

Supplementary Information

A deep learning-enriched framework for analyzing brain functional connectivity

Davide Borra¹ (0000-0003-3791-8555)

Elisa Magosso^{1,2} (0000-0002-4673-2974)

¹Department of Electrical, Electronic and Information Engineering “Guglielmo Marconi” (DEI), University of Bologna, Cesena Campus, Cesena, 47522, Italy

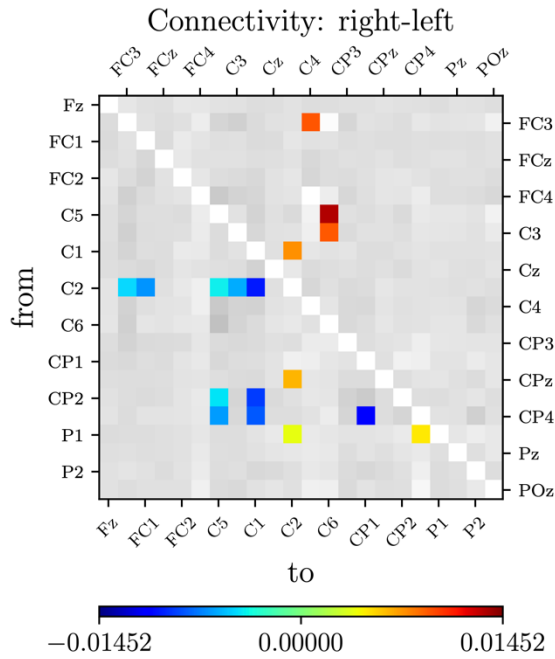
²Alma Mater Research Institute for Human-Centered Artificial Intelligence, University of Bologna, Bologna, 40126, Italy

Correspondence

Davide Borra

e-mail: davide.borra2@unibo.it

(a)



(b)

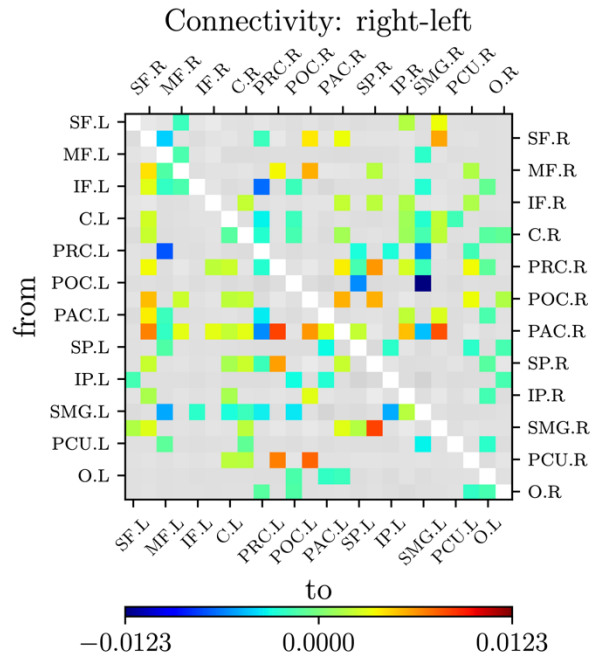
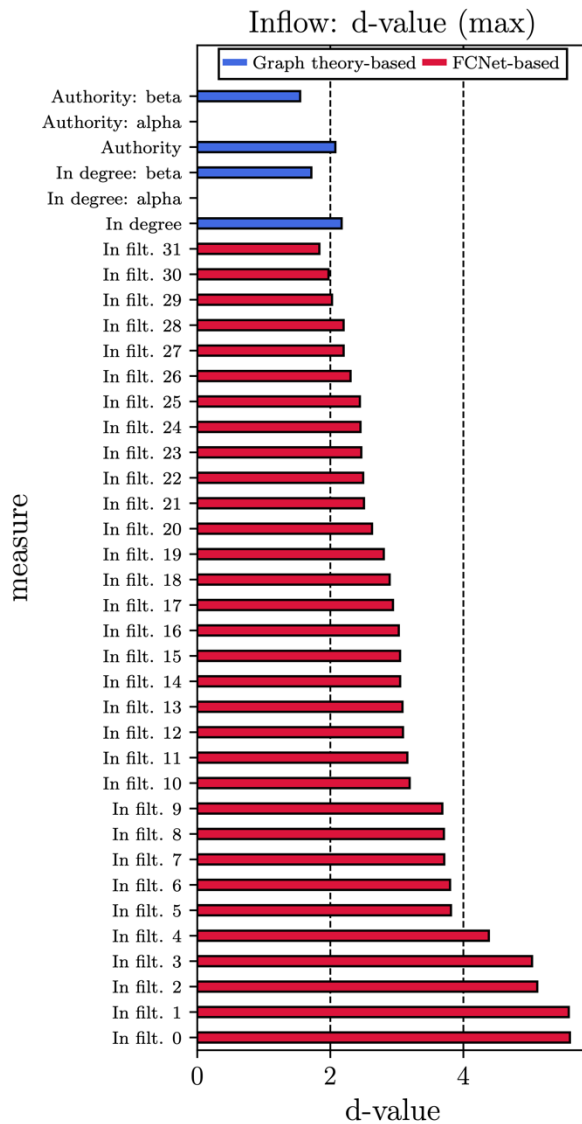


