ANERIS EURO BIOIMAGING FRANCE-BIOIMAGING אוניברסיטת חיפה University of Haifa جامعة حيفا

AI4 | eosc

WORKSHOP ON AI BASICS FOR IMAGE PROCESSING

SESSION 3: IMAGE CLASSIFICATION AND SEGMENTATION

December 7th from 10:00 AM to 13:00 CEST

UAV-based Thermography: Using AI with Multispectral Data

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Funded by the European Union

Agenda

1. Motivation: What is thermography and how can we use it in the urban energy context?
2. Deep learning models to aid in urban infrastructure maintenance
   - TBBRDet – thermal bridges on building rooftops detection
   - TUFSeg – thermal urban feature segmentation
3. AI4EOSC project & training platform

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Motivation

Bing Image Creator from Microsoft
https://www.bing.com/images/create/

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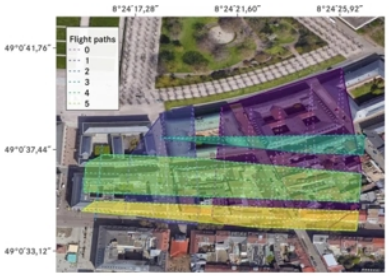
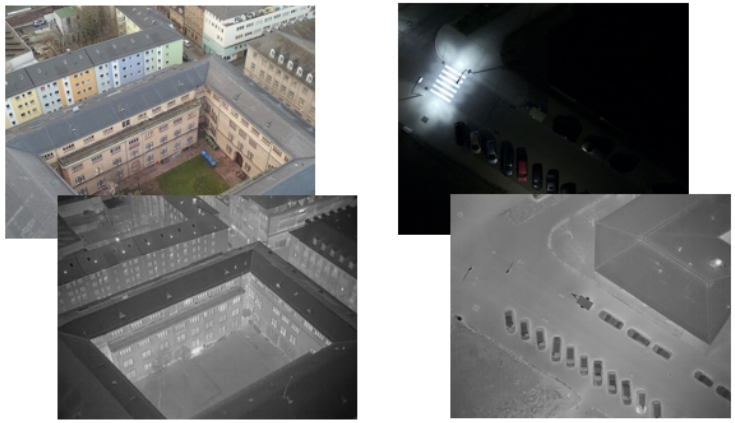
Motivation





urban infrastructure (potentially damaged)

organise

automatic UAV flights

acquire

RGB and TIR images

analyse

identify thermal anomalies

repare

RGB = Red Green Blue
TIR = Thermal InfraRed
UAV = Unmanned Aerial Vehicle

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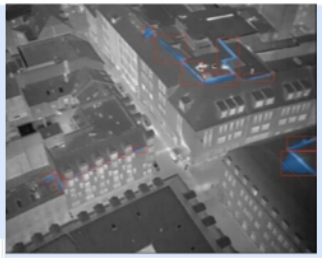
Deep learning models: Case descriptions

TBBRDet
(Thermal Bridges on Building Rooftops Detection)

Energy use: Buildings

Find thermal bridges on building rooftops
→ provide pointers for energy retrofitting measures

single-class
object detection
or instance segmentation



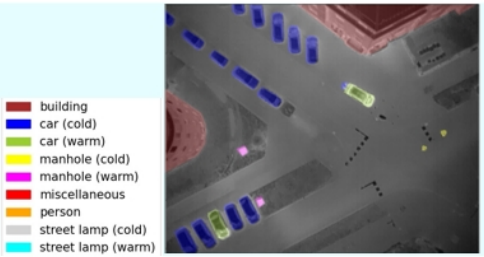
Dual camera[1]: RGB + TIR
UAV-based[2]: 45° pitch, high overlap
Day-time flights in Karlsruhe (DE)

TUFSeg
(Thermal Urban Feature Segmentation)

Energy supply: District heating networks (underground)

Identify common thermal features in urban settings
→ sort out false alarms while searching for leakages

multi-class
semantic segmentation



Dual camera[1]: RGB + TIR
UAV-based[2]: 90° pitch, high overlap
Night-time flights in Karlsruhe & Munich (DE)

[1] Zenmuse XT2 camera with a FLIR Tau 2 thermal sensor
[2] DJI M600 and DJI M300 UAVs

