

Workflow-based medical image analysis algorithms assessment

Medical imaging session

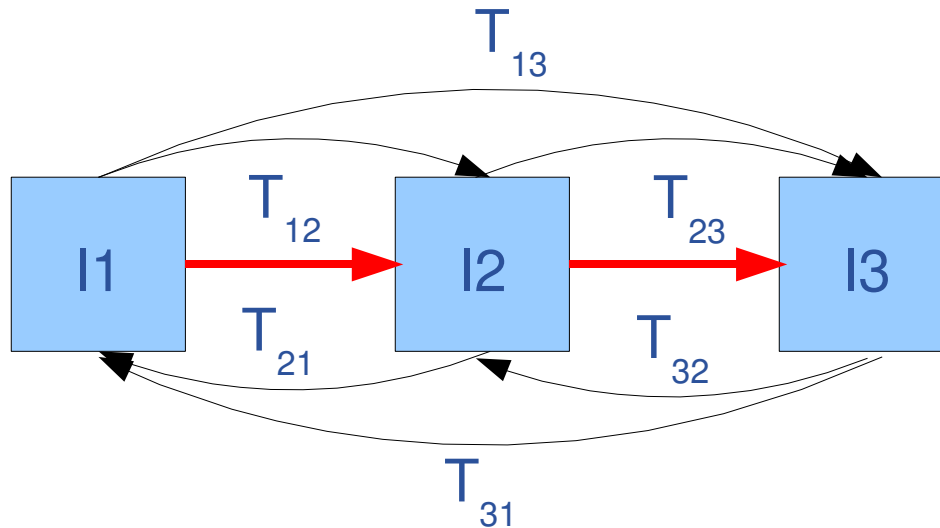
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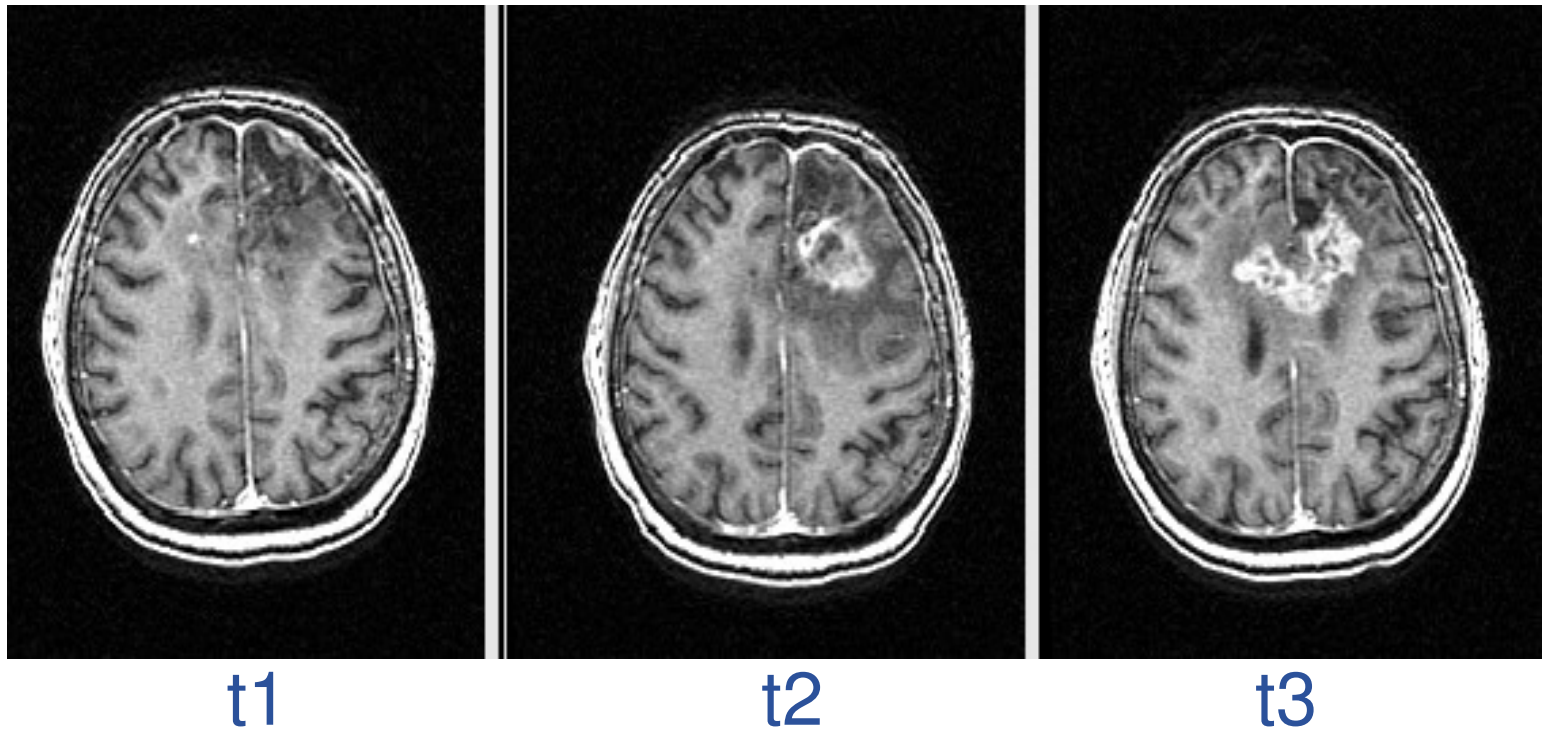
- **Assessment of rigid registration algorithms**
 - Lack of reference or “gold standard”
 - Experimental framework to re-evaluate in different conditions
- **A statistical solution**
 - The Bronze Standard method
- **A grid implementation**
 - Workflow-based
 - The larger the test sample, the more accurate the evaluation

