SIG-based Curve Reconstruction

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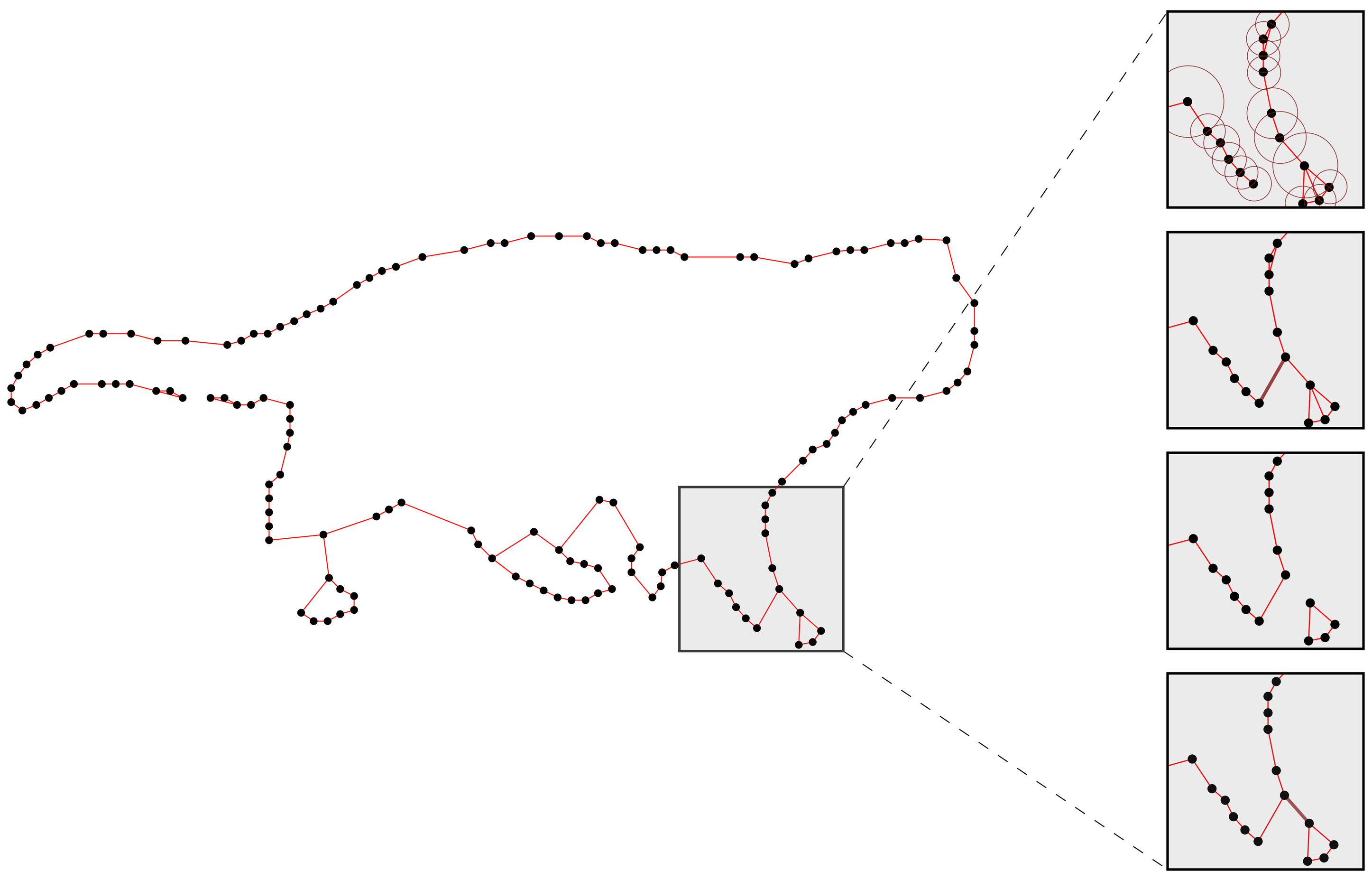
Introduction

Reconstructing a curve based on given samples with no additional information besides position is a difficult task, since no connectivity information is present.

We introduce a new method for curve reconstruction, based on a combination of Delaunay triangulation (DT) and the Spheres-of-influence graph (SIG), which we present below. Our method is inspired by the Connect2D algorithm [OM13], replacing their starting graph with a SIG-based graph, and then enhancing it. That graph is then processed by inflating and sculpting, as in Connect2D, creating a final boundary for the input point set.

