

Spring 2015

CSCI 599: Digital Geometry Processing

Exercise 4. Surface Quality and Smoothing



Kyle Olszewski
<http://cs599.hao-li.com>

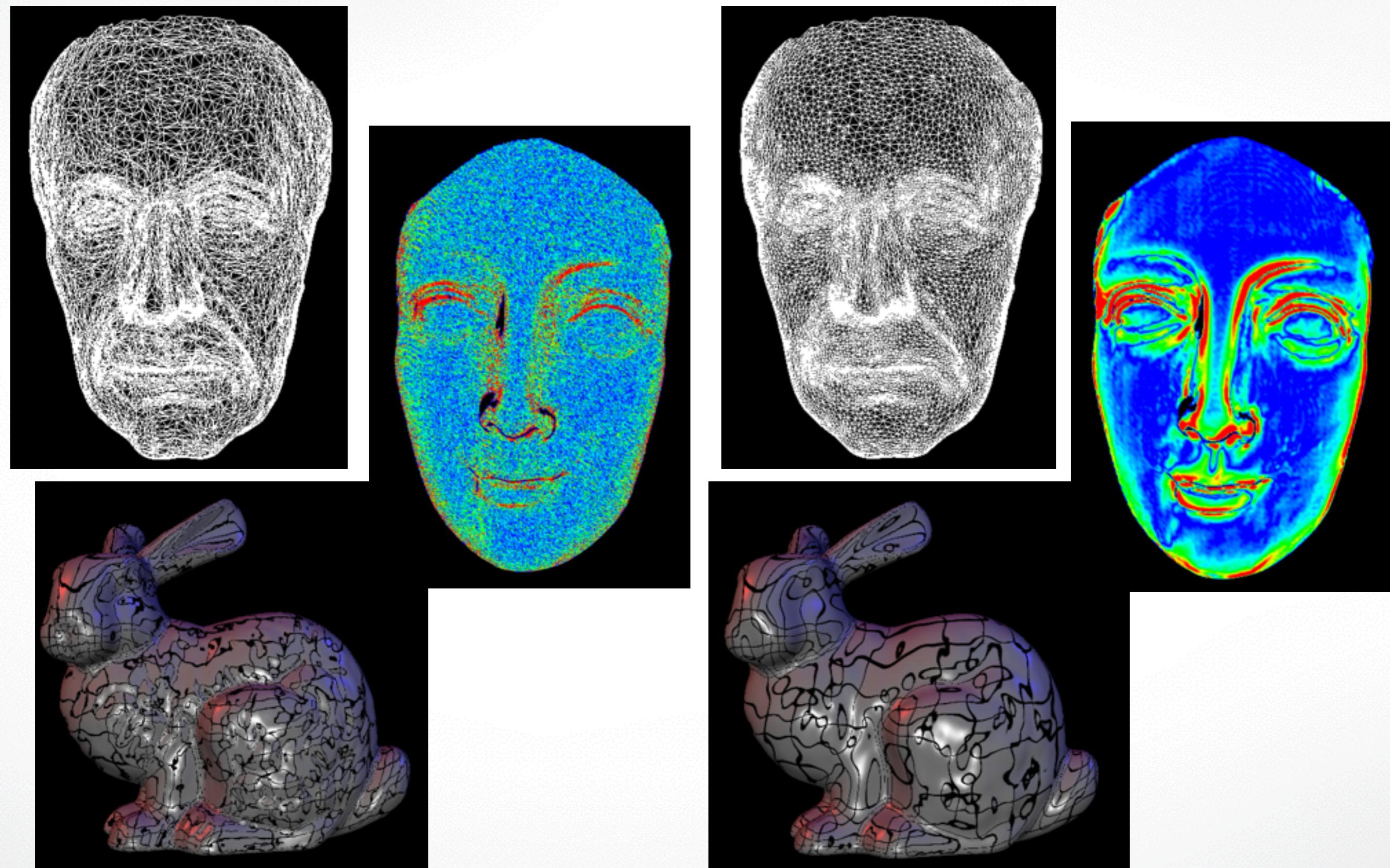
Surface Smoothing

- Spectral analysis
- **Diffusion flow**
 - Uniform Laplace operator
 - Laplacian-Beltrami operator
- Energy minimization