Fig. S1 – Total functional connectivity matrix. Here, the connectivity matrix integrated within the entire frequency axis (i.e., total connectivity matrix) is shown, displaying its difference between right-hand and left-hand motor imagery conditions (on average across EEG epochs and participants) as obtained in the experiments conducted at the scalp-level (panel a) and cortex-level (panel b). Only the connectivity values that resulted significantly different ($p < 0.05$) between the two motor imagery conditions are color-highlighted, as obtained by a permutation t test with t_{max} correction for adjusting p-values for multiple tests.

(a)

Inflow measures: right vs. left



(b)

Inflow measures: right vs. left

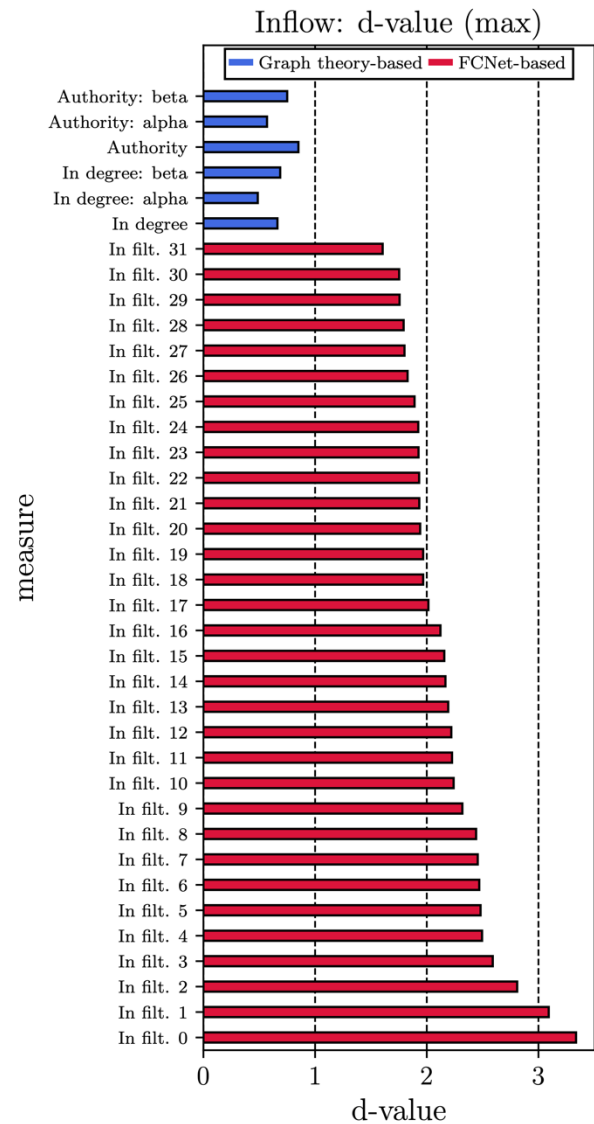
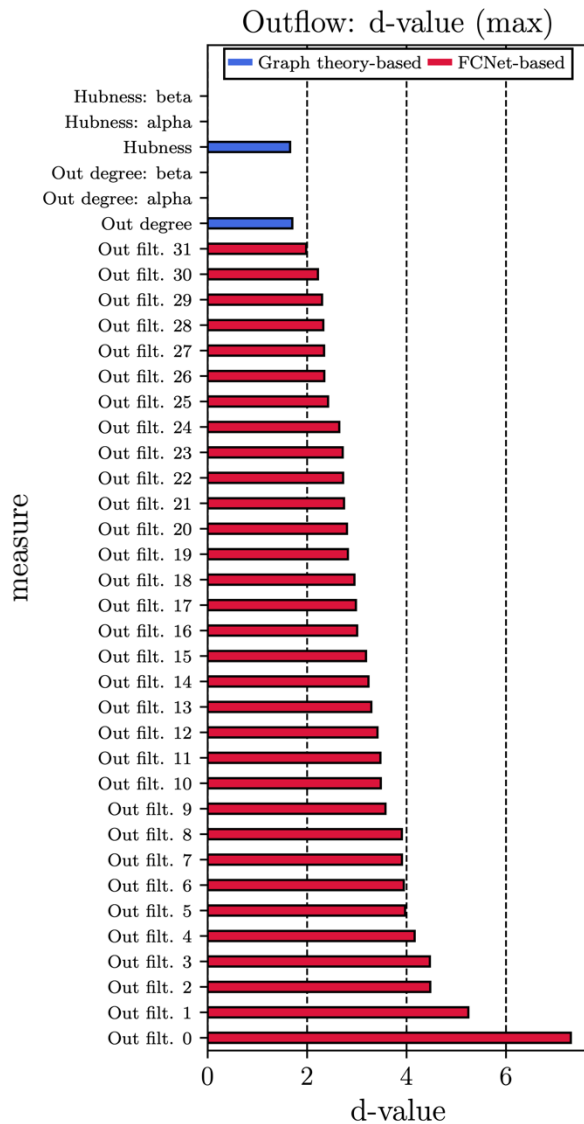