Initial Graph Computation



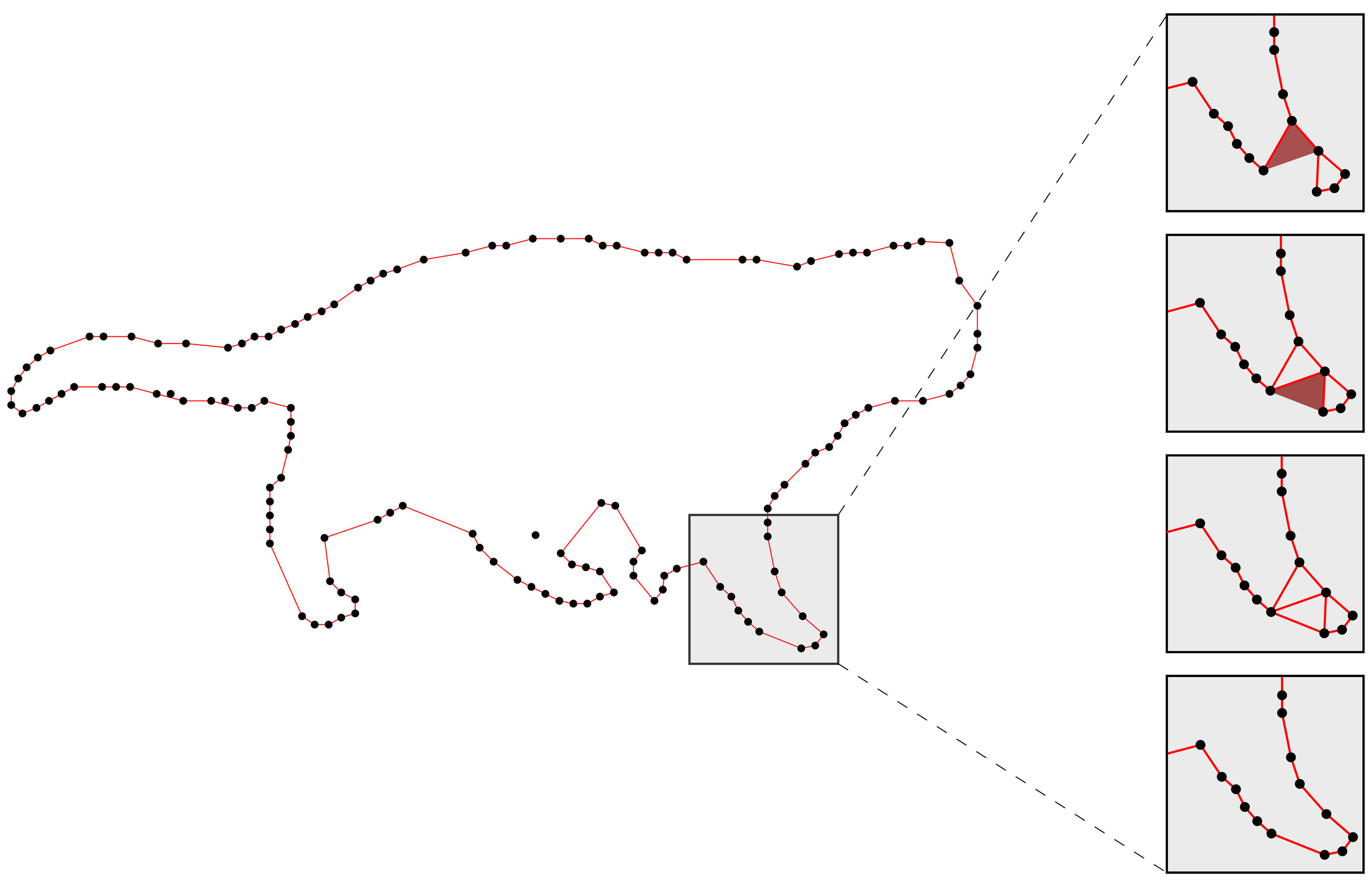
We filter edges from the Delaunay triangulation which are also in the SIG [Tou88]. An edge is in the SIG if it is shorter than the sum of distances of its vertices' nearest neighbours, as illustrated by overlapping circles.

We eliminate leaf vertices by adding their shortest incident Delaunay edge to the graph.

We remove longest edges for vertices with degree more than two until their degree becomes two, as long as no new leaf vertices are created.

We connect the graph into a single connected component via a disjoint set, and apply a boundary closing heuristic in case of holes.

