Leveraging Domain Adaptation for Low-Resource Geospatial Machine Learning

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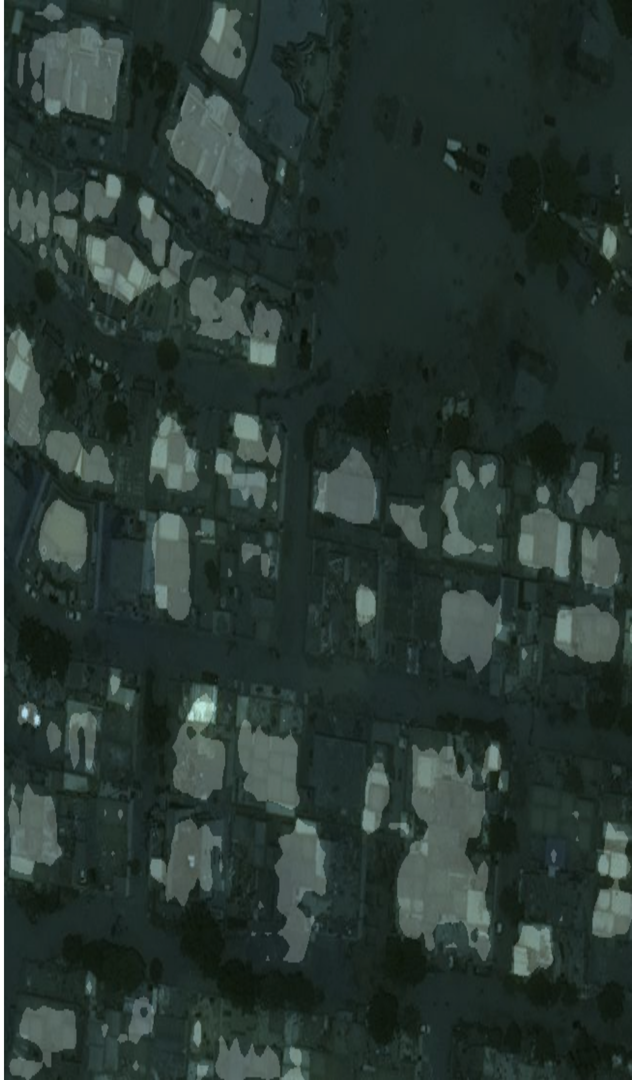
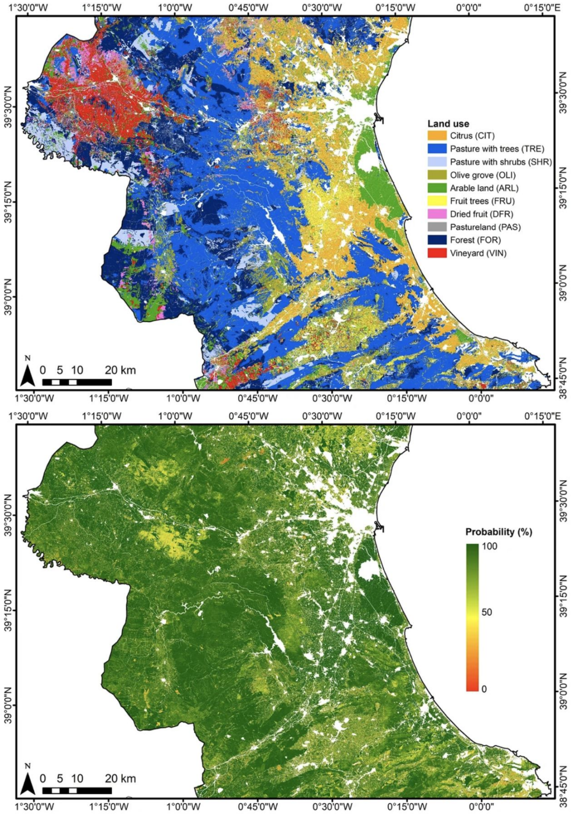
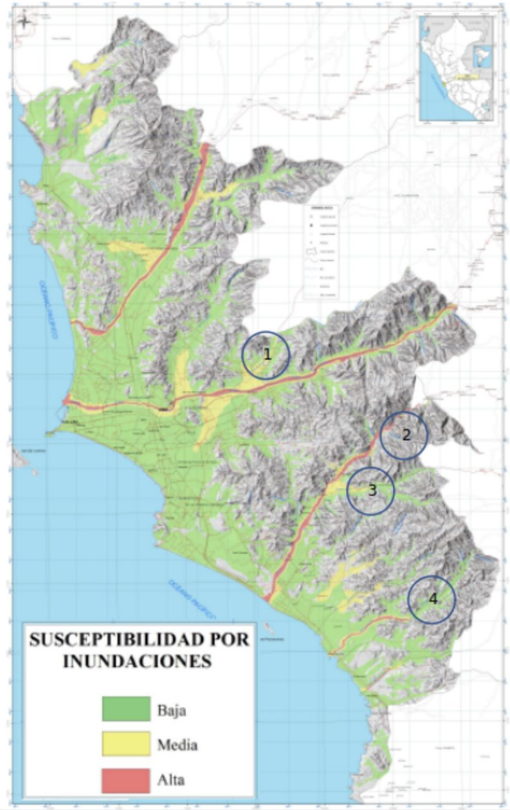


