AI4 copernicus

Reinforcing the AI4EU Platform by Advancing
Earth Observation Intelligence, Innovation & Adoption

Bridging the European Earth-Observation and AI Communities for Data-Intensive Innovation

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DEMOKRITOS

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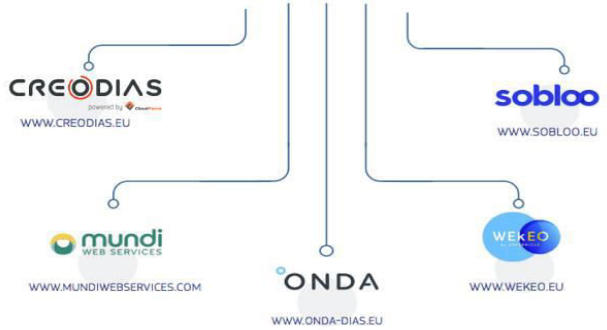
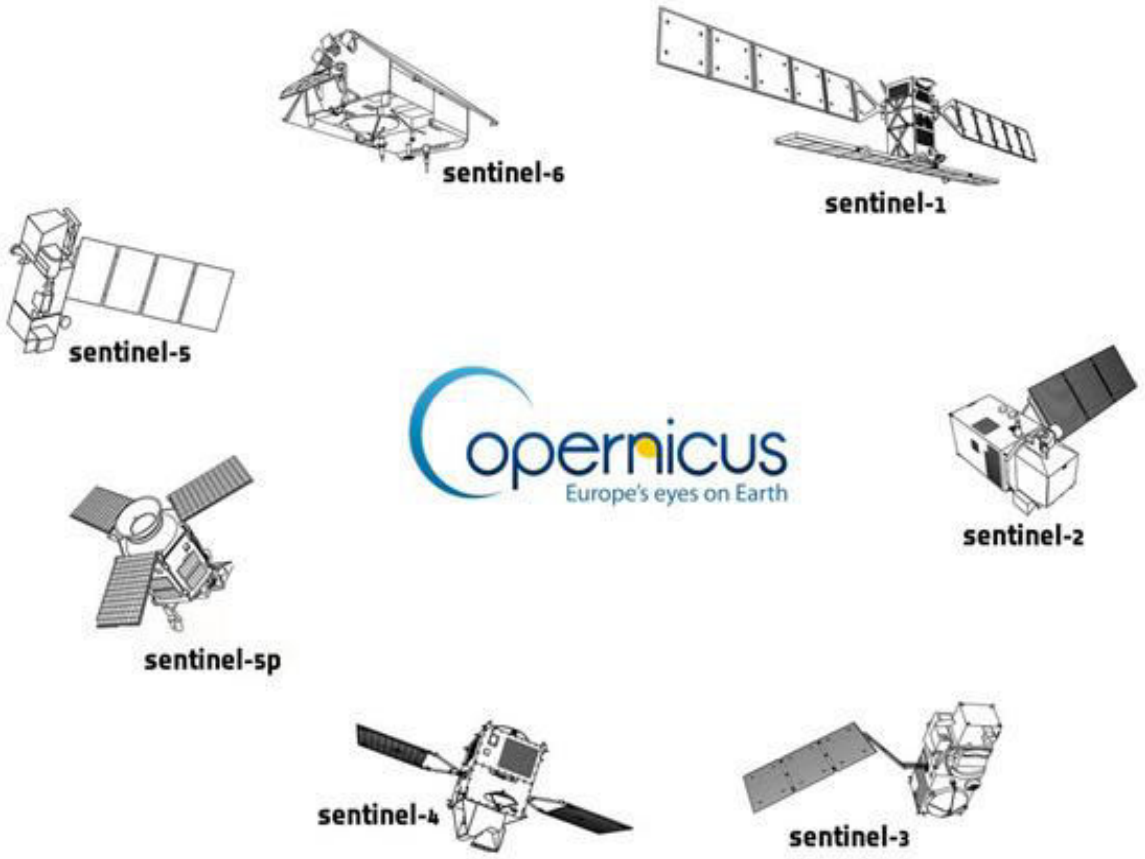
Outline

1. The European AI & EO communities
2. The AI4Copernicus framework
   a. User journey
   b. Cloud resources and services
   c. Bootstrapping services and tools
   d. Semantic services and tools
3. Use cases
4. Evaluation
5. Conclusions & Future Work

The Copernicus programme

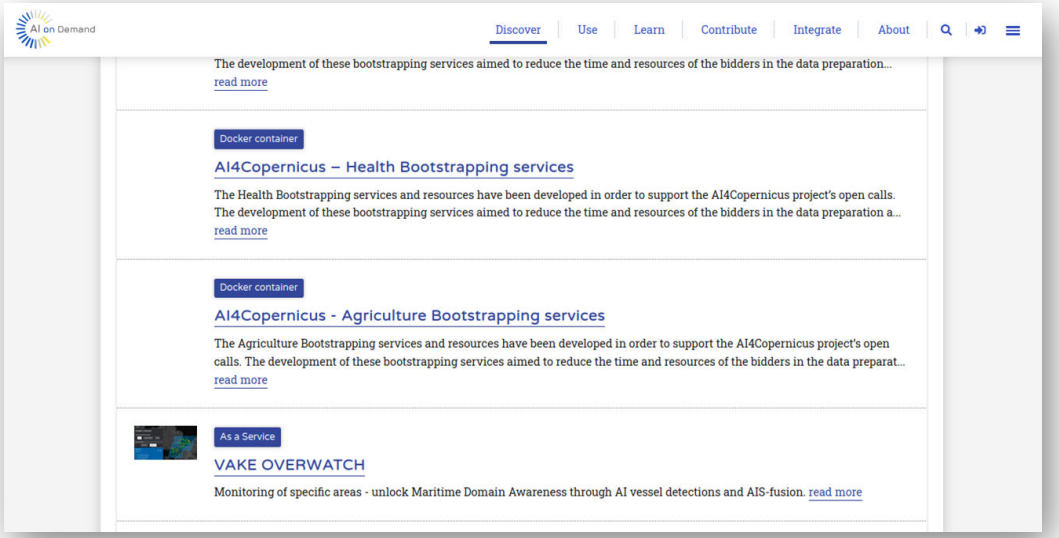
- Copernicus is the European programme for monitoring the Earth
- Set of systems that collect data from satellites and in-situ sensors
- Free and openly accessible to users
- To facilitate and standardise access to data, the EC has funded the deployment of five DIASes



