An a contrario approach for the detection of activated brain areas in fMRI
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**Results:** 12 healthy subjects were involved in this study and underwent 3 BOLD fMRI sessions of a block motor paradigm [3]. In order to compare the performances of the standard massively univariate GLM with the proposed *a contrario* approach, we used Receiver-Operating-Characteristics (ROC) curves and estimated the area under the curve for false positive rates ranging from 0 to 0.1 (as only a small percentage of the voxels are expected to be active). Validation of fMRI analysis is still challenging due to the lack of ground truth. We focused on a well-studied right-hand motor paradigm in which the main activations are expected in the precentral and postcentral sulci (Left and Right) and in the Supplementary Motor Area (SMA) (Left and Right) [3]. We studied two different “ground truths”. First, as suggested in [3], we targeted the activation of the grey matter in the right hand motor area precentral and postcentral sulci (Left and Right) and in the Supplementary Motor Area (SMA) (Left and Right) [3]. We studied two different “ground truths”. First, as suggested in [3], we targeted the activation of the grey matter in the right hand motor area as manually delineated by an expert neuro-radiologist, while the surrounding white matter was expected to be inactive. Second, we also tested a global criterion, in which activation in both the hand motor area and part of the SMA (as defined by the AAL atlas) were activation targets, while whole-brain white matter (>70%) was expected to be inactive. We compared the standard massively univariate GLM (no smoothing and smoothing with a gaussian FWHM kernel of 6mm³) with the *a contrario* approach.

Fig. 1 displays the expected active and inactive regions for a representative subject along with the associated ROC curves averaged over sessions and subjects. Overall the *a contrario* approach outperformed both the unsmoothed and smoothed massively univariate GLM in term of area under the curve. Two sample t-tests were performed in order to detect significant improvement at the group level (false discovery rate q < 0.05). The *a contrario* approach with local ground truth was significantly better than the smoothed GLM for all sessions (p = 0.018, p = 0.038, p = 0.016) and than the unsmoothed GLM for 2 sessions out of 3 (p =0.003, p = 0.005). Moreover, using the global ground truth, the *a contrario* approach performed significantly better than the smoothed GLM for all sessions (p = 0.003, p = 0.009, p = 0.006) and than the unsmoothed GLM for 2 sessions out of 3 (p = 0.002, p = 0.002)

**Discussion:** We propose a new *a contrario* approach to detect fMRI activations. This method displayed better spatially defined activations with a more interesting trade-off between sensitivity and specificity by comparison to the standard massively univariate GLM.