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REGIONE DEL VENETO



SATSDIFACTION

Artificial Intelligence to Advance Earth Observation

From Data to Knowledge: Transforming Satellite Observations

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Riga 10-11 september 2025 |

A wealth of data has a little value without
converting **pixels** to **information** for decision
makers

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A Planet of Pixels

**02**Teaching AI to
See**03**Beyond Pixels:
Knowledge**04**Talking to the
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1

A Planet of Pixels

The Great Data Deluge

SATSDIFACTION



Data firehose



Satellite generate enormous quantites of raw data but it's useless without a way to interpret it.

Stream of pixels

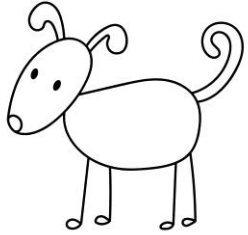




2

Teaching AI to See

More Than Just Cat Photos



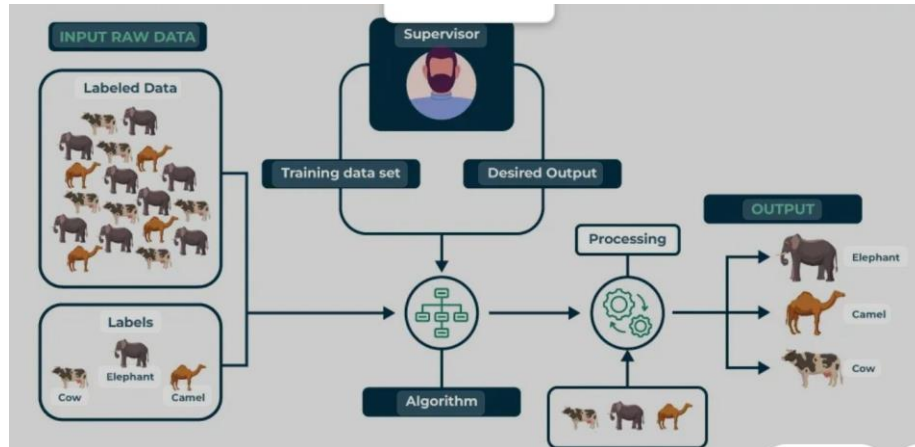
Single source (e.g. photo), data-driven patterns, and abundant, well-labeled data.



Data Fusion (optical, SAR, Physical Knowledge Integration, Sparse & Imperfect Labels.

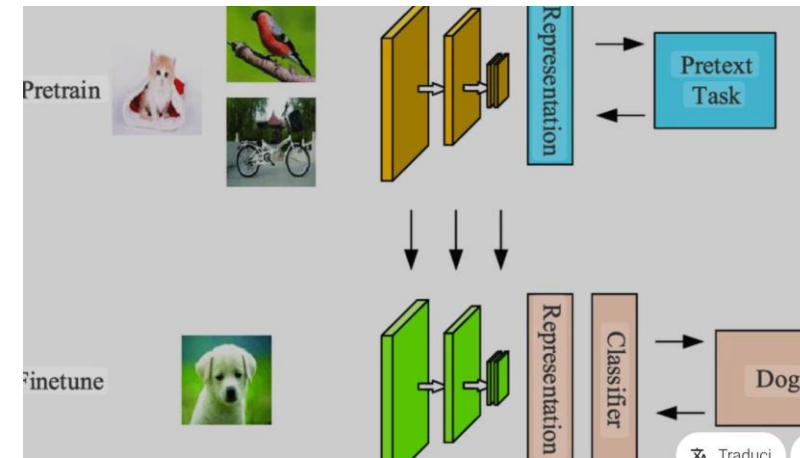


How AI Models Learn



Supervised Learning

Requires Massive amounts of human-labeled ground truth data, which is expensive



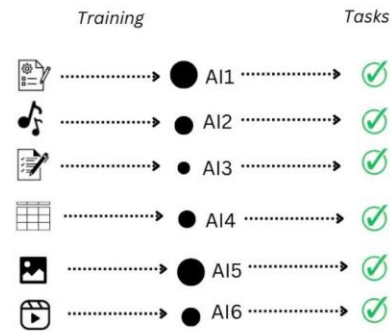
Self-Supervised

AI learns from vast unlabeled data by creating its own «pretext» tasks, like predicting masked parts.

