EARSeL | EUROPEAN ASSOCIATION OF REMOTE SENSING LABORATORIES

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EO for Cultural and Natural Heritage Workshop 2024

15-16 October 2024 | ESA/ESRIN

ARCHAELOGY AND EO IN THE ERA OF AI

Challenges, opportunities and the way forward

iit @Ca'Foscari ISTITUTO ITALIANO DI TECNOLOGIA CENTER FOR CULTURAL HERITAGE TECHNOLOGY

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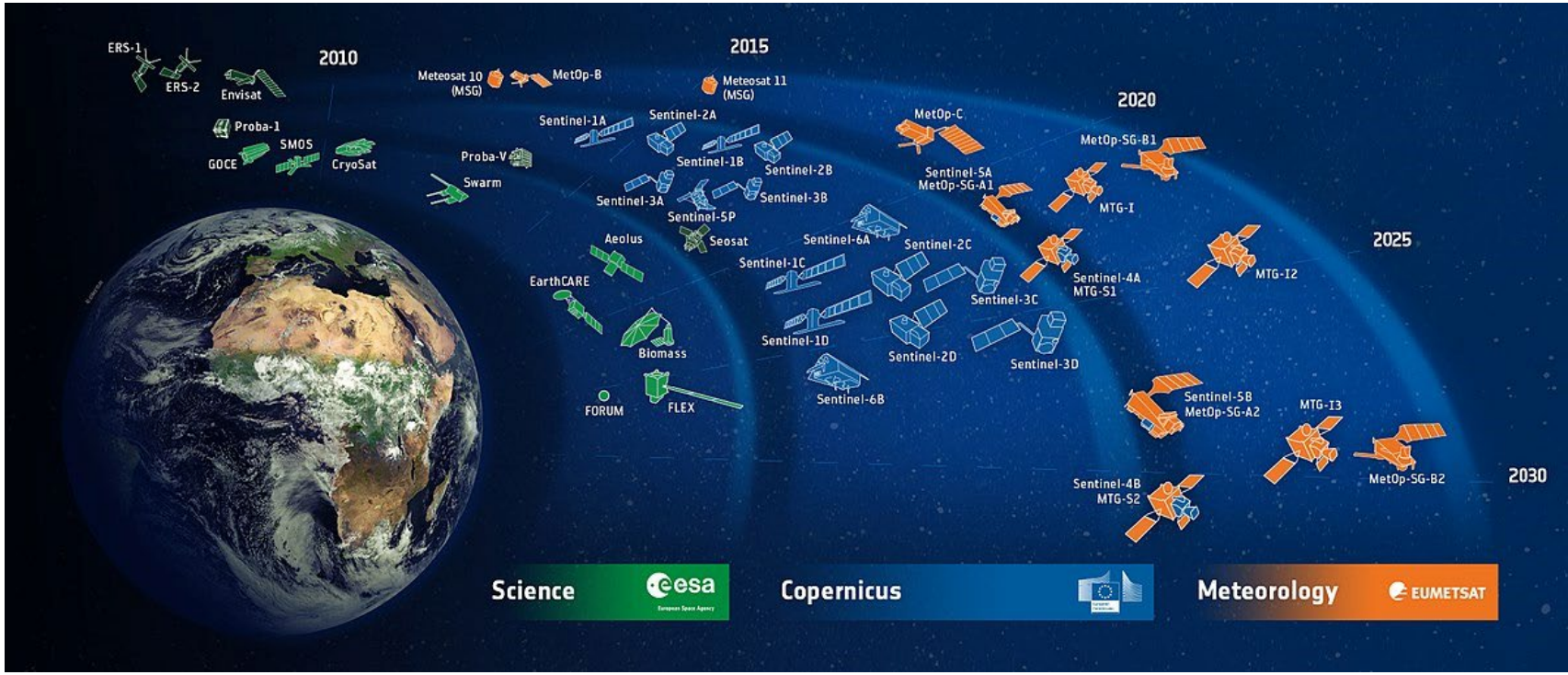
EO data availability

