Introduction

For 3D microstructure characterization in material science, X-ray tomography is an attractive non-destructive technique. To exploit this technique a series of data processing steps are required in the tomography pipeline. Each of these steps can be performed using a variety of methods and each step will introduce errors and uncertainty to different degrees that will propagate through the pipeline. This means that it is challenging to assign meaningful error bars to the extracted material parameters, which in turn limits the strength of the conclusions that can be drawn based on the measurements. In this project, we look into the uncertainty in the extracted material parameters, aiming for a better understanding of how errors propagate through the pipeline of tomography and affect the accuracy of the final result.

The tomography pipeline

**Problem**
Each of the steps in the pipeline can be performed using a variety of methods. Errors and uncertainty is introduced that will propagate through the pipeline. This makes it challenging to assign meaningful error bars to the extracted material parameters.

**A theory that models and propagates errors and uncertainty through the analysis pipeline is crucially needed.**

Initial investigations will focus on the segmentation and measurement steps.

**Issues with the current approach**
When measuring material parameters in the segmented data, the accuracy depends on the quality of the segmentation. Often, the evaluation of the segmentation quality is based on what visually appears to be correct. This is problematic because it introduces an operator bias, can be time consuming and makes the results difficult to reproduce. For huge data sets like tomography time series, manually assessing the segmentation result is no longer feasible. Moreover, the lack of a ground truth makes it challenging to assess the uncertainty.

Further work
The ultimate goal of the project is to model the entire pipeline such that all sources of errors and uncertainty can be traced back to physical sources (e.g. material properties and data acquisitions parameters). This will in turn provide higher accuracy and enable assignment of meaningful error bars to the extracted material parameters.

References

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