A learning strategy for contrast-agnostic segmentation of brain MRI scans

Benjamin Billot

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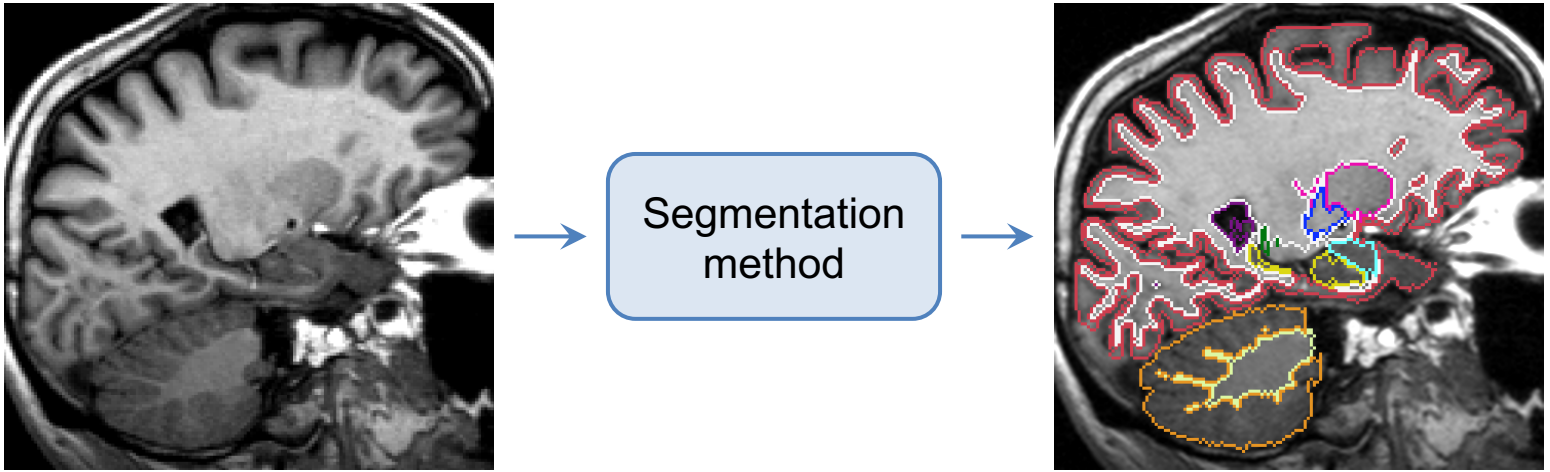
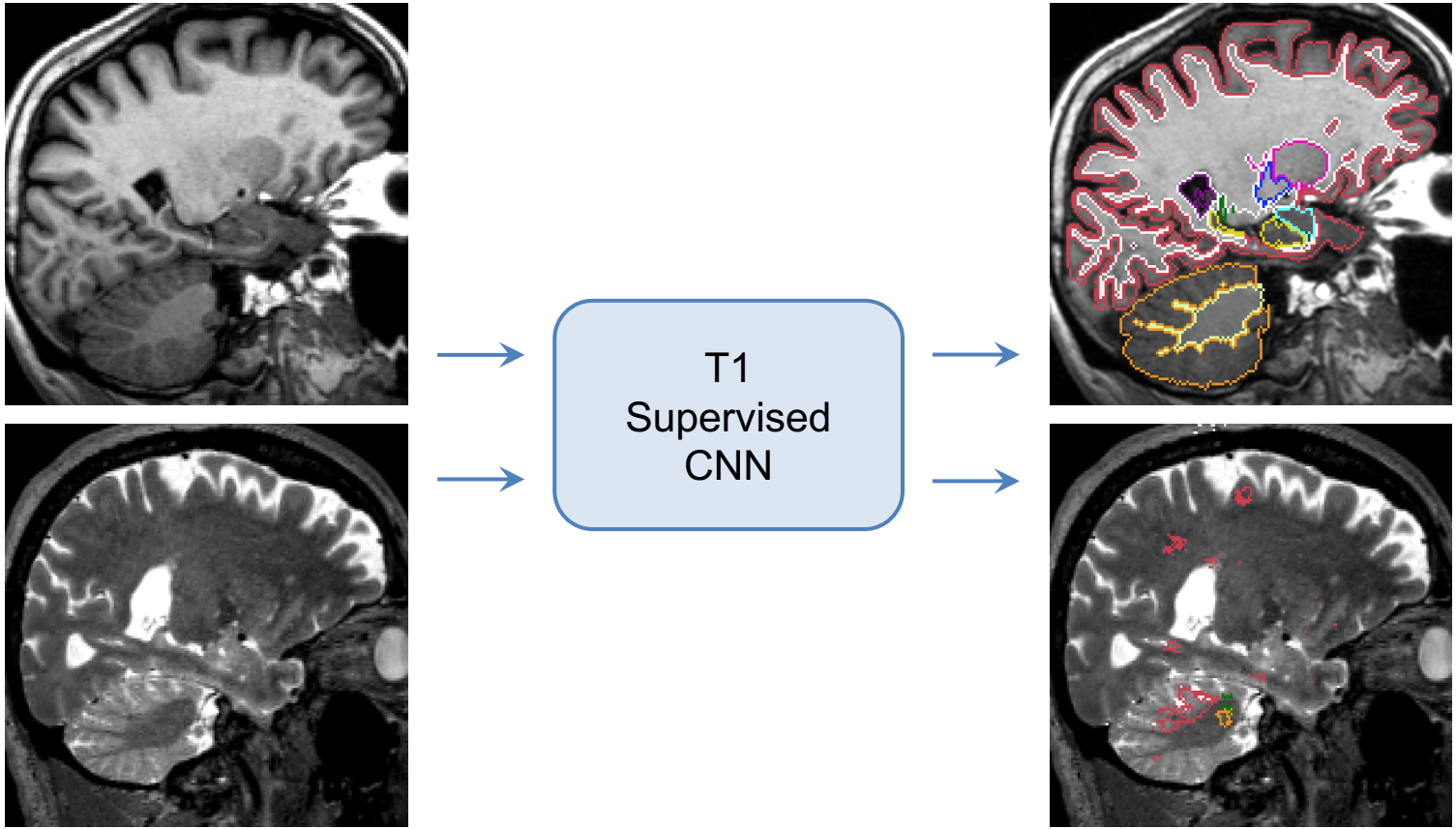
Segmentation