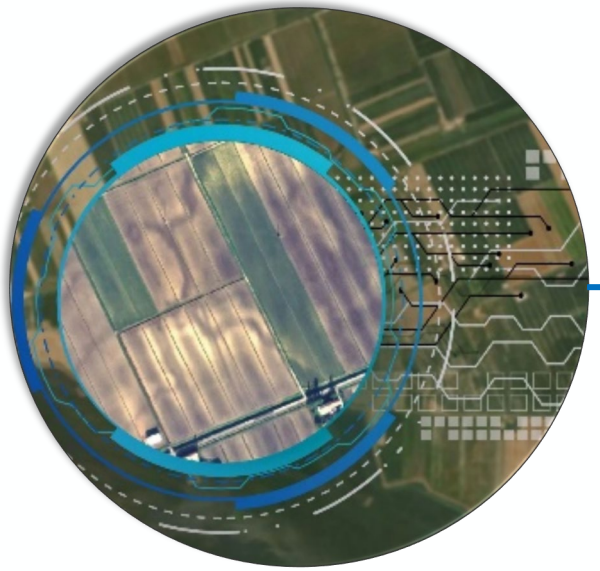
- Increase in Earth Observation missions
- Copernicus Data Space Ecosystem hosting 34 petabytes of Earth Observation data (2023)
- Earthdata Cloud: more than 59 petabytes of data (2021). This amount is expected to increase to more than 250 PB in 2025.



Value of data: ability to extract relevant information

The role of Artificial Intelligence

Artificial Intelligence can be used at various stages of EO data lifecycle:



Data preprocessing

Improve the quality of RS products

- De-noising
- Pansharpening
- Atmospheric correction
- …….

Analysis

Reduce costs and time of analysis

Process larger quantities of data

Extracting information from “complex” and integrate data

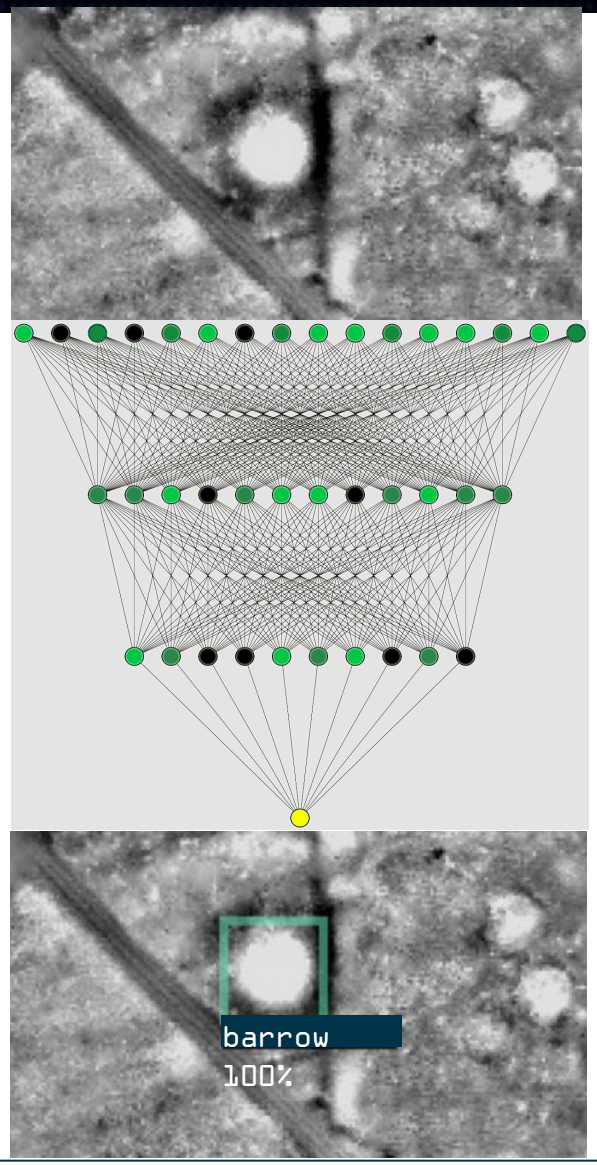
- Reduce loss of information
- Rapid response to risks and damages
- Scalability for global applications
- Temporal analysis over extended periods
- *…and more!*

Data preprocessing: approaches

- AI can enhance the image improvement process by automating procedures based on the data contained within the images themselves.
- Pansharpening techniques to enhance spatial resolution while preserving spectral information.
- This advancement opens up opportunities in the realm of hyperspectral imaging.

