

Our Contributions

We investigate a causal data augmentation technique for removing confounding bias during pretraining on synthetic and semi-synthetic data.

- We extend causal bootstrapping (Little and Badawy, 2020) to five practical confounded-data generation scenarios.
- We compare its ability to remove confounding bias with other non-causal data augmentation schemes on five datasets with synthesized and real-world shifts.
- We demonstrate benefits of the proposed pre-training method to train models that generalize to reverse-confounded and unseen test environments, providing evidence that such methods help deep networks rely on generalizable associations in the data as opposed to spurious ones.

Paper: https://arxiv.org/abs/2108.12510 **Code**: https://github.com/MLforHealth/CausalDA

Background: Shortcut Learning

- Machine learning models often rely on "shortcut" biases to achieve good predictive performance.
- Such models experience a degradation in performance under changes in the spurious correlation.

Training y = 0



y =

 $\hat{y} = ?$

Test

This can be viewed as a form of **confounding bias**.



Problem Setup

We can construct **robust** machine learning models using **causality**.



Observed Training Distribution



Desired Distribution (In causal terms: Interventional)

Goal: Given samples from observational distribution, how can we simulate samples from the intervention?

References

• Little, Max A., and Reham Badawy. "Causal bootstrapping." arXiv preprint arXiv:1910.09648 (2019).

• Geirhos, Robert, et al. "Shortcut learning in deep neural networks." Nature Machine Intelligence 2.11 (2020): 665-673.

Pulling Up by the Causal Bootstraps: Causal Data Augmentation for Pre-training Debiasing

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Experimental Flow











arget	U=1	U=0	Unseen Domain
ender	Rotate 90°	No Transform	N/A
resence of Atelectasis	Rotate 90°	No Transform	N/A
resence of Tumor	Hospital 3	Hospital 4	Hospital 5
sset Wealth	Malawi, Tanzania	Kenya, Nigeria	19 Other Countries
resence of Atelectasis	MIMIC-CXR	CheXpert	NIH