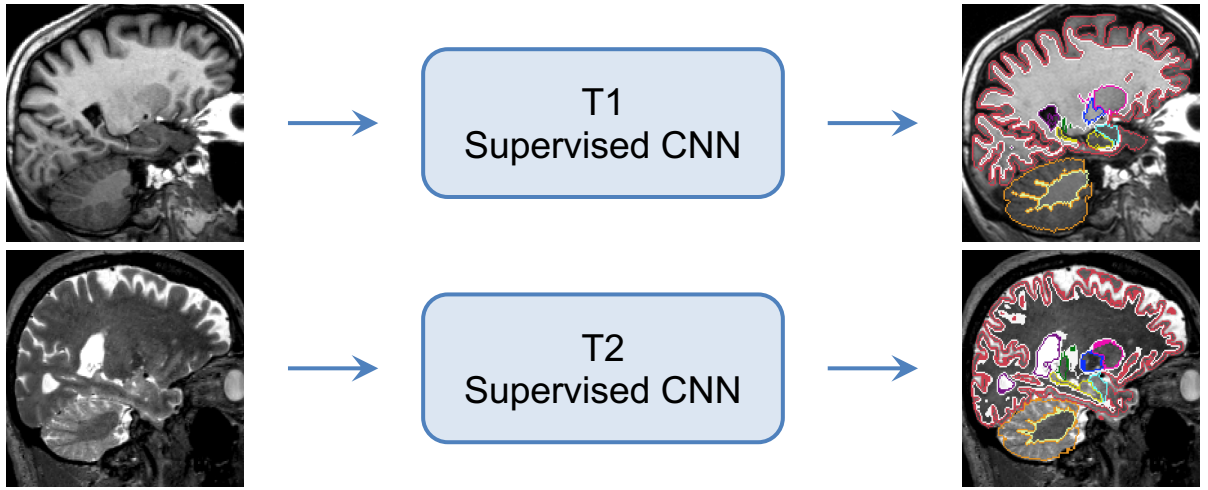
Types of methods

Methods	Speed	Modality-agnostic
Manual	---	+++
Multi-atlas segmentation	-	+
Bayesian segmentation	+	++
Supervised CNN	+++	---

Modality-specific CNN



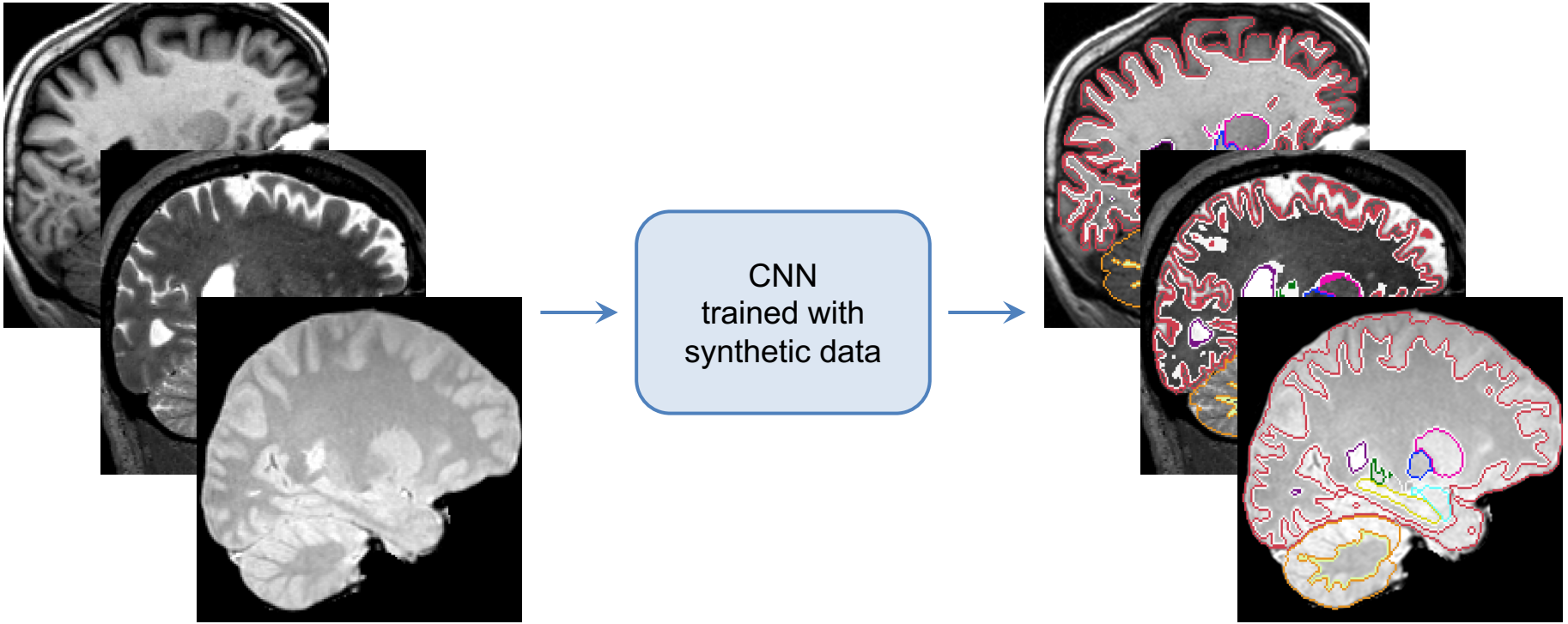
Supervised segmentation



Problems with supervised CNNs

- only work on modalities they were trained with
- sensitive to pre-processing
- require supervised data

