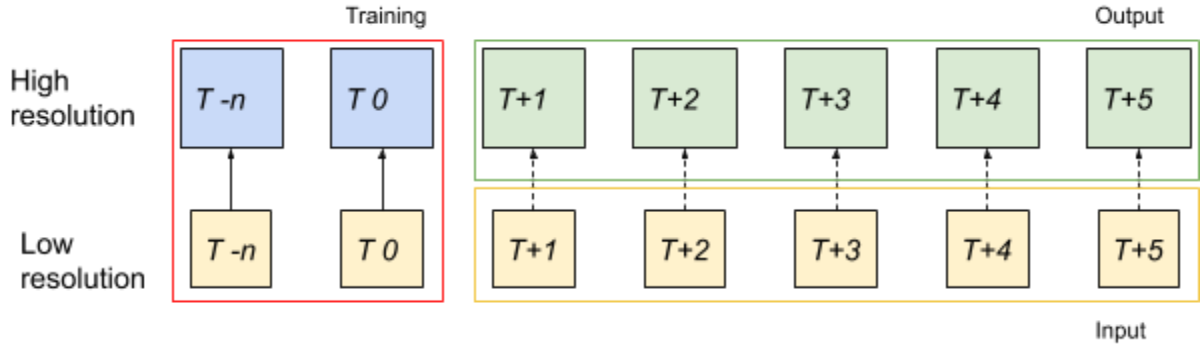
Super resolution method



Representation of the Super resolution method

Prior art

Nowadays super resolution is used for many applications, it goes to medical imagery to face detection and video-frame enhancement. Many powerful models exists as the most famous SRCNN : "Image Super-Resolution Using Deep Convolutional Networks" [1], it modified and optimized version FSRCNN : "Accelerating the Super-Resolution Convolutional Neural Network" [2]. In remote sensing field the few are the methods using CNN for enhancement of satellite imagery, some relevant work are using earth observation data to provide better resolution data as the winning model of an ESA challenge for super resolution on Porba-V sensor data : "DeepSUM: Deep Neural Network for Super-Resolution of Unregistered Multitemporal Images" [3]. In the case of this project, only Single Image Super Resolution (SIRS) is considered, event if there is a temporal dimension there is no shift in the data that provide different angle of view as it's explained for the "DeepSUM" method.

