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constellr

Hyperspectral imagery and AI use cases

AI4Copernicus
3rd of May 2022

ConstellR: Water and Vegetation monitoring at scale

Data fusion platform for comprehensive crop monitoring

Globally scalable

Single, comparable dataset for the whole planet

Affordable

Few Euros per hectare per year

Reliable

Real physical measurement at field level

Symptoms instead of damage

Sees vegetation stress days to weeks before crop damage

Source: LisR (thermal) recording on 03/23/22 over Sacramento, 7 pm PDT

ConstellR in a nutshell

The backbone of an EO analytics company

ConstellR's proprietary TIR data: LisR (ISS payload) and HiVE (satellite constellation)

Highest quality TIR images: HiVE technology prototype

LisR-ISS

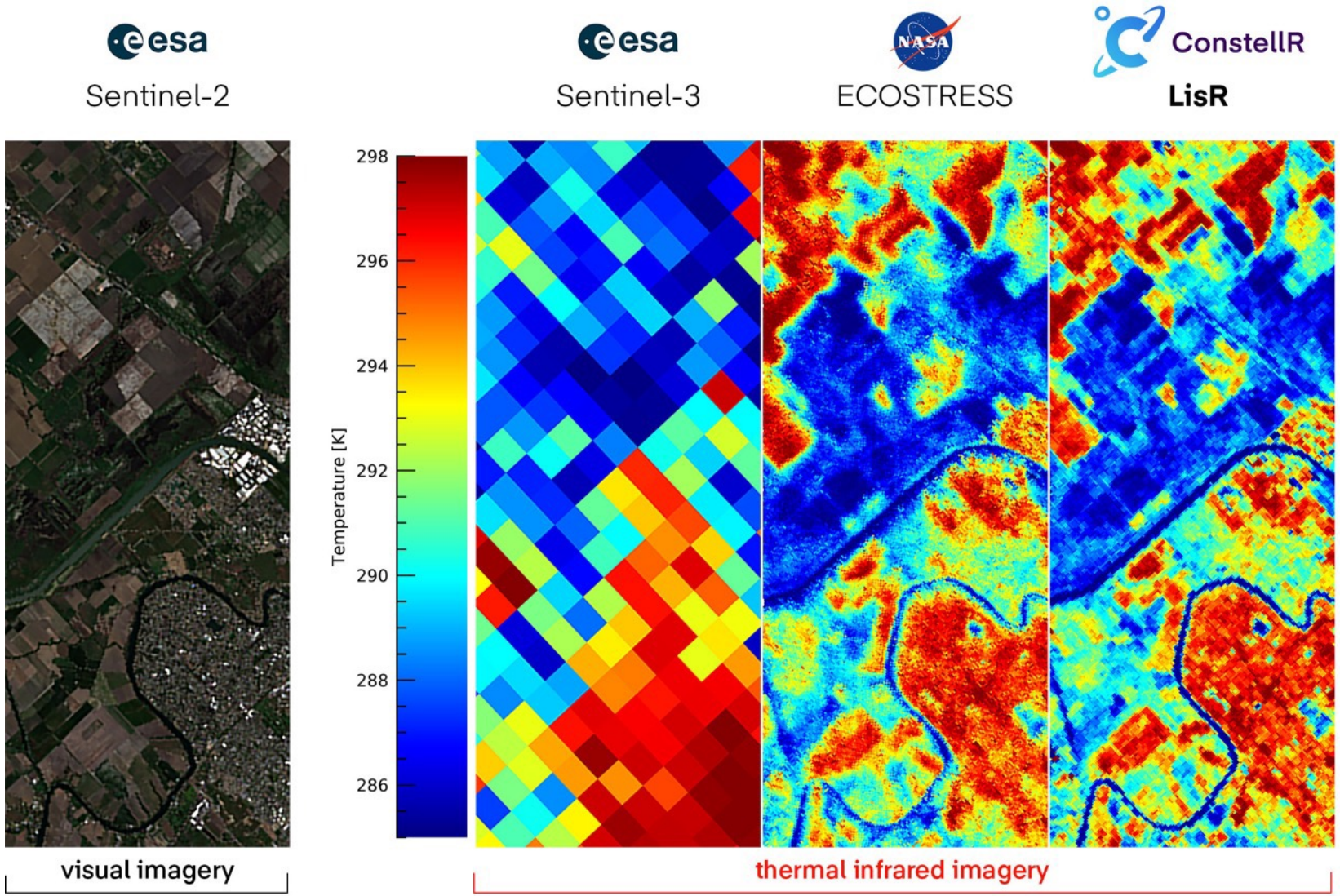
First light on 16th March 2022.

