Advanced AI for scientists: the AI4EOSC platform approach

Judith Sáinz-Pardo Díaz and Ignacio Heredia Cachá

Advanced Computing and e-Science group
Institute of Physics of Cantabra (IFCA) - CSIC | UC

Funded by the European Union

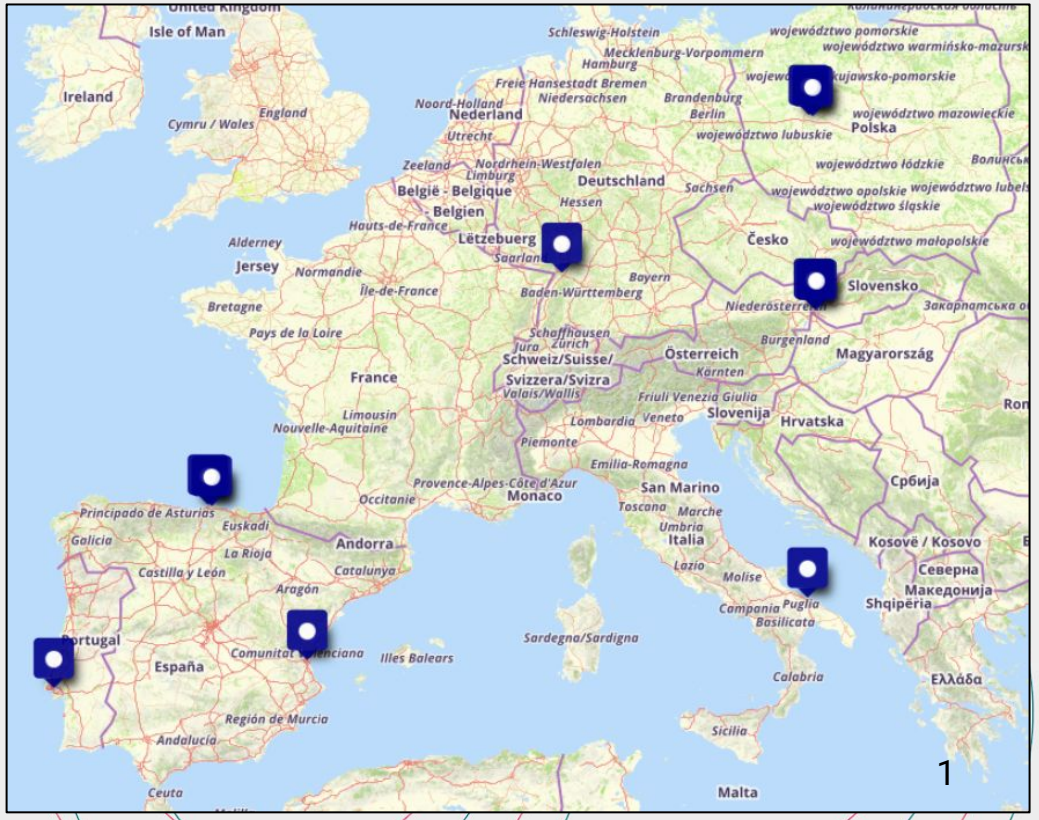
11 | 06 | 2024 by J. Sáinz-Pardo and I. Heredia

Artificial Intelligence for the EOSC

- Evolution of the DEEP Hybrid DataCloud platform
- 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

- Funding: 5M€
- 3 workshops on AI, image processing, federated learning
- 1 external users open call
- 8 peer reviewed publications in high impact journals
- 2 peer reviewed publications in high impact conferences
- Collaboration with several EU funded and INFRAEOSC projects



CSIC Consejo Superior de Investigaciones Científicas · KIT Karlsruher Institut für Technologie · LIP · Ústav Informatiky Slovenská akadémia vied · Universitat Politècnica de València · INFN Istituto Nazionale di Fisica Nucleare · PSNC · WODR · MicroStep-MIS · predictia

Funded by the European Union

11 | 06 | 2024 by J. Sáinz-Pardo and I. Heredia

AI4 | eosc

AI4EOSC main objectives

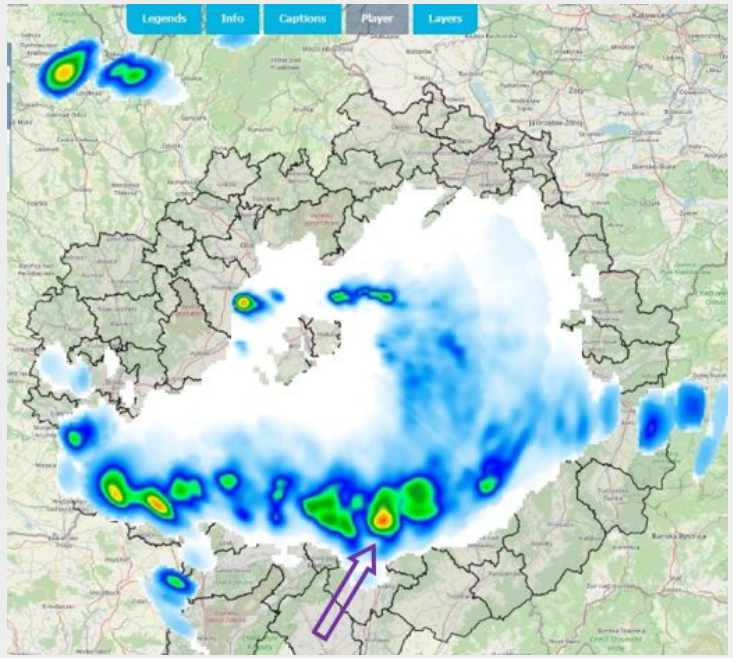
1. Feature rich **services and platform** to build and deploy **custom AI applications in the EOSC**
2. Support for **building AI systems on distributed datasets**, with a particular focus on **federated learning**
3. Services to **compose AI tool workflows**, enabling the development of complex data-driven AI applications
4. **AI Exchange Hub** in the context of the EOSC, enhancing and increasing the application offer currently available
5. **Extend** the service offer and the **capabilities** being offered through the **EOSC portal**, with focus on AI

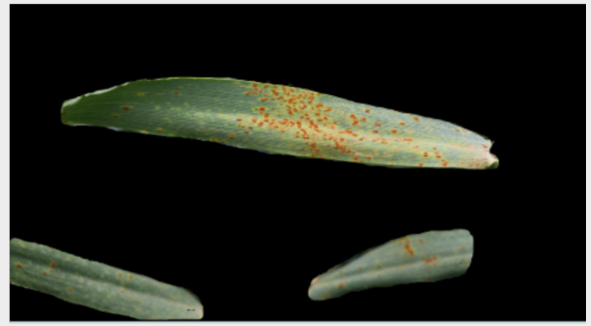
Funded by
the European Union

AI4 | eosc

AI4EOSC use cases:

- Agrometeorology
- Integrated plant protection
- Automated thermography





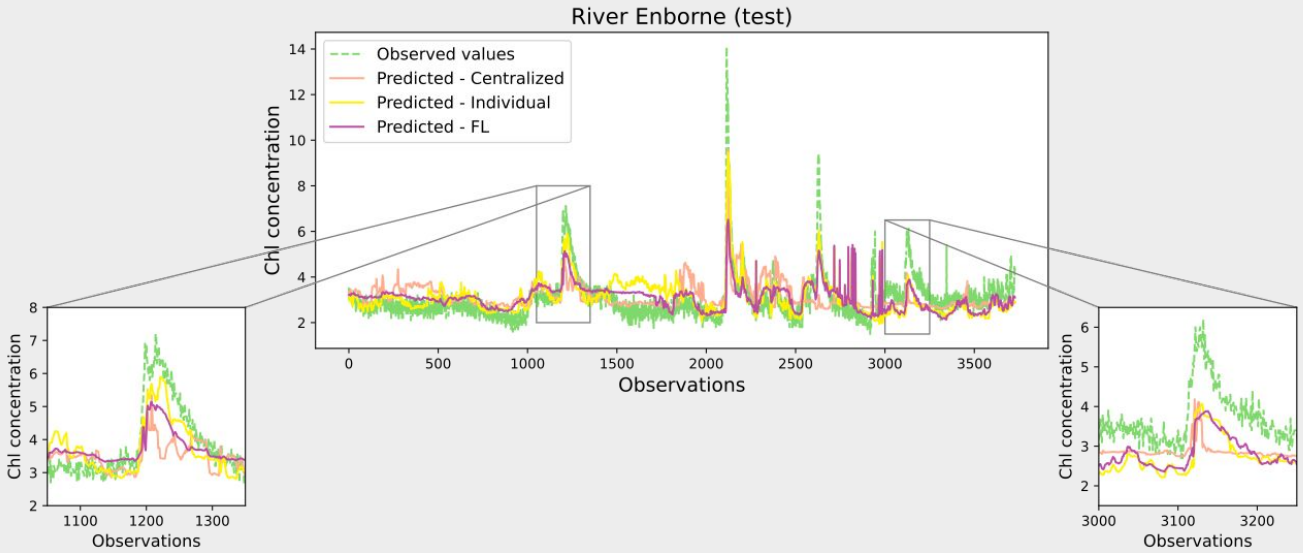
Funded by the European Union

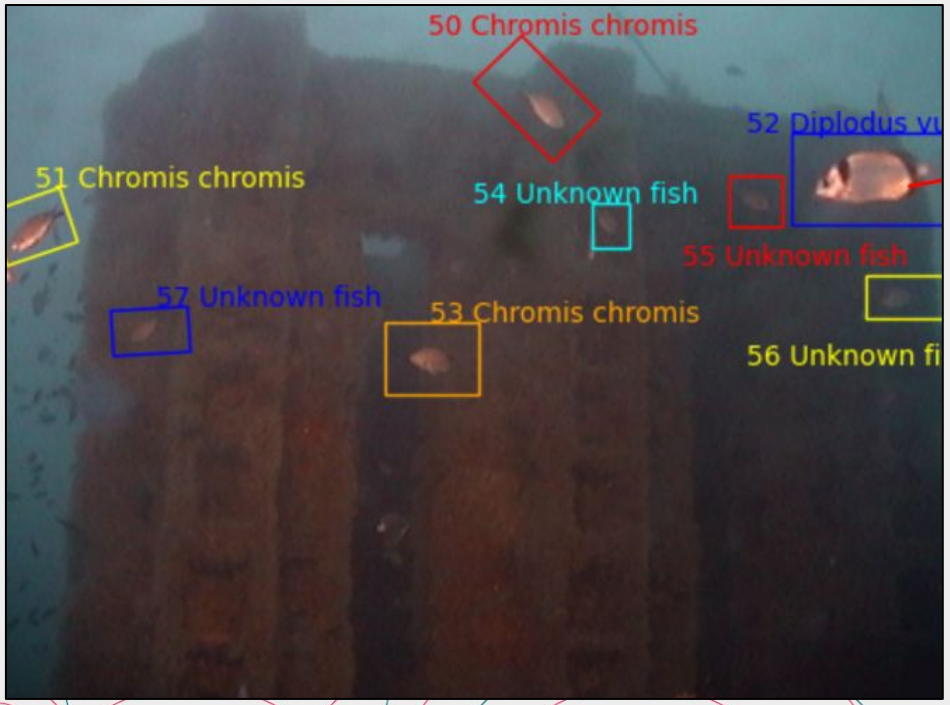
11 | 06 | 2024 by J. Sáinz-Pardo and I. Heredia

Additional use cases

Water quality: predicting Chl concentration

Fish detection and classification





Sáinz-Pardo Díaz, Judith, Castrillo, María and López García, Álvaro. "Deep learning based soft-sensor for continuous chlorophyll estimation on decentralized data." Water Research 246 (2023): 120726. https://doi.org/10.1016/j.watres.2023.120726

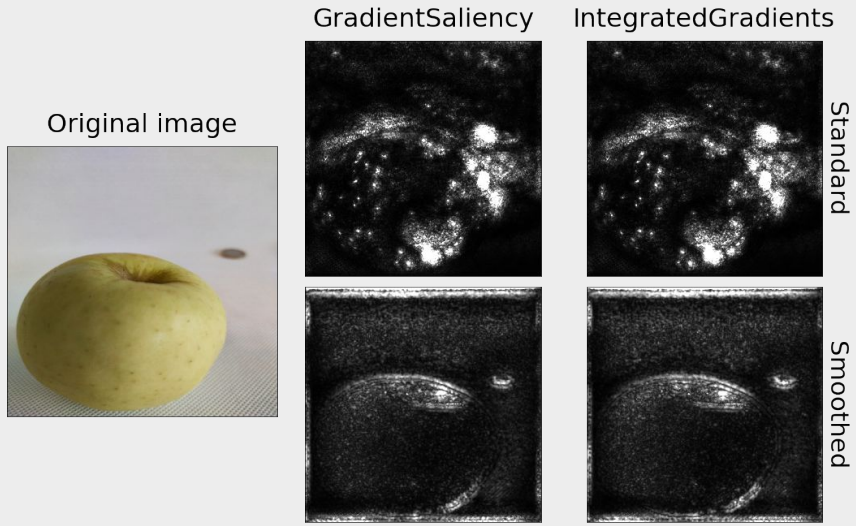
Martinez, Enoc and Valentin Kozlow. OBSEA Fish detector. https://github.com/EnocMartinez/obsea-fish-detection

