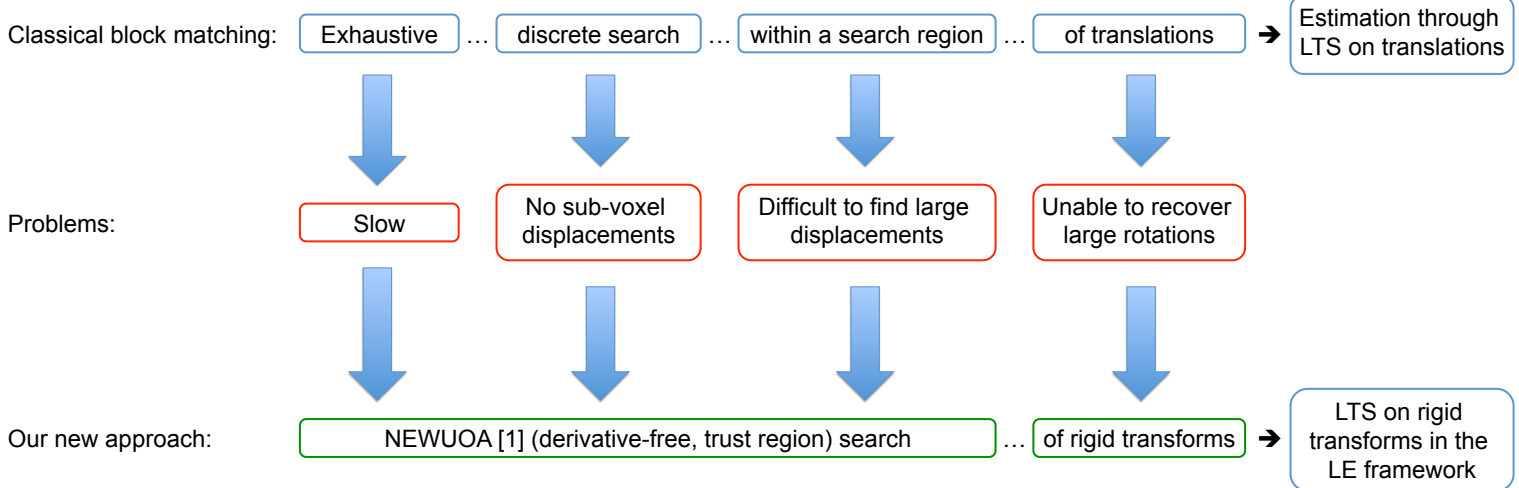


# Block-Matching Strategies for Rigid Registration of Multimodal Medical Images

## Material and Methods



### LTS criterion

- Estimation from the local rigid transforms  $R_i$
- LTS in the Log-Euclidean framework on rigid transforms [2]

$$\log \tilde{R} = \arg \min_R \sum_{i=1}^{n-h} (r^2)_{i:n}, \text{ where } r_i \equiv \|\log(R) - \log(R_i)\|,$$

and  $0 \leq h \leq \lfloor n/2 \rfloor$  and  $(r^2)_{1:n} \leq \dots \leq (r^2)_{n:n}$

### LTS solution

- Iterative least-squares problem
- At each iteration  $m$ ,  $\tilde{R}^m$  has a closed-form:

$$\tilde{R}^m = \exp\left[\left(\sum_{i=1}^{n-h} \log R_{i:n}^{m-1}\right) / (n-h)\right]$$

where  $R_{i:n}^{m-1}, i = 1 \dots n$  are the  $R_i$  ordered according to their residuals

## Experiments

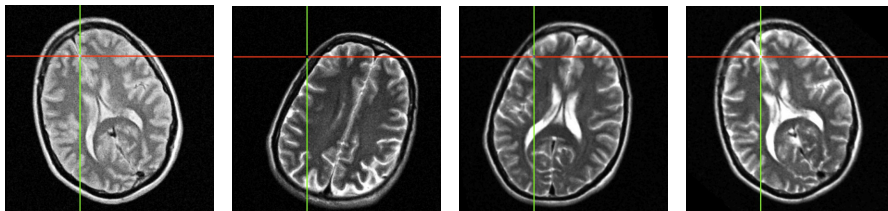
### Experiment 1

- T2 / PD dataset (256x256x44, 1x1x3 mm<sup>3</sup>)
- Random rigid transforms (angle range: 45 deg, translation: 10 mm)
- Registration with exhaustive search (FS), NEWUOA rigid search (N-Rig)

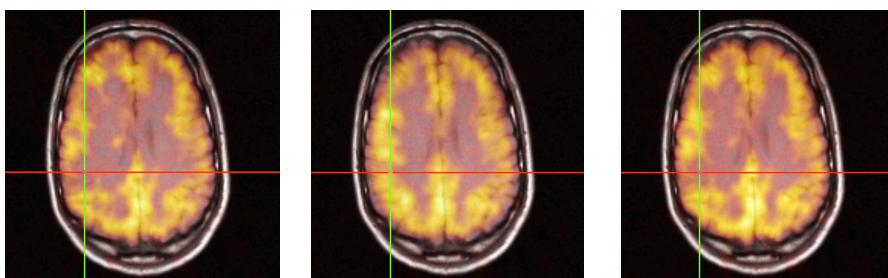
### Experiment 2

- R.I.R.E. training dataset (MR: 256x256x26, 1.25x1.25x4 mm<sup>3</sup>, PET: 128x128x16, 2.6x2.6x8 mm<sup>3</sup>)
- Registration with exhaustive search (FS), NEWUOA rigid search (N-Rig)

## Results



Reference image    Floating image    FS registration    N-Rig registration



True MR/PET alignment    FS alignment    N-Rig alignment

## Conclusion

- Improved robustness on simulated data
  - FS robustness: 65 %
  - N-Rig robustness: 99 %
- Equivalent or faster computation times
  - FS: 10 min
  - N-Rig: from 3 to 10 min
- Better accuracy on real MR/PET data
  - FS accuracy: 9.8 mm
  - N-Rig accuracy: 3.6 mm (sub-voxel)
- Future works
  - Account for bounds on parameters: BOBYQA
  - Easily extensible to other transformations
    - e.g. affine

[1] M.J.D Powell: The NEWUOA software for unconstrained optimization without derivatives. *vol. 83 of Nonconvex Optimization and Its Applications*, pp. 255–297, 2006.

[2] V. Arsigny, et al: A Fast and Log-Euclidean Polyaffine Framework for Locally Linear Registration. *JMIV*, vol. 33, no. 2, pp. 222–238, 2009.