- N images, m algorithms
 - $N \cdot (N-1) \cdot m$ transformations measured
 - $N-1$ transformations to estimate
- } Redundancy



- **Exploit redundancy to compute**
 - Mean transformations \overline{T}_{ij} (Bronze standard)
 - Variances on the transformations (Accuracy)

- 126 images
- 2 time points minimum
- Gadolinium injected T1 MRIs
- Example for one patient (3 time points):



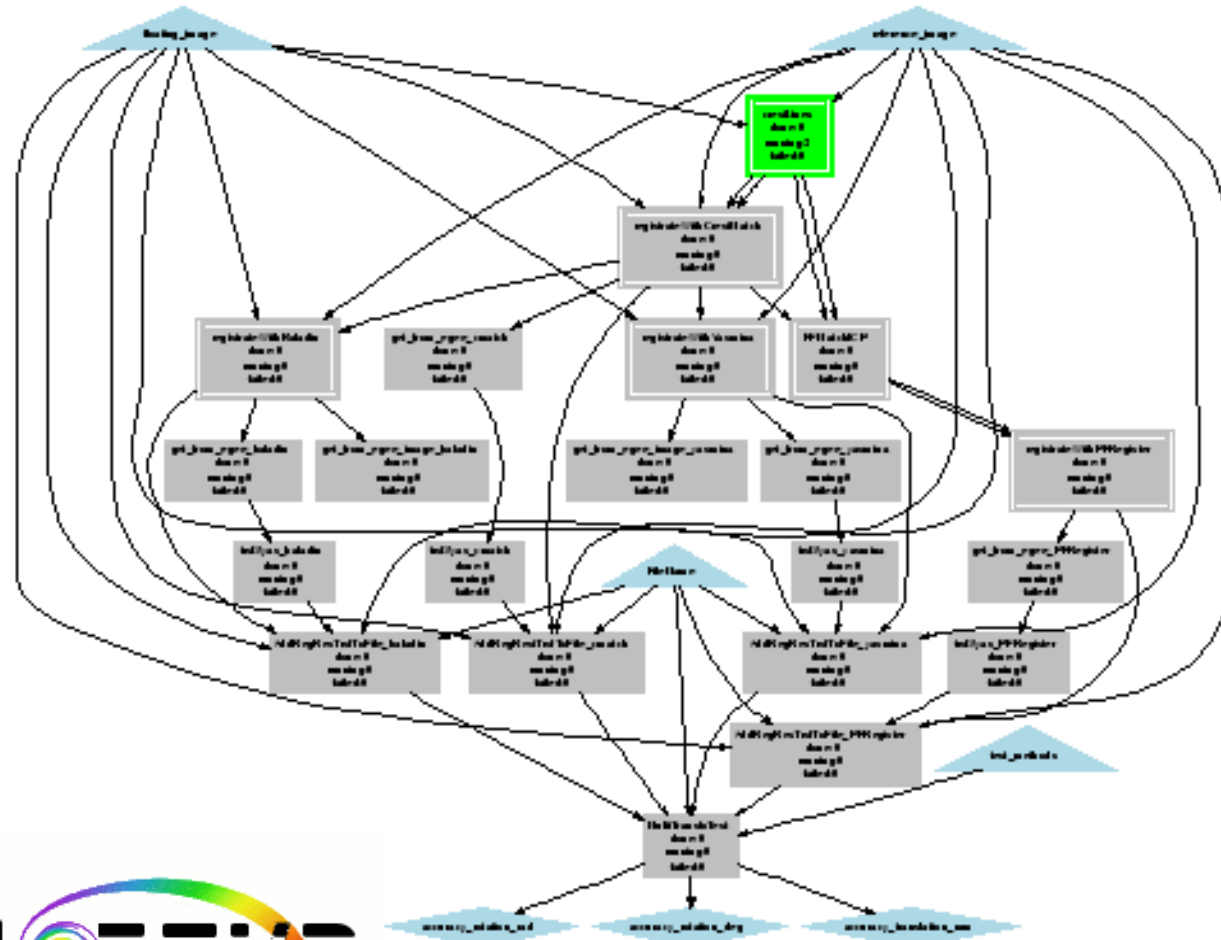
t1

t2

t3

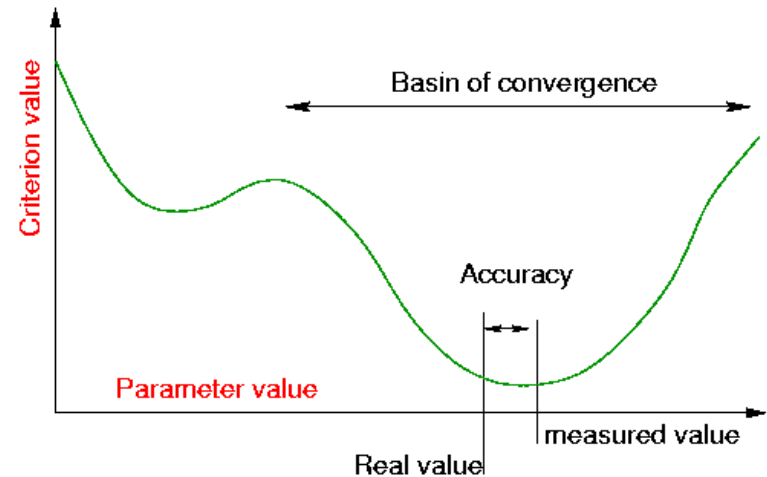
- Computing weight

- 126 image pairs x 4 algorithms x 6 CR = 3024 registration computations
- 7.5 days on a single PC
- 4.8 hours on Grid'5000



- **Optimization criterion:**

- Several basins of attraction
- Problems of convergence



- **Robustness: ability to find the right transformation (success/failure)**

- Number of outliers detected by the χ^2 test + visual inspection

- **Accuracy: variability w.r.t. the ground truth**

- Distance to the BS computed on uncompressed images

- Mean error on the transformations:

$$\sigma_r = 0.130 \text{ deg} ; \sigma_t = 0.345 \text{ mm}$$

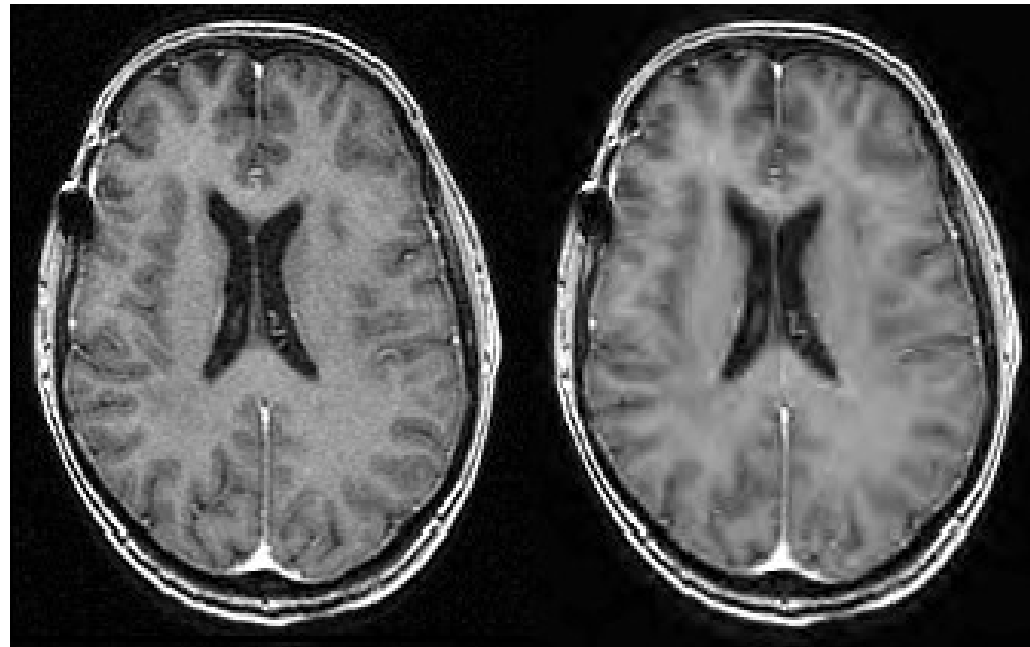
- Error on the bronze standard:

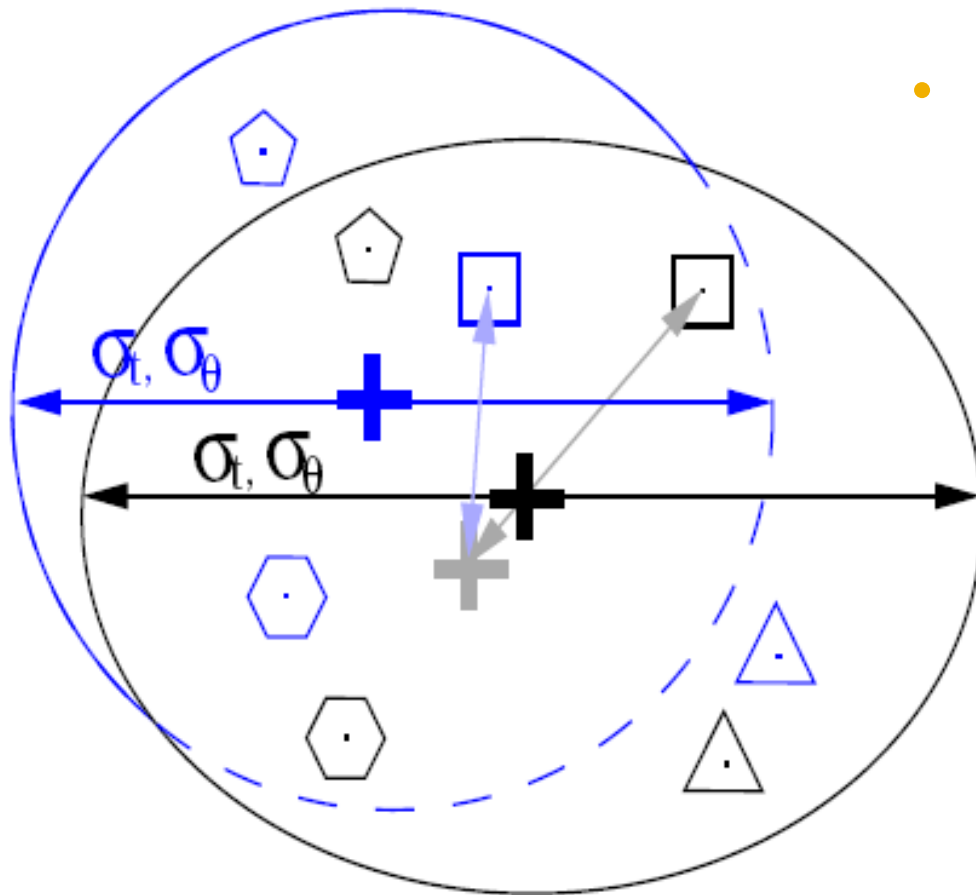
$$\sigma_r = 0.05 \text{ deg} ; \sigma_t = 0.148 \text{ mm}$$

- Accuracy of the algorithms:

Algorithm	σ_r (deg)	σ_t (mm)
CrestMatch	0.150	0.424
PFRegister	0.180	0.416
Baladin	0.139	0.395
Yasmina	0.137	0.445