RGB = Red Green Blue
TIR = Thermal InfraRed
UAV = Unmanned Aerial Vehicle

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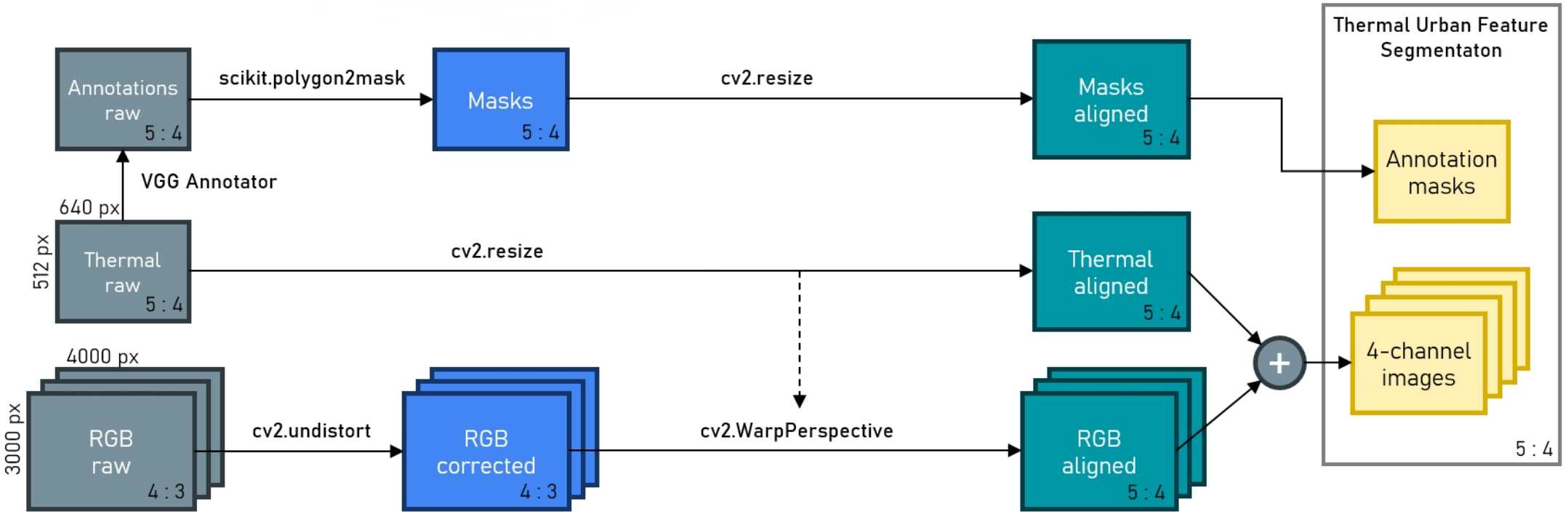
Deep learning models: Data preprocessing – TUFSeg



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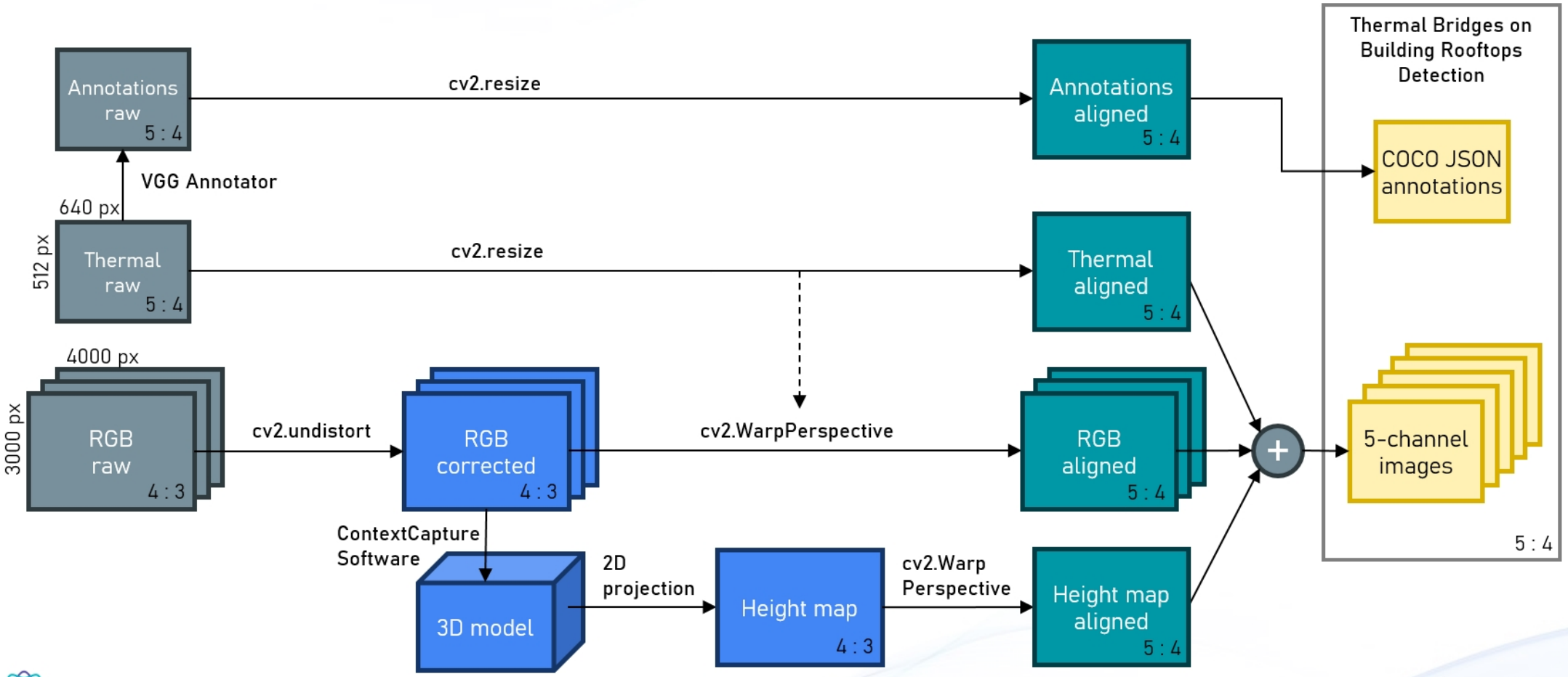
Deep learning models: Data preprocessing – TBBRDet



