LifeWatch ERIC e-Science for NIS research workshop | 20-21 May 2021

An event organised within the framework of the LifeWatch ERIC Internal Joint Initiative and with the support of the ENVRI-FAIR project

Session 3: Mapping the invasion: detection and monitoring through remote sensing

AILANTHUS Workflow - development, current status, functionalities

Cristina Tarantino, Palma Blonda | National Research Council of Italy-Institute for Atmospheric Pollution Research (CNR-IIA), Bari, Italy
Ismael Navas-Delgado | LW-ERIC ICT-Core UMA
Angela Martiradonna | Department of Mathematics, University of Bari, Italy | Institute for Applied Mathematics (IAC) – CNR, Bari, Italy

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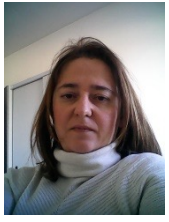


Cristina Tarantino, Palma Blonda | National Research Council of Italy-Institute for Atmospheric Pollution Research (CNR-IIA), Bari, Italy

The problem

Alien plants, also termed non-native, exotic or allochthon plants, can modify diversity and functioning of ecosystems especially when they exhibit invasive tendencies.

Ailanthus altissima (Mill.) Swingle in the Alta Murgia protected area

Addressing the problem

- To address problems caused by invasive alien species, reduce and monitor their negative impact on the environment, the European Member States have approved a specific regulation (Regulation 1143/2014).
- This act supports interventions aimed at prevention, early detection, rapid eradication and management of invasive species spreading.

- Traditionally, early detection of alien species has been based on in-field inspections.
- Area accessibility, extent and speed of alien plants invasion can be both time consuming and costly especially in areas where quick management decisions needed.
- Remote Sensing (RS) data and techniques can not only allow coverage of large areas repetitively, but also provide data for areas difficult or dangerous to reach.

alien plant detection with RS

Ailanthus altissima (Mill.) Swingle

Common name: Tree of Heaven **Native to**: China and Taiwan
Deciduous tree in the Simaroubaceae family.
Characteristics: Rapid growth
Reproduction from both seeds and root sprouts
High seed production and good seed viability
Seeds are able to grow in a variety of site conditions


Courtesy of F. Casella

The tree was brought to Europe in the 18th century for ornamental purposes.

Subsequently, the plant spread and became an invasive species due to its ability to colonise quickly any area, either natural or disturbed, and to compete with native species for the use of resources.

The tree also resprouts vigorously when cut, making its eradication difficult and time-consuming.

Alta Murgia protected area

(SCI/SPA) within the EU Natura 2000 network, National Park included since 2004

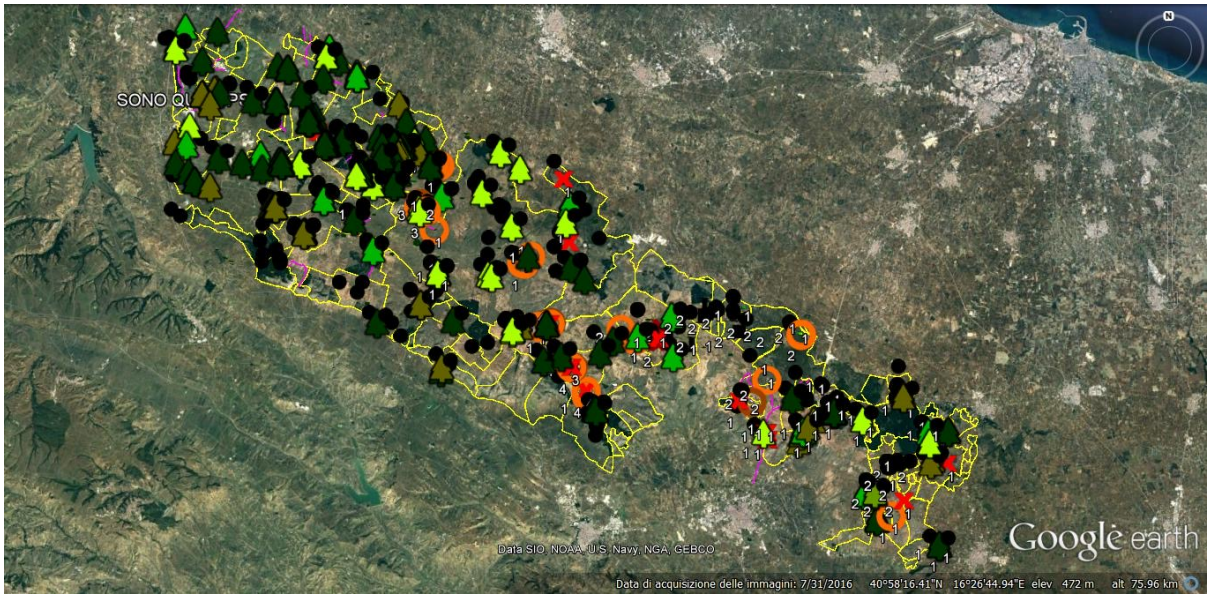
- Surface area: 68077 hectares
- It is among the most important karst areas in Italy
- The most significant habitat types are dry grasslan and quercus woods
- The Park hosts about 1500 plant species, rare bird species and many other animals.
- Part of the area is exploited for agricultural and pastoral activities

It is included in the 25 Protected Areas within EU H2020 ECOPOTENTIAL project (2015-2019) (http://www.ecopotential-project.eu/)

Damages caused by Ailanthus in Alta Murgia

- Loss of biodiversity
- Changes of the ecosystem structures
- Alteration of native plant communities of considerable conservation value
- Natural habitat loss and degradation
- Damages to agriculture
- Damages to structures and to cultural landscape

In-situ measurement of Ailanthus infestation in Alta Murgia (project LIFE Alta Murgia) - 2012



LIFE Alta Murgia
LIFE12 BIO/IT/000213

Control and eradication of the invasive and exotic plant species *Ailanthus altissima* in the Alta Murgia National Park
(http://lifealtamurgia.eu/)

Duration of project:
01/10/2013 – 31/12/2019

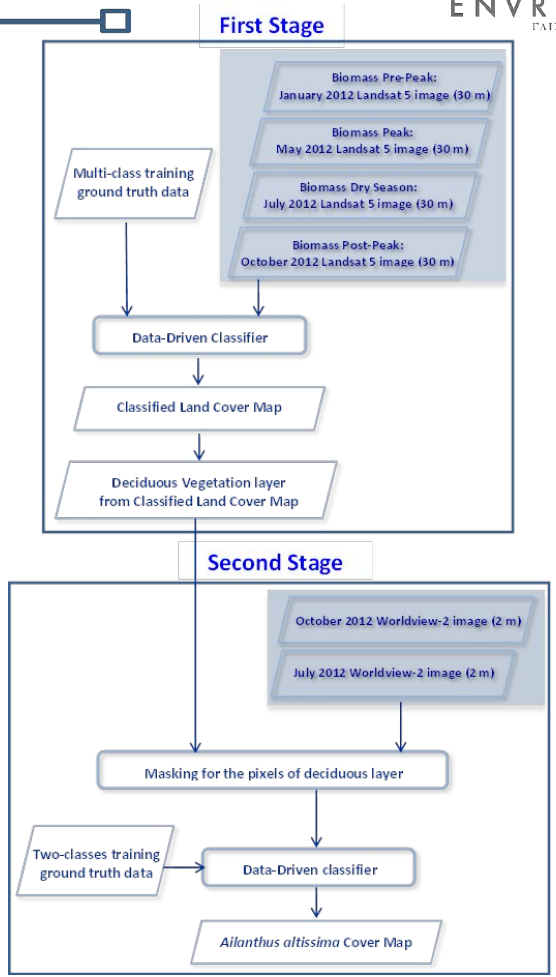
Data available on the website of the project

Ailanthus altissima mapping

Two-stages cascading classification approach

Mapping deciduous vegetation

- High spatial resolution (30 m) - (free available)



Mapping *Ailanthus altissima*

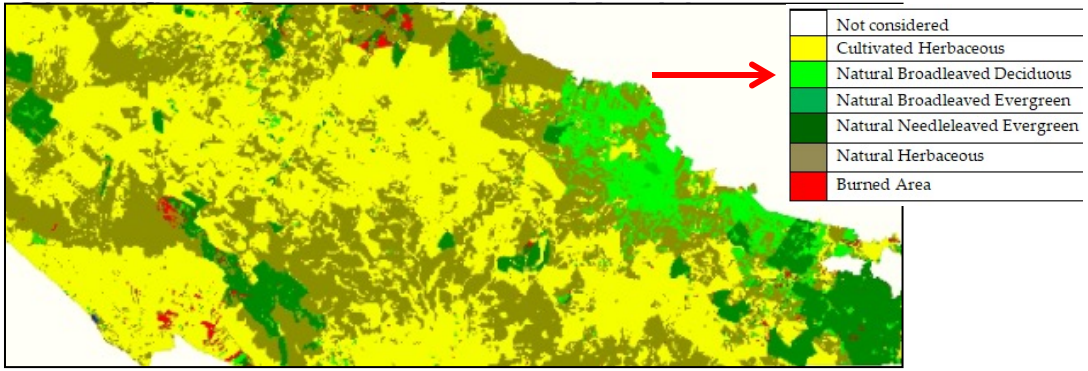
- Very High spatial resolution (2 m) – (Commercial)

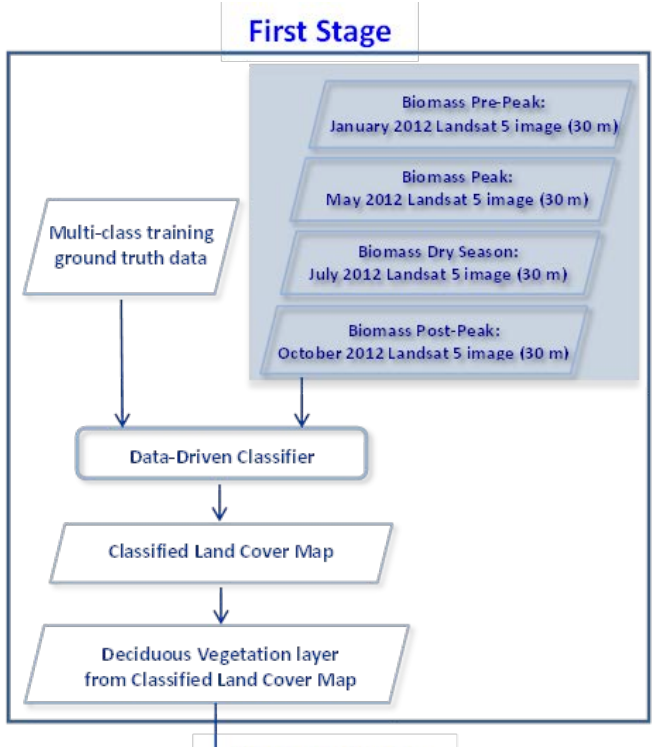
Algorithm Workflow: First stage

Multi-class classification problem

Input: 4 multi-seasonal Landsat 5 images (30 m)

