The generalized ANOVA decomposition in the random Fourier feature setting

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We study the problem of scattered-data approximation on $\mathbb{R}^d$, where we have given sample points and the corresponding function evaluations of a function f. In the random Fourier feature approach, we draw frequencies $\boldsymbol{\omega}_j \in \mathbb{R}^d$ at random and learn coefficients a_j from the given data to construct the approximant, i.e.

$$f(\cdot) \approx \sum_j a_j \, \mathrm{e}^{\mathrm{i}\,\langle \boldsymbol{\omega}_j, \cdot \rangle}.$$

We use the classical analysis of variance (ANOVA) decomposition

$$f(\mathbf{x}) = \sum_{\mathbf{u} \subseteq \{1,\ldots,d\}} f_{\mathbf{u}}(\mathbf{x}_{\mathbf{u}})$$

for approximating high-dimensional functions of low effective dimension. Thereby we give a relation between the Fourier transform of the function f and the ANOVA terms $f_{\mathbf{u}}$.
In the case for dependent input variables, the ANOVA decomposition is generalized with the aim to detect the structure of the function, i.e. to find which input variables and variable interactions are important. This information is then used to boost random Fourier feature algorithms.

This talk is based on joint work with Daniel Potts.

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