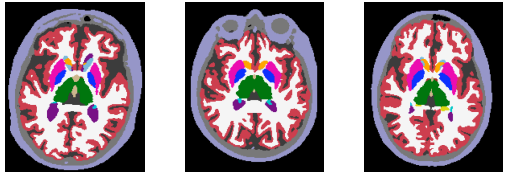
Solution: Synthesise data…

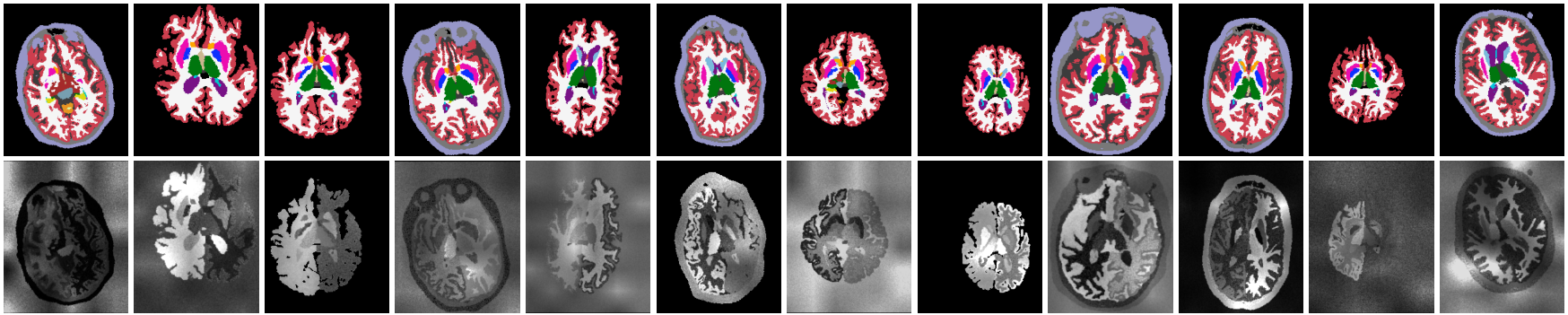


…of random contrast !

