Computer graphics

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Second Graded Project

1. Voronoi diagram (Sec. 4.2 and 4.3, lab 6)

In lab6, we built a Voronoi diagram using Voronoi Parallel Linear Enumeration with Sutherland-Hodgman polygon clipping algorithm. Voronoi Parallel Linear Enumeration treats each Voronoi site independently and computes their Voronoi cell independently in parallel.

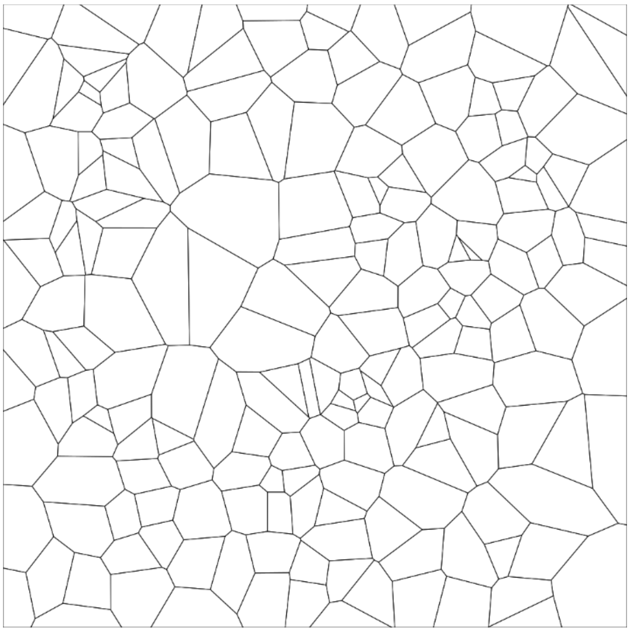

Figure 1: Voronoi diagram using Parallel Linear Enumeration with Sutherland-Hodgman polygon clipping algorithm with 200 cells. The rendering time is 18ms.

2. Power Diagram (Sec. 4.4.3, lab 7) and weights optimization using LBFGS (Sec 4.4.4, lab 7)

In lab 7, we extended our Voronoi diagrams to power diagrams, in which the size of the cells can be controlled using weights. Equal weights lead to a power diagram that corresponds to the Voronoi diagram. Moreover, increasing the value of a weight while keeping the others equal increases the area of the corresponding cell.

However, it is not easy to set the value of the weights to control the areas of the cells. Setting the weights can be seen as an optimal transport problem, where one wants to set the mass of the Voronoi cell according to the population density of the points. To find the optimal weights, we thus maximize a function using L-BFGS thanks to the libLBFGS library.

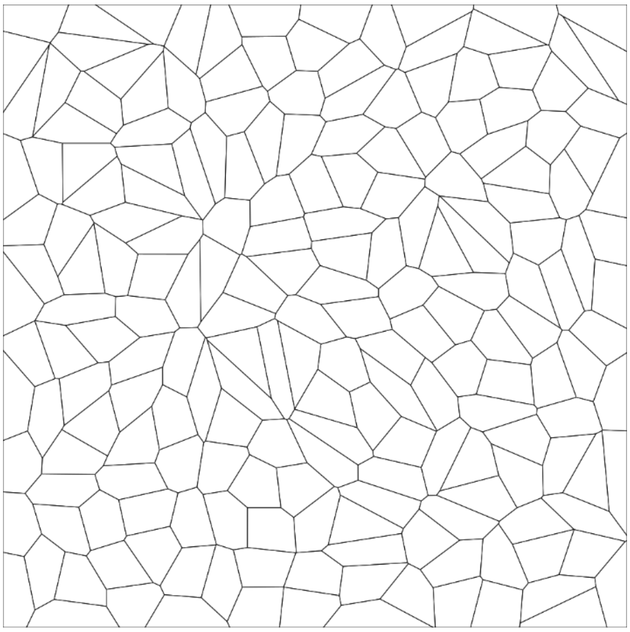

Figure 2: Power diagram with 200 cells. The weight optimisation is achieved using LBFGS algorithm. The rendering time is 1800ms. We can observe that every cell have a similar area

3. Gallouet-Mérigot incompressible Euler scheme

In lab 7, we used semi-discrete optimal transport method to simulate fluids via incompressible Euler's equations, a simplification of Navier Stokes equations. We also added a spring force to each Laguerre's cells' centroid. We again use L-BFGS instead of a newton's optimizer, and our previous power diagram algorithm. Compared to lab 7, we are no longer optimizing N weights (each corresponding to each of the cell), but N+1 weights, as we add a weight that is optimized such that the sum of all volumes of all Laguerre's cells remains constant (conservation of volume).

To obtain the following results (one frame every 50 time-step is displayed bellow), we used 500 frames, 200 cells, disks made out of polygons of 200 edges and a time-step of 0.004s. This took about 20 minutes due to the large number of edges. With 10 cells and using 500x500px frames, the computations take 7 minutes.