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NUMERICAL ANALYSIS ON POLYTOPE MESHES: GEOMETRY PROCESSING, SBFEM, VEM AND BEYOND

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ABSTRACT

Polytope elements provide great flexibility with respect to meshing complex or evolving geometries. Polytope meshes can be refined locally and generated automatically using digital images or CAD data. In the latter case, the geometrical description of design objects and the numerical analysis of physical problems on these objects can be linked by using the same basis functions through the concept of isogeometric analysis. Polytope elements have therefore gained popularity in applications such as fracture mechanics, topology optimization and microstructure modelling. However, established numerical techniques such as the finite element method typically rely on triangular or quadrilateral element shapes and cannot be used on polytope elements straightforwardly.

In addition, polytope discretizations play an important role in geometry processing, where the aim is to display geometry as accurately as possible while simultaneously reducing the computational cost of graphics applications. This can be achieved by clustering best-fit regions, thus generating polygonal surface meshes. Since numerous open questions exist with respect to using polytope-based discretizations both from the computational mechanics and geometry processing point of view, one aim of this Minisymposium is to bring together researchers from both communities to share different perspectives and identify synergies between the two fields.

With respect to numerical techniques for the solution of physical problems on polytope meshes various approaches exist, such as methods based on the use of barycentric coordinates, the virtual element method (VEM) or the scaled boundary finite element method (SBFEM). While contributions dealing with all types of computational solution techniques for physical problems on polytopal meshes are invited, special focus is placed on the latter and its isogeometric variant (SB-IGA). The scaled boundary finite element method in its original form is a semi-analytical technique that not only excels in facilitating the use of polytopal meshes, but also in representing radiation damping and stress singularities accurately. We therefore also welcome contributions that develop SBFEM or apply it to challenging problems, irrespective of the use of polytope elements. Possible areas of application include fracture mechanics, wave propagation, topology optimization, structural acoustics, linear and nonlinear solid mechanics, contact, plate and shell analysis, coupled problems and multi-scale modeling.

This Minisymposium aspires to gather researchers from geometry processing, numerical mathematics and computational mechanics who aim to combine forces to fully leverage the potential of polytope discretization and analysis methods and experts developing the SBFEM and other polytope-based techniques for fruitful moments of exchange of ideas and inspiration.