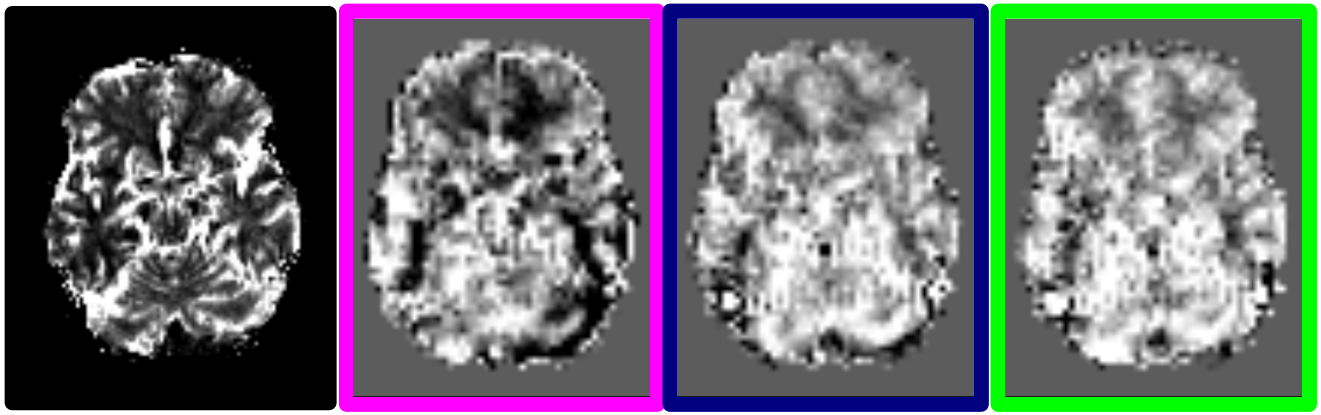
Robust perfusion maps in Arterial Spin Labeling by means of M-estimator

Camille Maumet[1], P. Maurel[1], J.-C. Ferré[1,2] and C. Barillot[1]

1. Inria, IRISA, Unit/Project Visages, Rennes, Brittany, France

2. Department of Neuroradiology, CHU Rennes, Rennes, Brittany, France

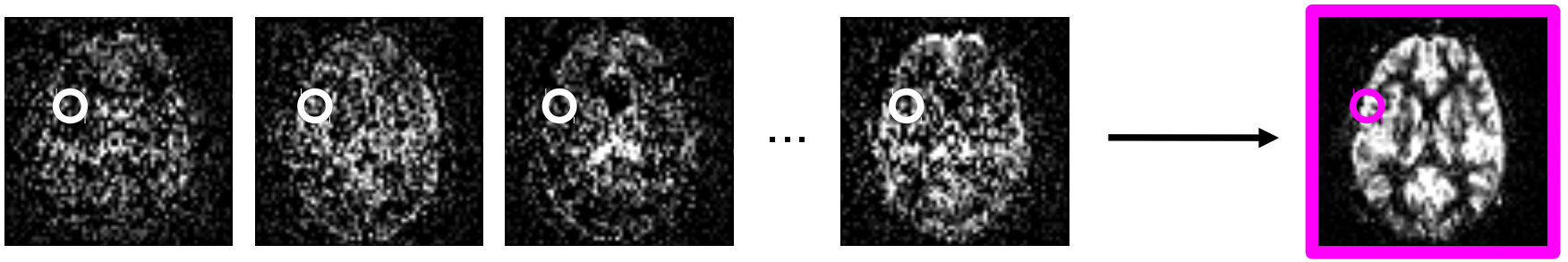


DSC CBF | ASL CBF Average | ASL CBF Z-score | ASL CBF M-estimator

Monitor 9

Introduction

- In ASL, the acquisition is usually repeated several times and the perfusion information is calculated by averaging across the repetitions.