How AI Models Learn

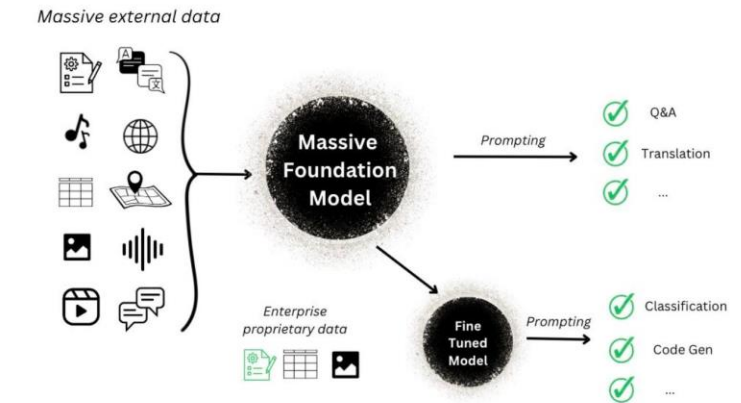
Massive, pre-trained AIs that have a general understanding of Earth and can be adapted to many different tasks.

Traditional ML



- Individual siloed models
- Require task-specific training
- Lots of human supervised training

Foundation Models

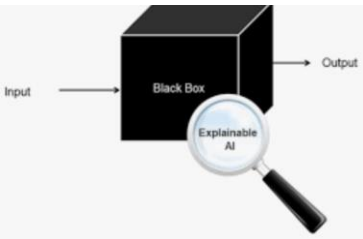


- Massive multi-tasking model
- Adaptable with little or no training
- Pre-trained unsupervised learning

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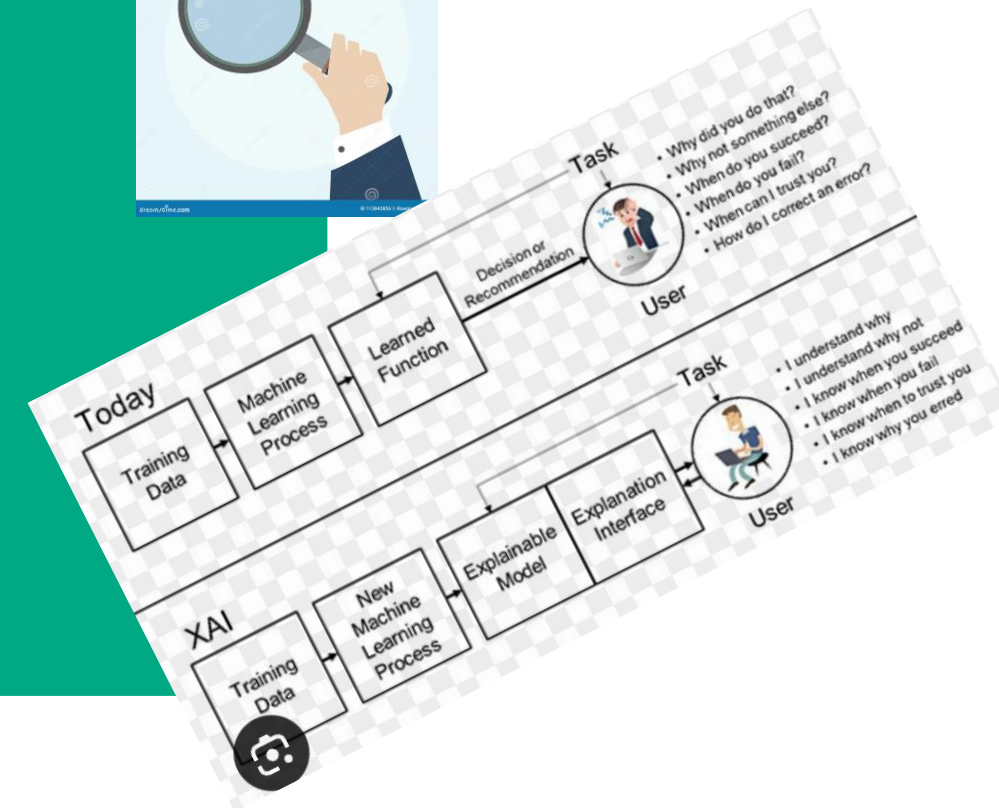
Beyond Pixels

