Automatic detection of patient-specific perfusion abnormalities in Arterial Spin Labeling

COST AID meeting

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October 15th, 2012

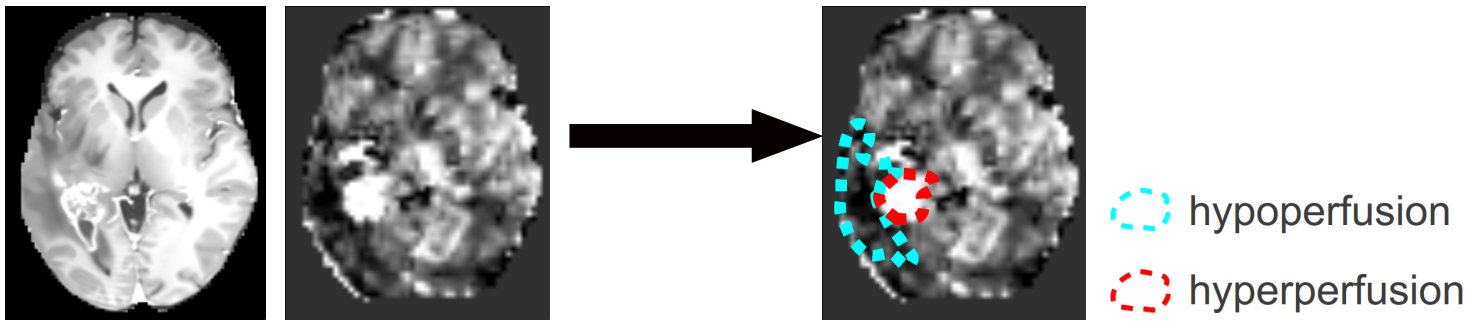
Outline

Outline

Context

Objective

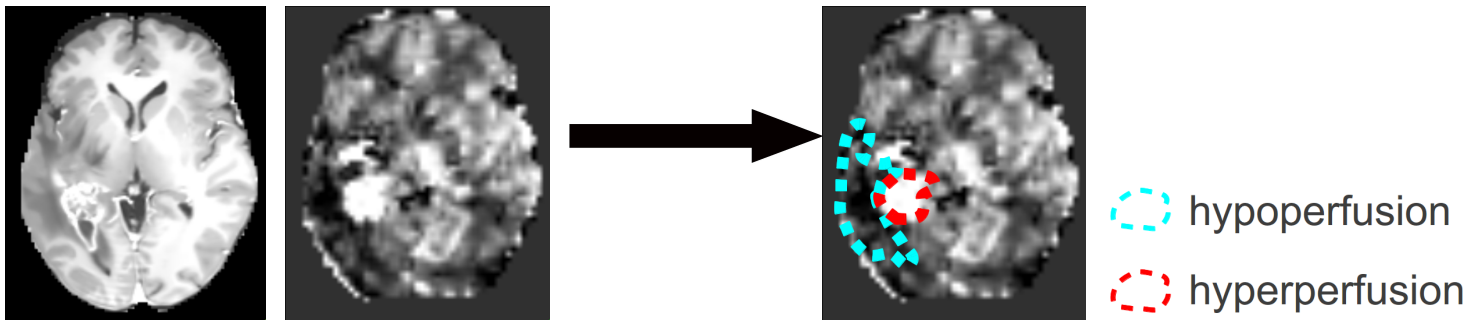
Quantitative *identification of* **voxelwise patient-specific** *perfusion abnormalities.*



Context

Objective

Quantitative *identification of* **voxelwise patient-specific** *perfusion abnormalities.*



Challenges:

- Low signal-to-noise ratio of the Q2TIPS PASL sequence.
- Presence of artefacts.

