

# Trustworthy processing of space images with a XAI-powered toolbox

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## Abstract

As part of the MILAN project (Machine Learning for Astronomy), the research team has collaborated with VAONIS, a fast-growing French company and pioneer in the design and development of smart telescopes. The goal of the project was to develop an innovative AI toolbox for the processing of high-resolution astronomical images [1].

Based on Deep Learning and Evolutionary Algorithms, the toolbox covers the complete workflow from data preprocessing to fast AI models execution on different types of devices (from HPC servers to low-resource devices). Mainly developed in Python, the toolbox provides access to a hundred of trained AI models specific to image denoising, image decomposition (background, stars, etc), image enhancement (sharpening, details recovering, etc.), Image Quality Assessment and automated objects detection (satellites trails, etc.). These AI models have been then declined & benchmarked for various architecture sizes (from tens of millions to a few thousand parameters) and various environments (servers, laptops, Raspberry Pi, Android/iOS devices) by using TensorflowLite, TensorflowJs and CoreML. Combined with pruning & optimisation techniques adapted to the specificities of space images, trained AI models have been benchmarked, and we obtained fast execution times to process data on limited-resources devices.

We are improving the toolbox by adapting and applying post-hoc eXplainable AI techniques. Firstly, both single-frame and multi-frames Super Resolution techniques will be applied to augment the native resolution of space images, while controlling with attention-based methods the undesired generation of undesired artefacts and hallucinated details [2]. Secondly, Knowledge Distillation will be applied to transform complex detection models to smaller models that are more interpretable [3], and Concept-based Attribution will be experimented to provide explicit insights about models outputs [4]. Finally, the toolbox will be derived to process Lunar remote-sensing data (such as Lunar Reconnaissance Orbiter images).

## References

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