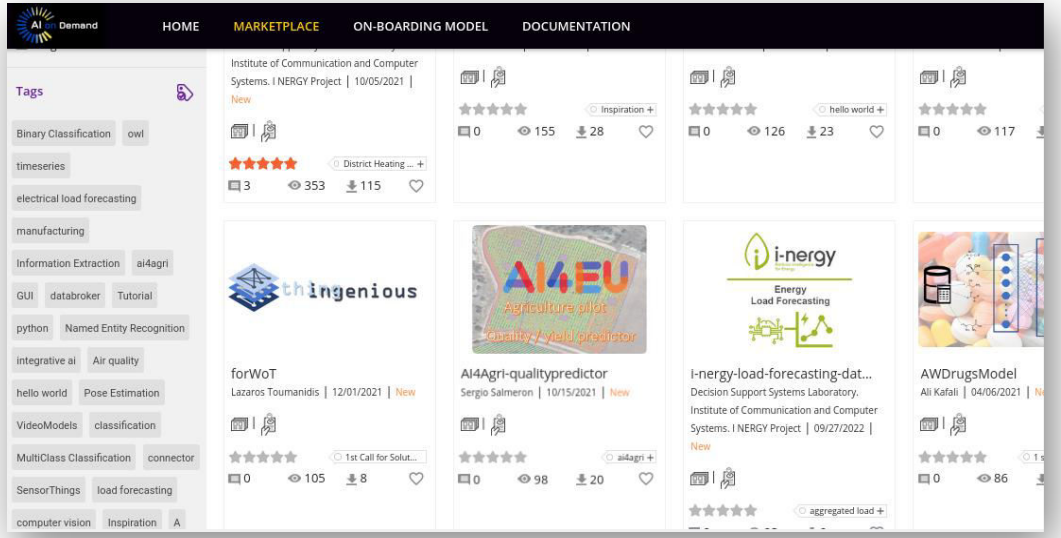


The AI-on-Demand platform

The AI on-Demand Platform https://www.ai4europe.eu/ (AIoD) is a platform for sharing AI resources produced in European projects, including high-level services, expertise in AI research and innovation, AI components and datasets, high-powered computing resources. It offers a catalogue of AI assets an open source platform for experimenting and deployment of AI pipelines.



AIoD Catalogue



AI4Experiments

The AI4Copernicus project

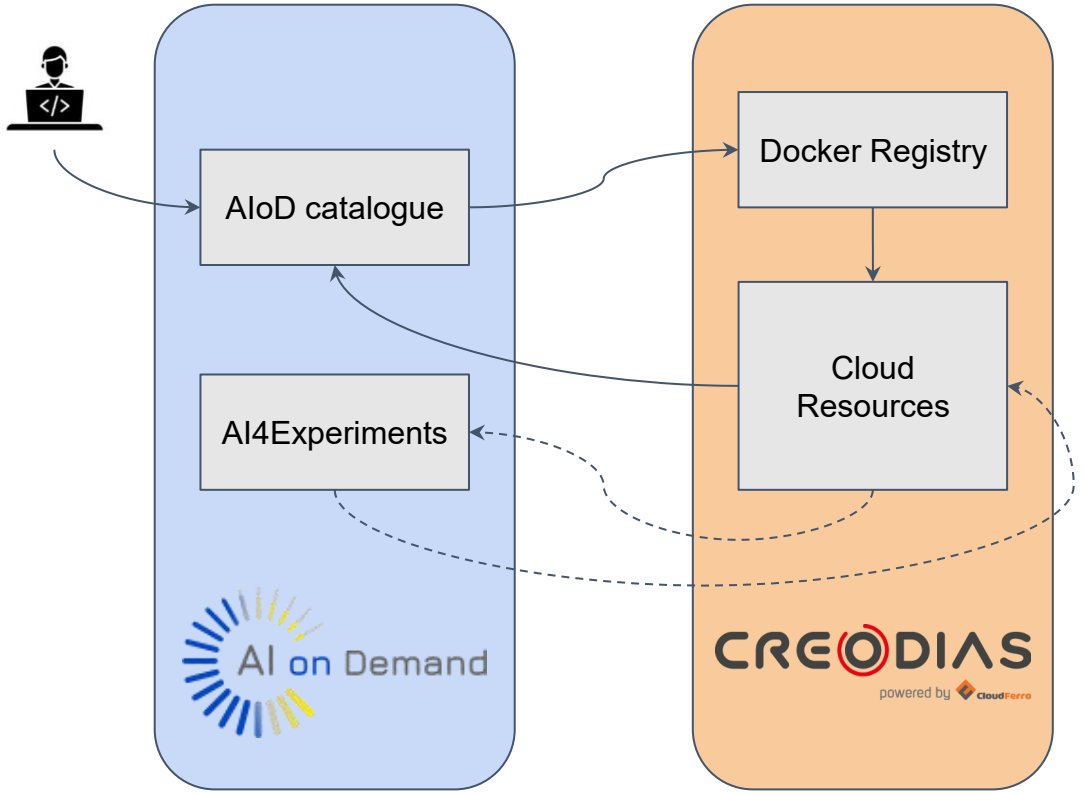
AI4Copernicus aims to bridge these two worlds:
Make the AI on Demand Platform, the platform of choice for users of Copernicus data along the value chain (scientists, SMEs, non-tech sector)

financial support through a series of Open Calls

services and tools to bootstrap the development of AI+EO applications

User Journey in AI4Copernicus

1. Discover the appropriate AI asset on the AIoD catalogue
2. Access the AI assets through CREODIAS Docker Registry
3. Develop on CREODIAS/WEkEO
4. Onboard onto AI4Experiments, possibly making use of additional resources
5. Deploy the solution on CREODIAS
6. Publish the solution and/or derivatives onto the AIoD catalogue