Introduction

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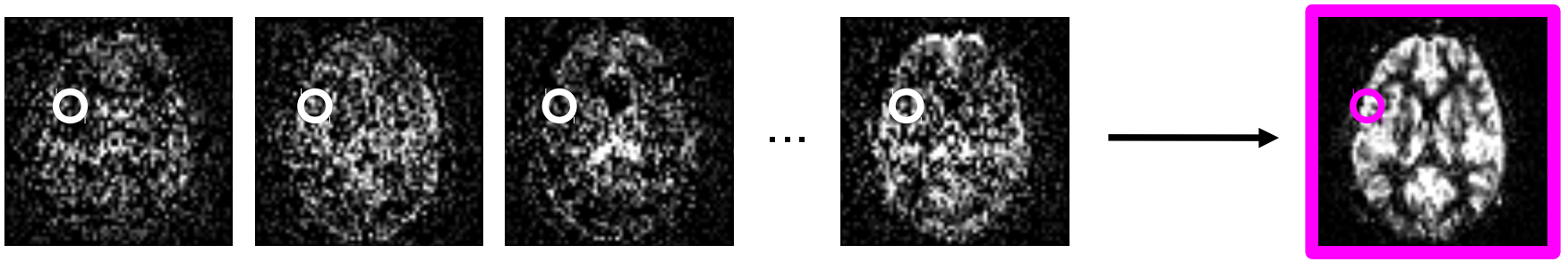
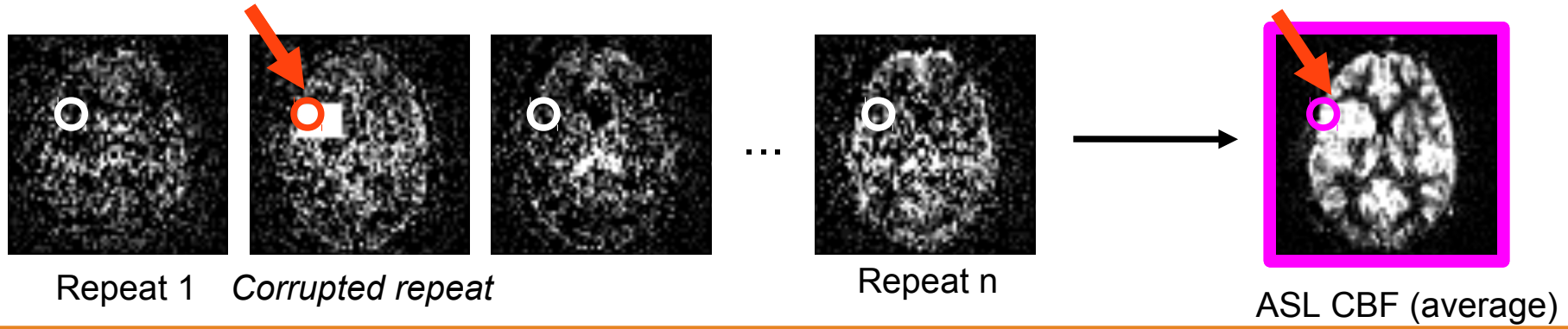
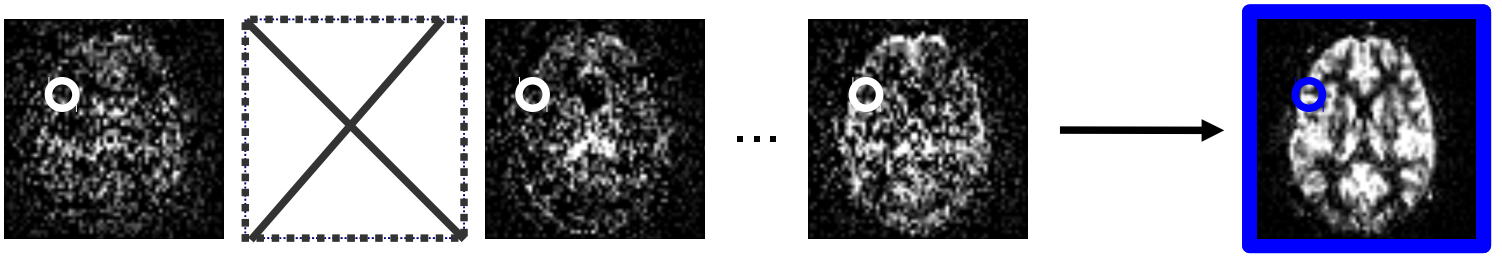


- But the sample mean is very sensitive to outliers.

