Kernel-free BEM for variable coefficients

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Classical boundary element methods rely on explicit fundamental solutions and singular kernel evaluations, which are generally unavailable for variable-coefficient elliptic problems. We present a kernel-free framework that replaces the boundary operator with a computable algebraic approximation constructed in a one-time preprocessing step from a volume Galerkin discretisation. Coupling this approximation with boundary spaces yields a boundary-only system that retains the dimension reduction of classical BEM. Stability and quasi-optimal error estimates relate the boundary accuracy to the underlying volume approximation, while the resulting operator is compatible with data-sparse compression and efficient large-scale computation.

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