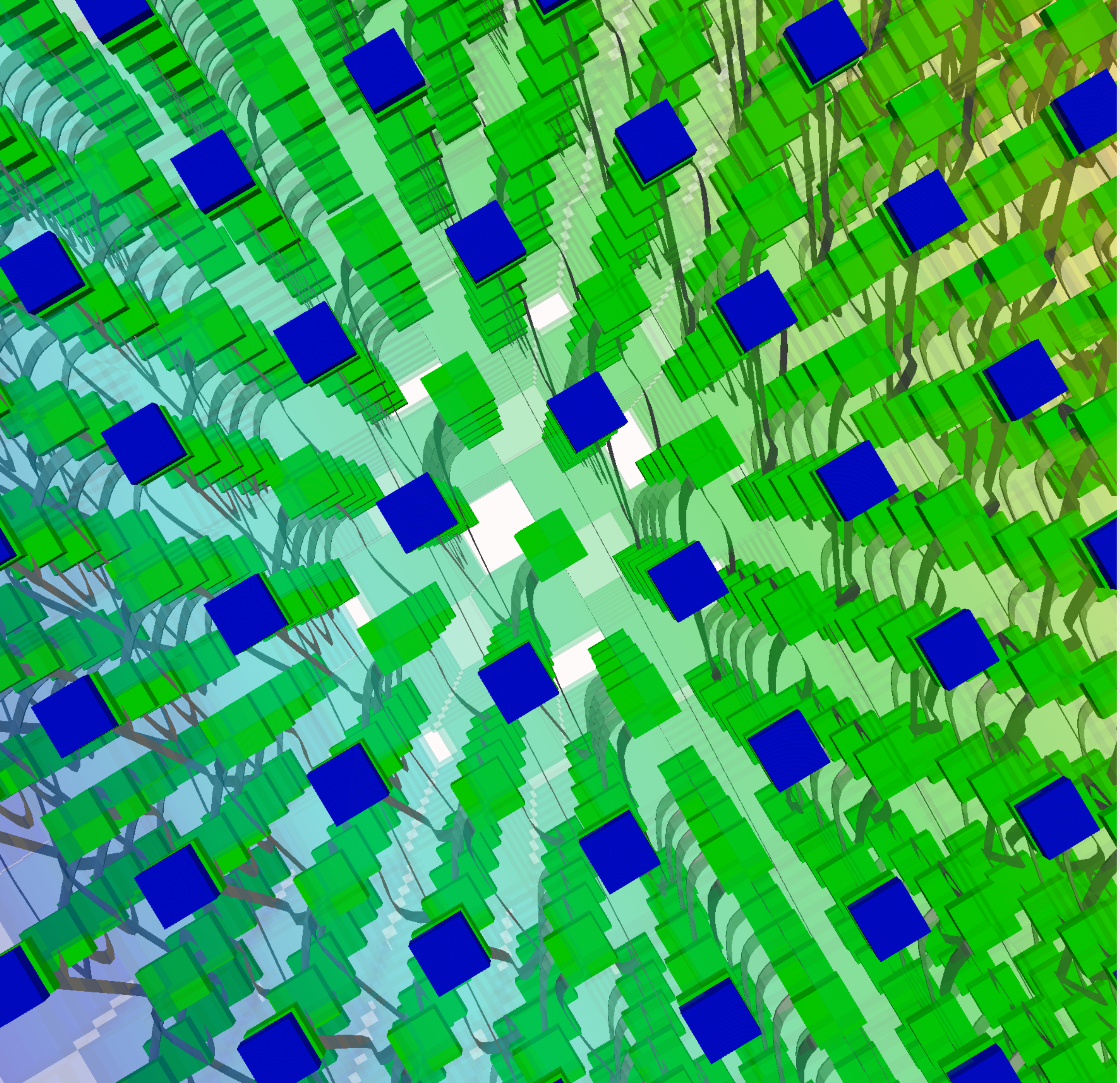

Loop Surgery for Volumetric Meshes:
Reeb Graphs Reduced to Contour Trees

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This paper introduces an efficient algorithm for computing the Reeb graph of a scalar function *f* defined on a volumetric mesh *M* in $\mathbb{R}^3$. We introduce a procedure called loop surgery that transforms *M* into a mesh *M'* by a sequence of cuts and guarantees the Reeb graph of *f(M')* to be loop free. Therefore, loop surgery reduces Reeb graph computation to the simpler problem of computing a contour tree, for which well-known algorithms exist that are theoretically efficient (*O(n log n)*) and fast in practice. Inverse cuts reconstruct the loops removed at the beginning. The time complexity of our algorithm is that of a contour tree computation plus a loop surgery overhead, which depends on the number of handles of the mesh.
Our systematic experiments confirm that for real-life volumetric data, this overhead is comparable to the computation of the contour tree, demonstrating virtually linear scalability on meshes ranging from 70 thousand to 3.5 million tetrahedra. Performance numbers show that our algorithm, although restricted to volumetric data, has an average speedup factor of 6,500 over the previous fastest techniques, handling larger and more complex data-sets. We demonstrate the versatility of our approach by extending fast topologically clean isosurface extraction to non-simply connected domains. We apply this technique in the context of pressure analysis for mechanical design. In this case, our technique produces results in matter of seconds even for the largest models. For the same models, previous Reeb graph techniques do not produce a result.

Paper

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