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Model-free data-driven computational mechanics enhanced by tensor voting. (English)

[71 07337781]


Summary: The data-driven computing paradigm initially introduced by T. Kirchdoerfer and the third author [Comput. Methods Appl. Mech. Eng. 304, 81–101 (2016; Zbl 1425.74503)] is extended by incorporating locally linear tangent spaces into the data set. These tangent spaces are constructed by means of the tensor voting method introduced by P. Mordohai and G. Medioni [J. Mach. Learn. Res. 11, 411–450 (2010; Zbl 1242.68239)] which improves the learning of the underlying structure of a data set. Tensor voting is an instance-based machine learning technique which accumulates votes from the nearest neighbors to build up second-order tensors encoding tangents and normals to the underlying data structure. The here proposed second-order data-driven paradigm is a plug-in method for distance-minimizing as well as entropy-maximizing data-driven schemes. Like its predecessor [Zbl 1425.74503], the resulting method aims to minimize a suitably defined free energy over phase space subject to compatibility and equilibrium constraints. The method’s implementation is straightforward and numerically efficient since the data structure analysis is performed in an offline step. Selected numerical examples are presented that establish the higher-order convergence properties of the data-driven solvers enhanced by tensor voting for ideal and noisy data sets.

MSC:
65-XX Numerical analysis
74-XX Mechanics of deformable solids

Keywords:
data-driven computing; tensor voting; second-order method; data science

Full Text: DOI

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