

The background features a dark blue gradient with faint, light blue circular patterns and a scale. The scale is a large arc on the left side, with numerical markings from 40 to 260 in increments of 10. There are also several smaller circles and arcs scattered across the background, some with arrows indicating direction.

# Assignment #5: Find Geodesic Paths by Flipping Edges

USTC, 2024 Spring

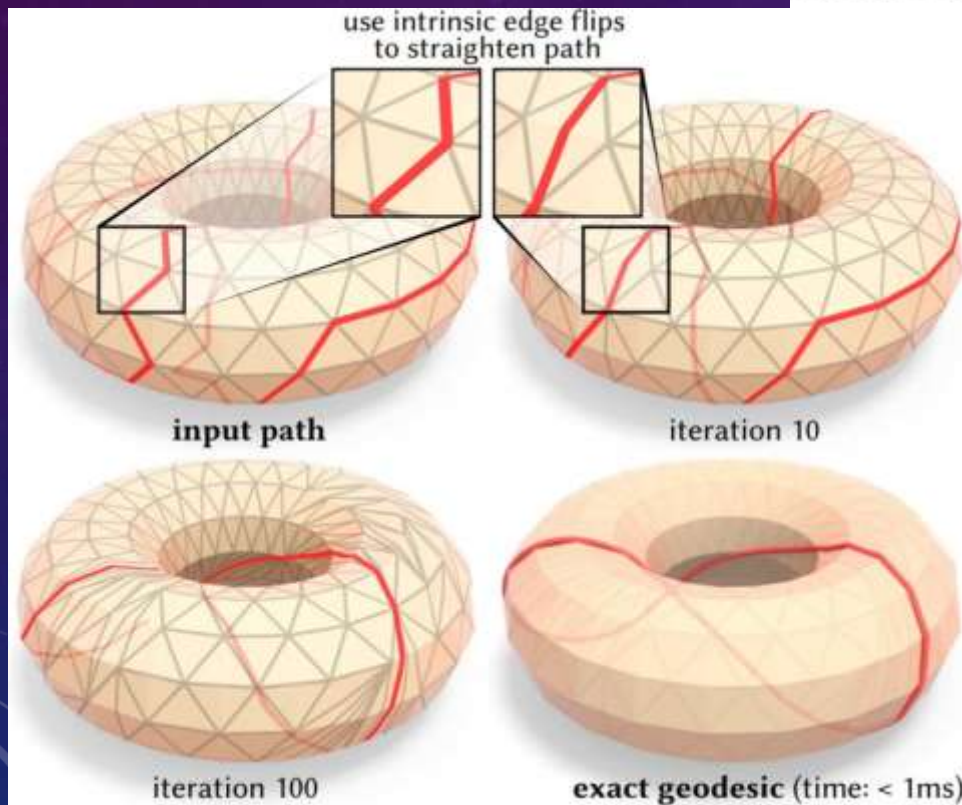
Qing Fang, [fq1208@mail.ustc.edu.cn](mailto:fq1208@mail.ustc.edu.cn)

<https://qingfang1208.github.io/>

# Implement algorithm in the following paper

## You Can Find Geodesic Paths in Triangle Meshes by Just Flipping Edges

NICHOLAS SHARP and KEENAN CRANE, Carnegie Mellon University



uses a new approach to computing geodesics on polyhedral surfaces. The basic idea is to iteratively perform *edge flips*, in the same way as the Delaunay flip algorithm. This process also produces a high-quality triangulation of the output geodesics, which is immediately useful for geometry processing and numerical simulation. More broadly, our algorithm transforms a given sequence of edges into a geodesic while avoiding self-crossings (formally: it finds a path in the same isotopy class). The algorithm is guaranteed to terminate in a finite number of operations; practical runtimes are on the order of seconds, even for meshes with millions of triangles. The same algorithm is applied to curves beyond simple paths, including closed loops, and multiply-covered curves. We explore how the algorithm is applied to tasks such as straightening cuts and segmentation boundaries, geodesic Bézier curves, extending the notion of *constrained Delaunay triangulations (CDT)* to curved surfaces, and providing accurate solutions for partial differential equations (PDEs). Evaluation on datasets such as *Thing10k* indicates that the method is both fast and accurate, even for low-quality triangulations.

