



# A Comprehensive Framework for the Detection of Individual Brain Perfusion Abnormalities Using Arterial Spin Labeling

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## Purpose

**Context:** Arterial Spin Labeling (ASL) enables measuring cerebral blood flow (CBF) in MRI without injection of a contrast agent.

**Problem:** In ASL, perfusion abnormality studies usually rely on manual regions of interest delineations, a time-consuming task prone to inter-expert variability.

**Our approach:** We propose an automatic framework to identify hypoperfused and hyperperfused regions in individual patients by comparison to a model of normal perfusion. This model takes into account the first level variance in order to model the subject-specific spatial noise distribution.

## Method

**ASL Template, a model of normal perfusion:**

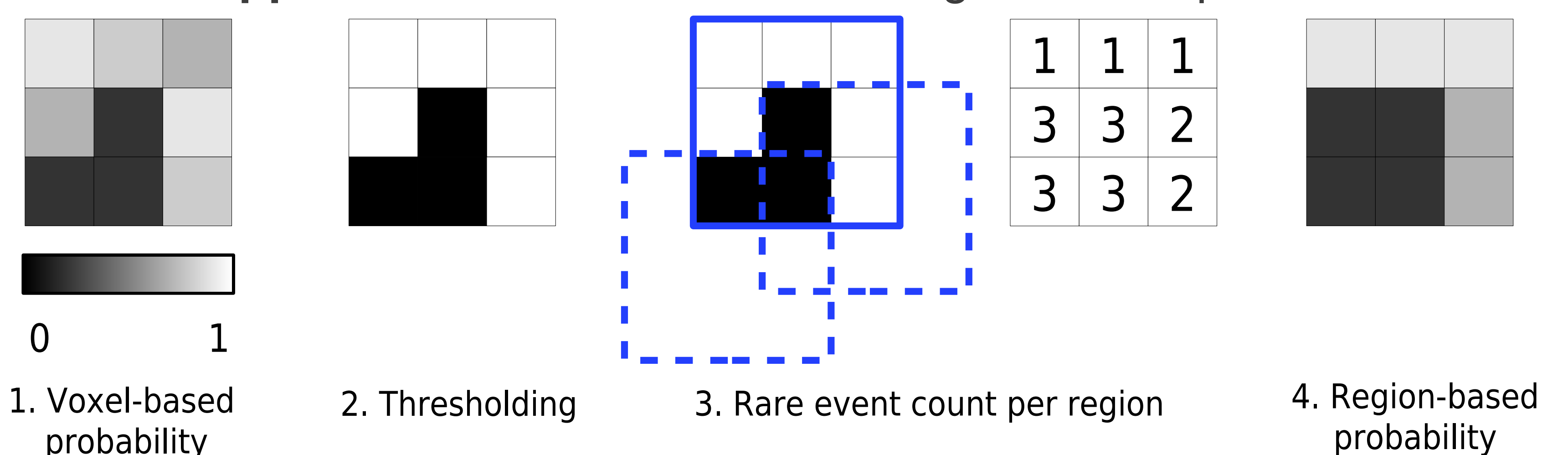
$$Perf \sim N(\mu_{pop}, \sigma_{pop}^2 + \sigma_{sub,tpl}^2)$$

inter-subject variance    intra-subject variance

**Comparison of a new subject:**

$$\hat{\beta} = perf_{N+1} - \hat{\mu}_{pop}, \quad \text{Var}(\hat{\beta}) = \frac{\sigma_{pop}^2 + \sigma_{sub,tpl}^2}{N} + \sigma_{pop}^2 + \sigma_{sub,N+1}^2$$

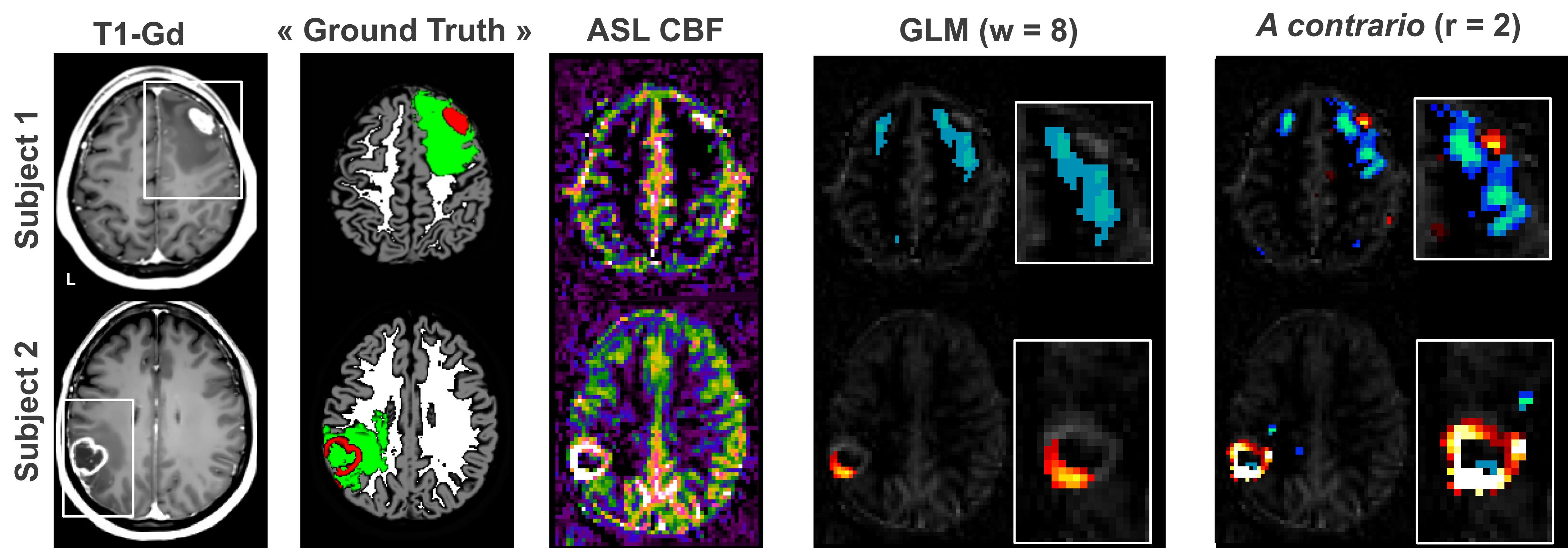
**A *contrario* approach: from voxel-based to region-based probabilities:**



## Results

**Data:** 12 patients diagnosed with brain tumors and 35 healthy subjects were involved in this study.

**Detection of patient-specific perfusion abnormalities:**



**Quantitative comparison:**

	GLM					<i>a contrario</i>	
	$w = 2$	$w = 4$	$w = 6$	$w = 8$	$w = 10$	$r = 1$	$r = 2$
<i>pseudo-sensitivity</i>	0.29	0.31	0.32	<b>0.33</b>	0.34	0.37	<b>0.53</b>
<i>pseudo-specificity</i>	0.98	0.97	0.96	<b>0.95</b>	0.94	0.96	<b>0.89</b>

## Conclusion

We have presented a comprehensive framework for the detection of brain perfusion abnormalities in individual patients by comparison to a template of healthy subjects. We applied this model to 12 patients suffering from brain tumors and compared our *a contrario* approach to the classical GLM with FDR correction. This analysis pointed out the benefits of the *a contrario* approach: a better conservation of the hypo- and hyper-perfusions boundaries and a greater sensitivity. This increase in sensitivity might be crucial in the study of pathologies presenting more subtle patterns of abnormal perfusion.