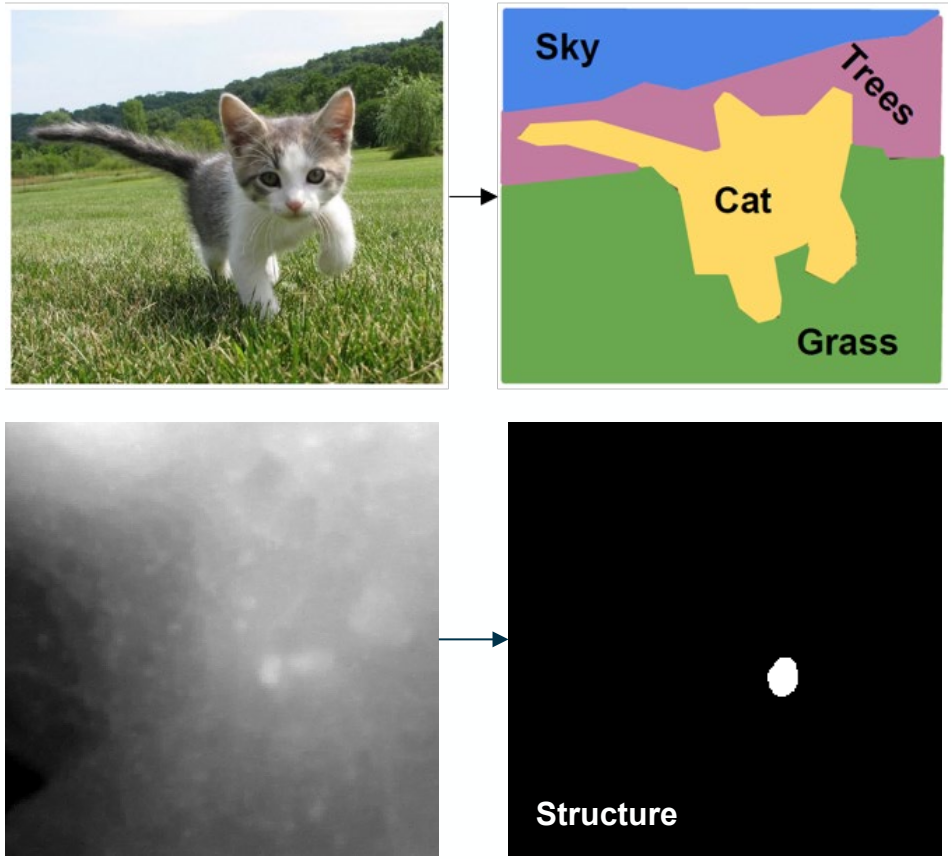
Analysis: approaches

- Automation in analysis techniques can leverage various approaches
- **Object detection** and **semantic segmentation** methods are used for detection of subsoil archaeological sites
- **Change detection** is useful for monitoring cultural heritage sites
  - above-ground archaeological sites
  - subsoil archaeological sites



Challenges in applying AI to RS

- Labeling the datasets for training AI models is labor-intensive and time consuming, especially for fine-grained or multi-class tasks
- Many datasets are available but often lack specificity for remote sensing applications: need for training datasets specific for remote sensing
- Effective training data must be diverse and representative, accounting for various geographic locations, seasonal variations and environmental conditions
- Reliable datasets requires the expertise of domain specialists.