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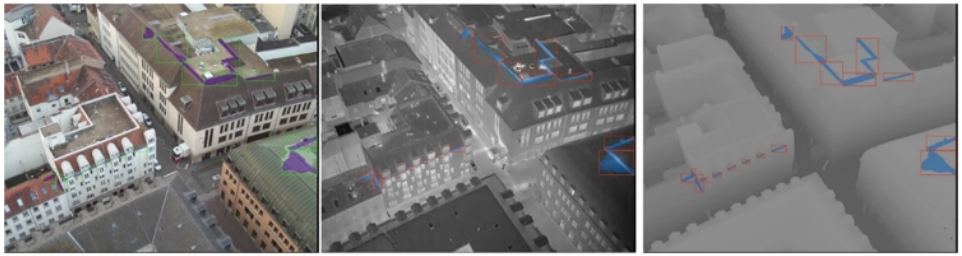
Deep learning models: Case descriptions

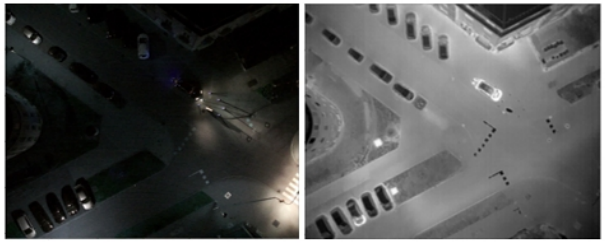
TBBRDet

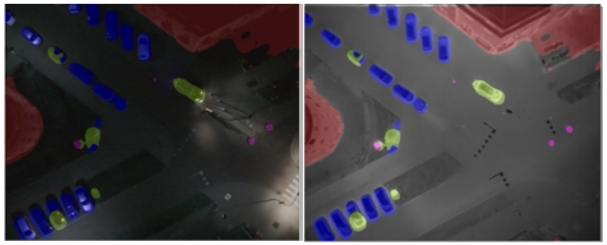
(Thermal Bridges on Building Rooftops Detection)



TUFSeg

(Thermal Urban Feature Segmentation)





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Deep learning models: Case descriptions

TBBRDet
(Thermal Bridges on Building Rooftops Detection)

723 train, 203 test images

single-class object detection or instance segmentation:
- MaskRCNN ResNet-18 backbone
- MaskRCNN ResNet-50 backbone
- MaskRCNN Swin-T Transformer backbone
- TridentNet*
- Feature Selective Anchor-Free (FSAF)*

Detectron2 and MMDetection toolboxes using PyTorch
Energy monitoring through HPC https://www.scc.kit.edu/en/services/horeka.php

Model ablation study

Evaluation: average recall

TUFSeg
(Thermal Urban Feature Segmentation)

634 train, 159 test images

multi-class semantic segmentation:
- U-Net ResNet-152 backbone

Segmentation_models toolbox using Tensorflow
Energy monitoring with Perun https://github.com/Helmholtz-AI-Energy/perun

Data pre-processing study IN WORK

Evaluation: precision, weighted precision, IoU, w IoU, F1

Mayer, Z. *et al.* Deep learning approaches to building rooftop thermal bridge detection from aerial images. In Automation in Construction Vol. 146, p. 104690 (2023). Elsevier BV. https://doi.org/10.1016/j.autcon.2022.104690

