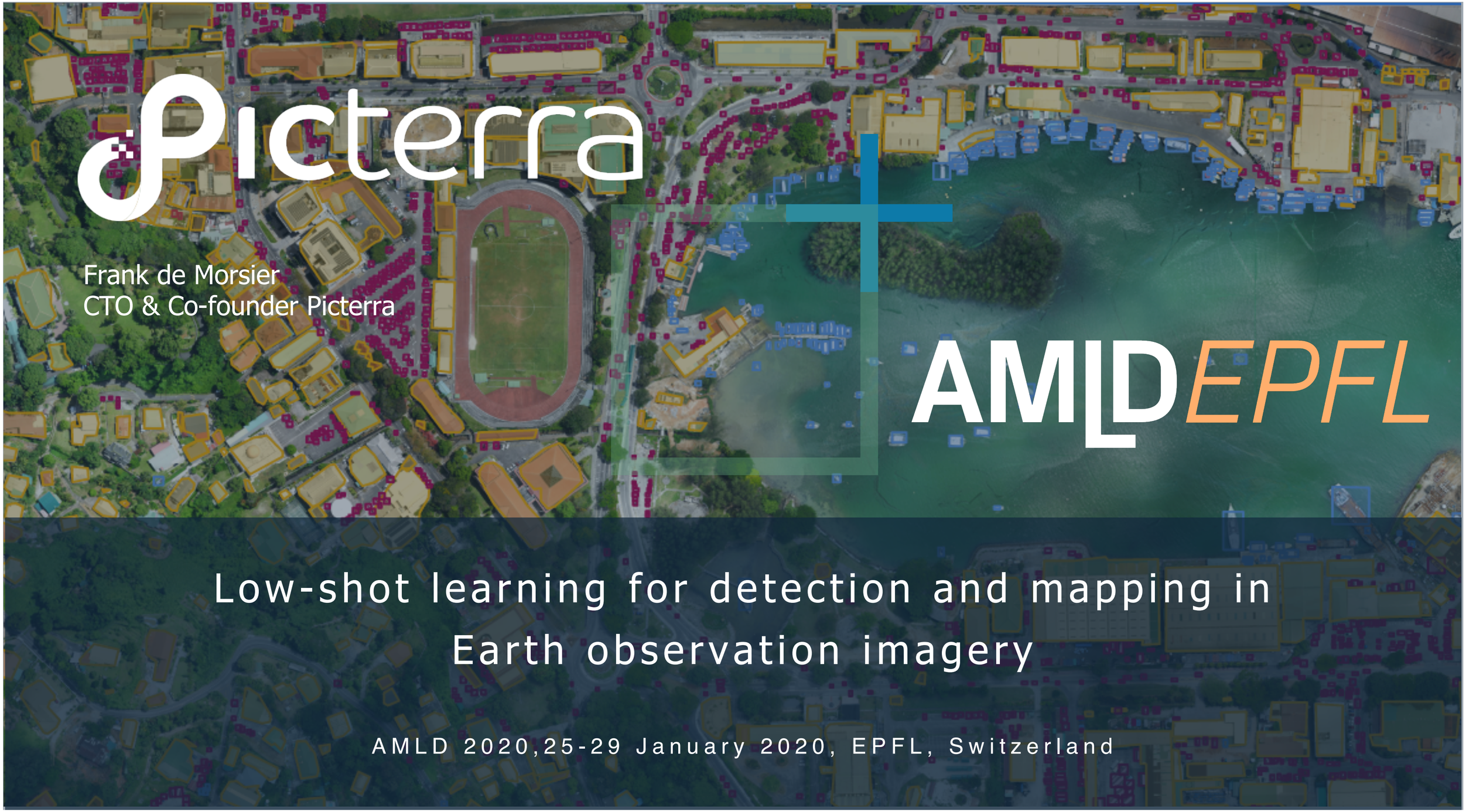



Frank de Morsier
CTO & Co-founder Picterra

# Low-shot learning for detection and mapping in Earth observation imagery

AMLD 2020,25-29 January 2020, EPFL, Switzerland

# PICTERRA PLATFORM


GENERATE CUSTOMIZED GEO-SPATIAL INFORMATION

ANNOTATION TOOLKIT

DETECTOR LIBRARY

CUSTOM DETECTION

# PICTERRA PLATFORM

WMS / WMTS / TMS

DATA SOURCES



USER

GENERATE CUSTOMIZED GEO-SPATIAL INFORMATION

