Finder©

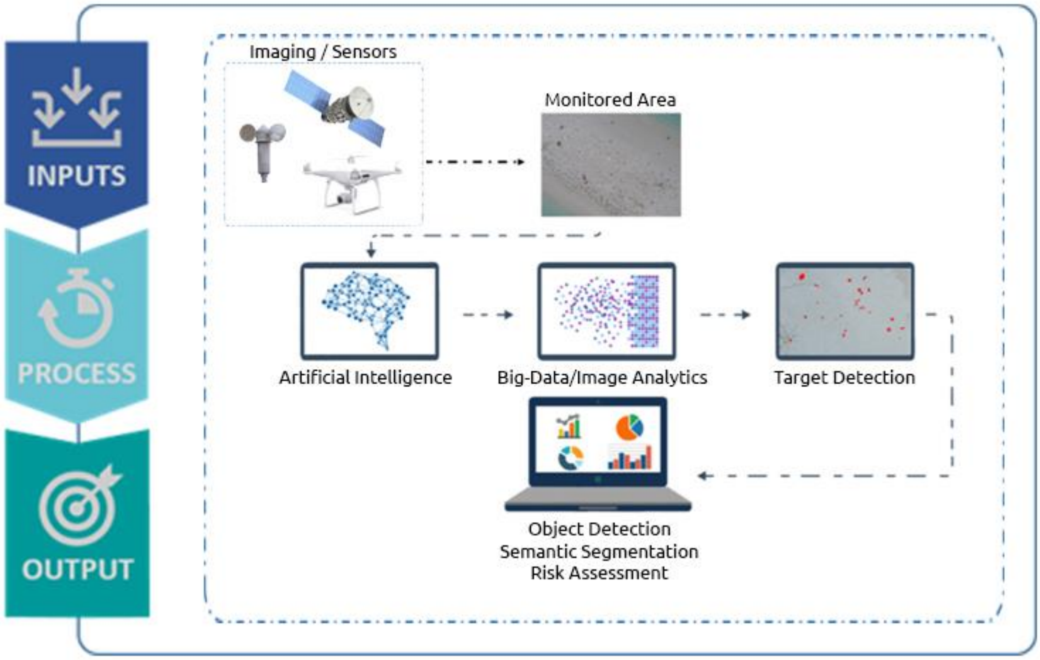
Deep Trace
TECHNOLOGIES

Finder© is a DeepTrace-Technologies proprietary-software platform of Big Data/Image analytics and Artificial Intelligence (AI) for statistical analysis and AI-modeling of environmental data, based on remote-sensing images integrated with other data (e.g. in situ) impacting on environmental conditions. Finder© is based on open-access and proprietary software allowing:

1- Preprocessing (big-data/image analytics and storage)
2- Statistical Analysis and Modeling (development of AI customizable-models and prototypes to track and predict various environmental impacts)
3- Use an existing model (using an existing AI model)
4- Data visualization of outcomes

The treatment of aggregated data and images can support the decision- and knowledge-management processes in the environmental-heritage field. Highly specialized algorithms based on Machine Learning, Deep Learning, Transfer Learning, Big Data Analytics and Mining, Image Processing, Image Analytics and Mining, and Texture Analysis are offered to end users in a user-friendly, robust and explainable modality, following a simple workflow.