- **3D-SPIHT algorithm**
 - Zero-tree-based compression algorithm
 - Very good performances reported for 2D
 - Extended to 3D (3D wavelet transform)
- **Compression Ratio (CR)**
 - 6, 12, 24, 48, 64
 - Example without compression and at CR=64:





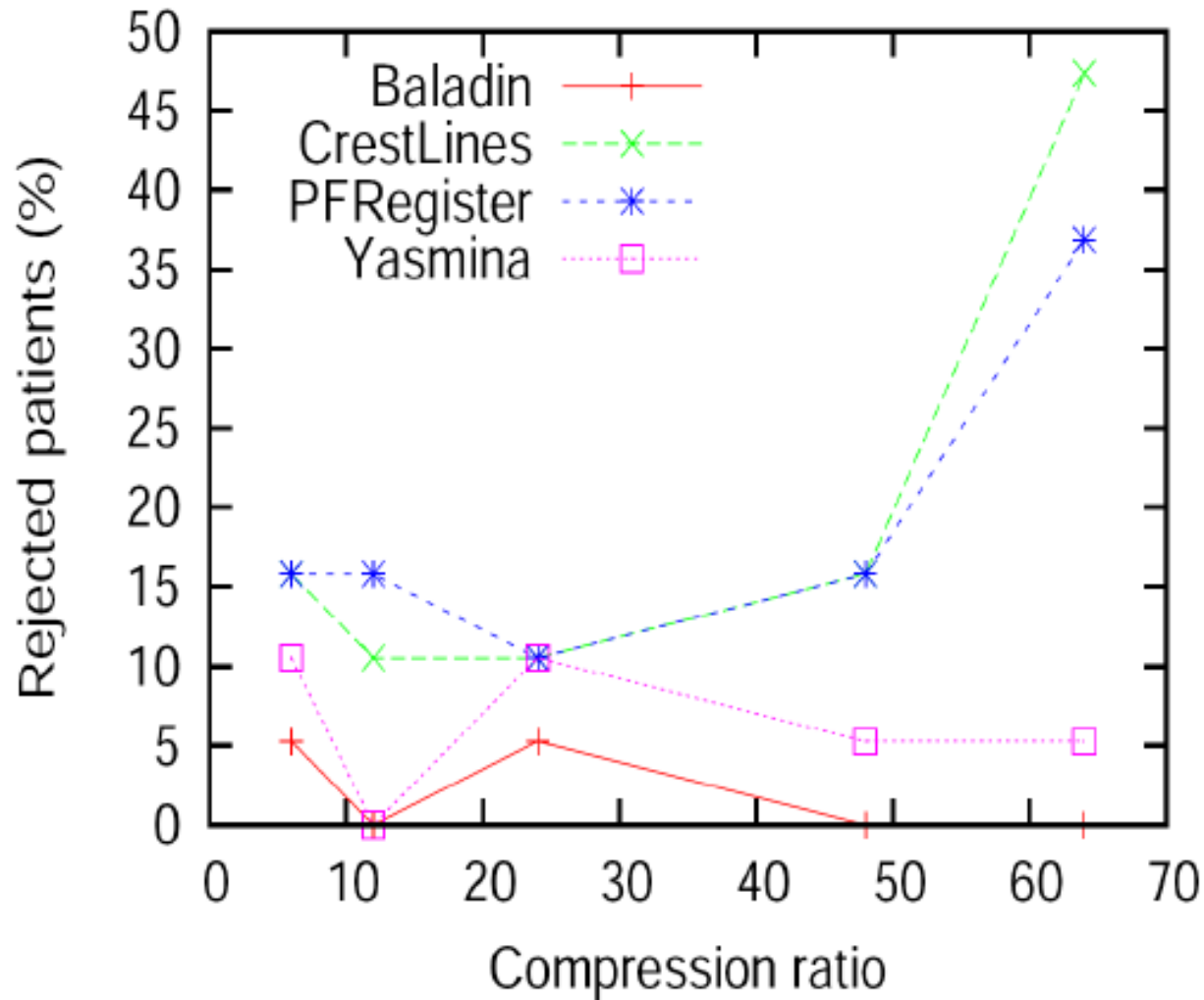
- **Legend**

Black: reference data
(uncompressed images)

