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EURO-BIOIMAGING



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אוניברסיטת חיפה
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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



Motivation



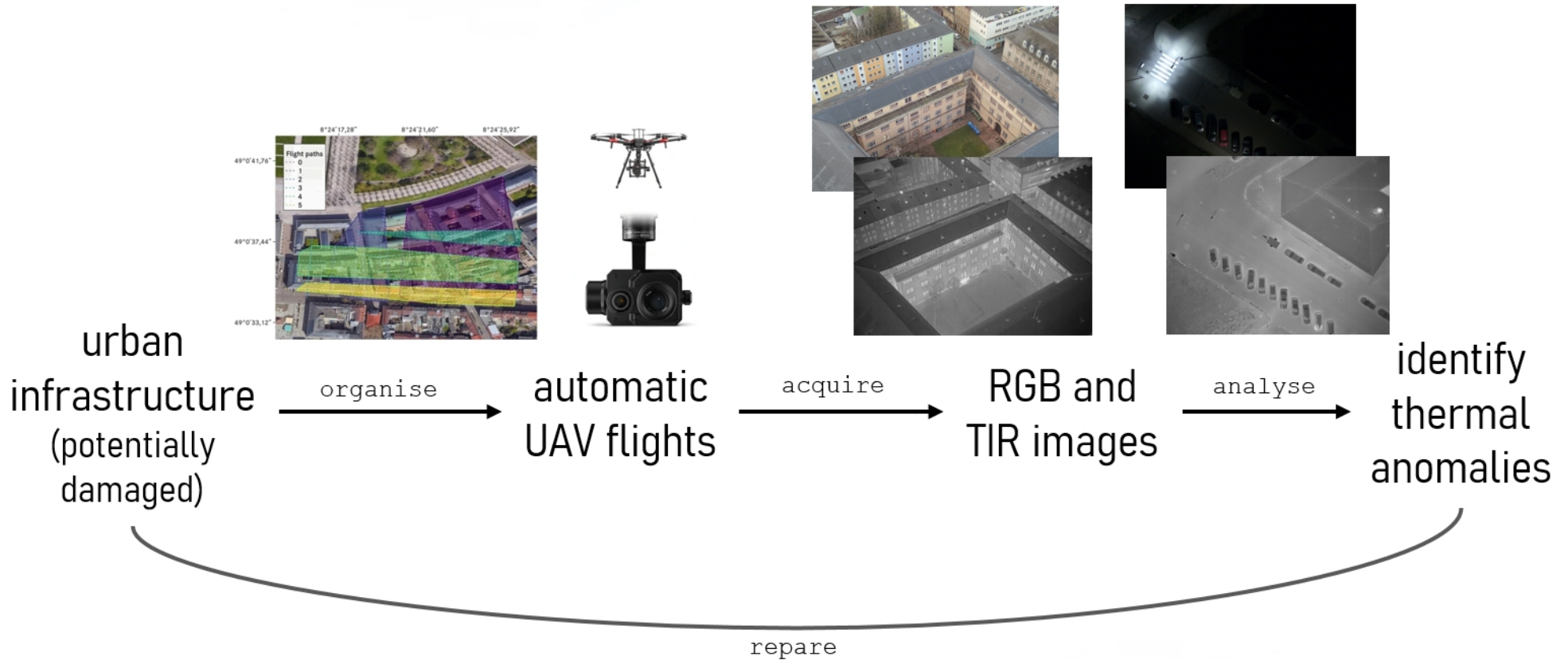
Bing Image Creator from Microsoft
<https://www.bing.com/images/create/>



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



Motivation



Deep learning models: Case descriptions

TBBRDet

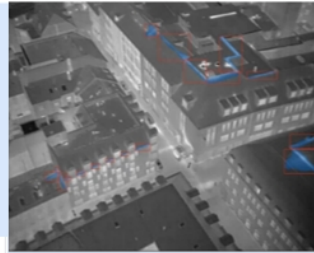
(Thermal Bridges on Building Rooftops Detection)