# PICTERRA PLATFORM

WMS / WMTS / TMS

WEB OPTIMIZED
CLOUD OPTIMIZED GEOTIFFS

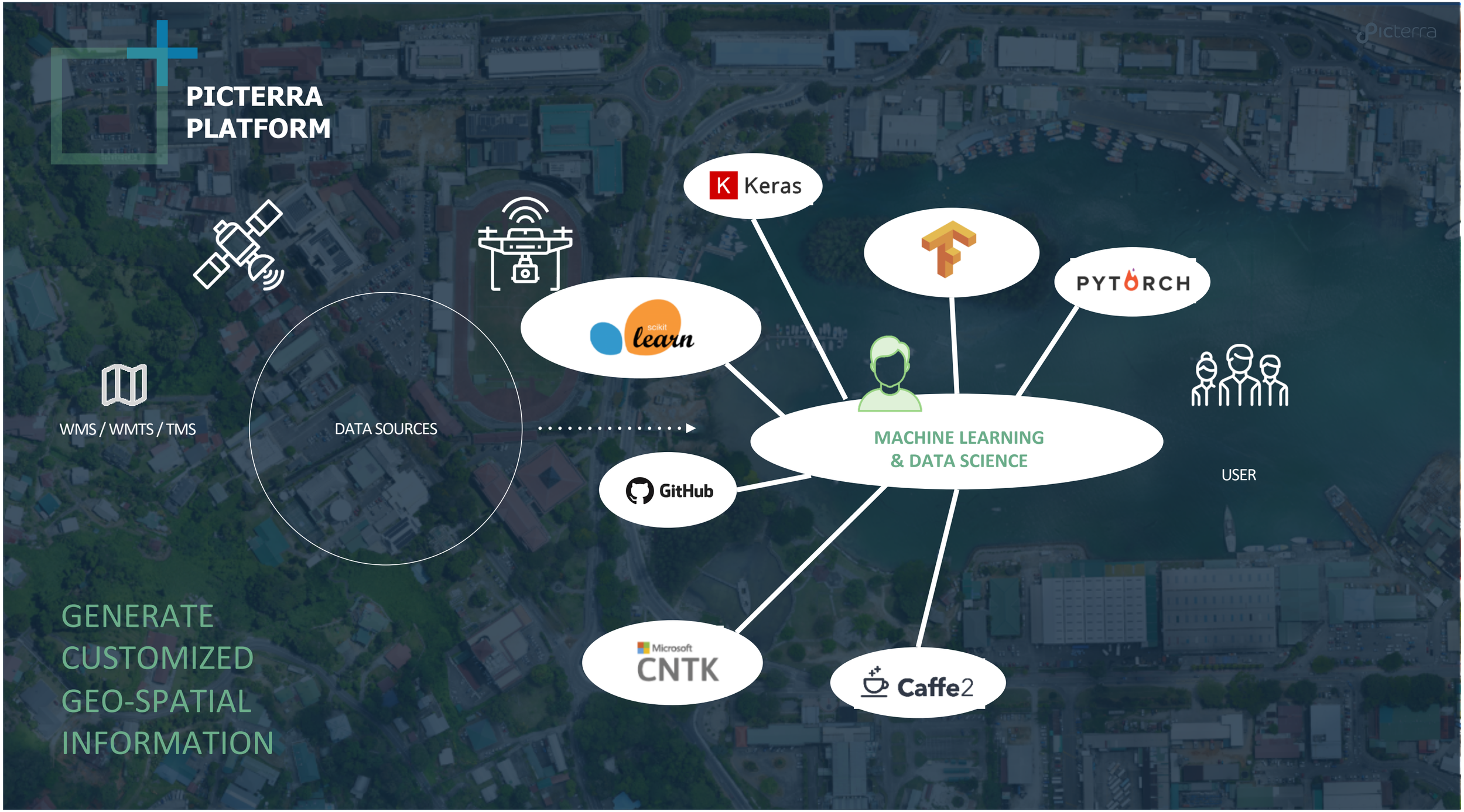
-Overview pyramids
-Pseudo-mercator
-HTTP requests

Dynamically Generated Map Tiles

Visualization & Processing

USER

GENERATE CUSTOMIZED GEO-SPATIAL INFORMATION


PICTERRA
PLATFORM
Keras
PYTORCH
scikit
learn
WMS / WMTS / TMS
DATA SOURCES
MACHINE LEARNING
& DATA SCIENCE
USER
GitHub
Microsoft
CNTK
Caffe2
GENERATE
CUSTOMIZED
GEO-SPATIAL
INFORMATION