Cloud Resources and Services

- Access to DIAS
  - CREODIAS http://creodias.eu
  - WEKEO http://wekeo.eu

- Provisioning of Cloud & Computing services
  - Copernicus data products
  - Kubernetes cluster
  - Docker Registry

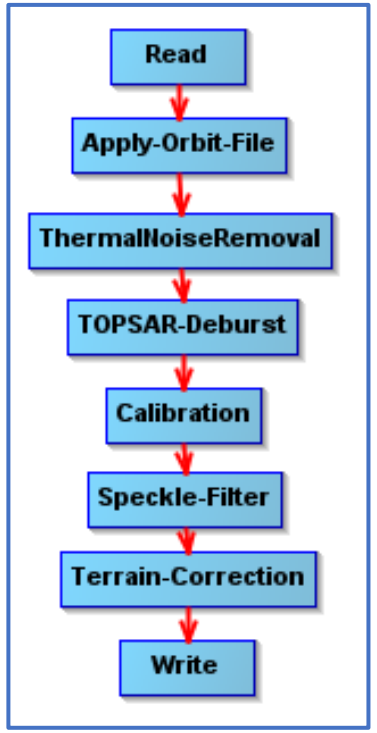
Datasets	Products	Instrument	Locally Held
Sentinel-1A & Sentinel-1B	GRD	SAR C-BAND	Full archive
	RTC		
	OCN		
	RAW		Last 6 months
	SLC		- Europe: full archive - Last 6 months / orderable
Sentinel-2A & Sentinel-2B	L1C	MSI	Full archive
	L2A		- Orderable */** - Cached ***
Sentinel-3A & Sentinel-3B	L1 SLSTR	SLSTR	Full archive
	L1 OLCI	OLCI	
	L1 SRAL	SRAL	
	L2 SLSTR (LST/WST)	SLSTR	
	L2 OLCI	OLCI	
	L2 SRAL	SRAL	
Sentinel-5P	L1B	TROPOMI	Full archive
	L2 ****		
Sentinel-6A	L1, L2	POS-4, AMR-C	Full archive
Landsat-5	L1G, L1T, L1GT	TM	Coverage of Europe (1984-2011)
Landsat-7	L1G, L1T, L1GT	ET	Coverage of Europe (1999-2017)
Landsat-8	L1T, L1GT	OLI, OLI TIRS	Coverage of Europe
Envisat	L1	MERIS	Global (2002-2012)
SMOS	L1B, L1C, L2	MIRAS	Global (2010-present)
S2GL	-	-	Coverage of Europe (2017)

Security Bootstrapping Service
S1 and S2 pre-processing

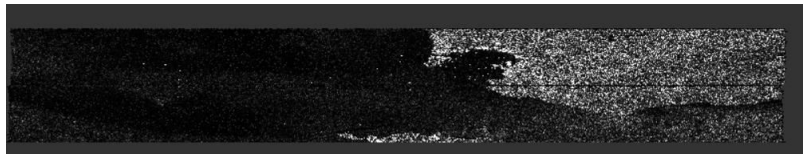
General tools for ingesting satellite images from S1 and S2:

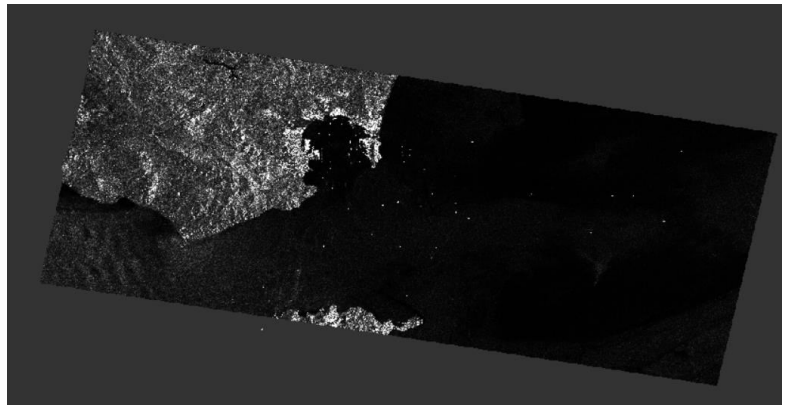
- Sentinel-1 GRD pre-processing
- Sentinel-1 SLC pre-processing
- Sentinel-2 pre-processing

S1 SLC pre-processing pipeline



S1 SM/IW SLC





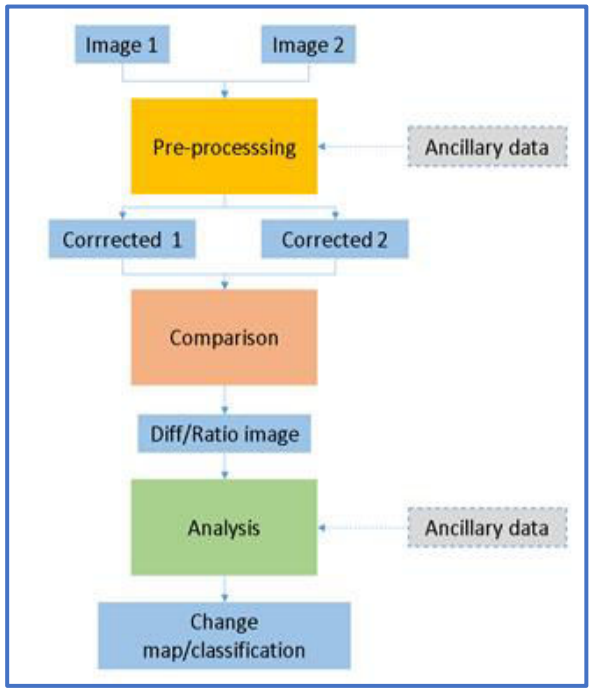
terrain-corrected calibrated backscatter