SynthSeg

Set of anatomical segmentations





Supervised CNN

Outline

Introduction

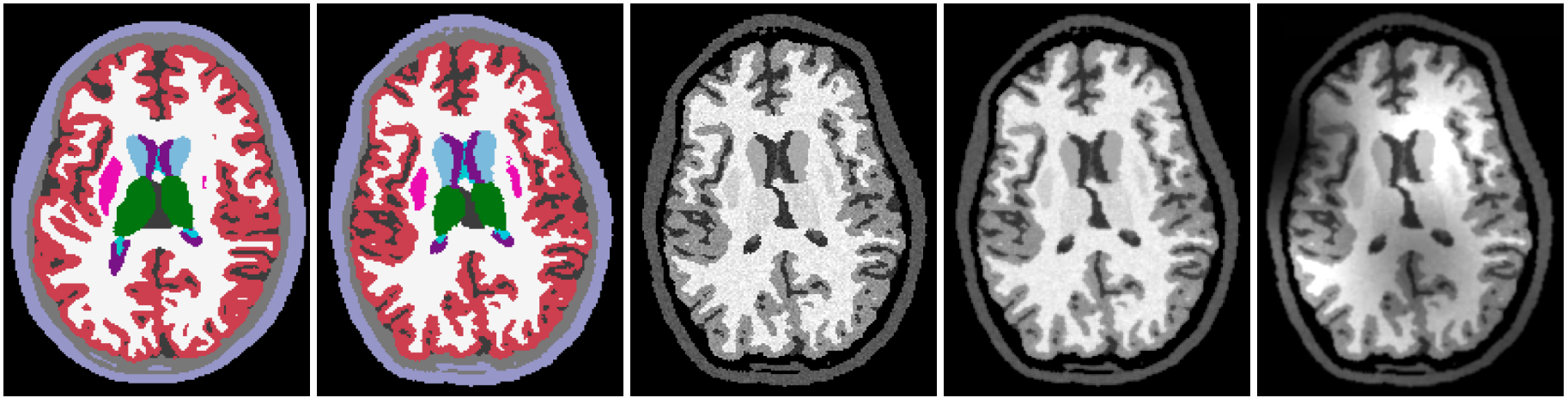
Methods
- Generative model
- Training

Experiments and results
- Experimental set-up
- Results

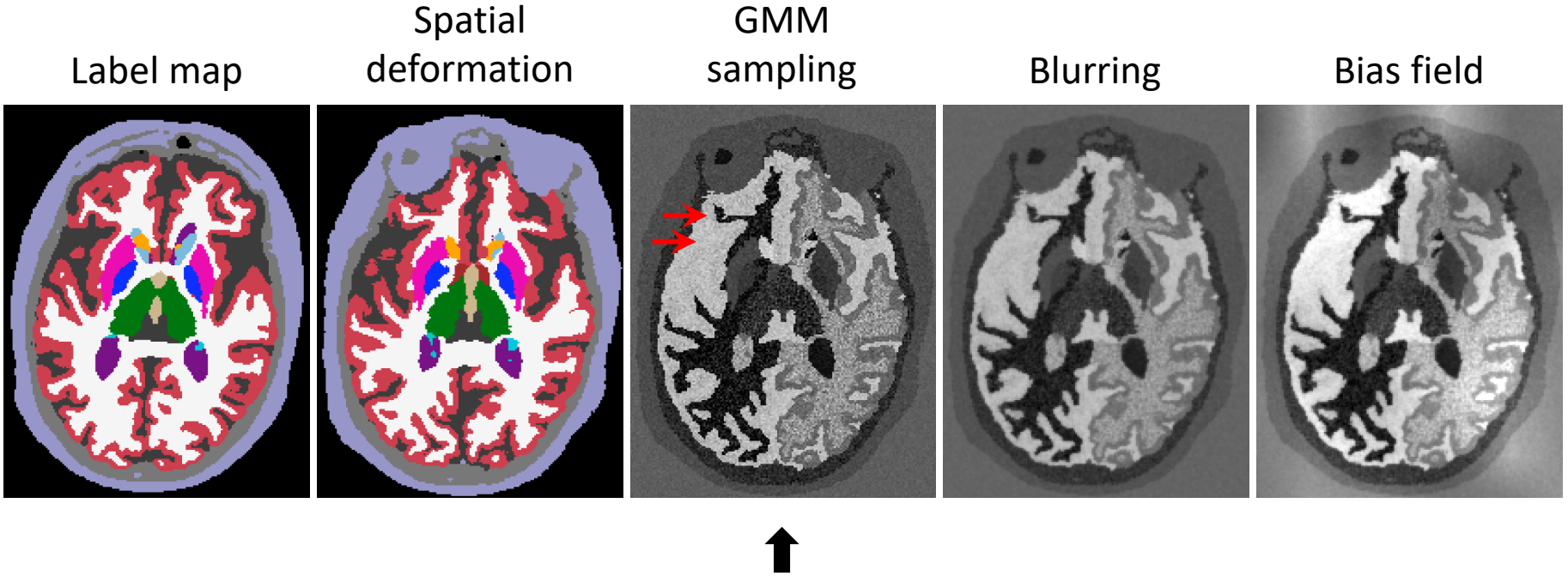
Conclusion

Generation of T1 contrast

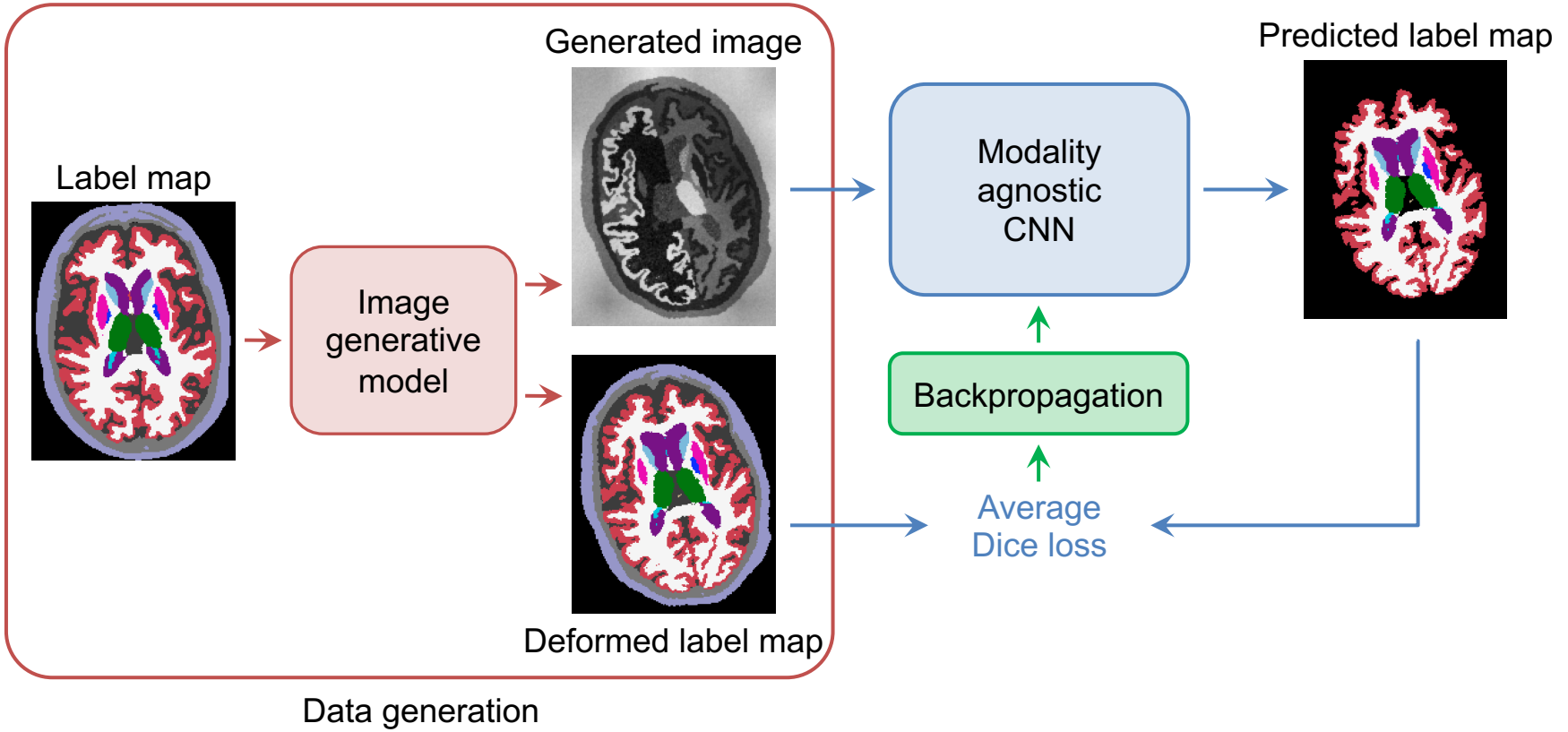
Label map | Spatial deformation | GMM sampling | Blurring | Bias field



Generation of random contrast



SynthSeg training overview



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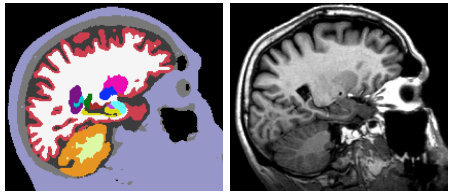
Datasets

T1-39:

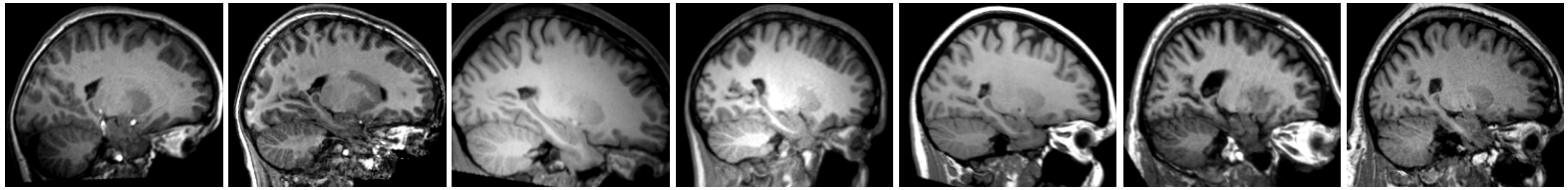
39 subjects



Training | Testing

T1mix:

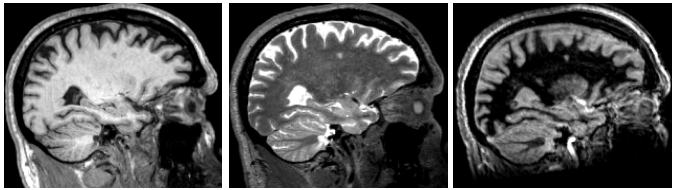
1,000 subjects



ABIDE | ADHD | HABRE | GSP | MCIC | OASIS | PPMI

FSM:

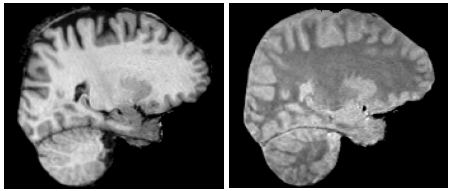
18 subjects



T1 | T2 | DBS

T1-PD-8:

8 subjects



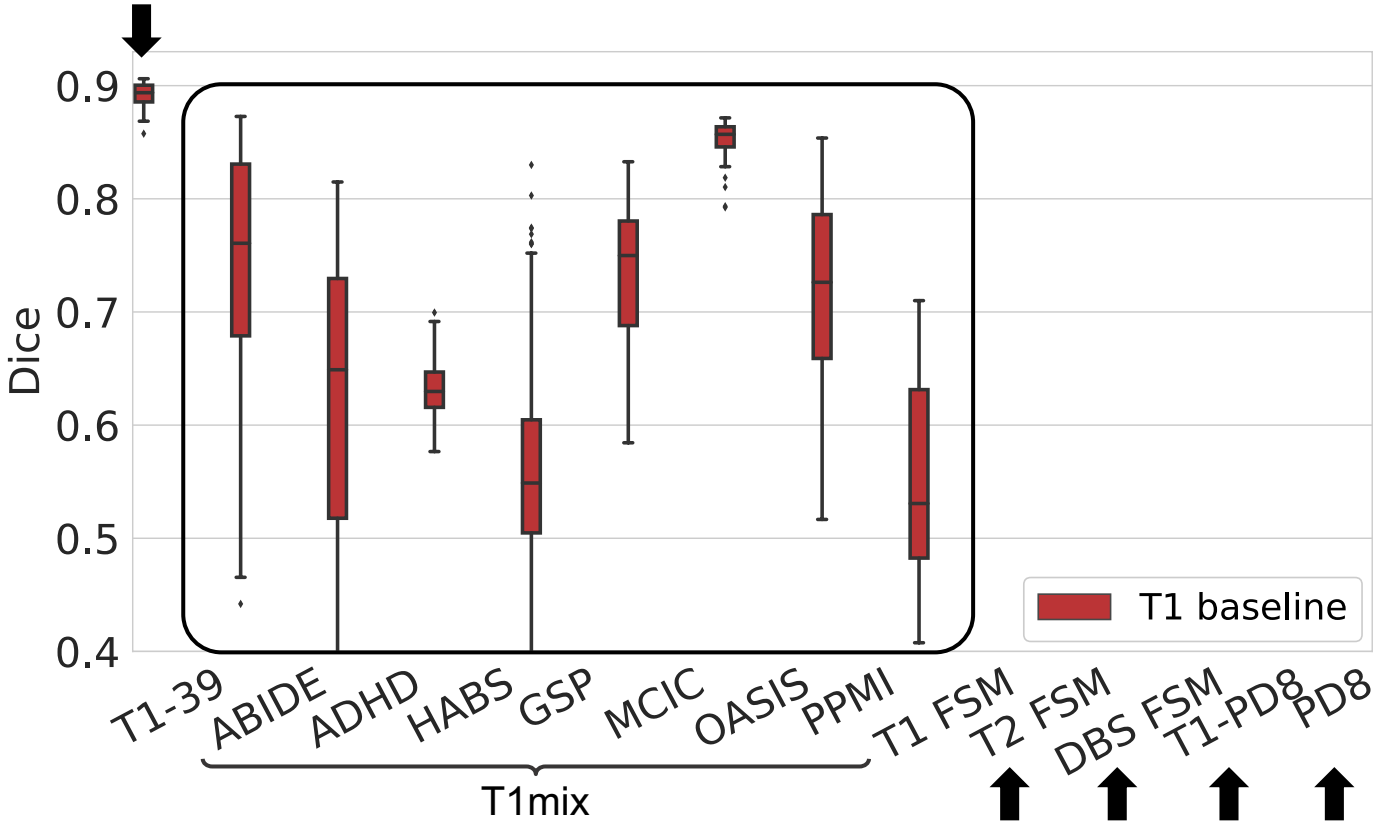
T1 | PD

Competing methods

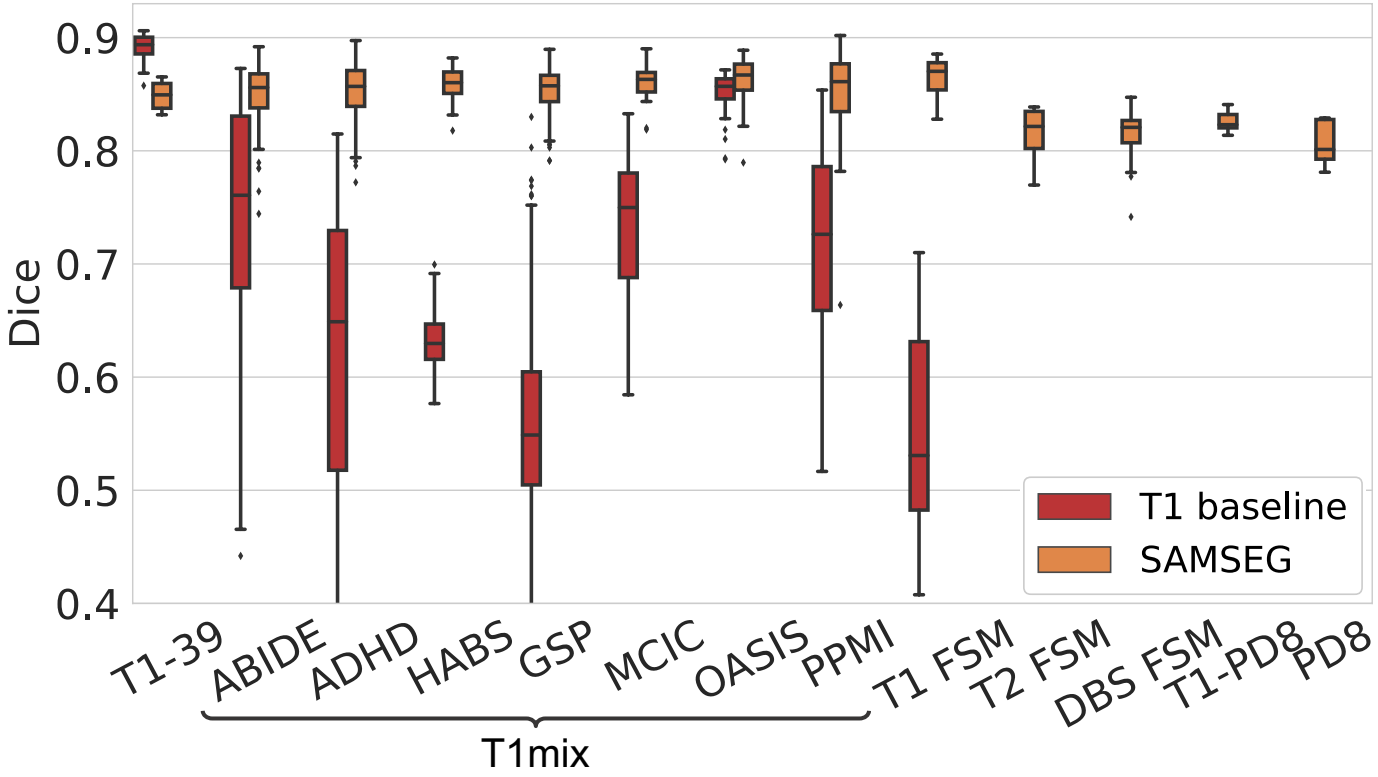
- T1-baseline: T1 supervised CNN
- SAMSEG [1]: modality-agnostic Bayesian segmentation
- SynthSeg
- SynthSeg-rule: trained with realistic contrasts