- LisR offers excellent image performance at close to field-level resolution
- LisR has < 2% of the mass and volume of NASA's ECOSTRESS

HiVE

Expected in 2023.

- HiVE will substantially improve image quality and resolution



Our infrastructure: tailor-made for large datasets and AI

Focusing on scalability and performance

Our implementation choices are the conclusions of a GSTP De-Risk activity with ESA: the HDSA Project (**Hyperspectral Data Store Access)**.

ZARR +

- Adopt Climate and Forecast Conventions
- Constraints for sustainable flexibility
- Multiscale support (COG-like display)

S3 +

- Fast and scalable
- Cloud native
- Standard protocols
- Data is ARD

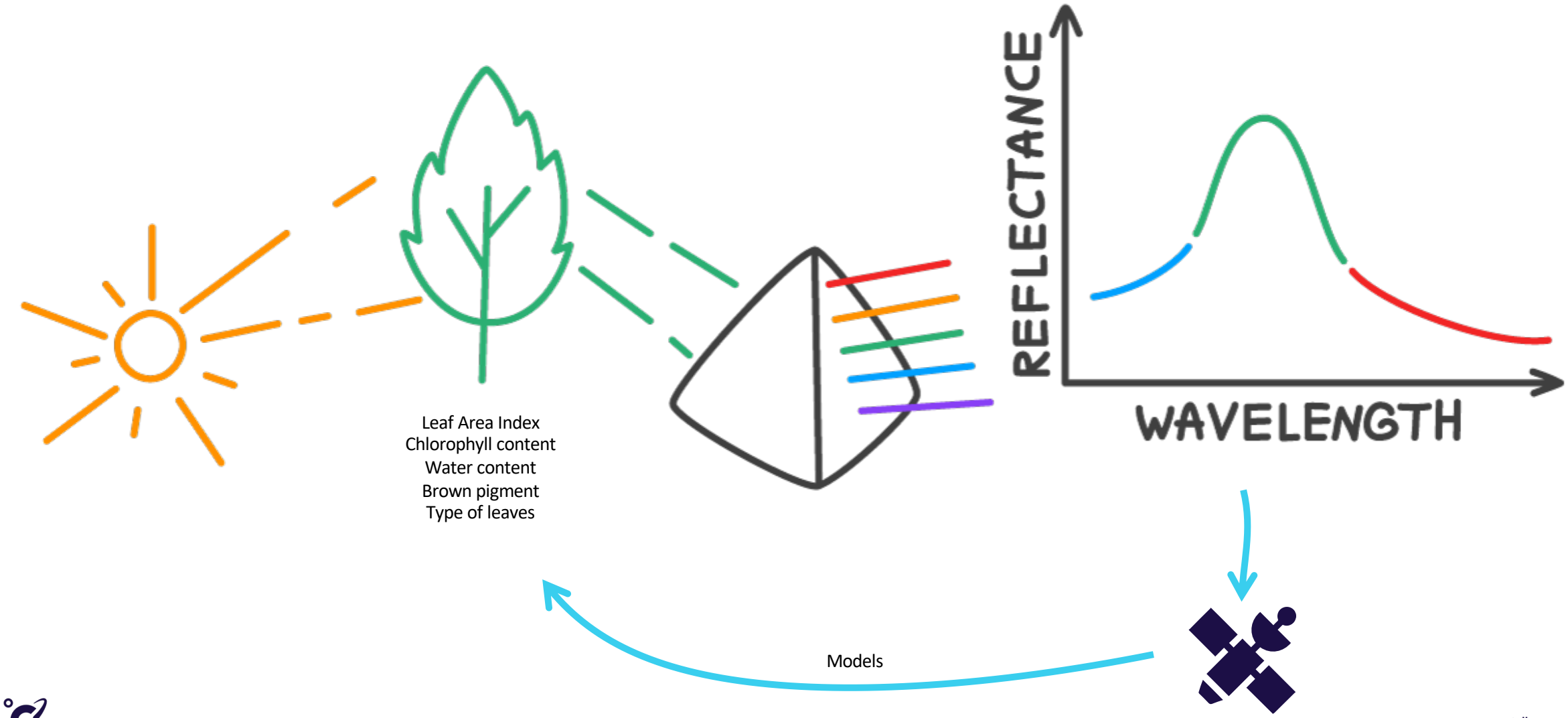
PANGEO =

- Xarray
- Dask
- Jupyter
- Scipy, Numpy,...
- Torch

The HDSA Project was performed in close collaboration with Spacebel.