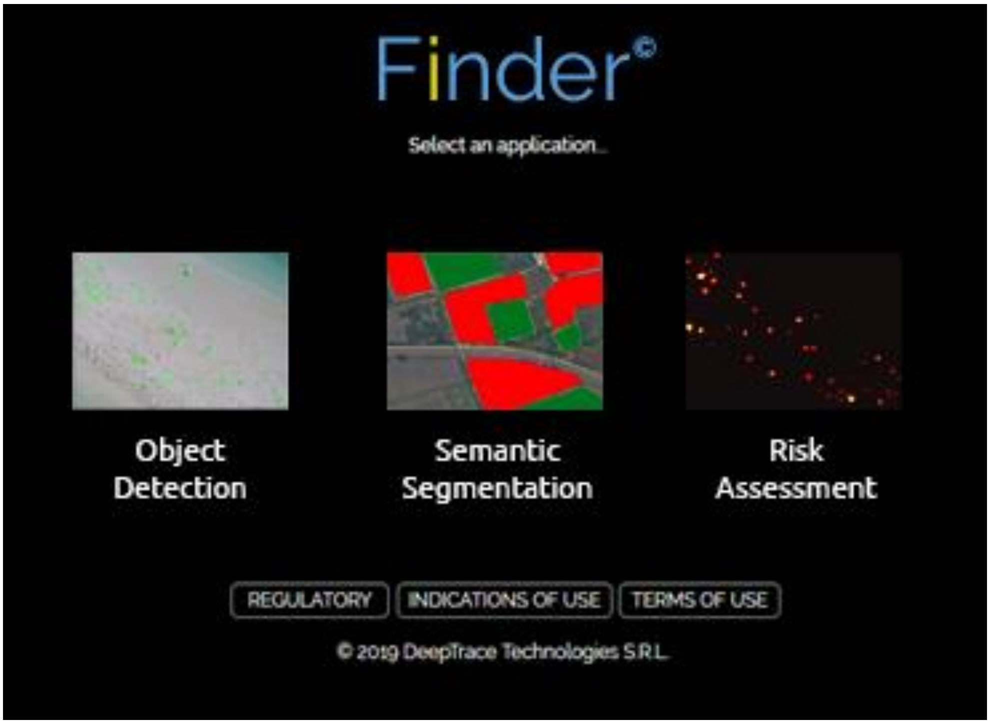
In this way, Finder© Platform offers an integrated data-driven and domain-specific decision-support tool almost in real time.



INDICATIONS OF USE

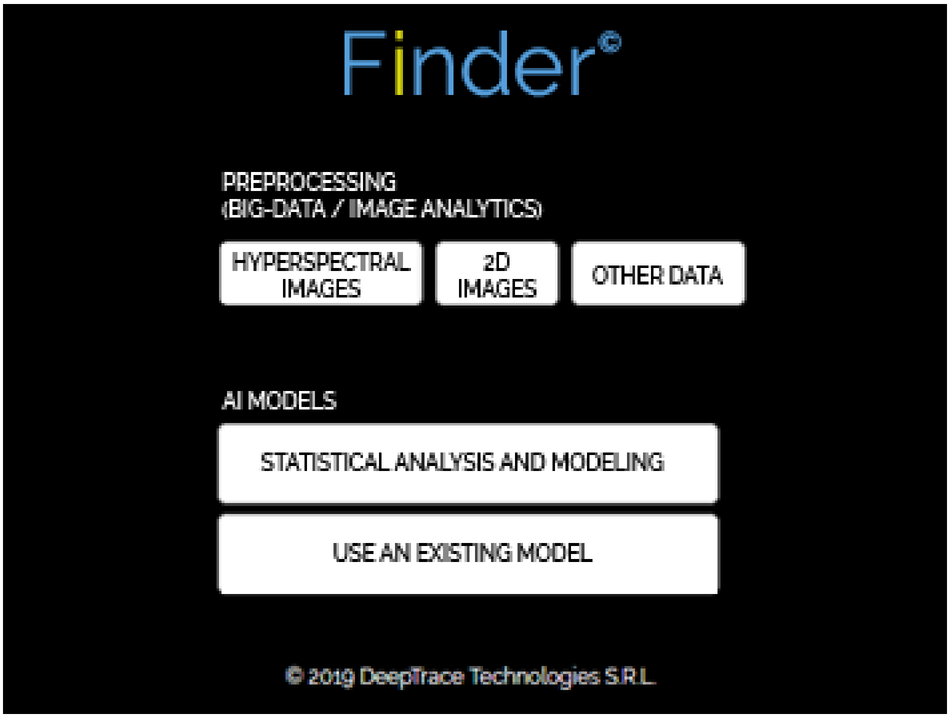
The Finder© Platform is intended for being used by specialized operators in the environmental-heritage sector (e.g. satellite or UAV manufacturers), as well as end users from related sectors (e.g. agricultural industries, land and water management, climate monitoring). They can use Finder© for displaying, processing, classifying, archiving, printing, reporting aggregated environmental data, including remote-sensing images from satellites or Unmanned Aerial Vehicles (UAVs) or in-situ data collected through specific technologies (e.g. sensors).

The Finder© Platform can be deployed on dedicated machines or workstations (on-premises solution, as stand-alone application on Microsoft Windows operating systems) or in a server-client configuration (software-as-a-service solution).



TECHNICAL DESCRIPTION

Data obtained from remote-sensing acquisition techniques such as satellites or UAVs, and in-situ specific technologies (e.g. sensors) can be aggregated using feature extraction methods, optionally using regions of interest defined by the user, in order to depict, localize, and/or quantify the heterogeneity and morphology/morphometry in environmental structures or regions (at different space resolution) for research and statistics purposes.



