Computed Tomography on all Scales using the ASTRA-Toolbox

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Tomography on all Scales

Computed Tomography (CT) is an imaging technique that has been in use for decades in medical settings. There are however many applications outside the field of medicine that could also benefit from tomographic imaging. These applications need not be restricted to a single length scale. A few examples:

- Individual atoms of **nanocrystals** can be located with sub-Angstrom resolution.
- Virtual models of **raw diamonds** can be constructed with µm-precision.
- **Trabecular bone** can be visualized, also at the µm-scale.
- At a very large scale, the location of **galaxies** can be determined.
- ...

Reconstruction problems at different scales,

- share many **common features,** and can thus be solved using similar methods.
- have some **important differences** as well, such as prior knowledge, different projection geometries, ...

It would be very useful to have a **single tomography platform** that could provide an extensive set of **basic algorithms** while leaving enough freedom to easily **modify** the tomographic reconstruction process according to some specific needs.

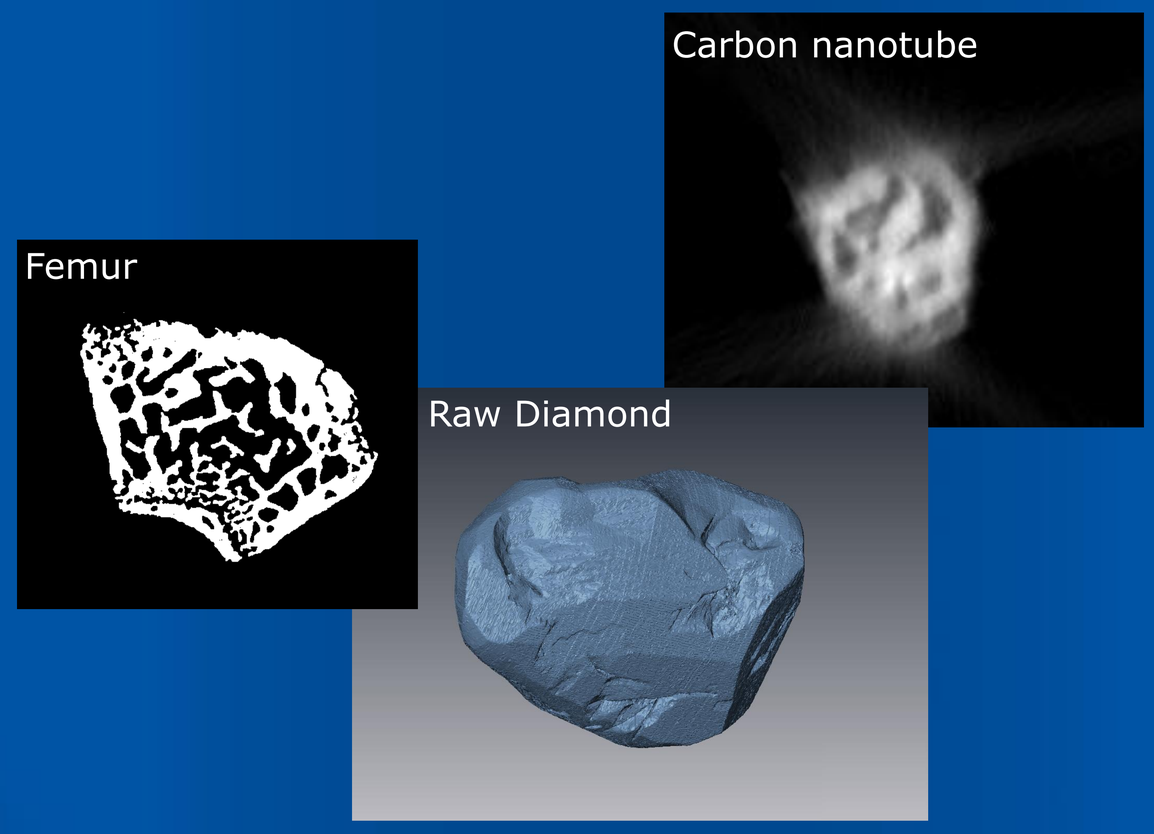

Figure 1: Different fields where tomography can be used.

