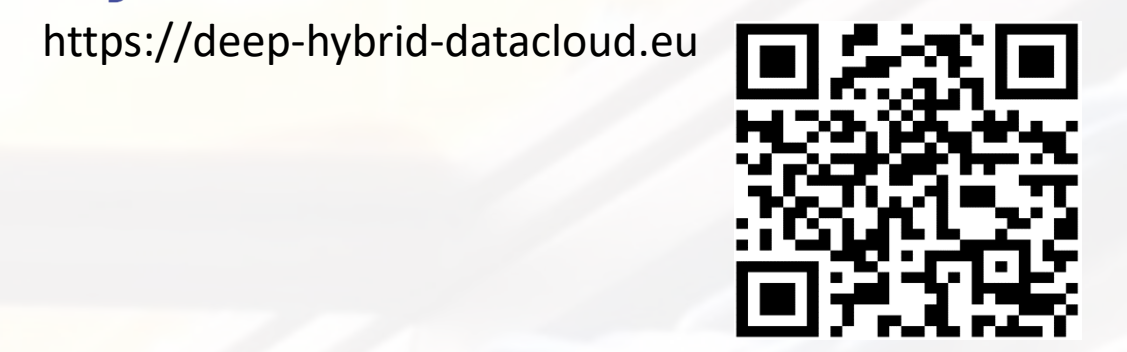


DEEP: Hybrid approach for Deep Learning

A.S. Alic ^{a)}, M. Antonacci ^{b)}, M. Caballer ^{a)}, I. Campos ^{c)}, A. Costantini ^{b)}, M. David ^{d)}, S. Dlugolinsky ^{e)}, G. Donvito ^{b)}, C. Duma ^{b)}, J. Gomes ^{d)}, M. Hardt ^{f)}, I. Heredia ^{c)}, L. Hluchy ^{e)}, K. Ito ^{g)}, V. Kozlov ^{f)}, L. Lloret ^{c)}, A. López García ^{c)}, J. Marco ^{c)}, L. Matyska ^{h)}, G. Moltó ^{a)}, G. Nguyen ^{e)}, P. Orviz ^{c)}, M. Plociennik ⁱ⁾, Z. Šustr ^{h)}, V. Tran ^{e)}, P. Wolniewicz ⁱ⁾, W. zu Castell ^{g)}

a) UPV b) INFN c) CSIC d) LIP e) IISAS f) KIT g) HMGU h) CESNET i) PSNC



The DEEP-Hybrid-DataCloud project researches on intensive computing techniques such as needed for deep learning. This requires access to specialized GPU hardware to explore very large datasets. DEEP applies a hybrid-cloud approach that enables such access. We understand the needs of our user communities and help them to combine their services in a way that encapsulates technical details the end user does not have to deal with.

DEEP Architecture components

DEEPaaS API

DEEP as a Service API is a REST API focused on providing **Basic Users** with web access to machine learning models. **Advanced users** can integrate arbitrary machine learning models.

DEEP Marketplace

The Open Catalog provides the universal point of entry to all services offered by DEEP:

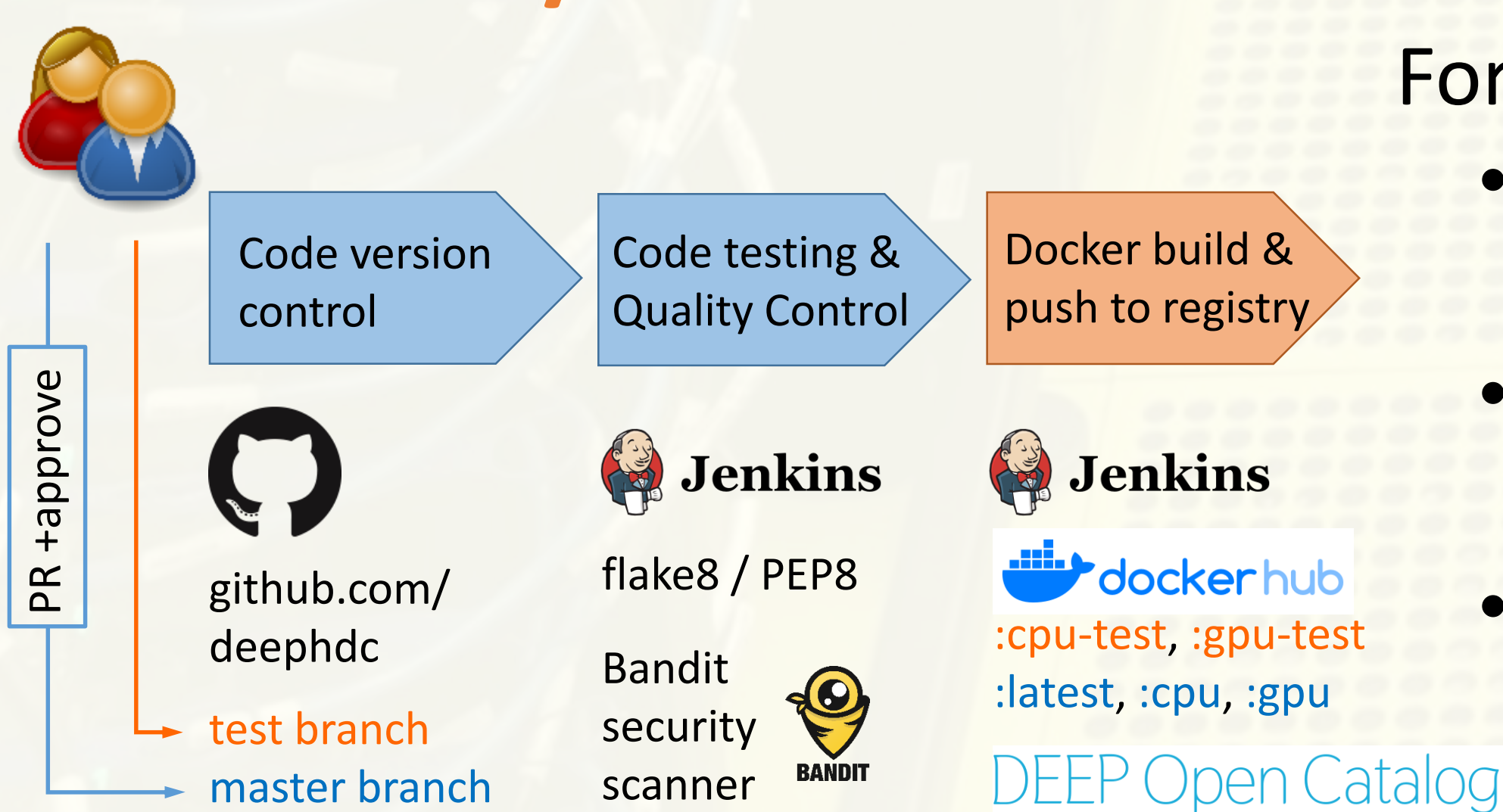
- Browse modules and learn from others
- Re-use and re-train existing modules
- Implement new

Pilot Testbed

Heterogeneous sets of resources are provided:

- Access to resources through orchestrator
- Alien4Cloud for a graphical composition of complex infrastructures
- HPC resources
- Supporting Nextcloud for remote synchronization

Jenkins CI/CD



For user applications:

- Automatization of code testing
- Docker image building
- Delivery to the registry

Deep Learning Use-cases

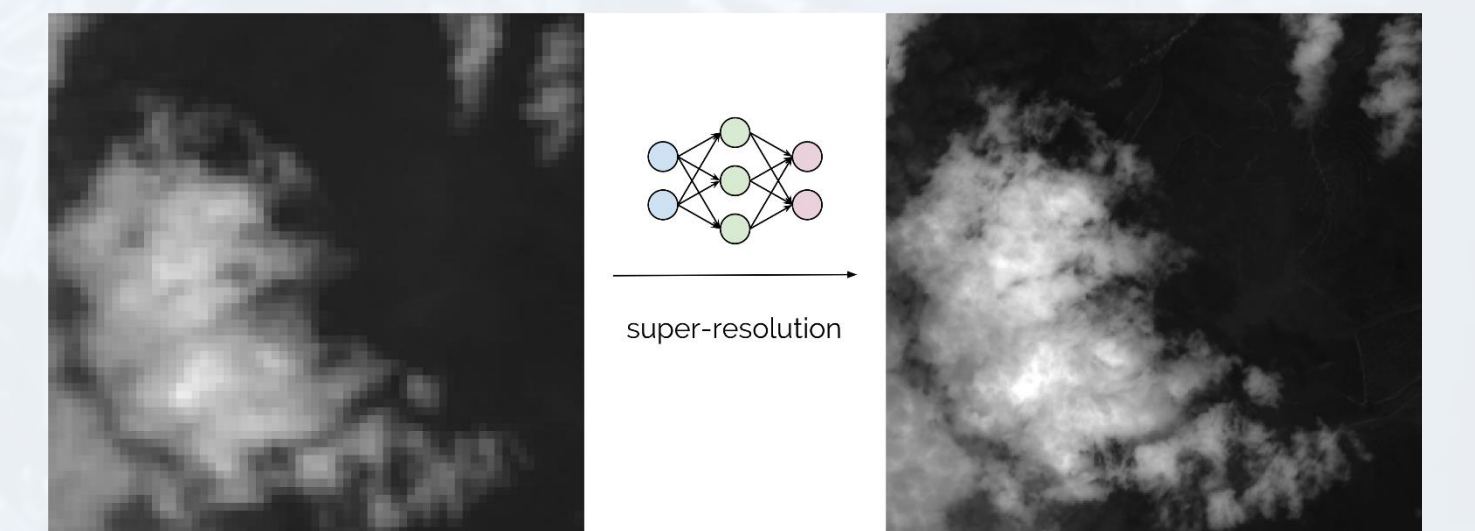
Exemplified use-cases demonstrating usefulness and scalability of the approach