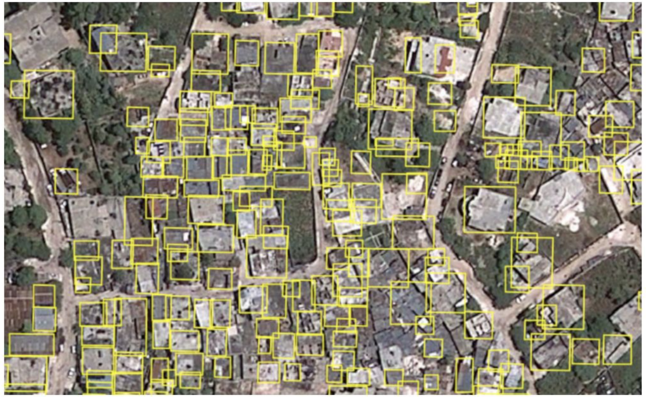
(Campos-Taberner et al., 2020)

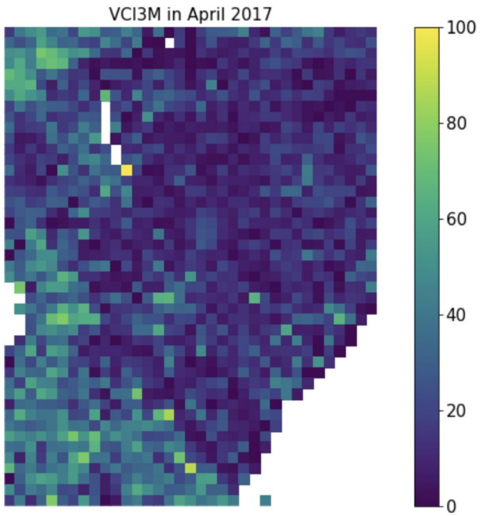


(Cerrón et al., 2020)



(Xu et al., 2019)





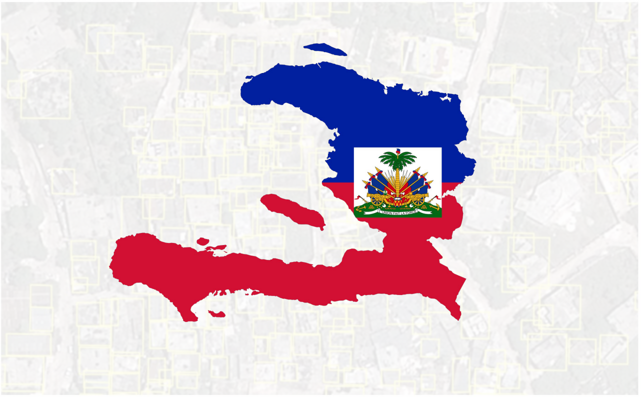
(Lees et al., 2019)

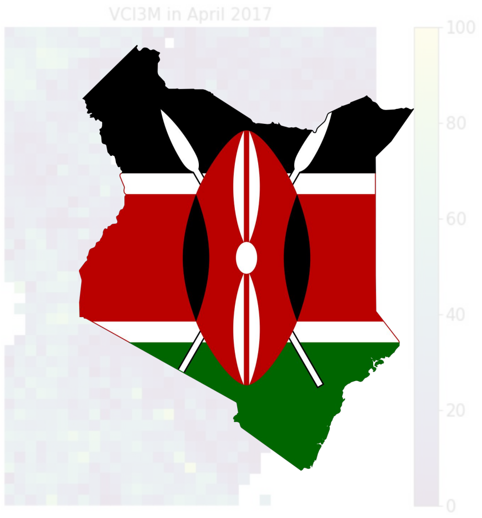
Geospatial ML is **growing**.