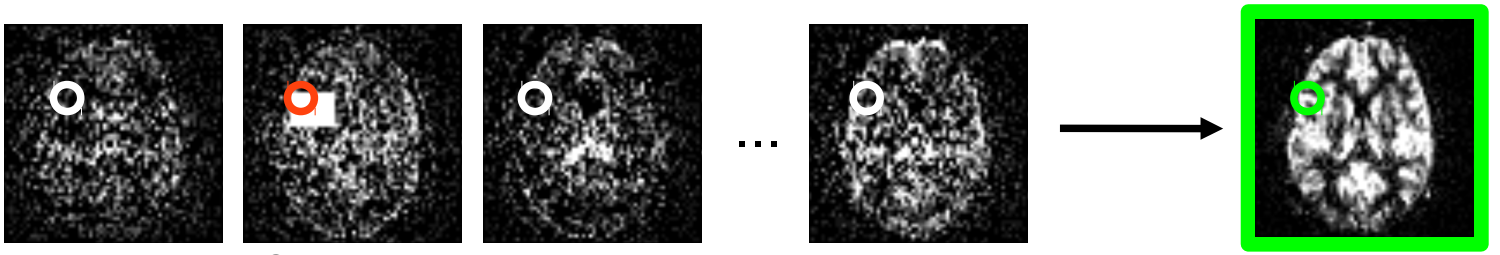


Theory

- In the literature, Tan et al. proposed an outlier removal technique based on z-scores applied to the mean (or standard deviation) of the volume intensity:

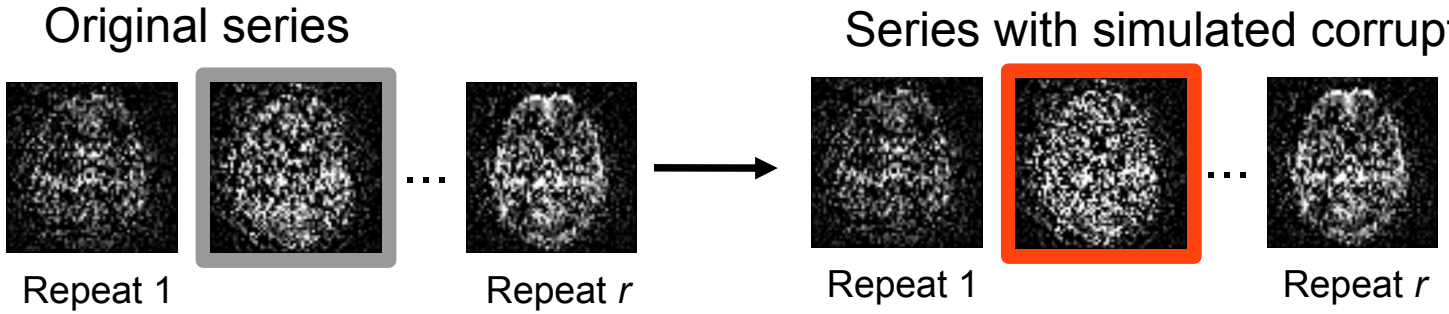


- We propose to rely on robust statistics, namely Huber's M-estimator:



Method

- **Experiment 1:** Illustration of the theoretical behavior of the 3 estimates.
- Simulated corruption:



For each corrupted volume

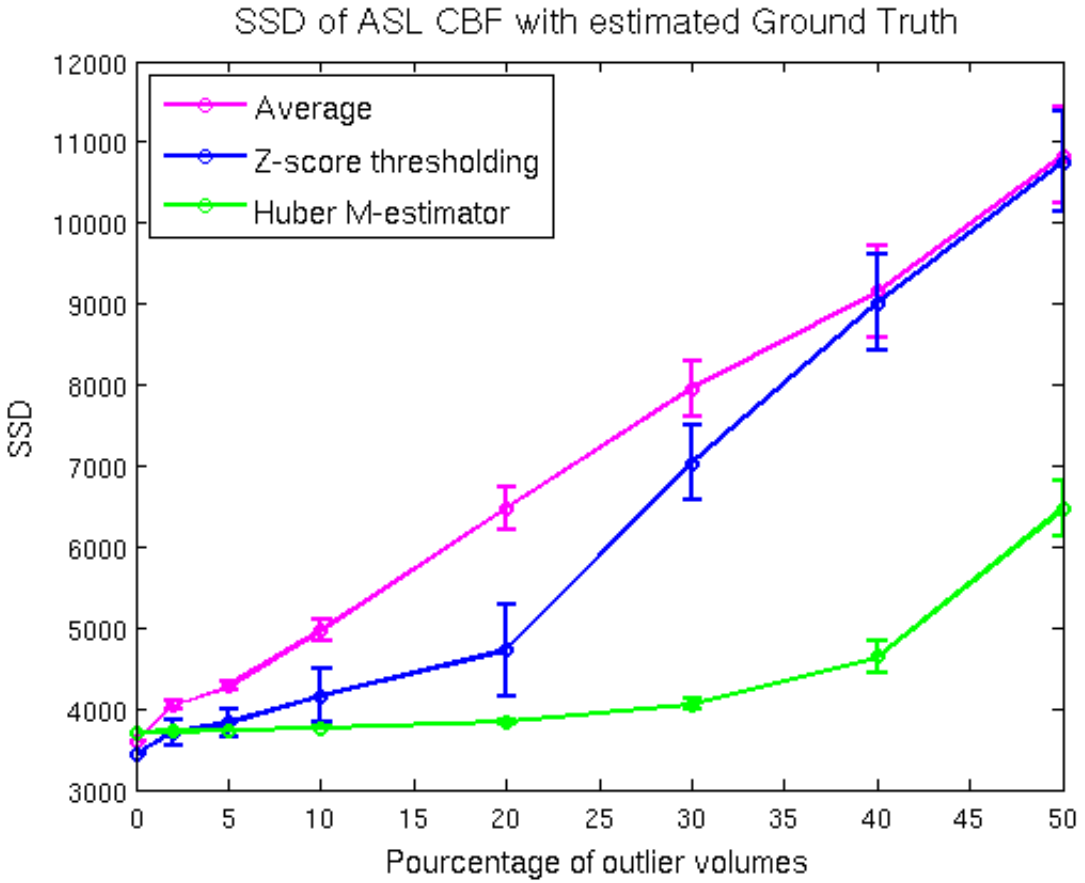
- Comparison of each estimate with the ground truth computed by averaging a very long ASL sequence (~25 min).

