Discrete differential forms based on T-splines

A. Buffa, G. Sangalli, R. Vázquez

Abstract

Isogeometric Analysis (IGA) is a method introduced for the discretization of partial differential equations (PDE), that was introduced in [1] with the aim of improving the interoperability between computer aided design software (CAD) and PDE solvers. In the first papers, IGA was based on B-splines and non-uniform rational B-splines (NURBS), a set of functions that are spreadly used in CAD. The method has two main features: it allows to maintain a NURBS description of the geometry, and, compared to FEM, the solution is more regular, since NURBS of degree \( p \) can have up to \( p - 1 \) continuous derivatives.

In [2] we extended the idea of IGA to discrete differential forms. The method is based on the construction of an exact sequence of B-spline spaces with mixed degree, and it can be understood as a generalization of edge and face finite elements with higher regularity. In that paper we also defined a family of \( L^2 \) stable projectors that, along with the continuous and discrete spaces, form a commuting De Rham diagram.

The main drawback of B-splines and NURBS is their tensor product structure, which does not permit local refinement. To overcome this problem, it was proposed in [3] a discretization based on T-splines. T-splines are a family of functions defined on meshes with hanging nodes, allowing for local refinement, and with the same regularity properties of NURBS and B-splines. Under mild assumptions on the distance between hanging nodes, it can be proved that T-spline spaces have good approximation properties.

Recently, we have extended the definition of isogeometric differential forms to T-splines, defining an exact sequence of T-spline spaces that generalizes the result for tensor product B-splines [4]. In this work I will present the latest results in the study of this T-splines compatible discretization, along with a brief review on the previous B-splines results.

References


*Instituto di Matematica Applicata e Tecnologie Informatiche “Enrico Magenes”-CNR, via Ferrata 1, 27100, Pavia. annalisa@imati.cnr.it, vazquez@imati.cnr.it
†Dipartimento di Matematica, Università di Pavia, via Ferrata 1, 27100, Pavia. giancarlo.sangalli@unipv.it