https://commons.wikimedia.org/wiki/File:Flag_map_of_Spain_(without_Catalonia).png

https://commons.wikimedia.org/wiki/File:Flag-map_of_Peru.svg

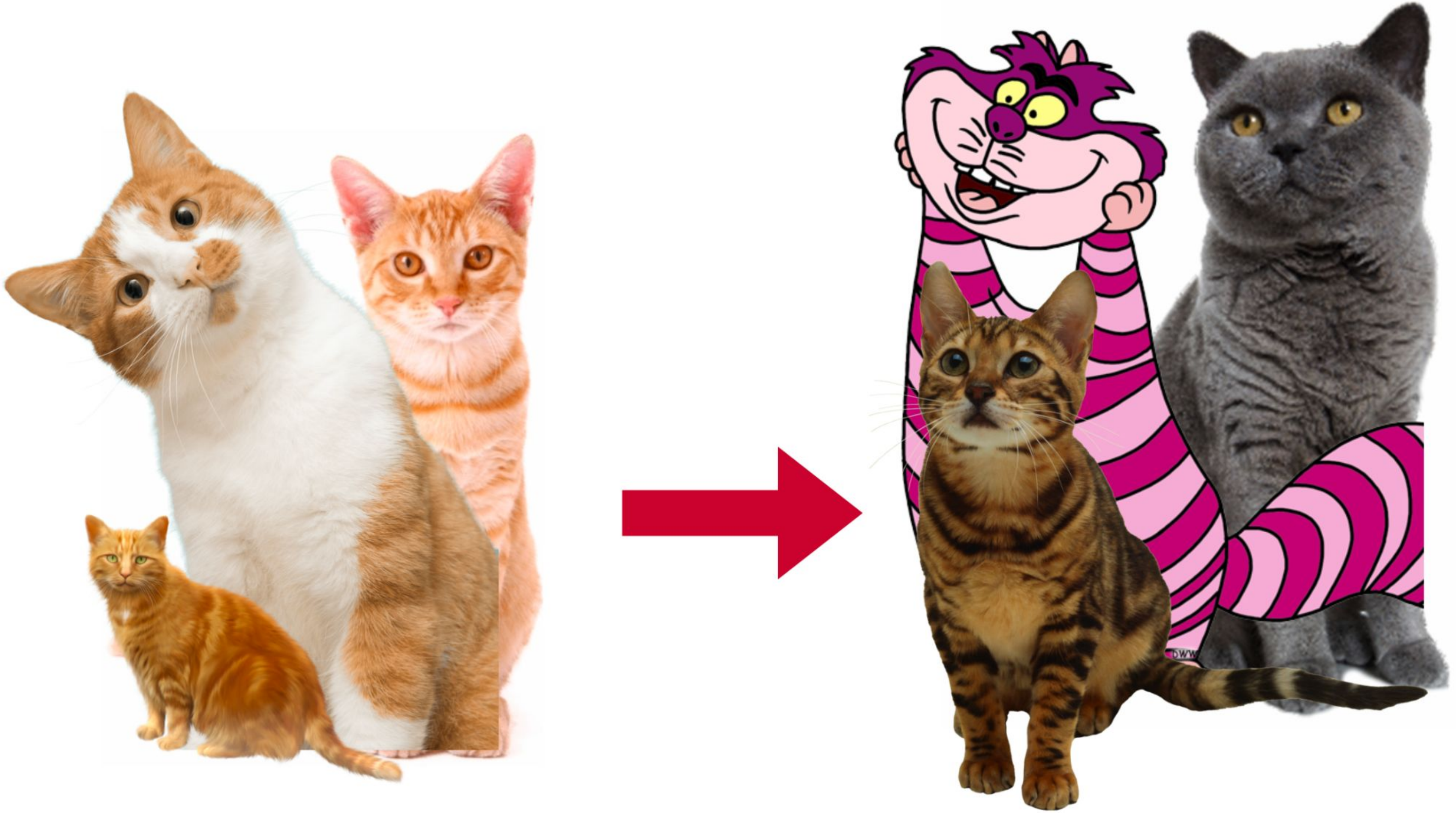
https://commons.wikimedia.org/wiki/File:Flag_map_of_Haiti.svg





https://en.m.wikipedia.org/wiki/File:Flag-map_of_Kenya.svg

Geospatial ML is (often) **domain-specific**.



Domain adaptation can help!

