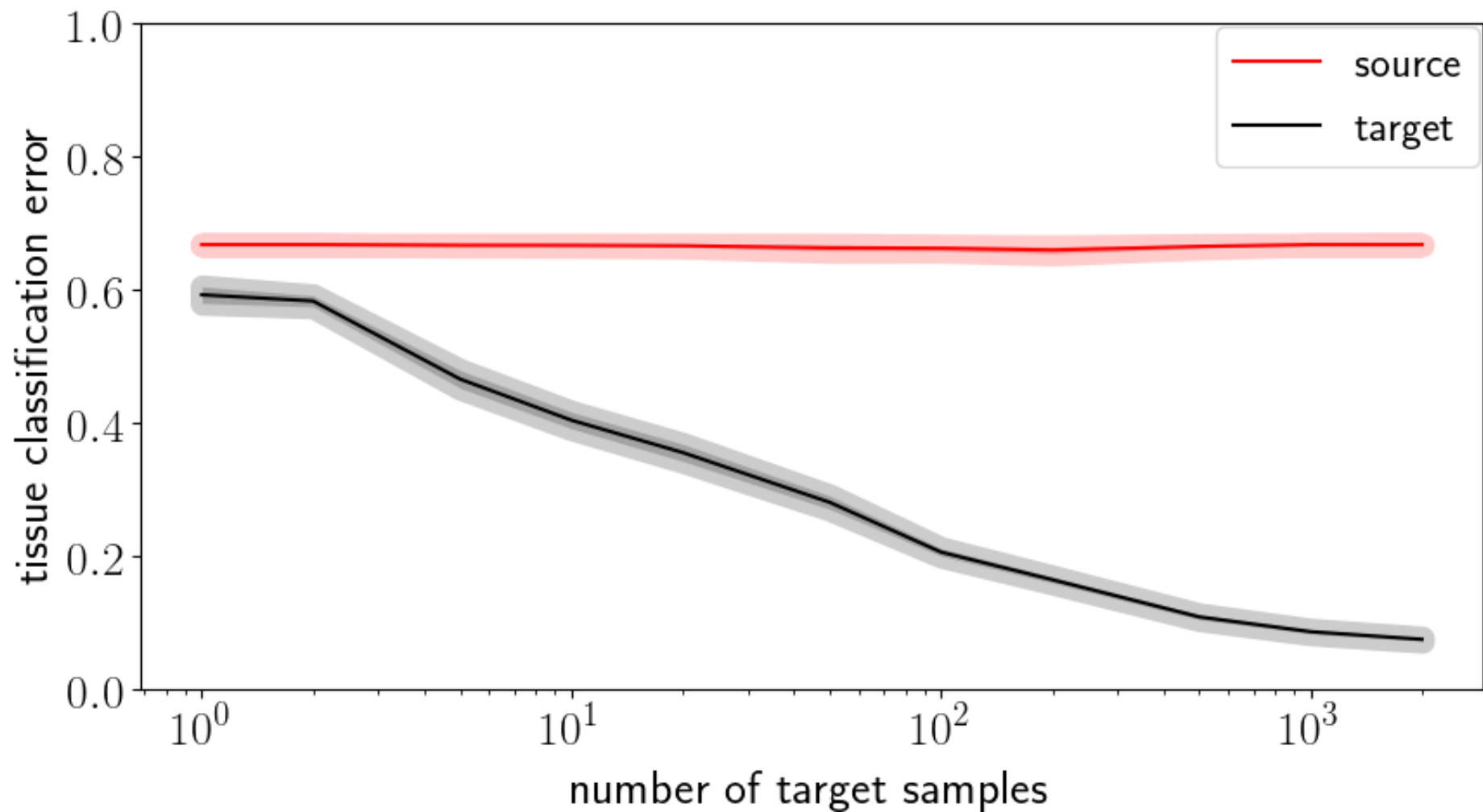
Generalizing across MRI scanners



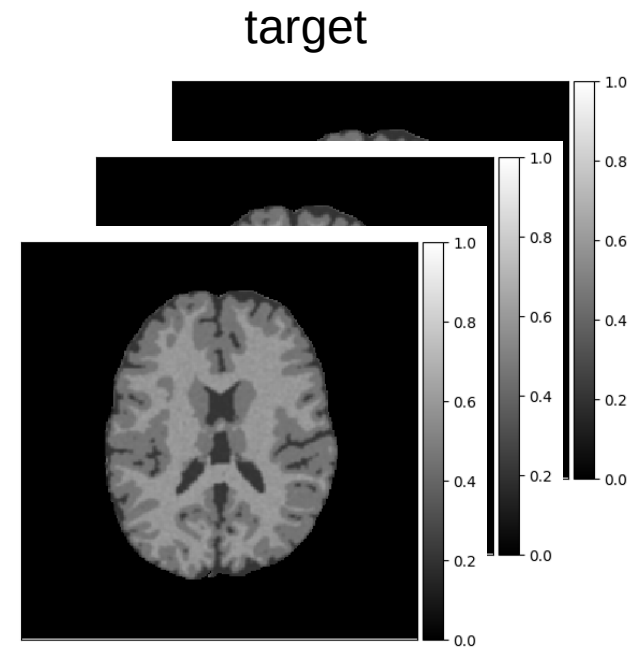
Generalizing across MRI scanners



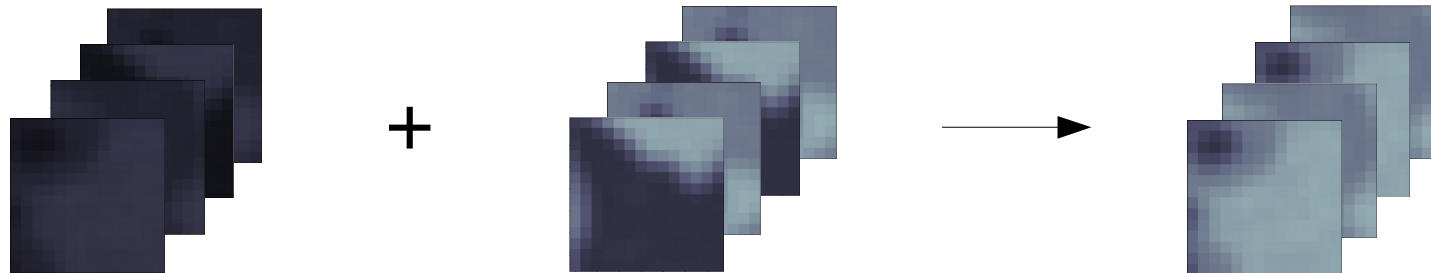
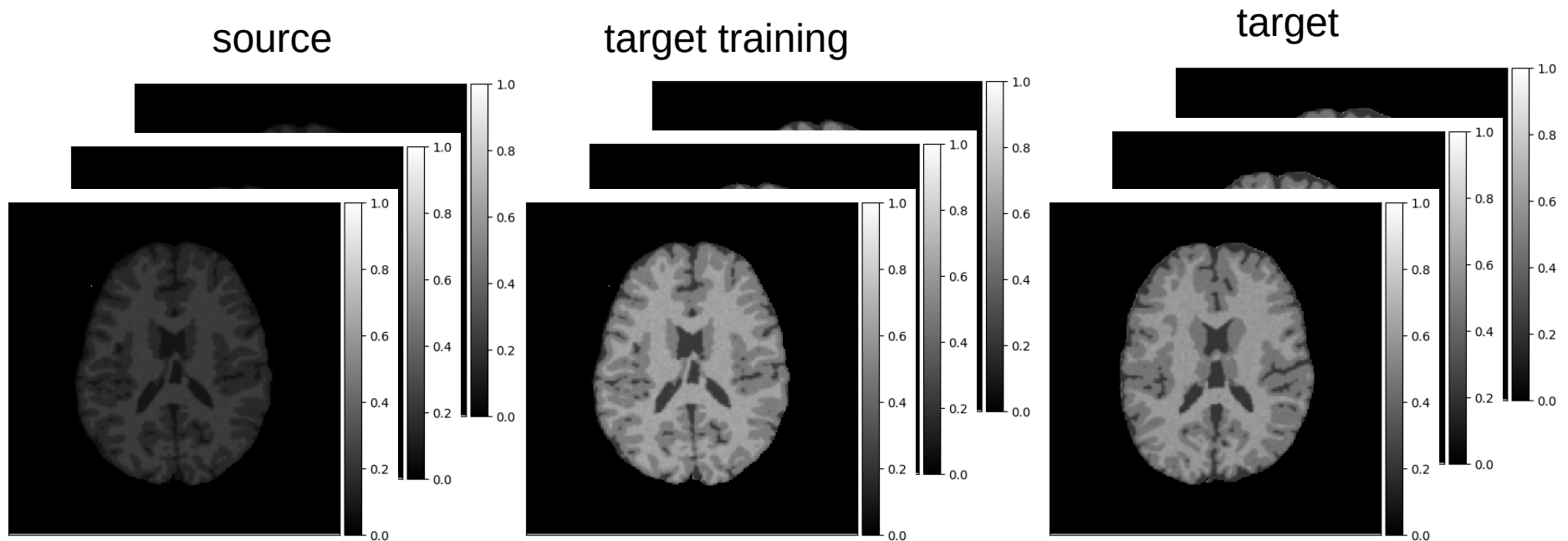
Generalizing across MRI scanners