Outline

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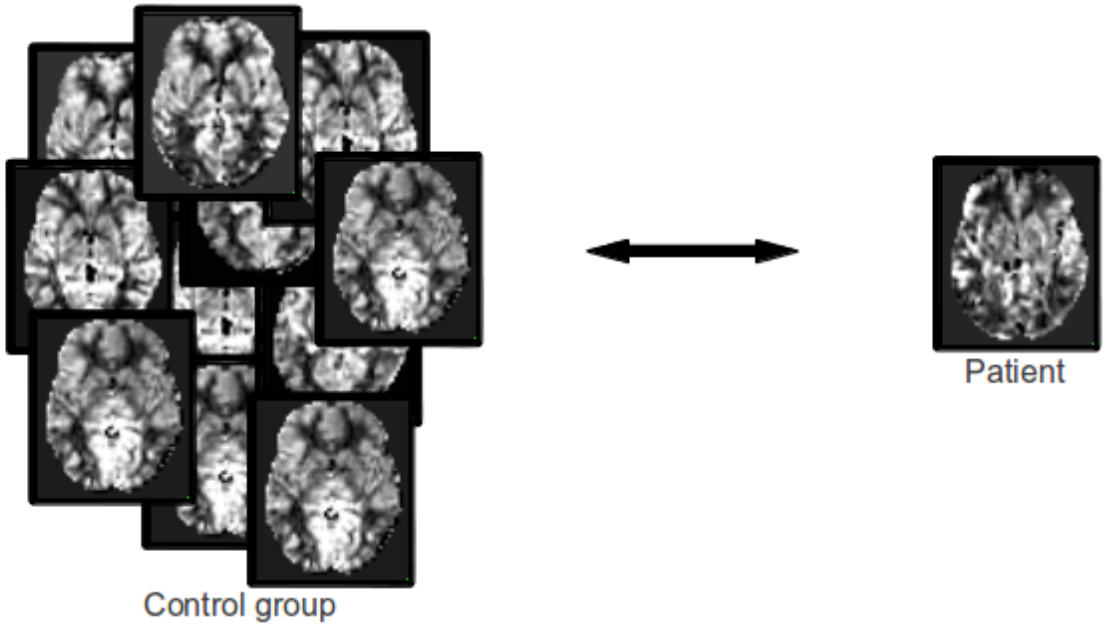
Method



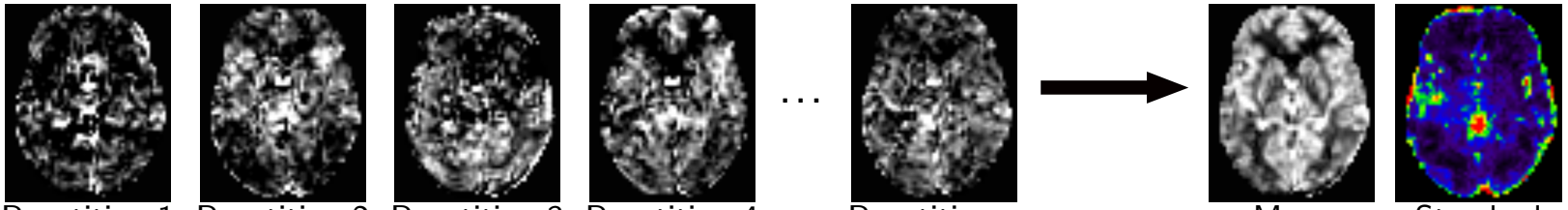
Method

Originality of our approach:

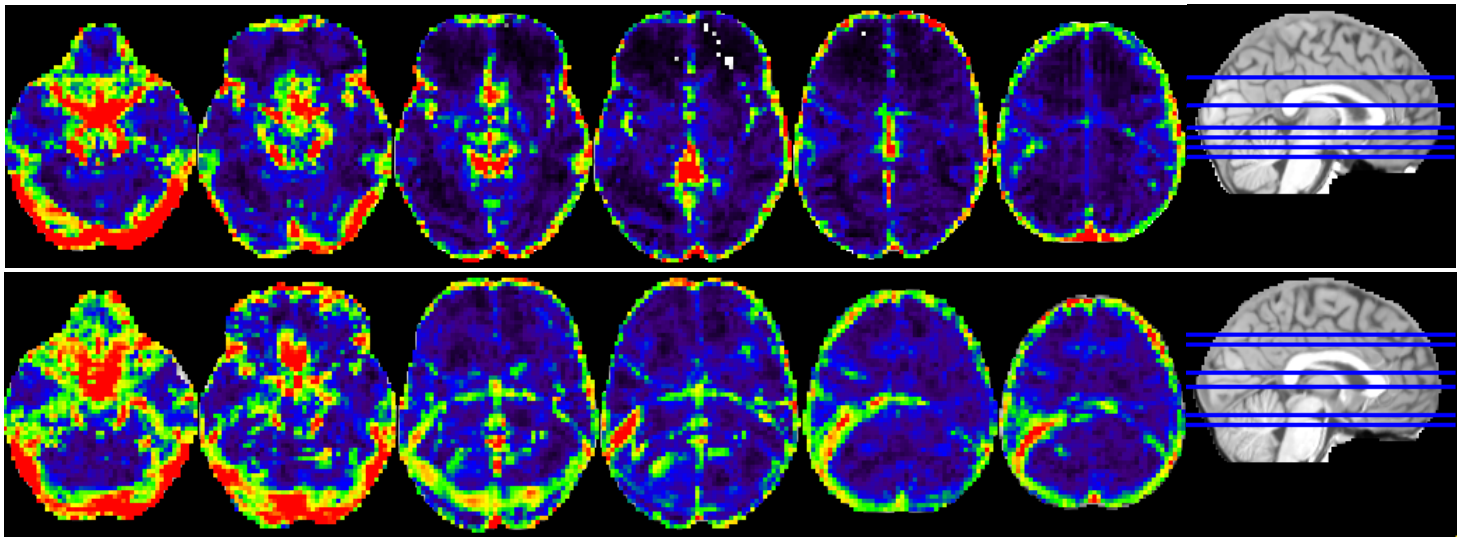
- *Explicit modelling of both* **intra-subject** *and* **inter-subject variances**.
- **No pre-smoothing** *of the data: a contrario approach.*