Security Bootstrapping Service
S1 and S2 change detection

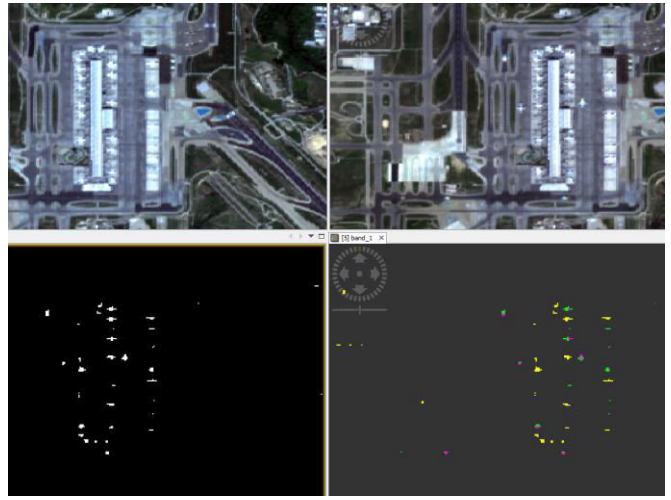
Change detection pipelines for S1 and S2:

- Sentinel-1 Change detection: Amplitude Change Detection and Multi-temporal Coherence
- Sentinel-2 Change detection

S2 Change Detection pipeline



Pair of S2 L2A

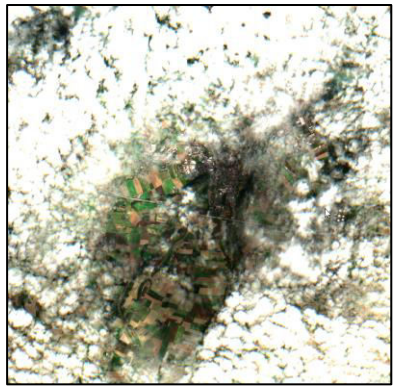


CVA Changes

Agriculture Bootstrapping Service
S2 Tile Harmonization


8th September


11st September


13rd September


Monthly Composite (September)


