Algoritmi di Plug and Play per tomografia ad angoli limitati

Componenti del gruppo:

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Obiettivi del progetto:

The goal of this project is to apply a Plug-and-Play algorithm for the reconstruction of limited-angle tomographic images and to compare the results with model-based algorithms using Total Variation regularization.

Descrizione del progetto:

1. Implement a Plug-and-Play method and apply it to the reconstruction of CT images in limited-angle geometry. Use a Residual U-Net as the denoising network, trained on image gradients (see reference b) in the bibliography), i.e., it denoises the gradients rather than the image itself.
2. Compare the results of the Plug-and-Play method with those obtained from a model-based reconstruction using Total Variation regularization**.**

Dataset: Mayo Clinic Dataset (CT):
https://drive.google.com/drive/folders/13BEiz6t57qSbwBpCtfqllmYTLmkhQeFE?usp=share_link

Output Attesi:

1. Test the previous project in the following geometries**:**
   • 30 angles in the range [-30°, 30°] (limited-angle)
   • 180 angles in the range [-90°, 90°] (full-view)
   • In both cases, test with and without noise on the sinogram, using a noise level of 0.01.

2) **For each of the runs in point 1, use the following error metrics:**
Relative Error (RE), Peak Signal-to-Noise Ratio (PSNR), and Structural Similarity Index (SSIM), calculated between the reconstructed images and the ground truth images from the dataset.

3) **Perform the tests described in point 1 on a selected image from the test set**, displaying the reconstructions and one or two meaningful zoomed-in regions, along with the metrics mentioned in point 2.

4) **Run the tests on the entire test set**, compute the average of the indicated metrics, and report them in a table.

Below is a list of reference papers that may help in carrying out the project (use Google Scholar to search for and download the articles). However, scientific literature—especially in this field—is often very complex and requires a strong foundation that can be challenging to acquire.

For this reason, it is highly recommended to make use of the many blogs and websites that explain the methods required for the project in much simpler terms than scientific papers, as well as to take advantage of large language models (LLMs), which can assist in both understanding the code and supporting development.

Finally, please remember that this project is intended as a direct *collaboration* with the supervising instructor. Therefore, do not hesitate to send me an email or schedule a meeting at any time.

a) Zhang, Kai, et al. "Learning deep CNN denoiser prior for image restoration." *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2017.

b) Cascarano, Pasquale, et al. "Plug-and-Play gradient-based denoisers applied to CT image enhancement." *Applied Mathematics and Computation* 422 (2022): 126967.

Submission: The project does NOT need to be submitted**.**
The results obtained from the project experiments will be discussed during the exam, according to the procedures that will be communicated in the upcoming lectures.