Assignment 2: Tutorials 6-8 report

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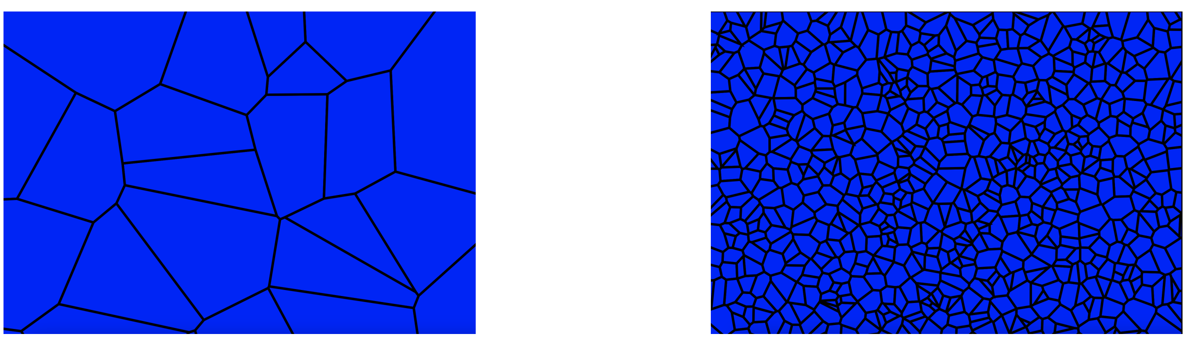
1 Introduction

This report presents the implementation of several algorithms and techniques in computational geometry (chapter 4) and fluid simulation (chapter 5). The focus of the assignment was to develop and understand the Voronoï Parallel Linear Enumeration algorithm, Sutherland-Hodgman polygon clipping algorithm, semi-discrete optimal transport, and the semi-discrete optimal transport fluid simulator with free surfaces. The report provides an overview of the theoretical background, step-by-step explanations of the implemented algorithms, and discusses the obtained results. The assignment demonstrates the ability to apply computational geometry and optimization techniques to solve complex problems in a practical setting.

2 Geometry Processing - Clipping and Voronoï Diagrams

In tutorial6, I implemented the Sutherland-Hodgman algorithm which is a widely recognized method for accomplishing this objective. This algorithm clips a polygon by a bisector defined by two points P0 and Pi. It iterates through the vertices of the input polygon and checks if each edge intersects with the bisector. Based on the intersection and the relative positions of the vertices, it adds the intersecting points to the resulting polygon.



(a) Voronoï diagram for 30 points

(b) Voronoï diagram for 1024 points

Figure 1: Figures from tutorial 6

3 Geometry Processing - More on Voronoï, and Optimization

Firstly, we delved into power diagrams and made adjustments to the formulas by incorporating weights P and considering the concept of "inside." This refinement enhanced the accuracy and effectiveness of the diagrams. Secondly, we utilized the libLBFGS library, which proved to be invaluable for optimization purposes. Lastly, we tackled the challenging task of solving optimal transport problems. To address this, we integrated the libLBFGS library into our project, allowing us to leverage its functionalities. Additionally, I worked on implementing an evaluate function that efficiently computed the objective function and its corresponding gradient.

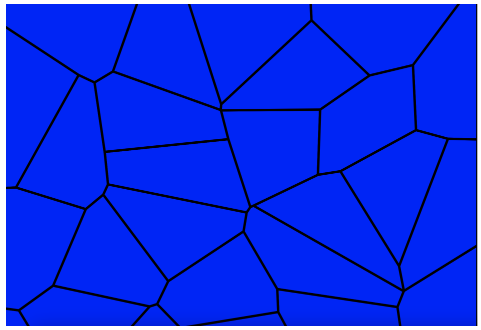


Figure 2: Optimized diagram figure by tutorial 7

4 Computational Fluid Dynamics

The focus of this lab was on implementing a semi-discrete optimal transport fluid simulator with free surfaces by adapting lab7. This result on "de Gallouet-Mérigot incompressible Euler" scheme that prescribes each fluid cell area and the sum of air cell volumes to given values, and add a spring force from each fluid particle to their Laguerre's cell centroid.