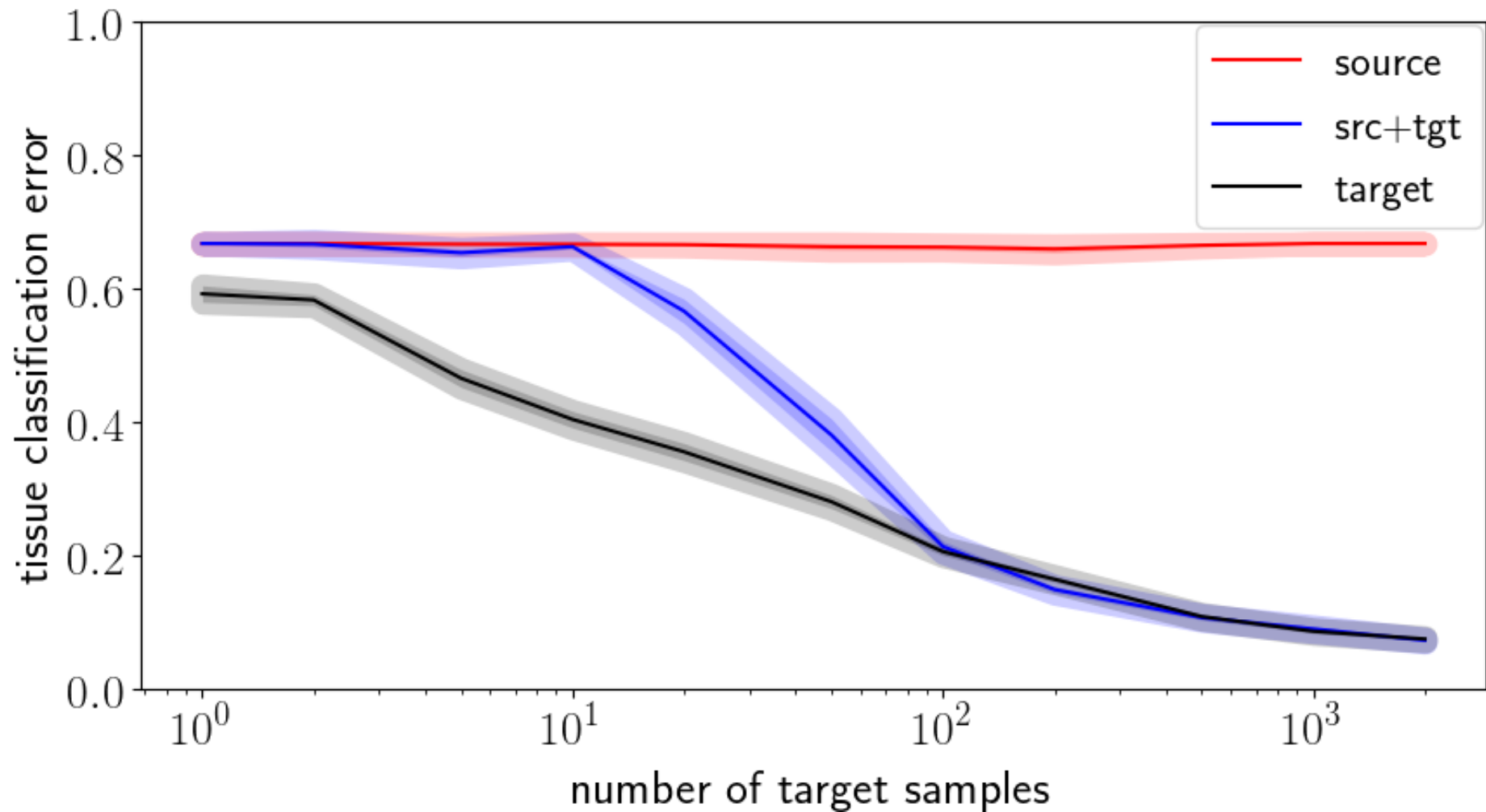
Generalizing across MRI scanners



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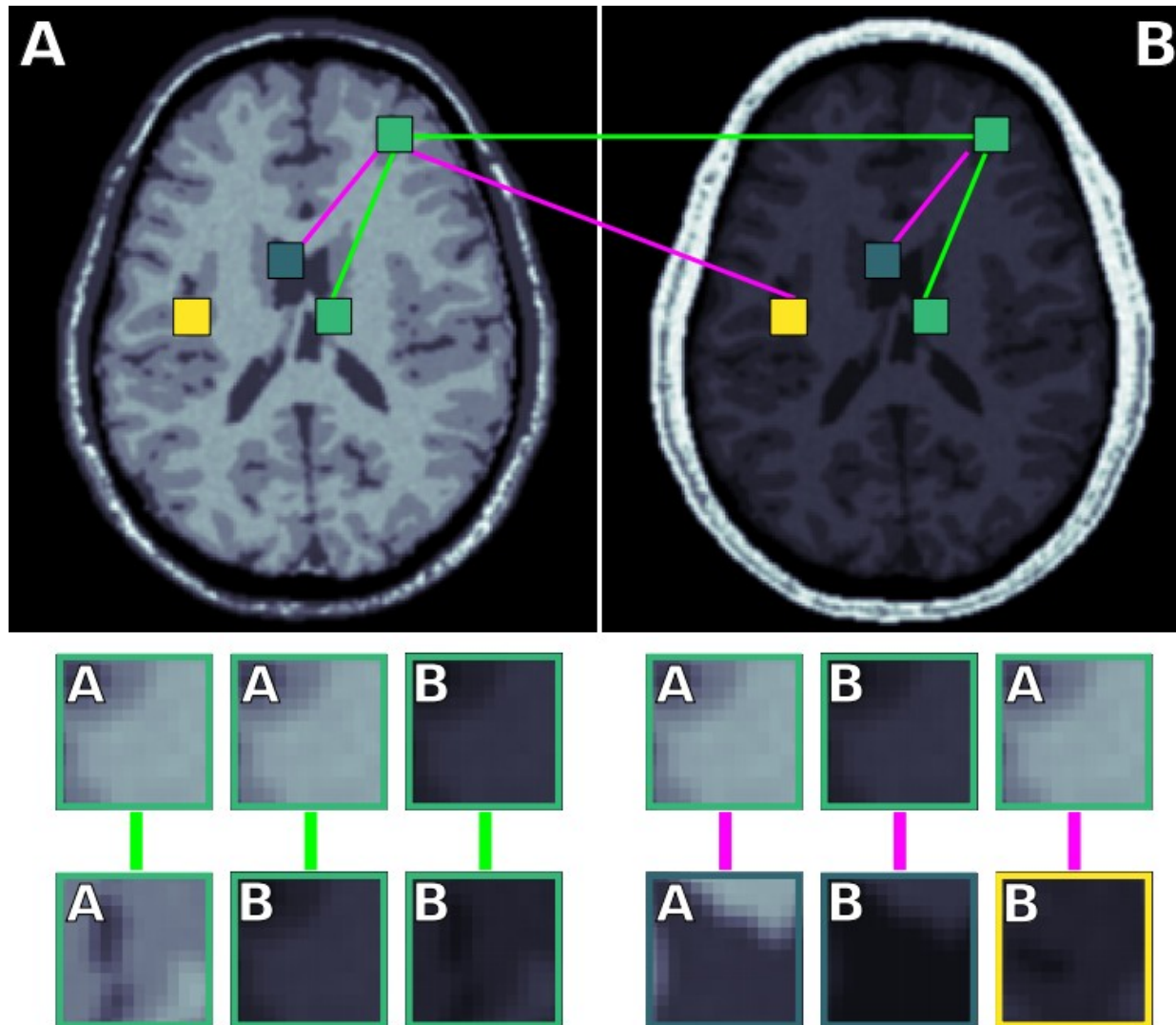
MRI acquisition-based variation

