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The Multi-Channel Maximum-Likelihood (MCML) method: towards a multisource detection and wave parameter estimations using deep learning

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We present an improvement of the Multi-Channel Maximum-Likelihood (MCML) method [1]. This approach is based on the likelihood function derived from a multi-sensor stochastic model expressed in different frequency channels. Using the likelihood function, we determine, for the detection problem, the Generalized Likelihood Ratio (GLR) with a p-value threshold to discriminate signal of interest and noise. For the estimation of the slowness vector, we determine the Maximum Likelihood Estimation (MLE). Comparisons with synthetic and real datasets show that MCML, when implemented in the time-frequency domain, outperforms state-of-the-art detection algorithms in terms of detection probability and false alarm rate in poor signal-to-noise ratio scenarios. We evaluate the capability of MCML to detect overlapping coherent signals in the same time frequency domain, depending on various scenarios with varying signal-to-noise ratio (SNR), frequency bands and array geometry. We quantify the performance of deep learning method to discriminate between interfering coherent signals by predicting the number of sources in a given time-frequency cell using synthetics and real data recorded by stations part of the International Monitoring System (IMS).

[1] B Poste, M Charbit, A Le Pichon, C Listowski, F Roueff, J Vergoz (2022), The Multi-Channel Maximum-Likelihood (MCML) method: a new approach for infrasound detection and wave parameter estimation, Geophysical Journal International, https://doi.org/10.1093/gji/ggac377