

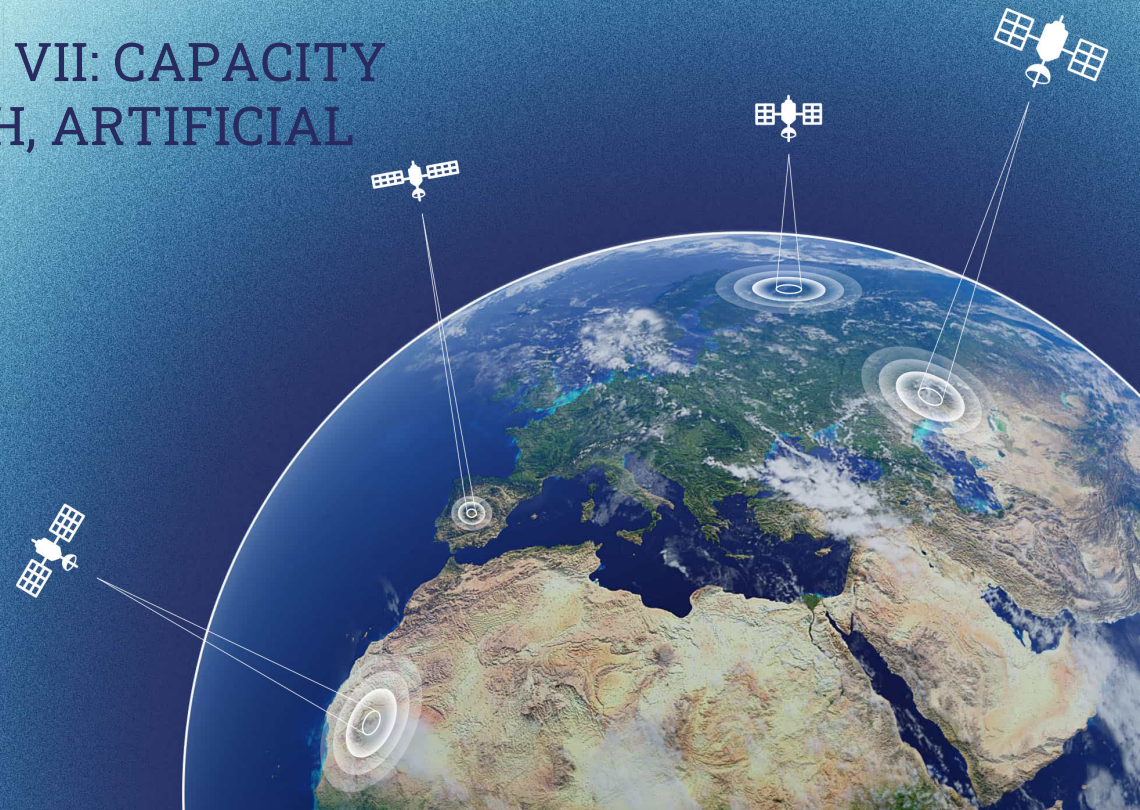
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# Space and Artificial Intelligence

EDUCATION AND TRAINING IN THE SPACE SECTOR VII: CAPACITY BUILDING SKILLS ACROSS DOMAINS: ARTS, HEALTH, ARTIFICIAL INTELLIGENCE

NEREUS, 20 June 2023

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*Mission*

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**Democratize the use of satellite analytics.**

Funded: 2020  
Team: 8  
(hiring!)