Uniform Laplacian Surface Smoothing

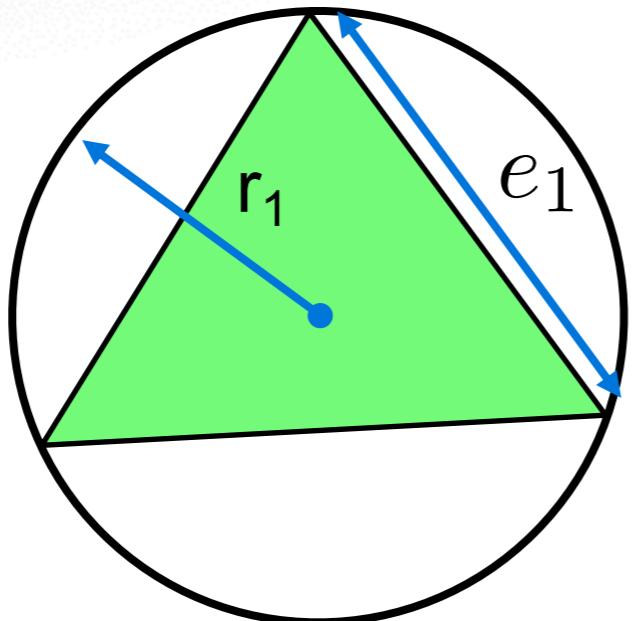
- Uniform Laplace operator $L_U(v) = \left(\frac{1}{n} \sum_i v_i\right) - v$
- Mesh smoothing $v' = v + \frac{1}{2} \cdot L_U(v)$
- Implement uniform Laplace operator in
`QualityViewer::calc_uniform_mean_curvature()` in `QualityViewer.cc`
- Implement uniform Laplacian smoothing
`SmoothViewer::uniform_smooth()` in
`SmoothViewer.cc`