Computing methodologies → Shape modeling.

Keywords and Phrases: geodesic, edge flip, triangulation

Format:

Keenan Crane. 2020. You Can Find Geodesic Paths in Triangle Meshes by Just Flipping Edges. *ACM Trans. Graph.* 39, 6, Article 249. 15 pages. <https://doi.org/10.1145/3414685.3417839>

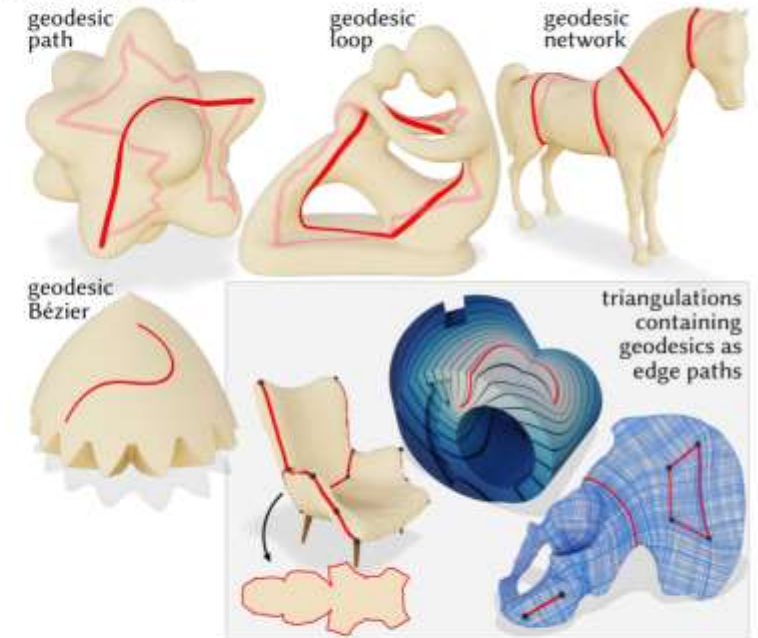
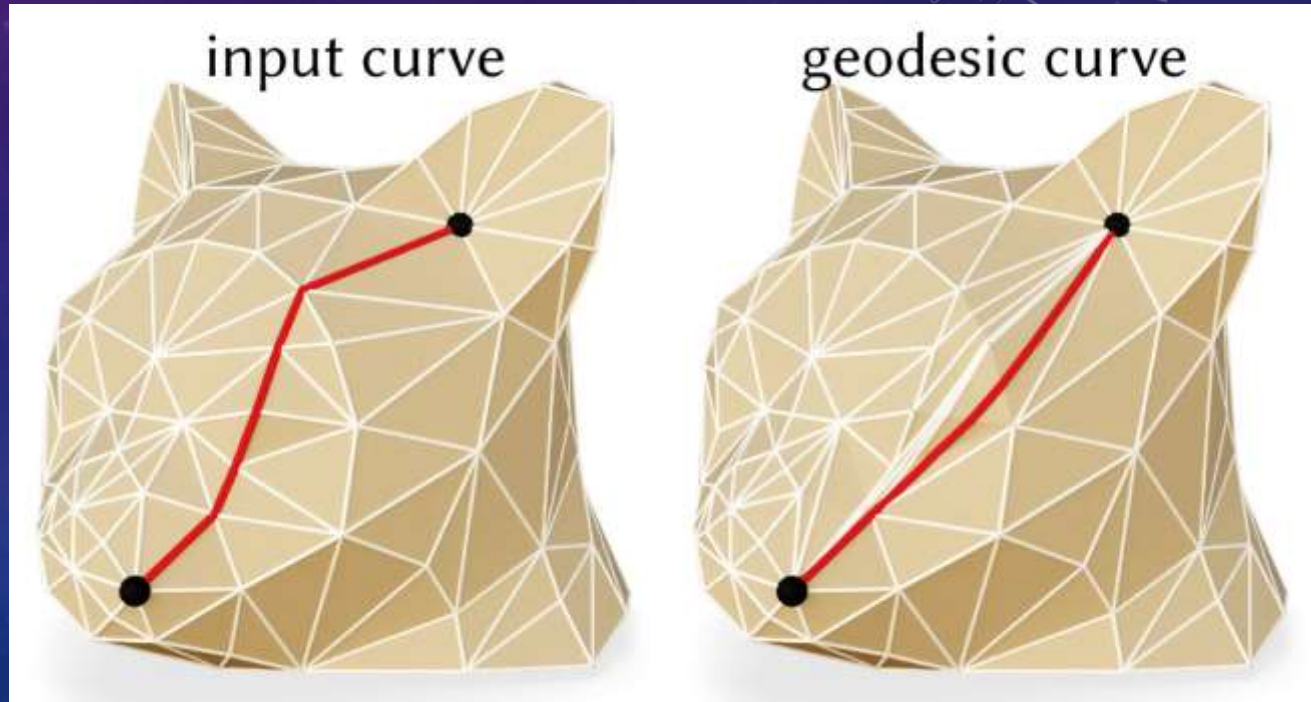


