Digital Copernicus

SSL4EO Put to the Test

a perspective through the lens of two Horizon Europe projects

presented by
Conrad M Albrecht

PI of
Embed2Scale and *EvoLand*

for the
Earth Observation Center (EOC), Oberpfaffenhofen
German Aerospace Center (DLR), Germany

in collaboration with
Nassim Ait Ali Braham, DLR (EvoLand) and
Isabelle Wittmann, IBM & Rikard Vinge, DLR (Embed2Scale)

ESA Living Planet Symposium
Vienna, Austria – June 27, 2025

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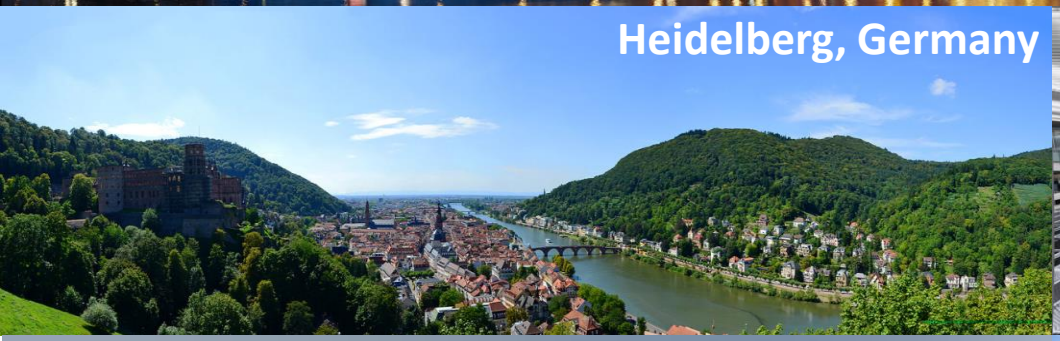
Funded by
the European Union

E2S EMBED 2SCALE

Background https://conrad-m-albrecht.github.io



PhD in Physics with extra certification in Computer Science

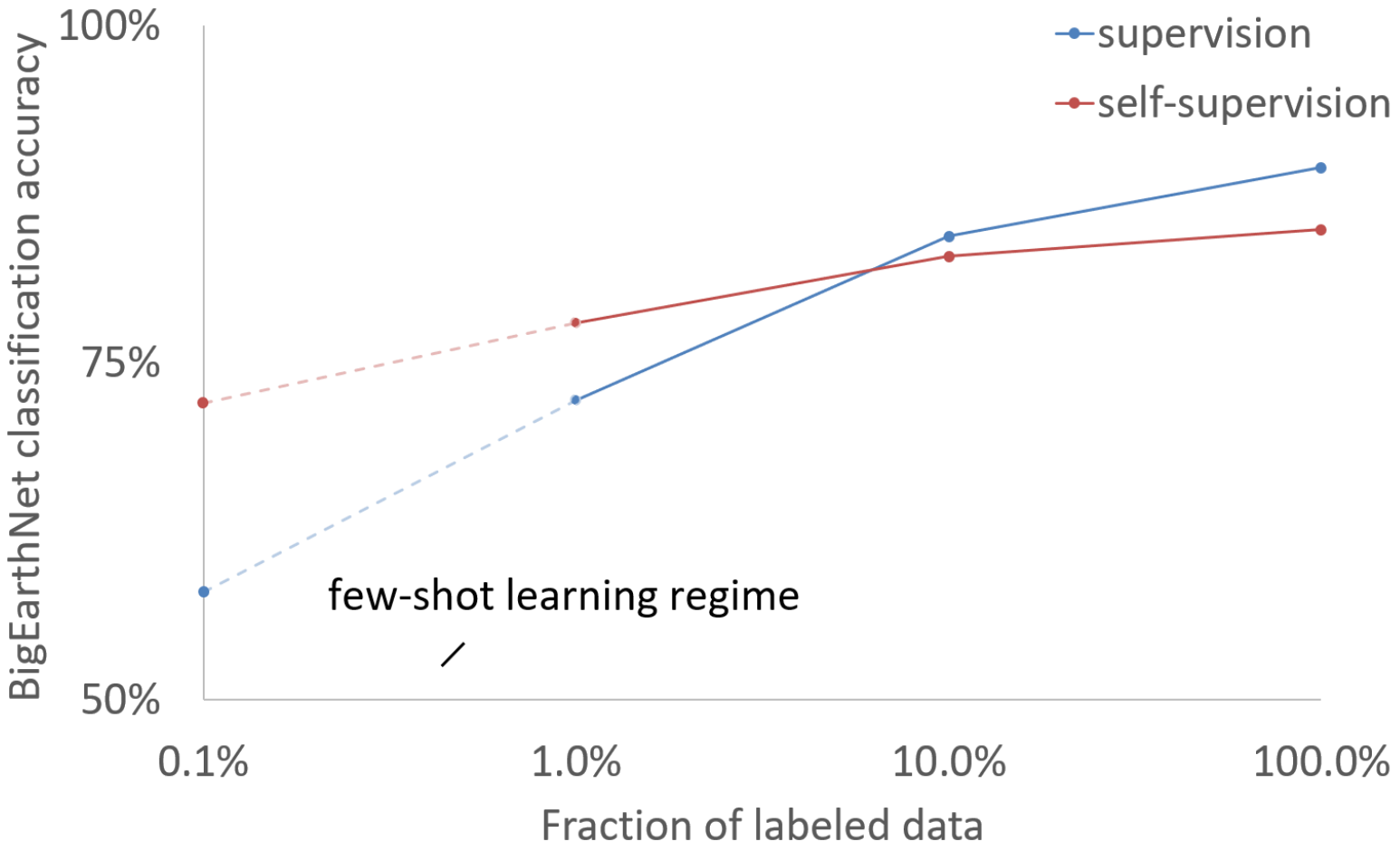
International Career in Geospatial Data Science at the interface of Academia – Gov. – Corp.

Agenda

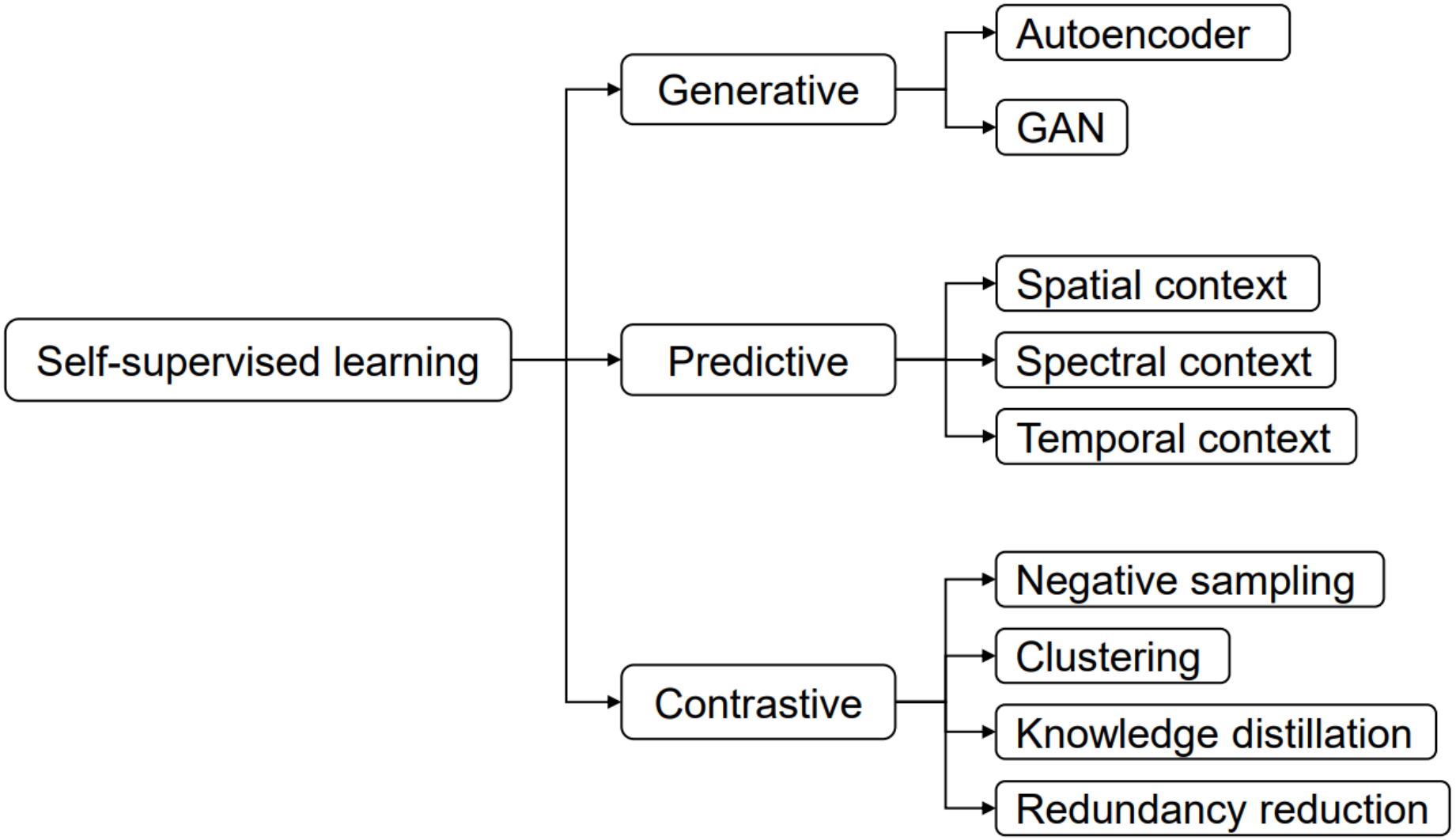
However as the progress in AI is accelerating and
brining enthusiasm of the community,

policy makers are increasingly **challenged**
to keep the investment momentum and
to create the right conditions for the European sovereign AI solution
to continue growing on the continent.