# PICTERRA PLATFORM

WMS / WMTS / TMS

DATA SOURCES



PLATFORM

USER

GENERATE CUSTOMIZED GEO-SPATIAL INFORMATION

# PICTERRA PLATFORM

WMS / WMTS / TMS

DATA SOURCES

TRANSFER LEARNING

PLATFORM

ACTIVE LEARNING

DETECTIONS & INSIGHTS

USER

MODEL INPUT

GENERATE CUSTOMIZED GEO-SPATIAL INFORMATION

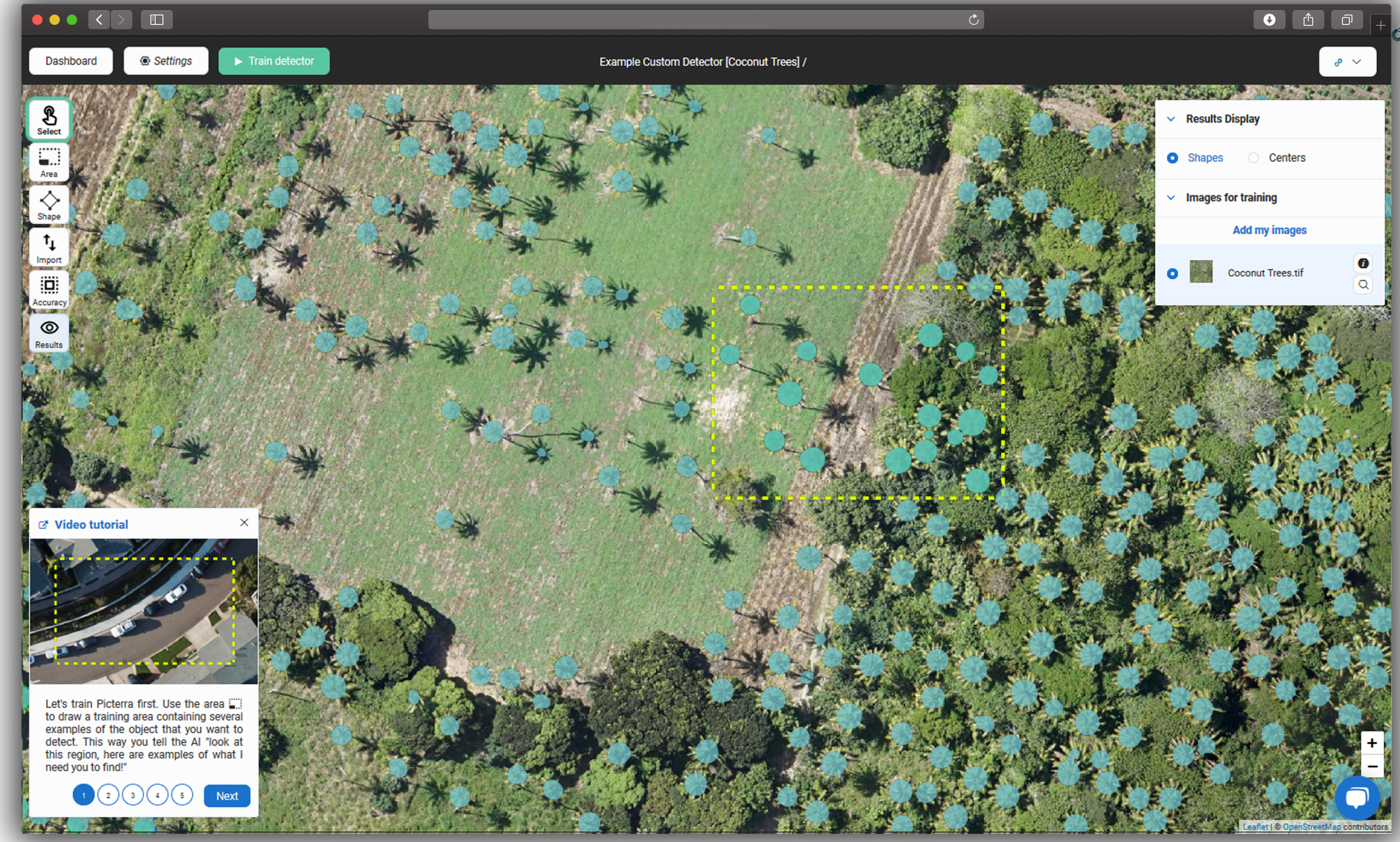
ENABLED BY LOW-SHOT LEARNING

Picterra

**IF YOU CAN SEE IT**

AI CAN LEARN TO FIND IT


Dashboard
Settings
Train detector
Example Custom Detector [Coconut Trees] /
Select
Area
Shape
Import
Accuracy
Results
Results Display
Shapes
Centers