Fig. 1. We introduce an edge-flip based algorithm for computing geodesic paths, loops, and networks on triangle meshes. The algorithm also yields a triangulation containing these curves as edges, which can be used directly for subsequent geometry processing (e.g., for cutting, or for solving PDEs).



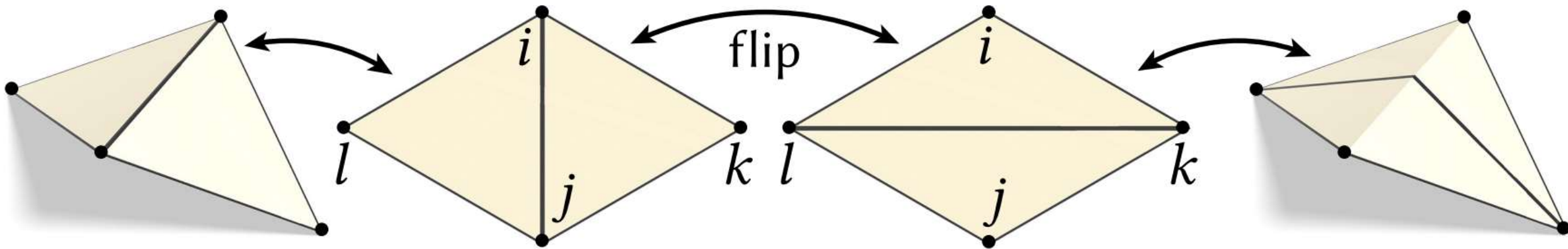
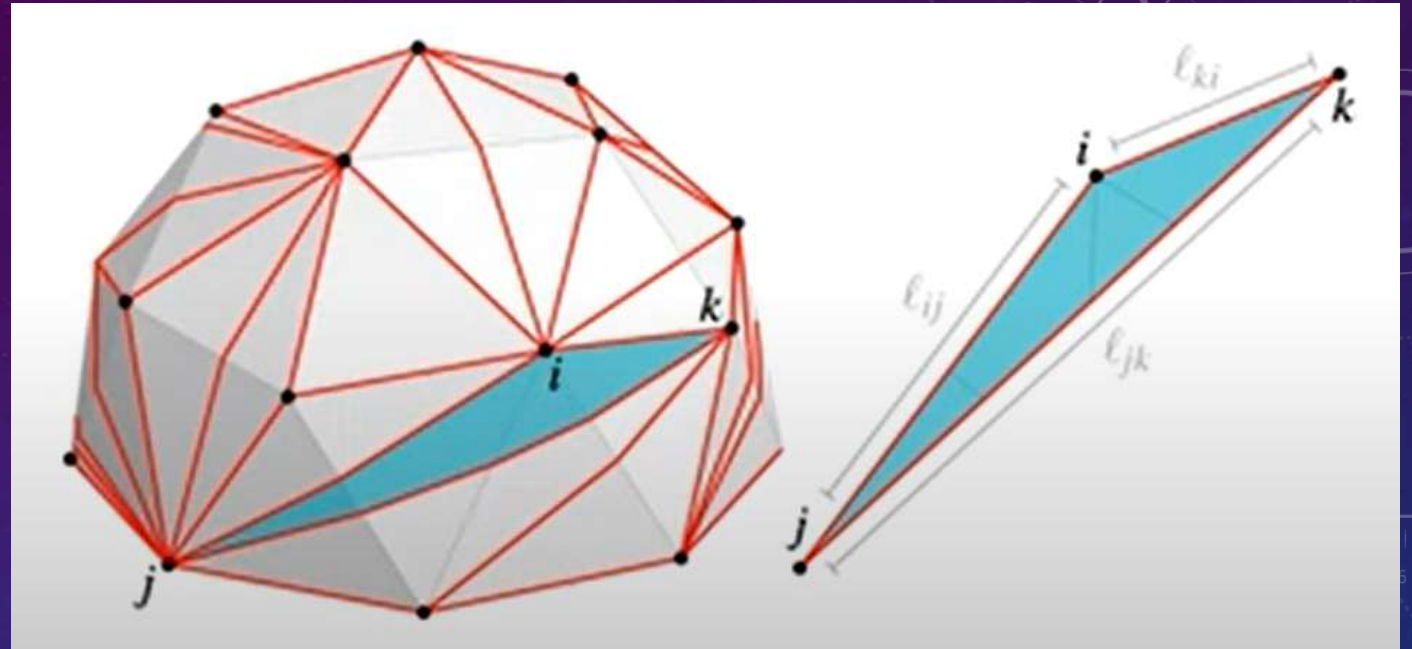
# Problem

