# Micro Project 2 B: AIR Stopping Rules

Per Christian Hansen, DTU, Denmark – pcha@dtu.dk
Jakob Sauer Jørgensen, DTU, Denmark – jakj@dtu.dk

## 1 The Problem: Stopping Rules for Iterative Methods

Software packages with implementations of algebraic iterative reconstruction (AIR) methods provide a number of different methods, but surprisingly few of these packages equip their methods with a stopping rule – except for the number of iterations. This is ok, as long as the user has a good intuition of how many iterations are needed. Nevertheless, it is interesting to study how well the standard stopping rules actually work, with an eye to their potential use in the CIL software package.

## 2 The Micro Project

This micro project is quite open-ended with the overall goal to investigate the use of the stopping rules presented in the lectures and exercises. In particular, it is interesting to study the *reliability* of these stopping rules when applied to larger problems solved by means of ASTRA. It is up to you to choose which stopping rules, iterative methods, and test problems to use, as well as how to evaluate the performance, robustness and reliability of the stopping rules.

- You do not need to modify the software; just run enough iterations and save the iterations $\boldsymbol{x}^{(k)}$ – then for each $k$ you can compute the needed quantities.
- To reduce storage you can save every $p$th iteration with, say $p = 10$. This is easy in AIR Tools II, see the documentation; with CIL you can repeatedly stop and restart after $p$ iterations.
- In all your experiments, use artificial test problems where you know the ground truth such that you can determine the optimal number of iterations.
- Choose one or more of the three stopping rules fit-to-noise-level, UPRE and GCV, using one or both of the trace estimates $\bar{t}_k^{\text{est}}$ and $t_k^{\text{est}}$.
- Study the use of the stopping rules in conjunction with one or more of the methods ART, Cimmino, and the method called SART in AIR Tools II and SIRT in CIL.
- You should probably start with experiments using small matrices, where you can initially compute the exact trace $t_k$.

## 3 Practical information and assessment

You will be working together in groups of 3–4 students. At the end of Friday, from around 2pm, each group will present their work to the lecturers and other groups in 10–15 min oral presentations, and each group member is expected to contribute. There is no written report – assessment is solely based on the oral presentation. In the presentation please explain what you have chosen to investigate, which theory/tools you have used, show your results (plots, reconstructions, etc.) and state your conclusions.