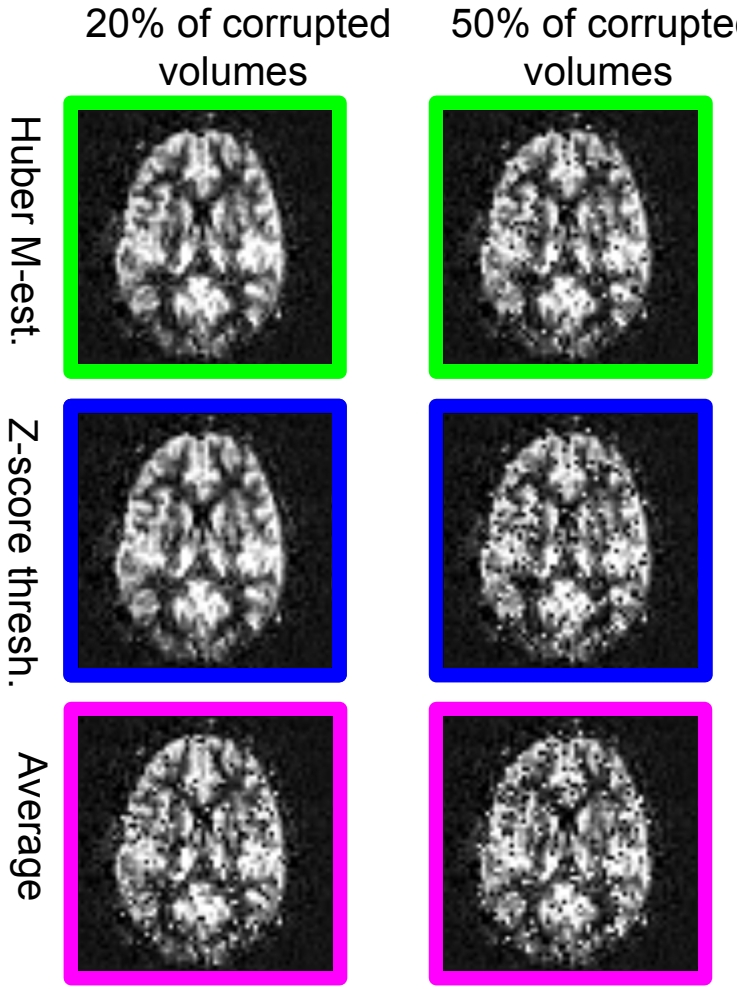
Method

- **Experiment 2:** Performances of the 3 estimates on real clinical datasets.
- Data:
  - 26 patients diagnosed with brain tumors.
  - PICORE Q2TIPS PASL, 60 repetitions
  - Dynamic Susceptibility Contrast imaging (DSC)
- Decimation of the data to get from 5 to 50 repetitions.
- Comparison of each estimate with the ground truth computed by from the DSC sequence with a correlation coeficient.

Results

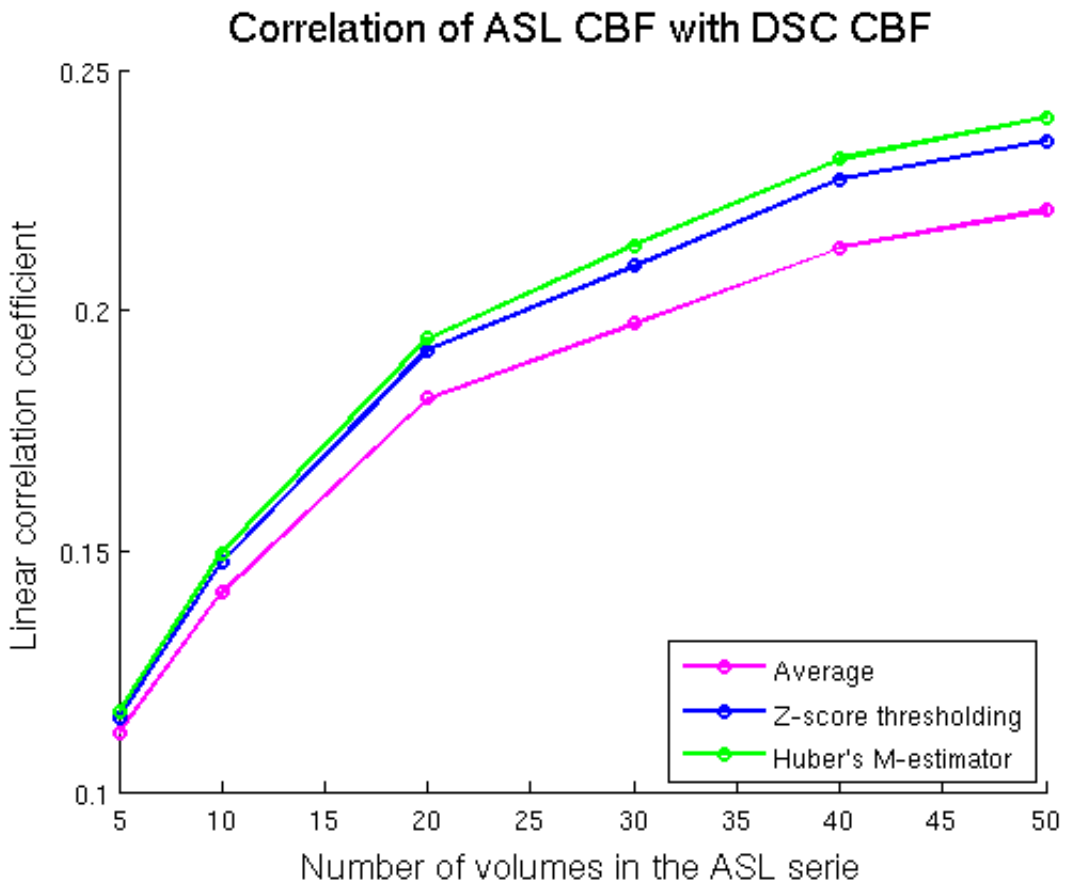
- **<u>Experiment 1:</u>** Illustration of the theoretical behavior of the 3 estimates.

