TD12: Height maps and Mesh visualization

In this practical work, the objective is to practice a bit with triangular mesh data-structures and 3D visualization using `DGtal`. The final objective is to render height maps as 3D meshes with colorimetric information.

1 Preliminaries

Visualization will be performed by `DGtal`. If you use the compiled library ("dcoeurjo" account), the viewer is enabled by default. If you use you own `DGtal` install, make sure that you have compiled the library with `WITH_QGLVIEWER` flag enables (e.g. `cmake .. -DWITH_QGLVIEWER=true`). You would need to have Qt and QGLViewer installed in your system.

Please also checkout the last release of the `DGtalSkel` folder. The file `image2mesh.cpp` gives examples of the `Viewer3D` usage (please have a look to the C++ comments for details).

First, compile this example and when executing it, you should see an OpenGL window with three triangles and two cubes. For this TP, you just need to know how to display triangles:

```
Z3i::RealPoint p1(1.0,0.0,0.0),
  p2(0.0,1.0,0.0),
  p3(0.0,0.0,1.0);
viewer.addTriangle(p1,p2,p3);
viewer  << Viewer3D<>::updateDisplay;
```

The idea is to construct a mesh from and image I such that the mesh vertices are given by 3D points $(i, j, I(i, j))$ for each point (i, j) in the image domain. As illustrated in Fig. 1, the mesh is constructed from a regular pattern with alternate triangles with respect to evenness of the y-coordinate for instance: $\{(i, j, I(i, j)), (i+1, j, I(i+1, j)), (i, j+1, I(i, j+1))\}$ or $\{(i, j, I(i, j)), (i+1, j-1, I(i+1, j-1)), (i+1, j, I(i+1, j))\}$

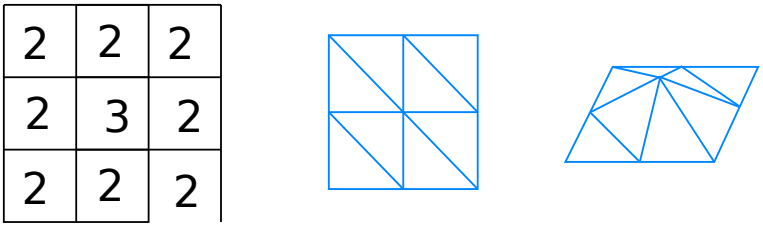


Figure 1: Image to height map mesh.

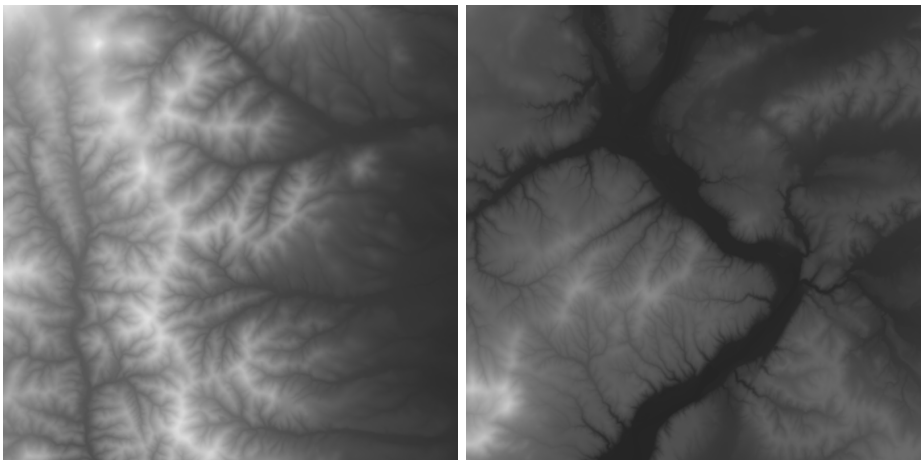
Please note that `image2mesh.cpp` also contains a piece of code to load a PGM grayscale image.

2 Mesh data-structure and visualization

Question 1 From a PGM image, construct a Face-Vertex data structure: the Vertex vector contains all point coordinates and the Face vector contains the faces (triple of vertex indices).

Question 2 Create a function which take in argument a mesh (the two Face/Vertex vectors) and send all triangles to a DGtal Viewer.

As an example, you can use height map of the Rhone (rhone1.pgm and rhone3.pgm in the git repository):



If the images are to large, please consider using gimp to subsample them.

Question 3 Update the drawing function to change the color of each triangle according to the mean height of the neighboring vertices (using for instance a colormap from DGtal or you own function).

3 Normal map rendering and curvature estimation

Question 4 We would like now to see the normal map rendering of the surface. Formally, if $\vec{n}$ is the normal vector to the triangle, we want the colormap to follow the quantity $\vec{n} \cdot (0, 0, 1)^t$ (scalar product between the normal and the z-axis.

Question 5 Curvature map: we would like now to color the mesh from curvature information. Since the original data is a 2-dimensional image, you can use a finite-difference approach to estimate the second derivative of the image values. Use these values to control the color of each triangle.