- **Medical images contain many factors of variation:**
 - Anatomical: age, gender, etc.
 - Pathological: lesions, tumors, etc.
 - Environmental: temperature, humidity, etc.
- **However, there are also factors caused by the scanner:**
 - Different vendors
 - Different scan sequences
 - Different positioning of gradients

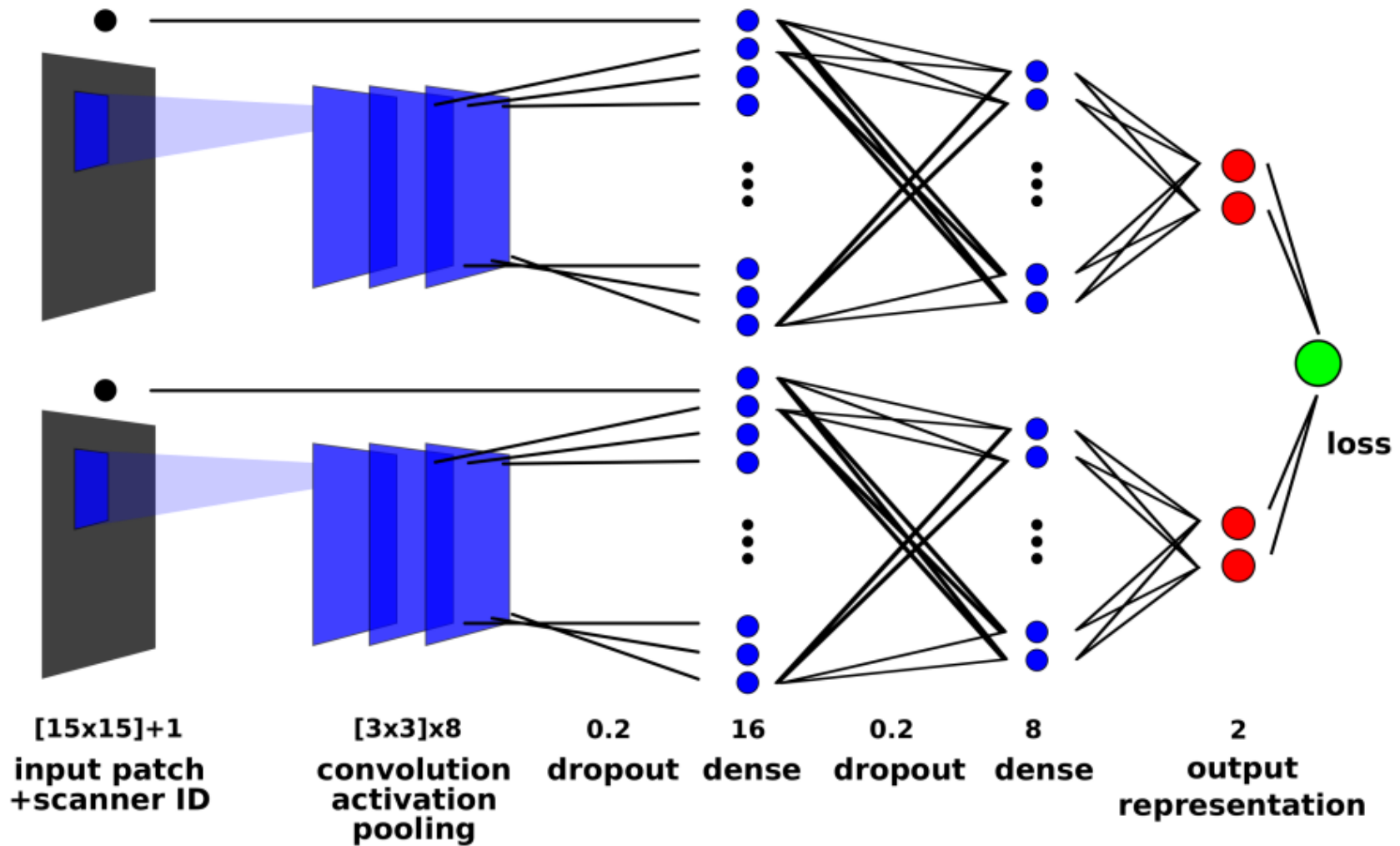
Removing scanner variation

- **Goal: represent the data such that the following occurs:**
 - Patches from the same class across different scanners are supposed to be similar.
 - Patches from different classes across either the same or different scanners are supposed to be dissimilar.