Fig. S2 – Inflow measures: maximum absolute d-value across the significant brain regions. The figure displays the effect size while comparing the two motor imagery conditions utilizing inflow measures obtained with the classic approach and with the deep learning-enriched approach, separately as to scalp-level experiment (panel a) and cortex-level experiment (panel b). In the classic approach the measures were the in degree and the authority, computed across the entire frequency axis, within alpha-band and beta-band. In the deep learning-enriched approach the measures were the 32 FCNet-based inflow measures. For each measure, the absolute Cohen's d-value is reported in its maximum value across the brain regions showing statistically significant difference ($p < 0.05$) between the two conditions. To ease the readability, FCNet measures were sorted from the lowest to the highest effect size.

(a)

Outflow measures: right vs. left



(b)

Outflow measures: right vs. left

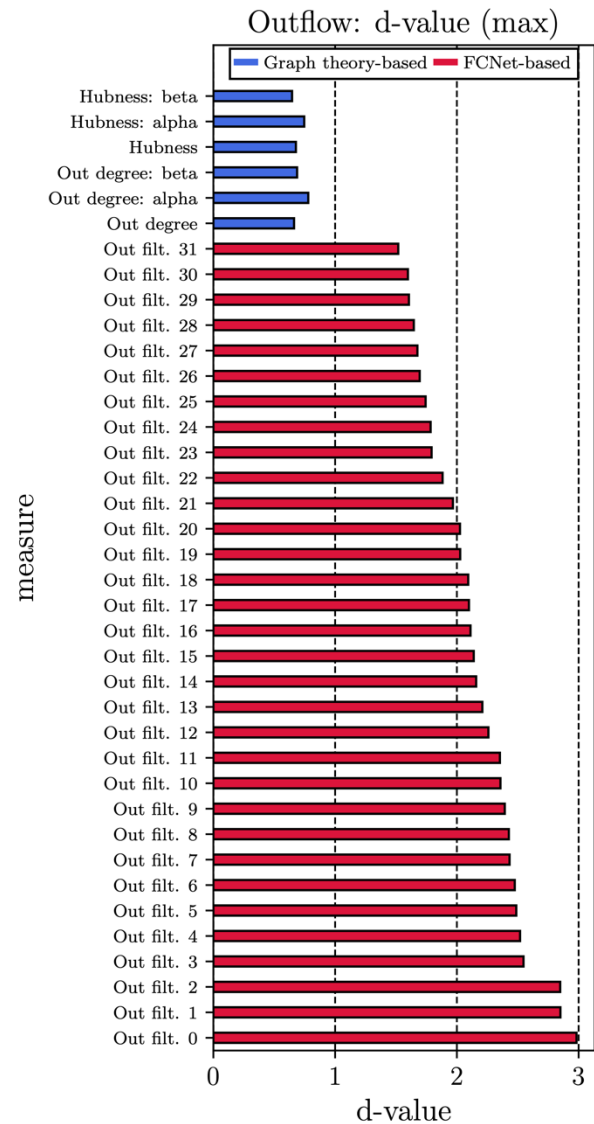


Fig. S3 – Outflow measures: maximum absolute d-value across the significant brain regions. The figure displays the effect size while comparing the two motor imagery conditions utilizing outflow measures obtained with the classic approach and with the deep learning-enriched approach, separately as to scalp-level experiment (panel a) and cortex-level experiment (panel b). In the classic approach the measures were the out degree and the hubness, computed across the entire frequency axis, within alpha-band and beta-band. In the deep learning-enriched approach the measures were the 32 FCNet-based outflow measures. For each measure, the absolute Cohen's d-value is reported in its maximum value across the brain regions showing statistically significant difference ($p < 0.05$) between the two conditions. To ease the readability, FCNet measures were sorted from the lowest to the highest effect size.