Approach: data-driven/pixel-based





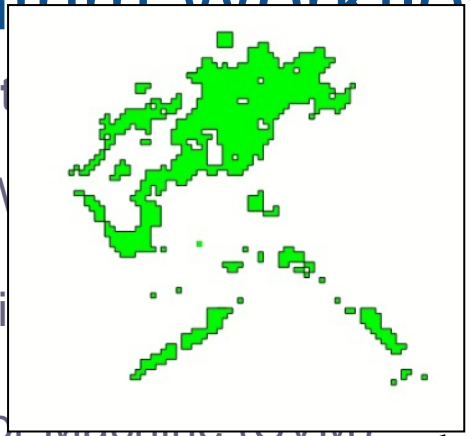
Algorithm Workflow: First stage

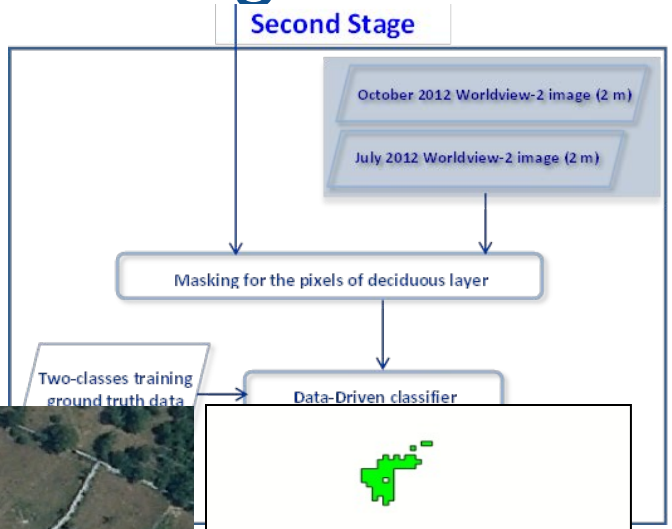
Tw

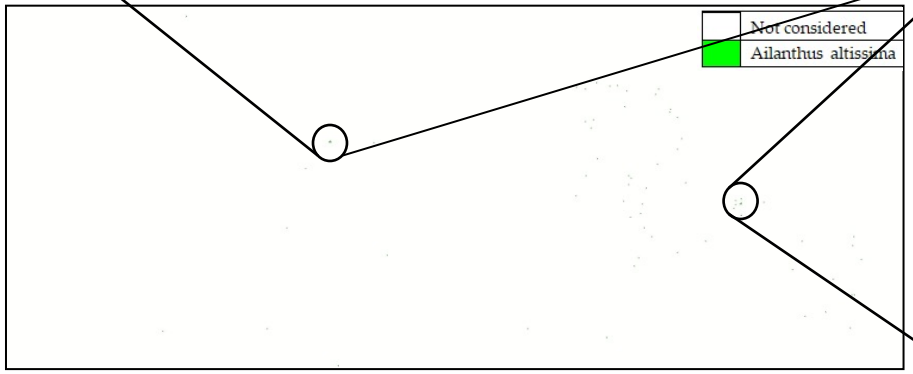
Inp

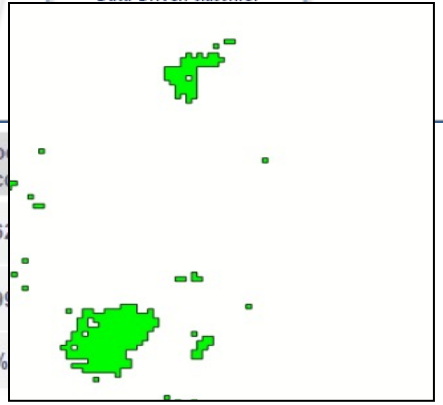
Ap

Classifier: Support Vector Machine (SVM)









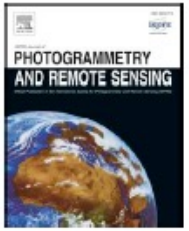
Paper published

ISPRS Journal of Photogrammetry and Remote Sensing 147 (2019) 90–103

Contents lists available at ScienceDirect

ISPRS Journal of Photogrammetry and Remote Sensing

journal homepage: www.elsevier.com/locate/isprsjprs



Ailanthus altissima mapping from multi-temporal very high resolution satellite images

Cristina Tarantino[a,*], Francesca Casella[b], Maria Adamo[a], Richard Lucas[c], Carl Beierkuhnlein[d,e,f], Palma Blonda[a]

[a] Institute of Atmospheric Pollution Research (IIA), National Research Council (CNR), c/o Interateneo Physics Department, Via Amendola 173, 70126 Bari, Italy
[b] Institute of Sciences of Food Production (ISPA), National Research Council (CNR), Via Amendola 122/D-O, 70126 Bari, Italy
[c] Institute of Geography and Earth Sciences, Aberystwyth University, Aberystwyth, Ceredigion SY23 2EJ, United Kingdom
[d] Chair of Biogeography, University of Bayreuth, 95440 Bayreuth, Germany
[e] Bayreuth Center of Ecology and Environmental Research, BayCEER, 95440 Bayreuth, Germany
[f] Geographical Institute Bayreuth, GIB, 95440 Bayreuth, Germany

Ailanthus altissima mapping Workflow

The workflow for Ailanthus altissima mapping results robust to be adapted to:

- different areas, asking for availability of:
  - ground truth data (training and validation) for each study area
  - 2 VHR multi-temporal images

- different invasive plant species, asking for:
  - Characterization of the invasive species (i.d., deciduous or not…)

Workflow Implementation by IJI Team

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Ismael Navas-Delgado | LW-ERIC ICT-Core UMA

BIGOWL

Expert Systems With Applications 115 (2019) 543–556

Contents lists available at ScienceDirect

Expert Systems With Applications

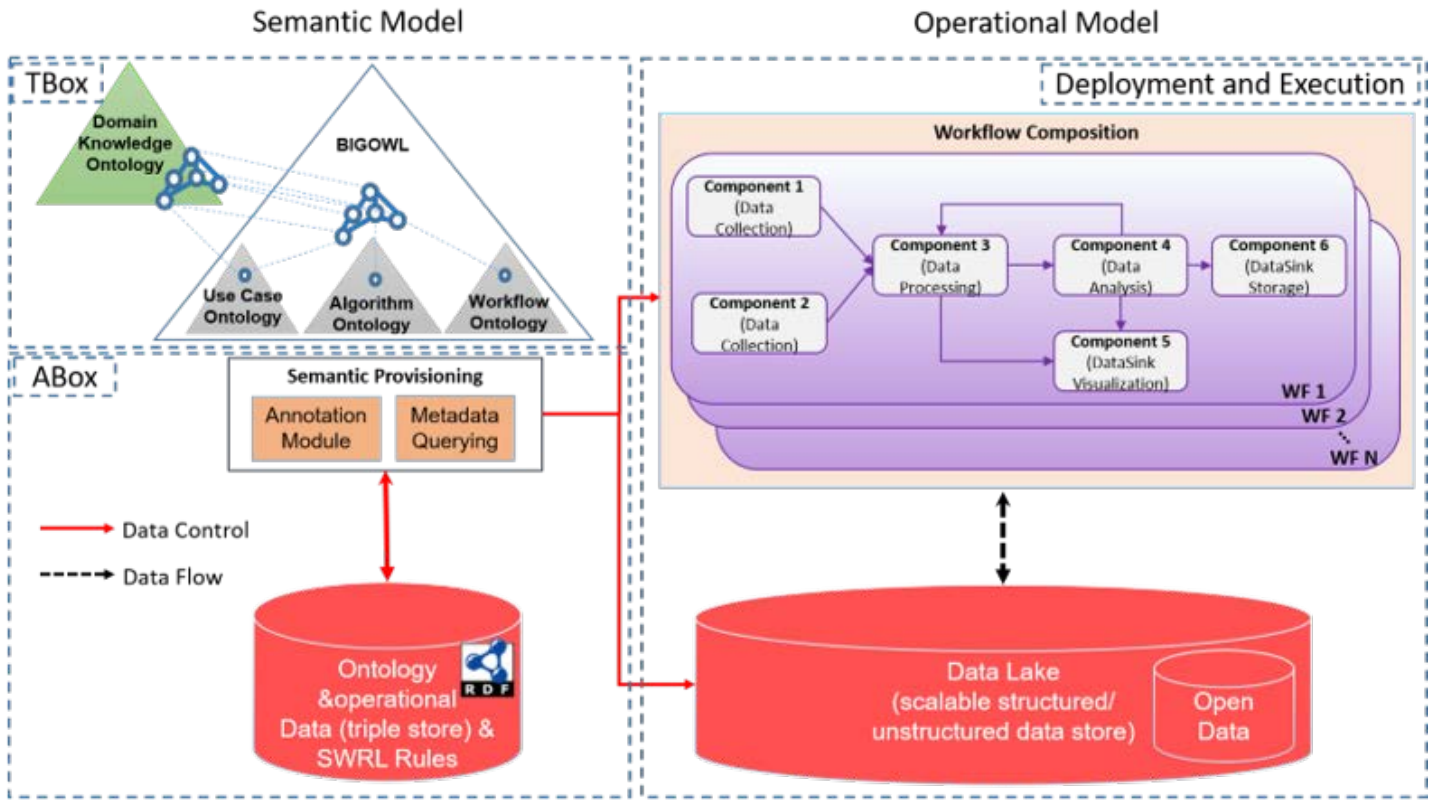
journal homepage: www.elsevier.com/locate/eswa