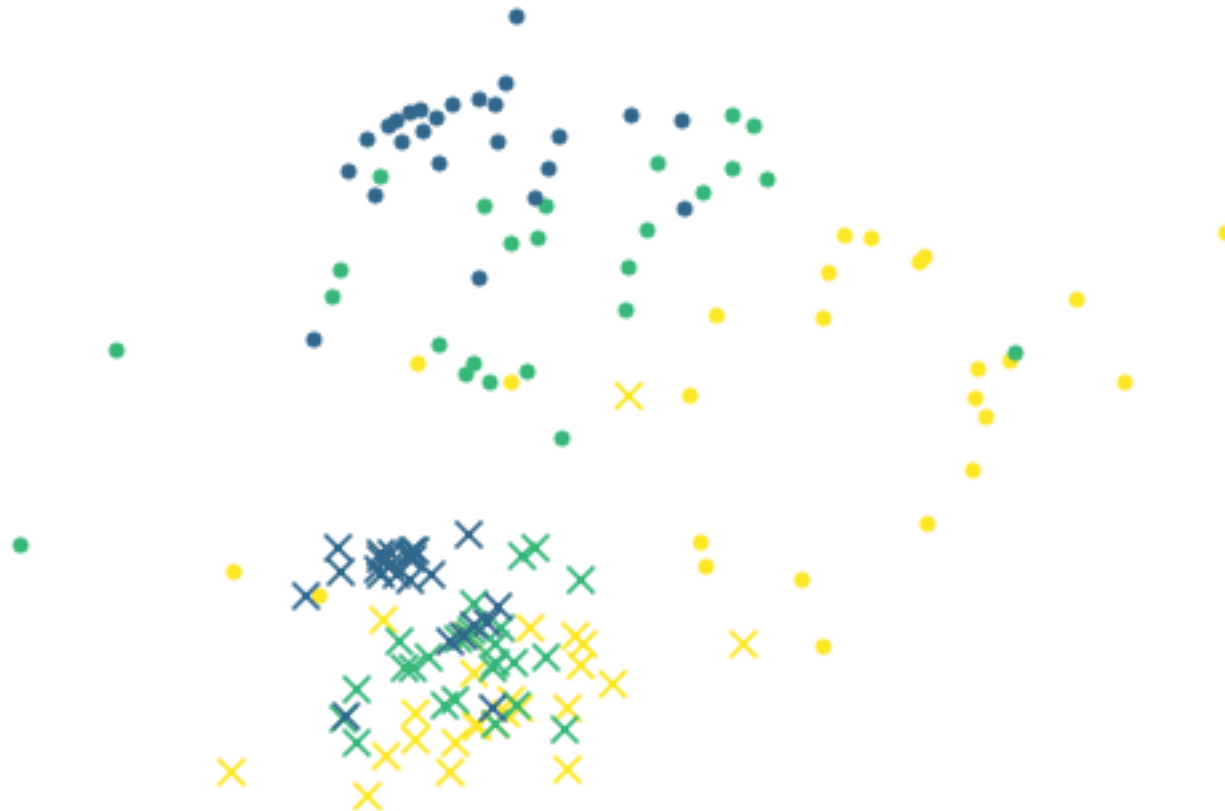
Generating pairs



MRAI-net



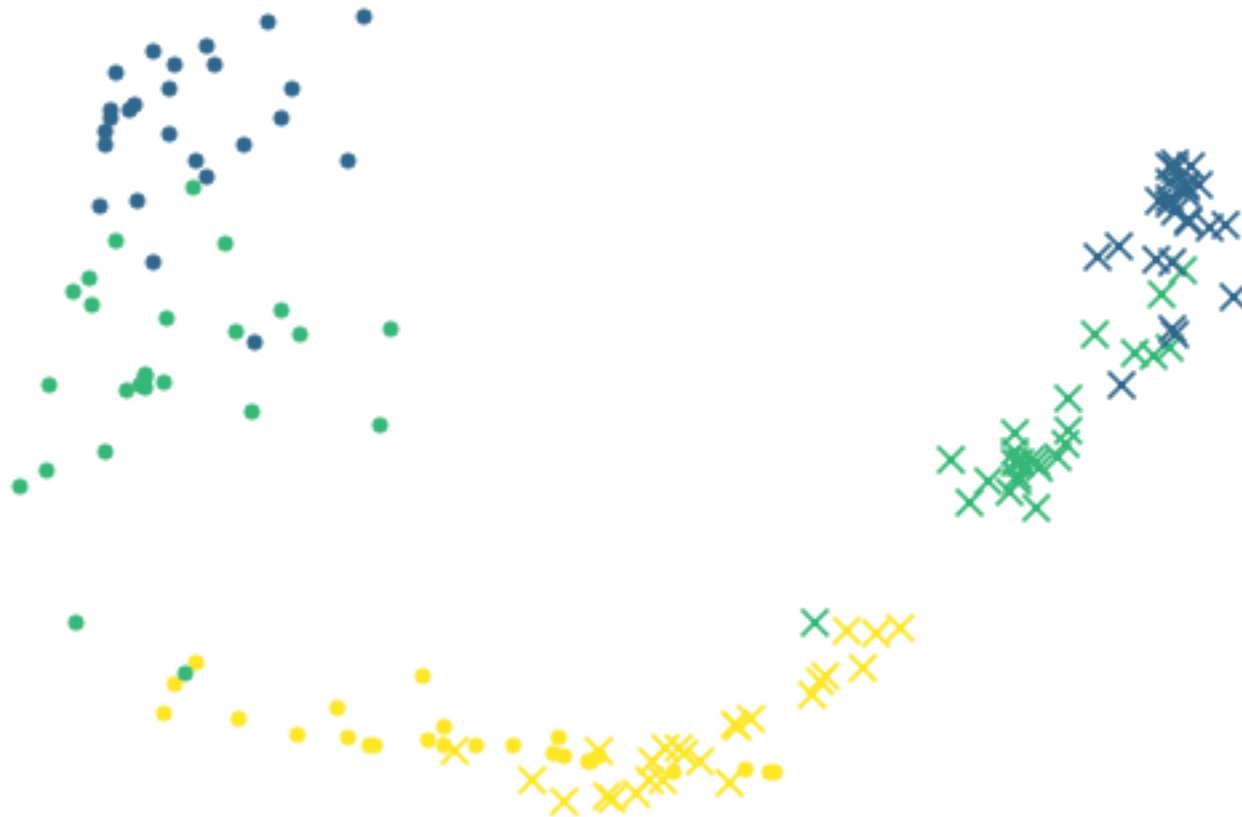
Training MRAI-net



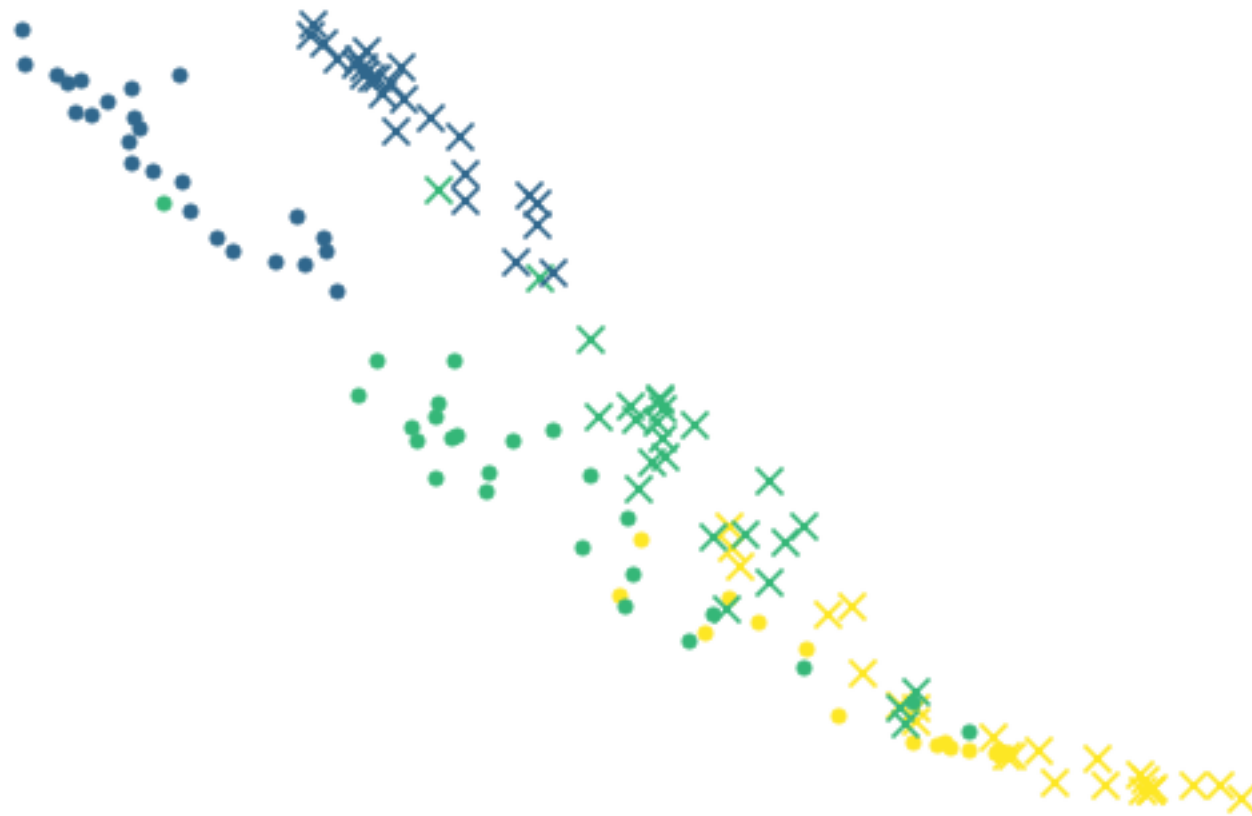
Training MRAI-net



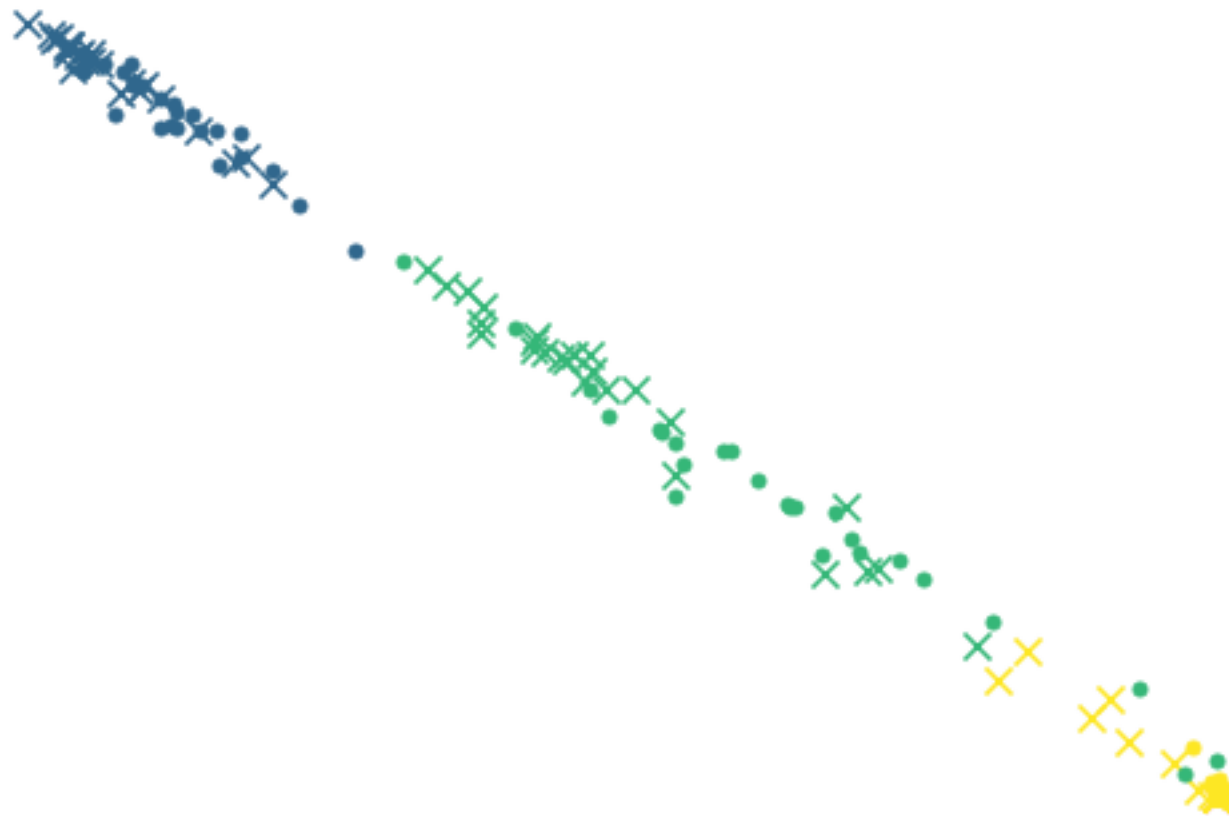
Training MRAI-net



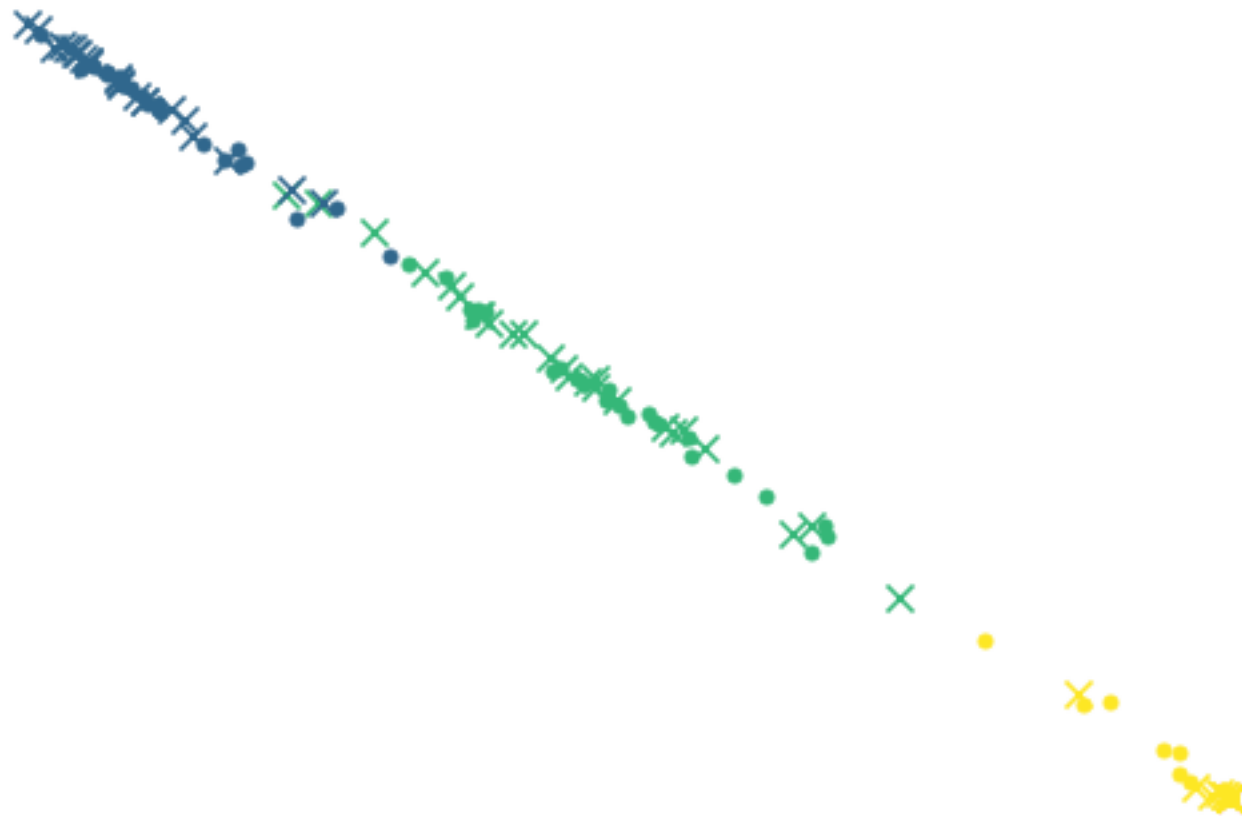