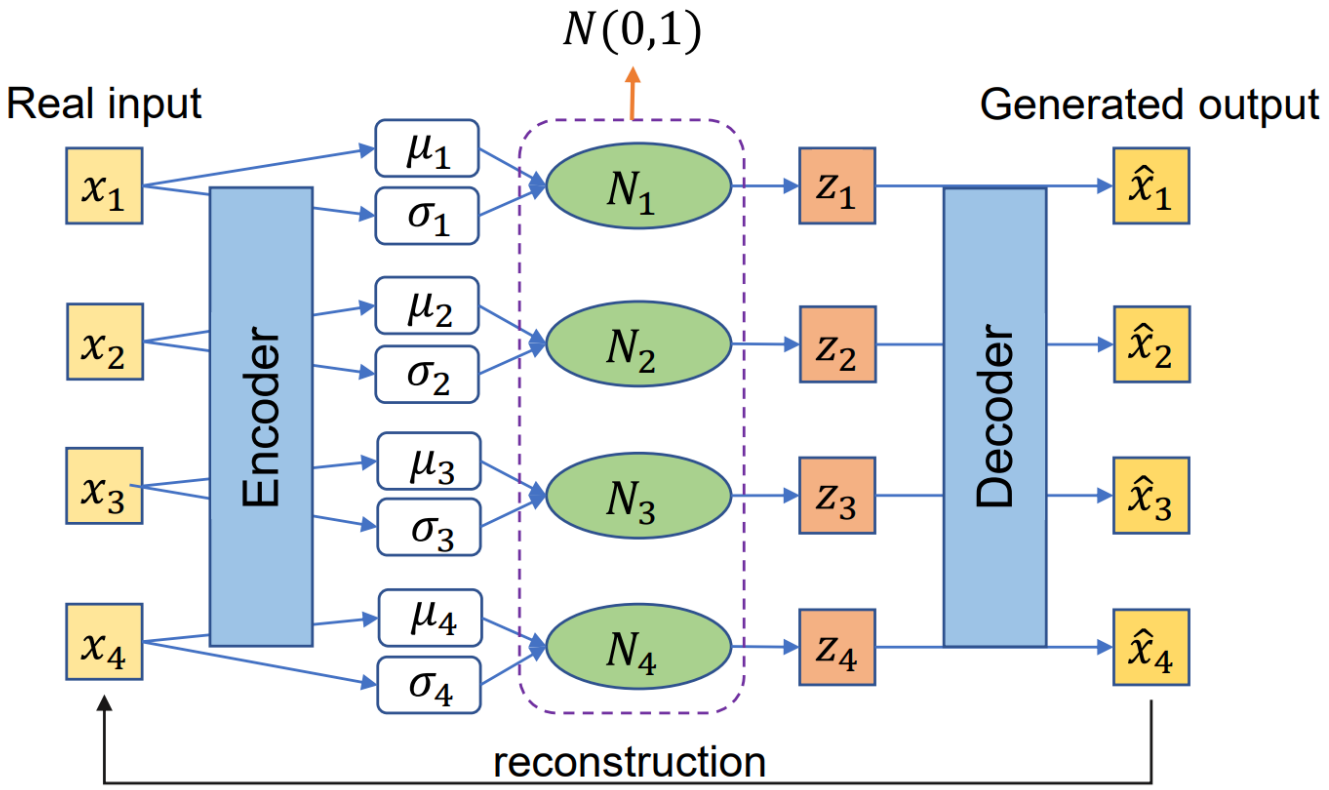
Self-Supervised Learning: Why?

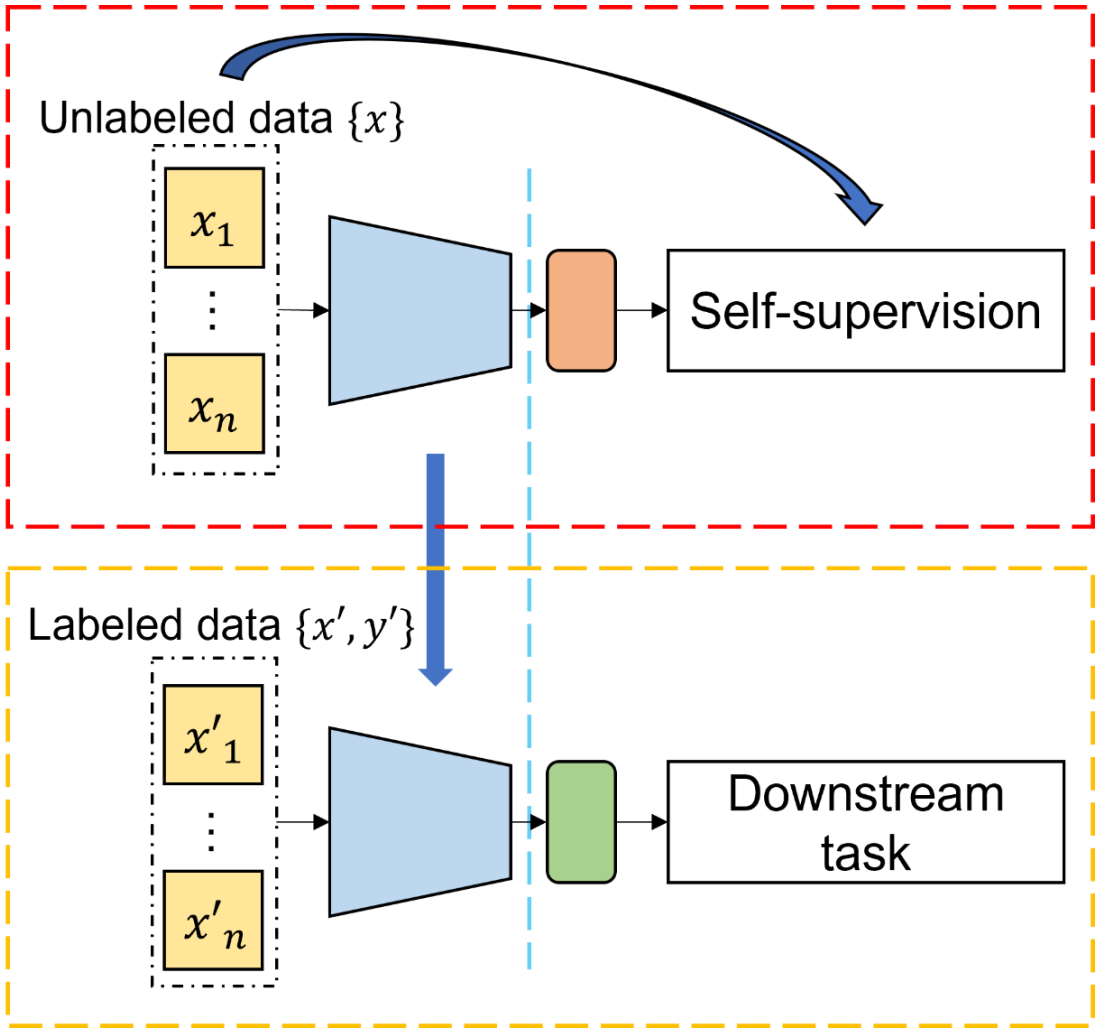


Self-Supervised Learning: What?