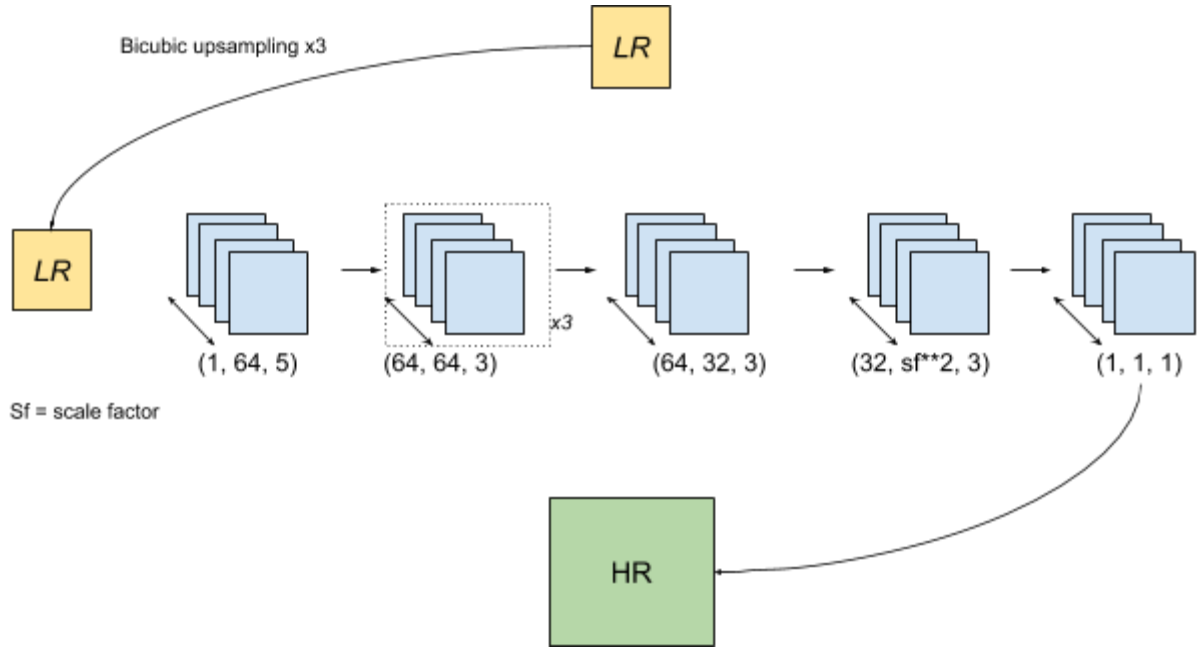
Model architecture

The architecture of the super resolution model is following the architecture of the state of the art convolutional neural network : "*Real-Time Single Image and Video Super-Resolution Using an Efficient Sub-Pixel Convolutional Neural Network*" [4]. The subpixel super resolution model

[1] Dong, Chao, Chen Change Loy, Kaiming He, et Xiaoou Tang. « Image Super-Resolution Using Deep Convolutional Networks ». *arXiv:1501.00092 [cs]*, 31 juillet 2015. http://arxiv.org/abs/1501.00092.
[2] Dong, Chao, Chen Change Loy, et Xiaoou Tang. « Accelerating the Super-Resolution Convolutional Neural Network ». *arXiv:1608.00367 [cs]*, 1 août 2016. http://arxiv.org/abs/1608.00367.
[3] Molini, Andrea Bordone, Diego Valsesia, Giulia Fracastoro, et Enrico Magli. « DeepSUM: Deep Neural Network for Super-Resolution of Unregistered Multitemporal Images ». *ArXiv:1907.06490 [Cs, Eess]*, 15 juillet 2019. http://arxiv.org/abs/1907.06490.
[4] Shi, Wenzhe, Jose Caballero, Ferenc Huszar, Johannes Totz, Andrew P. Aitken, Rob Bishop, Daniel Rueckert, et Zehan Wang. « Real-Time Single Image and Video Super-Resolution Using an Efficient Sub-Pixel Convolutional Neural Network ». In *2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 1874-83. Las Vegas, NV, USA: IEEE, 2016. https://doi.org/10.1109/CVPR.2016.207.

realized has an architecture of combination of 2D convolutions. This architecture was chosen based on research on super resolution, GAN model or models that use deconvolutional layer for upscaling are presenting artifacts in the output.

Some limits are seen to this method based on the dataset used. First of all, Sentinel-5p is a data with “noises”, due to the masking every image is composed of “None” values, these values can have an effect on the training of such model. Secondly the ratio between the two datasets used is really high, to reach the same resolution of Sentinel-5p from the numerical model the upscaling factor has to be 12. Usually in super resolution applications to other kinds of images, the scale factor is smaller. Finally the non correlation between the two datasets, even if both measurements are representing the same thing, it can happen that there is no correlation between what Sentinel-5p is showing and what the numerical model do. Due to these multiple issues, it may need some adjustment on the realisation of this method. it corresponds to bicubic interpolation to upsample the low resolution input or downsample the high resolution target. By applying interpolation it permit to reduce the scale factor for super resolution and provide more correlation between input and target. Bicubic interpolation is something usually done in super resolution methods before fitting with the input.