* Architectures that only perform the object detection task

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AI4EOSC project

- AI / DL / ML services for the european open science cloud
- computing resources from pan-European e-Infrastructures

Project AI4EOSC

- Evolution of the DEEP Hybrid DataCloud platform
- HORIZON-INFRA-2021-EOSC-01-04 call
- Runs September 1st 2022 – August 2025 (36 months)
- 7 academic + 2 SME + 1 non-profit organization

Advanced features for distributed, federated, composite learning, metadata provenance, MLOps, event-driven data processing, and provision of AI/ML/DL services

Websites: https://ai4eosc.eu/ ; https://dashboard.cloud.ai4eosc.eu/marketplace

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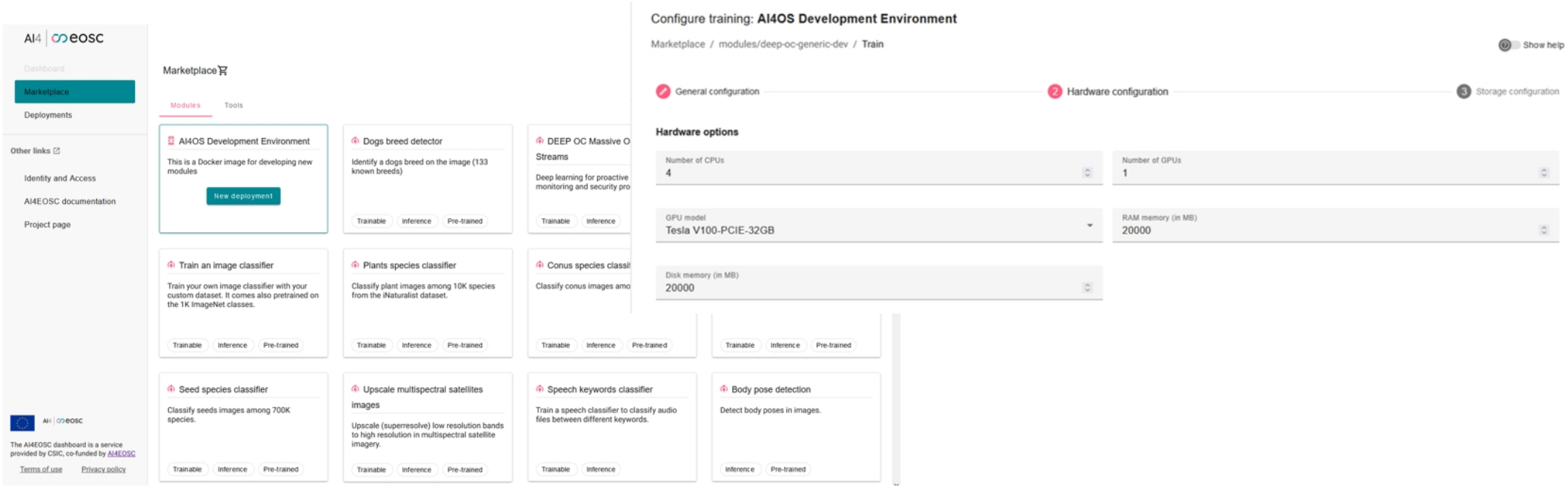
AI4EOSC project: Training platform