Energy use: Buildings

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

single-class
object detection
or instance segmentation

thermal bridges



Dual camera¹: RGB + TIR
UAV-based²: 45° pitch, high overlap
Day-time flights in Karlsruhe (DE)



TUFSeg

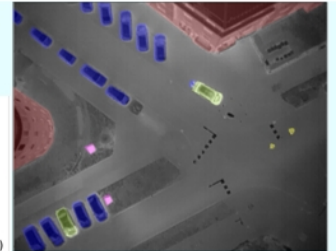
(Thermal Urban Feature Segmentation)

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

building
car (cold)
car (warm)
manhole (cold)
manhole (warm)
miscellaneous
person
street lamp (cold)
street lamp (warm)



Dual camera¹: RGB + TIR
UAV-based²: 90° pitch, high overlap
Night-time flights in Karlsruhe & Munich (DE)

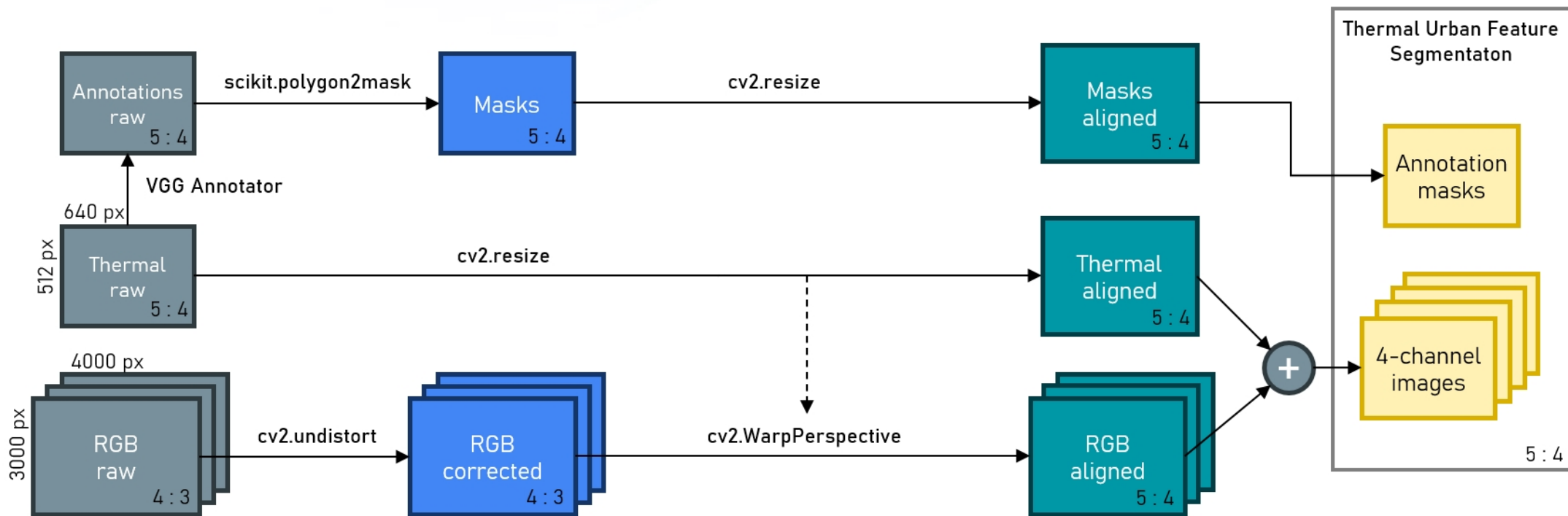


¹ Zenmuse XT2 camera with a FLIR Tau 2 thermal sensor

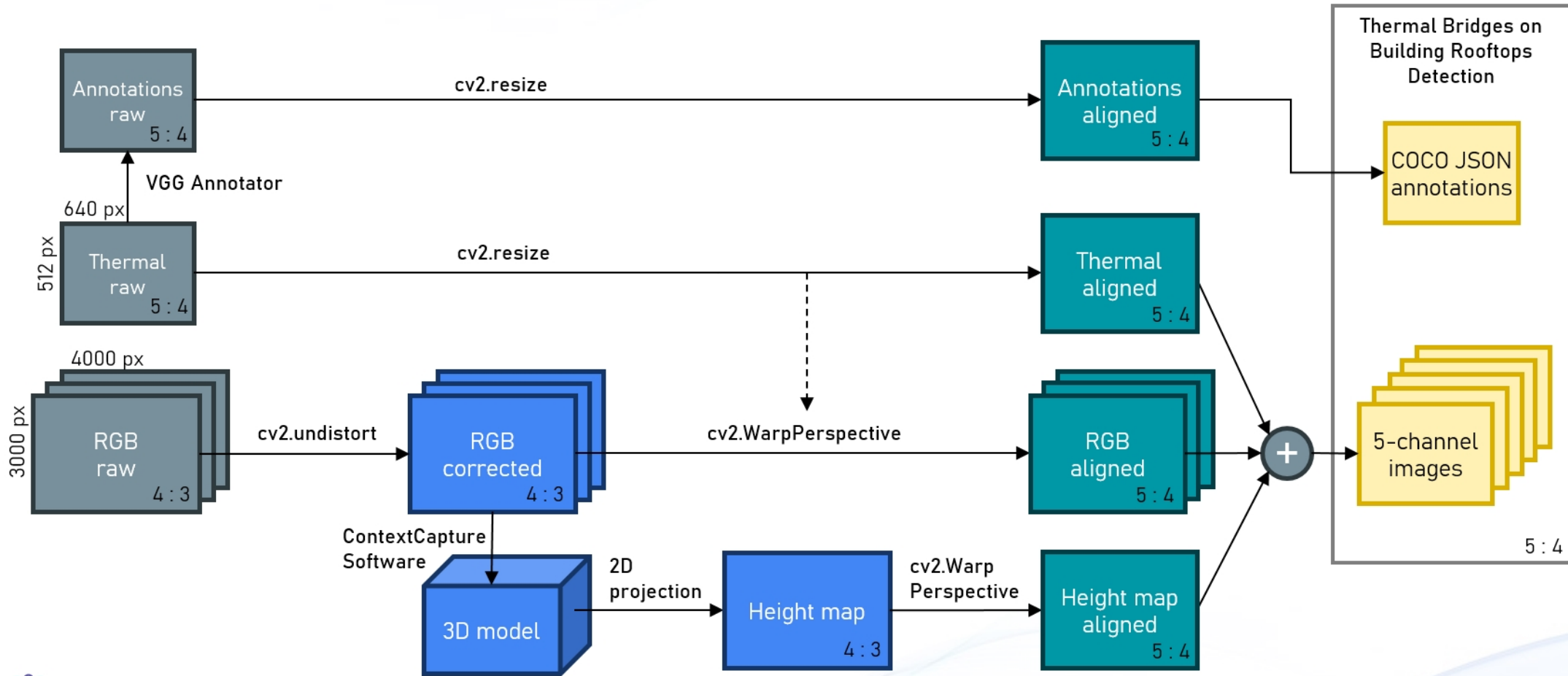
² DJI M600 and DJI M300 UAVs



Deep learning models: Data preprocessing - TUFSeg



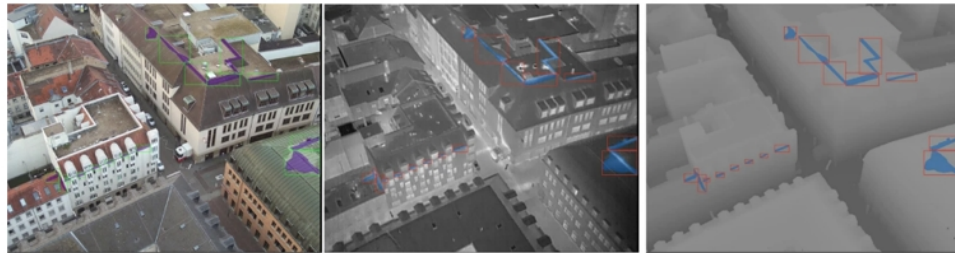
Deep learning models: Data preprocessing – TBBRDet