Representation of the architecture of super resolution model

Results

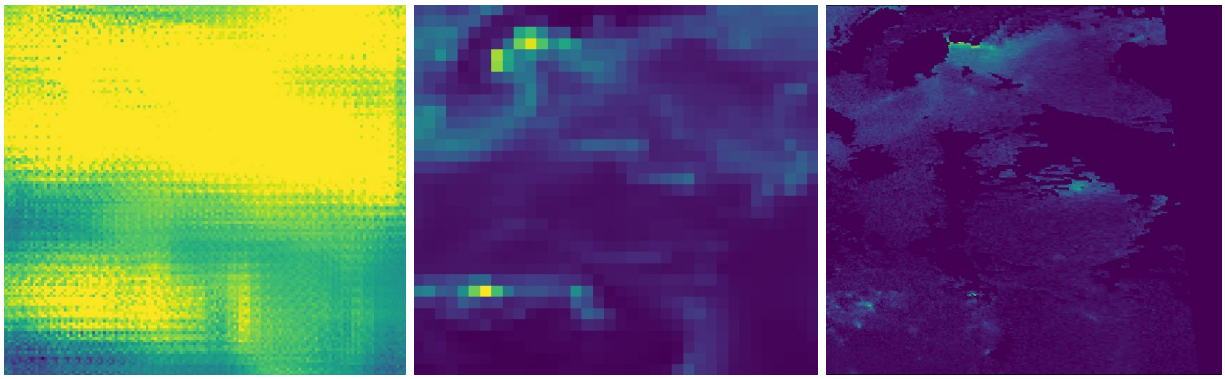
Results provided by the model were not good enough to provide more information. Unfortunately the model was not able to reach from the numerical model the resolution of Sentinel-5p.

The reasons of this failure can be multiple :

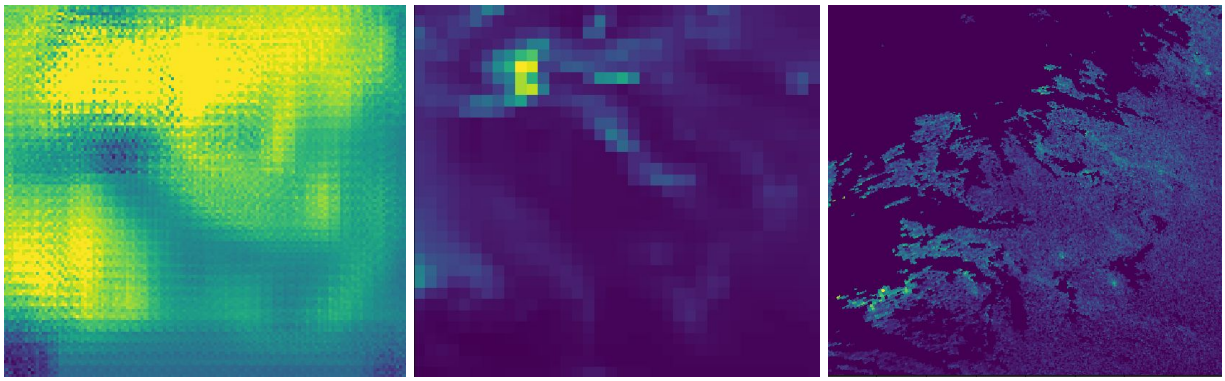
- The model is not strong enough to provide any good output
- The difference between the two data is too high, sometimes S5p is showing a phenomenon but it cannot be seen on the numerical model. Difference of value also, the intensity between the two data is different.
- The upscaling factor is really high (12x), the idea of the super resolution here is to create twelve pixels from one.

Compared to the state of the art super resolution is usually using same images (same representation), moreover the scale factor is not that high.

Example of result : over Italy (1st line : 2019/12/03 at 11pm / 2nd line : 2019/12/01 at 10pm)



Output Input Target



Content in Github

All the codes of the model used is available, parameters probably need to be set up. This code can be used for improvement of the work on super resolution.

- Dataset.py : Data loader to create dataset for training the model. Apply normalization and bicubic upsampling on the input.
- Main.py : main file to launch for training and testing the model (some parameters in it have to be adjusted).
- Model.py : file of the model architecture.
- Trainer.py : contain all the process of training and testing.
- Utils.py : functions used for all the files mentioned before.