WHO

**Satellite  
Analytics** for  
decision  
making.

WHAT

Fast and easy  
thanks to  
**Artificial  
Intelligence.**

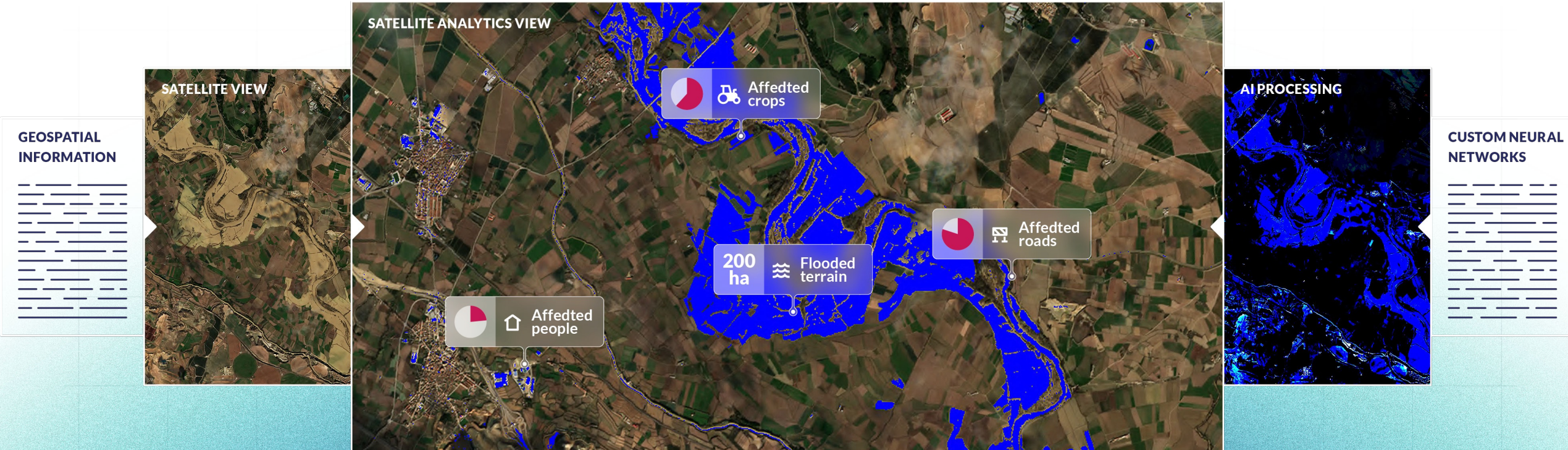
HOW



*Solution*

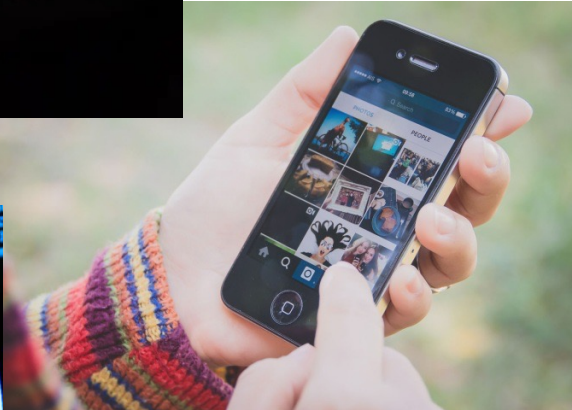
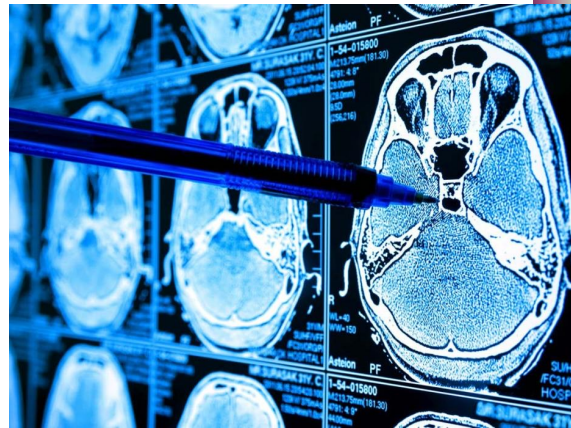
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# AI4EO





# What is Artificial Intelligence?



Write a short definition of Artificial Intelligence and give five examples of its application to the Space Sector



Artificial Intelligence (AI) refers to the simulation of human intelligence processes by machines, especially computer systems. This involves acquiring information and rules for using the information, reasoning to reach approximate or definitive conclusions, and self-correction. In essence, it's about creating machines that can think and learn like humans.