Deep learning models: Case descriptions

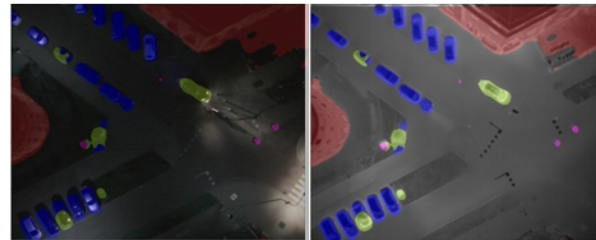
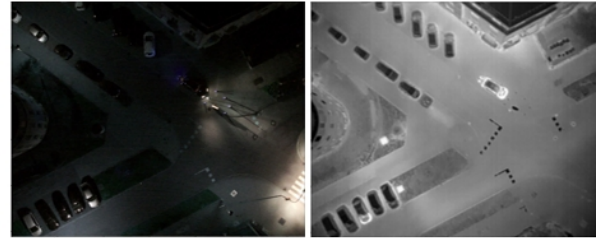
TBBRDet

(Thermal Bridges on Building Rooftops Detection)



TUFSeg

(Thermal Urban Feature Segmentation)



Deep learning models: Case descriptions

TBBDet

(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

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

IN WORK



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>



AI4EOOSC project: Training platform

The screenshot displays the AI4EOOSC training platform interface. On the left is a navigation sidebar with the AI4EOOSC logo, a 'Marketplace' button, and links for 'Deployments', 'Other links', 'Identity and Access', 'AI4EOOSC documentation', and 'Project page'. The main area is divided into two sections: a 'Marketplace' and a 'Configure training' page.

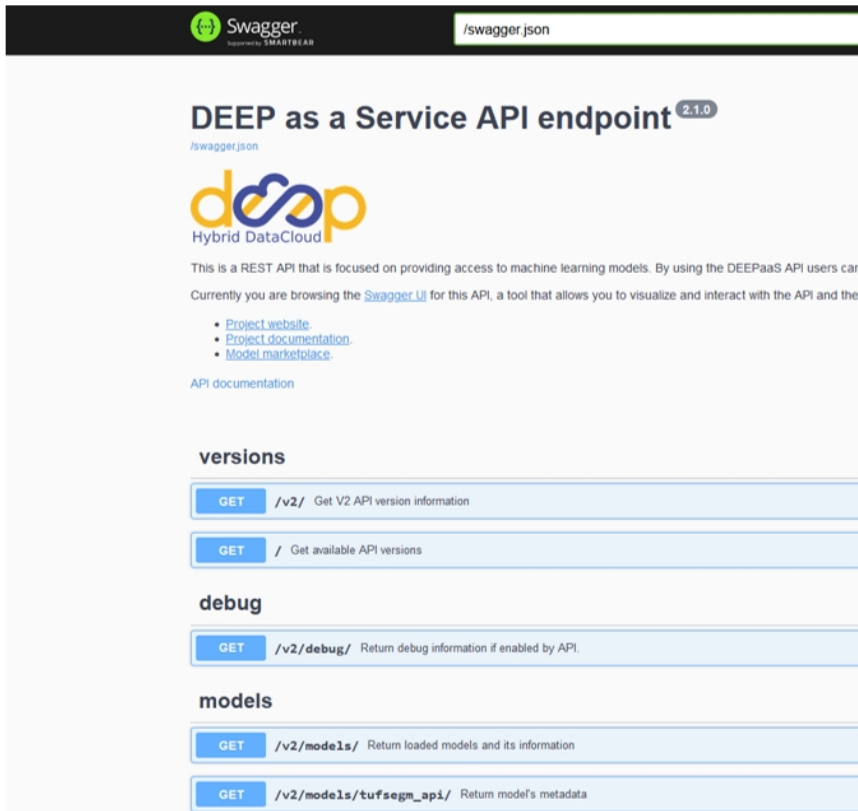
Marketplace: This section lists various modules for training. The 'AI4OS Development Environment' is highlighted, described as a Docker image for developing new modules, with a 'New deployment' button. Other modules include 'Dogs breed detector', 'DEEP OC Massive O Streams', 'Train an image classifier', 'Plants species classifier', 'Conus species classifier', 'Seed species classifier', 'Upscale multispectral satellites images', 'Speech keywords classifier', and 'Body pose detection'. Each module card includes a brief description and buttons for 'Trainable', 'Inference', and 'Pre-trained'.

