VARIATIONALLY CONSISTENT INTEGRATION FOR MESHFREE AND ISOGEOMETRIC ANALYSIS

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Insufficient quadrature for the Galerkin method results in the loss of Galerkin orthogonality which can give large solution error as well as sub-optimal convergence. This issue is typically more crucial when approximation functions are either non-polynomial type or have overlapping supports [1]. In the case of meshfree and isogeometric analysis, approximations are generally rational and have domains of influence which are not necessarily restricted to or even associated with element discretizations. While efficient integration rules have been proposed for the latter [2], the general framework of variationally consistent integration (VCI) can be applied to both regardless of the quadrature rules [1]. In this work, several variationally consistent integrations are proposed for both methods, and the resulting solution error is orthogonal to the test functions restoring solution accuracy giving optimal convergence with fewer quadrature points than would otherwise be required.

Given a type of numerical integration, test functions are constructed to meet variational consistency based on the boundary value problem at hand. For meshfree methods, Gaussian or nodal quadrature can be corrected in addition to smoothed gradient integration. In the case of isogeometric analysis, solution behaviour can also be improved using VCI with either micro- or macro-cells, with or without the efficient quadrature rules. Construction and specifics for each of the methods are given, and several numerical examples show the improved performance of the proposed integrations.

REFERENCES

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