Knowledge & Wisdom

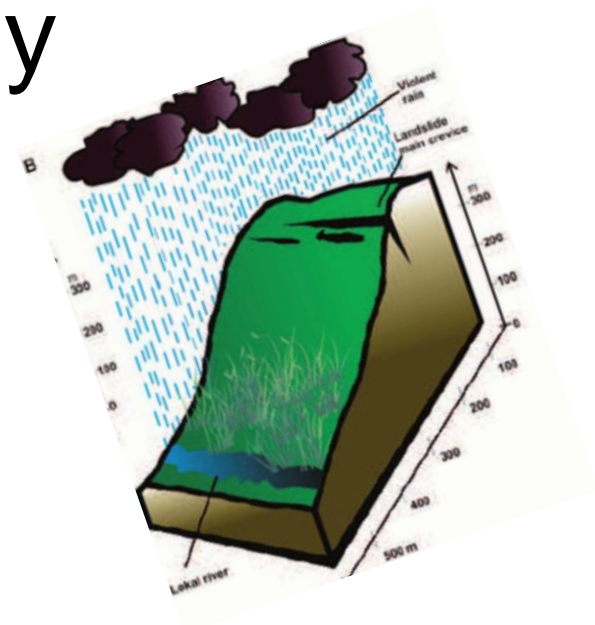


Explainable AI (XAI)

Methods that help humans understand and trust the results and output from machine learning algorithms

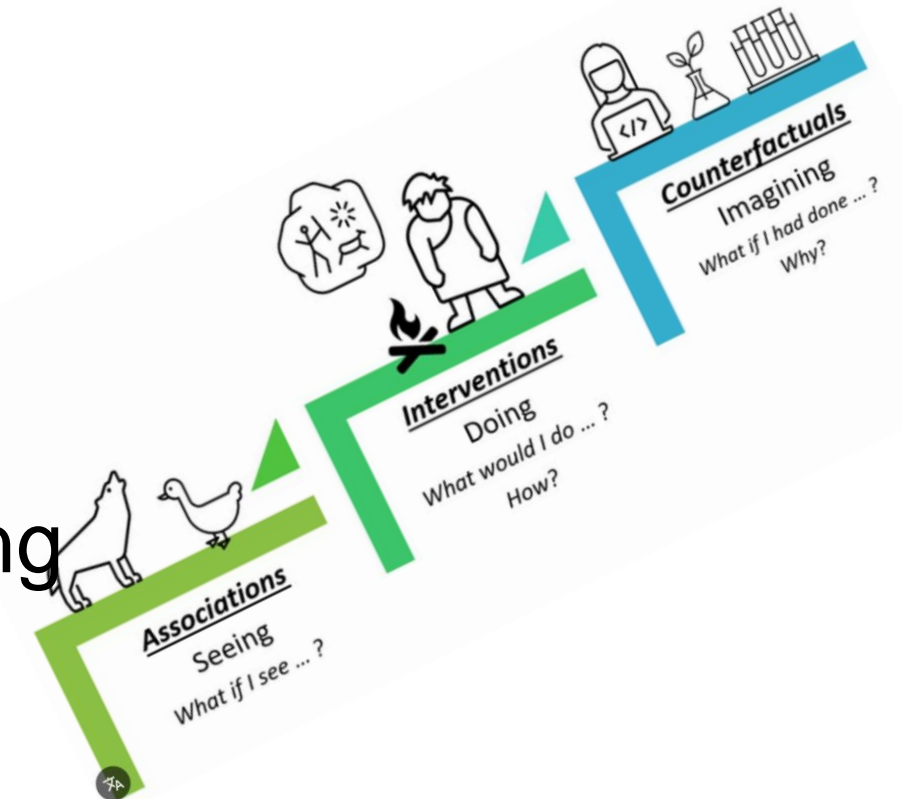


Does an explainable model truly understand the real world?