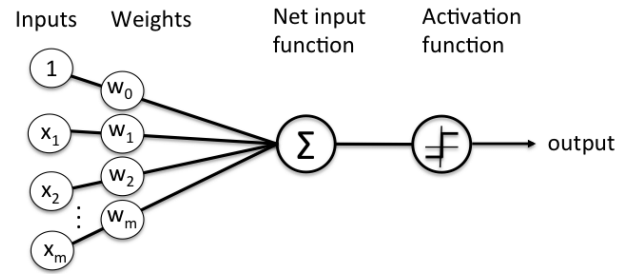
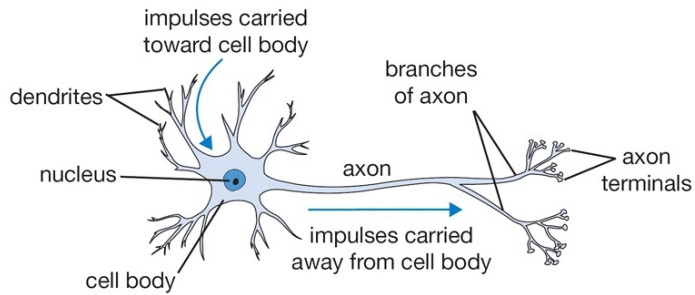
Applications of AI in the Space Sector:

1. **Satellite Image Analysis:** AI algorithms can analyze satellite images to detect and recognize patterns that a human eye might miss. For example, detecting changes in vegetation, monitoring sea traffic, or identifying changes in weather patterns.
2. **Spacecraft Navigation and Control:** AI can be used to autonomously navigate spacecraft and adjust their course based on real-time data, reducing the need for constant human monitoring and manual corrections. For instance, NASA's Mars rovers use AI for autonomous navigation on the Martian surface.
3. **Space Exploration:** AI is used in rovers and probes to explore planets, moons, and asteroids. They are programmed to interpret environmental data and adjust their exploratory actions accordingly, allowing them to operate efficiently in unpredictable or hazardous conditions.
4. **Astrophysics and Cosmology:** AI helps in processing large volumes of data from space telescopes and observatories, recognizing patterns and anomalies that might indicate the presence of new celestial bodies, or phenomena such as gravitational waves.
5. **Space Debris Tracking and Mitigation:** AI can be utilized to track the thousands of pieces of space debris in orbit around Earth, predict their trajectories, and propose mitigation strategies to prevent collisions with operational satellites or the International Space Station.