[1] Puonti et al., Neuroimage, 2016.

Dice scores


Dice
0.9
0.8
0.7
0.6
0.5
0.4
T1 baseline
T1-39
ABIDE
ADHD
HABS
GSP
MCIC
OASIS
PPMI
T1mix
T1 FSM
T2 FSM
DBS FSM
T1-PD8
PD8

Dice scores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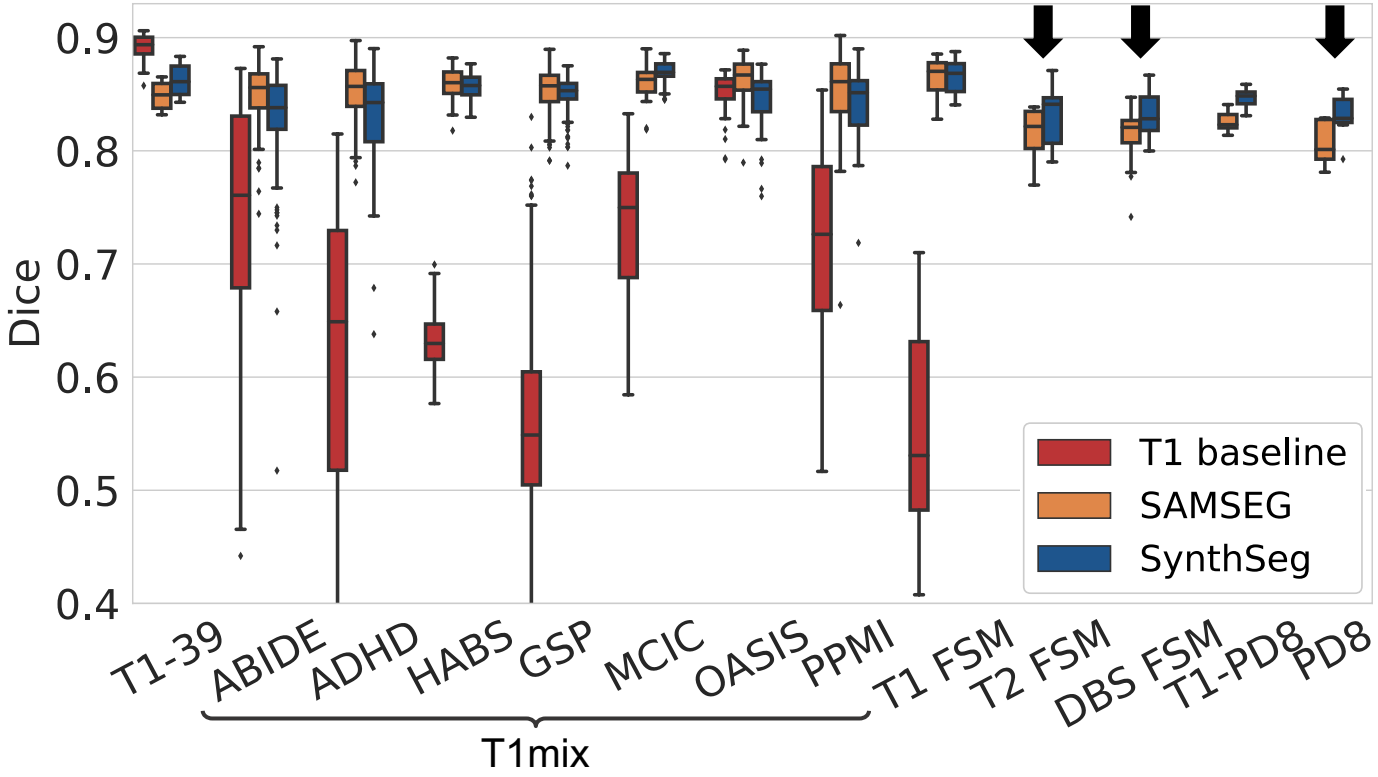