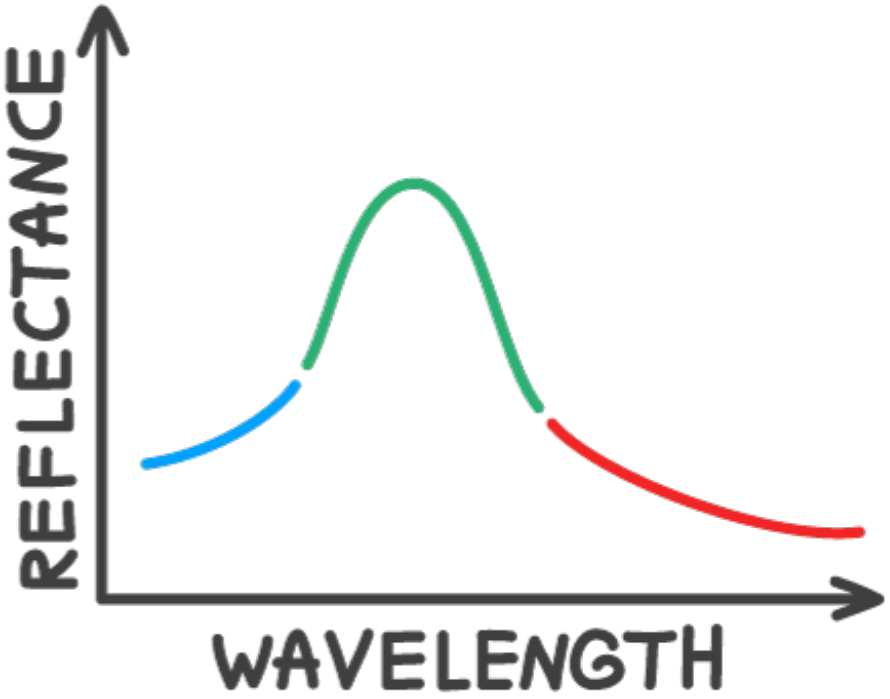
AI Use case #1: regression model on vegetation variables

Remote sensing aims at estimating vegetation parameters

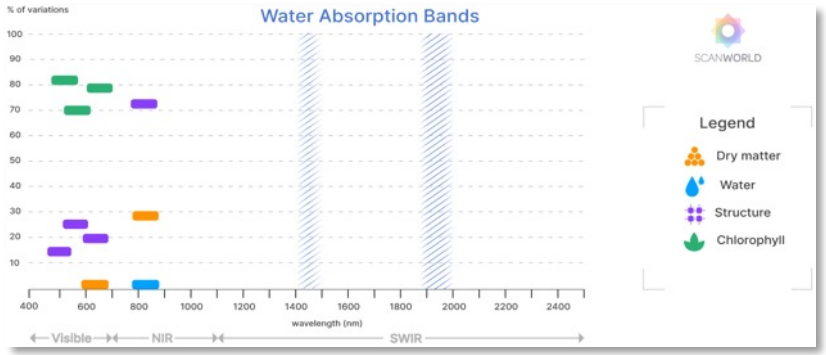


AI Use case #1: regression model on vegetation variables

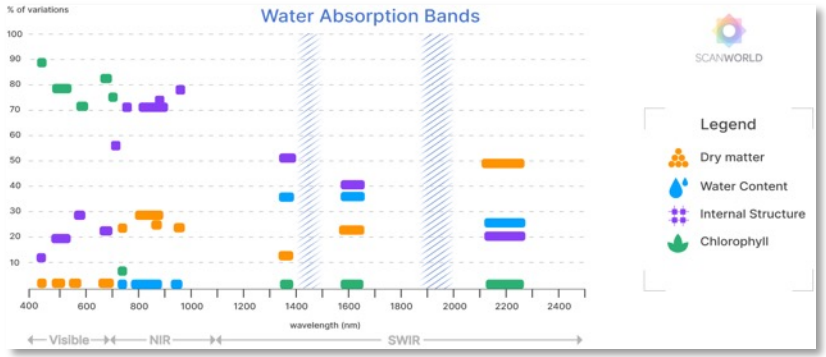
Hyperspectral imagery provides a much larger number of features in a broader range