Image classification module

Generic model to train and test image classifiers (e.g. ResNet50, Xception). Several services are derived:

- Plants (Plantnet dataset)
- Seeds
- Conus marine snails
- Phytoplankton

Satellite imagery

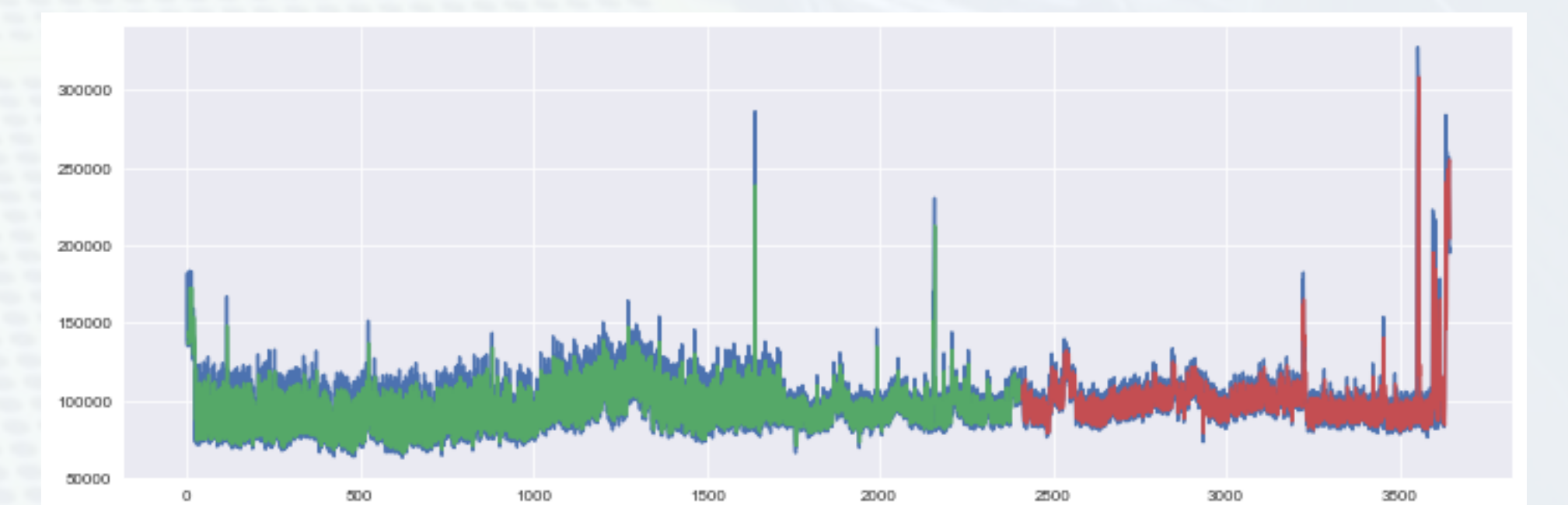


An image super-resolution service for satellite imagery (Sentinel2, Landsat8, VIIRS, MODIS) to upscale low resolution bands to high resolution with Deep Learning (e.g. DSen2)

Massive Online Data Streams

A service is aimed at analyzing online data streams in order to generate alerts in real-time. The principle is proactive time-series prediction adopting artificial neural networks (e.g. LSTM, GRU).