Uniform Laplacian Surface Smoothing

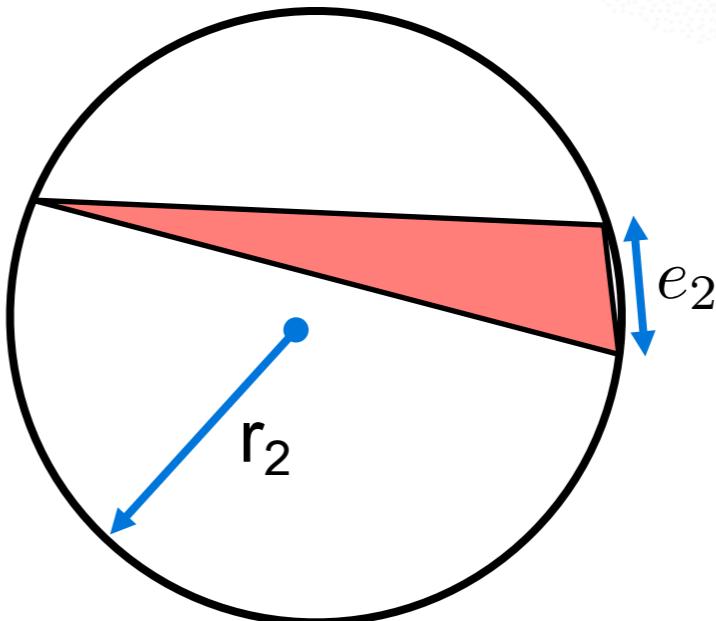


Triangle Quality