Funded by the European Union

Additional use cases

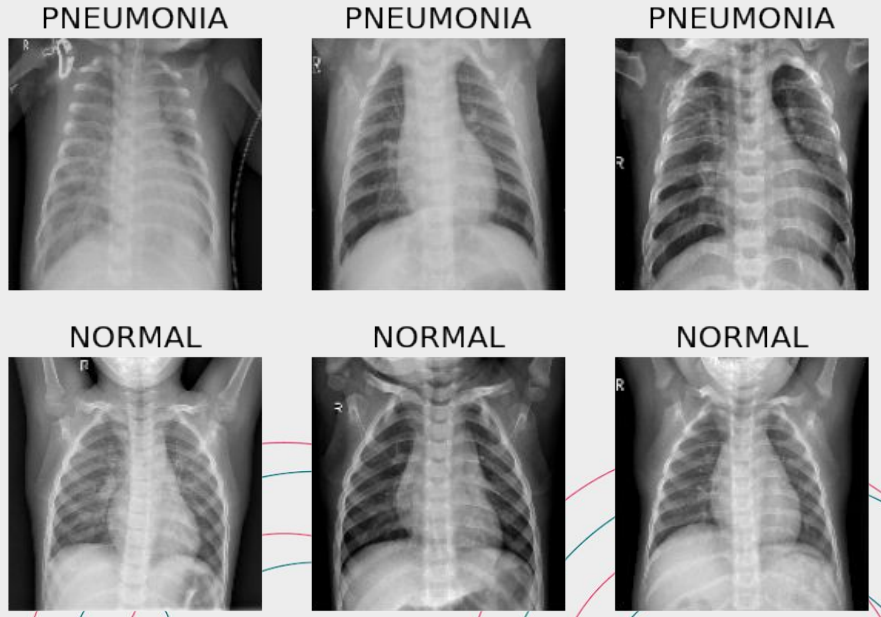
Medical imaging using federated learning

AI for precise weight measurement of fruits



Izquierdo, Pablo, from CSIC DigitalAlimenta project.
https://digitalalimenta.csic.es/

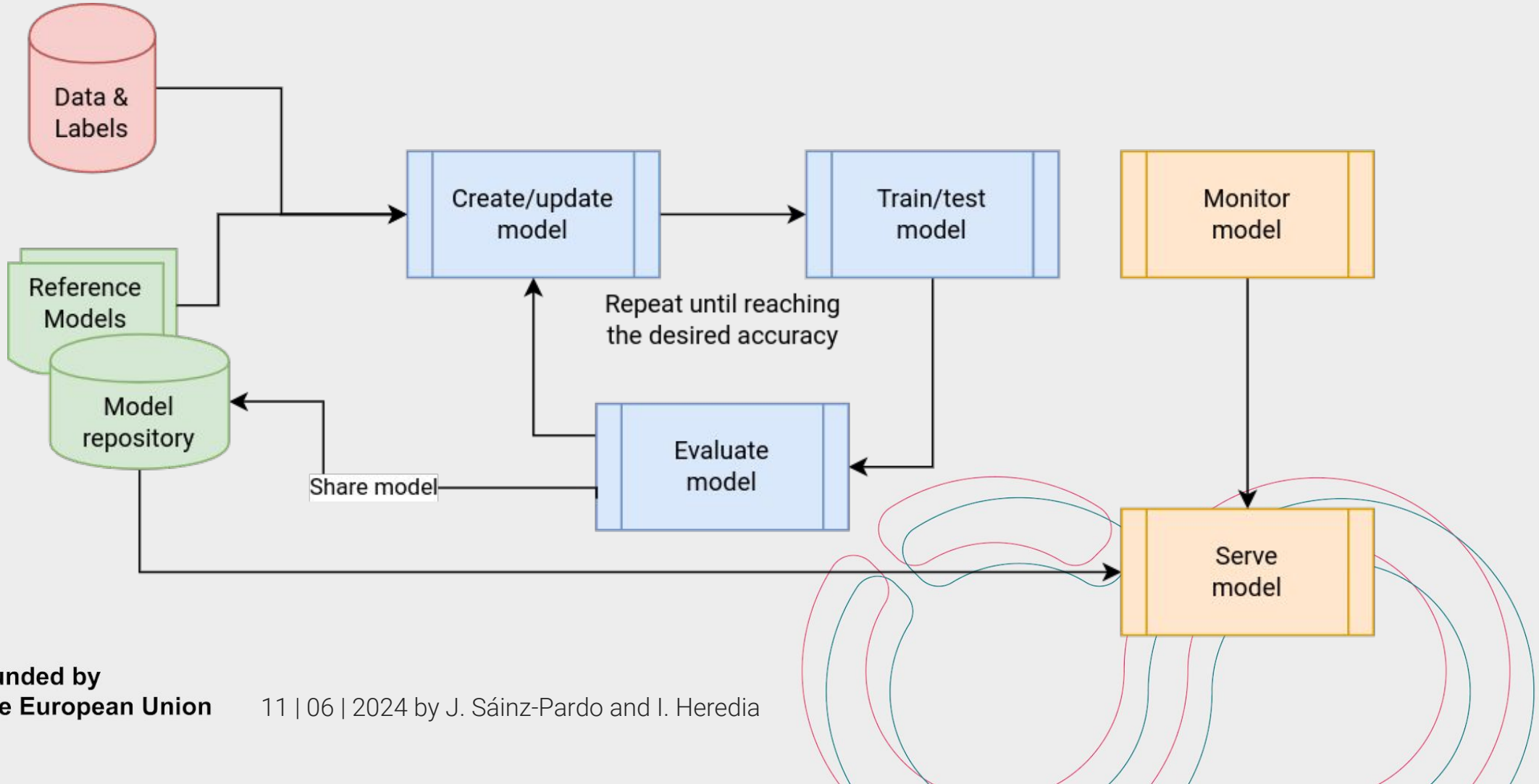
Sáinz-Pardo Díaz, Judith, and López García, Álvaro. "Study of the performance and scalability of federated learning for medical imaging with intermittent clients." *Neurocomputing* 518 (2023): 142-154.
https://doi.org/10.1016/j.neucom.2022.11.011