Images for training
Add my images
Coconut Trees.tif
Video tutorial
Let's train Picterra first. Use the area to draw a training area containing several examples of the object that you want to detect. This way you tell the AI "look at this region, here are examples of what I need you to find!"
1
2
3
4
5
Next
Leaflet | © OpenStreetMap contributors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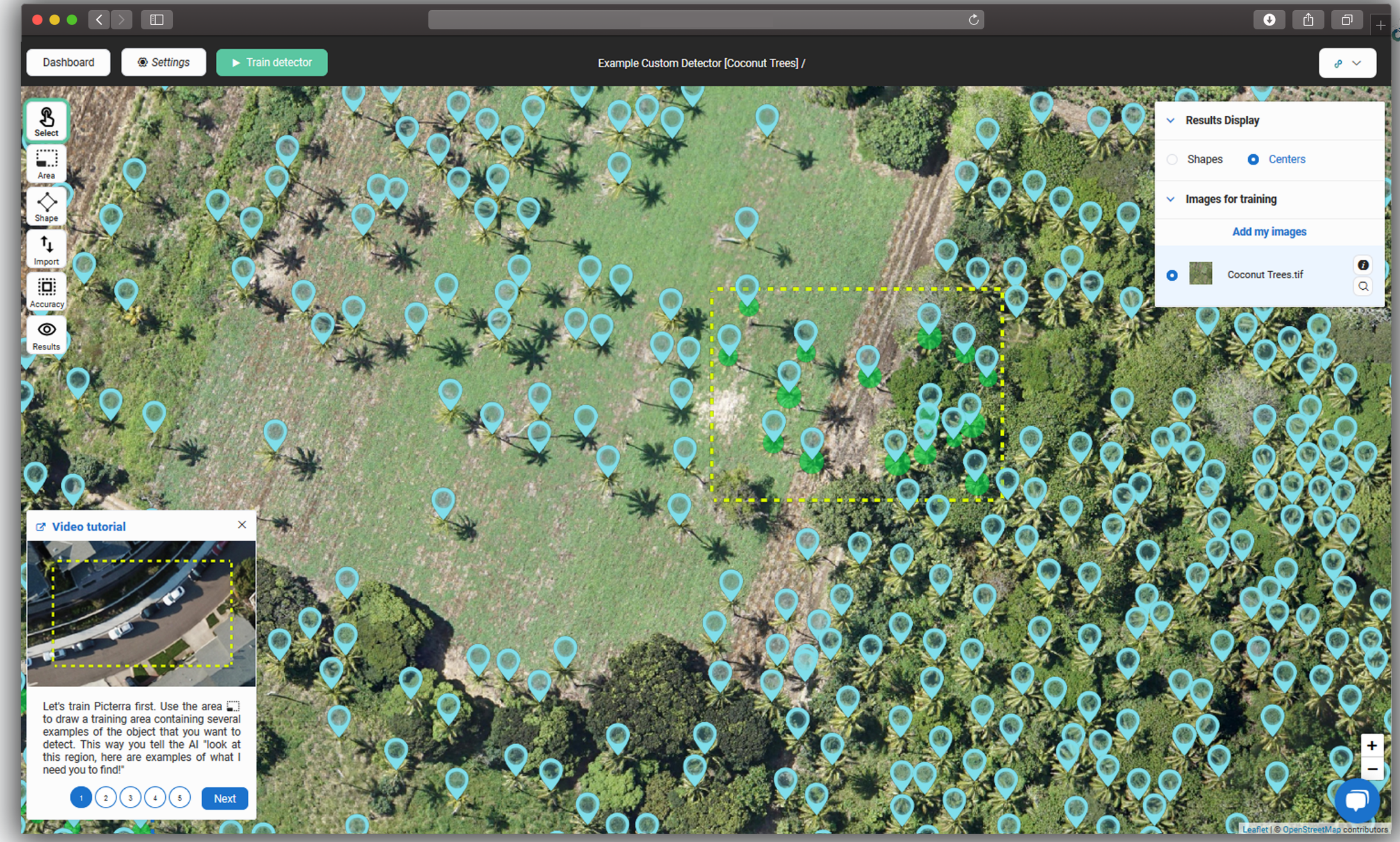
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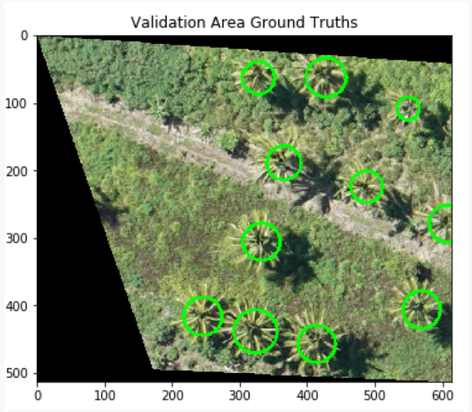
# COUNTRY-SCALE DETECTION WITH ….. TRAINING ANNOTATIONS