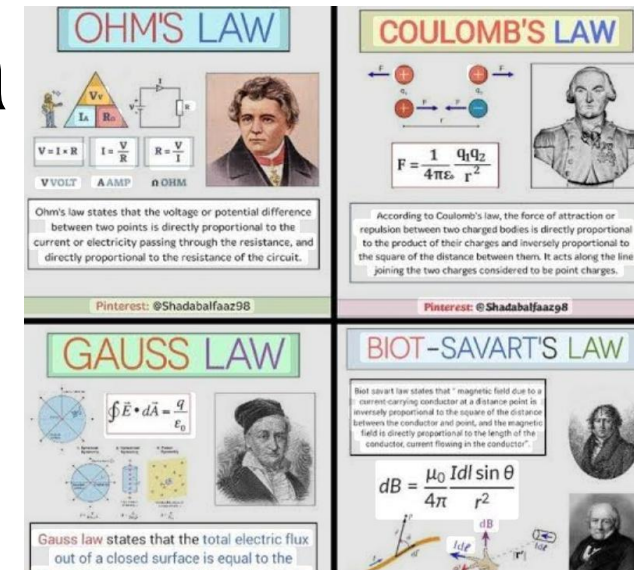
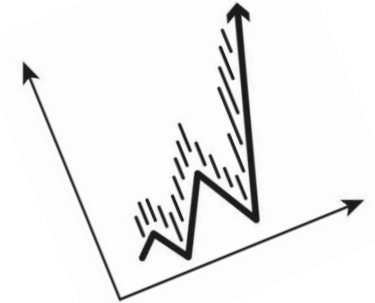


The Ladder of Causality

- Association (What is?): Standard ML finds correlations.
- Intervention (What if?): Simulating the effect of an action.
- Counterfactuals (Why?): Understanding the root cause.



Embedding physical laws into AI models creates more robust systems that require less data and don't make impossible predictions.

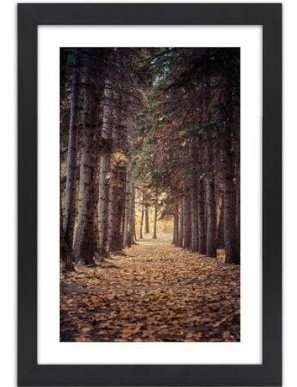




Talking to the Data

A New Conversation

Training AI to connect semantic concepts in text (like «forest») with visual patterns in satellite images.





You can query a model for something it was trained on, like 'roads', and it will highlight them in the image.





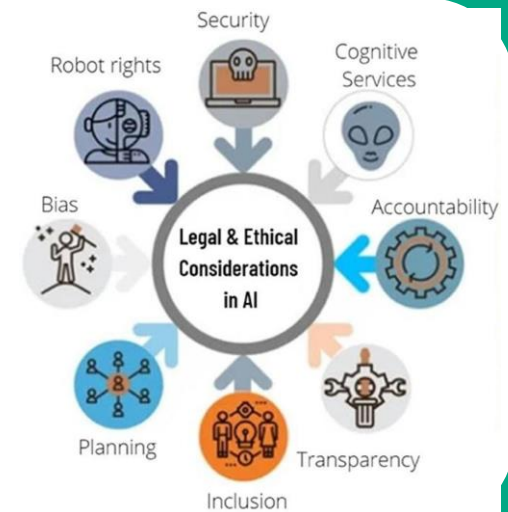
You can also query for abstract concepts it has never seen, like «a place for swimming», and it will identify relevant areas.