Funded by
the European Union

AI4 | eosc

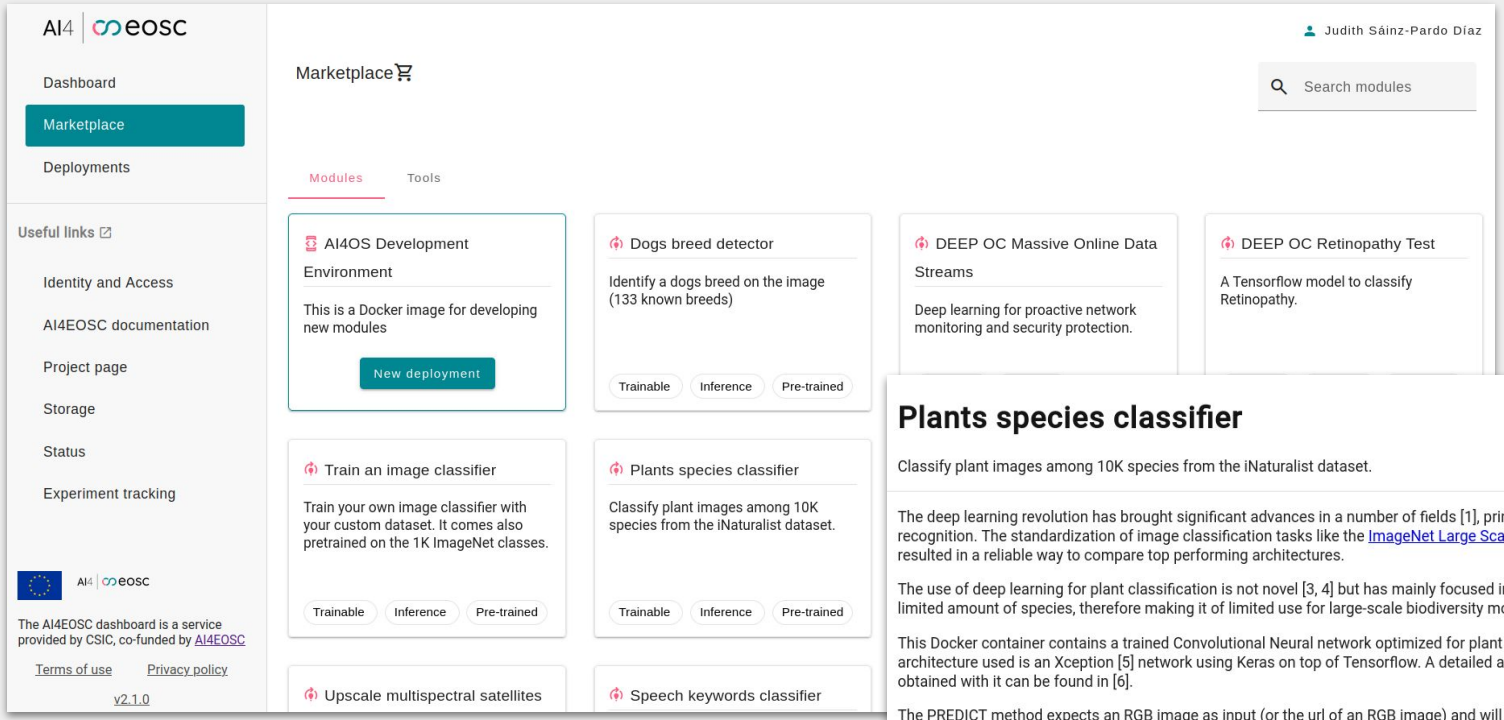
The Machine Learning Lifecycle

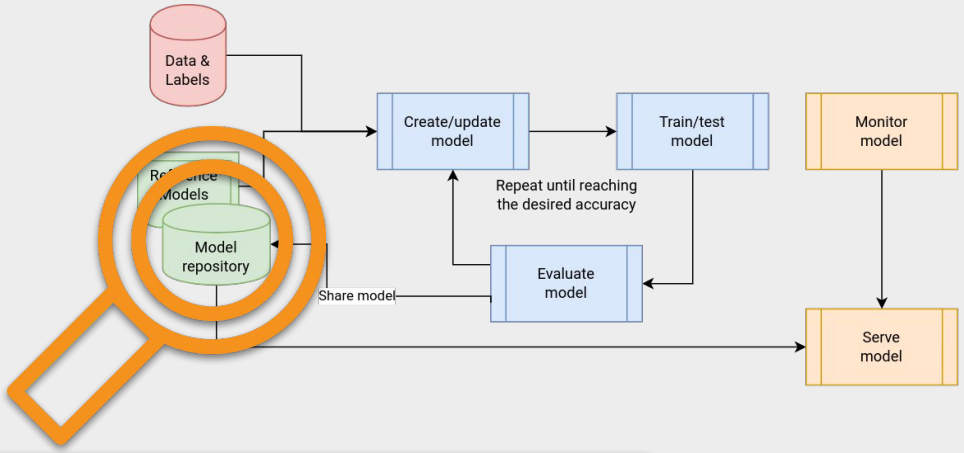


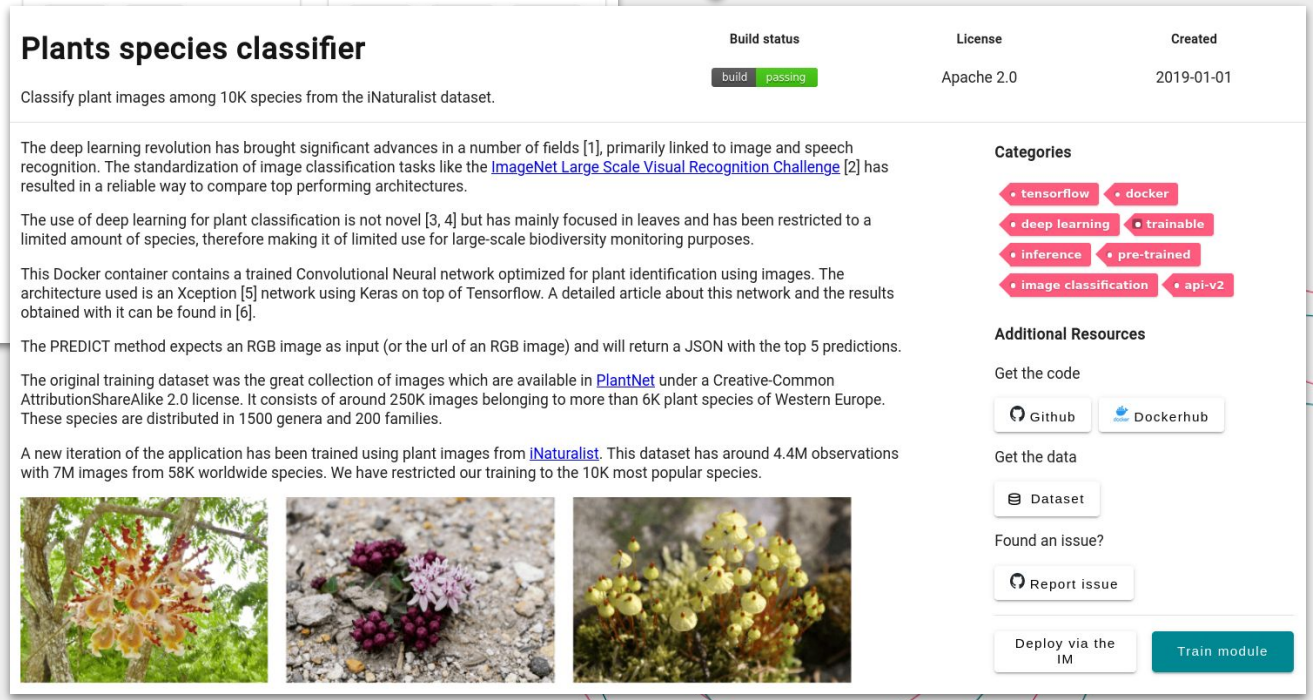
Funded by the European Union

Services for AI/ML development

Model marketplace



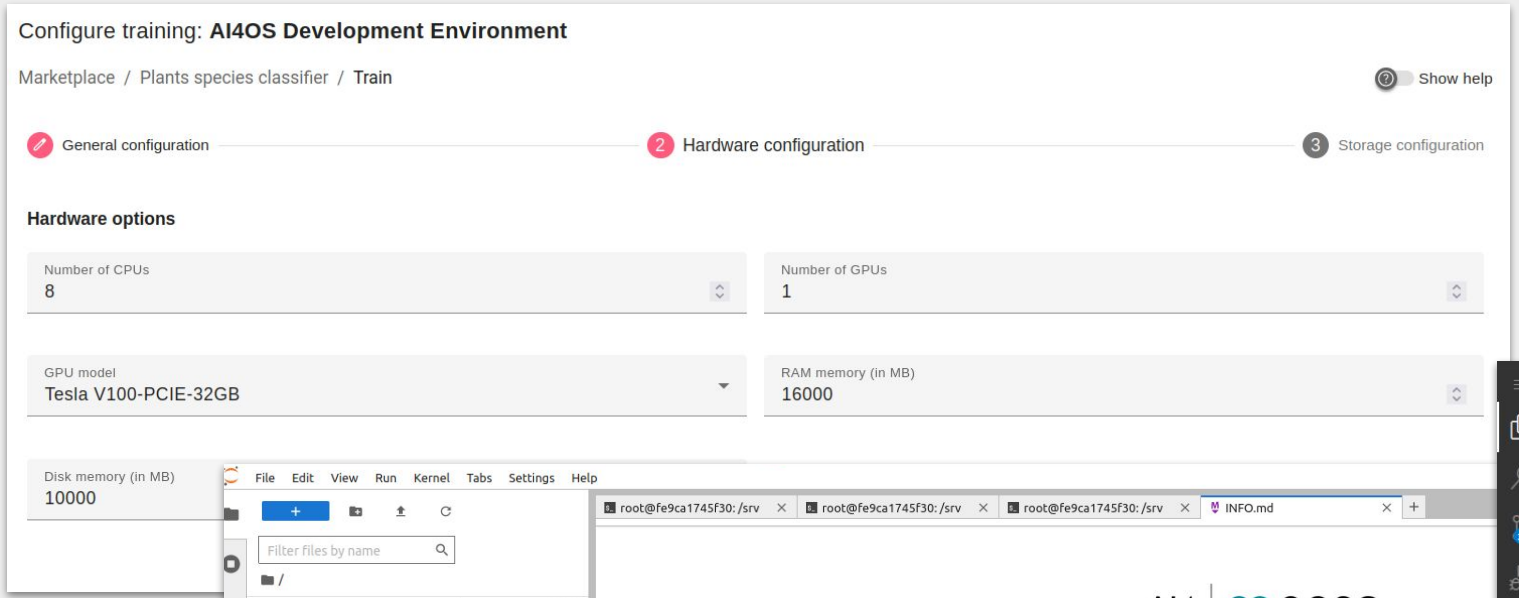


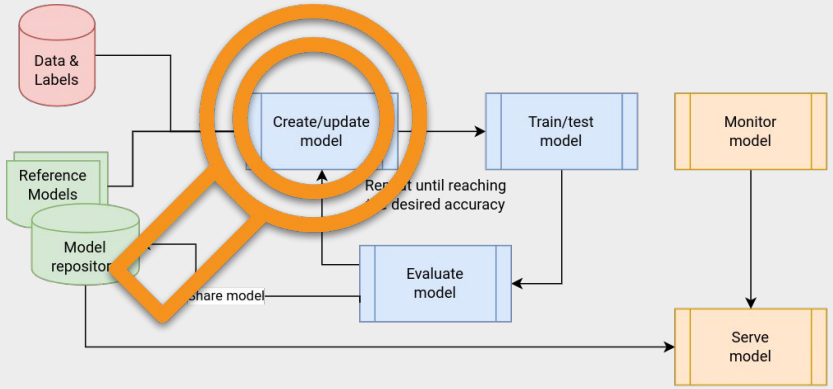


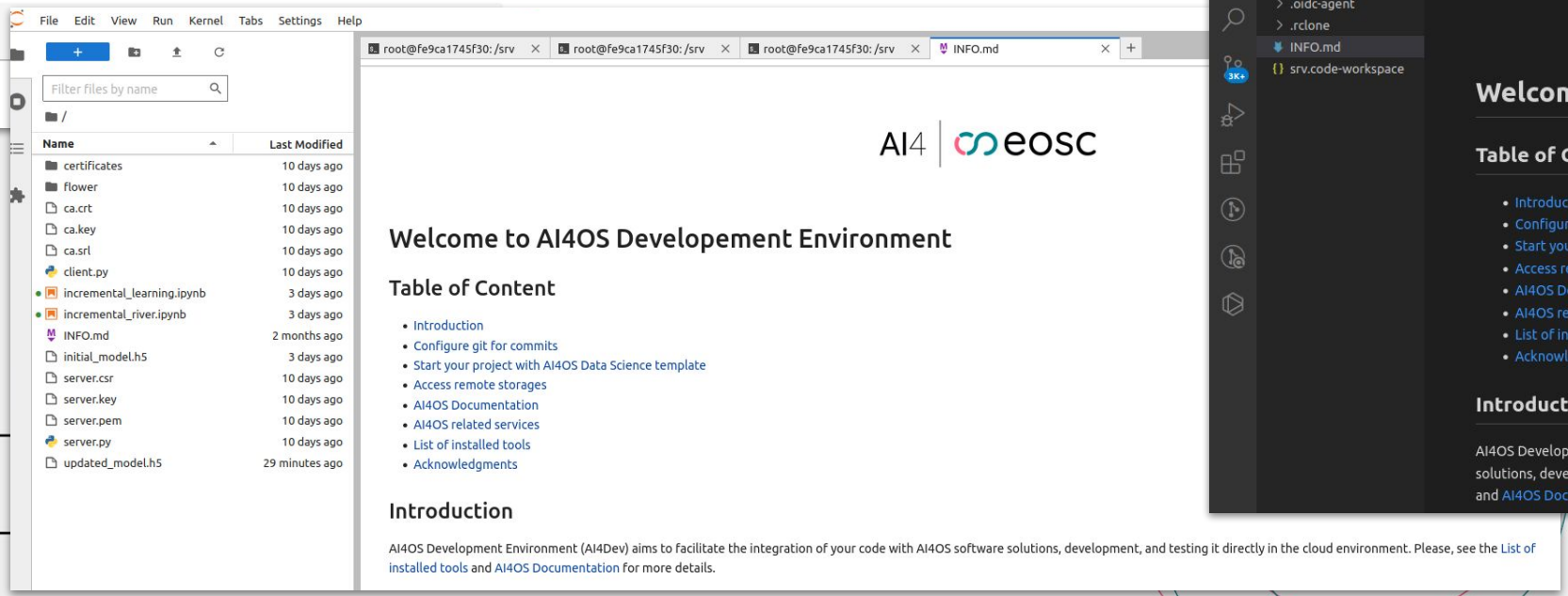
Funded by the European Union

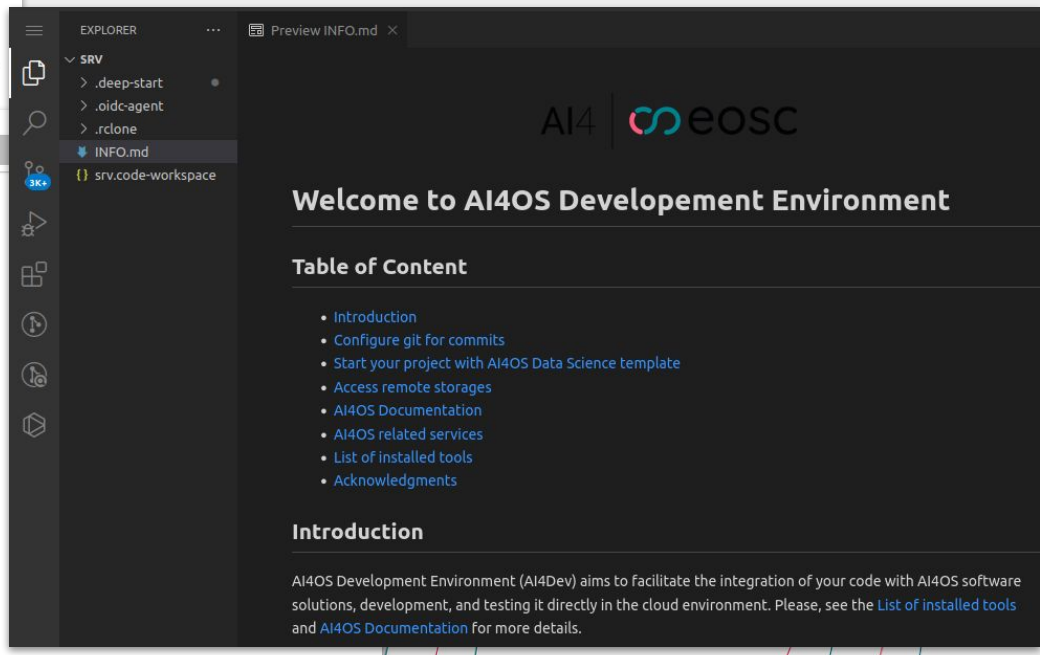
Services for AI/ML development

Create your own model





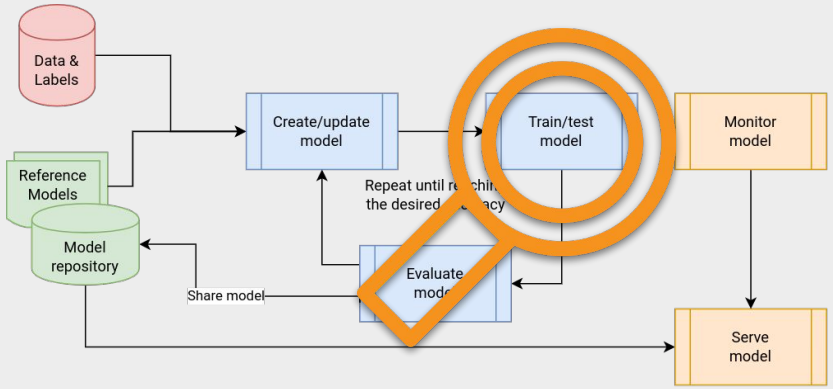


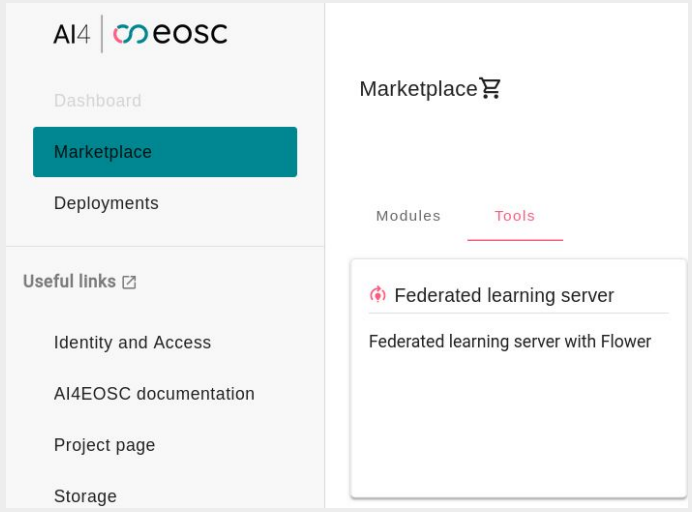


Services for AI/ML development

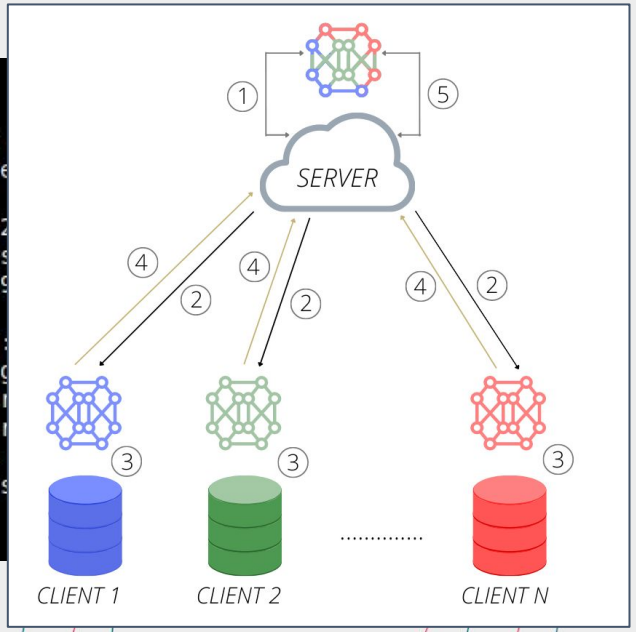
Training: federated learning

