

Simplifying Unstructured Grids for Oceanographic Visualizations



Ole Tytlandsvik

December 6, 2024

Oceanbox

- Tromso-based
- Interactive oceanographic simulations
- Oceanography as a Service
- Web-Based Geographic Information System (Web GIS)
- Digital twin of the coastal ocean



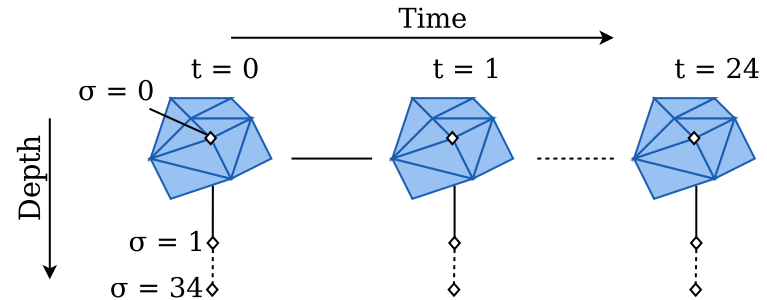
The Problem

- Large data sets
 - High resolution (millions of spatial points)
 - Multi-dimensional
 - Payloads of 20Mb+
 - Unresponsive web application
 - Increased bandwidth costs

The Solution: Lossy Compression

- Traditional approaches tricky
 - Accuracy of coordinates are important
 - Tiling/Multi-resolution not trivial with *unstructured grids*
 - Inflated data size should be smaller on the client
- Grid simplification
 - Remove vertices/nodes
 - Maintain visualization quality
 - **Angle bound half-edge collapse**

FVCOM grids



- Unstructured grid
 - Variable resolution
- Multiple dimensions
 - Coordinates, depth, time

Related Work

Rasterization-based approaches

- Good compression rates (90%)
- Requires *structured* grid layout

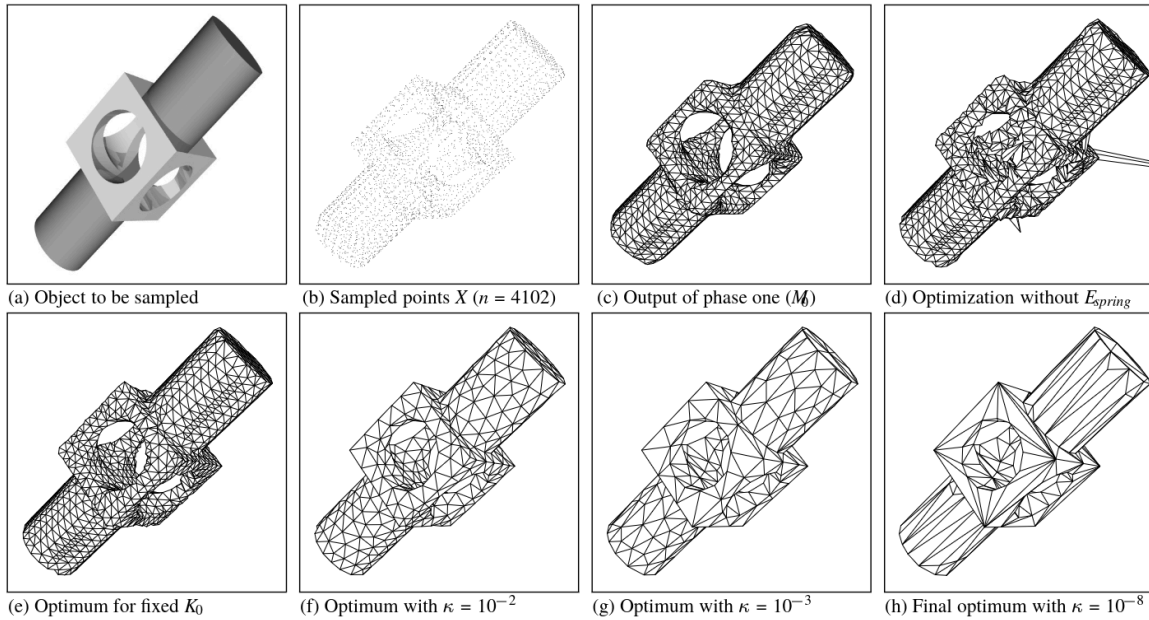
Tiling approaches

- Load only what you need
- Varying resolution
- Also requires structured grids

Mesh simplification

- More suited for unstructured grids
- Popular in literature: *3D mesh decimation*
- Not necessarily directly applicable...