Intra-subject variance

Intra-subject variance models variability across repetitions

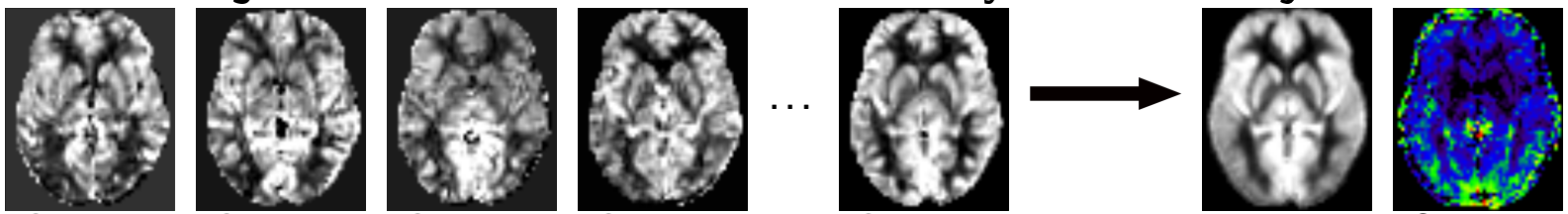


Examples

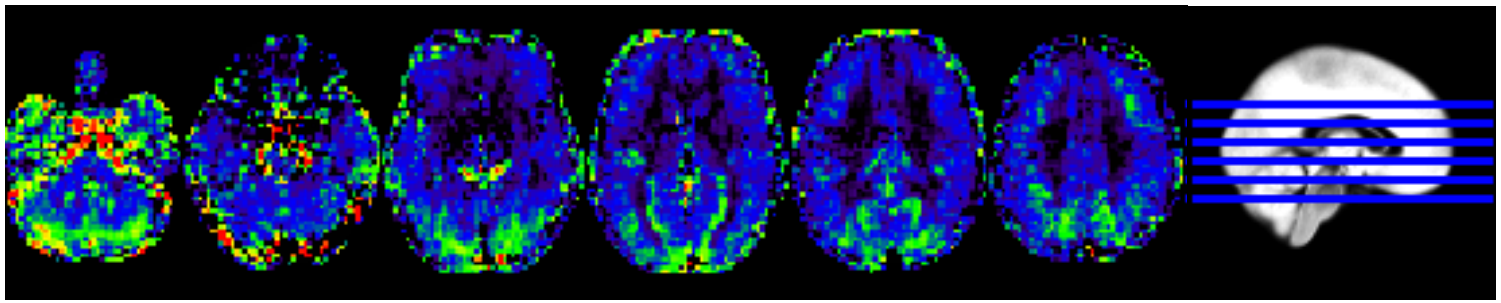


Inter-subject variance

Inter-subject variance models variability across subjects



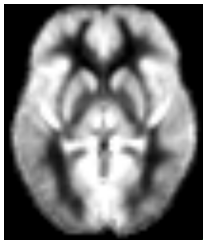
Inter-subject standard deviation (35 healthy subjects)