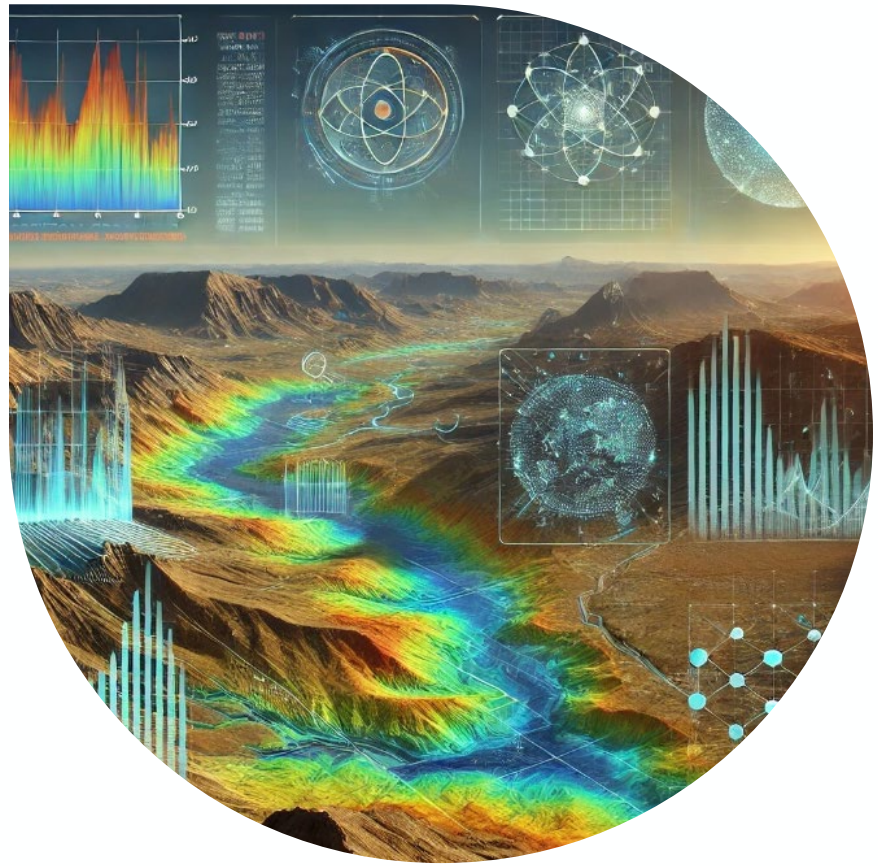


Training datasets

Challenges in applying AI to RS

- Black-box models can make it difficult to understand the reasons behind AI predictions
- Applying AI models trained on a specific dataset to perform well on other datasets require additional resources
- High computational and training resources for AI algorithms.

Computational aspects



Challenges in applying AI to RS

- Access to imagery subject to commercial licenses poses a significant challenge: difficult to obtain large volumes of images necessary for model training.
- temporal coverage of available imagery is often limited: unsuitable for tasks that require more frequent observations
- spatial resolution may not meet the requirements for specific applications.

Practicalities

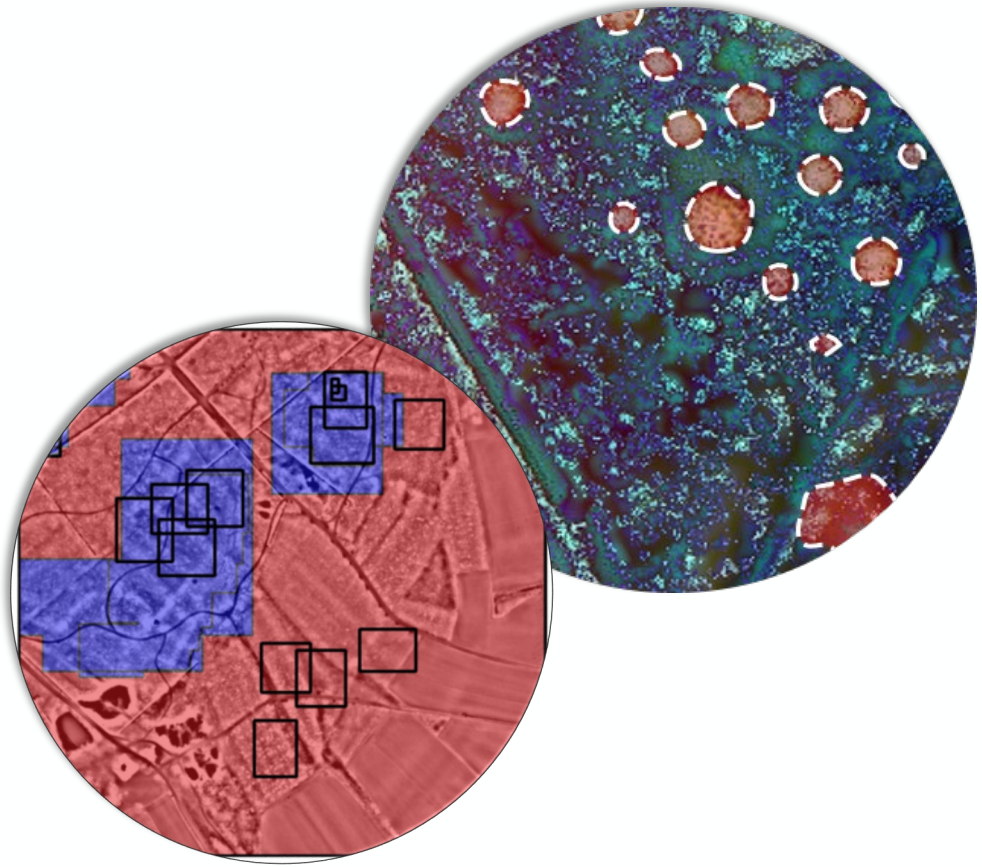
Identifying user scenarios and requirements