BIGOWL: Knowledge centered Big Data analytics☆

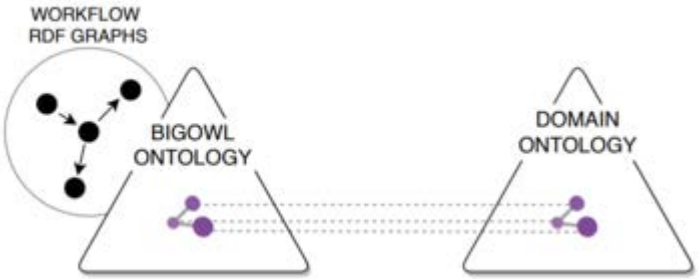
Cristóbal Barba-González, José García-Nieto*, María del Mar Roldán-García, Ismael Navas-Delgado, Antonio J. Nebro, José F. Aldana-Montes

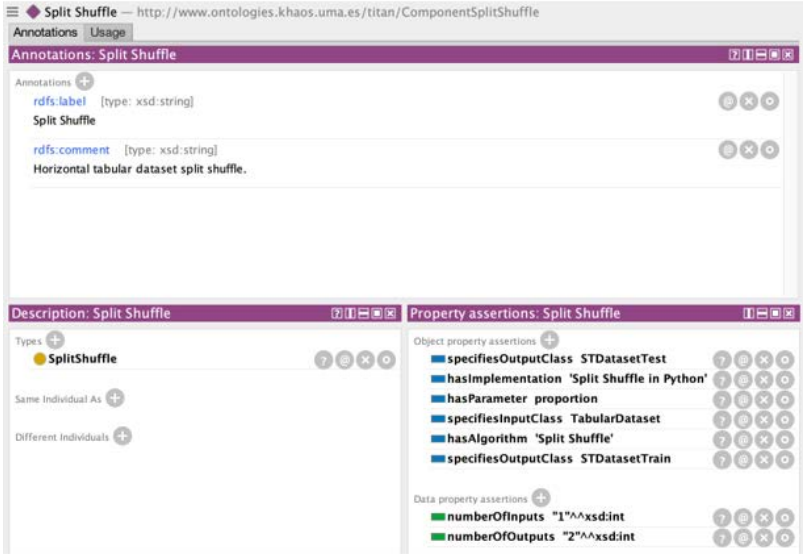
Departmento de Lenguajes y Ciencias de la Computación, University of Málaga, ETSI Informática, Campus de Teatinos, Málaga 29071, Spain

BIGOWL


Semantic Model
Operational Model
TBox
Domain Knowledge Ontology
BIGOWL
Use Case Ontology
Algorithm Ontology
Workflow Ontology
ABox
Semantic Provisioning
Annotation Module
Metadata Querying
Data Control
Data Flow
Ontology &operational Data (triple store) & SWRL Rules
RDF
Deployment and Execution
Workflow Composition
Component 1 (Data Collection)
Component 2 (Data Collection)
Component 3 (Data Processing)
Component 4 (Data Analysis)
Component 5 (DataSink Visualization)
Component 6 (DataSink Storage)
WF 1
WF 2
WF N
Data Lake (scalable structured/ unstructured data store)
Open Data

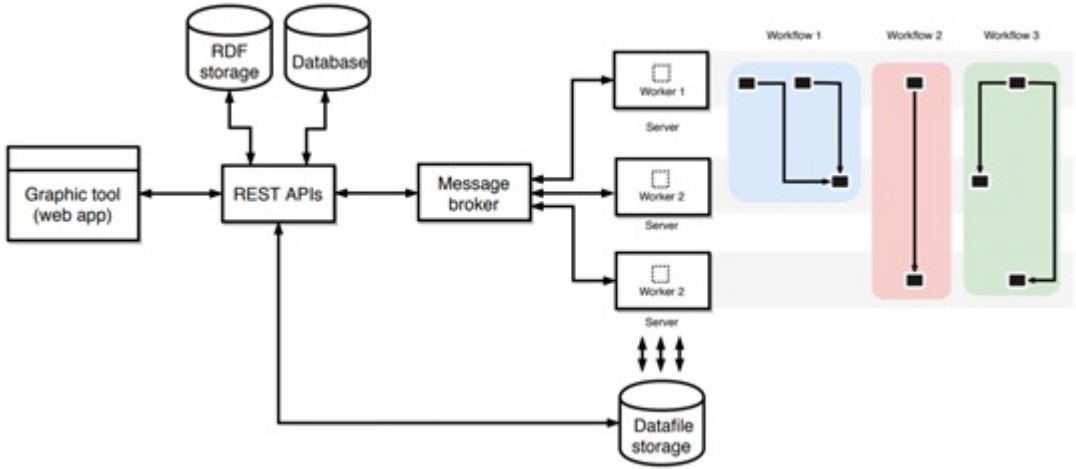
BIGOWL


WORKFLOW
RDF GRAPHS
BIGOWL
ONTOLOGY
DOMAIN
ONTOLOGY


Split Shuffle — http://www.ontologies.khaos.uma.es/titan/ComponentSplitShuffle
Annotations
Usage
Annotations: Split Shuffle
Annotations
rdfs:label [type: xsd:string]
Split Shuffle
rdfs:comment [type: xsd:string]
Horizontal tabular dataset split shuffle.
Description: Split Shuffle
Types
SplitShuffle
Same Individual As
Different Individuals
Property assertions: Split Shuffle
Object property assertions
specifiesOutputClass STDatasetTest
hasImplementation 'Split Shuffle in Python'
hasParameter proportion
specifiesInputClass TabularDataset
hasAlgorithm 'Split Shuffle'
specifiesOutputClass STDatasetTrain
Data property assertions
numberOfInputs "1"^^xsd:int
numberOfOutputs "2"^^xsd:int

TITAN

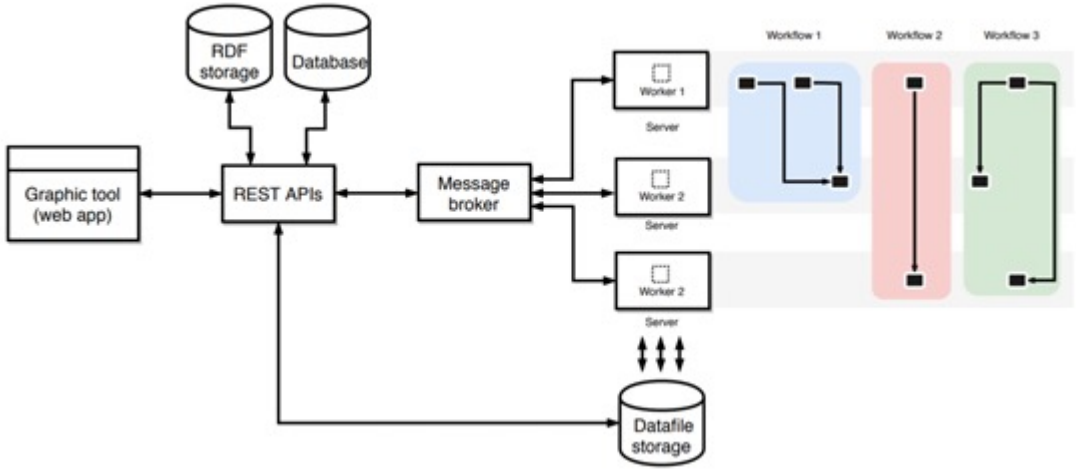
Core TITAN platform's architecture is composed of a **Graphical user interface**, a **REST API** and an **orchestrator** for executing the workflows.



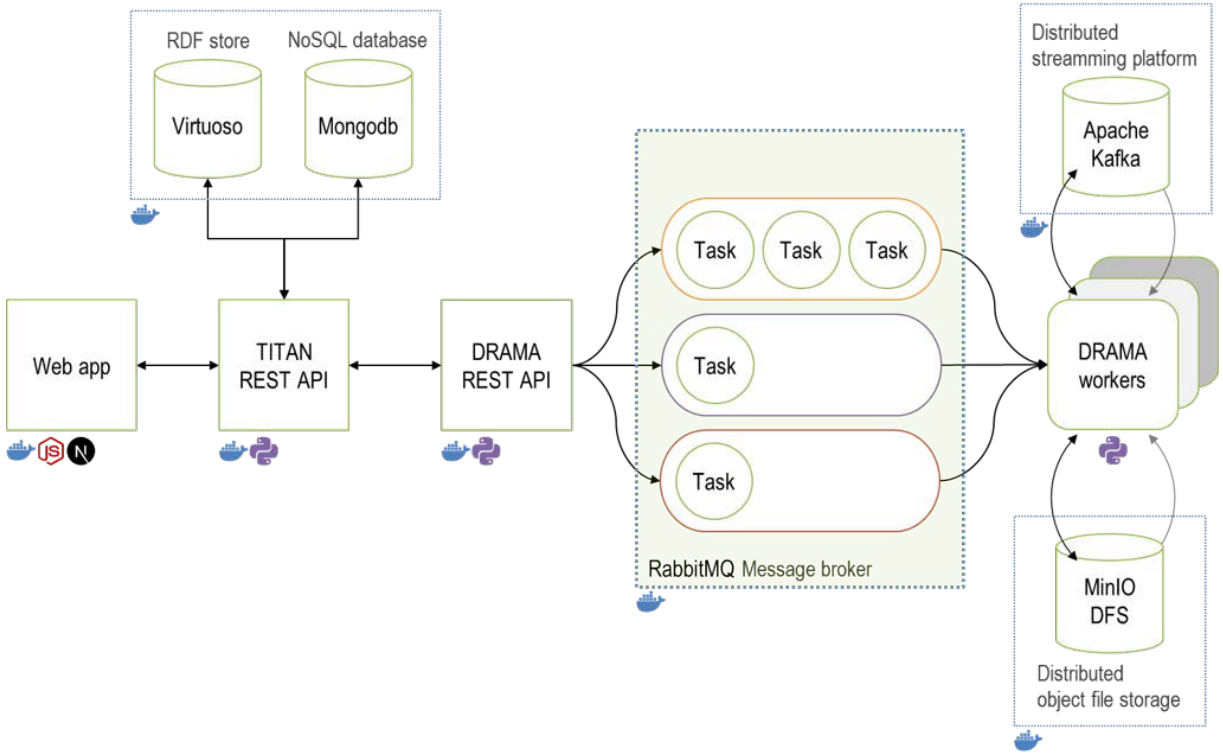
TITAN: A knowledge-based platform for Big Data workflow management. Knowledge-Based Systems. Under Review.