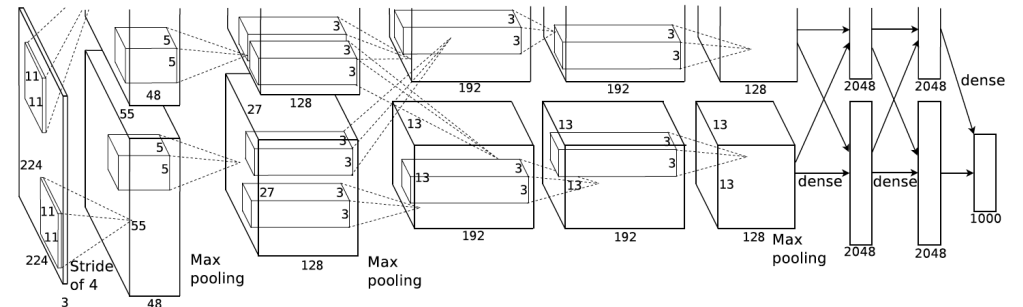
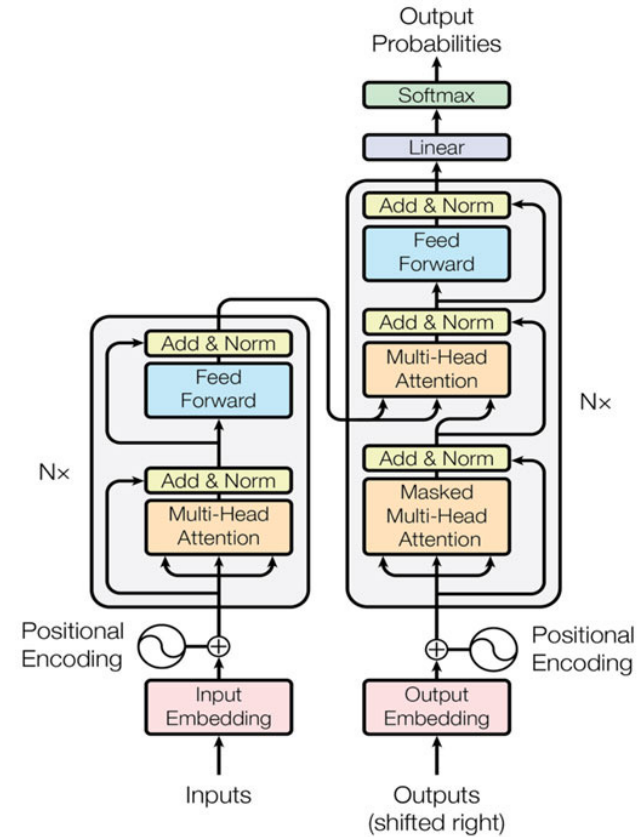
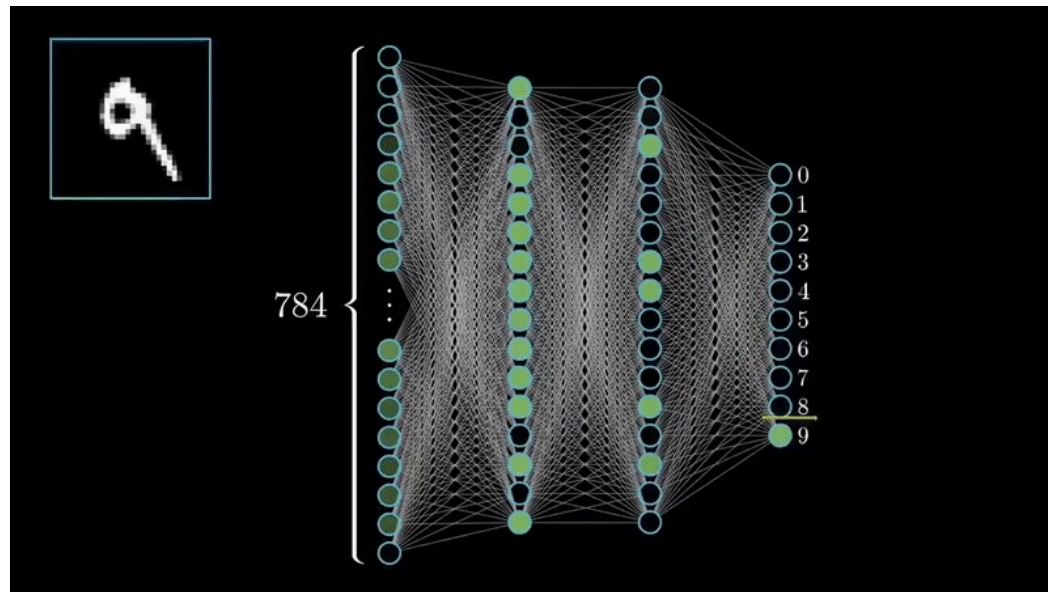


# Deep Learning (Neural Networks)

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$$\hat{y} = f(\mathbf{w} \cdot \mathbf{x}) = f(w_0 + w_1x_1 + \dots + w_mx_m)$$

