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HARFE: Hard-Ridge Random Feature Expansion

We propose a random feature model for approximating high-dimensional sparse additive functions called the hard-ridge random feature expansion method (HARFE). This method utilizes a hard-thresholding pursuit based algorithm applied to the sparse ridge regression (SRR) problem to approximate the coefficients with respect to the random feature matrix. The SRR formulation balances between obtaining sparse models that use fewer terms in their representation and ridge-based smoothing that tend to be robust to noise and outliers. We prove that the HARFE method is guaranteed to converge with a given error bound depending on the noise and the parameters of the sparse ridge regression model. Based on numerical results on synthetic data as well as on real datasets, the HARFE approach obtains lower (or comparable) error than other state-of-the-art algorithms. As an extension of sparse random feature expansion, we propose an approximation method using time delayed embeddings with random feature matrices when the dynamical system is unknown. We test our method on epidemiological based simulated and real data and show that our method outperforms existing models in terms of seven-day prediction accuracy.