- Detections of slurry tanks nearby 34’000 farms over all Denmark
- ~1 TB of imagery at 25cm over 34’000 detection areas
- Detector trained to recognize tanks and discriminate covered and uncovered ones

# COUNTRY-SCALE DETECTION WITH 56 TRAINING ANNOTATIONS

# LOW-SHOT LEARNING



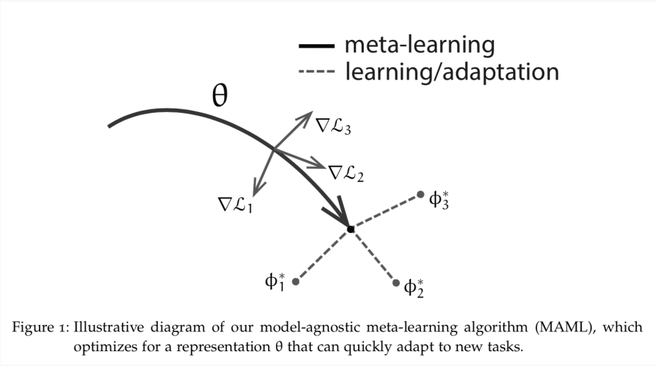




Figure 1: Illustrative diagram of our model-agnostic meta-learning algorithm (MAML), which optimizes for a representation θ that can quickly adapt to new tasks.

## Requirements:

- Preserve user interaction
- Detection of custom objects

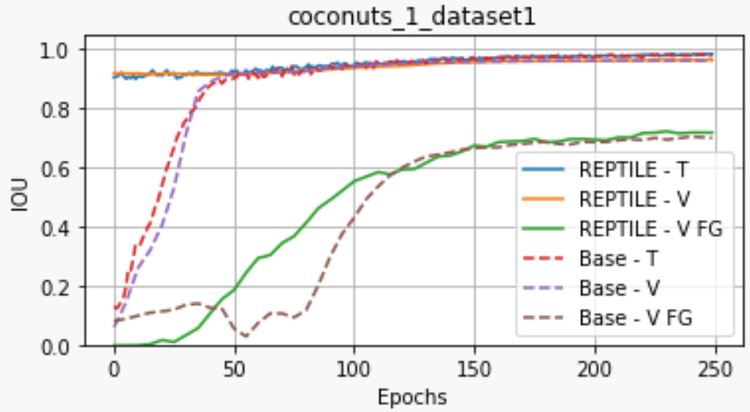
## Approach:

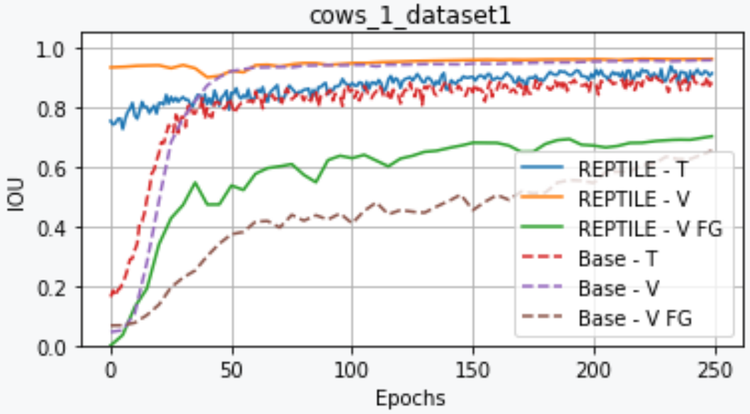
- Meta-Learning training scheme (vs. data augmentation approaches)

**Algorithm 1** Reptile (serial version)

Initialize $\phi$, the vector of initial parameters
**for** iteration $= 1, 2, \ldots$ **do**
  Sample task $\tau$, corresponding to loss $L_\tau$ on weight vectors $\widetilde{\phi}$
  Compute $\widetilde{\phi} = U_\tau^k(\phi)$, denoting $k$ steps of SGD or Adam
  Update $\phi \leftarrow \phi + \epsilon(\widetilde{\phi} - \phi)$
**end for**

