

Bachelor/Master Thesis Project

Computational Science & Engineering)

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Quadtree Techniques for the Construction of Structured Auxiliary Meshes

Prerequisites. Programming skills in MATLAB and C++/JAVA. Some knowledge about finite elements.

Problem description. The auxiliary space method [2, 1] is a methodology for preconditioning elliptic problems that have been discretized on a single unstructured mesh.

They require a semi-structured auxiliary grid as depicted in Fig. 1. This auxiliary mesh has to be completely contained in the domain covered by the unstructured grid. Moreover, the local meshwidth of the auxiliary mesh should roughly match that of the unstructured mesh. This will entail a treatment of hanging nodes in the case of non-uniform unstructured meshes.

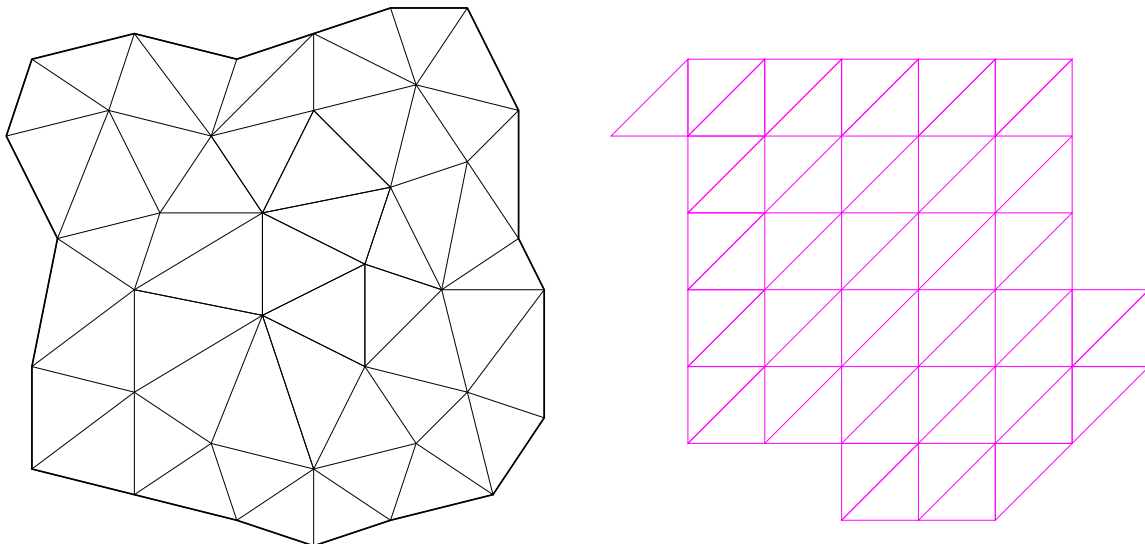


Figure 1: Unstructured mesh (left) and embedded semistructured auxiliary mesh (right)

On the auxiliary grid we would like to invoke a geometric multigrid solver, which requires a hierarchy of nested meshes.

Issues.

- Efficient representation of semi-structured auxiliary meshes (hash tables ?)

- Quadtree based construction of auxiliary mesh based on geometric information about unstructured mesh
- Coarsening of auxiliary mesh.

Task. Based on a grid generator in MATLAB the project involves implementation of a C++/JAVA code that can construct, handle and coarsen auxiliary meshes. The data structure should be powerful enough to support finite element discretizations and multi-grid implementations on the auxiliary mesh.

References

- [1] R. HIPTMAIR, G. WIDMER, AND J. ZOU, *Auxiliary space preconditioning in $\mathbf{H}_0(\mathbf{curl}, \Omega)$* , Numer. Math., (2005). Submitted. Published as Technical Report CUHK-2005-06 (327), Department of Mathematics, The Chinese University of Hong Kong.
- [2] J. XU, *The auxiliary space method and optimal multigrid preconditioning techniques for unstructured grids*, Computing, 56 (1996), pp. 215–235.