- Collaborative and decentralized approach to build ML models
  - No need to centralize a dataset (i.e. technical or privacy restrictions)
- Management of experiments through platform dashboard
- Participating clients both within AI4EOSC platform or external (with authentication)






```
root@8878206726fb:/srv# cd federated-server/fedserver
root@8878206726fb:/srv/federated-server/fedserver# python3 server.py
INFO flwr 2024-04-18 14:10:23,381 | vault.py:76 | Configured Vault Bearer token
INFO flwr 2024-04-18 14:10:23,381 | vault.py:77 | Reading tokens stored in: 'use
a3f-0242ac130005/federated'
Getting tokens from Vault ->  users/7d7a87545b700b38b54e2b5b4713084fd2b8d7e5ed82
INFO flwr 2024-04-18 14:10:23,790 | vault.py:79 | Configured Vault Bearer tokens
86bf6d2843ad31a8879a5fab0c1318', '6707ded3dab865271f4a5ac637601cbb38269b808f2029
INFO flwr 2024-04-18 14:10:23,790 | server.py:80 | Token interceptor created
INFO flwr 2024-04-18 14:10:23,791 | app.py:158 | Starting Flower server, config:
INFO flwr 2024-04-18 14:10:23,800 | app.py:172 | Flower ECE: gRPC server running
INFO flwr 2024-04-18 14:10:23,800 | server.py:91 | Initializing global parameter
INFO flwr 2024-04-18 14:10:23,800 | server.py:282 | Requesting initial parameter
INFO flwr 2024-04-18 14:10:49,423 | server.py:288 | Received initial parameters
INFO flwr 2024-04-18 14:10:49,424 | server.py:93 | Evaluating initial parameters
INFO flwr 2024-04-18 14:10:49,424 | server.py:106 | FL starting
```

