Voronoi box based finite volume methods: advantages and challenges

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The Voronoi box based finite volume method on unstructured triangular and tetrahedral meshes for elliptic and parabolic problems combines the advantages of classical two point flux based finite difference methods with recent progress in mesh generation. Historically, the method allowed straightforward generalization of finite difference discretization approaches from orthogonal meshes to unstructured meshes. Results on mass conservation, maximum principle, positivity, and compatibility to thermodynamic model concepts are of particular importance.

The method draws heavily on the possibility to generate boundary conforming Delaunay meshes in two and three space dimensions, so we give a short overview on this topic.

For a number of problems, we discuss the implementation of the finite volume method, examples of their application.

While successful in several important fields, namely semiconductor device simulation, when compared with competing discretization approaches, it faces a number of challenges which should influence decisions on the choice of an appropriate discretization method. At the same time, some of these challenges raise interesting questions for further research. These include proper coupling to flow equations and automatic anisotropic mesh generation.