Two automatic partitioning methods for multi-disciplinary non-orthogonal building spatial design optimisation

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Introduction

Sub-optimal decisions at the conceptual phase of design have a large impact on the final performance of the building. Better support with relevant tools at the beginning of the design process will thus give a great improvement to this performance. Relevant tools should consider multiple disciplines and Non-Orthogonal Buildings Spatial Designs (NOBSD) to better represent buildings found in practice.

Conformal geometry

Within such a tool, the transition from a NOBSD to multiple discipline-specific models may be facilitated by a conformal geometry. A conformal geometry is characterized by the fact that it contains no non-corner vertex intersections. Also, it is only allowed for any borderlines of the geometry to fall on any adjacent geometry's borderlines or no geometry. See figure 1 for an example of a conformal geometry and the visualization of two of the three use-cases related to discipline-specific model definitions: (1) to solve element connection and intersection problems within a finite element mesh, (2) to allows for the grouping of sub-parts of the geometry into zones for spatial layouts that are more logical from a discipline’s point of view, and (3) to define properties and loads on the geometry.

Automatic partitioning methods

Two automatic partitioning methods are proposed to obtain this conformal geometry. These are developed for the NOBSD representation consisting of non-orthogonal defined quad-hexahedrons with vertical and horizontal planes. Both methods result in a collection of conformal geometry, either in quad-hexahedrons or triangular prisms. An overview of the steps performed in both methods to obtain this result is shown in figure 2.

Future work

Currently, both automatic partitioning methods are researched regarding the requirements and preferences. These are the following: (1) the automatic partitioning method should result in a conformal geometry for as many, if not all, NOBSD; and (2) it should apply to other ground shapes of NOBSD apart from the quad-hexahedron. The partitions are preferred to (3) be of consistent size and as close as possible to a convex region to be suitable for the multi-block meshing principle presented in figure 1; and (4) to resemble a feasible structural grid for the application of the zoning use-case presented in figure 1. The first requirement has already been tested on 20 NOBSD cases. As a result, the iterative partition method generated 9 and the triangular partition method 19 conformal geometries.