6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

# A variational framework for data-driven computational mechanics applied to elasticity

**L. T. K. Nguyen[1], M. Rambausek[1] and M.-A. Keip[1]**

[1] Institute of Applied Mechanics (CE), University of Stuttgart

**Keywords**: *Data-driven mechanics, variational principles, finite element method*

A boundary value problem of continuum mechanics consists of three ingredients: compatibility conditions, conservation laws, and material laws that relate work conjugates such as strain and stress. Material laws are usually expressed in terms of a functional relationship that fits empirical observations based on experiments. It is sometimes difficult to calibrate a material model to fit the collected data for sophisticated material behavior. In data-driven computation the functional relation is replaced with an abundant collection of material data, see e.g. [1, 2, 3]. An approach for the analysis of material data under uncertainty via neural networks is given by [4].

The present contribution discusses a variational framework for the data-driven approach to computational mechanics suggested by Kirchdoerfer and Ortiz [1]. It introduces Lagrange multipliers for both the conservation laws and the compatibility conditions in the continuous setting [5]. An interpretation of the resulting algorithm as a staggered scheme is also presented. From this generalization we obtain different Galerkin-based implementations. We provide several representative examples in order to justify the proposed variational formulation.

## REFERENCES

[1] T. Kirchdoerfer, M. Ortiz, Data-driven computational mechanics, *Computer Methods in Applied Mechanics and Engineering* 304 (2016) 81–101.

[2] R. Ibañez, E. Abisset-Chavanne, J. V. Aguado, D. Gonzalez, E. Cueto, F. Chinesta, A manifold learning approach to data-driven computational and inelasticity, *Archives of Computational Methods in Engineering* 25 (2018) 47–57.

[3] L. T. K. Nguyen, M.-A. Keip, A data-driven approach to nonlinear elasticity, *Computers and Structures* 194 (2018), 97–115.

[4] M. A. Bessa, R. Bostanabad, Z. Liu, A. Hu, D. W. Apley, C. Brinson, W. Chen, W. K. Liu, A framework for data-driven analysis of materials under uncertainty: Countering the curse of dimensionality, *Computer Methods in Applied Mechanics and Engineering* 320 (2017) 633–667.

[5] L. T. K. Nguyen, M. Rambausek, M.-A. Keip, A variational approach to data-driven computational mechanics, *in preparation.*