- Input: a path (or loop/network) on the surface of a mesh
- Output: an exact geodesic path (or loop/network)



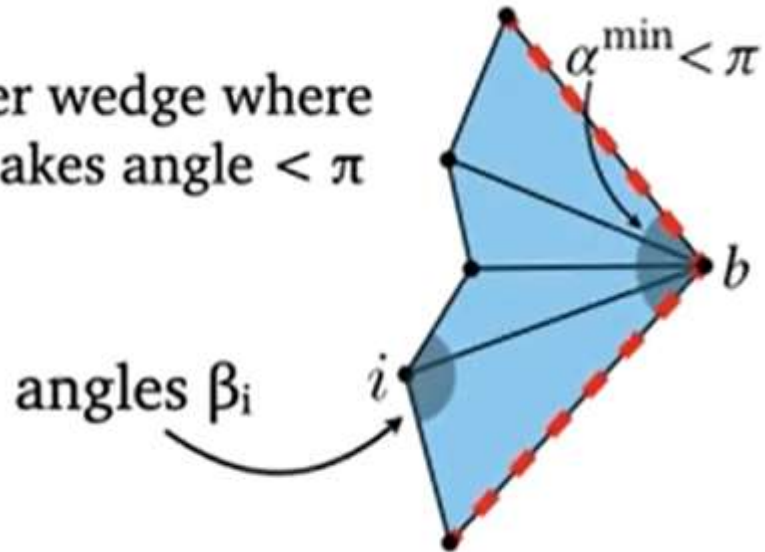
# Intrinsic flip

- Flip edges on a mesh  
(unfolding)