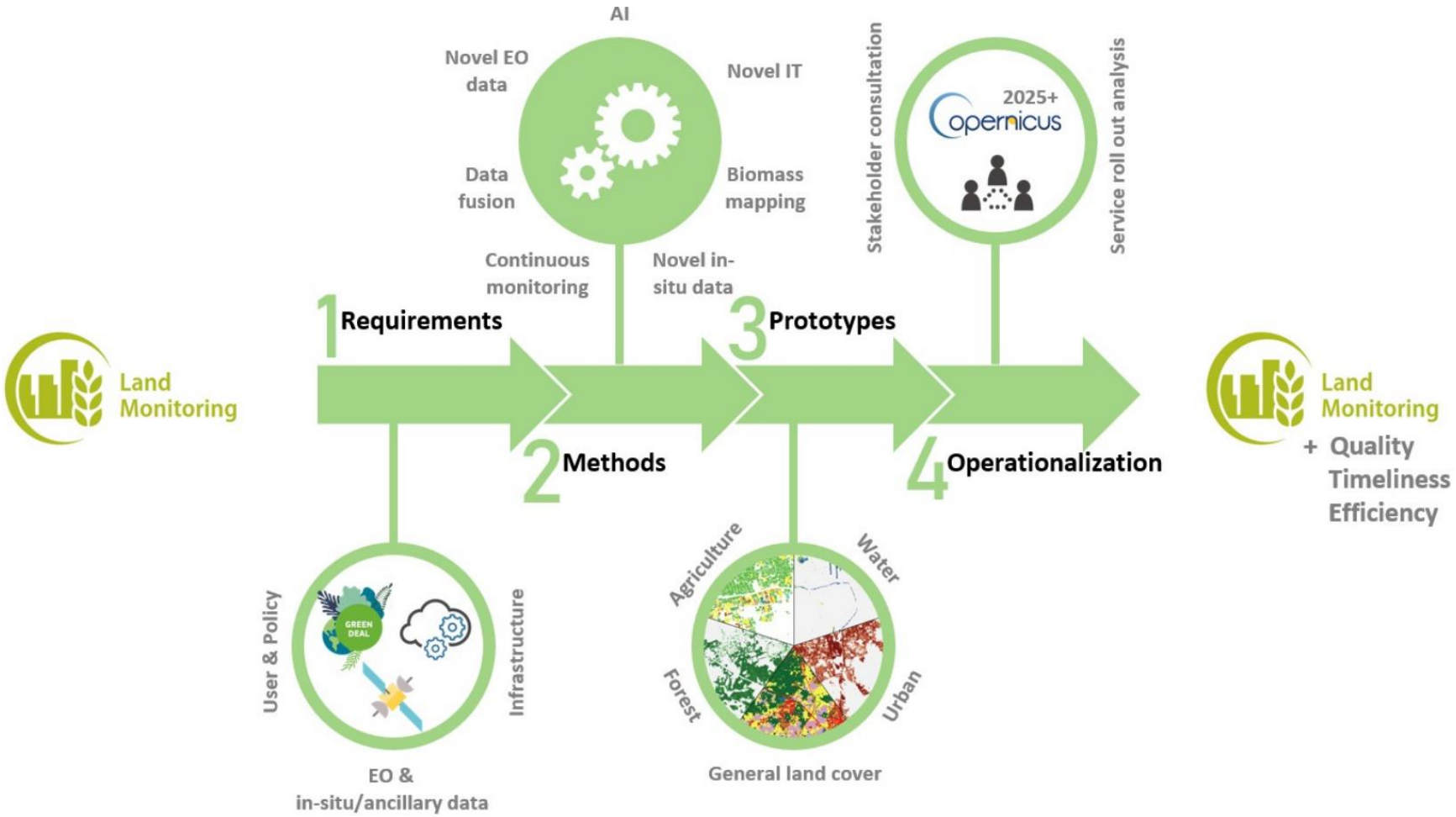


Self-Supervised Learning: How?





EvoLand in a Nutshell



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Mind the Gap: Academia vs. Real World

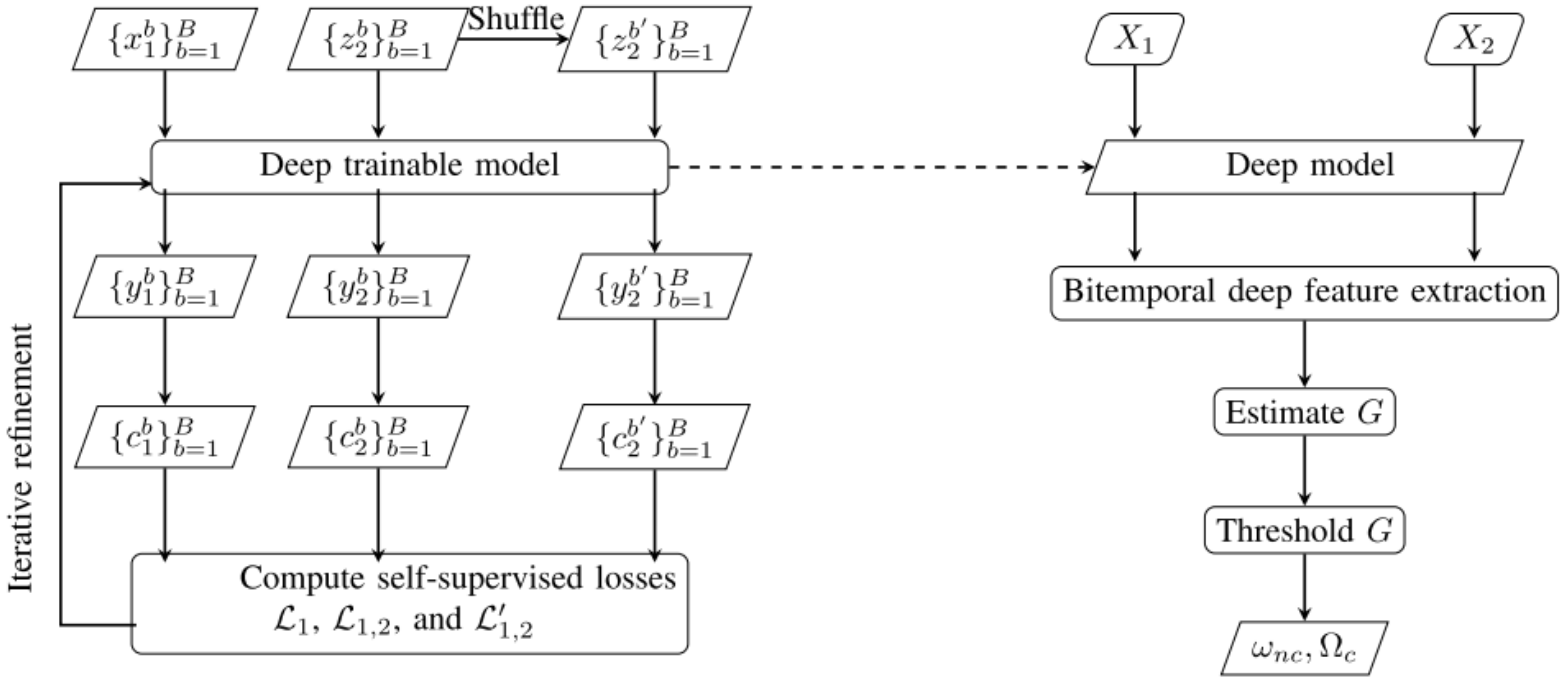

Fig. 2. Proposed unsupervised multisensor (optical-SAR) CD framework. The left-hand side denotes the self-supervised training process, while the right-hand side shows the CD process using already trained model.

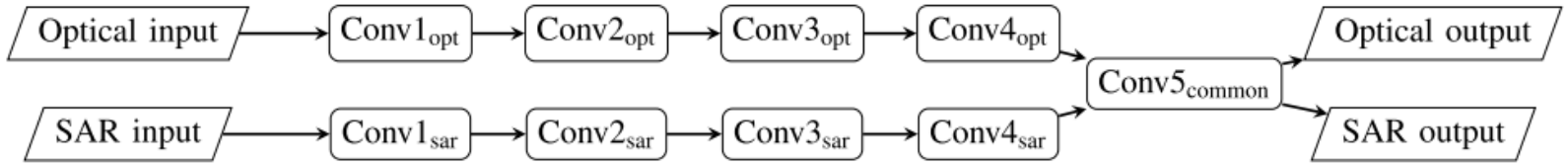

Fig. 3. Network simplified architecture with $L_1 = 4$ and $L_2 = 1$. Optical and SAR inputs are processed separately and subsequently fed to a common prediction layer.

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Self-Supervised Multisensor Change Detection

Sudipan Saha, *Member, IEEE*, Patrick Ebel, and Xiao Xiang Zhu, *Fellow, IEEE*

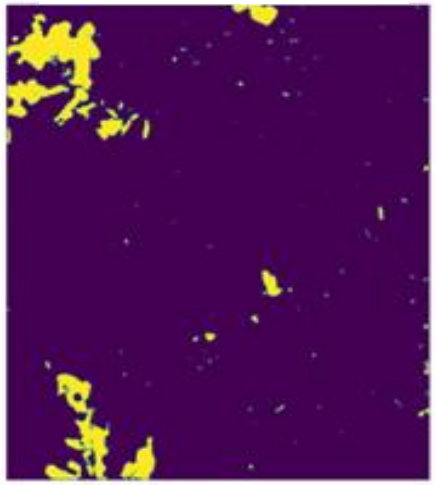
Mind the Gap: Academia vs. Real World

DLR

Sentinel-2 before

Sentinel-2 after

unsupervised change detected



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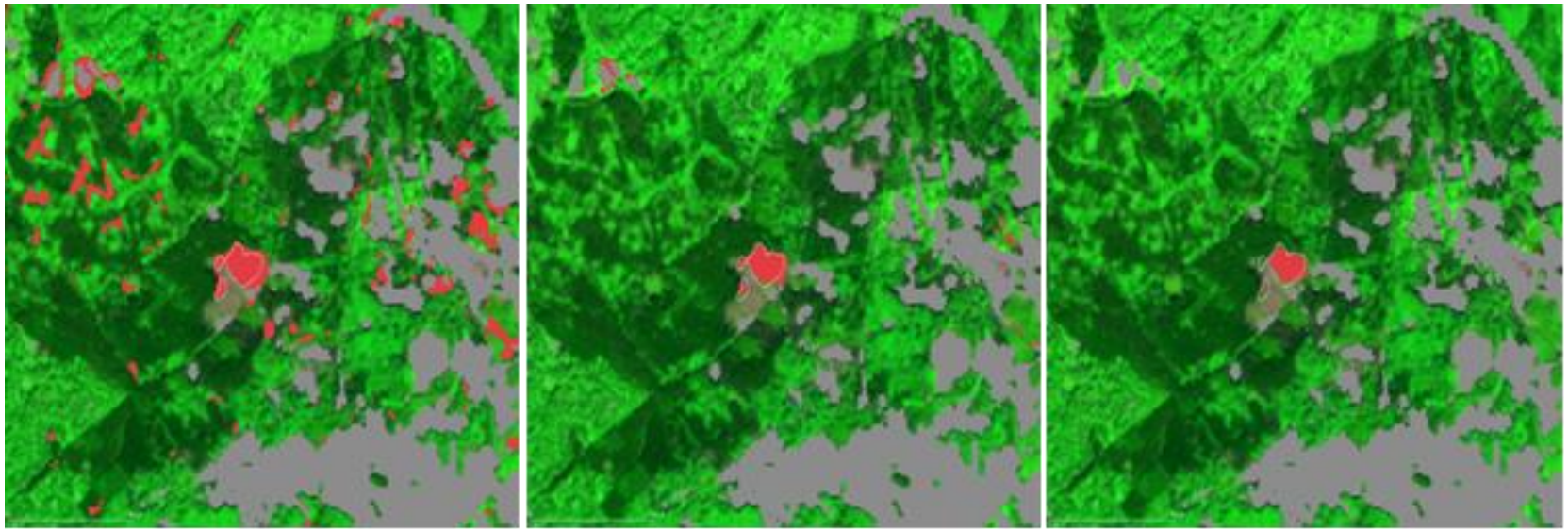
Mind the Gap: Academia vs. Real World