OBJECT DETECTION AND SEMANTIC SEGMENTATION

The “Object Detection” application option enables classification, detection, quantification, archiving and displaying on imaging maps of objects of interest defined by the user’s needs.

The “Semantic Segmentation” application option enables the labelling of every pixel in an image followed by quantification and displaying on imaging maps of every class of interest defined by the user’s needs.

Features extracted from images are quantitative measures dependent on the heterogeneity and morphology of structures in the considered region. Features can be extracted through fully-automated techniques (aiming at maximizing/minimizing variables in the set of samples) as well as through predefined techniques such as texture analysis, resulting in more explainable features expressed in terms of Morphology, Morphometry Intensity-based Statistics, Intensity Histogram, Gray-Level Co-occurrence Matrix (GLCM), Gray-Level Run Length Matrix (GLRLM), Gray-Level Size Zone Matrix (GLSZM), Neighborhood Gray Tone Difference Matrix (NGTDM), Gray-Level Distance Zone Matrix (GLDZM), Neighboring Gray Level Dependence Matrix (NGLDM).

Starting from extracted features, different systems of machine-learning classifiers and models can be trained, validated, and tested as multivariate models for detection, classification and prediction tasks, even at the voxel level for segmentation purposes. These classifiers include machine-learning and deep-learning classifiers (for which the feature-extraction phase is completely embedded in the training-and-validation process, see page 7 of this technical sheet).

RISK ASSESSMENT

The use of the "Risk Assessment" application-option enables statistical multivariate analysis on features extracted from aggregated data (data and/or images) using the best machine learning system for the task of interest defined by the user (e.g. image/data from group 1 vs image/data from group 2). The use of this option may support in the detection and quantification of regional heterogeneity and morphology which can be associated with environmental impact, thus serving as a *risk-assessment* tool to track and predict various environmental impacts.

Different systems of machine-learning classifiers can be trained, validated, and tested as multivariate models for binary-classification or prediction tasks (e.g. data and images from group 1 vs group 2, based on the supervised training by the user), reducing the most stable and reproducible features to not-redundant features, in a number of degrees of freedom appropriate with respect to the number of collected samples (approximately 1 feature every 10 samples). One of the machine-learning system is an ensemble of hundreds of Decision Trees combined with the majority-vote rule; another machine-learning system is an ensemble of hundreds of Support Vector Machines combined with Principal Components Analysis and Fisher Discriminant Ratio with majority-vote rule.
For each system, nested K-fold cross validation method is used.
The performances of the different classification systems are measured across the different k folds in terms of maximum and mean Accuracy, Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and AUC (with standard deviation, confidence interval and statistical significance of each metric).
The classification system with the best performance is selected as the best classification system for the binary-task of interest. The best predictors (more stable, reproducible, not redundant and accurate in the classification task) are obtained as an intermediate output of the AI-modelling process.

DEEP-LEARNING MODELING

Deep-Learning Modeling application-option enables 1) training deep-learning classifiers based on features learnt from images belonging to different classes of interest, 2) classifying new images based on deep-learning models previously trained on the Platform.

Deep-learning models can be trained, validated, and tested for both binary and multiple-classification tasks, based on the supervised training performed by the user.

Deep-learning architectures adopted for image analysis are based on convolutional neural-networks (CNNs) composed of many layers whose aim is to learn a rich feature-representation of the input classes, and to use this representation to classify new images as belonging to one of the input classes.

Deep-learning architectures can also be obtained by pre-trained open-access CNNs and fine-tuned (Transfer Learning) in their last layers for the task of interest.

In order to increase environmental-image diversity among different training phases (epochs), automatic data-augmentation techniques (including image rotation, shear and reflection) are applied to the images during the training of the classifier.

The performance of the deep-learning classifiers are performed across different folds when a cross-validation approach is adopted, in terms of maximum and mean Accuracy, Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NNPV), and Receiver-Operating Characteristics-Area under the Curve ROC-AUC (with standard deviation, confidence interval and statistical significance of each metric).

TERMS OF USE AGREEMENT

Acceptance of Agreement.
The user agrees to the terms and conditions outlined in this Terms of Use Agreement ("Agreement") with respect to the software suite “Finder©" created by DeepTrace Technologies S.R.L. (the "software”).
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