- Growing interest in advancing AI for Earth Observation
- End users who rely on the results generated by these technologies
- Survey conducted as part of ALCEO project (ESA)
- Potential primary users of AI applications:
  - Cultural Heritage Institutions;
  - landscape managers, urban planners, and infrastructure developers; and
  - archaeologists who may not be skilled in AI or remote sensing but are interested in the results.

User requirements

According to Users, an AI application with practical usability should be:

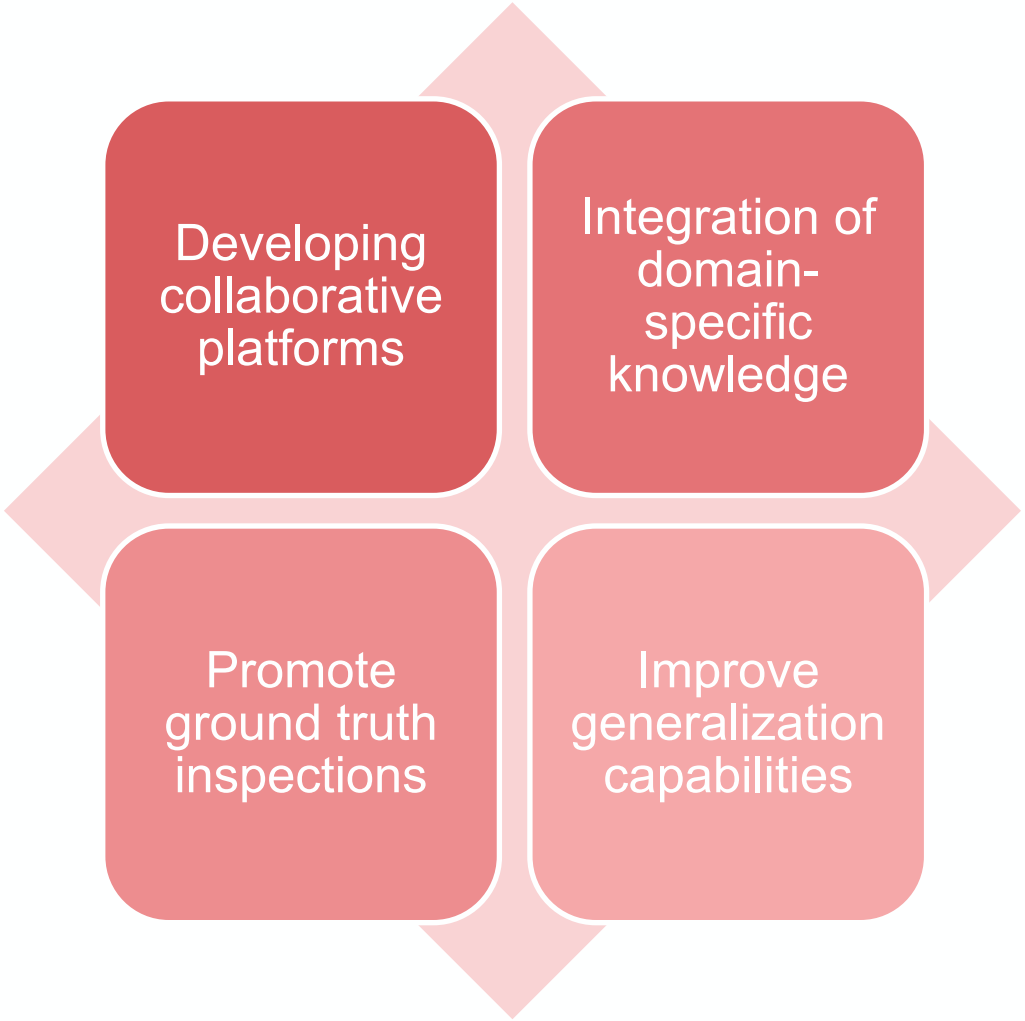
- applicable in several contexts
- trustworthy
- applicable to (freely) available images with certain characteristics
- implemented in a chain of processes for alerting and developing rapid intervention.