# FlipOut subroutine

consider wedge where  
path makes angle  $< \pi$



**func FlipOut()**

**Input:** path through vertices  $a, b, c$

- while any  $\beta_i < \pi$

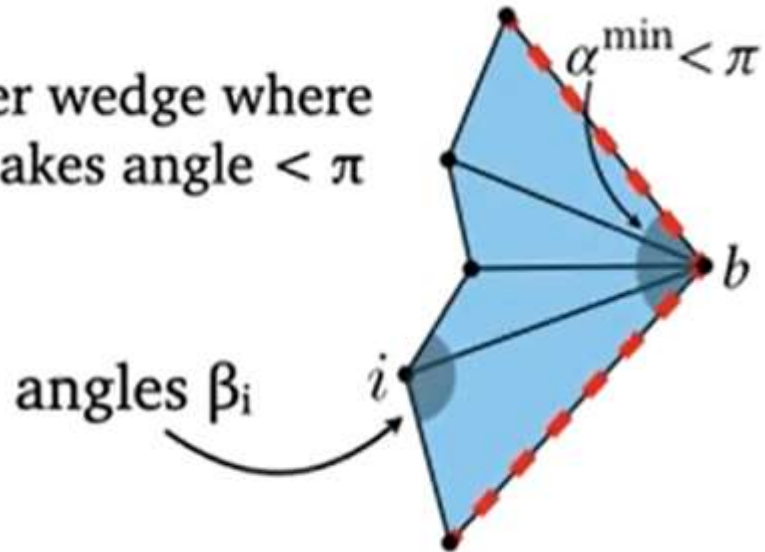
- flip first such edge  $bi$

**Output:** shorter path along boundary



# FlipOut subroutine

consider wedge where path makes angle  $< \pi$



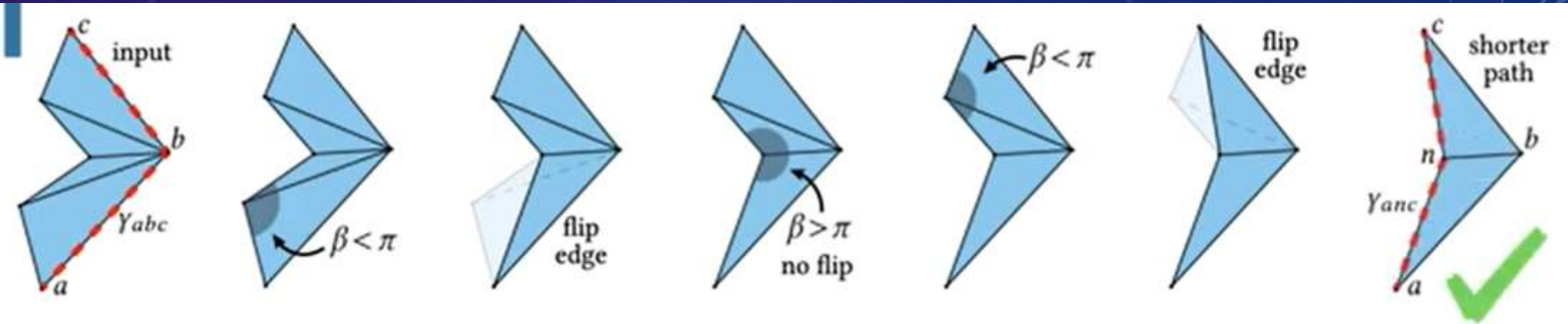
**func FlipOut()**

**Input:** path through vertices  $a, b, c$

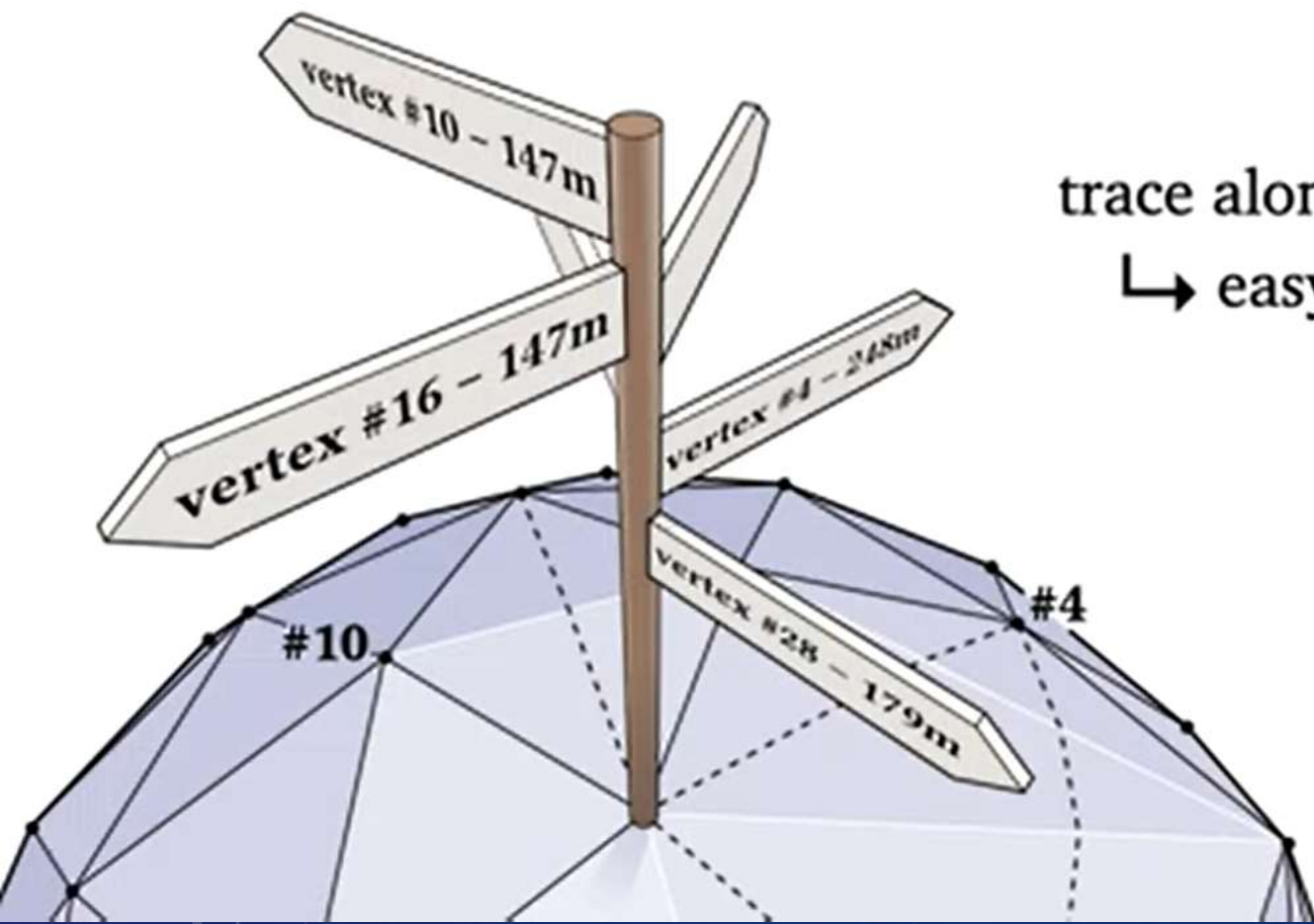
- while any  $\beta_i < \pi$

- flip first such edge  $bi$