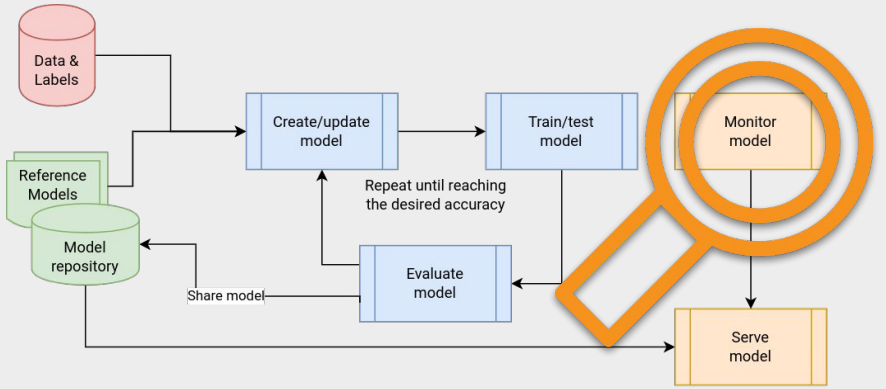


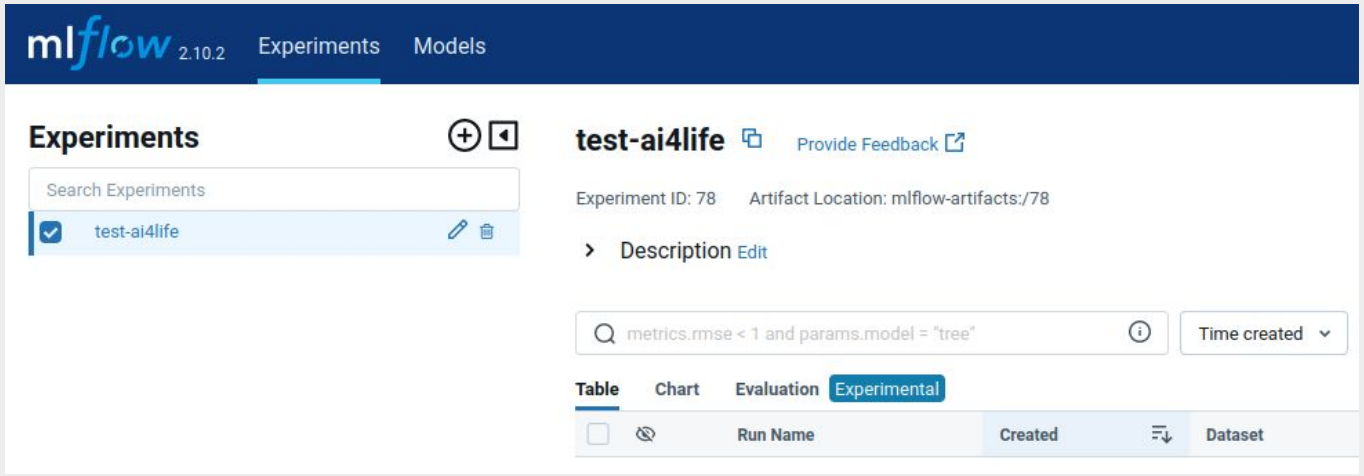
Funded by the European Union

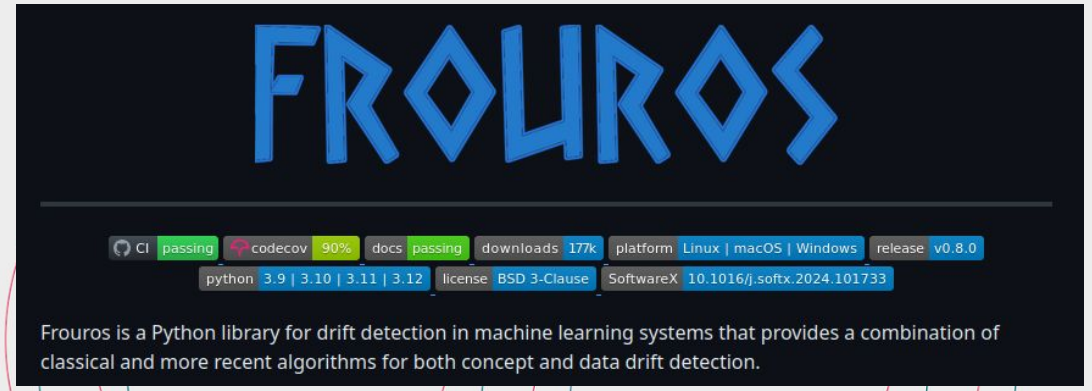
Services for AI/ML development

Monitor the model: MLOps and drift detection

- Monitoring of models in production is not enough
  - Model learns from data, data is not stationary
  - Concept learnt by the model may change over time
- Data and concept drift detection→ essential to build more robust models
- Frouros: state-of-the-art Python library for drift detection in ML problems: https://github.com/IFCA/frouros
- MLOps is an engineering practice that aims to automate and streamline the ML lifecycle
- MLflow tracking server: https://mlflow.cloud.ai4eosc.eu