Khartoum

Vegas

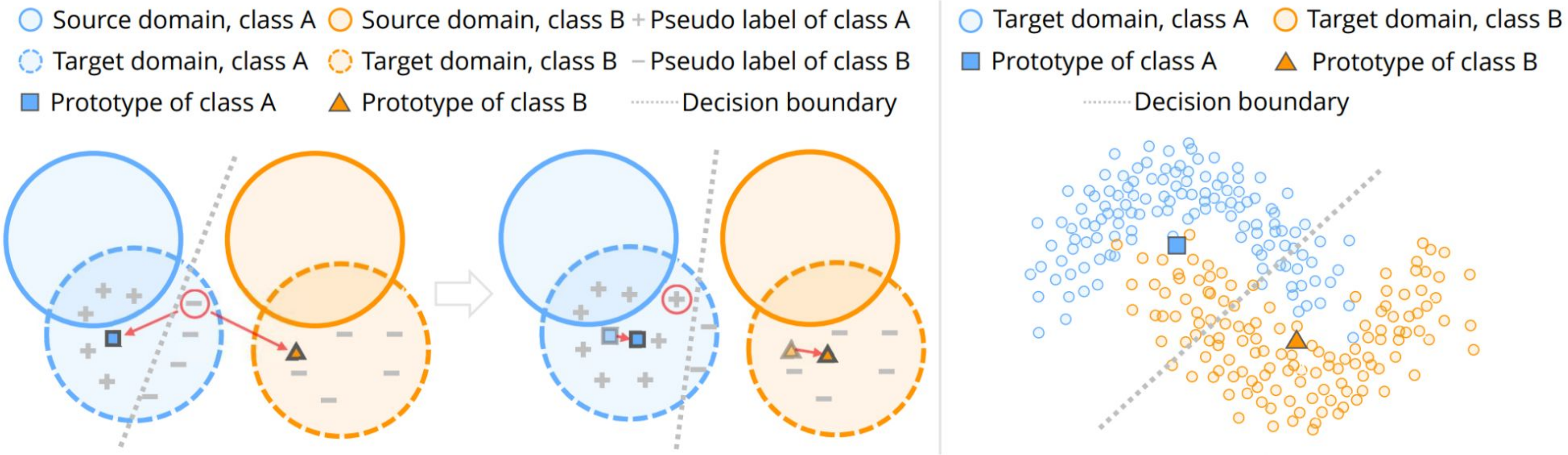
SpaceNet 2:

City-to-City Adaptation

Very Off-Nadir

On-Nadir

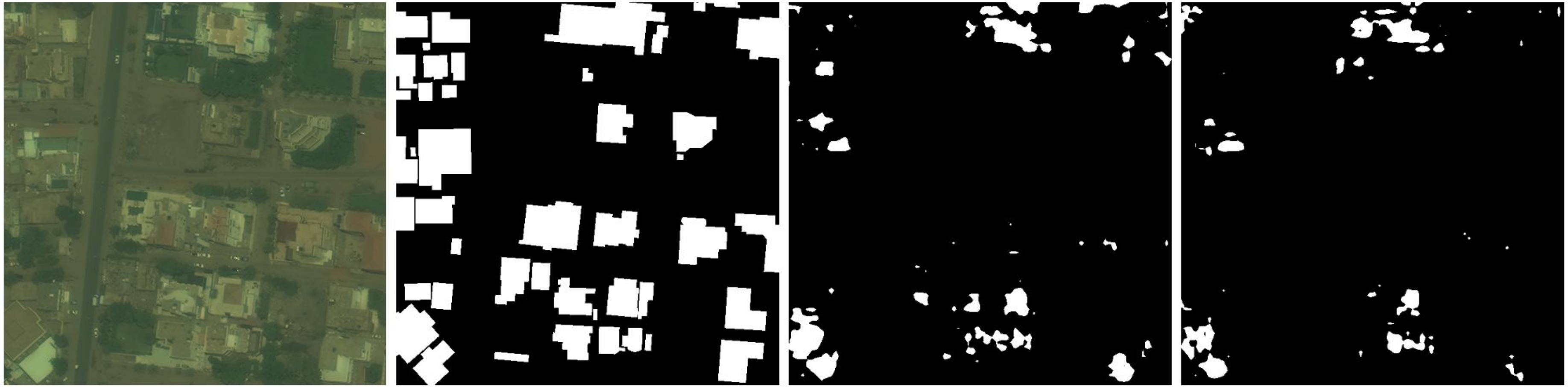
SpaceNet 4:
On-to-Off-Nadir Adaptation



(a) (b)