Inflate



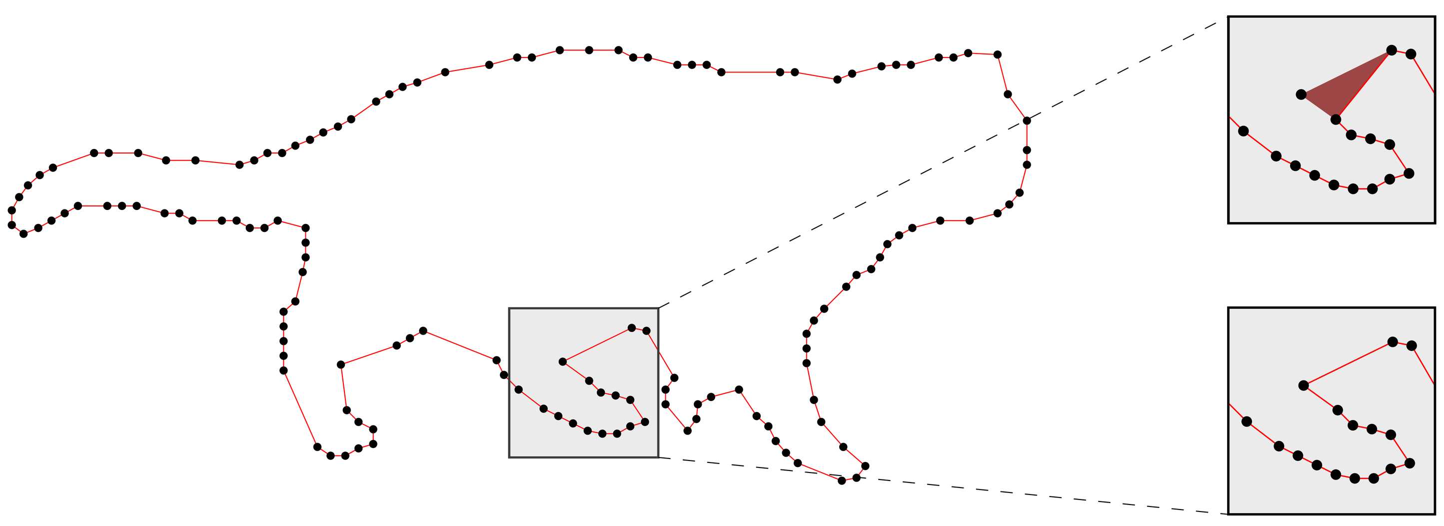
We find non-conforming vertices, i.e., vertices with degree greater than two, and add incident exterior triangles as candidates.

We sort candidates by the least increase in the total boundary length of the curve. This is computed by adding the length of new edges and subtracting the length of removed ones.

When a candidate triangle is added, we add all of its edges to the current reconstruction.

We remove interior edges that are not part of the boundary.

Sculpt



We find interior vertices, i.e., isolated vertices, and add incident triangles in a priority queue as candidates, sorted by the least increase in the boundary length.

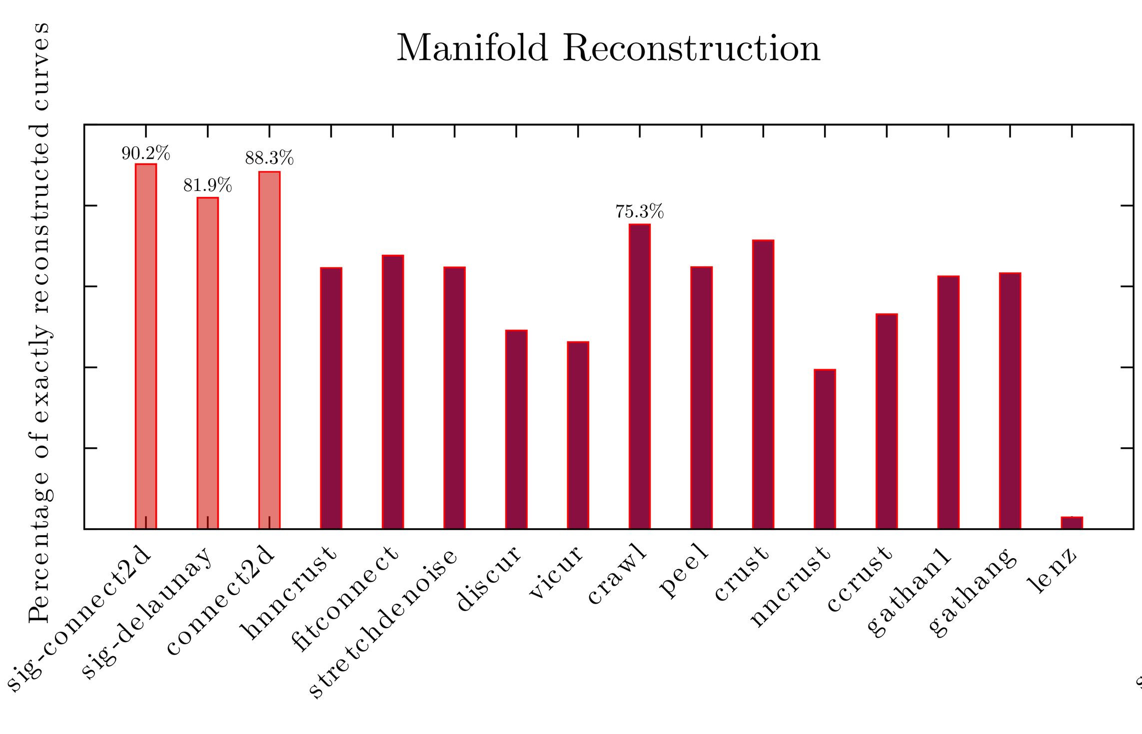
We add a candidate triangle by adding the edges which are not already present in the graph and removing those that were part of the reconstruction. This procedure exposes the interior vertex to the boundary.

