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Towards automated model reduction: exact error bounds and simultaneous finite-element reduced-basis refinement

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We develop a reduced basis method for parametrized coercive partial differential equations (PDEs) with two objectives: providing an error bound with respect to the exact weak solution of the PDE as opposed to the typical finite-element "truth" solution; providing automatic adaptivity in both physical and parameter spaces. The error bound builds on two key ingredients: a minimum-residual mixed formulation which provides an upper bound of the dual-norm of the residual computed in an infinite-dimensional function space; an extension of the successive constraint method which provides a lower bound of the stability constant computed in the infinite-dimensional function space. The automatic adaptivity is provided in the offline stage which combines a spatial mesh adaptation for finite elements and a greedy parameter sampling strategy for reduced bases to yield a reliable online system in an efficient manner. We demonstrate the effectiveness of the approach for parametrized elasticity problems.