18th September

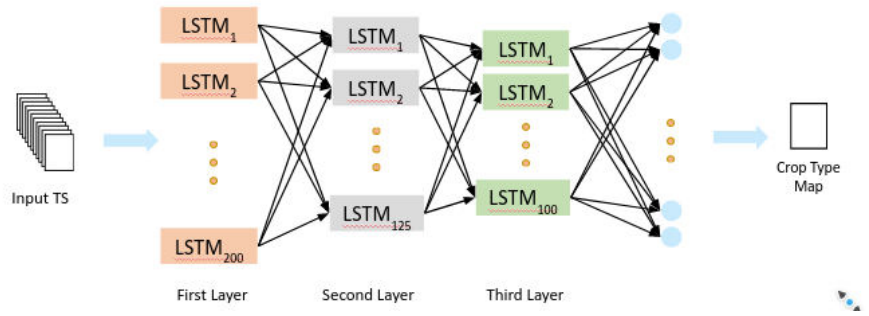

21st September

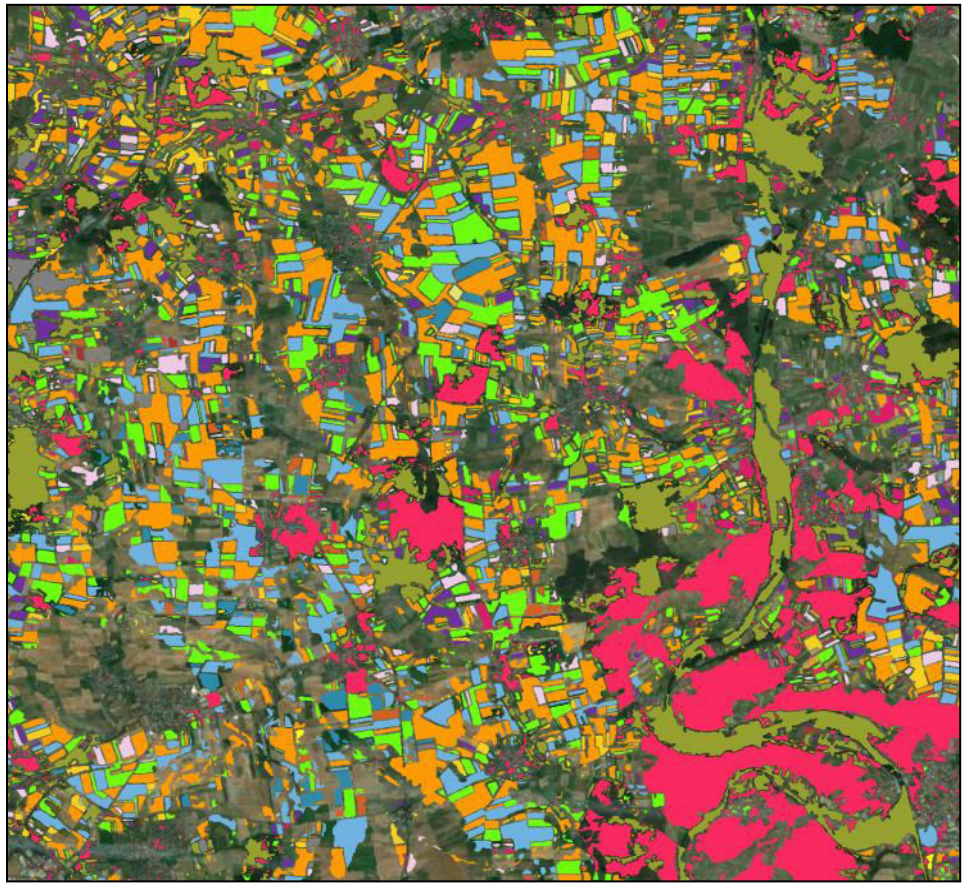

28th September

- The service aim to harmonize Sentinel-2 Time Series (TSs) through a monthly composite approach to create temporally homogeneous time series.
- Allows processing of different TSs length.
- Mitigates the presence of clouds in the scene.

Agriculture Bootstrapping Service
LSTM for S2 for crop type classification

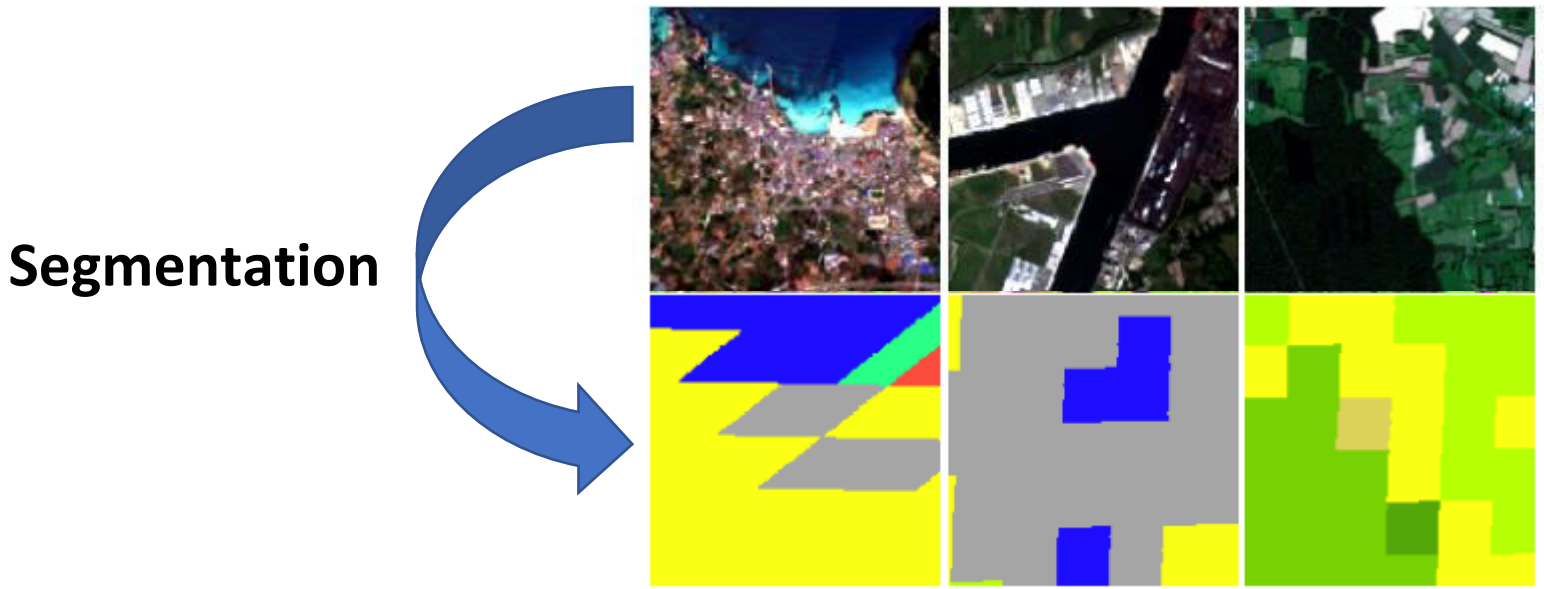
- Pe-trained Long Short-Term Memory (LSTM) for crop-type classification.
  - Input: S2 time series (e.g. monthly composites)
  - Output: crop-type map
- The network can also be trained from scratch, either using the (publicly available) TimeSen2Crop dataset or with a dataset created by the user.





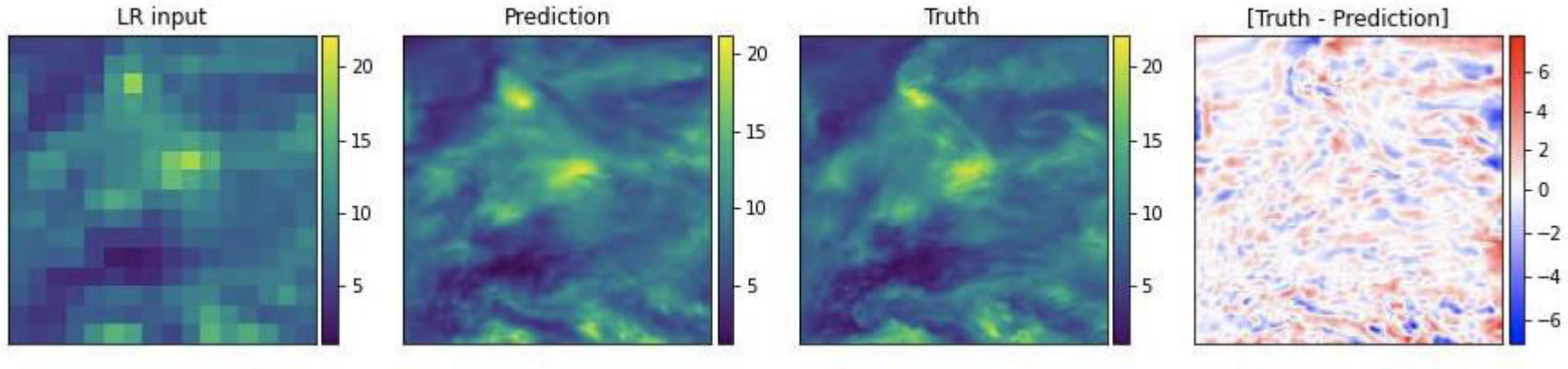
Deep Network for pixel-level classification of S2 patches