Zhang et. al., 2021 *Tsai et. al., 2018* *Vu et. al., 2019*

ADVENT



(a) Input (b) Ground Truth (c) ADVENT (d) Source-Only

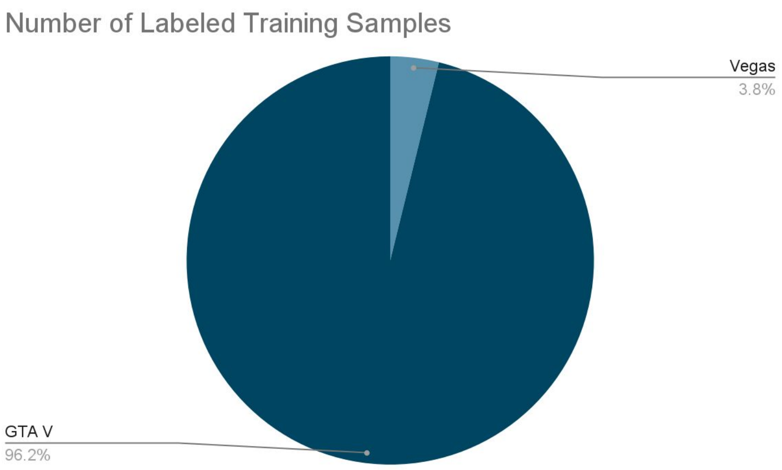
	GTA → CS	V → K	V, P → K	P, S → K	V, S, P → K	ON → V. OFF
IOU (ADVENT)	47.6	13.59	9.95	26.36	25.05	11.03
IOU (SRC-ONLY)	36.6	15.09	17.56	23.62	30.09	14.77
Δ IOU	+11.0	−1.50	−7.61	+2.74	−5.04	−3.74

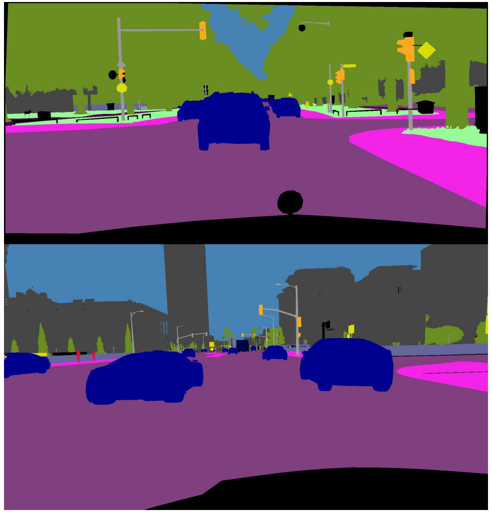
Adaptation **failure**

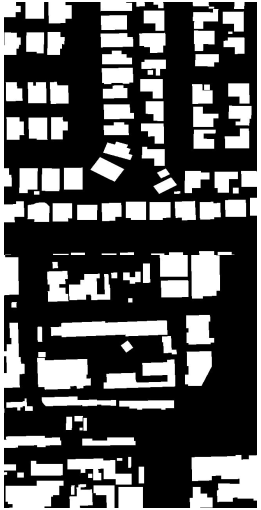
Vu et. al., 2019

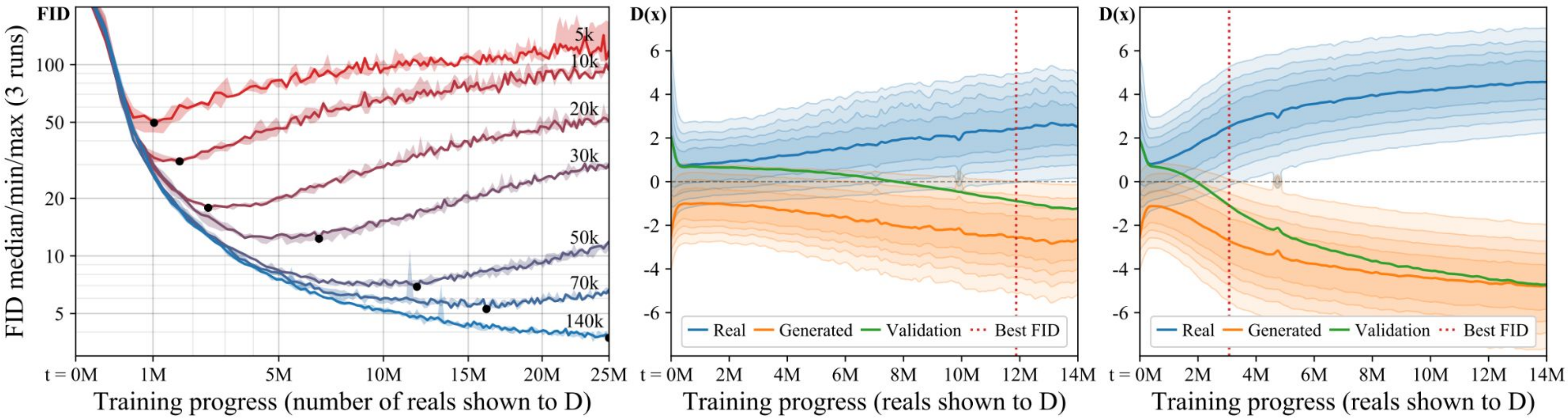
Core Assumptions of Adversarial Domain Adaptation

