Algoritmi unrolling per tomografia ad angoli limitati

Componenti del gruppo:

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Aim of the project:

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

Project description:

1. Implement an unrolling method (specifically, the one described in Adler's paper cited in the bibliography) and apply it to the reconstruction of CT images in limited-angle geometry. Use a Residual U-Net as the network architecture.
2. Compare the results of the unrolling Plug-and-Play algorithm with those of a model-based reconstruction using Total Variation regularization.

Dataset: Mayo Clinic Dataset (CT)

https://drive.google.com/drive/folders/13BEiz6t57qSbwBpCtfqllmYTLmkhQeFE?usp=share_link

Required Outputs

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, showing 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.

Bibliography:

Below are some reference papers that may assist in carrying out the project (use Google Scholar to search for and download the articles). However, scientific literature—especially in this field—is generally very complex and requires a set of foundational knowledge that can be difficult to attain.

For this reason, it is recommended to make use of the numerous blogs and websites that describe the methodologies required for the project in much simpler terms than the papers, as well as large language models (LLMs) that can assist in both code development and understanding.

Finally, I would like to remind you that the purpose of this project is a direct "collaboration" with the supervising professor. Therefore, do not hesitate to send me emails or schedule meetings at any time.

a) Adler, Jonas, and Ozan Öktem. "Learned primal-dual reconstruction." *IEEE transactions on medical imaging* 37.6 (2018): 1322-1332.

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.