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The Big Ethical Questions

Power & Responsibility





With the ability to monitor the globe, what are your duties?.

Category	Includes
Privacy	Non-stigmatization authonomy
Honesty	Trasparency explainability
Integrity	Robustness, security
Fairness	Non-bias, diversity
Responsability	Human Oversight, accountability
Sustainability	Environmental, socio-cultural



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The Future From Above

What's next for AI4EO

Future Directions

- Multi-modal foundation models combining all sensor types.
- Causal Machine Learning to truly understand Earth's systems.
- Conversational AI (chatbots) for democratizing access to data.
- Lightweight models for AI processing directly on satellites.



How do we ensure this knowledge
leads to greater wisdom?






*Now We are going to use the AI to
search Satellite Images*



Show me from space ▾

 **Show me from space**
Di community builder 8
Easily view satellite imagery from via Copernicus Browser

Show me London Show me the Alps in winter Teach me about river deltas with images of real... Show me an random interesting event which can b...

show me images sentinel 2 of flooding in Riga Latvia during and before for comparison

Here are Sentinel-2 images showing the area around **Riga, Latvia**, during a recent **flooding event in late July 2025**, compared with an image from **early July 2025** before the flooding. The Daugava River and surrounding lowlands appear visibly more inundated in the later image.

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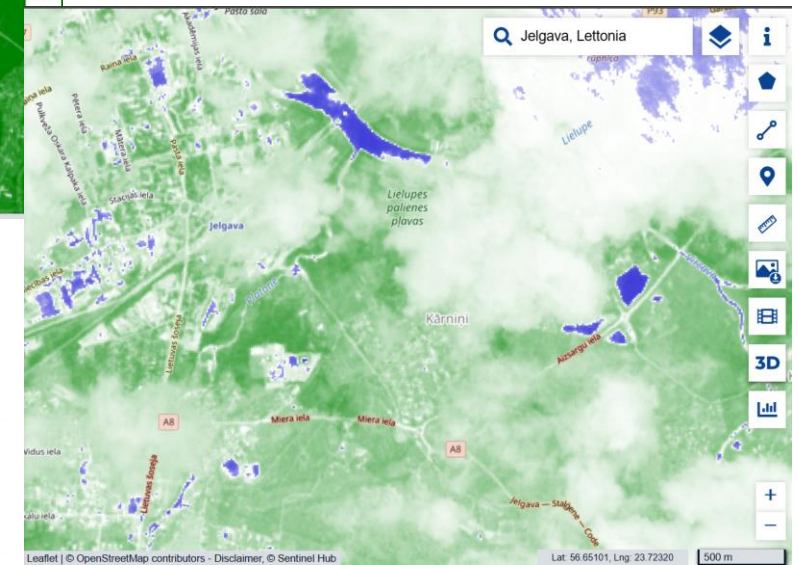
**BEFORE (early July 2025):**

https://dataspace.copernicus.eu/browser/?zoom=12&lat=56.95&lng=24.1&themeld=DEFAULT-THEME&visualizationUrl=https%3A%2F%2Fsh.dataspace.copernicus.eu%2Fogc%2Fwms%2F92b0b3ee-9e53-459c-a45f-b5e4b4c22d86&datasetId=S2_L2A_CDAS&fromTime=2025-07-01T00%3A00%3A00.000Z&toTime=2025-07-07T23%3A59%3A59.999Z&layerId=1_TRUE_COLOR&cloudCoverage=20&mosaickingOrder=leastCC

DURING FLOODING (late July 2025):

https://dataspace.copernicus.eu/browser/?zoom=12&lat=56.95&lng=24.1&themeld=DEFAULT-THEME&visualizationUrl=https%3A%2F%2Fsh.dataspace.copernicus.eu%2Fogc%2Fwms%2Fb8ce1d50-0a12-4a40-93ff-b5c2b02a0d89&datasetId=S2_L2A_CDAS&fromTime=2025-07-25T00%3A00%3A00.000Z&toTime=2025-08-03T23%3A59%3A59.999Z&layerId=1_TRUE_COLOR&cloudCoverage=20&mosaickingOrder=leastCC