- You have sufficient labeled **source data**.
- The source and target **label distributions** are fairly similar.







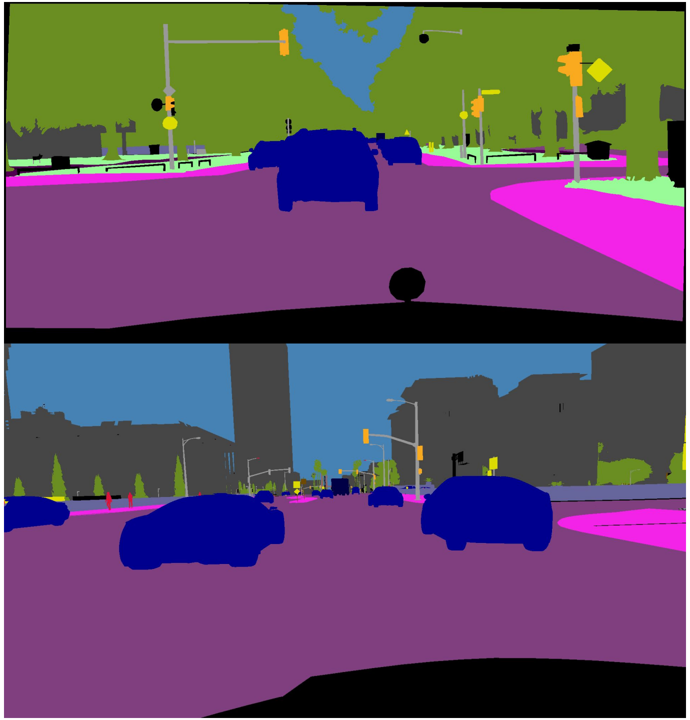


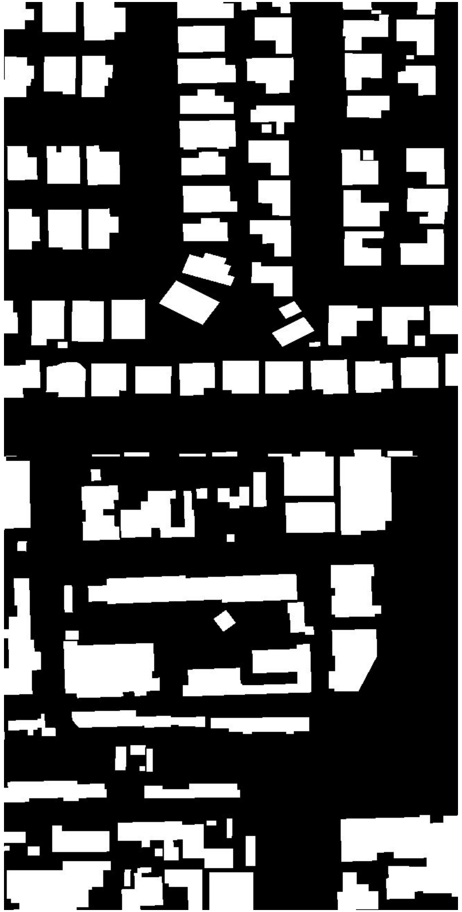
(a) Convergence of FFHQ (256 × 256) (b) Discriminator outputs, 50k (c) Discriminator outputs, 20k

Discriminator **overfitting** (Karras et al., 2020)