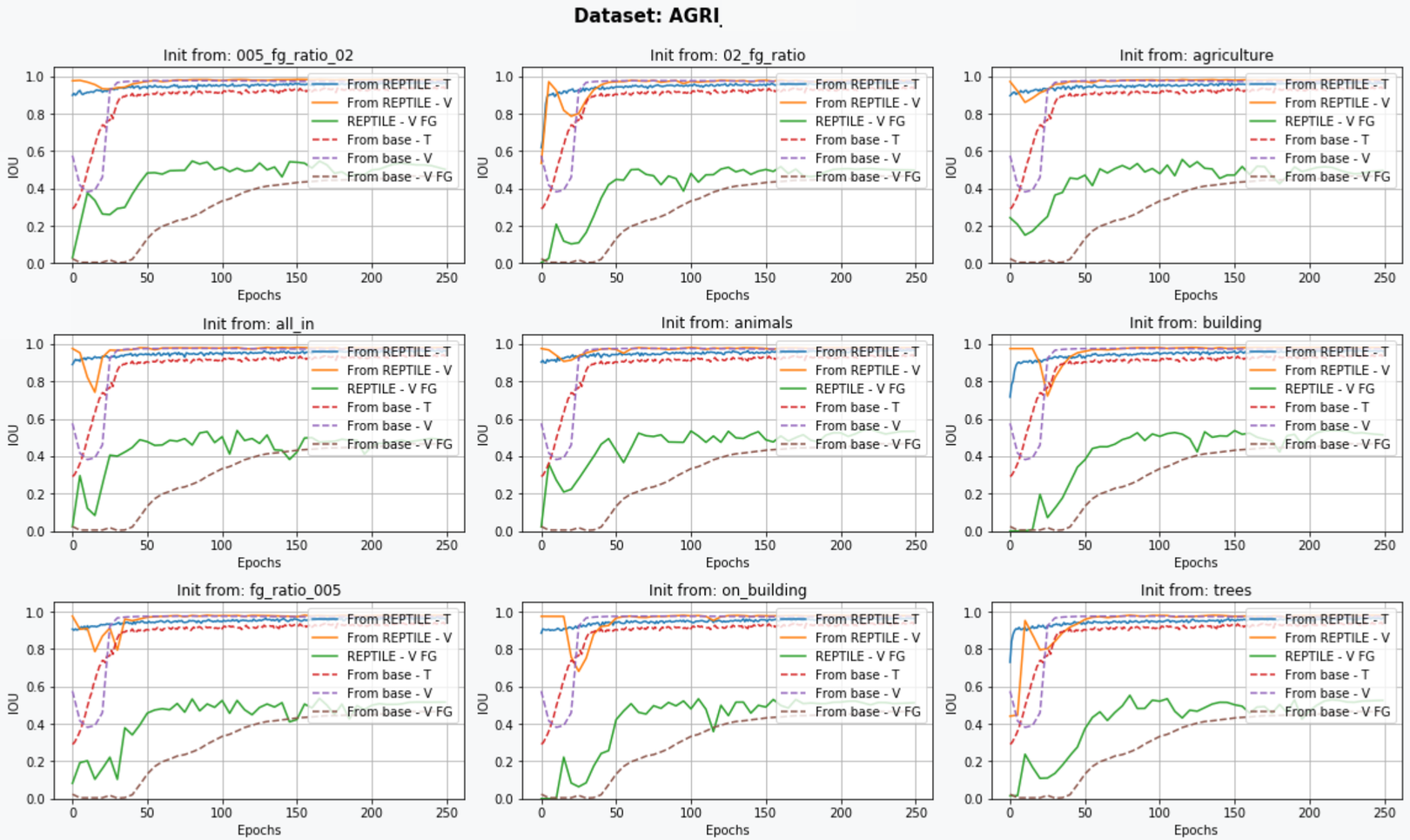
Alex Nichol, Joshua Achiam and John Schulman. On First-Order Meta-Learning Algorithms. arXiv:1803.02999