DLR

Model Hyperparamter Tuning



detected change

non-forest areas

Sentinel-2 NDVI

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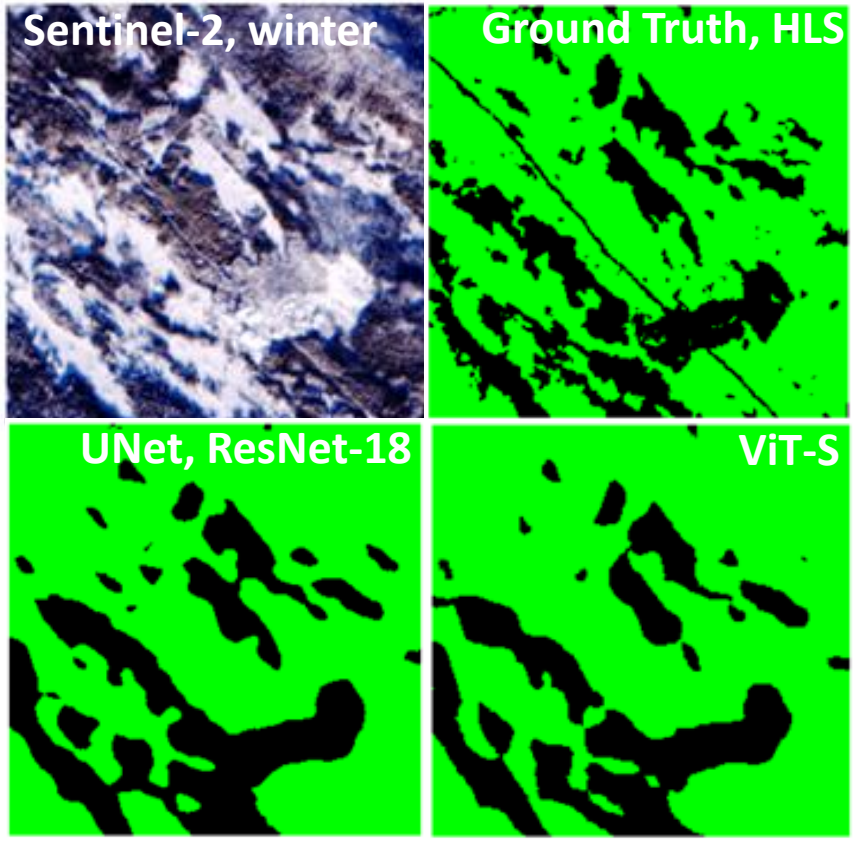
The Beauty of Simple: Good Old UNet is Up and Alive, but …

… Visual Perception Matters in Products!



overall accuracy: ~85% @ "blobby"

Model	HLS Burns	MADOS	PASTIS	Sen1Floods11	xView2	FBP	DynEarthNet	CropMap	SN7	AI4Farms	BioMassters	# Top-2
CROMA	81.52	57.68	32.33	90.57	51.44	48.01	38.30	42.20	59.31	28.19	38.50	4
DOFA	78.02	55.21	28.60	88.39	58.91	36.90	**39.20**	30.93	47.06	26.69	42.81	2
GFM-Swin	74.36	**63.37**	20.41	71.61	57.81	63.14	31.25	31.42	59.83	28.43	48.19	2
Prithvi	80.89	40.79	33.13	89.69	45.79	40.27	33.43	**42.51**	49.45	29.27	41.03	1
RemoteCLIP	74.28	53.26	17.46	71.67	57.43	**65.92**	30.91	36.3	50.83	25.11	50.09	1
SatlasNet	75.97	52.24	16.78	89.45	50.74	46.04	36.34	35.29	60.74	27.08	42.23	1
Scale-MAE	75.47	46.87	23.26	72.54	**59.45**	62.11	32.60	20.32	**61.24**	26.40	46.74	2
SpectralGPT	76.40	58.00	34.61	87.52	45.94	21.71	36.52	32.09	56.28	27.46	37.34	2
S12-MoCo	79.79	42.90	32.59	89.22	49.66	46.92	34.45	41.32	56.21	28.38	41.08	0
S12-DINO	80.12	40.42	**35.71**	88.93	48.46	44.85	32.76	31.13	55.14	25.68	41.47	1
S12-MAE	80.13	44.29	31.15	88.43	47.09	45.63	33.29	28.07	55.55	27.50	41.66	0
S12-Data2Vec	79.82	41.22	33.42	86.58	48.84	46.73	32.61	28.53	56.94	25.84	42.82	0
UNet Baseline	**82.39**	43.87	30.25	**90.91**	56.58	55.42	35.14	36.30	46.82	**45.02**	**36.72**	4
ViT Baseline	78.17	28.77	**38.71**	86.08	54.82	57.32	37.33	39.53	49.21	38.37	39.56	2

https://github.com/VMarsocci/pangaea-bench

PANGAEA

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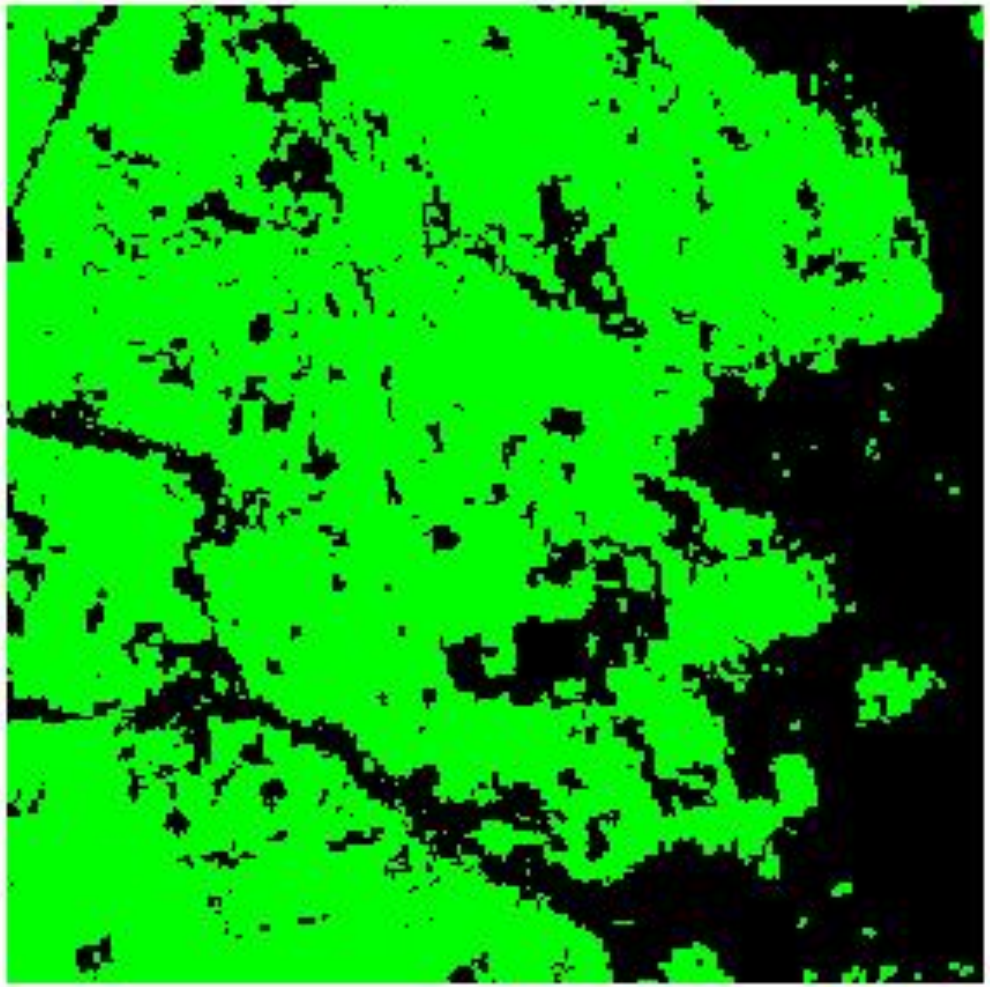
Garbage in, Garbage out: Labels, Labels, Labels!