- Allow user to train pixel-level segmentation models on Sentinel-2 (S2) images.
- The goal is to detect one of/a combination of S2 classes: crop types (corn, sunflower, wheat, etc), land cover (urban vs natural, water vs land), road extraction (road vs other).



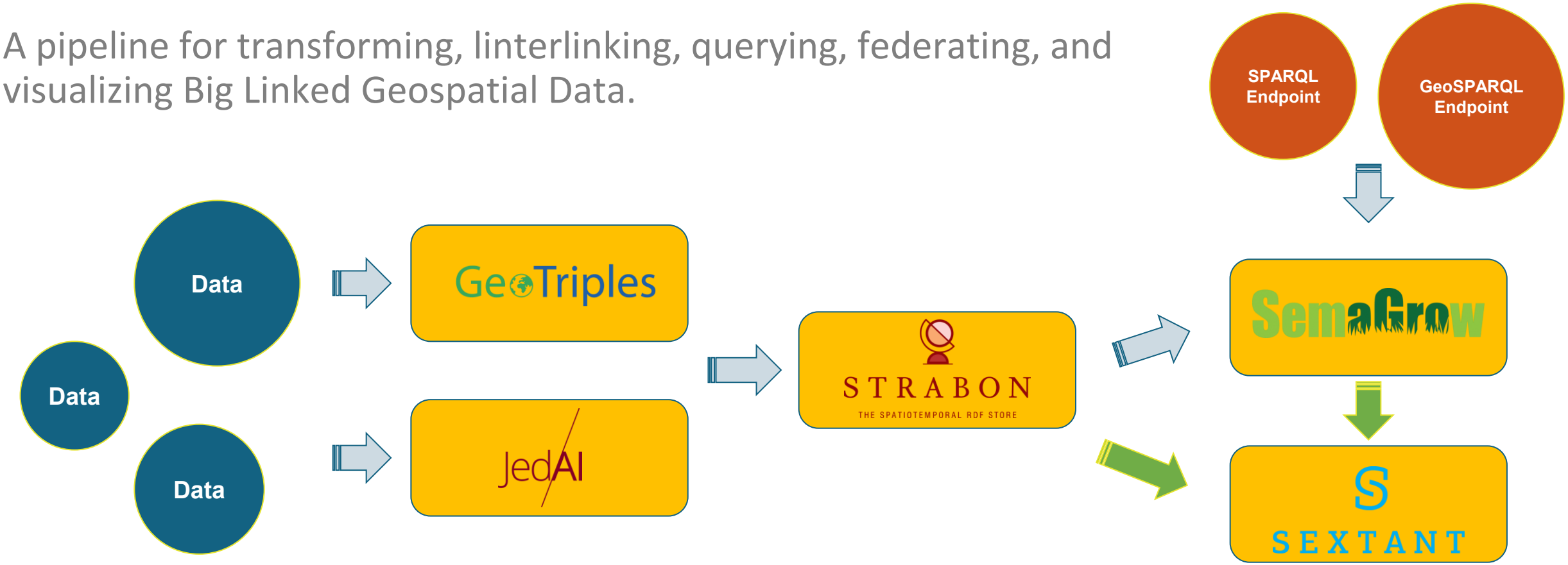
Probabilistic downscaling of CAMS data

- Address current public health and air pollution / quality challenges using EO.
- Probabilistic **downscaling (super-resolution)** of **CAMS air quality (AQ)** and **atmospheric composition (AC)** model output (using GANs).
- Example: Super-resolution of PM2.5 (80km to 10km)