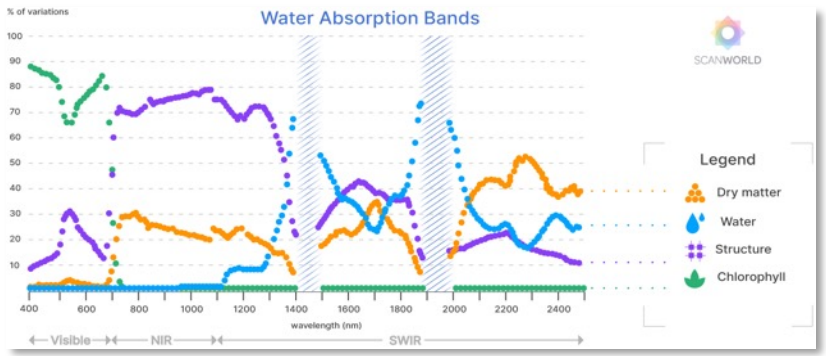
RGB+



S2



HSI



Graphs based on the work of **Pietro Ceccato:**

[1] Ceccato, P., Flasse, S., Tarantola, S., Jacquemoud, S., & Grégoire, J.-M. (2001). ***Detecting vegetation leaf water content using reflectance in the optical domain****. Remote Sensing of Environment, 77, 22–23.*

[2] Ceccato, P., Gobron, N., Flasse, S., Pinty, B., Tarantola, S. (2002). ***Designing a spectral index to estimate vegetation water content from remote sensing data: Part 1: Theoretical approach****. Remote Sensing of Environment, 82 (2-3), 188-197.*

More information: https://www.linkedin.com/pulse/agriculture-can-hyperspectral-imagery-change-game-pietro-ceccato/

AI Use case #1: regression model on vegetation variables

Using AI to assess the optimal number of bands in our imagery

More Features

Increased measurement accuracy

Feature robustness and redundancy

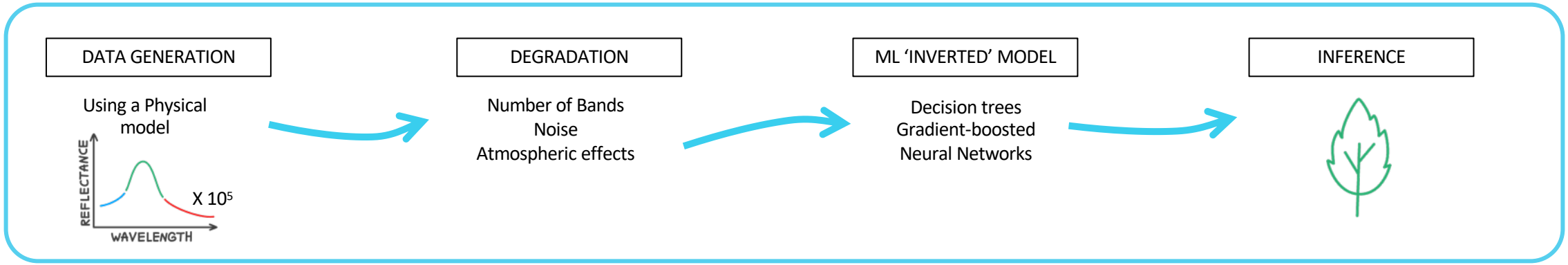
A wider spectrum

More relevant features

How many bands?

Reducing the number of bands may help optimising the hardware design

We used ML to build regression models and assess the best accuracies achievable in theory with specific band parameters