Detection of perfusion abnormalities

Model of normal perfusion:

$$\sim \mathcal{N}\Big($$



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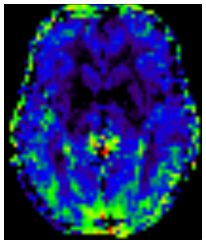
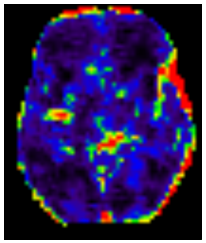


$$^2 +$$



$$^2 \Big)$$

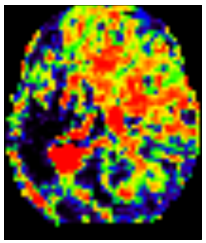
Patient map

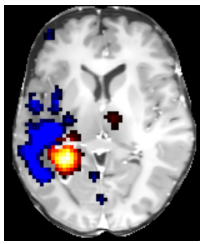
Mean across subjects

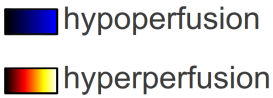
Inter-subject variance

Intra-subject variance

Detection of hypoperfusions and hyperperfusions:







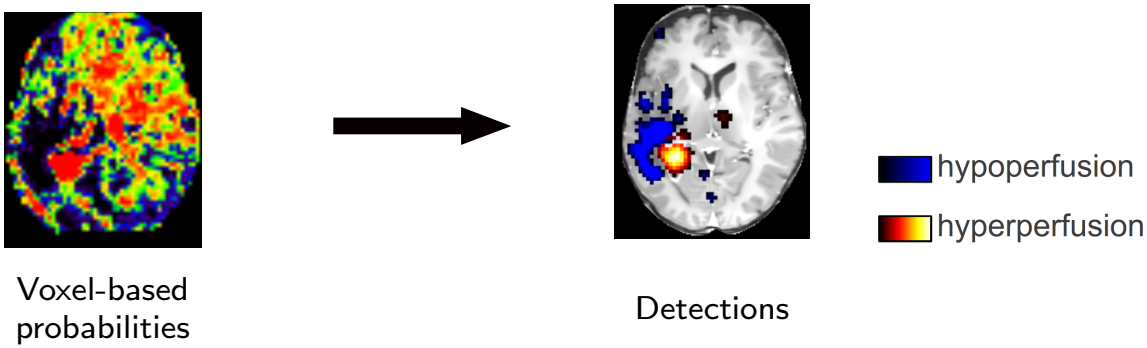
Voxel-based probabilities

Detections

Known as a mixed-effect general linear model.

Detection of perfusion abnormalities

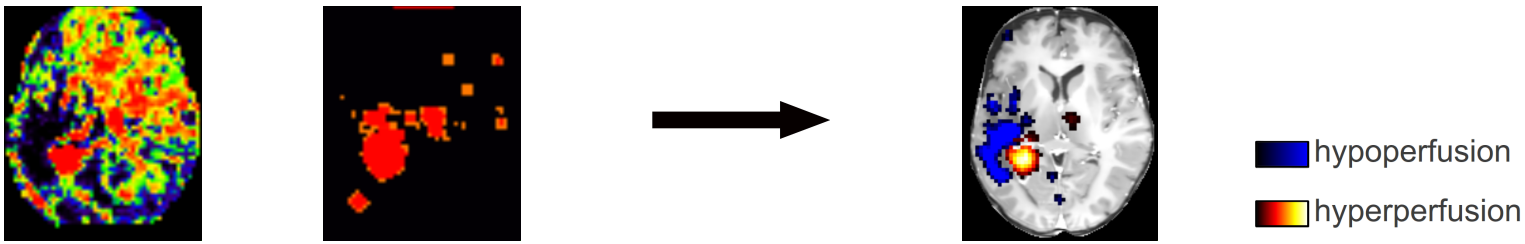
Mixed-effect General Linear Model:



Voxel-based probabilities

Detections

Mixed-effect *a contrario* approach:



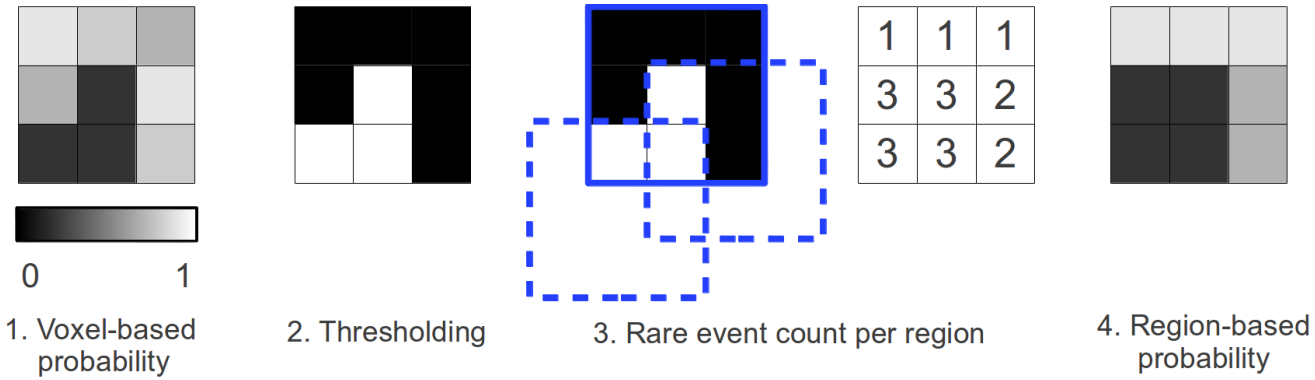
Voxel-based probabilities

Region-based probabilities

Detections

A contrario approach

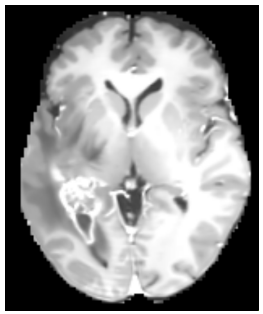
From voxel-based to region-based probabilities:



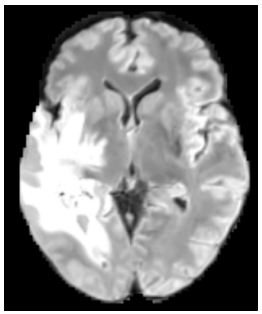
Outline

Ground Truth estimation

Step 1 – Segmentation of the tumor:



T1 Gadolinum

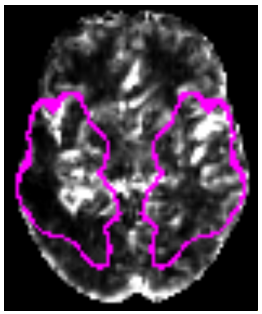


T2 FLAIR

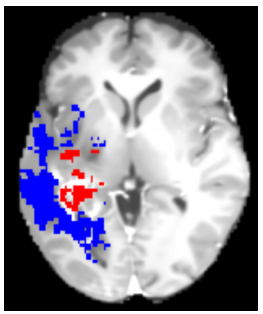
Tumor and edema segmentation

Step 2 – Combination with T2 perfusion information:

Tumor segment.