DLR

Sentinel-2

“Ground Truth”



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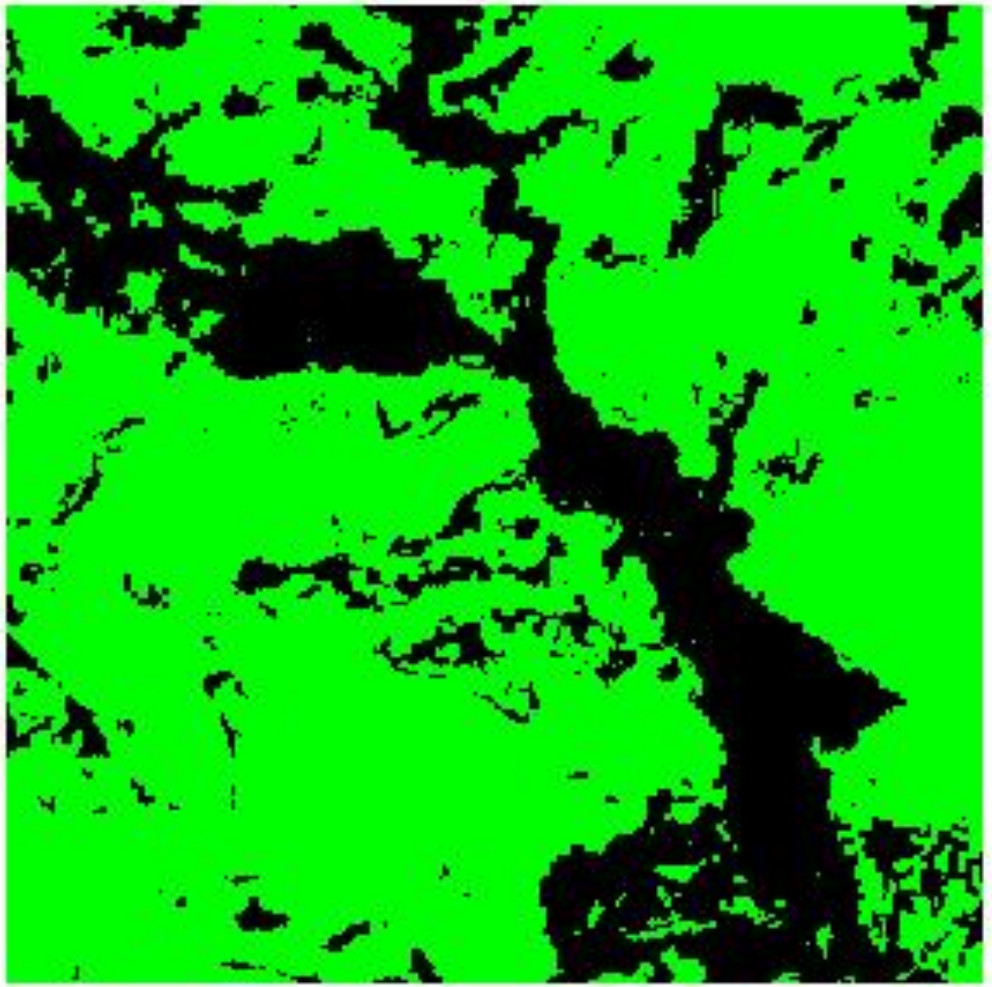
Garbage in, Garbage out: Labels, Labels, Labels!

DLR

Sentinel-2

“Ground Truth”



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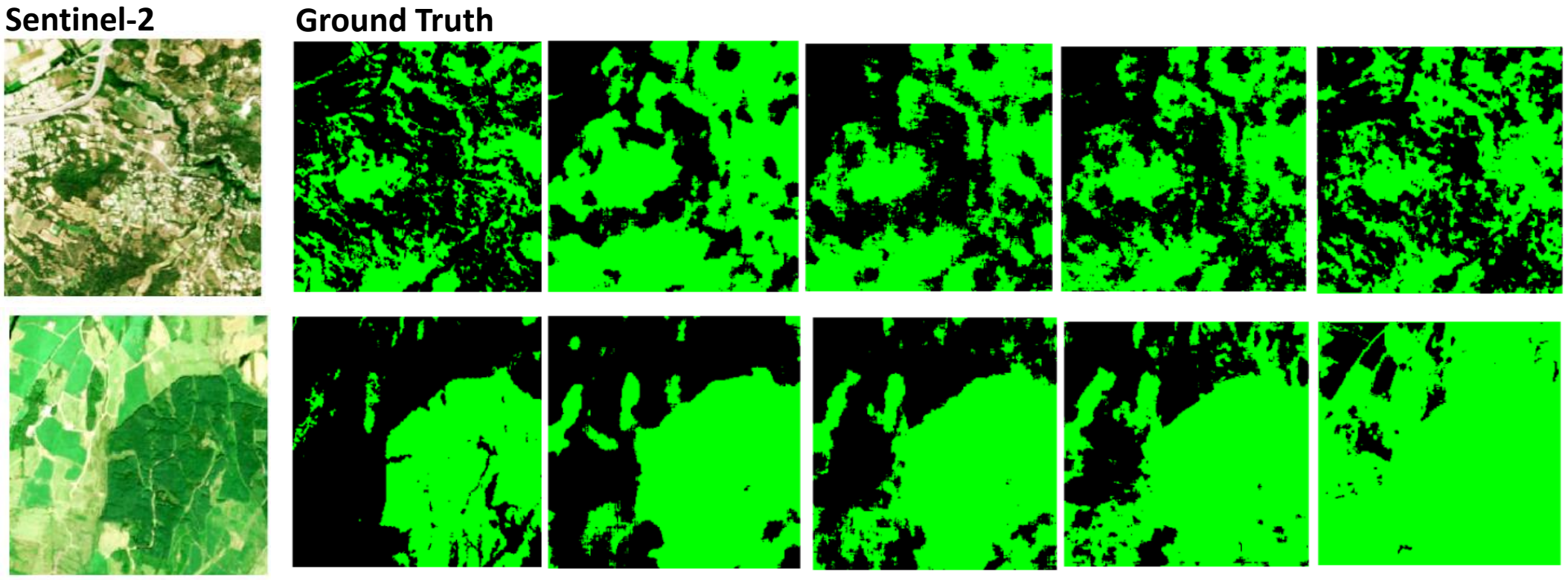
Expectations: Trading Semantics for Pixel-Level Details



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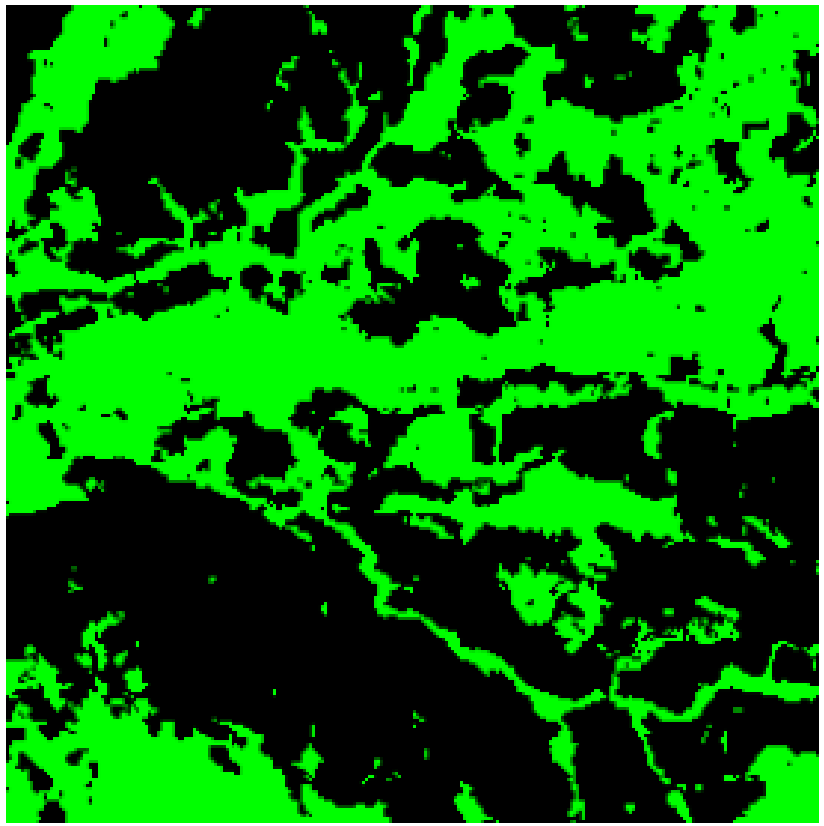
Engineering: Tricks to Tailor a Custom-Made Solution

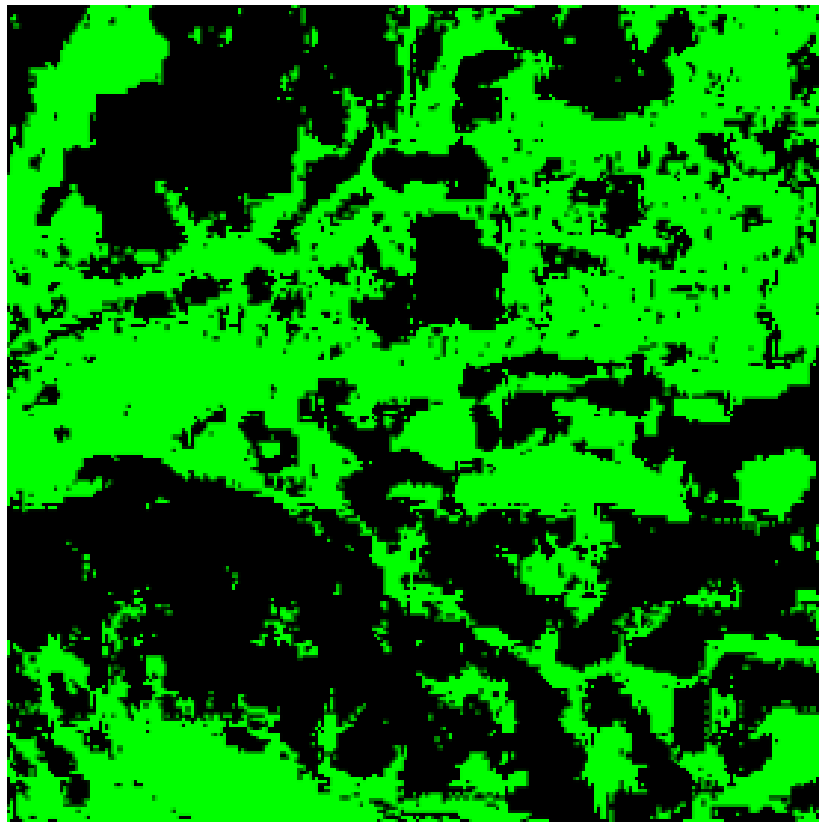
DLR

Sentinel-2

Ground Truth



Model Prediction



Model	Overall Accuracy	Mean IoU
Custom-ResNet18	86.08%	75.55%
Custom-ResNet18-WCE-Filtered	91.5%	85.3%