TITAN

The REST API requires **RDF storage** and **database** solutions for data persistence. Besides, workflow executors also depend on remote data file storage for storing component's outputs. Finally, a **message broker (Kafka)** is used for distributing messages between the components



LifeWatch ERIC Tesseract



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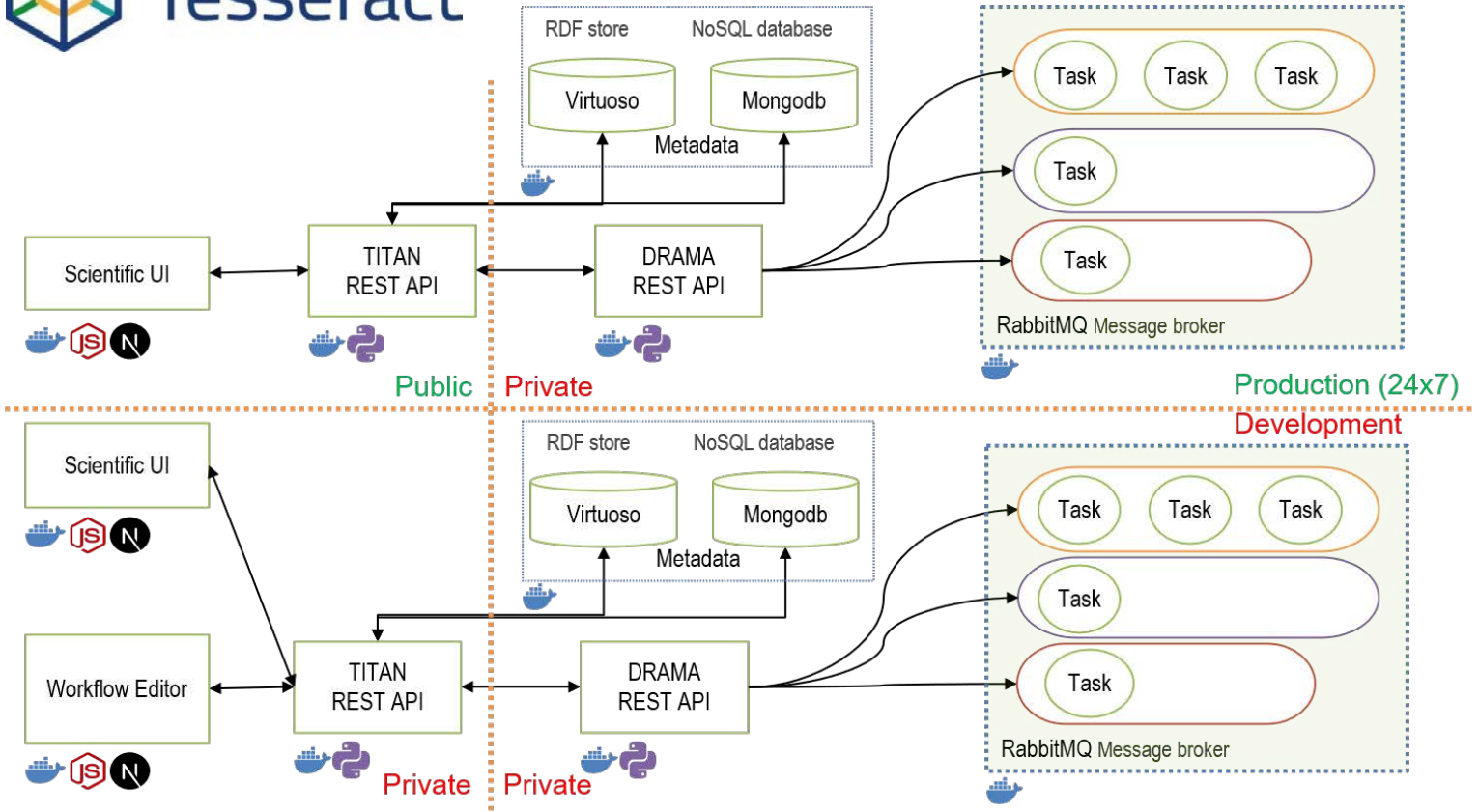

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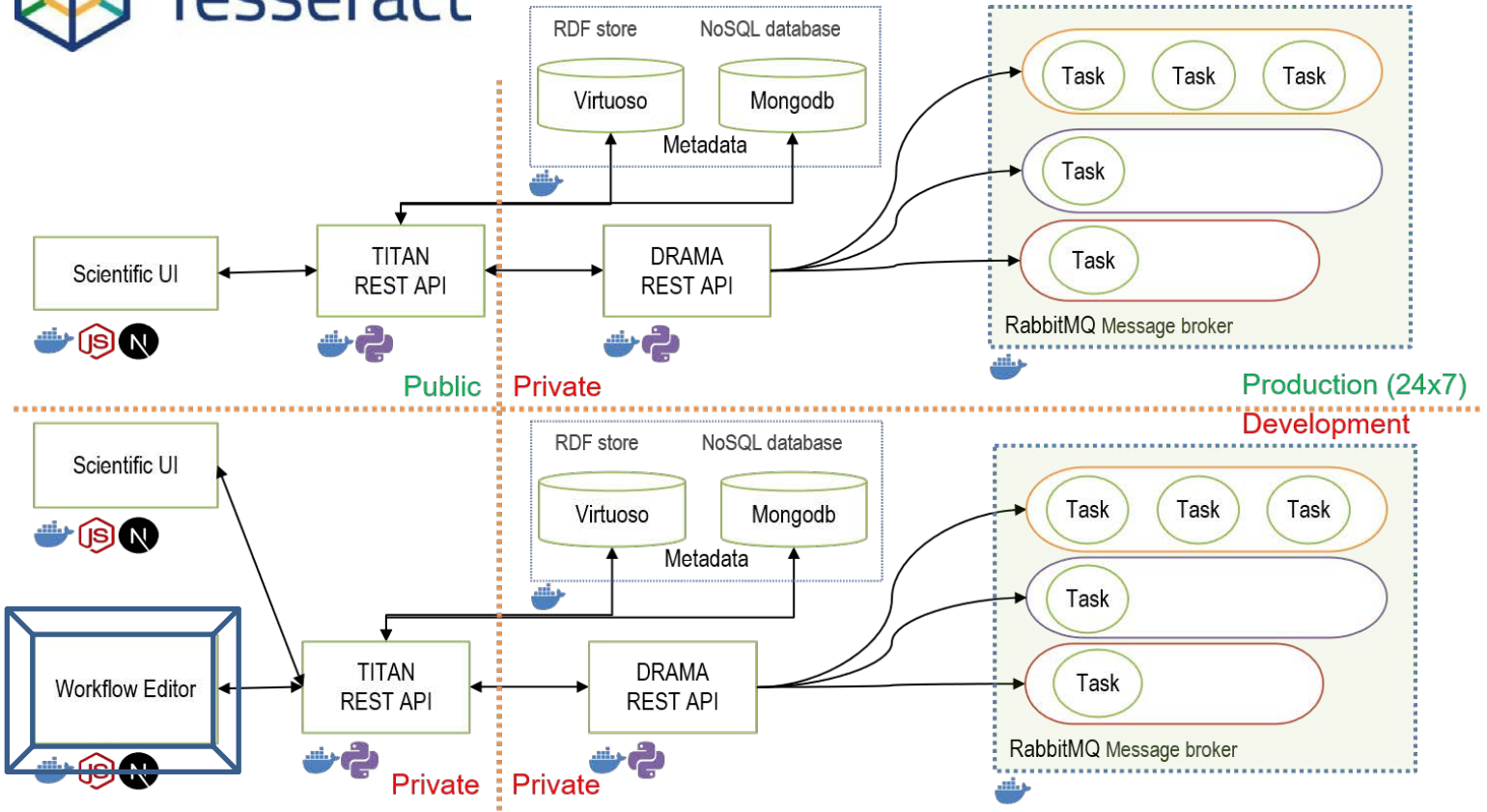