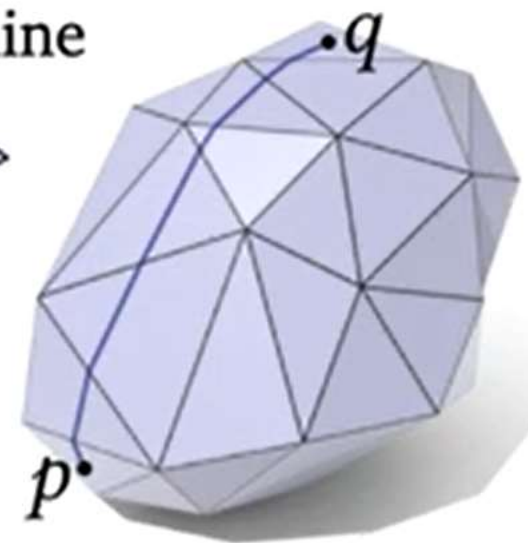
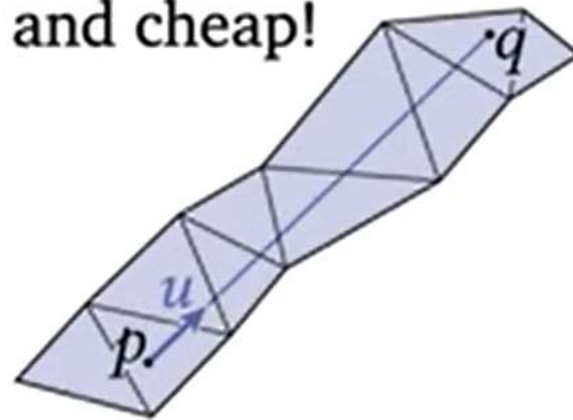
**Output:** shorter path along boundary



# Implementation details



trace along surface to get polyline  
↳ easy and cheap!



Navigating Intrinsic Triangulations.  
Sharp, Soliman, & Crane. SIGGRAPH 2018

# Assignment requirements

- Input : any two point on the mesh
- Alg:
  - Find the shortest edges' path by Dijkstra's algorithm
  - Change the path to geodesic path by flipping edges.
- Email: ID\_name\_homework#5.zip
- Deadline: 2024.05.01, 23:59