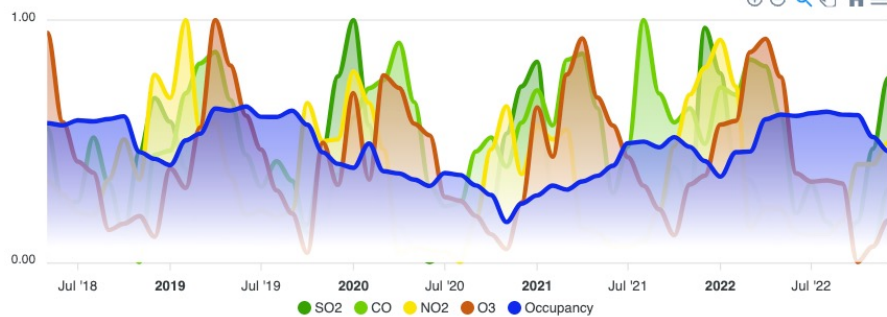
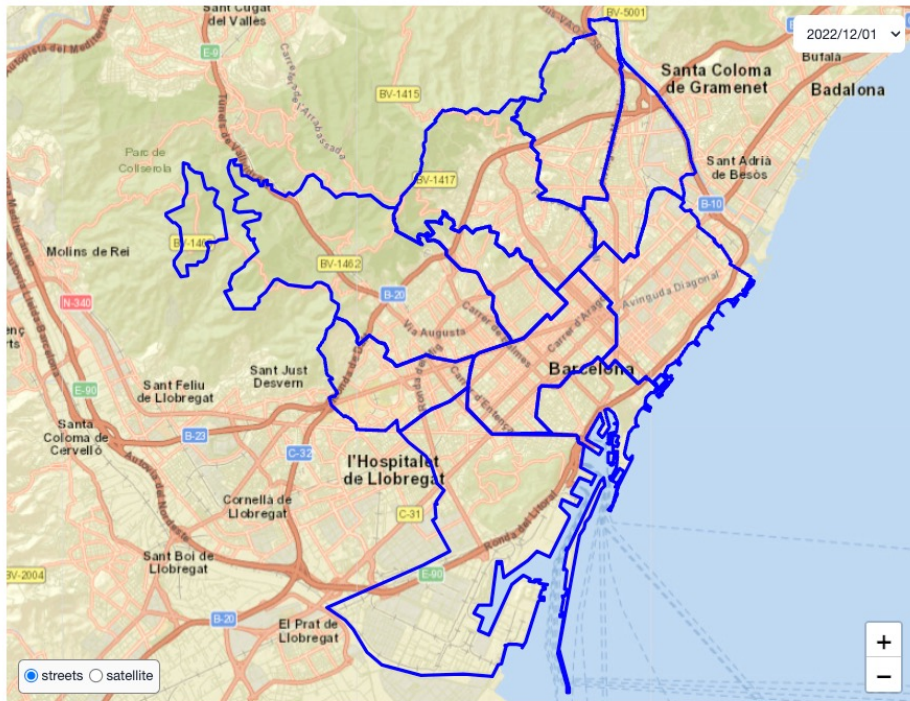
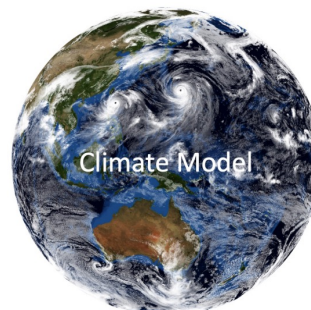






*Artificial Intelligence for  
Earth Observation*





multiple Sentinel-2 images



land use



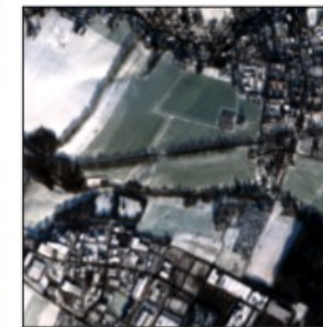
- unlabeled
- none
- wooded
- agricultural
- residential
- industrial
- commercial
- recreation
- airport
- quarry
- military
- desert\_sand
- mountain\_rock
- other\_natural



water and roads



- unlabeled
- none
- water
- road



buildings



- unlabeled
- none
- building



# Limitations & Future directions



*Models*

*Data*

- EO data peculiarities
  - Multi-modal (data fusion)
  - Geolocalized
  - Temporal (time series)
  - Big data
  - High complexity
- Lack of training datasets (<https://www.eotdl.com/>)
- Models developed (and pre-trained) in the natural domain ([https://github.com/earthpulse/pytorch\\_eo](https://github.com/earthpulse/pytorch_eo))
- Challenges and learning resources (<https://platform.ai4eo.eu/>)