Configure training: AI4OS Development Environment: This page allows users to configure training parameters. It features a progress bar with three steps: 'General configuration', 'Hardware configuration' (the current step), and 'Storage configuration'. Under 'Hardware options', users can set the 'Number of CPUs' (4), 'Number of GPUs' (1), 'GPU model' (Tesla V100-PCIE-32GB), and 'Disk memory (in MB)' (20000). 'RAM memory (in MB)' is set to 20000. At the bottom of the configuration page, there are buttons for 'Trainable', 'Inference', and 'Pre-trained'.

<https://dashboard.cloud.ai4eoosc.eu/marketplace>



AI4EOSC project: Training platform




Swagger
powered by SMARTBEAR

/swagger.json

DEEP as a Service API endpoint ^{2.1.0}

/swagger.json



Hybrid DataCloud

This is a REST API that is focused on providing access to machine learning models. By using the DEEPaaS API users can currently you are browsing the [Swagger UI](#) for this API, a tool that allows you to visualize and interact with the API and the

- [Project website](#)
- [Project documentation](#)
- [Model marketplace](#)

API documentation

versions

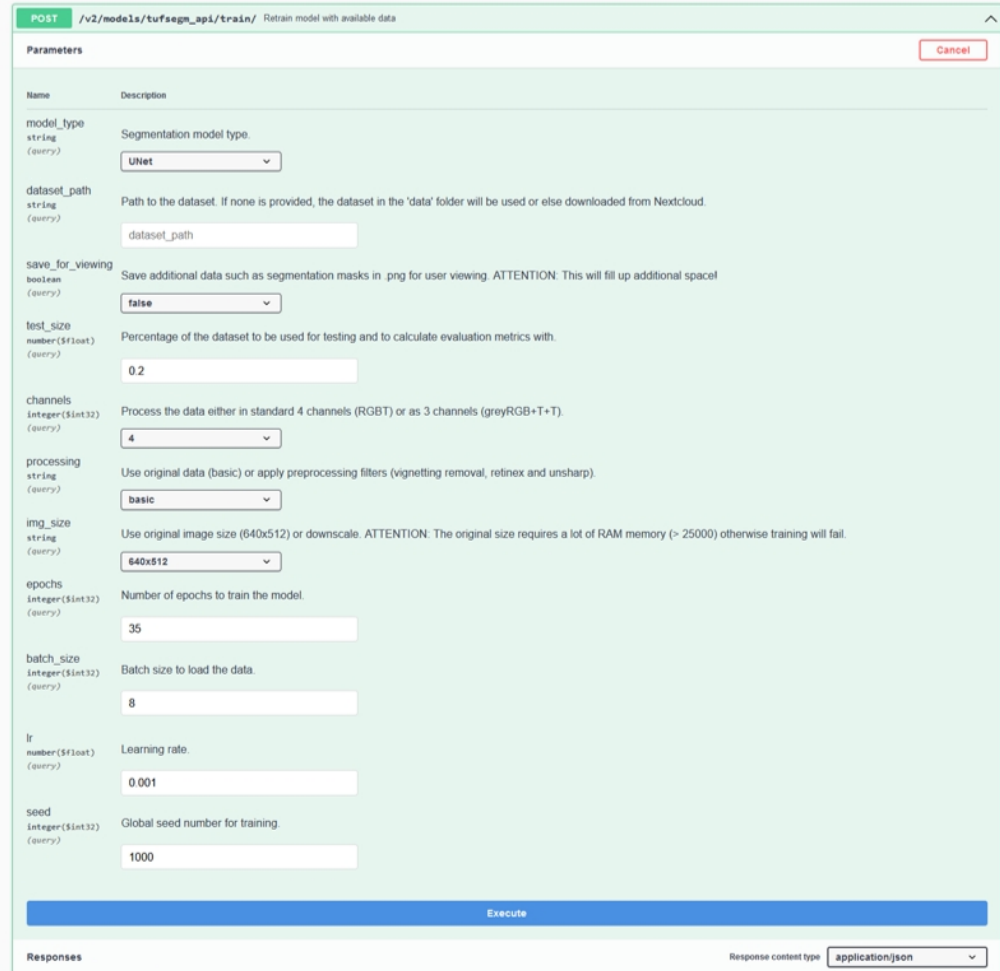
GET	/v2/	Get V2 API version information
GET	/	Get available API versions