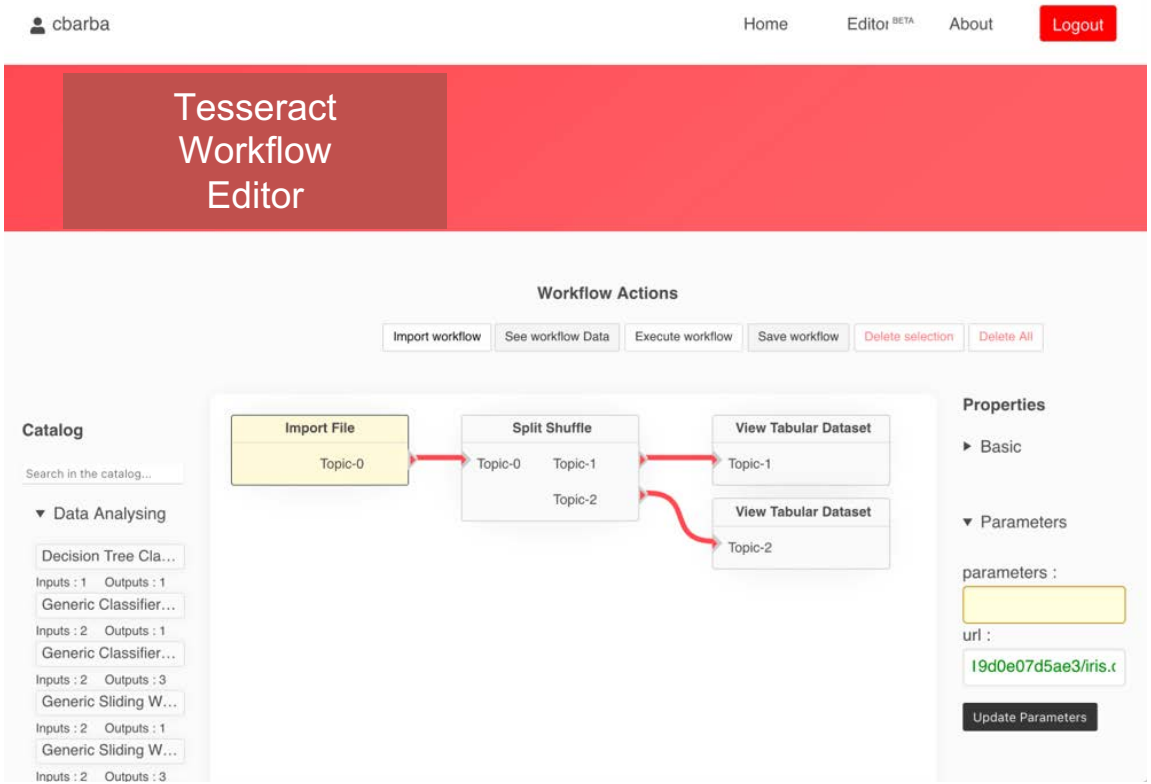
LifeWatch ERIC Tesseract

DESIGN

TESTING

DEPLOYMENT

Tesseract Workflow Editor



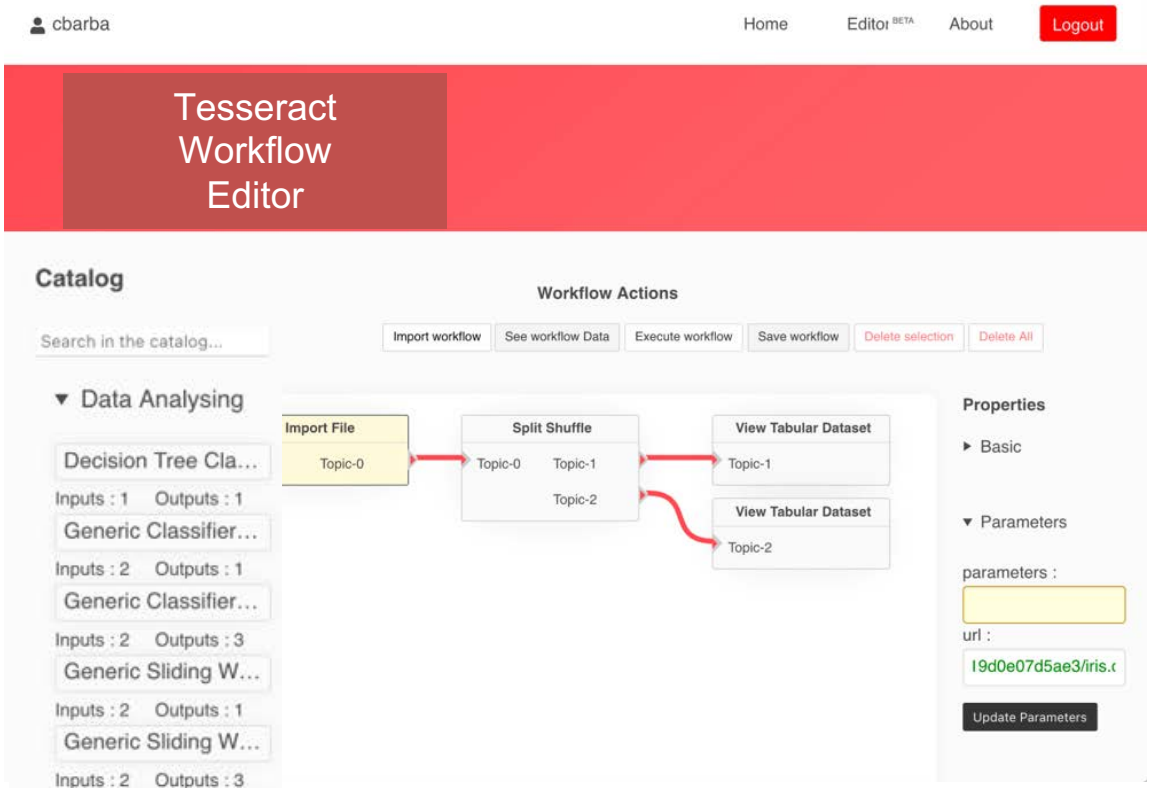
LifeWatch ERIC Tesseract

DESIGN

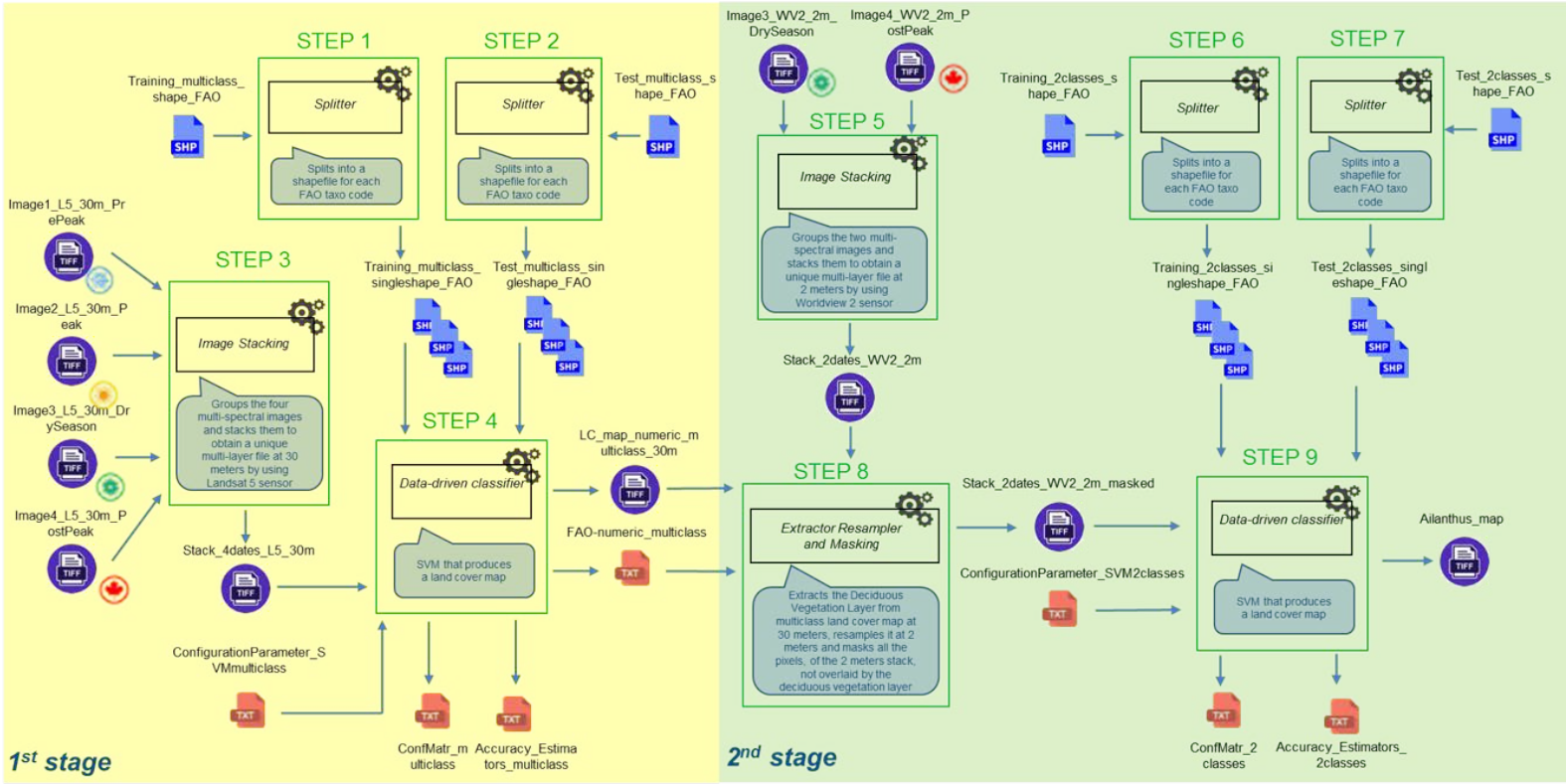
TESTING

DEPLOYMENT

Tesseract Workflow Editor



AILANTHUS Workflow



AILANTHUS Workflow

Component	Type	Script
Import File	Data Ingestion	Python
Image Stacking	Data Transform	R
Splitter	Data Transform	Python
SVM Classifier	Data Analysis	R
Extractor Resamper Masking	Data Processing	R
Extractor	Data Processing	R

