# Fast and exact geodesic distance on triangular mesh

## Motivation

Given a 3D mesh, one could want to be able to compute distance on the mesh. One possible application for an exact computation of geodesic distance on 3D mesh would be the ability to draw Beziers and Splines curves on those meshes.

## Existing methods and limitations

We could easily approximate distance between two points by limiting ourselves to edges, using Djikstra algorithm. Using this method, the shortest path between two given points would mainly consist of a walk along the edge of the mesh. This approximation might hold for graph that are sufficiently tight and regular, but the error with this method is arbitrary high if the mesh or the points are not well chosen.

## Exact computation of geodesic distance

Even if Djisktra’s method is not adapted to the problem we are trying to tackle, we can use the same paradigm to compute the exact geodesic distance : propagating information step by step, keeping at any given point in time the optimal information, and stopping when there is no information left to propagate.

In this case, the information is a “window” on an edge h. This window describes a way of reaching a subset of h from a point S called the source or the pseudo-source. Furthermore, the window can be reached from S using only straight lines in the planar unfolding of the faces that lie between s and the edge.

On one window, the distance to point S on the mesh is completely known, and if we know the distance from S to the starting point, we can derive the distance field over the window through S.

In a Djikstra-like manner, we would now like to propagate this information to edges that are across a new adjacent face. We can do this by adding the new face to the planar unfolding, then drawing straight lines from S through the window. This will define a certain number of new windows on which the distance field through S is known.

However, the new windows might intersect with existing windows that were already here. We then need to merge the existing windows and the new window so as to keep only the minimum distance to the starting point.