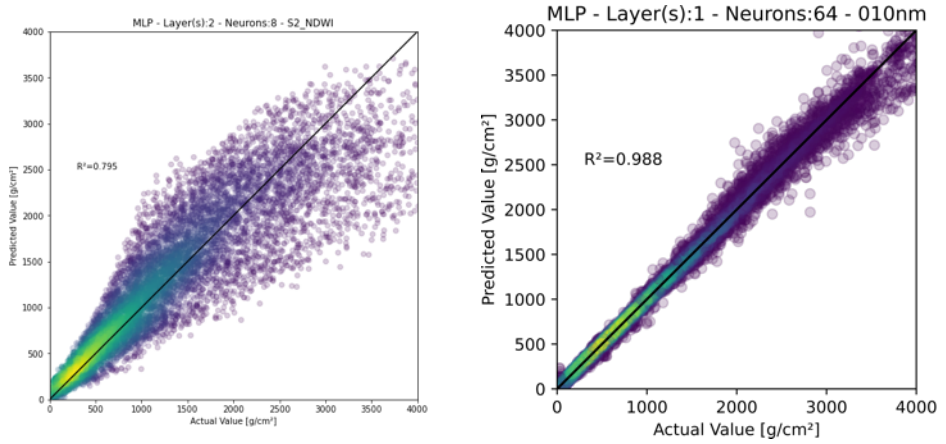


AI Use case #1: regression on vegetation variables

Hyperspectral imagery and the increased number of features impacts the accuracy

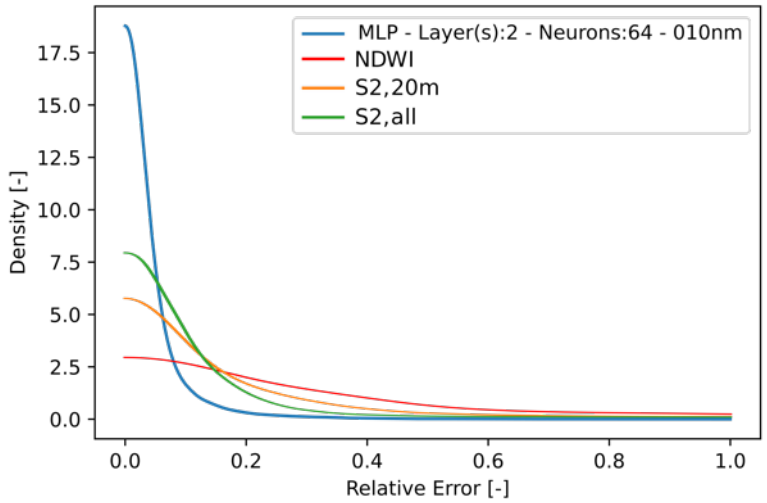
Accuracy Metric

Increasing the number of features has a positive effect on the accuracy metrics



Relative Error

A more striking effect can be noted on the relative error distribution

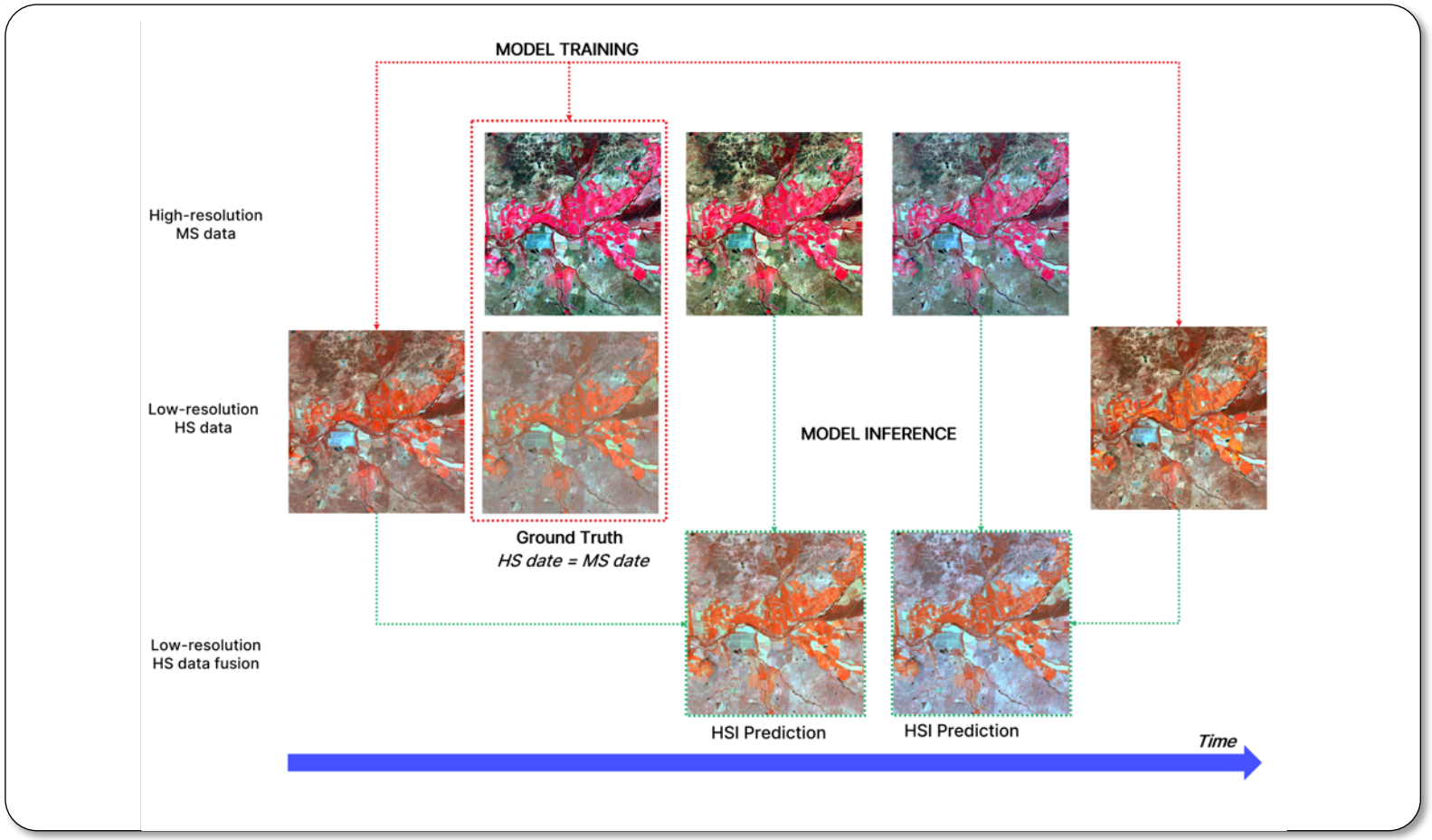


AI Use case #2: Filling gaps in temporal series of images

Using MSI and HSI to create synthetic HSI images

Creating images that couldn't get captured: Data fusion: increasing the revisit time by generating data

We used other satellites (MS, less spectral content) to generate synthetic data in HS



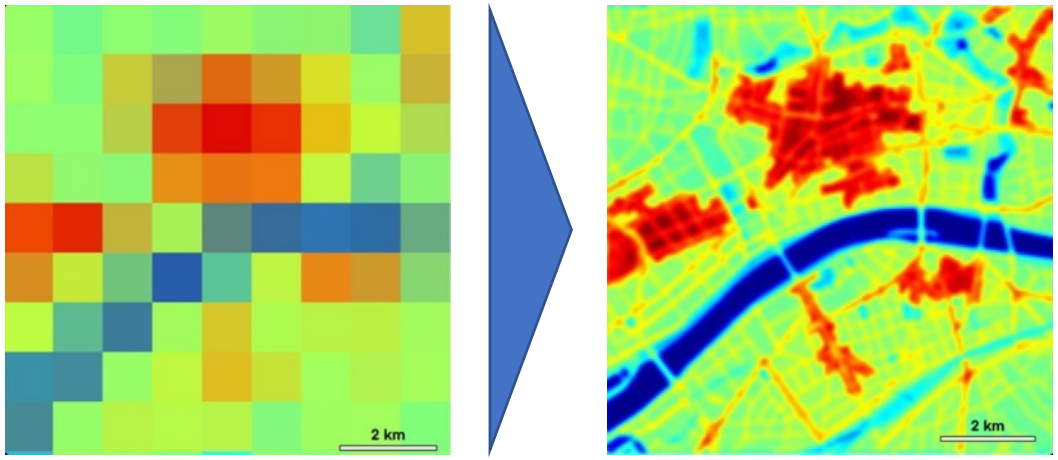
Tremplin IA

AI Use case #3: super-resolution on thermal imagery

Increasing the spatial resolution of existing data using additional data sources

Super resolution, increasing the spatial resolution by adding details, using higher resolution MS imagery

a. Thermal data typically cannot be acquired at very high resolution, because of technical constraints
b. Using algorithms to increase the resolution helps in making the data more actionable
c. AI, Deep-learning in particular, can help in increase the level of details with high accuracy, using other data sources



(images for illustration purposes only)

Conclusion

We’re Hiring!

Our observations

1. Starting with simple, concrete use cases helps
2. It is hard to move from a POC to an industrial application
3. We’re hiring!

Contact us!

→ **tomi@constellr.space**