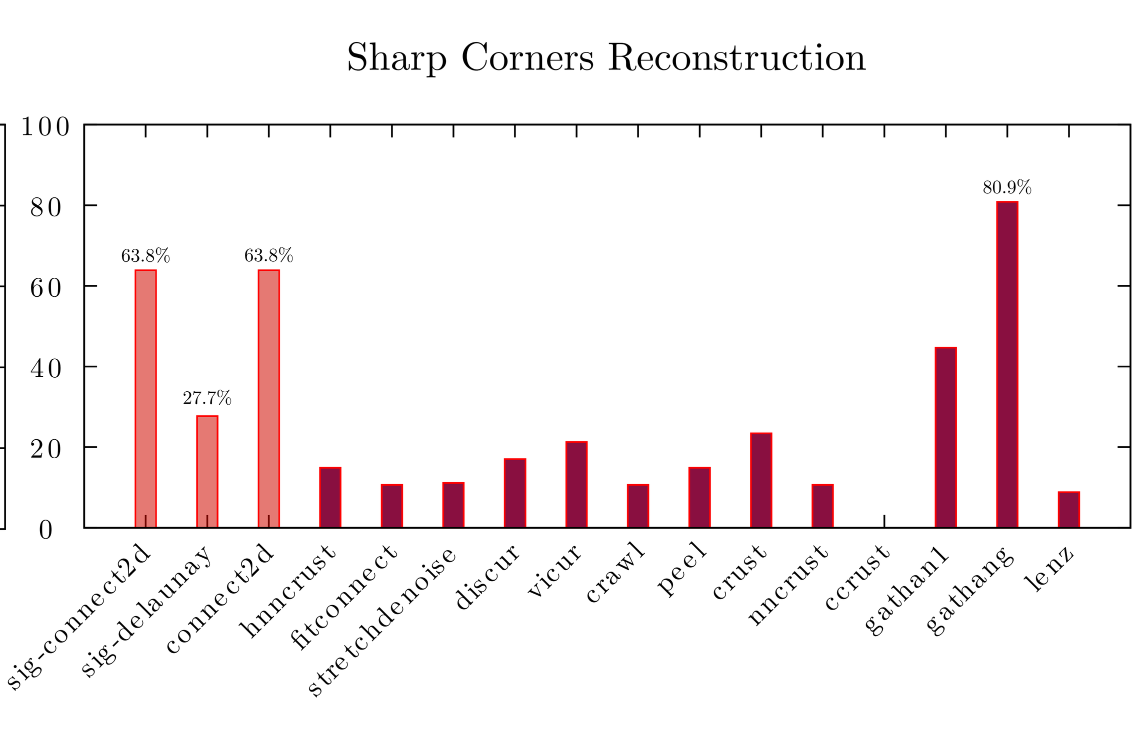
Results

Our method performs best for manifold reconstruction compared to state-of-the-art algorithms. For datasets with sharp corners, the performance is still comparable to existent techniques, being only superseded by GathanG [DW02], which specialises in sharp corners.

Furthermore, the SIG+Delaunay (Initial Graph) computation has an accuracy comparable to state-of-the-art algorithms for curve reconstruction having the additional advantage that it can also reconstruct multiple curves and open curves.

The results have been computed using the 2D Points Curve Reconstruction Survey and Benchmark [OPP*21], on a subset that interpolates all input points.





References

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