AILANTHUS Workflow

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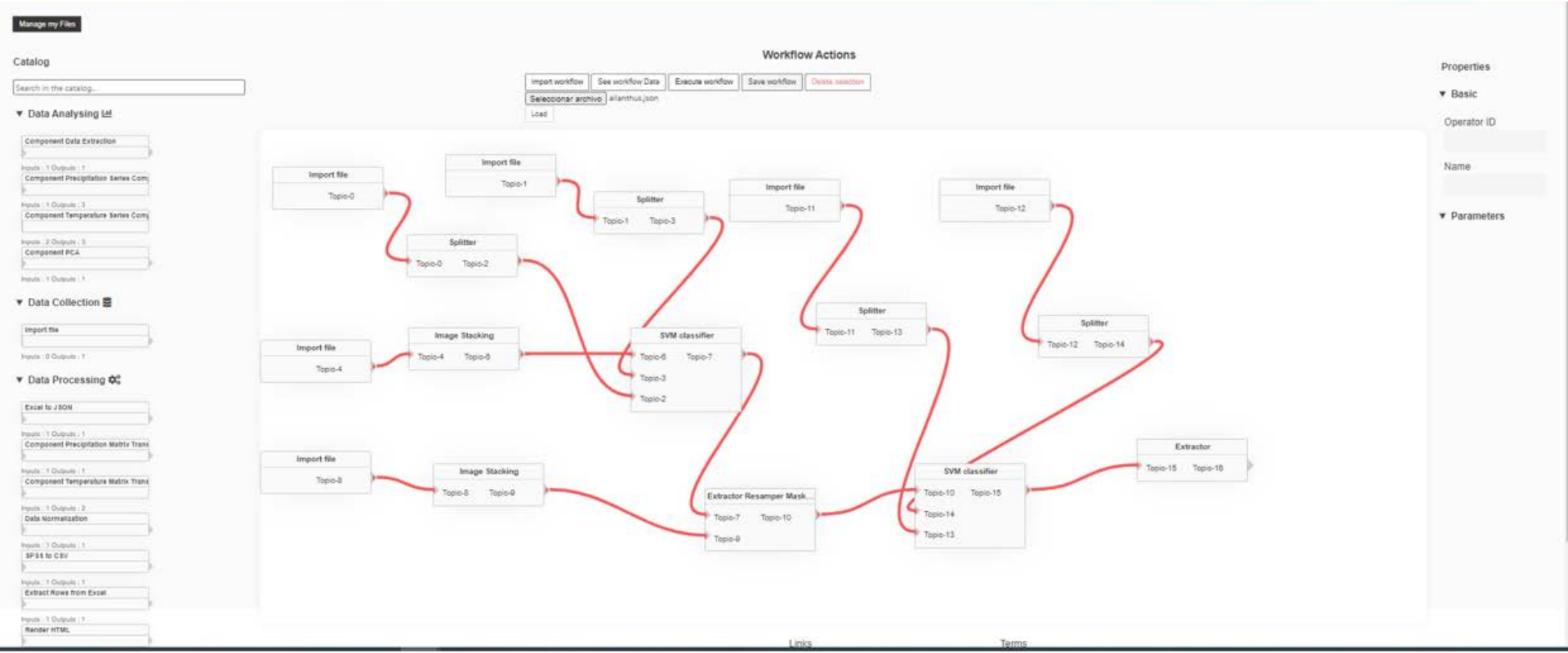
Splitter	Data Transform	Python
SVM Classifier	Data Analysis	R
Extractor Resamper Masking	Data Processing	R
Extractor	Data Processing	R