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Engineering: Tricks to Tailor a Custom-Made Solution

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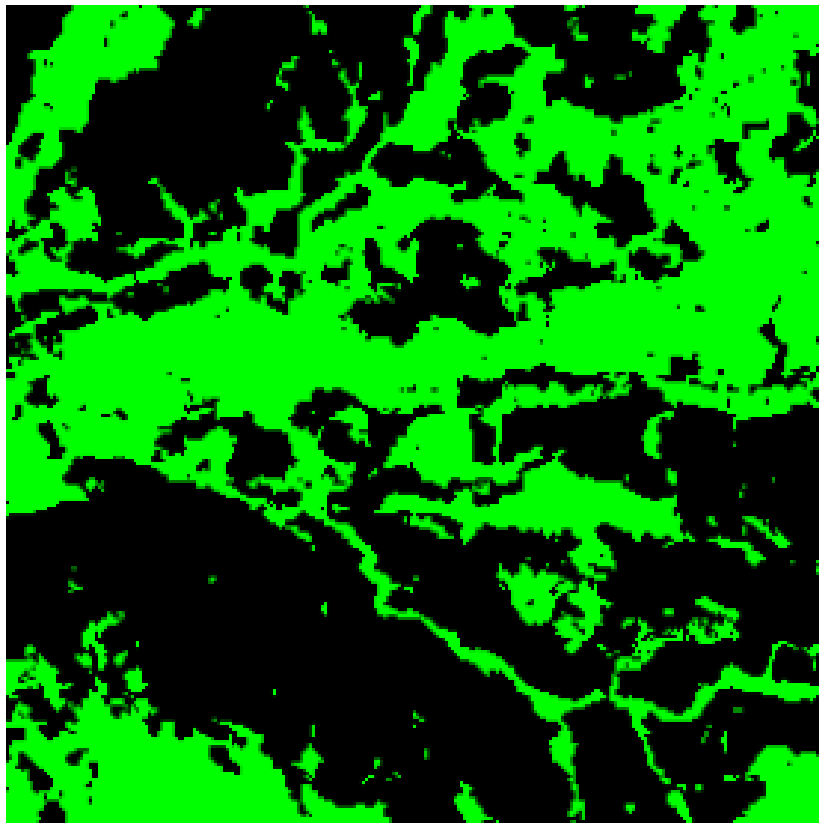
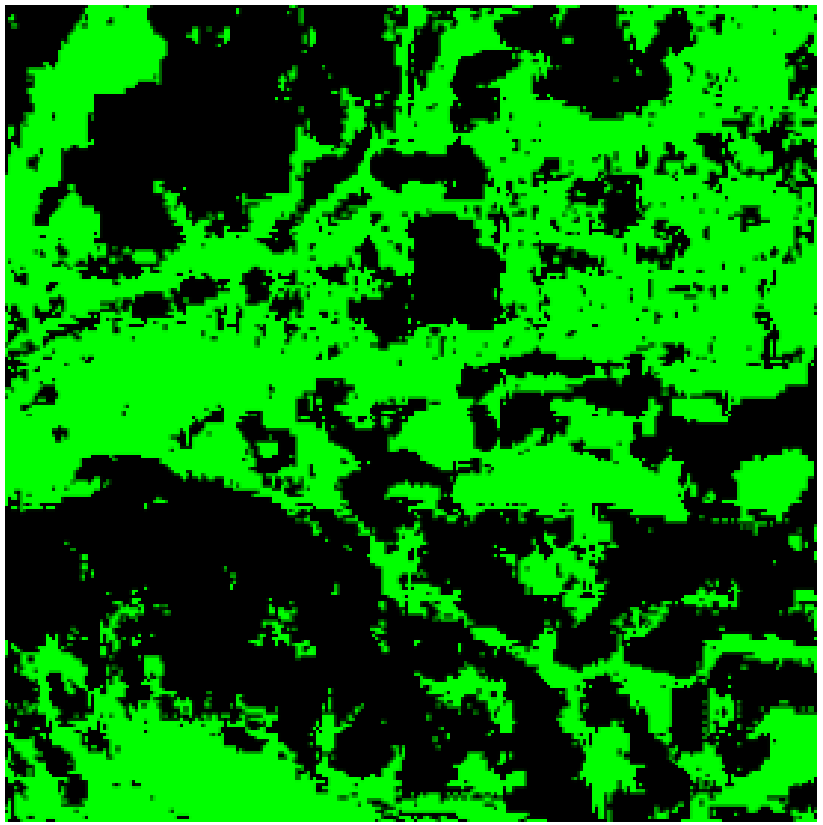
Sentinel-2

Ground Truth



Model Prediction



breaking (at least)
"the 90% barrier" @ "fine-grained"

Model	Overall Accuracy	Mean IoU
Custom-ResNet18	86.08%	75.55%
Custom-ResNet18-WCE-Filtered	91.5%	85.3%

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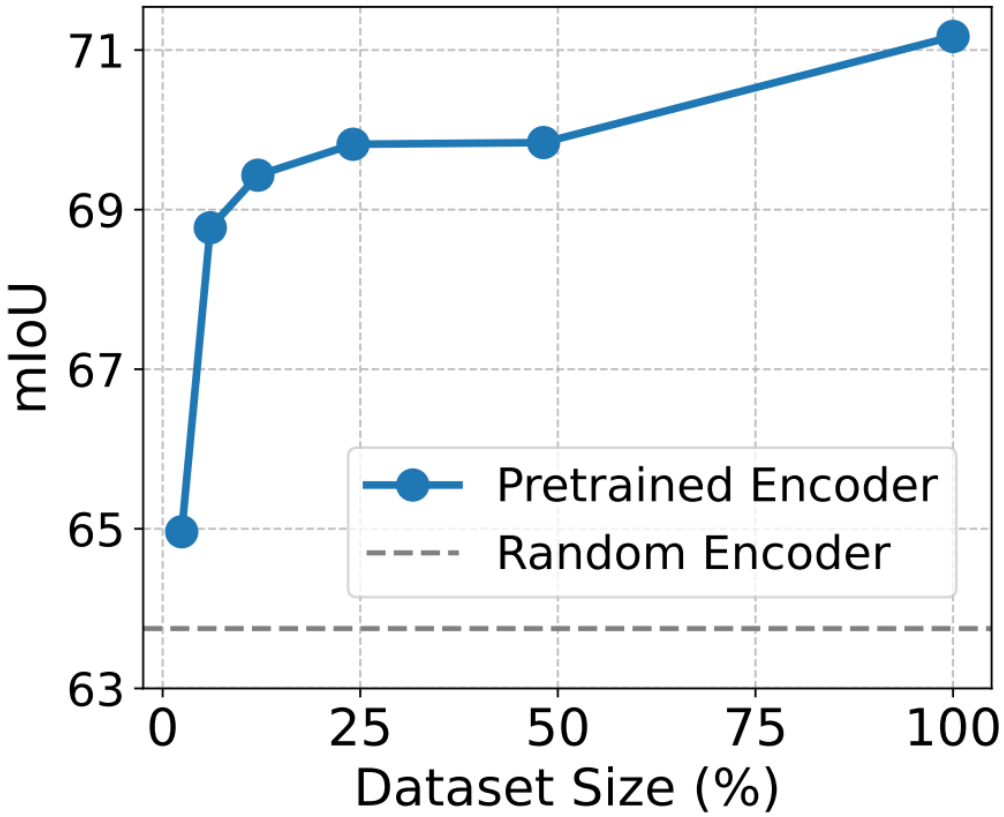
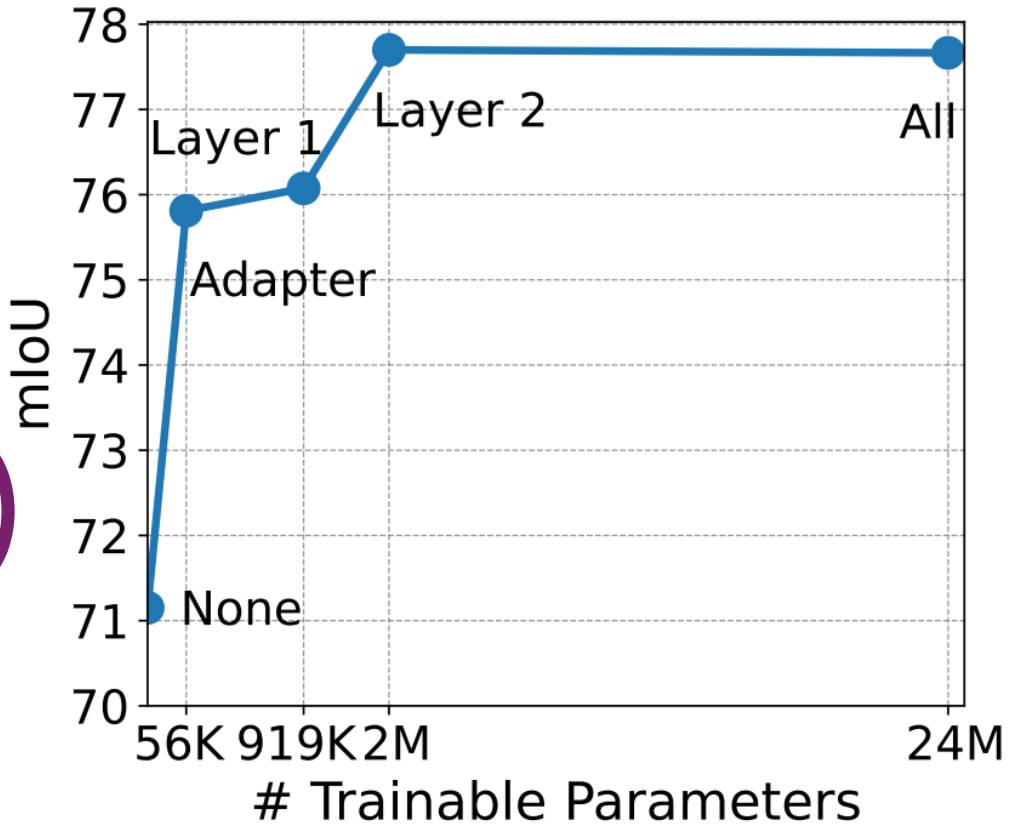
Project PhD 2025

Thx!