CityScapes

GTA V

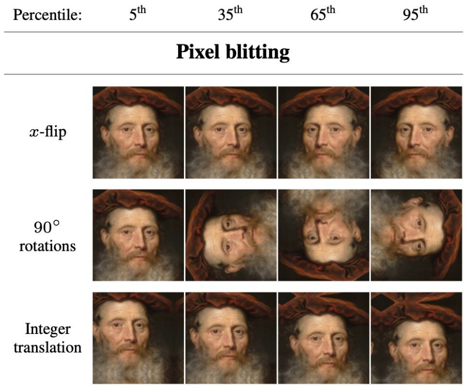


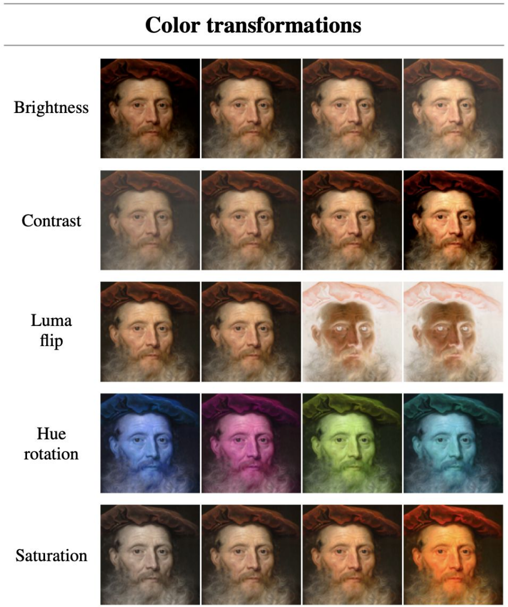


Vegas

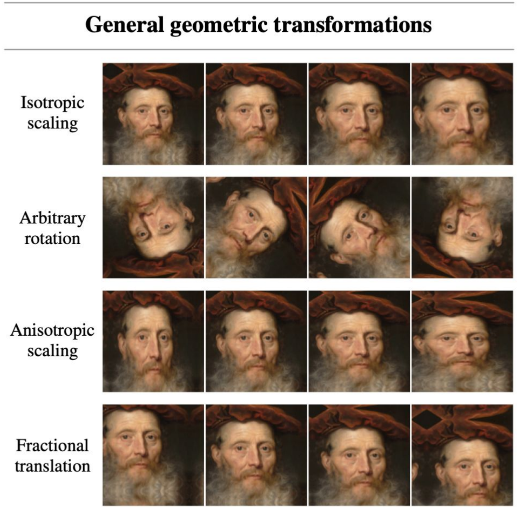
Khartoum

Label distribution **discrepancies**

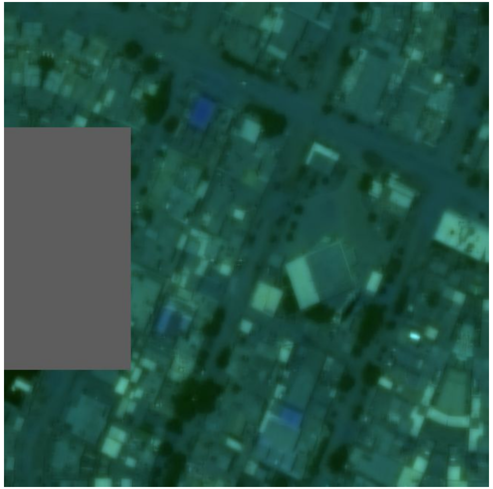


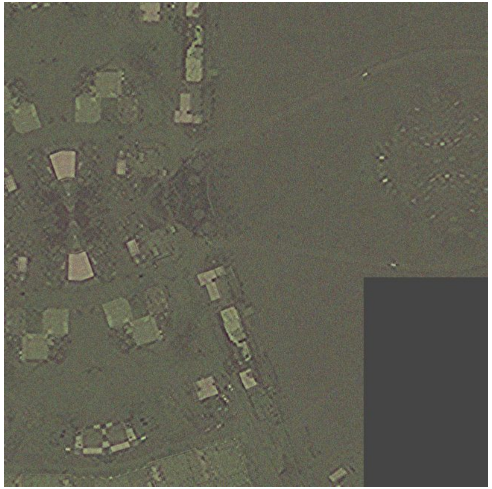


(Karras et al., 2020)