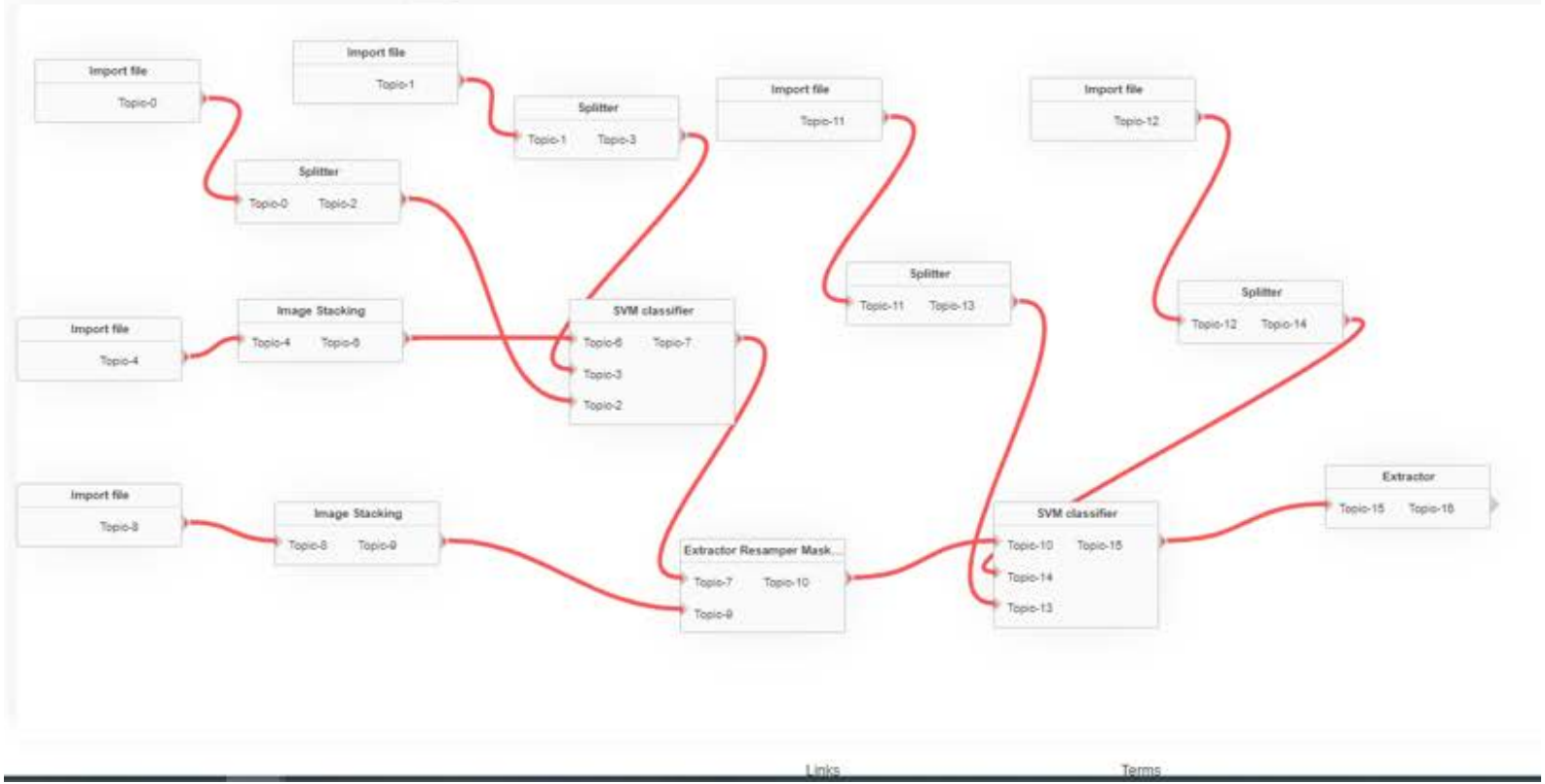
AILANTHUS Workflow

Full catalog of components that could be reused in new VREs

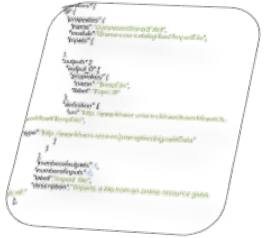
AILANTHUS Workflow



AILANTHUS Workflow

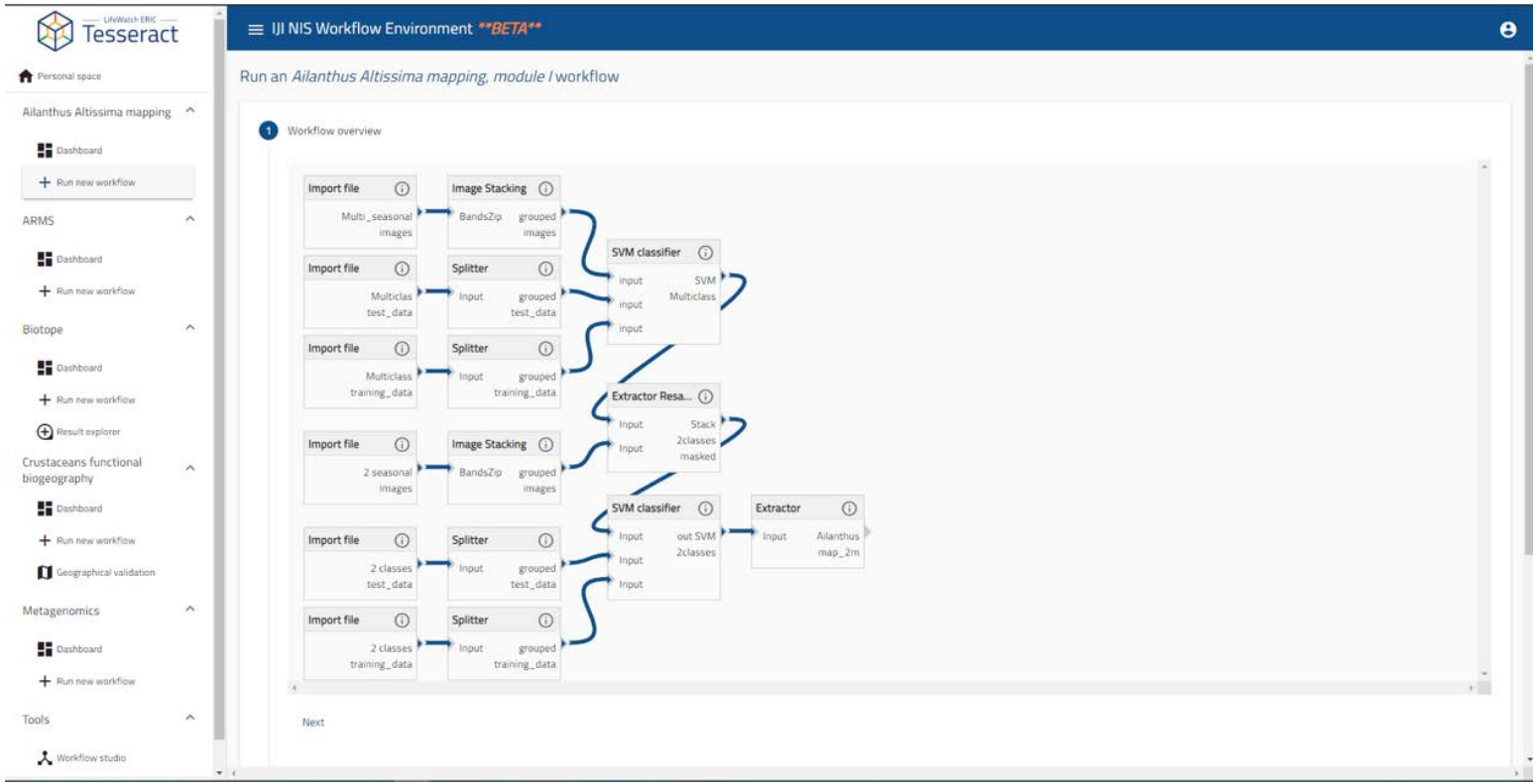


AILANTHUS Workflow

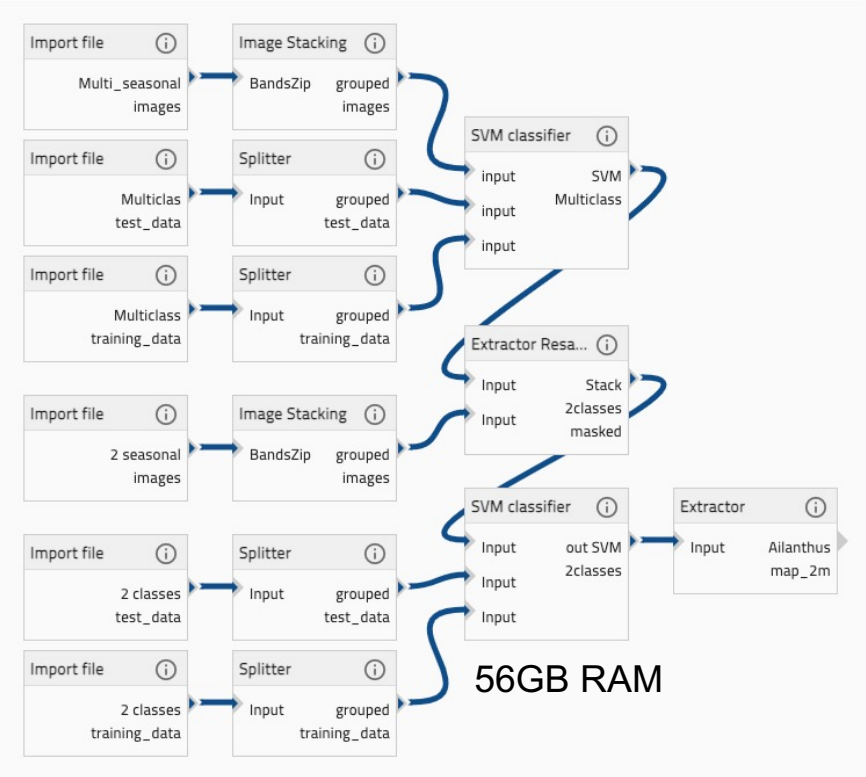


{JSON}

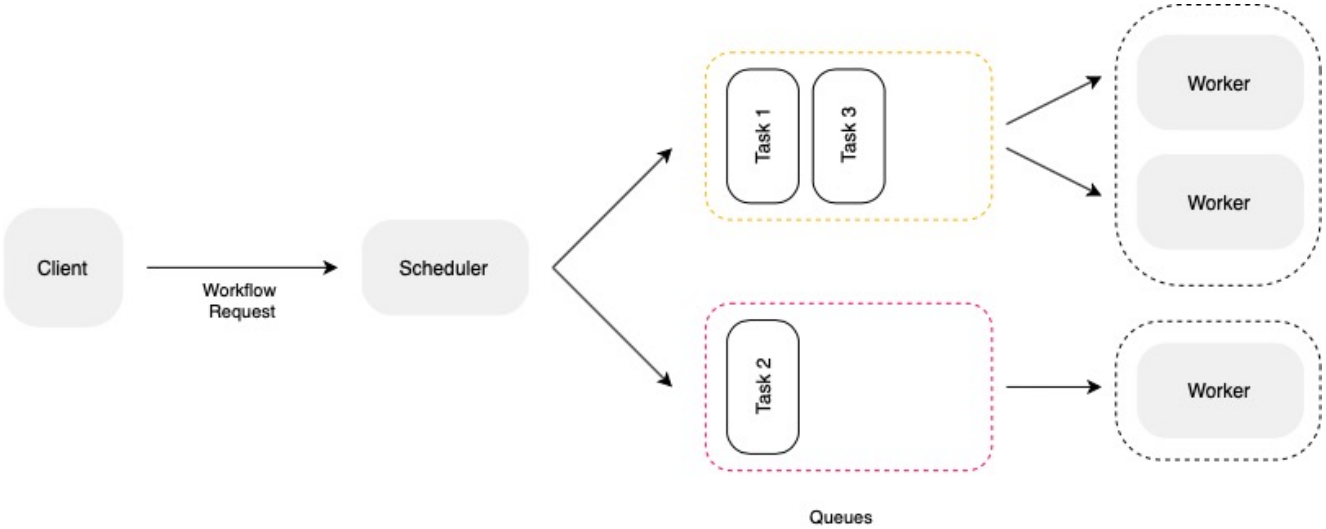
AILANTHUS Workflow



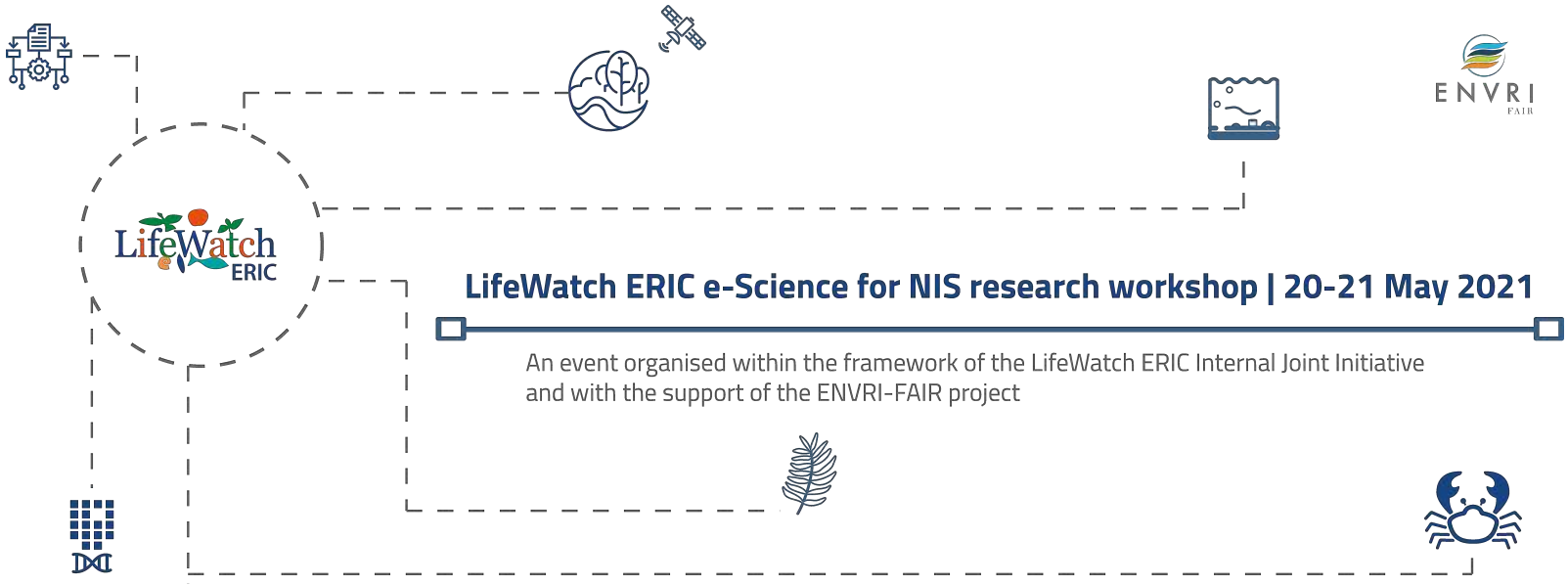
AILANTHUS Workflow



AILANTHUS Workflow



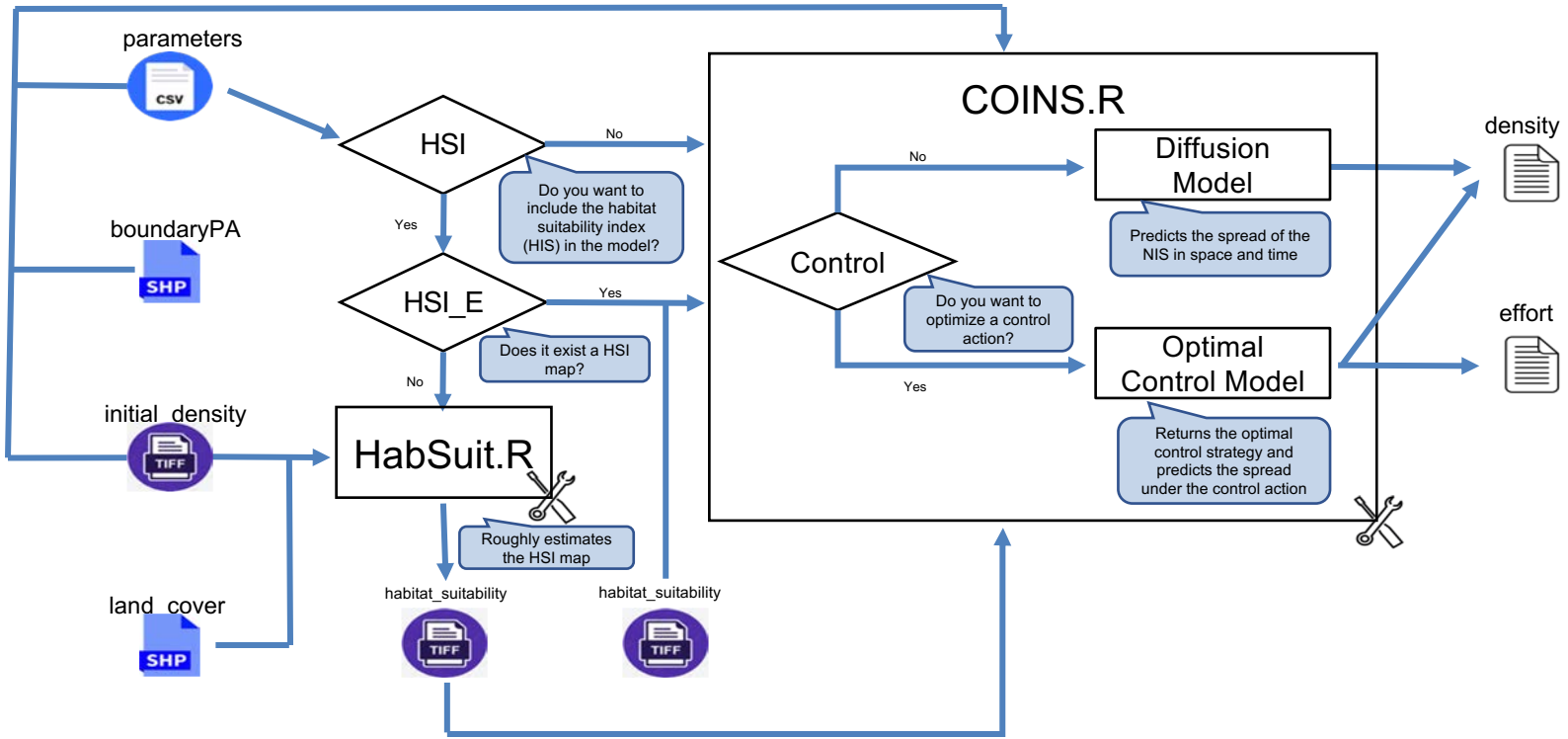
TITAN's scheduler manages the queues in order to control the number of task in a queue. In this case, we have configured TITAN for checking if the next task is "SVM-Classifier-2", which requires an enormous amount of RAM memory, and thus, that component is executed in exclusivity in a worker.



