

## DATA DRIVEN APPROACH FOR COUPLED ELECTRO-MECHANICAL PROBLEMS

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The classical approach in the computational mechanics considers the formulation of material models whose development rely on the data usually collected either through experimental measurements or numerical simulation. The constitutive model should describe the data set as faithfully as possible, keeping at the same time it's mathematical structure as simple as possible. Those two opposite demands usually lead to material model that contains a number of simplifications and adjustments leading to empirical model which is less rich than the data used for it's formulation. To overcome this information loss, Kirchdoerfer and Ortiz [1] recently proposed a new approach which avoids the need of constitutive model in computational mechanics, replacing it by material data.

In this work, we propose an application of the data driven approach (DDA) to the coupled, electromechanical behaviour. More precisely, we focus on the linear piezo-electric continuum whose governing equations are related to 1. mechanical (M) sub-problem described by elasticity, related kinematics and boundary conditions; 2. electrical (E) sub-problem related to the electrostatics, Gauss and Maxwell law and related boundary conditions; 3. electro-mechanical coupling defined *only through the constitutive relations*. As opposed to 'standard' DDA related to elasticity [1] where the local state of the system in every material point is characterized by set of stress-strain couples, here the material response is characterized by 4-tuples composed of strain, stress and electrical field and electrical displacement. In DDA the solution is characterized by electro-mechanical points that are '*the closest*' to material points, we propose an extension of the norm to metrize the distance. In addition, we give the details of the DDA algorithm for coupled piezoelectric behaviour. Analogously as in standard DDA, the objective here is to find *electromechanical states* (4-tuples) such that: (i) the strain and electrical fields are derived from displacement and electrical potential fields respecting the mechanical compatibility equations and Maxwell's law and (ii) that the stress and electrical displacement verify the corresponding mechanical equilibrium as well as Gauss law (dielectric equivalent). The coupling being only in terms of constitutive model, which we abandon, the great advantage of applying DDA approach to a class of coupled multiphysics problems is that it results in two *decoupled* sub-problems, the mechanical and dielectric problem. The performance of the proposed extension is shown on few illustrative examples.

### REFERENCES

- [1] T. Kirchdoerfer and M. Ortiz, Data-Driven Computational Mechanics, *Comput. Methods Appl. Mech. Engrg.* 304 (2016) 81–101.