Super-resolution of satellite imagery using GANs

Satellite imagery evolved significantly over time, in particular the spatial resolution that easily reach 10 m/pixel today. The high variability of this spatial resolution generate inconstancy in studies, especially for the ones working on larger time scales. Therefore, a statistical super-resolution homogenization would allow to extract more information from these lower-resolution images.

With time many approaches were used to make super-resolution. But deep learning revolutionized strategies over the last years. In particular, approaches using GANs show exceptional potential on very diverse task. Therefore, the goal was to investigate the capabilities and limitations of generative adversarial networks (GANs) based single image super-resolution (SISR) for the downscaling of satellite images.

The ESRGAN architecture that represents state-of-the art approach was selected for this task. It is based on the pioneer SRGAN architecture and improves upon it to further increase perceptual quality while massively reducing computational complexity.

Firstly, we created an appropriate dataset composed Sentinel-2A images taken on every continent to encounter a wide variety of scenes. The dataset contains more than 40k image pairs consisting of a high-resolution image, used as the ground truth, and low-resolution counterpart used as the network input. The dataset conception followed the framework used in the SISR field where the low-resolution image is computed from the high-resolution with a factor of 4 in each direction.

Secondly, multiple models were trained in parallel on the specific dataset for more than one million iterations until convergence was reached. The performance of each successful model was evaluated quantitatively and the best performing one was used to compare the performance of a generically trained network against the performance of a specifically trained one.

The satisfactory results encouraged us to test the performance of the trained network on a non-synthetic dataset. For this experiment Landsat 8 imagery was selected. It has natively a similar resolution and is widely used in the scientific community.