Related Work: Mesh Simplification



- Approximate a surface¹
- Preserve topology
- Good reduction

However

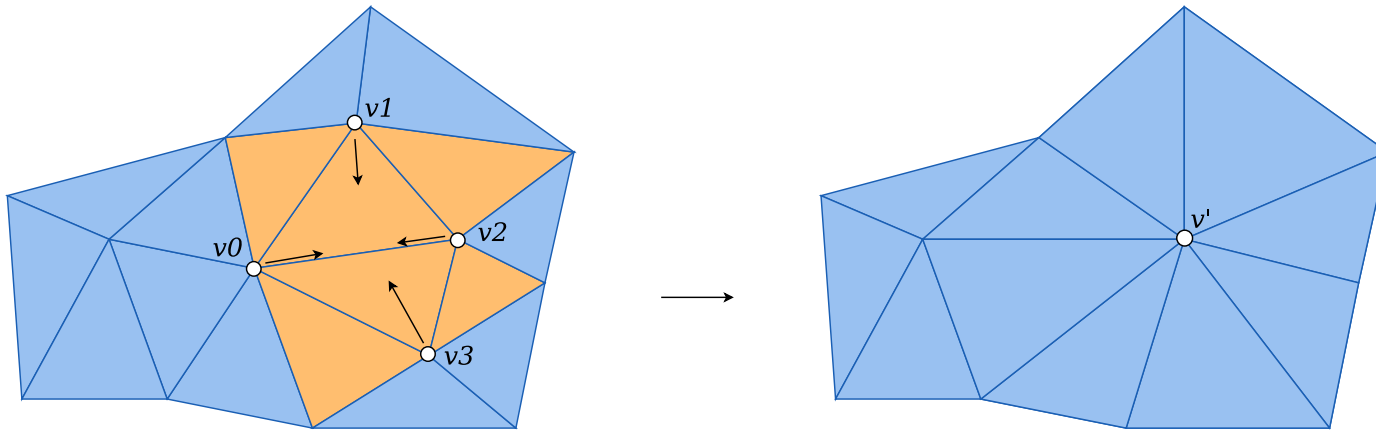
- Not ideal for 2D grids
- Need even resolution

¹Figure from Hoppe et al. “Mesh Optimization”, ACM, 1993, pp. 19-26

Related Work: Mesh Simplification Operators

Vertex Clustering

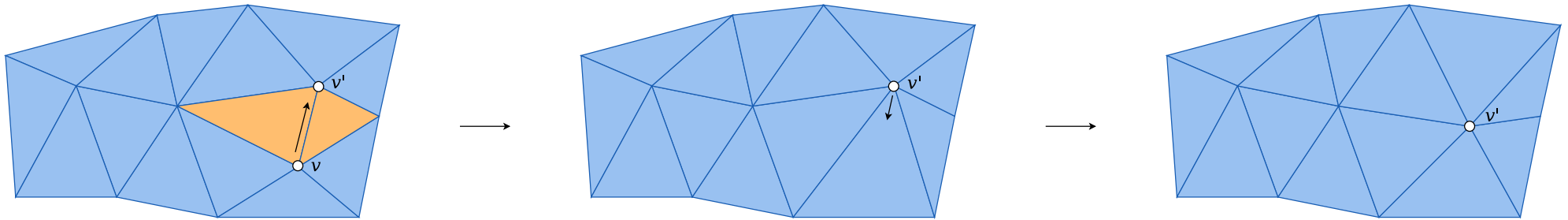
Identify a “cluster” of vertices and represent them all with one vertex



Related Work: Mesh Simplification Operators

Edge Collapse

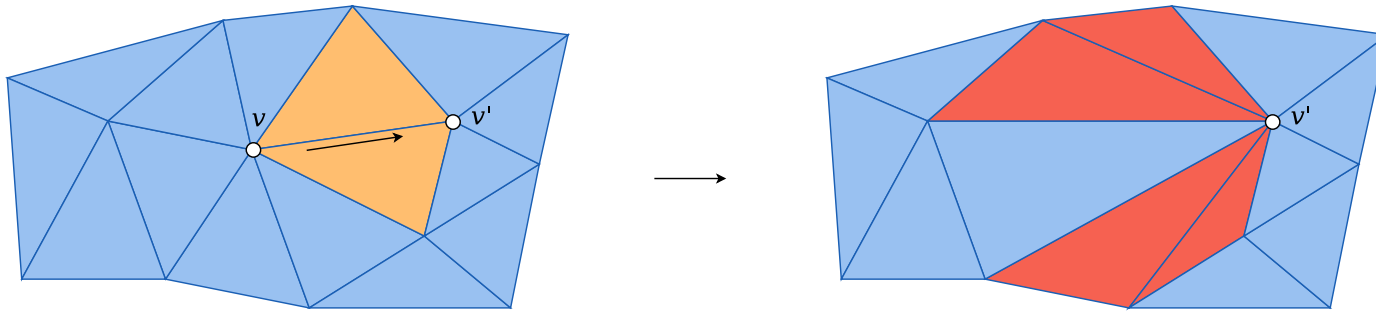
Collapse an edge between two vertices, representing them with one vertex



Our Approach: Angle Bound Half-edge Collapse

Adaptation from previous work¹

Half-edge collapse with a minimum angle criterion to inner angles



¹Hinderink et al. "Angle-Bounded 2D Mesh Simplification." *Computer Aided Geometric Design*, vol 95, May 2022, p. 102085

Architecture Overview

First, consider the data flow in Oceanbox's web app