good triangle



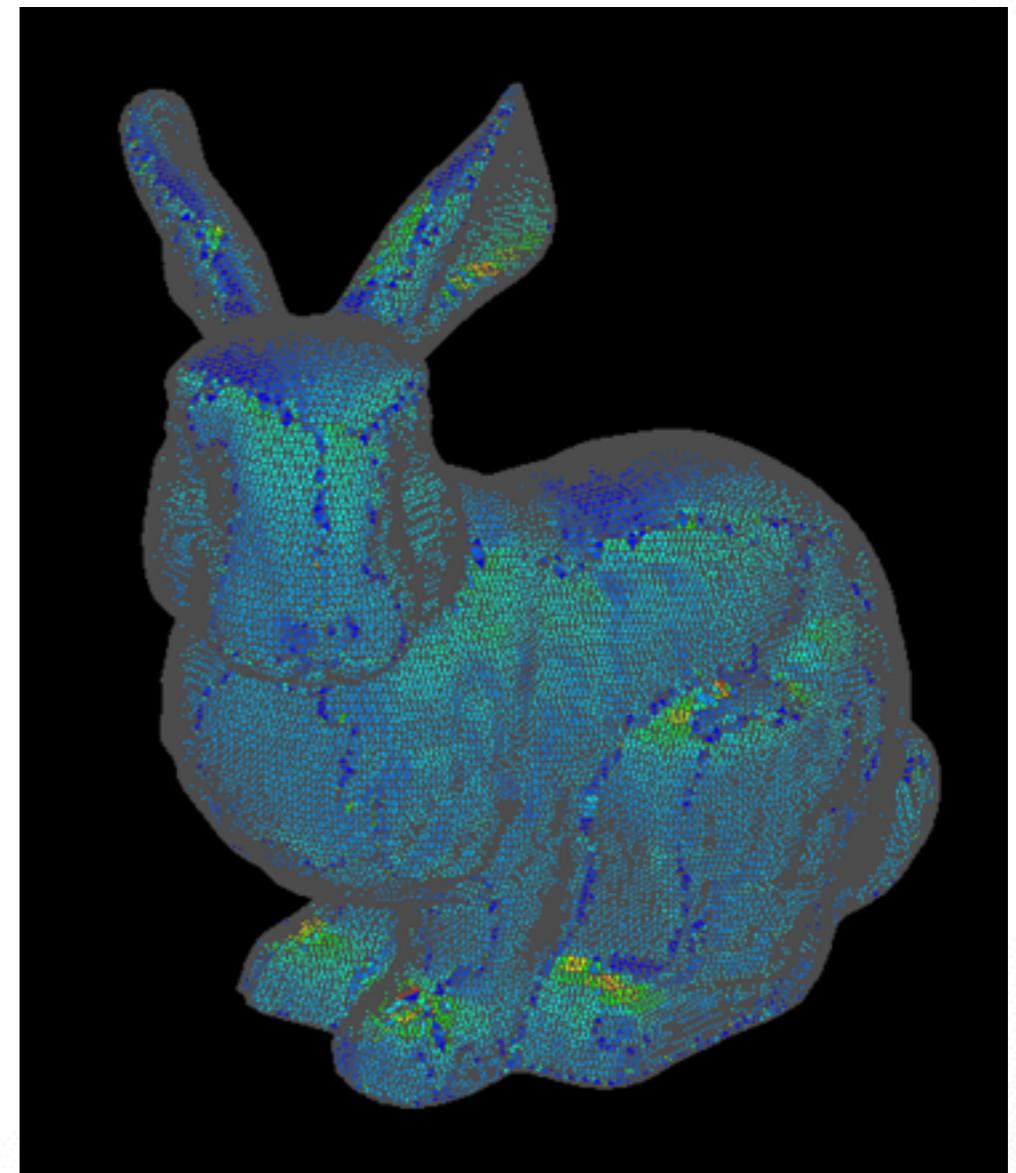
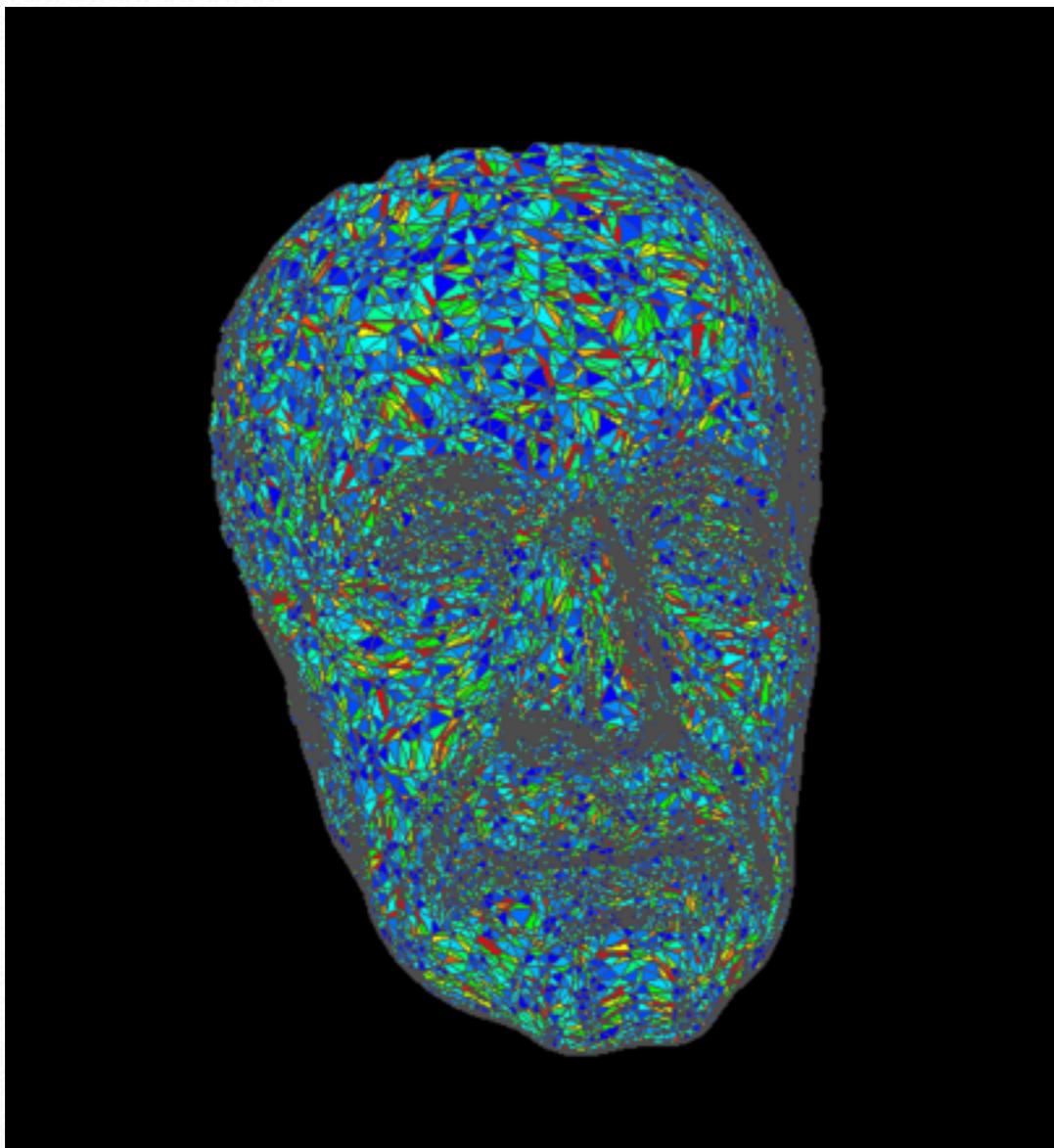
bad triangle