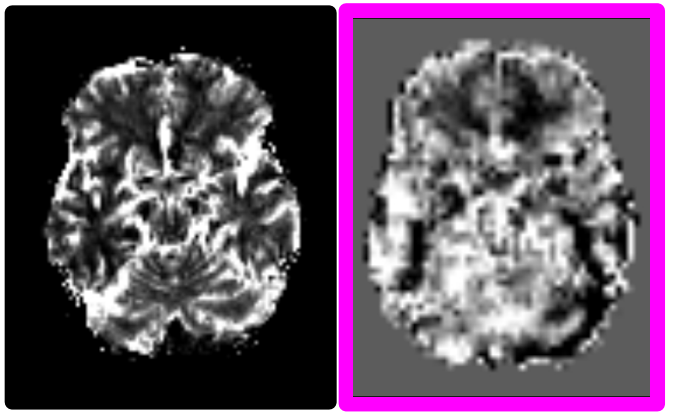




Results

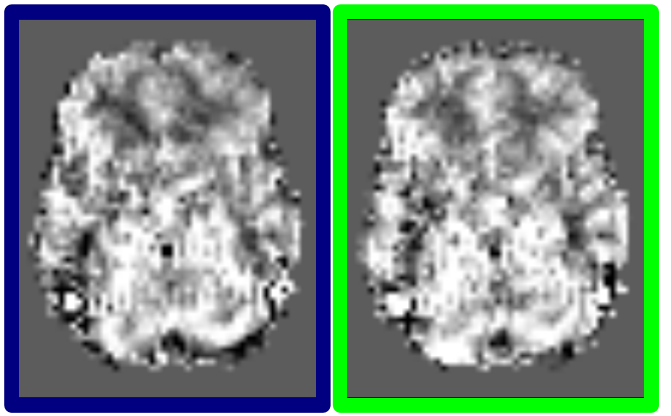
- **<u>Experiment 2:</u>** Performances of the 3 estimates on real clinical datasets.





DSC CBF
Ground truth

ASL CBF
(Average)



ASL CBF
(z-score)

ASL CBF
(Huber's M-est.)

Conclusions

- We studied the behavior of z-thresholding and Huber's M-estimators to compute CBF estimates in ASL.
- On theoretical ground, Huber's M-estimator is clearly more robust than z-thresholding.
- On the tested clinical cases, the superiority was less pronounced but still present.
- Overall, both robust methods outperform the sample mean on simulated and real data. In patient populations, where artefacts are more frequent, we advise the use of a robust approach to compute CBF maps in ASL.