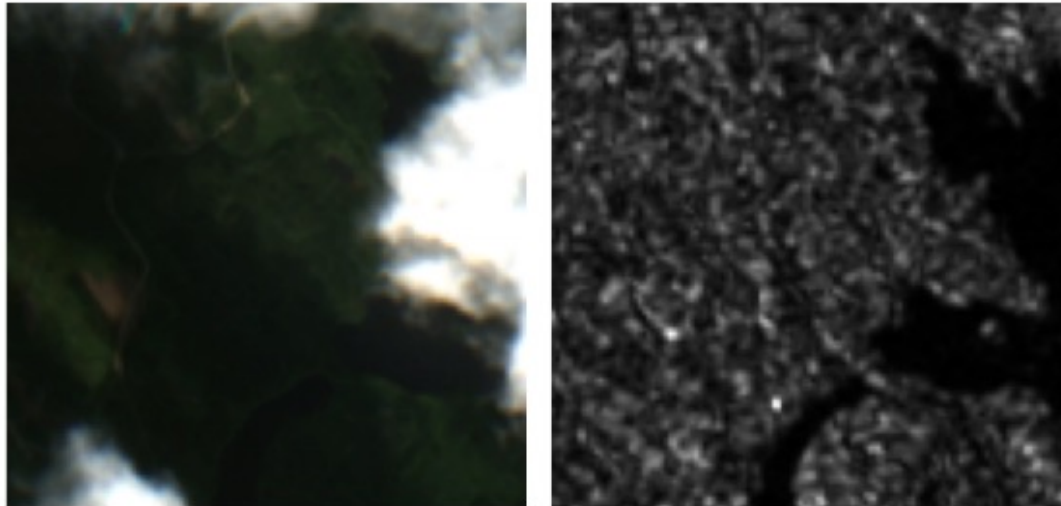




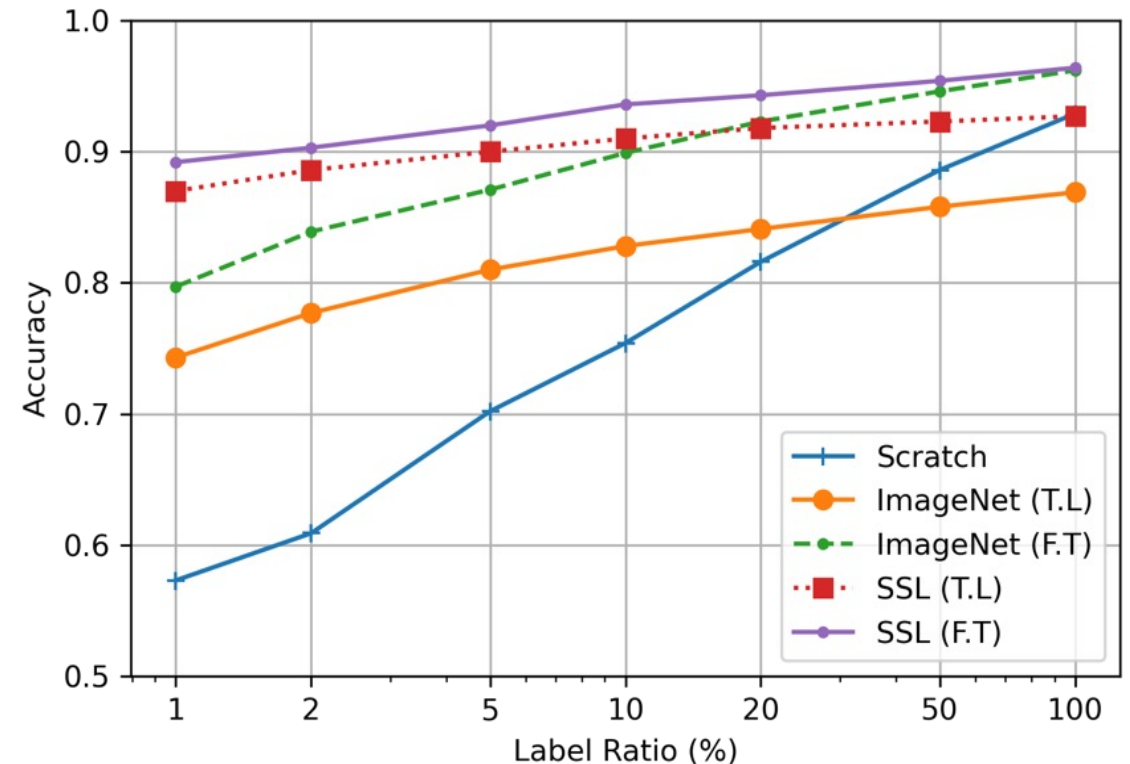
# Data Fusion / Self-Supervised Learning