Dice scores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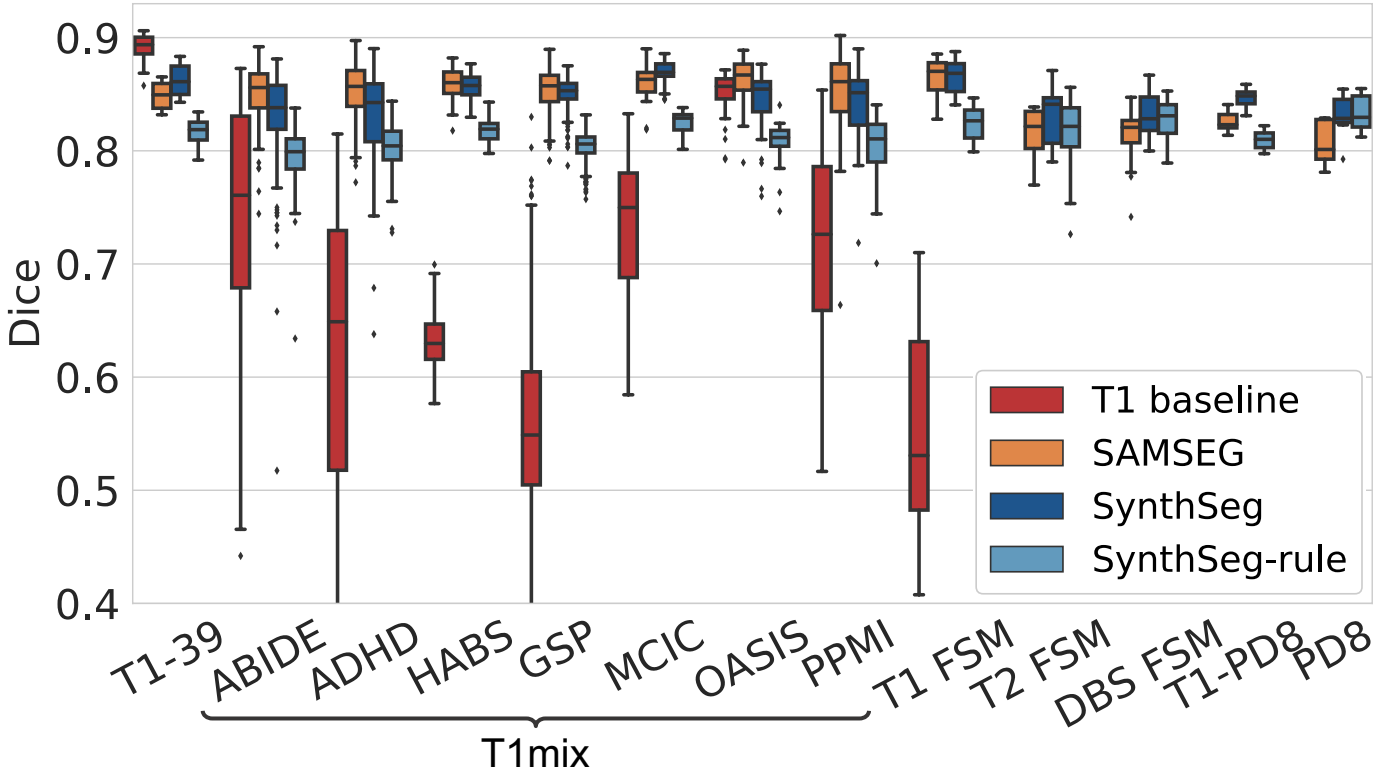
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T1-39
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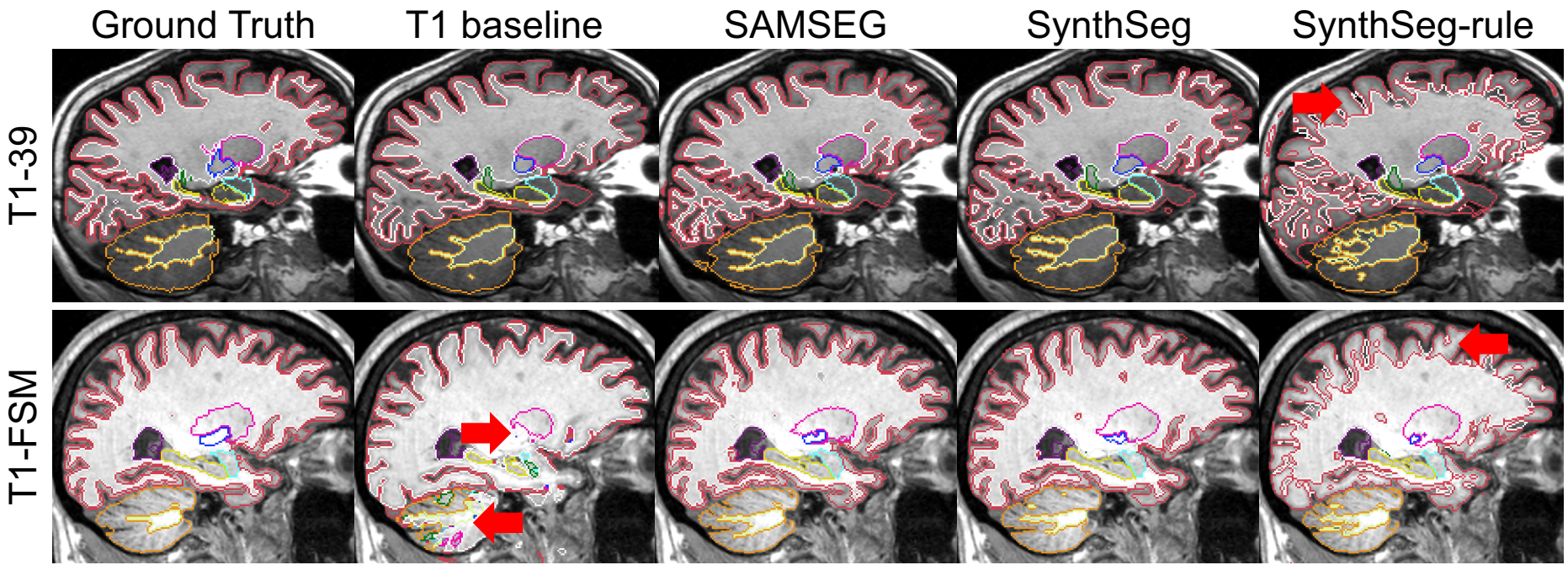
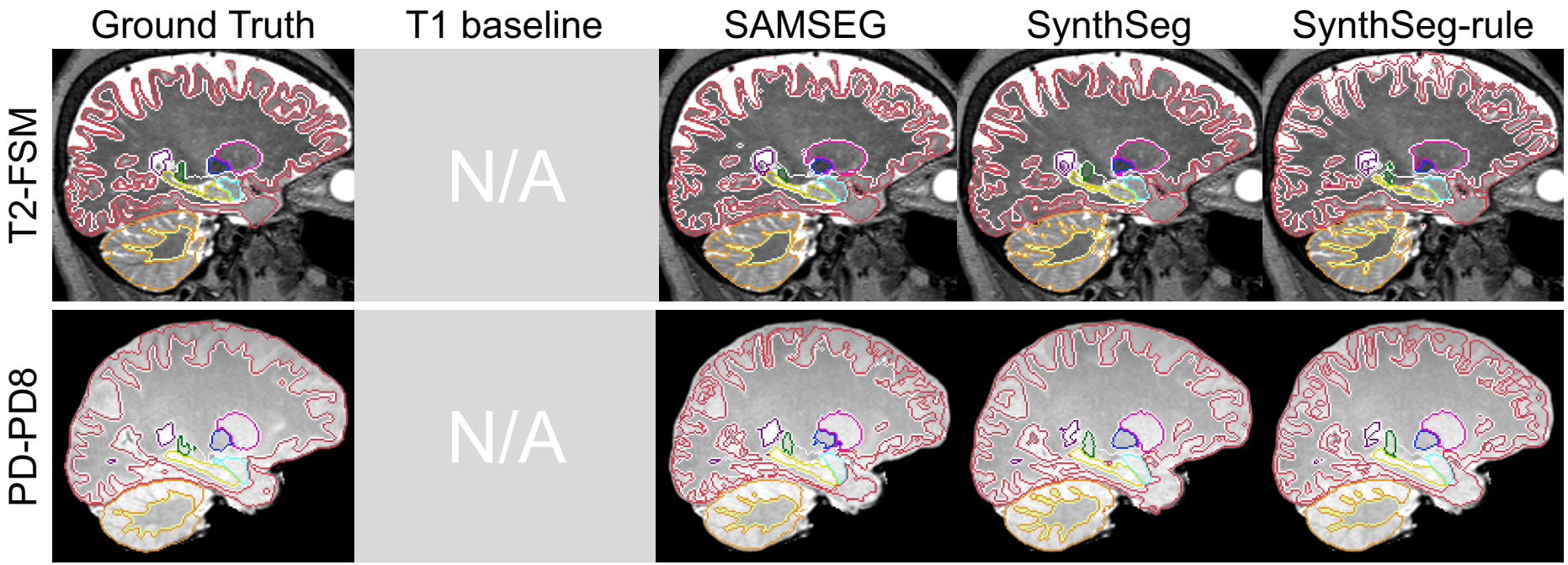
PPMI
T1 FSM
T2 FSM
DBS FSM
T1-PD8
PD8
T1mix