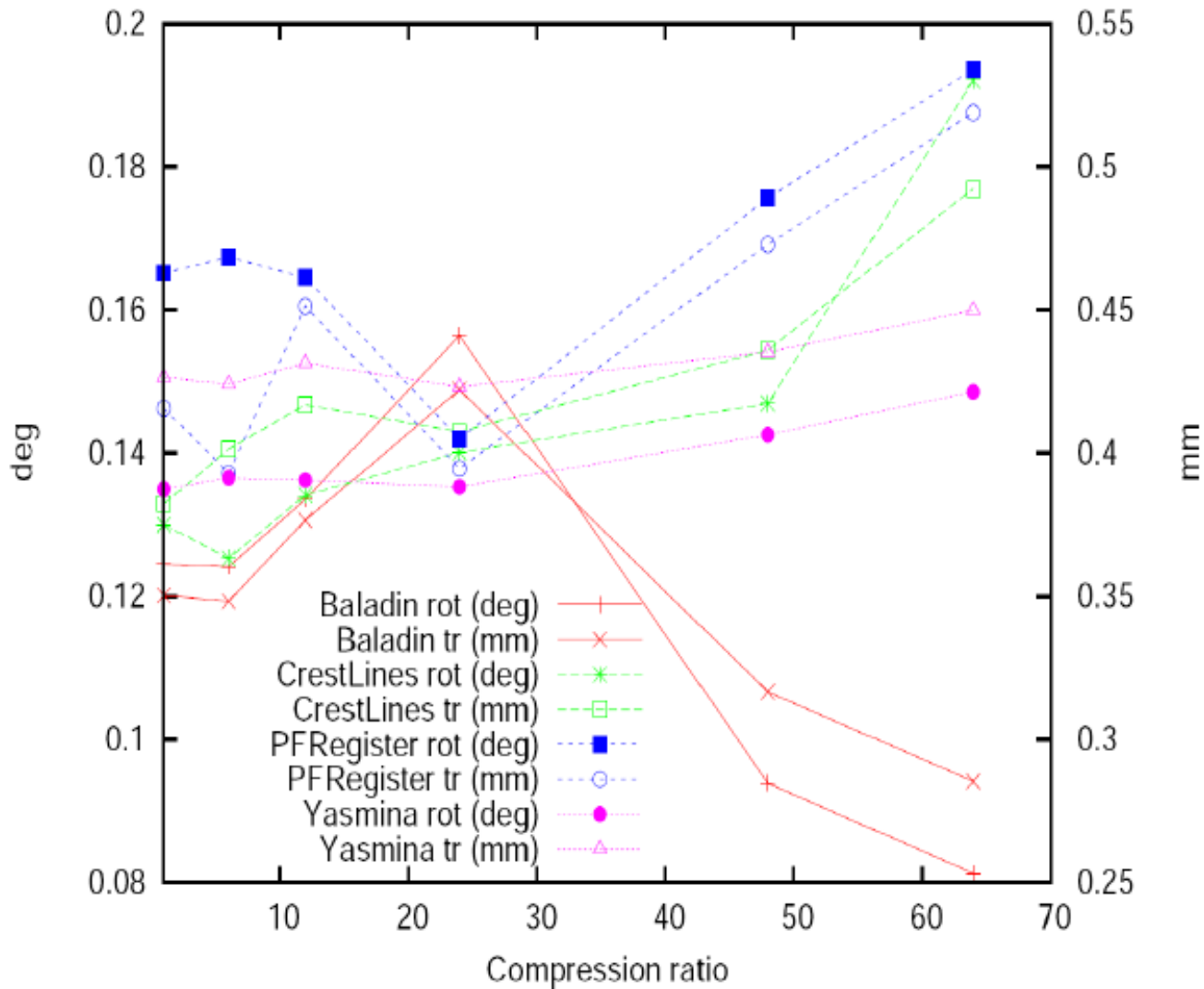
Blue: compressed data

\triangle , \square ...: algorithms

\oplus : Bronze Standard



Baladin and Yasmina are the more robust (multi-scale strategies)



Performance acceptable up to CR=64

Improvement of Baladin

- **Quantitative assessment of rigid registration algorithms**
- **Impact of lossy compression on rigid registration of brain images**
 - Loss of robustness
 - Good accuracy
- **Grid-computing for medical imaging algorithms assessment**
 - Exploit databases
 - Compare algorithms
 - Explore parameters space