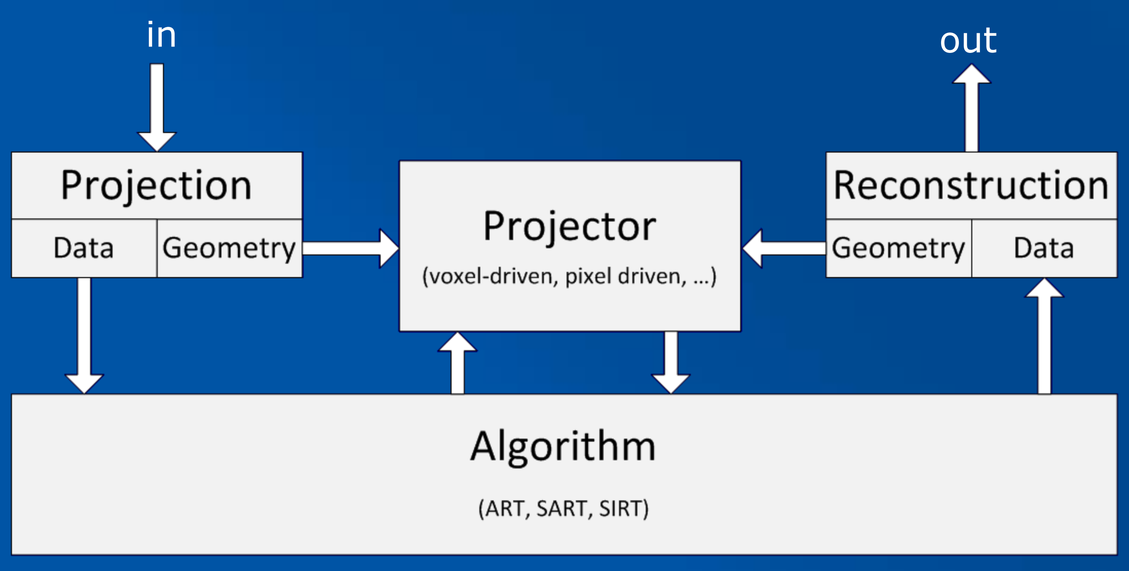

Figure 2: Workflow of a reconstruction using the ASTRA-Toolbox

The ASTRA-Toolbox

By focusing on the underlying general mathematical reconstruction problems instead of a specific application field, our goal is to **distribute our knowledge of CT** across multiple application fields. Therefore, we are developing the ASTRA-toolbox ("All Scale Tomographic Reconstruction Antwerp").

Some of its main goals are:

- **Speed:** We use C++ to provide fast and efficient implementations.
- **Open, modular and extensible:** A user can add or change algorithms according to his specific needs.
- **Easy to use**, even for those who lack experience in C++. To that extent we provide a wrapping layer around the core ASTRA-toolbox that brings the fast C++ implementations to the MATLAB environment.
- **Platform independence**

Current Key Features

In the first release of the ASTRA-toolbox, the following features are available:

- **Algebraic Reconstruction Techniques:** ART, SART and SIRT
- **Parallel-beam projectors:** both voxel-driven and pixel-driven and both using a voxel grid as well as radially symmetric kernels.
- Support for **fan-beam and other 2D projection geometries** by means of projection data rebinners.
- **File handling capability** for several popular data formats.
- Easy to use **MATLAB wrapping layer**.

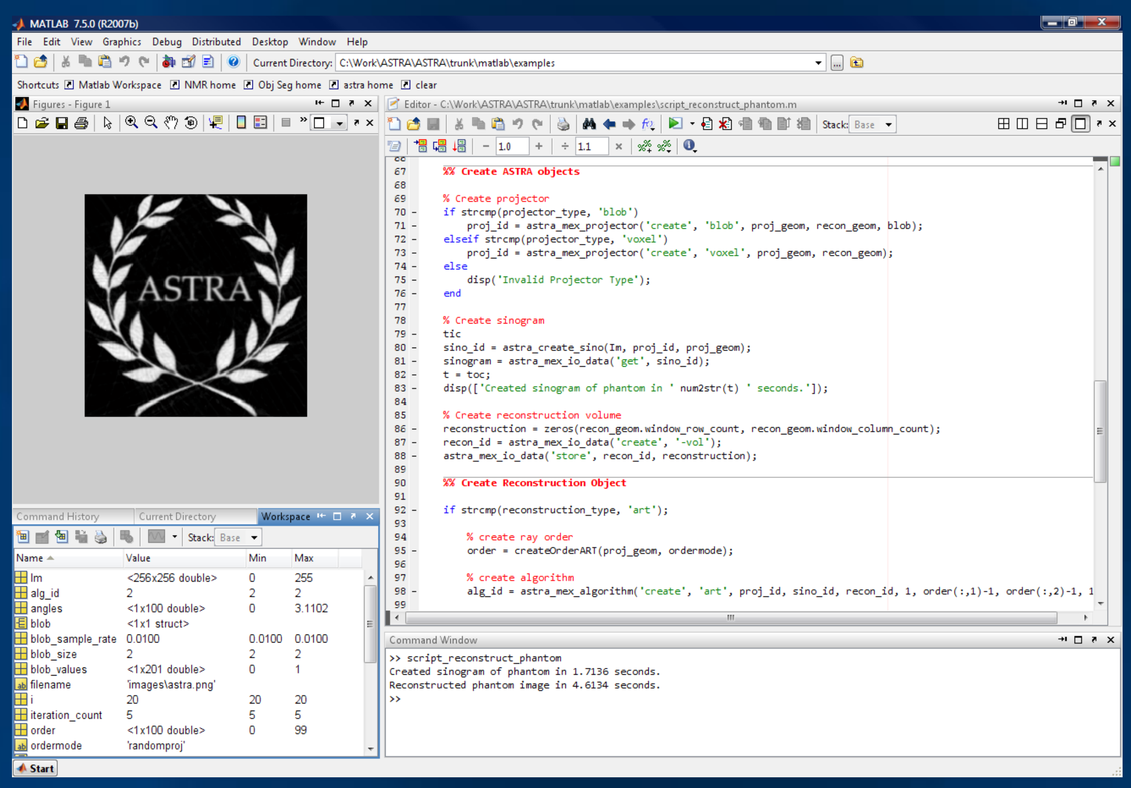

Figure 3: Screenshot showing the MATLAB wrapping layer.

Future Features and Research

For future versions, we will perform research on various aspects of CT:

- Competitive projection algorithms for **cone-beam** and other types of projection geometries.
- l1-norm minimization and TVM when only a few **sparse projections** are available.
- **Advanced segmentation algorithms** and **discrete tomography** (DART).
- Harvesting the power of modern GPU-cards for **real-time reconstructions**.
- ...

More Information?

visit http://www.astra.ua.ac.be