S2 ['Coniferous forest', 'Mixed forest']  
 S1 ['Coniferous forest', 'Mixed forest', 'Transitional woodland, shrub', 'Inland waters']  
 DF ['Coniferous forest', 'Mixed forest', 'Inland waters']  
 GT ['Coniferous forest', 'Mixed forest', 'Inland waters']



Data source	Clouds and shadows (10k)	
	10%	100%
S2	0.469 (-21.6%)	0.778 (-4.3%)
S1	0.624 (-6.1%)	0.723 (-9.8%)
<b>DF (S1+S2)</b>	<b>0.685</b>	<b>0.821</b>





# Language User Interfaces

## SPAI



What are you interested in?

Search...



Examples:

How did the floods over Banteay Meanchey (Cambodia) during the end of 2020 affected the city schools?

I want to know the turbidity of the water in the Foix reservoir (Catalonia) for the past 5 years.

Compute the Chlorophyll levels in Sau (Catalonia) during 2019.

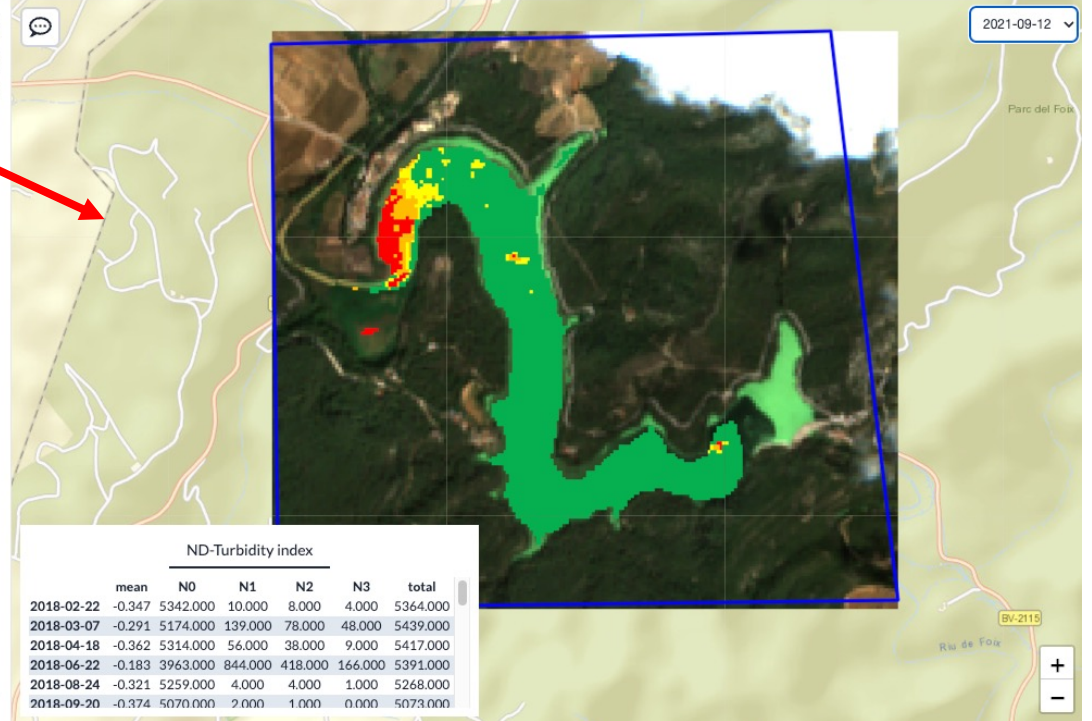


Andrej Karpathy

@karpathy

The hottest new programming language is English

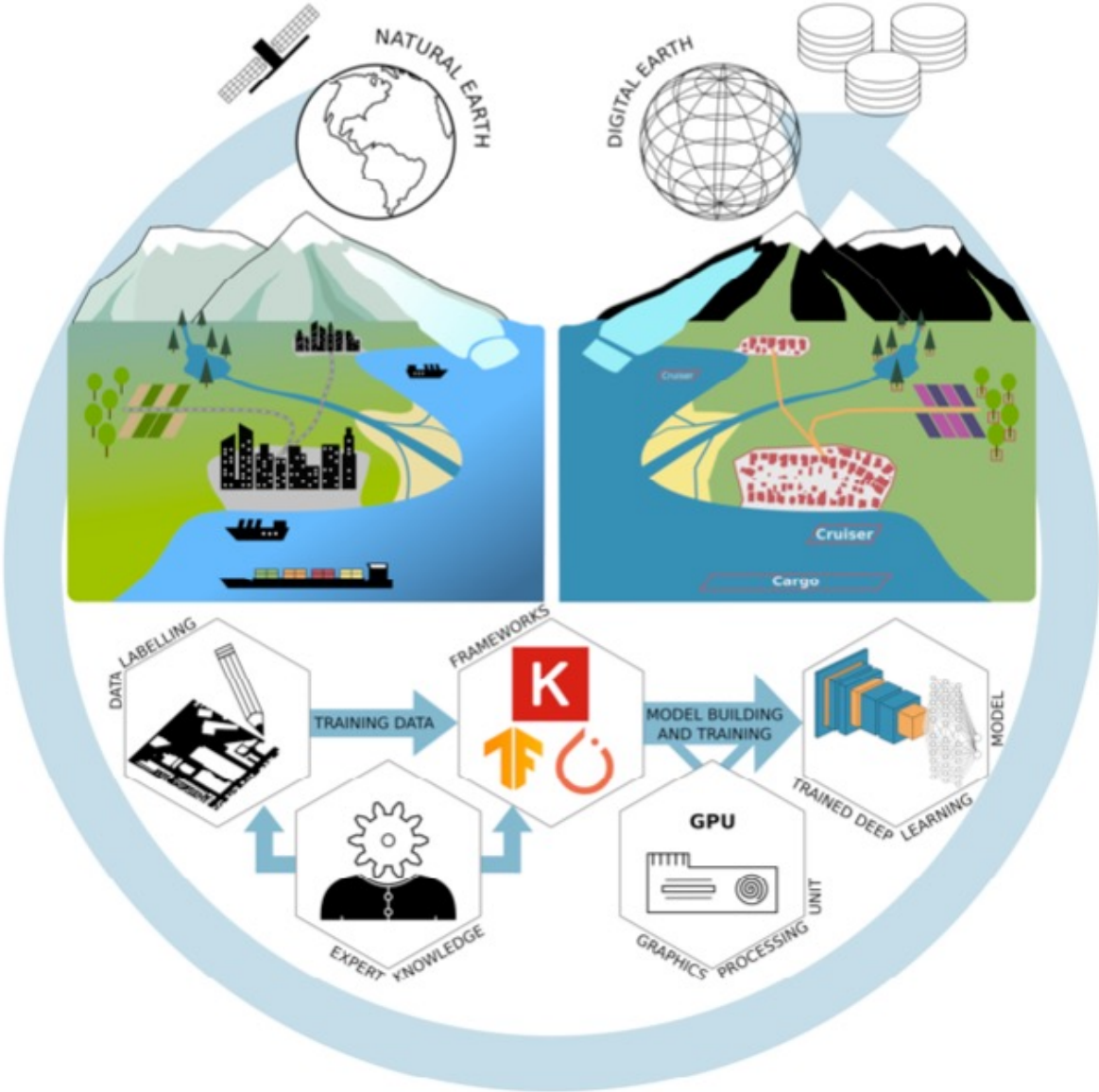
## SPAI





# The Goal: Digital Twin Earth

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**Thanks!**  
**Questions?**

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