A step forward: modeling Ailanthus diffusion and optimizing control actions

Angela Martiradonna
Department of Mathematics, University of Bari, Italy
Institute for Applied Mathematics (IAC) – CNR, Bari, Italy

Optimal control model workflow (module II)



The model

Habitat suitability

$$\frac{\partial n}{\partial t}(\boldsymbol{x},t) = D\Delta n(\boldsymbol{x},t) + r\, n(\boldsymbol{x},t)\left(\rho(\boldsymbol{x}) - \frac{n(\boldsymbol{x},t)}{k}\right) - \frac{\mu\, n(\boldsymbol{x},t)\, E(\boldsymbol{x},t)}{1 + h\,\mu\, n(\boldsymbol{x},t)}$$

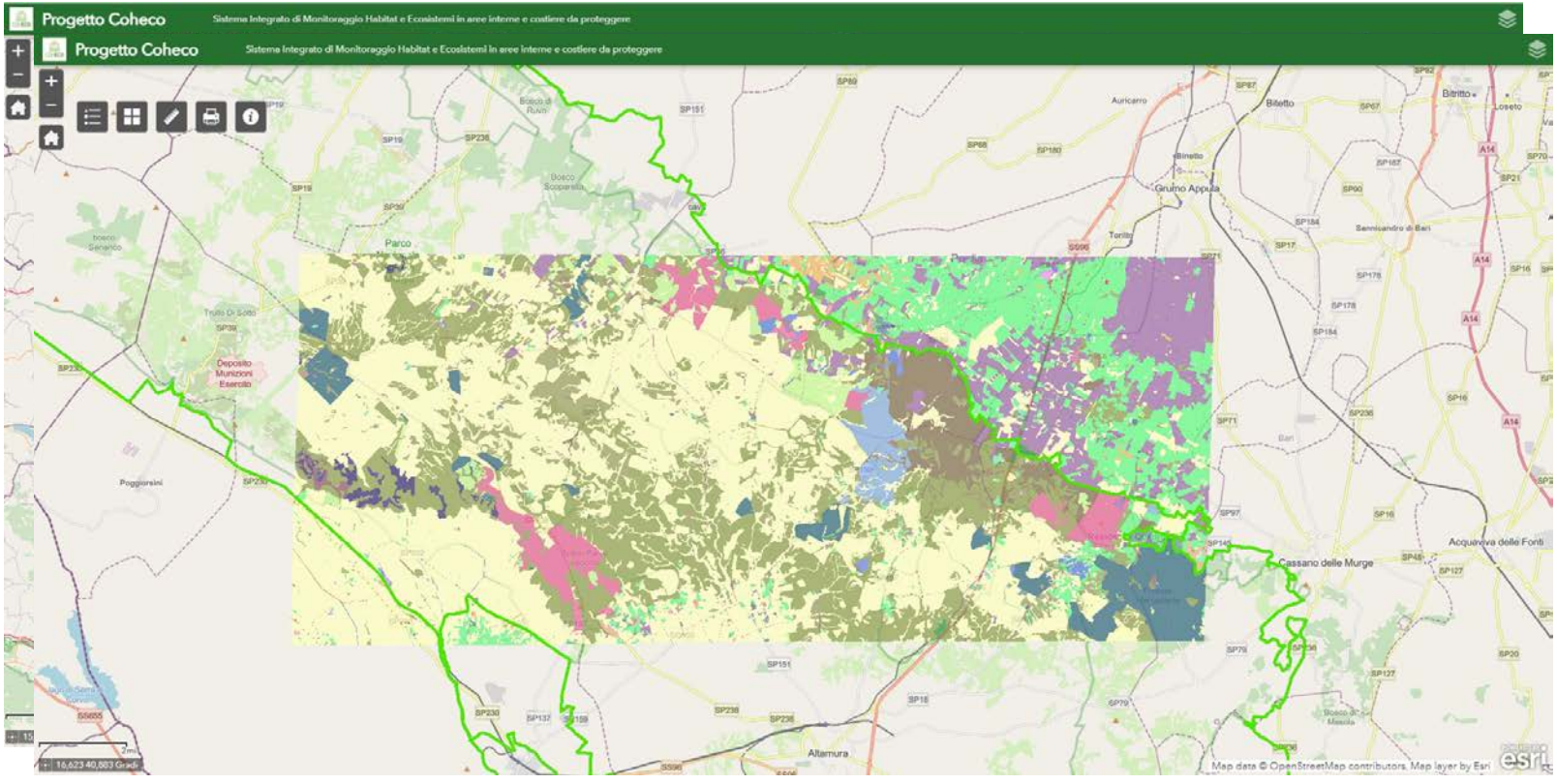
$$n(\boldsymbol{x},t) = n_0(\boldsymbol{x}), \qquad \boldsymbol{x} \in \Omega, \qquad \nabla n \cdot \hat{\boldsymbol{n}} = 0\,, \qquad on\ \partial\Omega\times[0,T]$$

Initial density

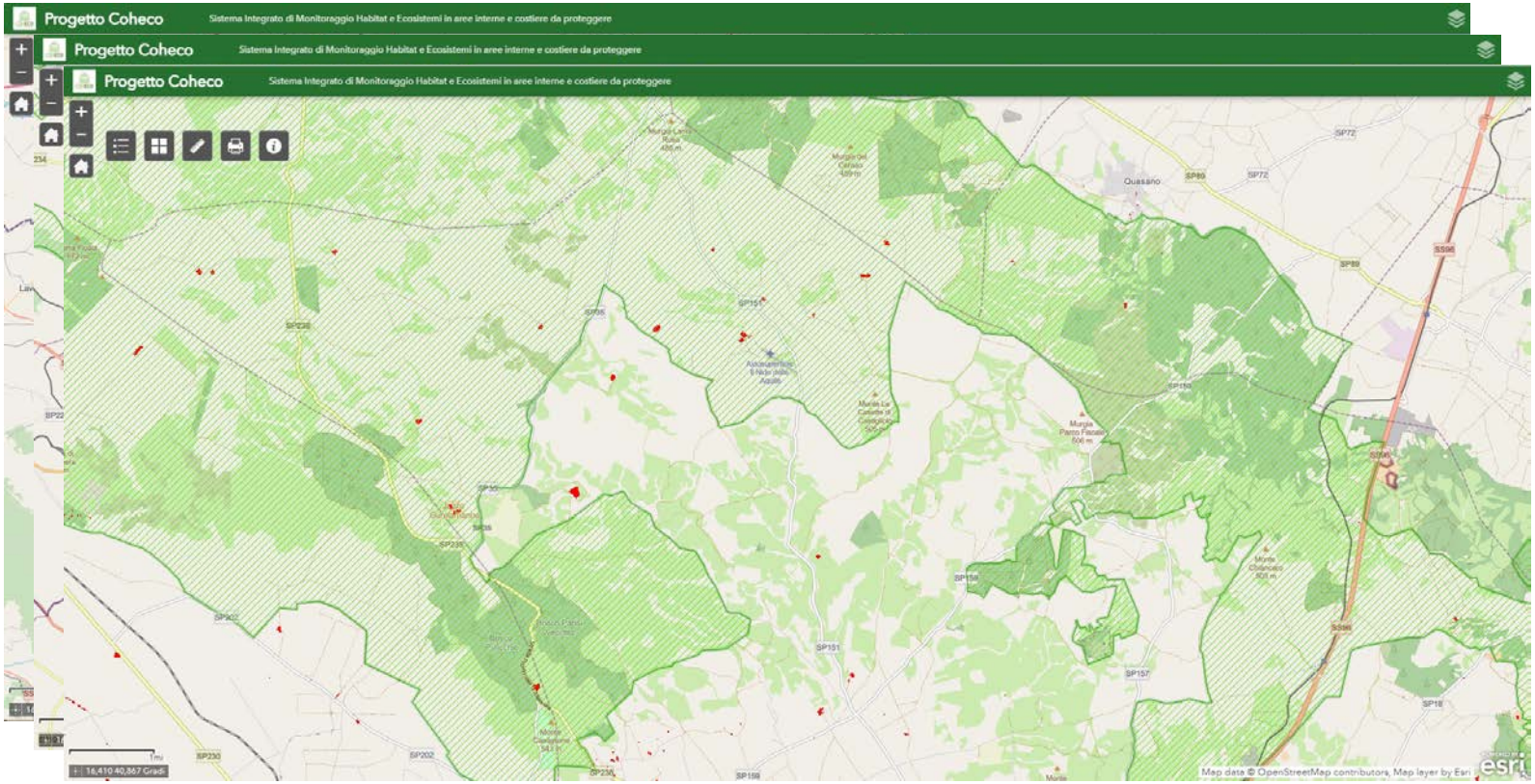
$$J(E) = \int_{\Omega} e^{-\delta T}\, v(\boldsymbol{x})\, n(\boldsymbol{x},T)\, d\boldsymbol{x} + \int_{\Omega\times[0,T]} e^{-\delta t}\,(E^2 + \omega\, n)\, d\boldsymbol{x}\, dt + \beta \int_{\Omega\times[0,T]} e^{-\delta t}\left(\frac{E}{B}\right)^3 d\boldsymbol{x}\, dt$$

$$U = \{E \in L^{\infty}(\Omega\times[0,T]):\ 0 \le E \le B\}$$

Habitat suitability map



Diffusion maps



Thanks!

cristina.tarantino@iia.cnr.it
ismael.navas@lifewatch.eu
a.martiradonna@ba.iac.cnr.it