Training MRAI-net



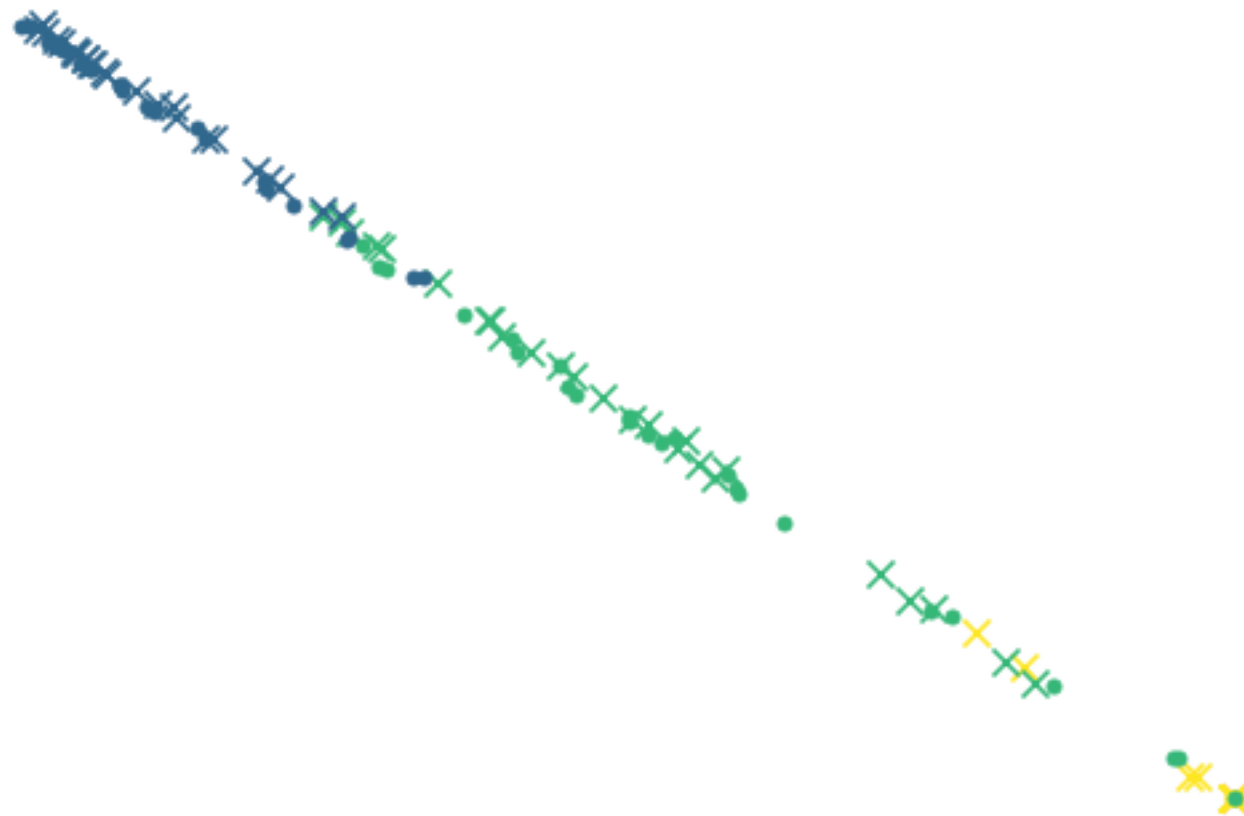
Training MRAI-net



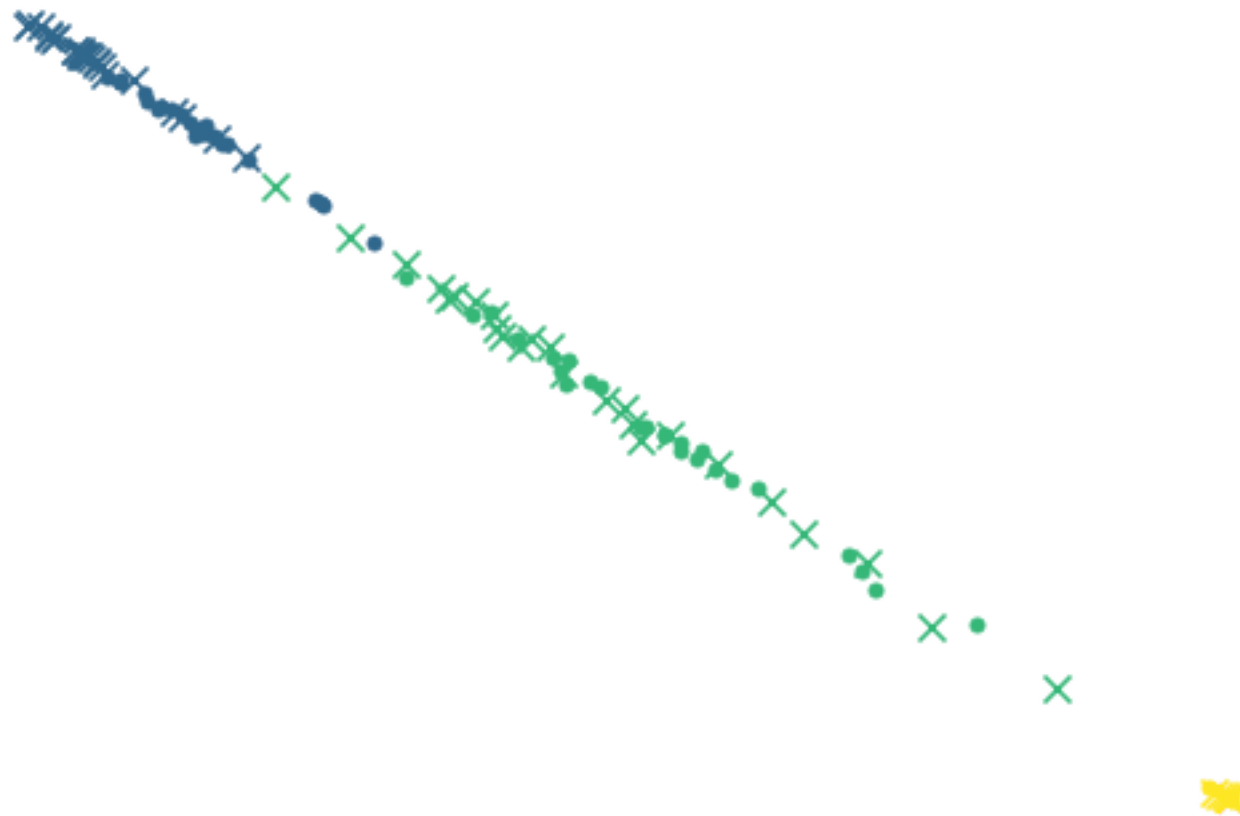
Training MRAI-net



Training MRAI-net



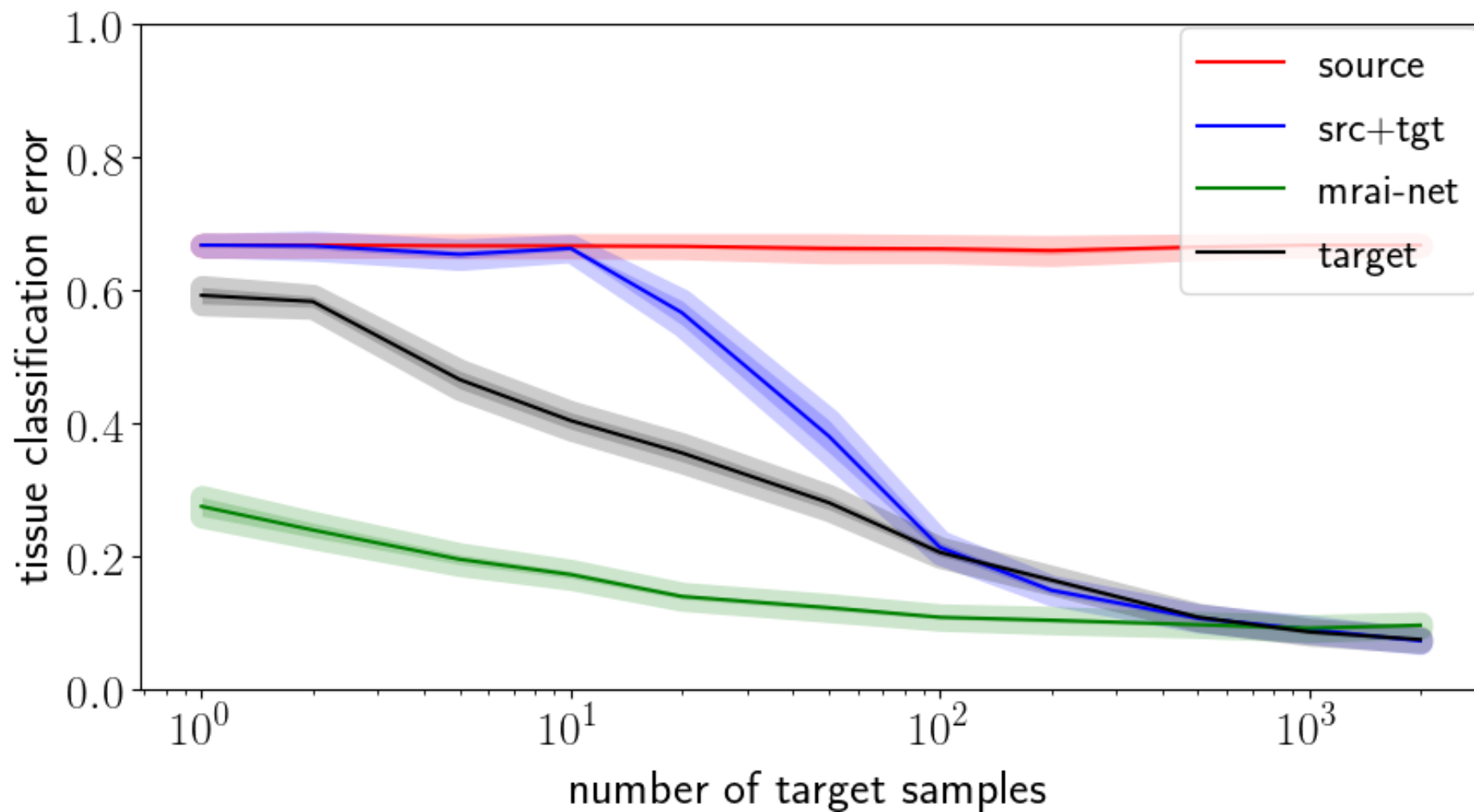
Training MRAI-net



MRAI representation

- Patches from either scanner can be fed through the network.