DSC CBF

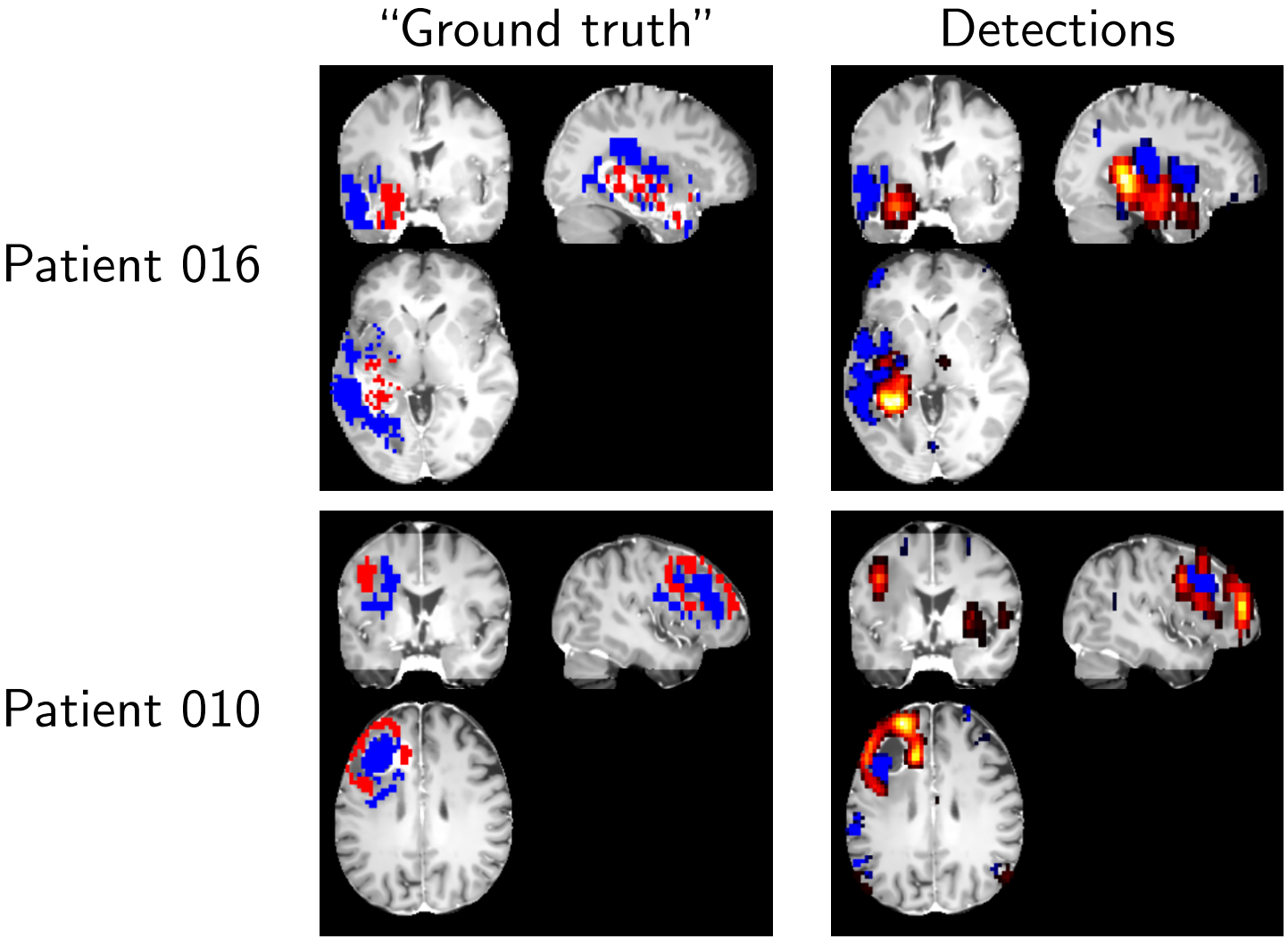


"Ground truth"

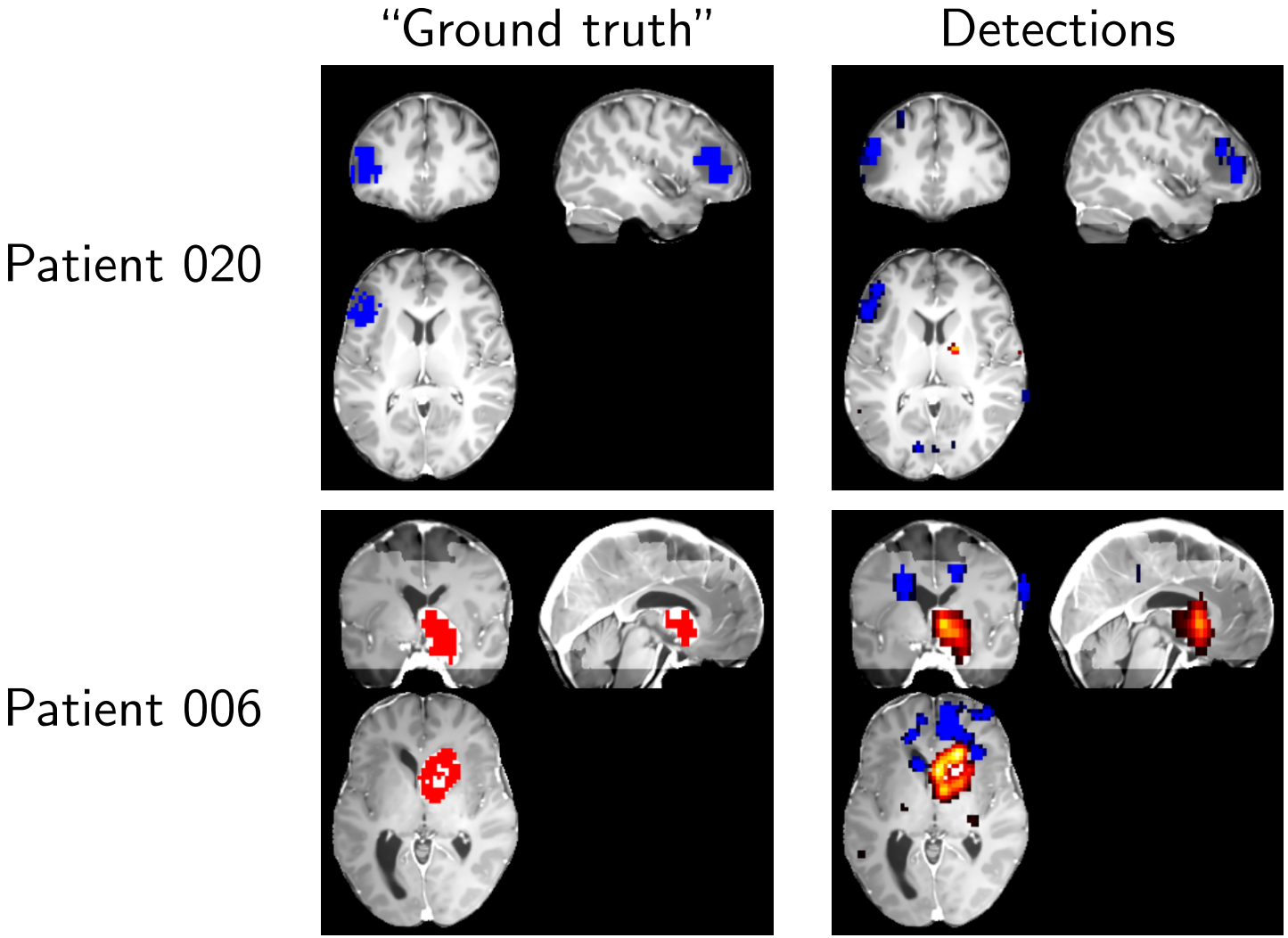
Step 3 – Visual assesment and manual corrections by a clinician