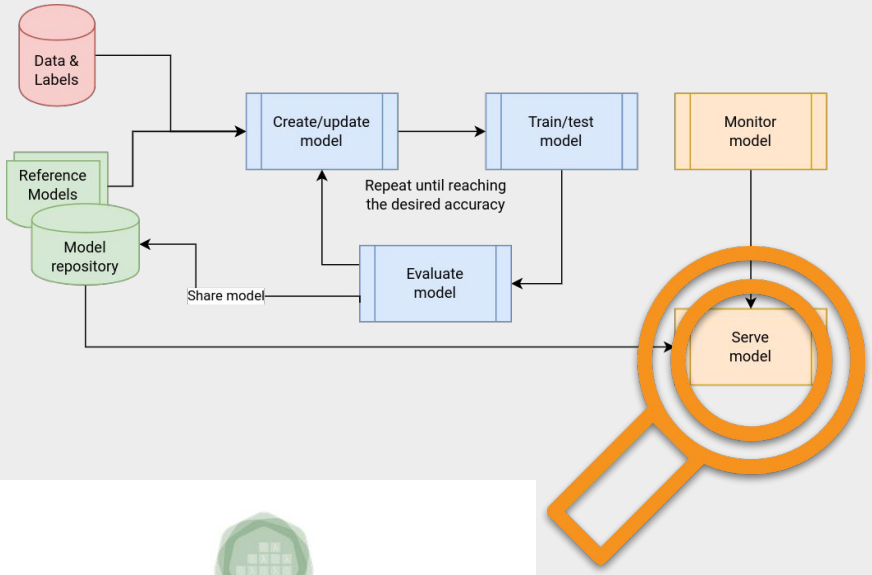




Services for AI/ML development

Serve the model: inference

https://inference.cloud.ai4eosc.eu/ui/

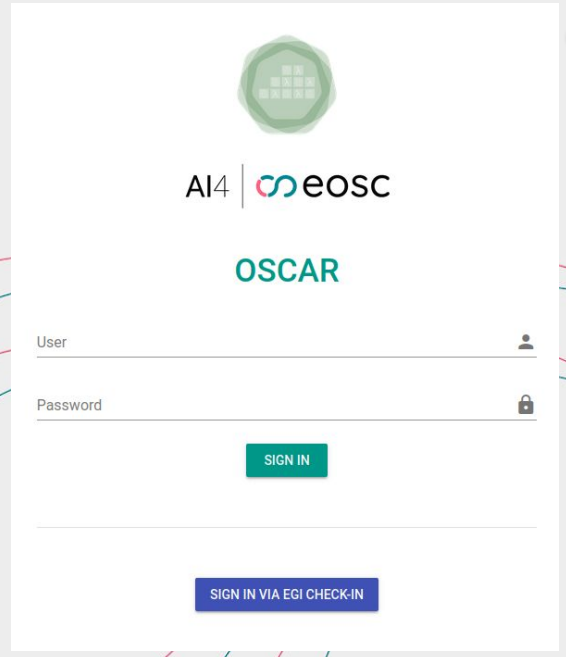


We use OSCAR to serve AI models for inference (AI as a Service).

It supports two serverless event-driven execution modes:

- **Asynchronous mode**: Files uploaded to the object-store automatically trigger the invocation of a data-processing script, that is run inside a container (out of user-defined Docker image) within a scalable Kubernetes cluster (e.g. batch jobs).
- **Synchronous mode**: Scalable HTTP-based endpoints (based on KNative). Direct requests to the model.

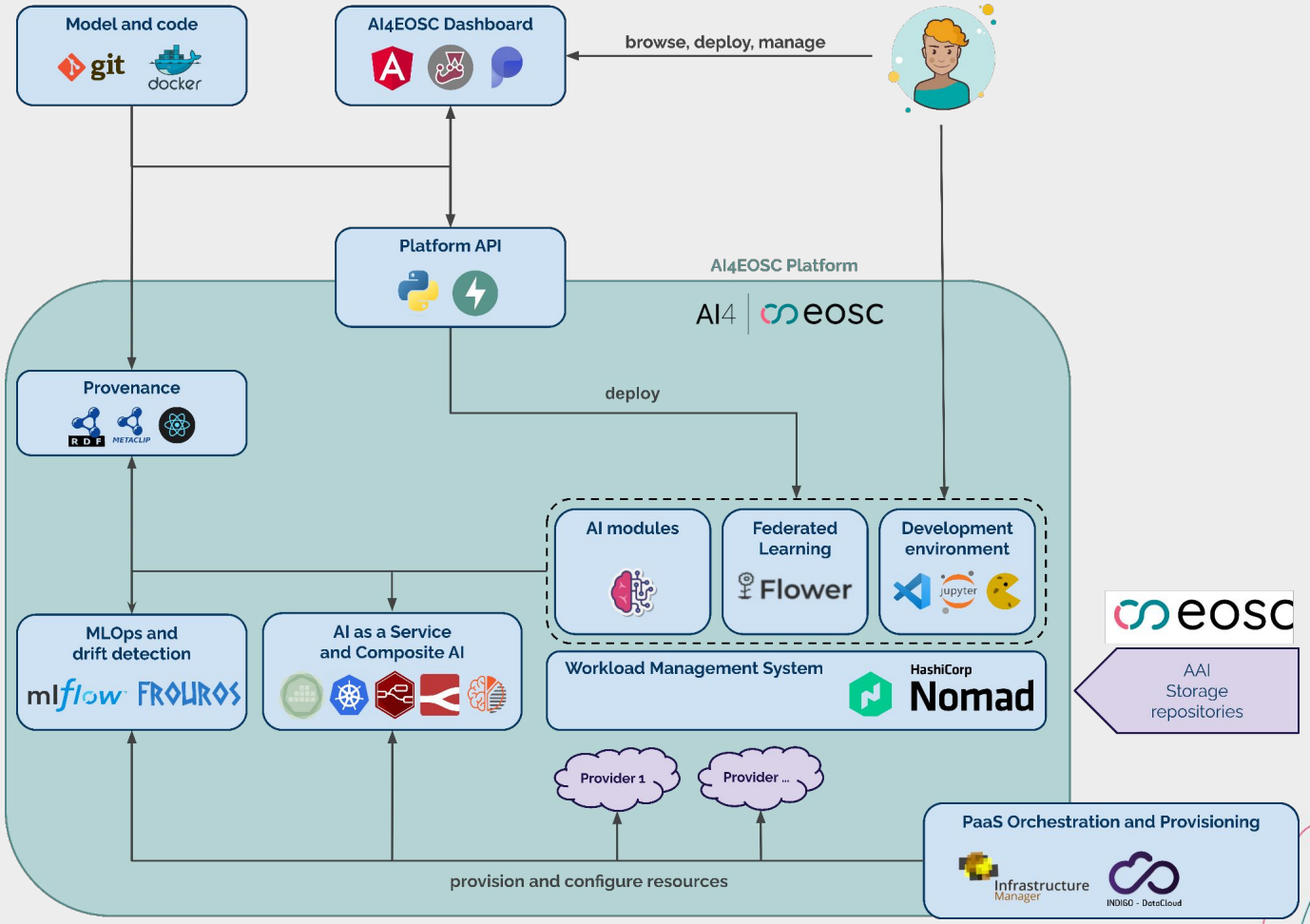
On top, we support building AI workflows using Flowfuse and Elyra through AI4Compose.



Funded by the European Union

11 | 06 | 2024 by J. Sáinz-Pardo and I. Heredia

AI4EOSC high level architecture



Interactive C4 diagrams available here.

C4 model
for visualising software architecture

Funded by the European Union

11 | 06 | 2024 by J. Sáinz-Pardo and I. Heredia

Showcasing the AI4EOSC platform

https://dashboard.cloud.ai4eosc.eu

Funded by
the European Union

11 | 06 | 2024 by J. Sáinz-Pardo and I. Heredia

Conclusions and collaboration

AI4EOSC empowers scientific research by…

- Providing users with advanced AI tools:
  - Model retraining (iterative learning, fine tuning)
  - Federated learning (including client authentication)
  - Parallel training in multiple GPUs (distributed training - data parallelism)
  - Model monitoring: MLOps, drift detection
  - Model inference
- Providing a simple and intuitive IDE for developing AI/ML/DL models (VSCode or JupyterLab)
- Allowing seamless access to computational resources to accelerate model development
- Deploying your models in production in a serverless environment

More info:
https://ai4eosc.eu/
https://docs.ai4os.eu/

Funded by the European Union

AI4 | eosc

Thank you for your attention!

Judith Sáinz-Pardo Díaz sainzpardo@ifca.unican.es
Ignacio Heredia Cachá iheredia@ifca.unican.es

Álvaro López García aloga@ifca.unican.es
(project coordinator)

Funded by the European Union