- The network maps the patches to a 2D feature vector representation.
- In this new representation, a linear classifier is sufficient to perform tissue classification.

MRAI representation

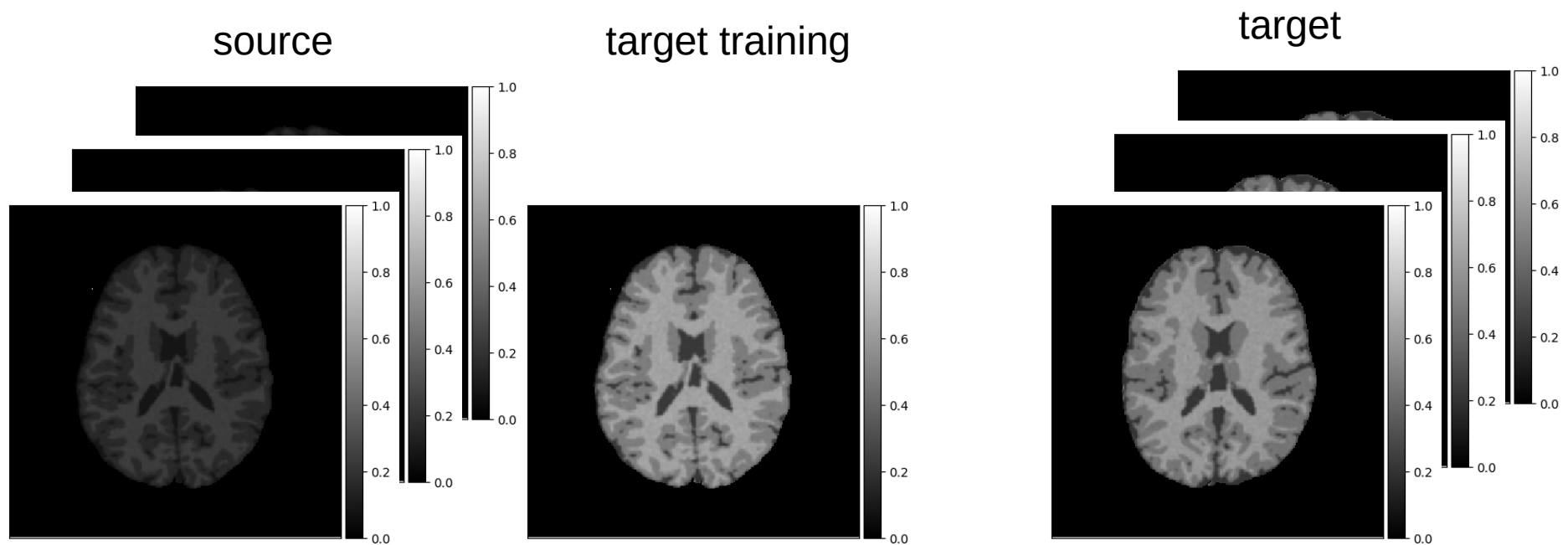


Predictions

- **A new image can be segmented by:**
 - Extracting all patches
