Gaussian Process Regression for Complex-valued Frequency Response Functions

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ABSTRACT

We address Gaussian process regression of frequency or parametric responses, where the system is either given as a state space model or a partial differential equation in the frequency domain. In both cases, we approximate the dependency of a single output quantity on the frequency variable (or another parameter) from data. We adopt a complex-valued setting, which requires the specification of a dedicated covariance and pseudo-covariance kernel. Inspired from work in Bayesian system identification [1, 2], these kernels are of rational type and constructed by taking the Fourier transform of fast-decaying non-stationary kernels on the positive real line, which enables the approximation of smooth functions. We compare the kernel methods against other available rational [3] and polynomial approximation methods and relate the setting to a recently introduced Gaussian process regression framework for parametric differential equations [4]. We also outline the possibility to adaptively select new sampling points and to include low-order rational terms in the mean function of the Gaussian process.

The complex-valued regression algorithm is realized in a non-intrusive way, which allows to employ existing real-valued Gaussian-process regression tools. The efficiency of the algorithm will be illustrated with several numerical results. In particular, we consider discrete circuit models, simple analytical functions and Helmholtz-type problems, which are used to simulate wave propagation.

REFERENCES