Hypes: Data, Data, Data? Model, Model, Model?





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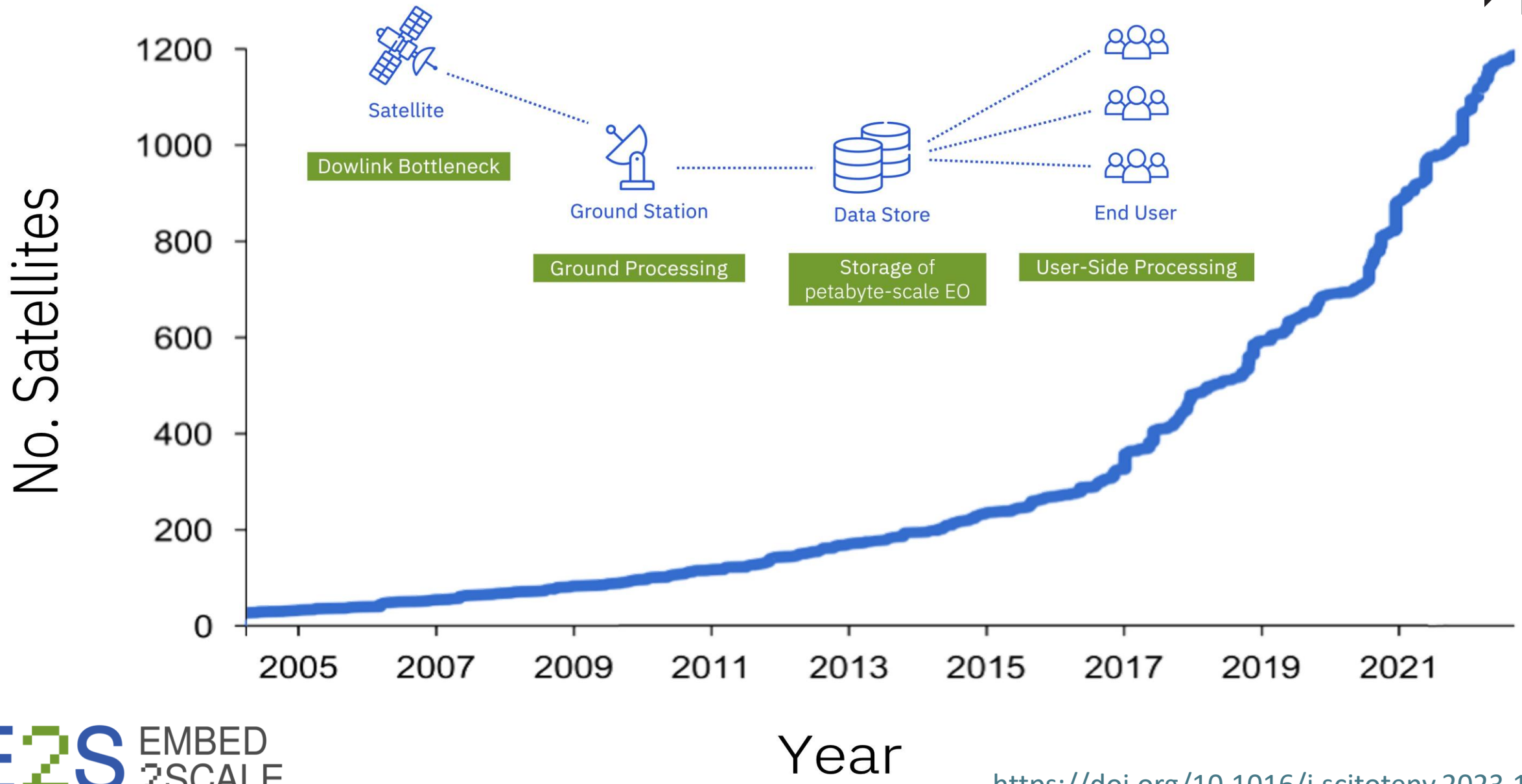
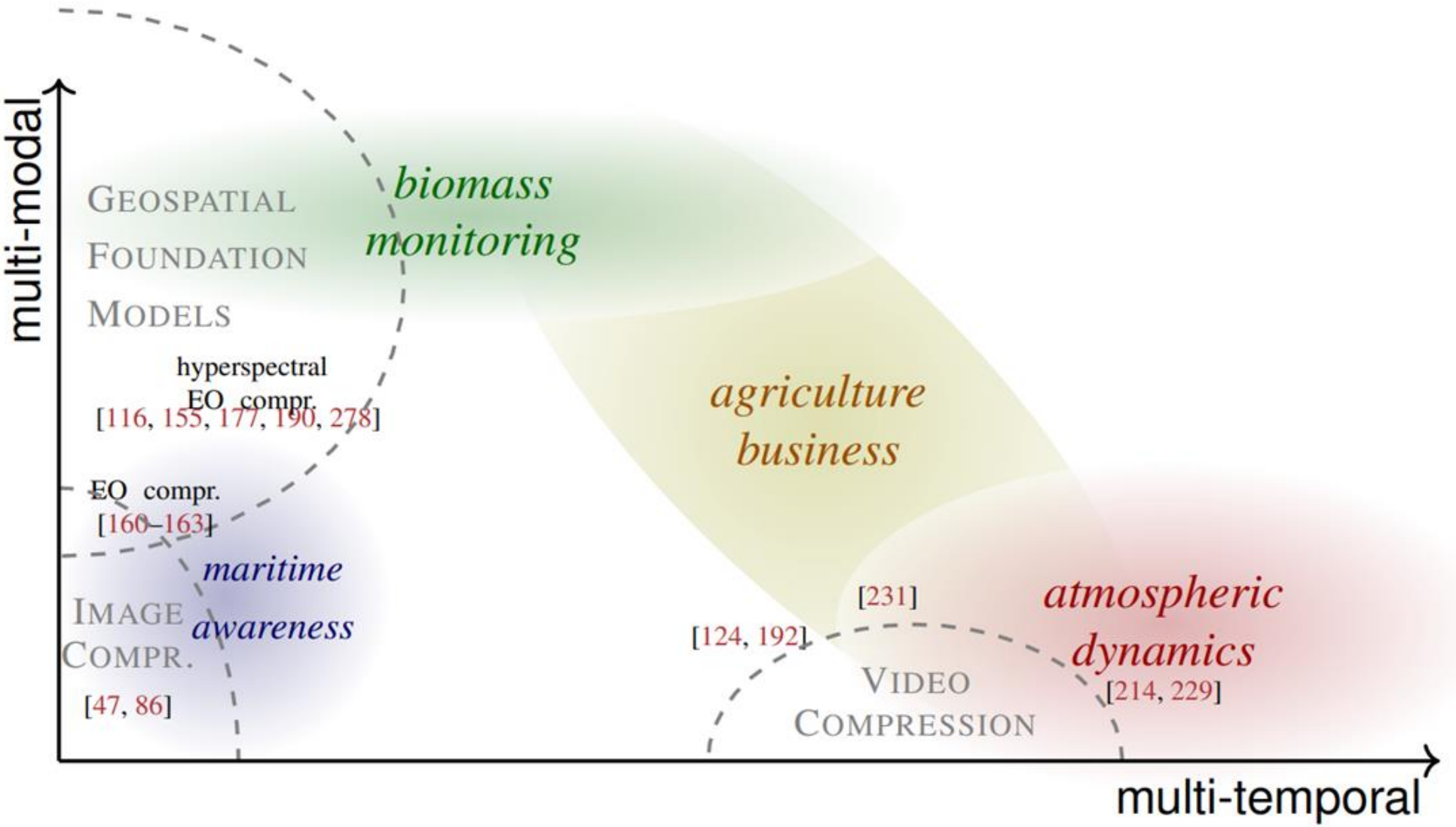
https://doi.org/10.1109/JSTARS.2025.3581451