Outline

Results



Results



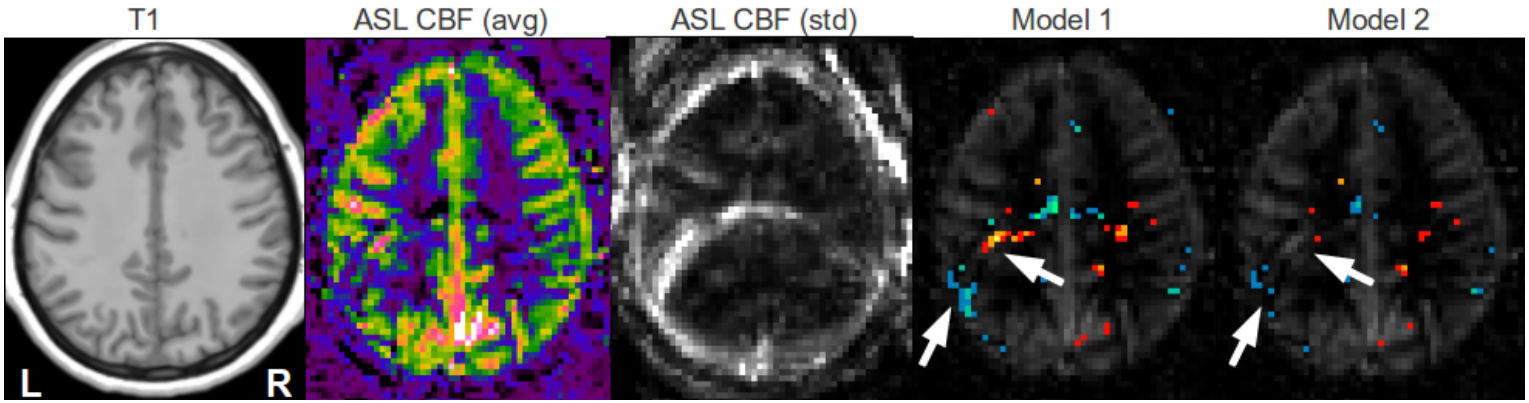
Results

Quantitative results on a dataset including 22 patients and 35 controls:

	Acontrario Mixed-effects
Specificity (controls)	0.99
Specificity (patients)	0.93
Sensitivity (hyper)	0.82

Results: Importance of intra-subject variance

Effect of intra-subject variance on the detections:

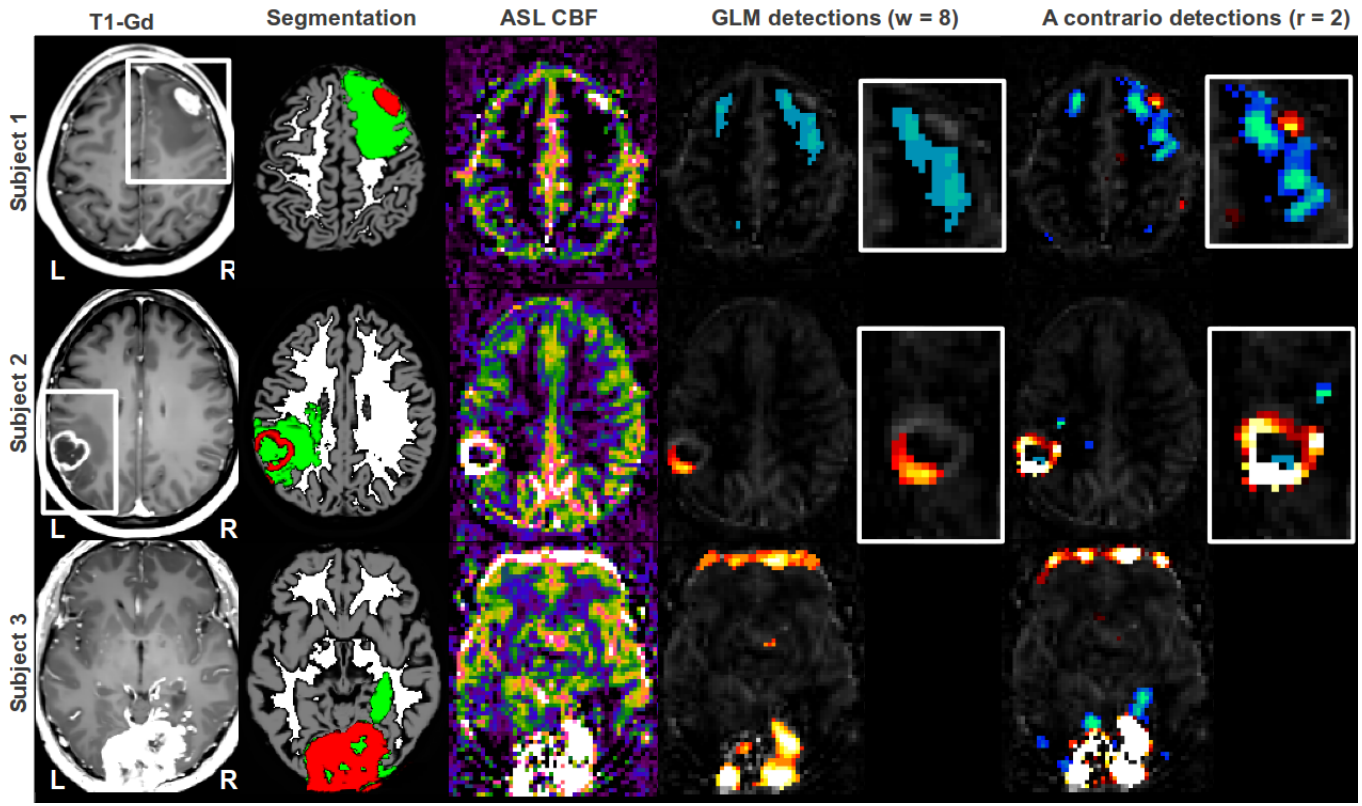


Quantitative results (22 patients, 35 controls):

	A contrario Mixed-effects	A contrario Random-effects
Specificity (controls)	0.99	0.92
Specificity (patients)	0.93	0.56
Sensitivity (hyper)	0.82	0.86

Results: advantage of the a contrario approach

A contrario approach and Mixed-effect General linear model detections:



Conclusion

Conclusions:

- Importance of intra-subject variance in the detection of patient-specific perfusion abnormalities.
- Good sensitivity and specificity of the proposed approach.
- Region-based a contrario probabilities outperform the standard voxel-based probabilities.

More details on the *a contrario* approach: C. Maumet, P. Maurel, J.-C. Ferré, and C. Barillot, "A comprehensive framework for the detection of individual brain perfusion abnormalities using arterial spin labeling" MICCAI 2012, pp. 542–549.

Questions

Q & A