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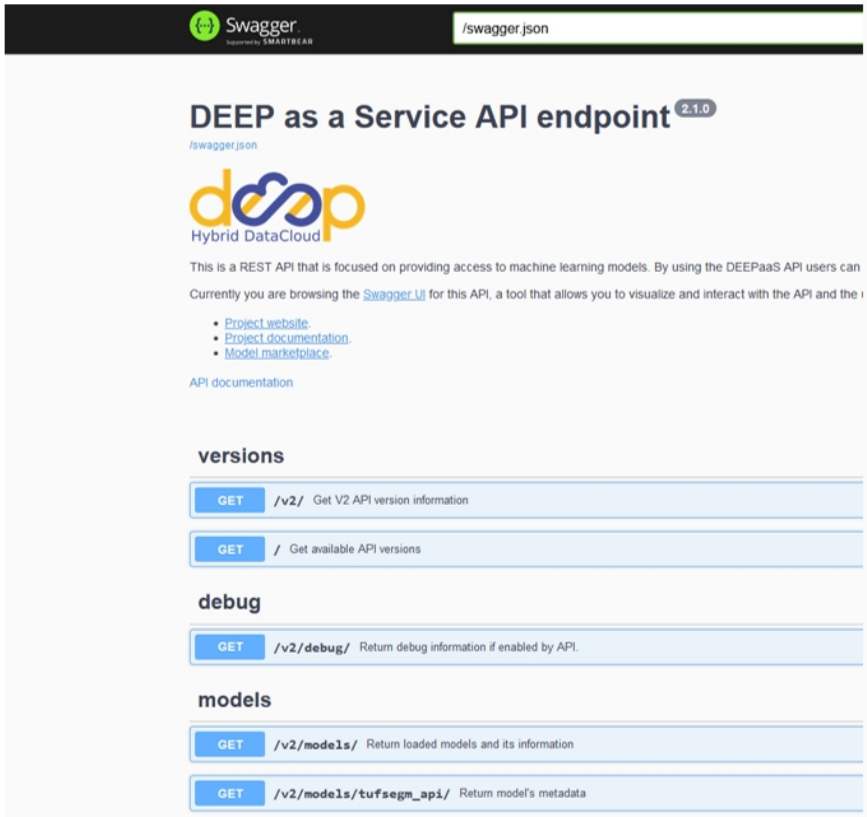
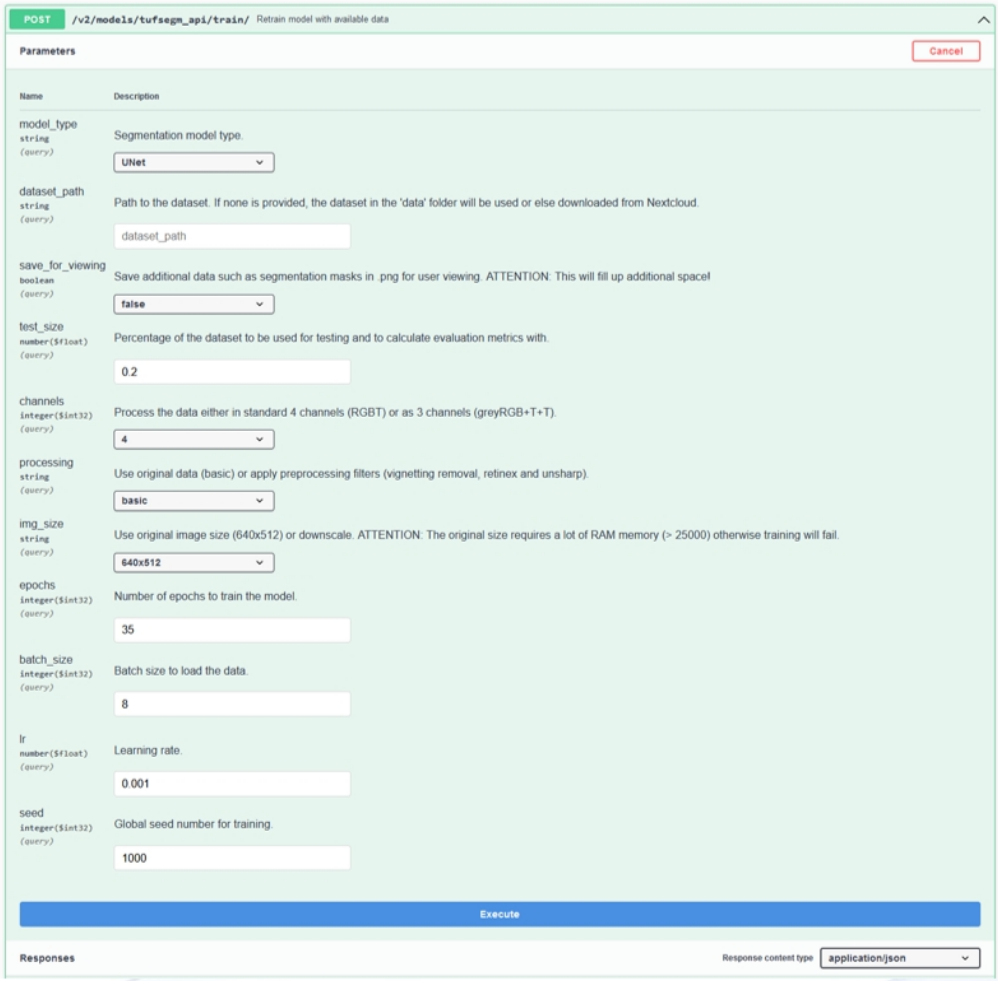
AI4EOSC project: Training platform





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Thank you for your attention.

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Institute for Industrial Production (IIP)
Team "Project and Resource Management in the Built Environment"
under the direction of Dr.-Ing. Rebekka Volk

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