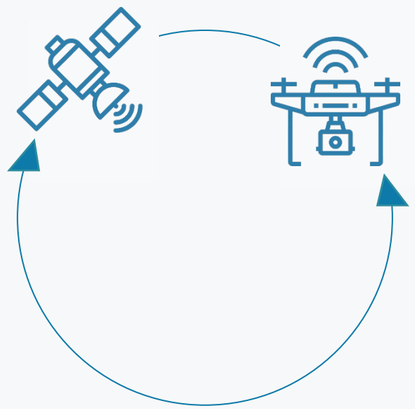



# LOW-SHOT LEARNING

## Reptile training: does grouping data matter?



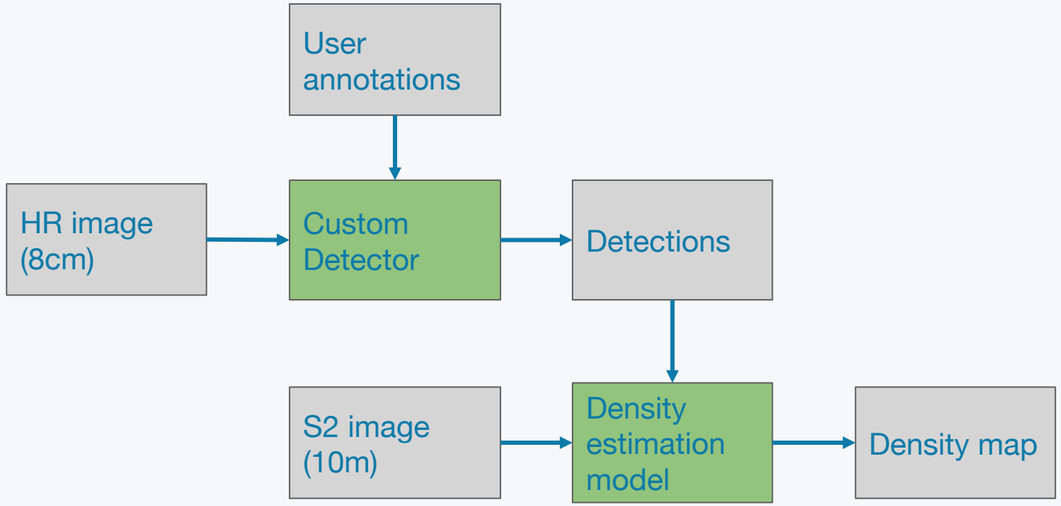
# GOING TOWARDS EXTREME TRANSFER LEARNING



How to detect object at sub-pixel level (too low resolution imagery)?
=> Learn to estimate object density on each pixel

Use case:

- VHR aerial imagery (<10cm) & Sentinel-2 imagery (10m)
- Plantation density estimation
- Density = count of objects contained in a pixel

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Picterra

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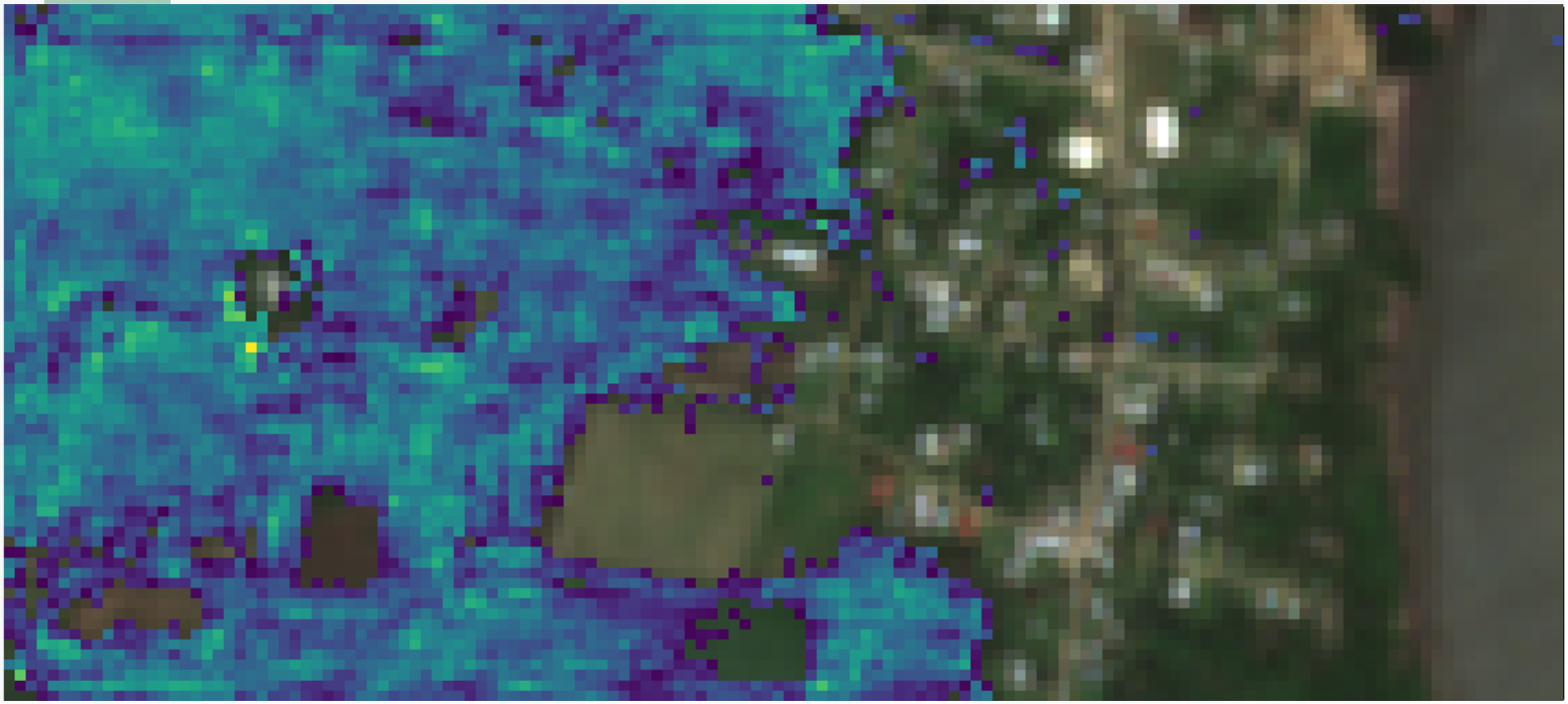