$$\frac{r_1}{e_1} < \frac{r_2}{e_2}$$

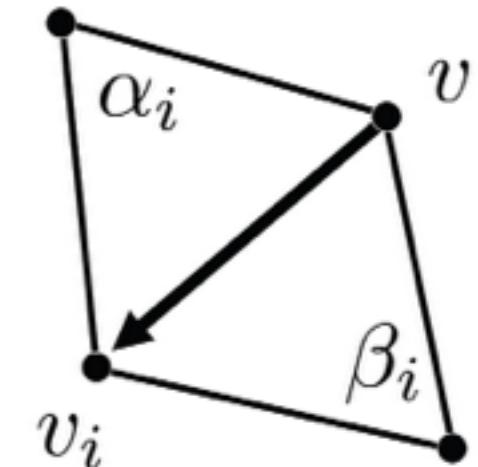
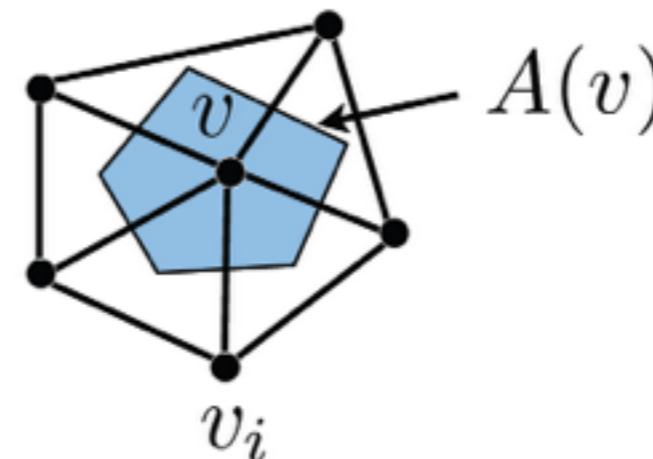
- Assess triangle quality by the circumradius to the minimum edge length ratio
- Circumradius is computed by $A = \frac{|a| \cdot |b| \cdot |c|}{4 \cdot r} = \frac{|a \times b|}{2}$
- Implement in QualityViewer::
`calc_triangle_quality()` in QualityViewer.cc

