HW5 Question 1&2

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1 Question 1: Cotangent Laplacian

- Calculate the cotangent weight matrix (implemented by **iterating the** half-edge structure, see fun Get_cotan() in Q1&2.cpp).
- Get the Diagonal Vertex area matrix (checking fun Get_diag() in Q1&2.cpp).

2 Laplace-Beltrami Eigenfunctions

Using spectra to get the eigvalues and eigvectors (first 300 elements that greater than $1e^{-12}$, see Fig 1 and fun).

```
//Initialize and compute
using OpType = SymShiftInvert<double, Eigen::Sparse, Eigen::Sparse>;
using BOpType = SparseSymMatProd<double>;
OpType op(-Cotan_matrix, Diag_matrix);
BOpType Bop(Diag_matrix);
SymCEigsShiftSolver<OpType, BOpType, GEigsMode::ShiftInvert>
    eigs(op, Bop, 301, 650, -1e-5);
//SparseSymMatProd<double> op(-Cotan_matrix);
//SparseCholesky<double> Bop(Diag_matrix);
//SymGEigsSolver<SparseSymMatProd<double>, SparseCholesky<double>, GEigsMode::Cholesky>
    //eigs(op, Bop, 300, 601);
eigs.init();
int nconv = eigs.compute(SortRule::LargestMagn);
Eigen::VectorXcd evalues;
Eigen:MatrixXcd evectors;
if (eigs.info() == CompInfo::Successful)
    evalues = eigs.eigenvalues();
    evectors = eigs.eigenvectors();
```

Figure 1: Calculating the eigenvalues and vectors.

```
source_3_eigvec.csv
                        39,242 KB 12/12/2021 下午 9:40:59
source_9_eigvec.csv
                         39,237 KB 12/12/2021 下午 9:43:46
                                                                        root
$\int\text{source_7_eigvec.csv} \quad 39,236 KB \quad 12/12/2021 下午 9:42:50
                                                           rw-r--r--
                                                                        root
                        39,215 KB 12/12/2021 下午 9:40:31
source_2_eigvec.csv
                                                           rw-r--r--
                                                                        root
                        39,207 KB 12/12/2021 下午 9:40:05
source_1_eigvec.csv
                                                           rw-r--r--
                                                                        root
target_eigvec.csv
                         39,178 KB 12/12/2021 下午 9:39:37
source_8_eigvec.csv
                         39,177 KB 12/12/2021 下午 9:43:18
                      39,158 KB 12/12/2021 下午 9:41:27
source_4_eigvec.csv
                                                           rw-r--r--
                                                                        root
source_6_eigvec.csv
                         39,148 KB 12/12/2021 下午 9:42:22
                                                           rw-r--r--
                                                                        root
                         39,143 KB 12/12/2021 下午 9:41:54
source_5_eigvec.csv
                                                           rw-r--r--
                                                                        root
                         4 KB 12/12/2021 下午 9:42:21
source_6_eigval.csv
                                                           rw-r--r--
source_5_eigval.csv
                             4 KB 12/12/2021 下午 9:41:53
                            4 KB 12/12/2021 下午 9:39:36
target_eigval.csv
                                                           rw-r--r--
                                                                        root
                            4 KB 12/12/2021 下午 9:41:26
source 4 eigval.csv
                                                           rw-r--r--
                                                                        root
source_1_eigval.csv
                            4 KB 12/12/2021 下午 9:40:04
                                                           rw-r--r--
                                                                        root
source_8_eigval.csv
                             4 KB 12/12/2021 下午 9:43:17
                                                           rw-r--r--
                                                                        root
source_2_eigval.csv
                             4 KB 12/12/2021 下午 9:40:30
                                                                        root
                            4 KB 12/12/2021 下午 9:43:45
source_9_eigval.csv
                                                           rw-r--r--
                                                                        root
source_3_eigval.csv
                             4 KB 12/12/2021 下午 9:40:58
                                                           rw-r--r--
                                                                        root
                             4 KB 12/12/2021 下午 9:42:49
source_7_eigval.csv
                                                           rw-r--r--
                                                                        root
```

Figure 2: Example result.

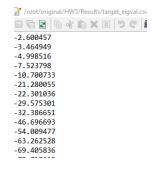


Figure 3: Example result.

3 Implementation

- you need to install the Eigen and Spectra library.
- You can run Report_all () to calulate the all meshes's eigen information, or run Eigen_computing to get the file of the specified mesh.
- After executing Report_all (), you would get all .csv files under the "./Results/" folder (see Fig. 2 and Fig. 3).