Embed2Scale in a Nutshell



https://doi.org/10.1016/j.scitotenv.2023.168584

Neural Compression Landscape



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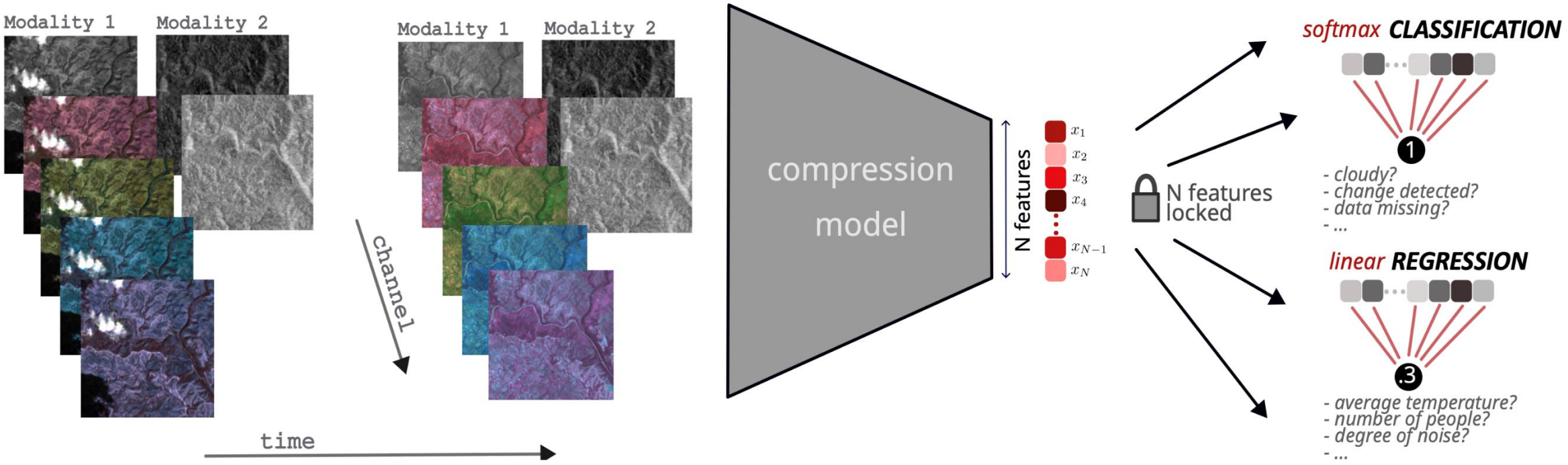
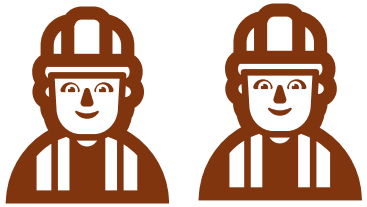
https://doi.org/10.1016/j.scitotenv.2023.168584

NeuCo-Bench: A *No-Cheating* Challenge for Academia

DLR

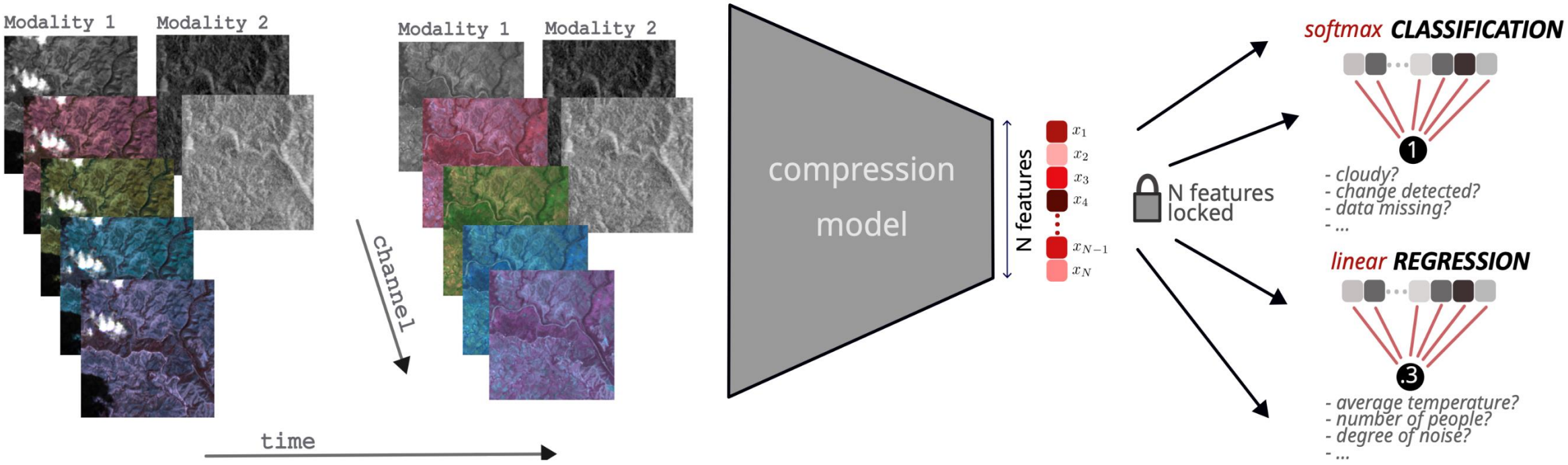


E2S EMBED 2SCALE



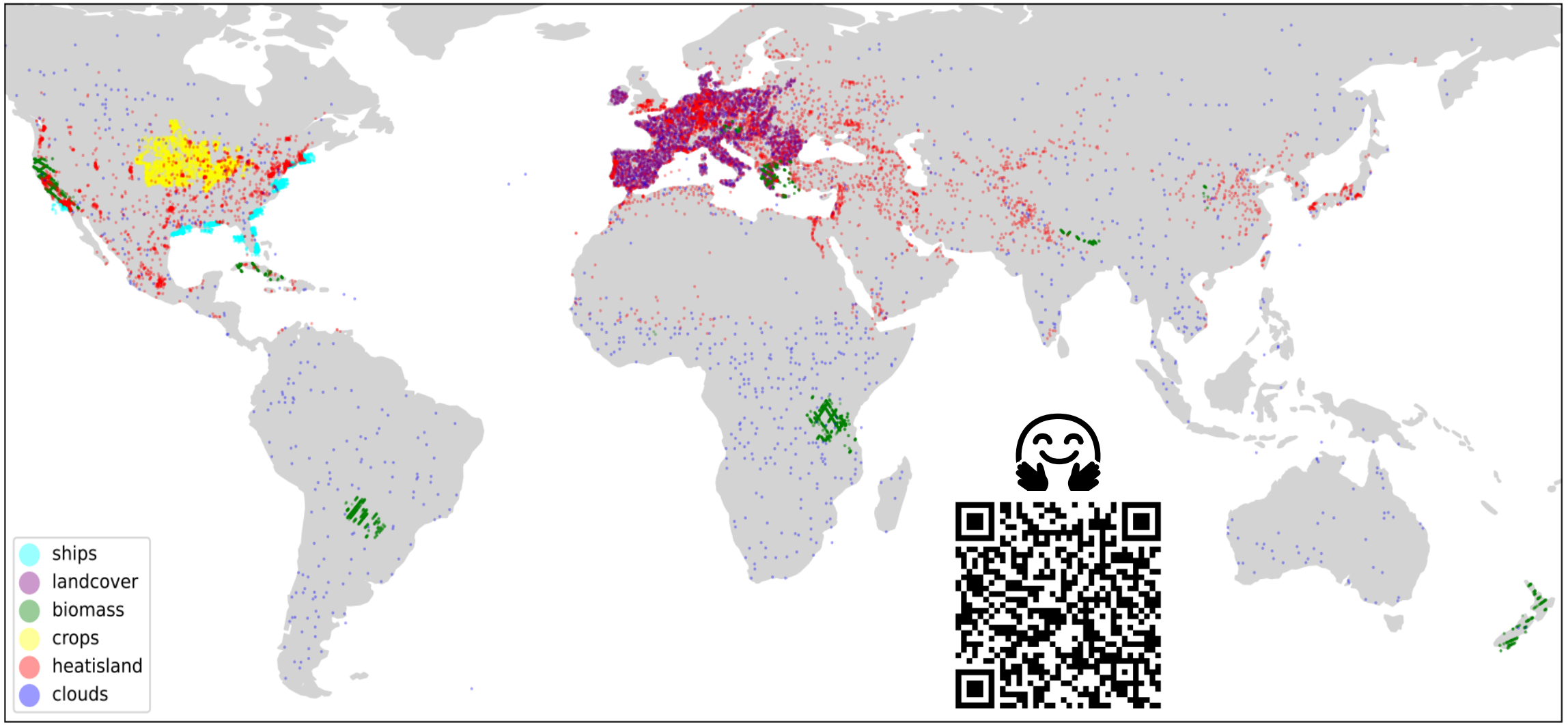
https://github.com/embed2scale/NeuCo-Bench

NeuCo-Bench: A *No-Cheating* Challenge for Academia



https://github.com/embed2scale/NeuCo-Bench

NeuCo-Bench: Downstream Tasks



https://huggingface.co/datasets/embed2scale/SSL4EO-S12-downstream

NeuCo-Bench: Downstream Tasks – for PANGAEA

EMBED 2SCALE

PANGAEA

https://github.com/VMarsocci/pangaea-bench

Earth2Vec: Join Corporate, Government, and Academia

asterisk labs

Spatial Informatics Group

eurac research

Universität Münster

Earth Genome

Universität Zürich[UZH]

CLARK UNIVERSITY

CENTER FOR GEOSPATIAL ANALYTICS

developmentSEED

CloudFerro

ETH zürich

planet.

Degas

Element 84

IBM

LEGEND

DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

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Join monthly community calls & Slack channel (email request)

Lessons Learned towards a successful Digital Copernicus

DLR

no hiding behind buzz words

“Big Geospatial Data Mining with a Quantum-Foundation Model on the Edge for Hybrid Cloud Downstream Tasks“

guide state-of-the-art AI by real-world use cases (downstream tasks)

accelerate Horizon Europe process closer to ESA model, and reduce + simplify EC reporting (KPI structure)

build kind and honest Open Science communities across domains

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Q&A + Feedback + Resources

SSL4EO review:
https://doi.org/10.1109/MGRS.2022.3198244
EvoLand:
https://www.evo-land.eu
Embed2Scale:
https://embed2scale.eu
(Lossy) Neural Compression review:
https://doi.org/10.1109/MGRS.2025.3546527
NeuCo-Bench framework:
https://github.com/embed2scale/NeuCo-Bench

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