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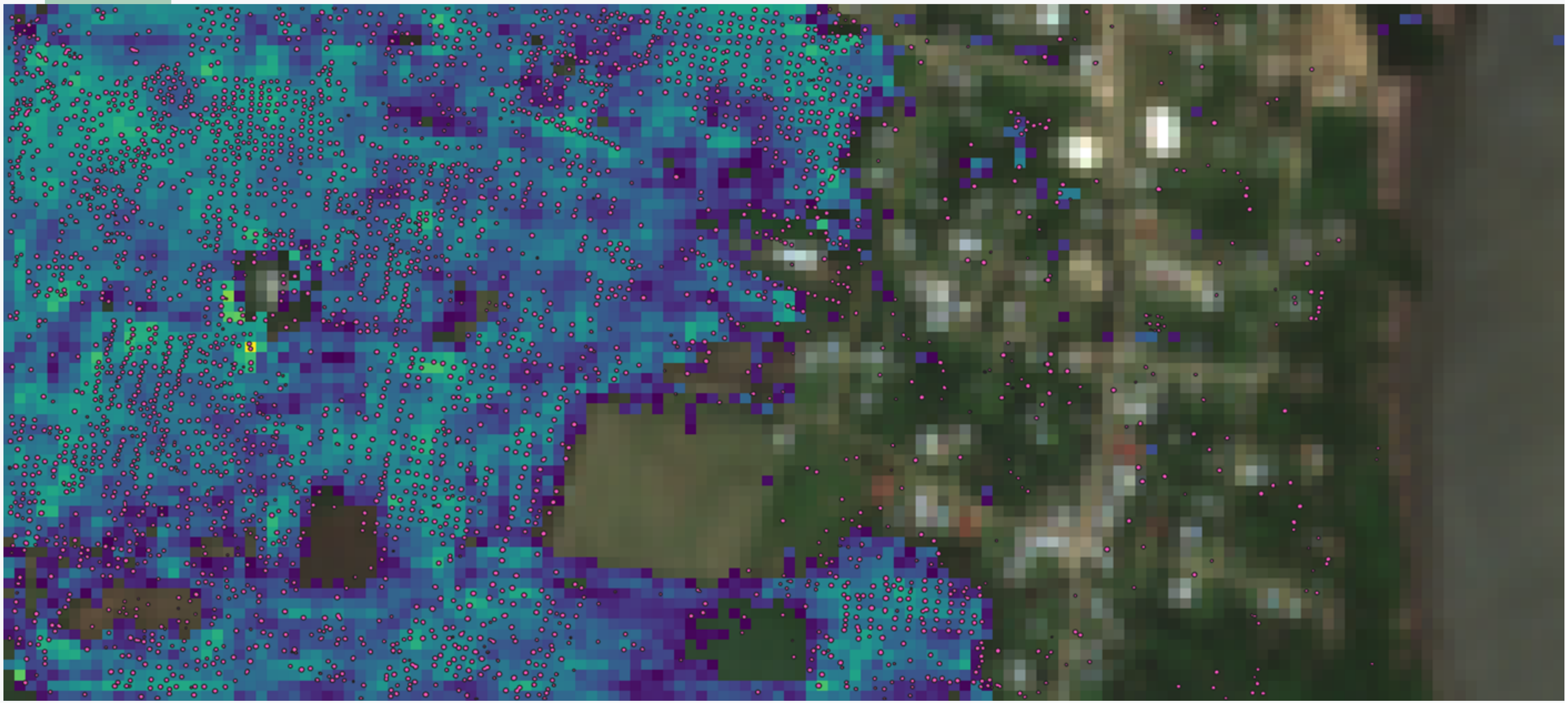

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