

## General Overview of the Code for Homogeneous Reconstruction

The purpose of this document is to provide a general overview of the code developed for homogeneous reconstruction, based on the hierarchical optimization framework (as described in Chapter 3 of my thesis). For clarity, only the main functions and files are presented here.

- The main function, named `gd_importance_sampling_3d`, implements the hierarchical optimization algorithm. It is located in the file `gradient_descent_importance_sampling.py` within the `learning_algorithms` folder. This function supports two types of volume representations: a voxel-based representation in the Fourier domain, and a Gaussian Mixture Model (GMM) representation. Further details on how to use this function are provided in its documentation.
- The `mains` folder contains various Python scripts demonstrating the usage of the aforementioned function. It is divided into two subfolders: `real_data` and `synthetic_data`, which include scripts for testing the method on real and synthetic datasets, respectively.
- The file `generate_data.py` in the `data_generation` folder provides functionality to generate simulated data based on ground truth objects. It rotates the 3d object in a set of random orientations, translate them , apply a convolution to simulate anisotropy of resolution then add a random gaussian noise.
- The `volume_representation` folder includes Python code that defines volume representation classes. The `Fourier_pixel_representation` class (in the file `pixel_representation.py`) corresponds to the voxel-based representation, while the `GMM_representation` class (in `GMM_representation.py`) implements the Gaussian Mixture Model representation.
- The file `metrics_to_compare_2_images.py` (in the `metrics_and_visualization` folder) implements various metrics to compare two images. These include SSIM, FSC, cone-shaped FSC, and Dice coefficient.
- The file `classes_with_parameters.py` defines classes that store the hyperparameters associated with different parts of the pipeline. The `ParametersMainAlg` class contains the hyperparameters related to the main function `gd_importance_sampling_3d`. The `ParametersDataGeneration` class holds the parameters for synthetic data generation. The `ParameterSGMM` class defines parameters specific to the GMM-based volume representation.