Adversarial Continual Learning for Multi-Domain Hippocampal Segmentation

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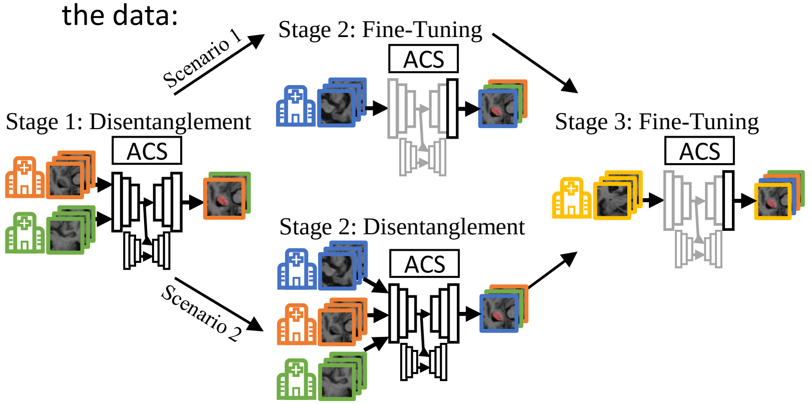
Problem Setting

- Continual learning is important for deep learning in a clinical context due to temporal limited access to data
- Recent methods train on datasets subsequently but only one at a time, making the problem unnecessary hard
- However, at least two or more datasets of different domains are available simultaneously through open access, relaxed restrictions, or access to historical data!

Novelty

- We propose the **Adversarial Continual Segmenter** (ACS) which can utilize simultaneous dataset availability to learn a domain-invariant disentanglement
- ACS is flexible in the domain and availability pattern of the data:



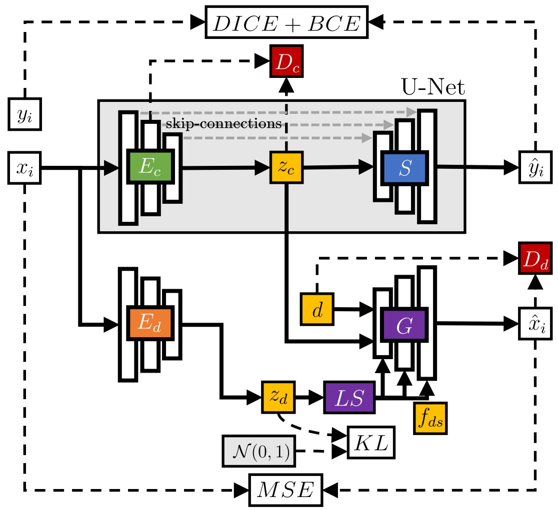
Datasets

- T1-weighted MRIs from different domains, i.e., varying acquisition modality and different disease patterns

Medical Segmentation Decathlon (A)	**Scientific Data** (B)	**Alzheimer's Disease Neuroimaging Initiative** (C)
195 subjects	25 subjects	68 subjects
90 healthy, 105 Non-affective psychotic disorder	25 healthy	Control group, mild cognitive impairment, Alzheimer's disease
Philips Achieva	Siemens TimTrio	Scanners from Siemens (23), GE (24), and Philips (21)

Methodology

Adversarial training of cross-domain disentanglement (E_d, G, D_d) and latent space regularization (D_c):



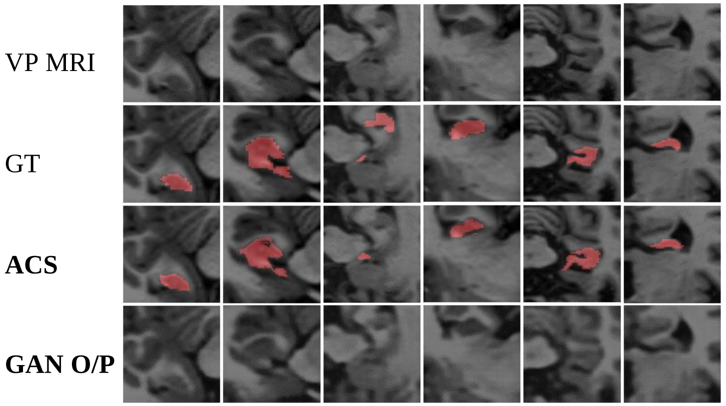
Continual Learning Results

Quantitative performance:

- Learn disentanglement on A and C, fine-tune on B

	Dataset A		Dataset B		Dataset C		Average	
	IoU	Dice	IoU	Dice	IoU	Dice	IoU	Dice
U-Net-ft	0.273	0.425	0.567	0.723	0.419	0.584	0.419	0.577
BS-MAS	0.307	0.466	0.702	0.825	0.364	0.523	0.458	0.604
OL-KD	0.094	0.171	0.381	0.549	0.400	0.571	0.292	0.430
ACS (ours)	**0.681**	**0.808**	**0.787**	**0.880**	**0.679**	**0.808**	**0.716**	**0.832**

Qualitative performance:



Conclusion

- ACS leverages simultaneous data availability
  - learn domain-invariant representation
- ACS outperforms SOTA methods on hippocampal segmentation and reduces catastrophic forgetting