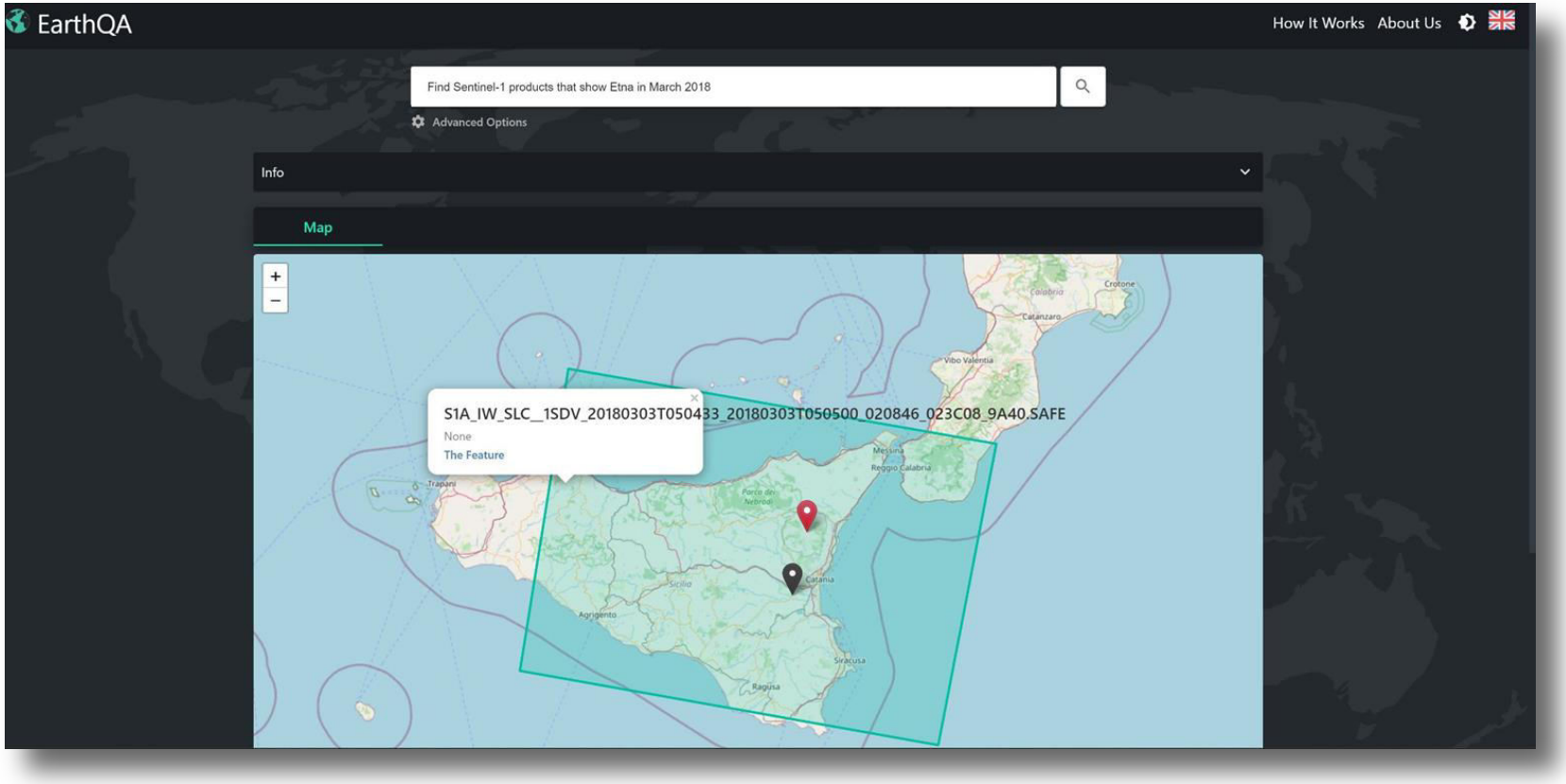
Linked Data Pipeline

- A pipeline for transforming, linterlinking, querying, federating, and visualizing Big Linked Geospatial Data.



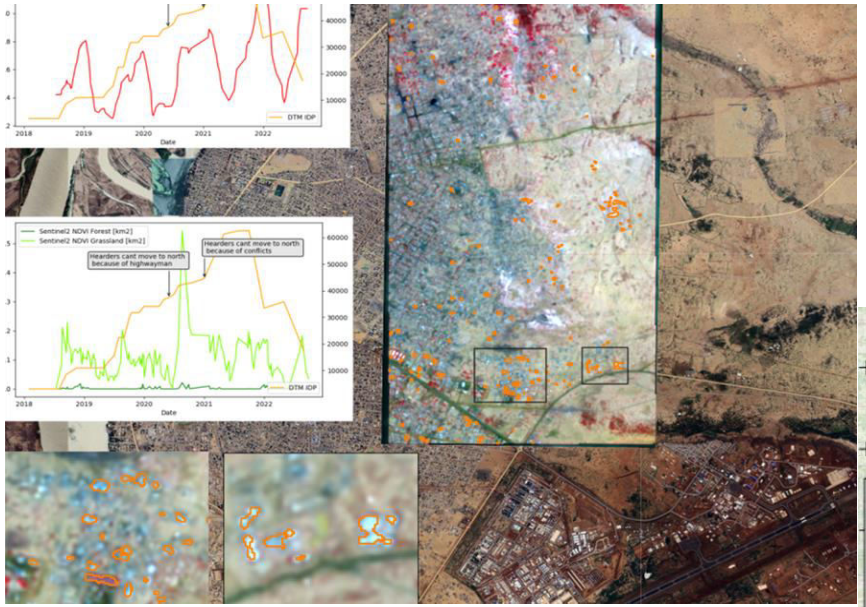
EarthQA question answering engine

- EarthQA accepts questions in natural language (English) that ask for EO datasets having certain properties and returns links to such datasets.
- Example: Find Sentinel-1 products that show Etna in March 2018.



Use case 1: Monitoring of conflict or crisis affected areas

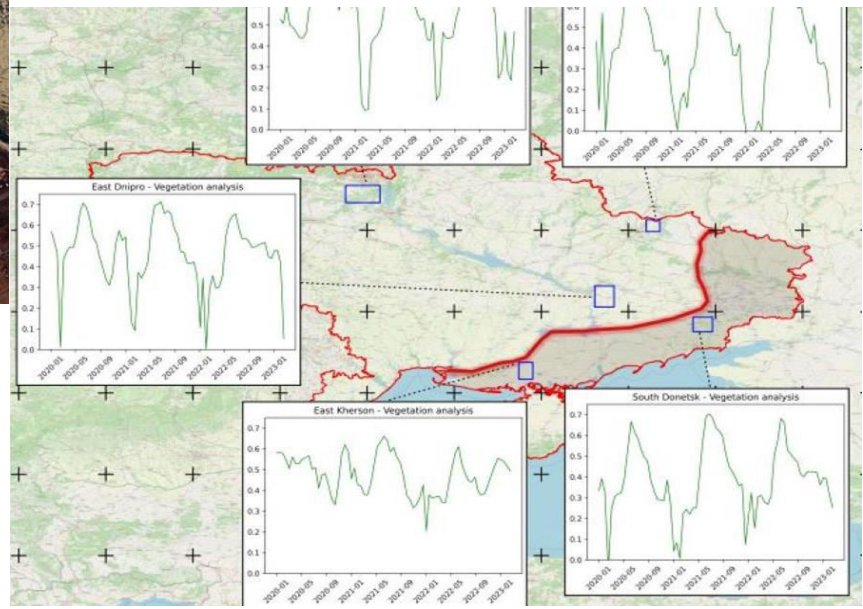
- **Domain:** Security
- **Project:** SR4C3
- **Companies**: Sistema GmbH, CMC Consulting
- **Countries**: Austria, Belgium
- **Problem:** Identification of the impact of conflicts on environment
- **Solution:** Single Image Super Resolution of Sentinel-2 images. Urban monitoring and abandoned crop detection on top of it.
- **AI Techniques:**
  - 10m to 3m Sentinel-2 *spatial resolution* enhancement
  - Sentinel-1 / Sentinel-2 *fusion* for vegetation monitoring