T1 segmentation examples



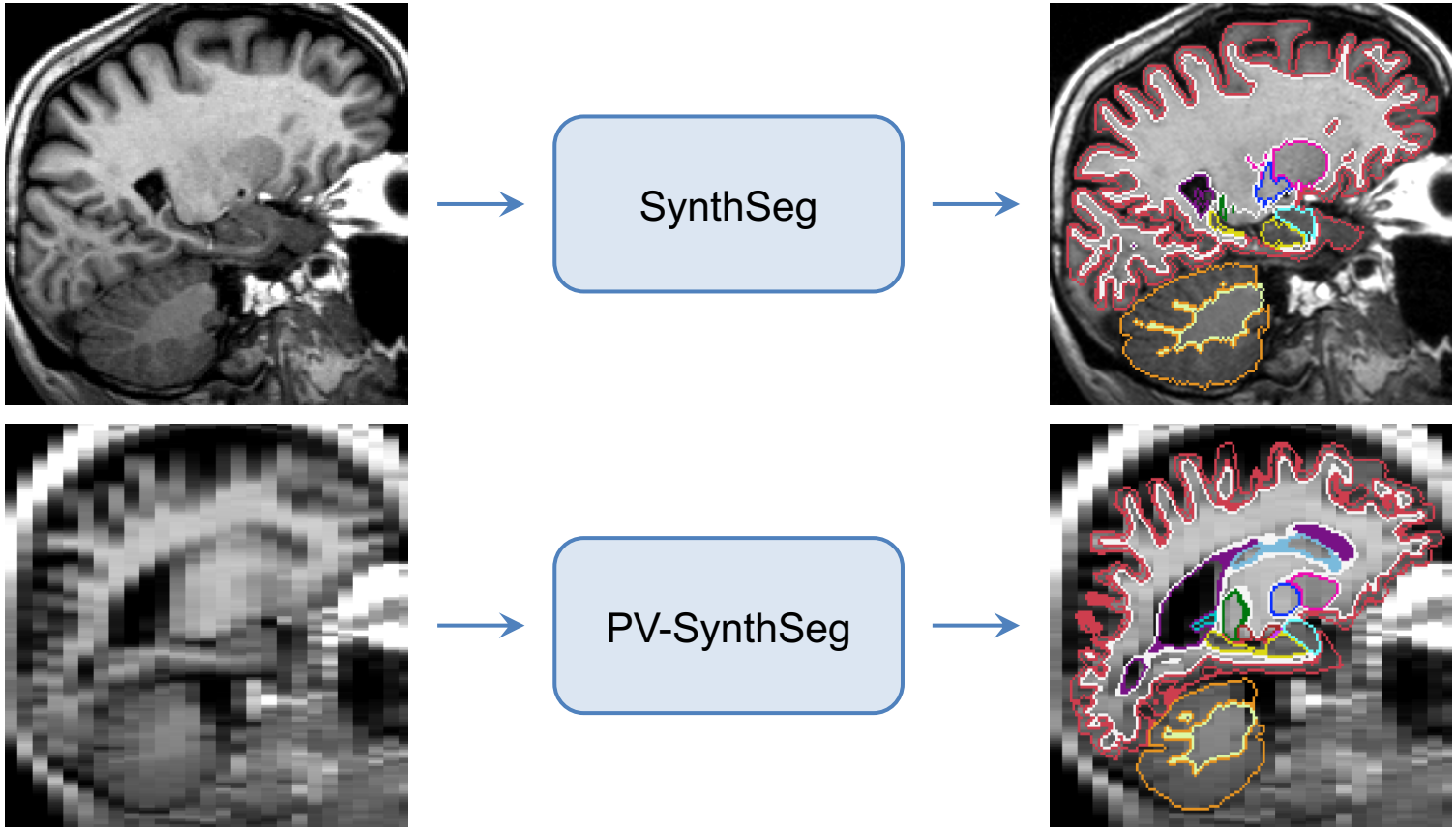
T2-PD segmentation examples



Key points

- SynthSeg enables fast contrast-agnostic segmentation of brain MRI scans, without retraining.
- SynthSeg does not require any preprocessing.
- SynthSeg only requires a set of segmentations as training data.
- Augmentation beyond realistic measures enables better generalisation.

Future directions



Acknowledgments

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EPSRC
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Collaborators:





Useful links

- **A Learning Strategy for Contrast-agnostic MRI Segmentation**
  MIDL 2020
  https://arxiv.org/abs/2003.01995

- **Partial Volume Segmentation of Brain MRI Scans of any Resolution and Contrast**
  MICCAI 2020
  https://arxiv.org/abs/2003.01995

- Generative model:
  https://github.com/BBillot/lab2im

- SynthSeg:
  https://github.com/BBillot/SynthSeg