Intern project: Vector-Dijkstra

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The project concerns the fast computation of geodesics. Speeding up the calculations has applications in among other; transport problems, (Delaunay) triangulations, anisotropic meshing and curve approximation.

Problem: Analysis of the vector Dijkstra method

Campen et al. have introduced the so-called vector Dijkstra method to compute geodesic distances and indirectly geodesics on Riemannian surfaces (surfaces endowed with a Riemannian innerproduct).

The method works roughly speaking as follows: We are given a grid-like point set on a surface as well as information on the distance to nearest neighbours. We apply Dijkstra's algorithm in the usual way, however we keep track of the shortest path that goes to a point (the points on this path will be called ancestors) and if we update the distances in Dijkstra's algorithm we are allowed to look back and calculate the distance to ancestors that are a few generations back instead of looking at only the last point.

This method works very well in practice, but little to no theoretical work has been produced on this.

This project will start with a simple theoretical analysis in Euclidean 2-space. Then we expect to be able to extend to surfaces with a controlled metric. Finally we shall investigate the higher dimensional setting. If successful in high dimensions we can also consider experiments in 3 and 4D.

References

M. Bernstein, V. de Silva, J.C. Langford and J.B. Tenenbaum, Graph approximations to geodesics on embedded manifolds.
M. Campen, M. Heistermann and L. Kobbelt, Practical Anisotropic geodesy.