

COMPUTING SHORTEST PATHS ON MANIFOLDS: ALGORITHMS AND APPLICATIONS

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Abstract. The Fast Marching algorithm is an efficient numerical method for computing the shortest path between points of a domain in R^d , by solving an eikonal PDE. It has numerous applications, ranging from motion planning to medical image segmentation. The unit of length, for computing the path length, may vary on the domain.

Motivated by applications, we generalize the algorithm to the case where the unit of length also depends on the path direction. A conflict arises between this anisotropic geometry and the rigid structure of the cartesian grid. Its solution involves elegant and uncommon tools in numerical analysis, such as the classification of low dimensional lattices, and Stern-Brocot's arithmetic tree. As an illustration, we extract the retina irrigation network by identifying vessels with weighted euler elastica curves (in collaboration with Laurent Cohen, Da Chen).