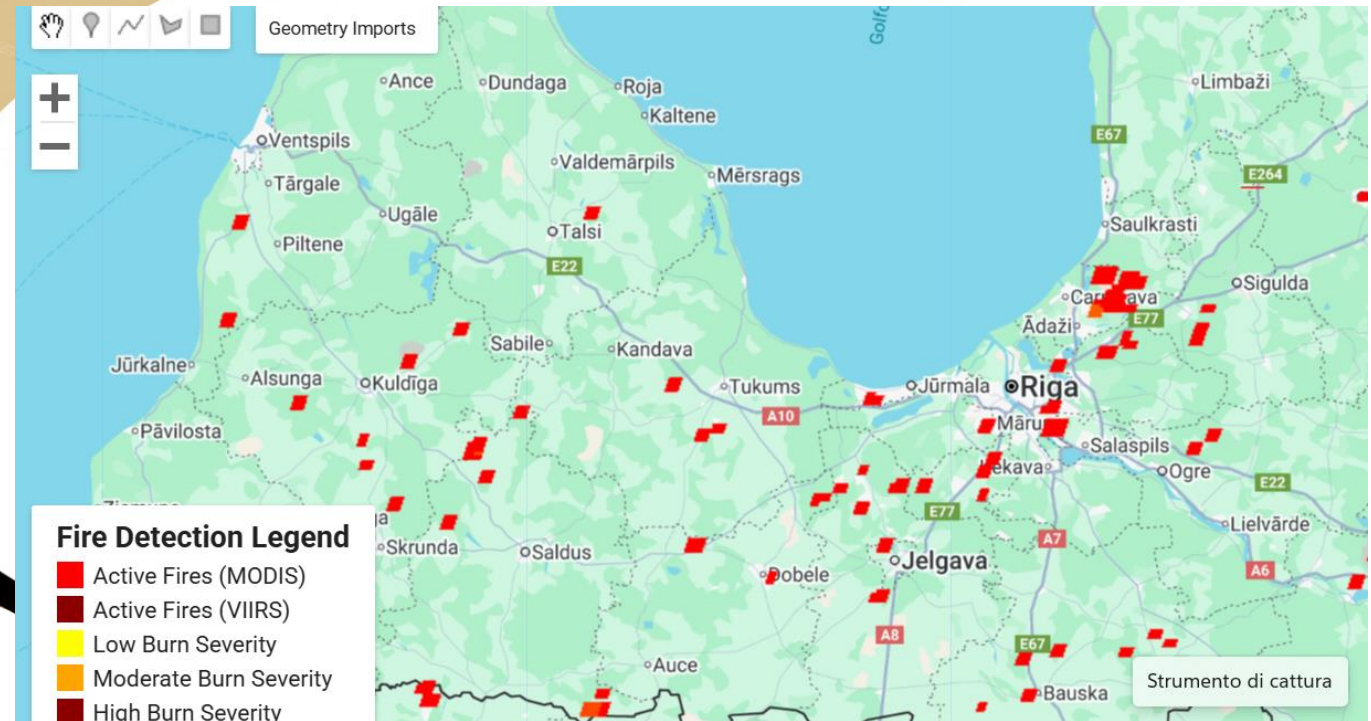




create a program for google earth
engine that highlights a large
wildfire in Latvia from sentinel 2
images

```
var mask = qa.bitwiseAnd(cloudBitMask).eq(0)  
    .and(qa.bitwiseAnd(cirrusBitMask).eq(0));  
  
return image.updateMask(mask).divide(10000);  
}
```

```
// Caricamento della collezione Sentinel-2 Level-2A  
var s2 = ee.ImageCollection('COPERNICUS/S2_SR')  
    .filterDate(startDate, endDate)  
    .filterBounds(italy)  
    .filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 20))
```

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Thank You

Questions & Discussion

Artificial Intelligence to Advance Earth Observation