Displacement movement and cropland changes monitoring in Mali and Ukraine

AI4Copernicus services used:

- Cloud resources
- Sentinel-1 preprocessing
- Mentoring services

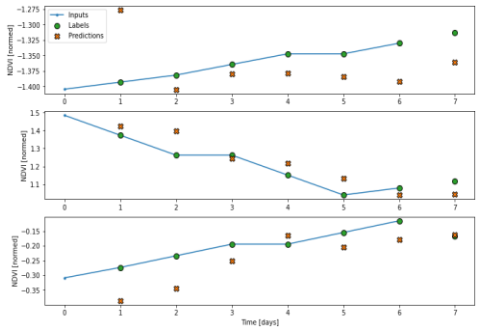


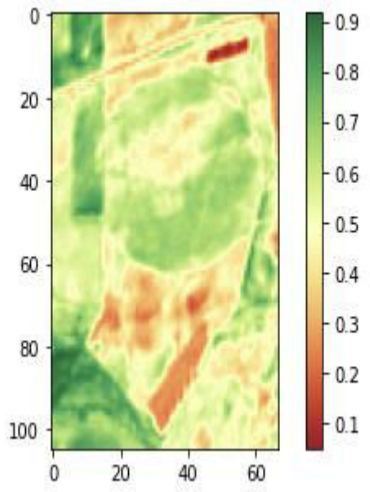
Use Case 2: Irrigation Management toolkit

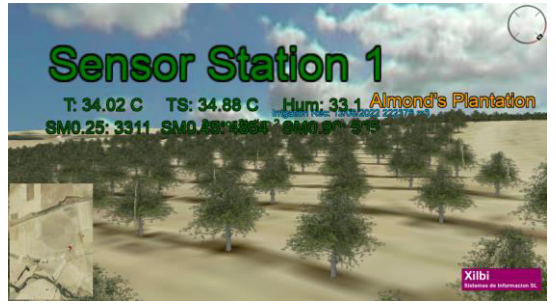
- **Domain:** Agriculture
- **Project:** OPTIMAL
- **Company**: Xilbi Sistemas de Informacion SL
- **Country**: Spain
- **Problem:** Irrigation area monitoring, water resources management and usage optimisation
- **Solution:** DSS support applied to Almond production (irrigation requirements forecast points or maps)
- **AI Techniques:**
  - Long Short-Term Memory Neural Network using Sentinel-2 (NDVI), weather, and onsite ground environmental sensor data

AI4Copernicus services used:

- Cloud resources
- Sentinel-2 preprocessing
- Long Short-Term Memory Neural Network for Sentinel 2
- Mentoring services







AI4Copernicus Open Calls

Open Call	#projects	Domains & #projects per domain	Status
1st	6	Security:3, Agriculture:2, Energy:1	Completed
3rd	8	Agriculture:5, Health:1, Maritime:1, Safety/Disaster risk reduction: 1	In Progress
4th	3	Urban Monitoring & Planning:1, Security:1, Agriculture:1	In Progress
5th	10	Agriculture:3, Health:3, Energy:2, Environmental:1, Education:1	In Progress
total	27	Security:4, Agriculture:11, Health:4, Energy:3, Other:5	In Progress

Usage of AI4Copernicus services

USAGE OF BOOTSTRAPPING SERVICES		#projects using the service	
Domain	Resource	used in the final product	used for testing & experiments
Security	Sentinel-1 pre-processing	3	1
	Sentinel-2 pre-processing	2	2
	Sentinel-1 change detection	-	-
	Sentinel-2 change detection	-	-
Agriculture	Deep network for pixel-level classification of S2 patches	-	3
	Harmonization of pre-processed time series of Sentinel-2 data	1	1
	LST Memory Neural Network for Sentinel-2	2	3
Health	Probabilistic downscaling of CAMS air quality model data	-	2
General	Linked Data pipeline & EarthQA	-	-

USAGE OF CLOUD RESOURCES						
usage	0%	1-10%	11-20%	21-40%	41-50%	51-100%
#projects	4	4	3	2	4	0

- Projects are using security and agriculture bootstrapping services (most projects are from these domains)
- Projects receive a fixed cloud resources quota either on CREODIAS or WEkEO.
- Some projects are more mature and reluctant to change their workflow.
- Most projects are work-in-progress, so in the forthcoming months we expect more of them to test and use the services from our framework.

Conclusions & Future Work

- **AI4Copernicus framework**: A set of services and tools to bridge AI & EO, utilized by several projects and real-world use cases.
- **Ongoing and Future work:**
  - Improve the integration between our framework and AIoD
    - Integration of the AI4Experiments with CREODIAS
      - Enables the deployment of AI pipelines in the execution environment of CREODIAS
      - Almost ready, under testing
  - Develop an AI+EO section on AIoD
    - Prospect of evolving into a (vertical) node within the AIoD platform

Thank you!

Questions?

Visit us at: https://ai4copernicus-project.eu/

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