Solution: (adaptive?) **augmentation**





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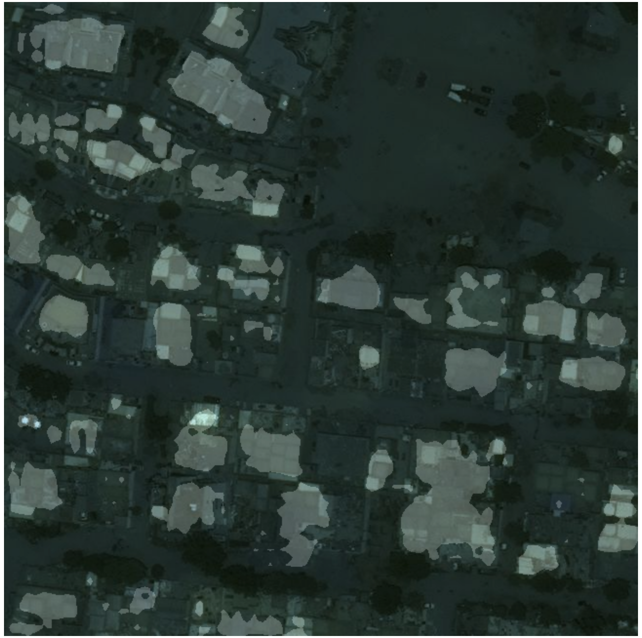
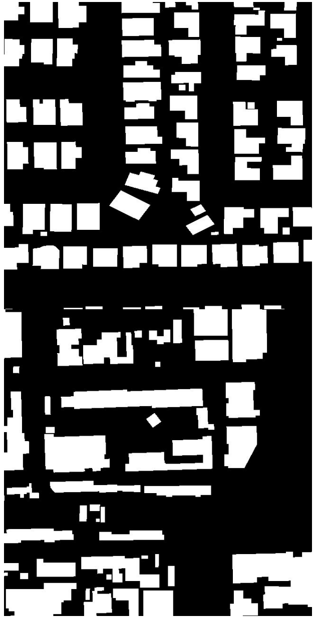
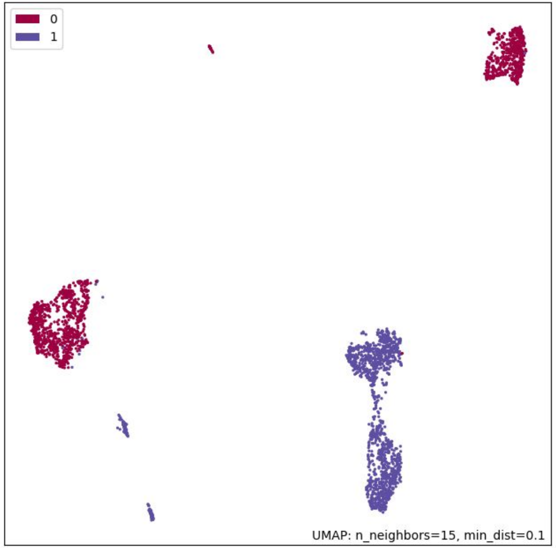


Augmentations **reduce** discriminator overfitting.



UMAP

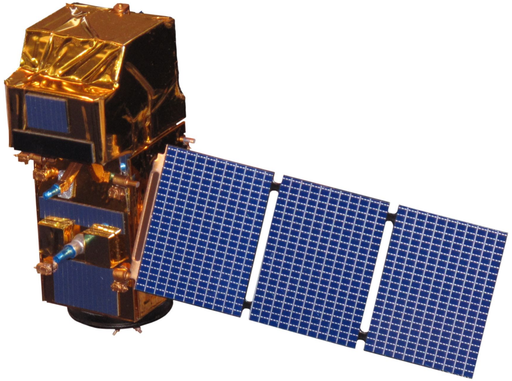


0D Persistent Homology

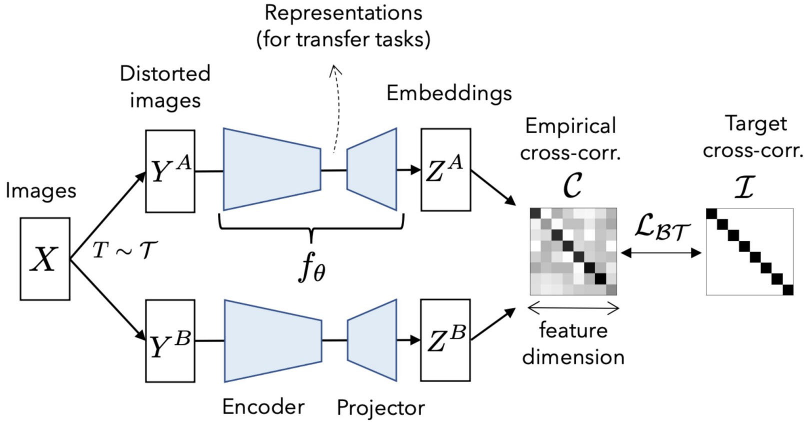
Label Purity Estimation

Relative Class Similarity Metric

Comparing **Label-Distribution Similarities** (with UMAP)



(Zbontar et al., 2021)



Opportunities in **self-supervised** Geospatial ML

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