

## IFT 6112: Assignment 2

Due: Oct, 18<sup>th</sup>, 2018

### Objective:

Construct the Laplacian matrix and apply it for mesh smoothing.

### Tasks:

1. Compute a Laplacian matrix using the FEM discretization.
2. Double-check the correctness of your Laplacian matrix.
3. Perform mesh smoothing using the implicit integration method of diffusion equation.

### Instructions:

1. Using our FEM cotangent discretization that we covered in lectures, write a function that computes a Laplacian matrix. Technically, you should write a function that, given a mesh, creates an Eigen::SparseMatrix<double> object. Pay extra attention to *how* you create this matrix: use the most efficient method available.
2. Double-check your Laplacian: print out its eigenvalues. Do you think they are correct? Is the matrix symmetric and sparse? Add an explanation (with a printout of eigenvalues/fill-in ratio/other tests) to your readme file. Do all your tests on the [armadillo](#) model.
3. Implement the implicit integration method for the diffusion equation, as described in the paper [Desbrun et al. 1999], equation (9).
4. Provide the ability to change both the lambda value and the number of iterations via either command-line arguments or interactive keystrokes. Document this in your README file.

For extra coolness factor, optionally turn in a side-by-side video of the smoothing in progress. For simplicity, you can assume that the mesh has no boundaries.

**BONUS:** You can get extra marks for implementing any of the following options (bonus at my discretion). For the description of each option, please refer to online literature on smoothing.

- Modify the method so that it tries to preserve mesh volume
- Make it work on meshes with boundaries
- Implement the explicit integration method, compare, and explain the difference.

You can use the same meshes as before or download whatever you like.

Make sure you understand every line of the code you write.

Submission: private message to me on Piazza with a source code attached.

**Reference:**

Mathieu Desbrun, Mark Meyer, Peter Schröder, and Alan H. Barr. [\*Implicit Fairing of Irregular Meshes Using Diffusion and Curvature Flow\*](#). *Proceedings of SIGGRAPH 99*. pp. 317-324, 1999.