A Space-Time Meshfree Collocation Method for PDEs

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An innovative Space-Time Meshfree Collocation Method (STMCM) for solving systems of nonlinear ordinary and partial differential equations by a consistent discretization in both space and time is proposed as an alternative to established mesh-based methods. The STMCM belongs to the class of truly meshfree methods, i.e. the methods which do not have any underlying mesh, but work on a set of nodes only, without an a priori node- to-node connectivity. A regularization technique to overcome the singularity-by-construction and to compute all necessary derivatives of the kernel functions is presented. The method combines the simplicity and straightforwardness of the strong-form computational techniques with the advantages of meshfree methods over the classical ones, especially for coupled engineering problems involving moving interfaces. The key features of the proposed approach are: (i) no need to generate a mesh, (ii) simplified imposition of boundary conditions, (iii) no need to evaluate integral forms of governing equations, (iv) applicability to complex irregularly-shaped domains. The proposed STMCM is applied to linear and nonlinear ordinary and partial differential equations of different types and its accuracy and convergence properties are studied.