 - Feeding all patches through MRAI-net
 - Applying the trained classifier
 - Mapping predictions back into an image

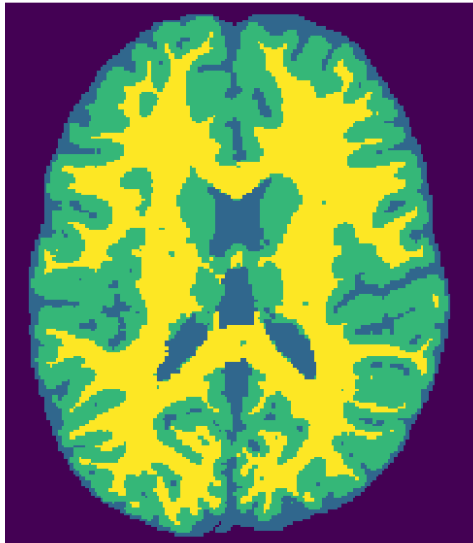
Predictions

- 1 labeled target sample per class:



Predictions

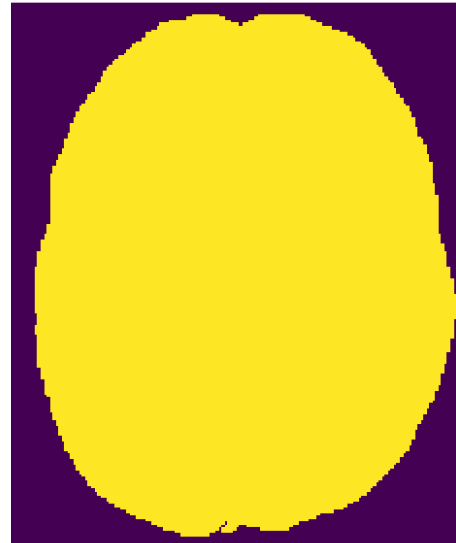
- 1 labeled target sample per class:



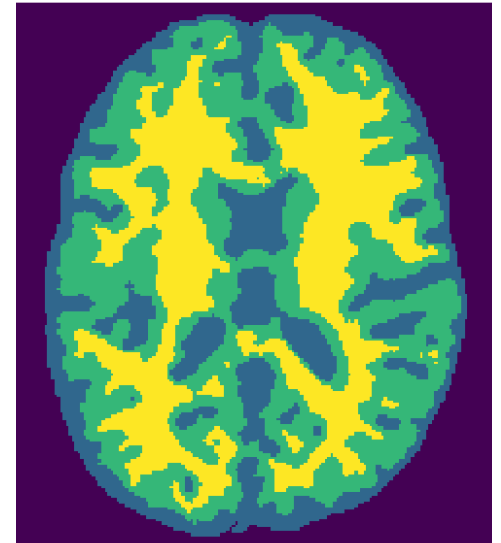
True



target



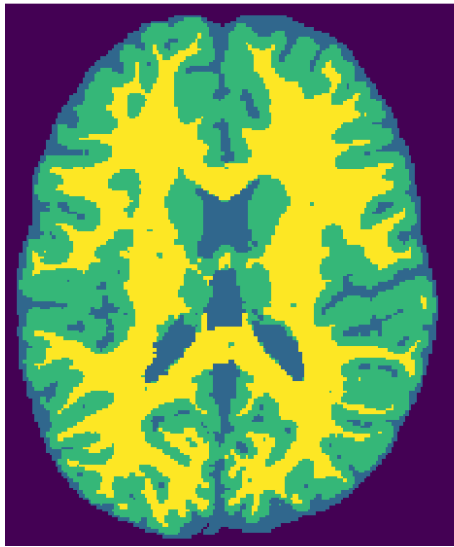
source+target



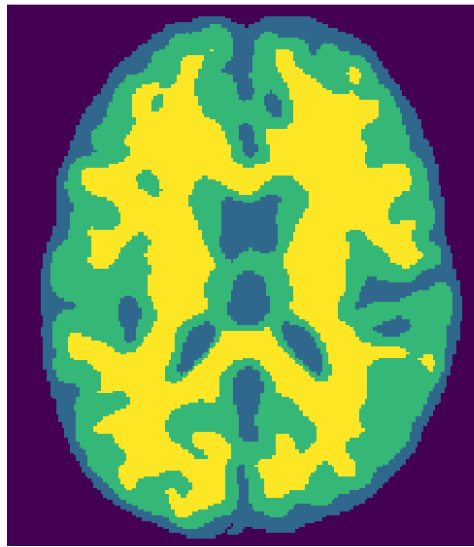
mrai-net

Predictions

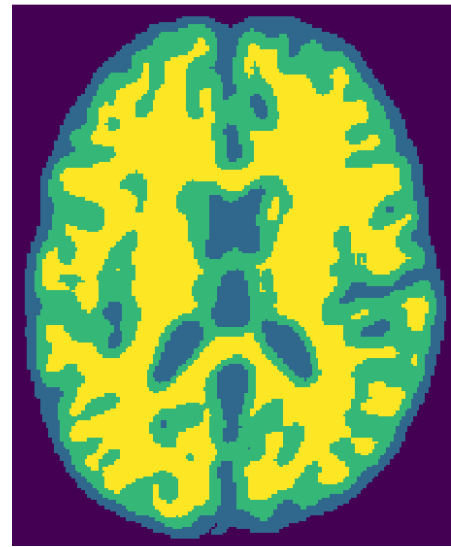
- 100 labeled target samples per class:



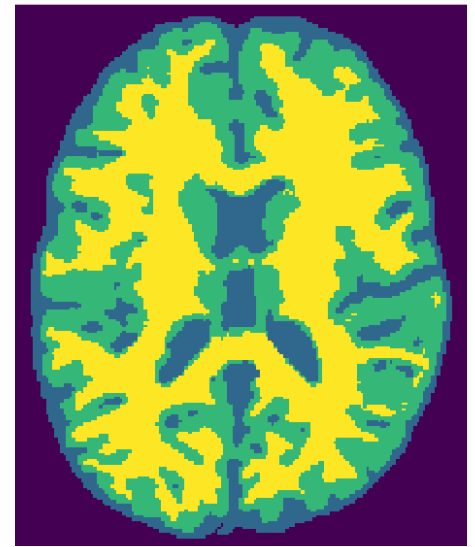
True



target



source+target

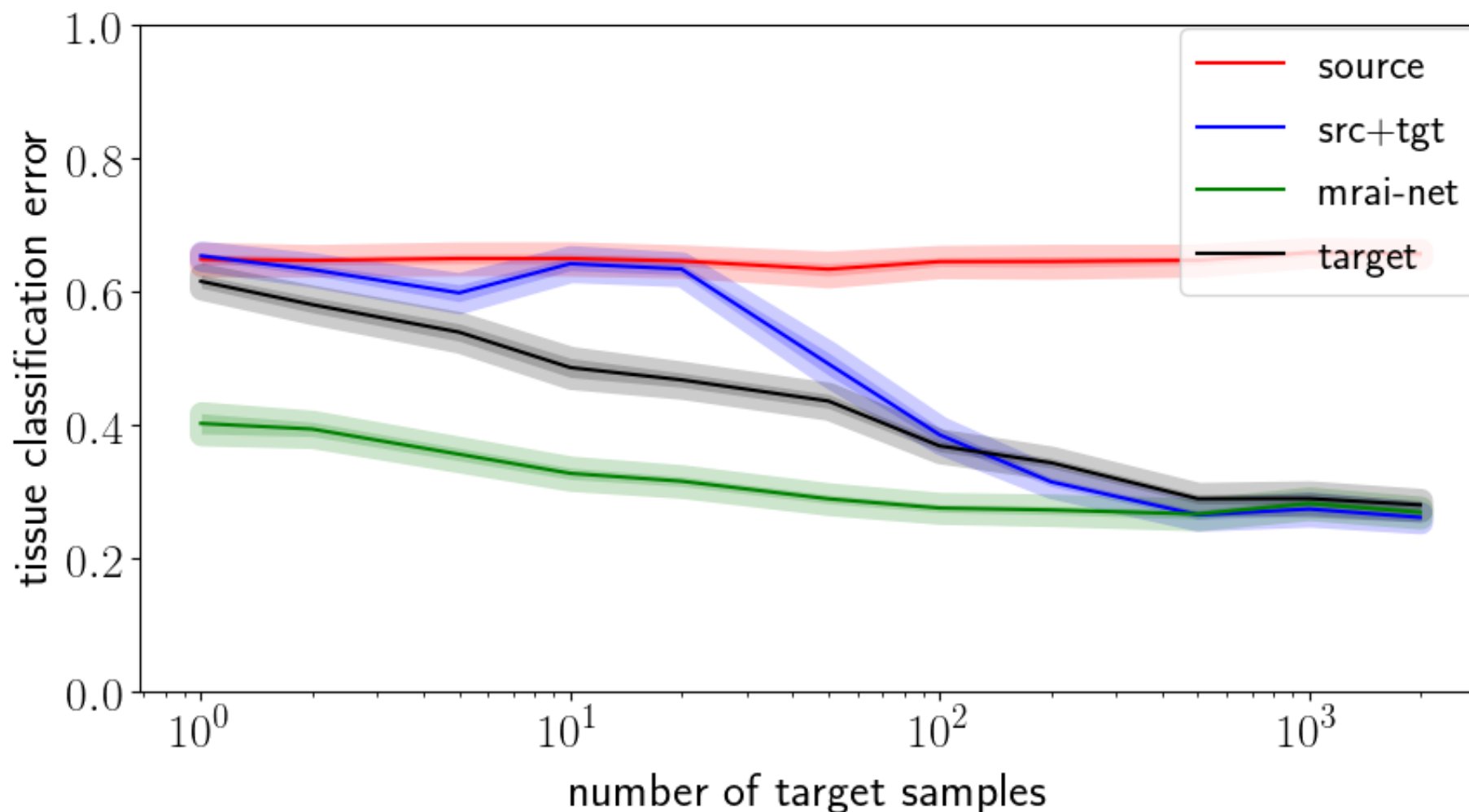


mrai-net

Questions

Brainweb1.5T → MRBrains

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Sacrificing human interpretability

- **Removing scanner-specific variation while maintaining human interpretability is difficult, because different forms of variation requires different types of transformation / normalization.**
- **Considering that the images are to be used by a classifier, we sacrifice human interpretability.**
 - This means that we map the image into a vector space representation.