debug

GET	/v2/debug/	Return debug information if enabled by API.
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models

GET	/v2/models/	Return loaded models and its information
GET	/v2/models/tufsegm_api/	Return model's metadata



POST /v2/models/tufsegm_api/train/ Retrain model with available data

Parameters Cancel

Name	Description
model_type string (query)	Segmentation model type. <input type="text" value="UNet"/>
dataset_path string (query)	Path to the dataset. If none is provided, the dataset in the 'data' folder will be used or else downloaded from Nextcloud. <input type="text" value="dataset_path"/>
save_for_viewing boolean (query)	Save additional data such as segmentation masks in .png for user viewing. ATTENTION: This will fill up additional space! <input type="text" value="false"/>
test_size number(\$float) (query)	Percentage of the dataset to be used for testing and to calculate evaluation metrics with. <input type="text" value="0.2"/>
channels integer(\$int32) (query)	Process the data either in standard 4 channels (RGBT) or as 3 channels (greyRGB+T+T). <input type="text" value="4"/>
processing string (query)	Use original data (basic) or apply preprocessing filters (vignetting removal, retinex and unsharp). <input type="text" value="basic"/>
img_size string (query)	Use original image size (640x512) or downscale. ATTENTION: The original size requires a lot of RAM memory (> 25000) otherwise training will fail. <input type="text" value="640x512"/>
epochs integer(\$int32) (query)	Number of epochs to train the model. <input type="text" value="35"/>
batch_size integer(\$int32) (query)	Batch size to load the data. <input type="text" value="8"/>
lr number(\$float) (query)	Learning rate. <input type="text" value="0.001"/>
seed integer(\$int32) (query)	Global seed number for training. <input type="text" value="1000"/>

Responses Response content type: application/json



Thank you for your attention.

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References

- International Energy Agency. Heating. <https://www.iea.org/energy-system/buildings/heating> (last viewed: 06.12.2023)
- 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>
- Mayer, Z., Kahn, J., Götz, M. *et al.* Thermal Bridges on Building Rooftops. In *Sci Data* 10, 268 (2023). <https://doi.org/10.1038/s41597-023-02140-z>
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- Vollmer, E., Volk, R., and Schultmann, F. Automatic analysis of UAS-based thermal images to detect leakages in district heating systems, *International Journal of Remote Sensing*, 44:23, 7263-7293, (2023). <https://doi.org/10.1080/01431161.2023.2242586>
- Vollmer, E., Volk, R., and Vogl, M. Automatic analysis of UAS-based thermal images to detect leakages in district heating systems: Source code and exemplary dataset. On Zenodo, v1.0.0 (2023). <https://zenodo.org/doi/10.5281/zenodo.7851725>