Conclusions and future perspectives

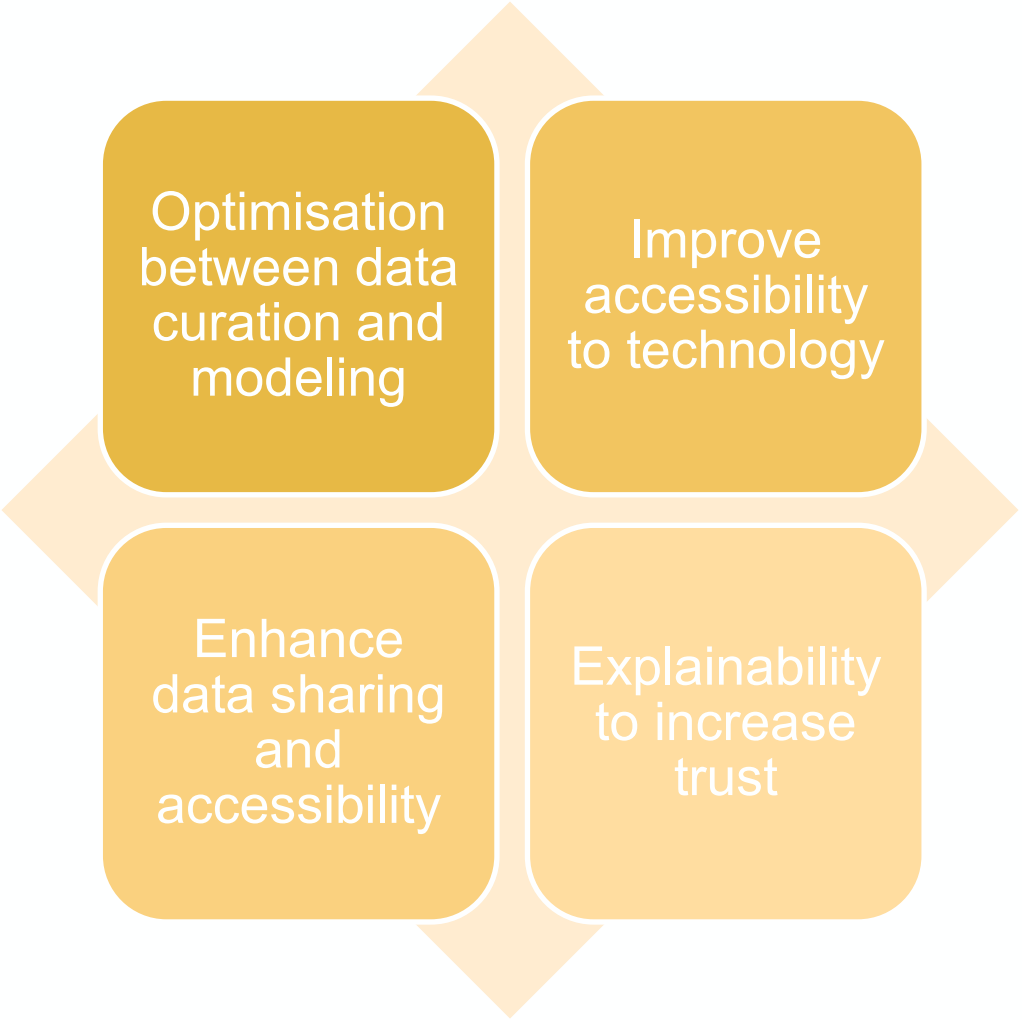
How to increase the potential use of AI:

- Development of AI systems in collaborative platforms
- Increase models performance integrating domain-specific knowledge and expertise
- Importance of ground-truth inspections
- Improve generalization capabilities



Conclusions and future perspectives

- Optimise the processes between the dataset curation and the predictive modelling.
- Accessibility to enable the use of AI applications to non-expert users
- Enhance sharing and accessibility of datasets
- Explainability to increase the trust in AI systems



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Thank you for your attention

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