Fig.: dataset, prediction (train), prediction (test). 6 month monitoring dataset for network traffic

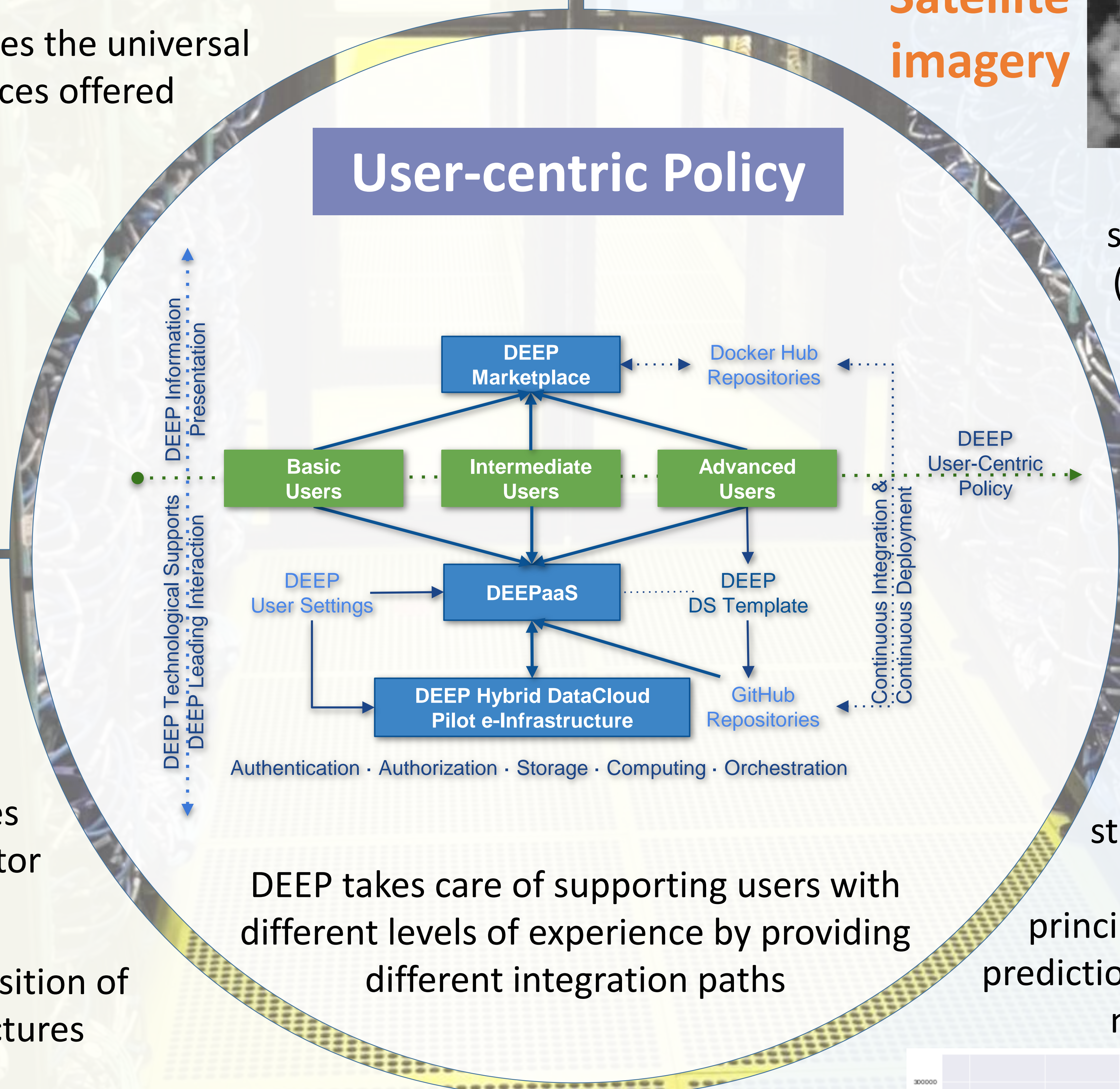


Retinopathy

A deep learning approach (e.g. ResNet50, InceptionV3) for automated classification of retinopathy based on color fundus retinal photography images



Color fundus retinal photography images for a healthy (DR0) and the most pathological level (DR4)



DEEP takes care of supporting users with different levels of experience by providing different integration paths