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Data 441

Data Science Insight 1

**The ɸ-Sat**

On September 3, 2020, the European Space Agency (ESA) launched the world’s first earth observation satellite with artificial intelligence (AI). The AI chip, named ɸ-sat (PhiSat), is designed to process satellite images and recognize and remove images that are obscured by cloud cover. The ɸ-sat is believed to be the first step in using AI to create more efficient and effective earth observation techniques.

In 2017, the Universitat Politècnica de Catalunya proposed the idea of a small constellation of satellites that would provide data on the Earth’s soil moisture content and ice coverings. This idea was developed by the ESA into the Federated Satellite Systems mission (FSSCat). The satellites use dual microwave and hyperspectral optical instruments to capture images of the Earth. These images allow for consistent monitoring of changes in vegetation, water quality, and other important earth features. While the satellites successfully capture terabytes of data, a challenge the FSSCat faces is determining which of the enormous number of pictures are usable, particularly in a timely manner.

The company *cosine Remote Sensing* constructed an AI algorithm that can detect when a satellite image has too much cloud coverage to provide useable data. The AI algorithm is held on a chip called the ɸ-sat. When added to the satellites, the AI processes incoming images, detects the level of cloud coverage, and discards images that are not suitable. The ɸ-sat is able to clean terabytes of data quickly and with high accuracy. This allows the Copernicus Land and Marine Environment service to receive good quality Earth images at an unprecedented speed.

The ɸ-sat has important applications to agent-based modelling because of its impact on Earth imaging and because of the precedent it sets for integrating AI into future geospatial projects. ɸ-sat provides a unique opportunity for data scientists to obtain timely, clean images of the Earth. This allows data scientists to maintain up-to-date models pertaining to weather patterns, soil moisture, ice coverings, topography, vegetation, and much more.

Furthermore, learning about the ɸ-sat reveals a need for more incorporation of AI into Earth observation tools. As current consumers of maps and earth images, it is important for us to understand the limitations of the data available to us. Learning about the common issues faced by Earth imaging—like cloud coverings—and understanding how AI can be used to fix those issues is critical for future data scientists like ourselves.

Fascinatingly, the ESA has already recognized this importance of the ɸ-sat’s technology and has begun a push towards incorporating more AI into satellites. As early as November of 2019, the ESA announced the development of a successor to ɸ-sat—ɸ-Sat-2. ɸ-Sat-2 is being developed to address a wide range of issues. ESA hopes that ɸ-Sat-2 will use AI to transform satellite images into street maps, do autonomous detection and classification of maritime vessels, monitor forests and land anomalies, and do improved cloud detection in satellite images. The expanded capabilities of ɸ-Sat-2 have endless applications to data science. Mostly, the ɸ-Sat-2 acts an important reminder to data scientists that our most important skill is looking to the future of the field, identifying the current limitations, and creating something that breaks those boundaries.

using state-of-the-art dual microwave and hyperspectral optical instruments, the two CubeSats, each about the size of a shoebox

hyperspectral camera on one of the CubeSats will collect an enormous number of images of Earth, some of which will not be suitable for use because of cloud cover. To avoid downlinking these less than perfect images back to Earth, the ɸ-sat artificial intelligence chip will filter them out so that only usable data are returned.

“the instrument – which covers the visible and near infrared with hyperspectral capability, enhanced with bands in the thermal infrared – is very powerful and will acquire terabytes of data that can be used to monitor vegetation changes and to assess water quality”

enerating this amount of data actually poses a problem, as the data have to be handled efficiently so that they can reach the users in a timely manner. With ɸ-sat we have effectively given the instrument its own brain, which processes the data onboard to detect clouds in the images.

ensures better quality data, but makes the delivery much more efficient.

 we are also soon going to release a new challenge to develop ɸ-sat-2.”

<https://www.esa.int/Applications/Observing_the_Earth/Ph-sat/First_Earth_observation_satellite_with_AI_ready_for_launch>

 on September 3, 2020, ESA launched its ɸ-Sat-1, an enhancement of the Federated Satellite Systems mission on-board a Vega rocket from Europe's spaceport in Kourou, French Guiana.

he AI cloud detection experiment is going to validate the performance of the on-board inference engine based on a machine learning algorithm for cloud detection.

to enhance the FSSCat mission.

 ɸ-Sat-2 mission has been planned to address a wide range of Artificial Intelligence applications which include transforming a satellite image into a street map, cloud detection in order to reduce the huge volume of data that needs to be downloaded to the ground base, autonomous detection and classification of [maritime vessels](https://interestingengineering.com/swan-shaped-luxury-electric-yacht-looks-straight-out-of-a-fairy-tale), forest monitoring and anomaly detection.

Current Sentinel missions have already enabled a variety of monitoring capabilities for disaster risk reduction and [emergency](http://www.un-spider.org/node/7670) [response](http://www.un-spider.org/node/7680).

sentinel-1 was the first mission to be launched under the Copernicus programme. Its radar imaging tools provide users with [Digital](http://www.un-spider.org/node/7750) [Elevation](http://www.un-spider.org/node/7768) Models (DEMs) which are particularly useful for flood [hazard](http://www.un-spider.org/node/7673) mapping

Sentinel-2, which was launched in 2015, collects [land cover](http://www.un-spider.org/node/7825) images. In disaster management these images are useful for a variety of disasters ranging from [burn severity mapping](http://www.un-spider.org/advisory-support/recommended-practices/recommended-practice-burn-severity-mapping) to [drought monitoring](http://www.un-spider.org/advisory-support/recommended-practices/recommended-practice-drought-monitoring-using-standard),

These two CubeSats are very small and contain instruments that measure soil moisture, ice extent, and ice thickness as well as an instrument to detect melting ponds over ice.

The data offered by ɸ-Sat-1 contributes to the universal monitoring capacities of, among other things, [disaster](http://www.un-spider.org/node/7661) related topics: Especially the soil moisture monitoring component can prove useful as this is not included in the current Sentinel portfolio.

<http://www.un-spider.org/news-and-events/news/new-esa-satellite-uses-ai-make-data-delivery-more-efficient>

http://www.esa.int/Applications/Observing\_the\_Earth/Copernicus/Smallsats\_win\_big\_prize\_at\_Copernicus\_Masters