

CCP PET-MR Hackathon 2

17-19 Dec 2018

St Thomas' Hospital

Attendees

1. David Atkinson (UCL)
2. James Bland (KCL)
3. Richard Brown (UCL)
4. Sam Ellis (KCL)
5. Abolfazl Mehranian (KCL)
6. Camila Munoz (KCL)
7. Evgueni Ovtchinnikov (STFC)
8. Edoardo Pasca (STFC)
9. Andrew Reader (KCL)
10. Razvan Sencu (Manchester)
11. Kris Thielemans (UCL)
12. Alexander Whitehead (UCL).



Aims

- Train new developers in SIRF (Python)
- Port a synergistic algorithm (with existing implementation) to SIRF (Python)
- Resolve remaining issues with processing data from the mMR (MR and static PET)
 - Finish image geometry
 - Test on more data (mMR software VE11 SP3)
- SIRFReg
 - Finalisation and testing
 - Start with MCIR in SIRF

Training

We used the [SIRF-Exercises](#) and SIRF/examples/Python as a basis for getting familiar with the code, VM, jupyter notebooks and spyder.

These were used as a starting point for developing bits of code, either independently or in small teams.

Examples included a minimal code-set to illustrate PET projections and a gradient descent MR reconstruction.

Code-setup and mechanisms

- Created SIRF-Contribs repo on <https://github.com/CCPPETMR/SIRF-Contribs>
- Attendees were given write access
- Project set-up
- Create issues inside SIRF-Contribs:
 - Implement MAPEM
 - Resampling adjoint
 - Image Geometry fill ISMRMRD
 - Abi's synergistic algorithm
 - Implement Gaussian Kernel Prior
- No intention to create “clean” code, but to get something working (Python only)

Implement MAPEM

The SIRF example Python code for the isotropically weighted quadratically penalised MAPEM algorithm was used as a starting point, both in terms of data to be reconstructed and structure of code. The De Pierro algorithm was written in a series of functions embedded in a script providing example usage. This code was tested for 2 cases: 1) using uniform (i.e. isotropic) weights 2) using Bowsher weights calculated using the Prior class also introduced during the hackathon. Based on these results it seems that the De Pierro MAPEM implementation is working, and ready to be fully incorporated into the SIRF framework in future.

Sam Ellis, Camila Munoz, James Bland

SIRFReg progress

It is now possible (with a small amount of work post-Hackathon) to convert STIRImageData objects into NiftiImageData3D objects. As long as an image can be converted into the NiftiImageData format, registration/resampling can be performed. This is therefore now possible with STIR, but requires more work in the MR side.

David, Richard, Evgueni, Alex

Abi's Synergistic Algorithm

We aimed to implement a regularized iterative SENSE MR image reconstruction with a weighted quadratic penalty (wQ-SENSE) optimized using either conjugate gradient or a classic gradient descent (GD). Initially, we tested the basic SIRF example, i.e. FullySampledReconstructor, for reconstruction of our fully-sampled 3D MPRAGE MR scan. The reconstructed image was correct without any noticeable artefacts. A 2D example dataset was then used to perform a wQ-SENSE-GD, using the Prior class.

Abolfazl Mehranian, Camila Munoz

Implement Gaussian Kernel Prior

A Prior Class was implemented in Python in order to

- perform finite forward and backward differences between image voxels over a neighbourhood, which is key part of a penalty function used in regularized PET and MR image reconstruction and
- calculate similarity kernels such as asymmetric Bowsher and symmetric Gaussians.

The class was debugged and used for MAPEM PET and wQ-SENSE MR image reconstructions.

Sam Ellis, Camila Munoz, Abolfazl Mehranian

Integration with CCPi CIL Optimisation

- Started at Hackathon 1
- Additional code modifications to the Python implementation of SIRF classes have been done in order to be able to use the CIL optimisation routines within SIRF.
- CIL optimisation package naming conventions with respect to methods and functions take from the underlying mathematical objects and it is different from what is normally used in SIRF. Therefore, particular emphasis has been devoted to documenting the new required methods and functions that were not present in SIRF.

Edoardo Pasca

Overall evaluation

- Overall very positive feedback.
- 2.5 day format was good.
- Useful to have the initial training at the start.

Many thanks to the KCL team (especially Camilla, Abolfazl and Ugwu Joy) for hosting us, and for showing the PET Centre at St Thomas to some of us.

Updates since the Hackathon

<https://github.com/CCPPETMR/SIRF-Contribs/commit/29ab88bb5a0032daa464c2617a49ba6881813902>

committed today by Sam!

Submitted
to PSMR