Triangle Quality



Laplace-Beltrami curvature and smoothing

- Laplace-Beltrami Operator

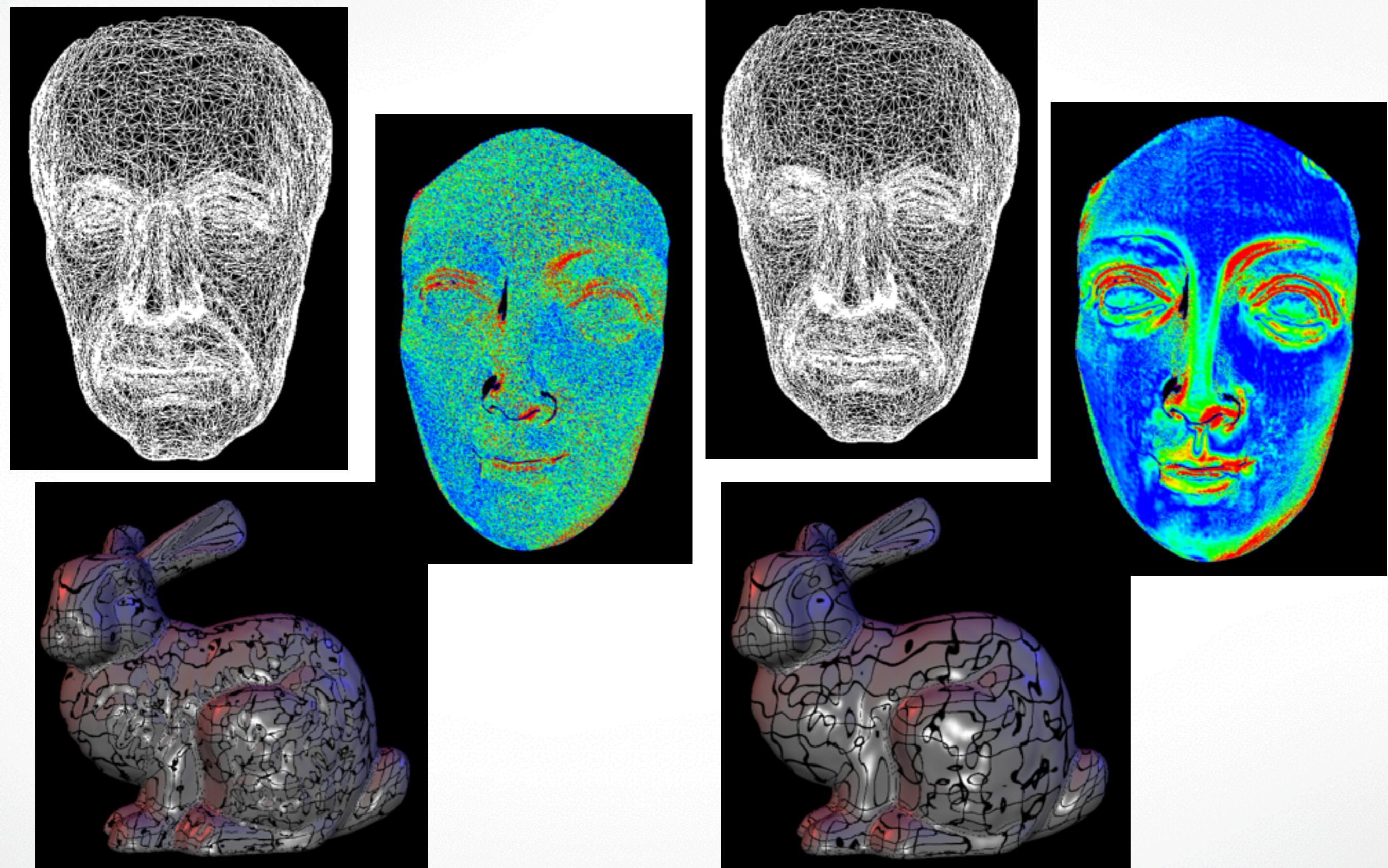


$$L_B(v) = \frac{1}{2A} \sum_i ((\cot \alpha_i + \cot \beta_i)(v_i - v))$$

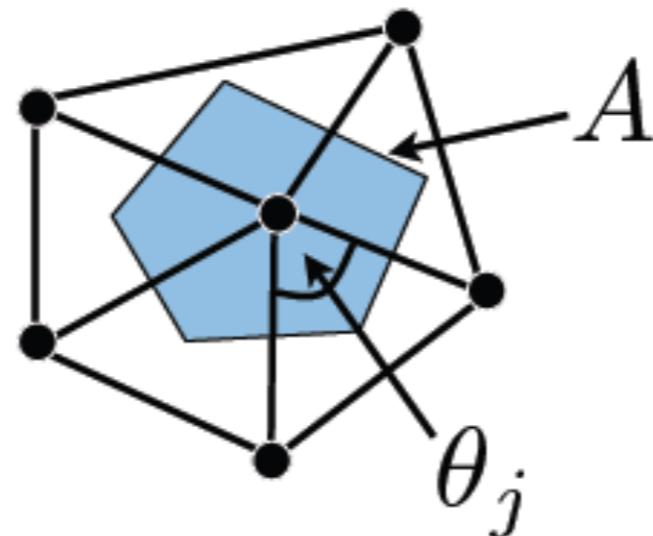
- Compute mean curvature using Laplace-Beltrami weights in QualityViewer::
`calc_mean_curvature()` in `QualityViewer.cc`

- Implement smoothing in SmoothViewer::
`smooth()` in `SmoothViewer.cc`

Laplace-Beltrami curvature and smoothing

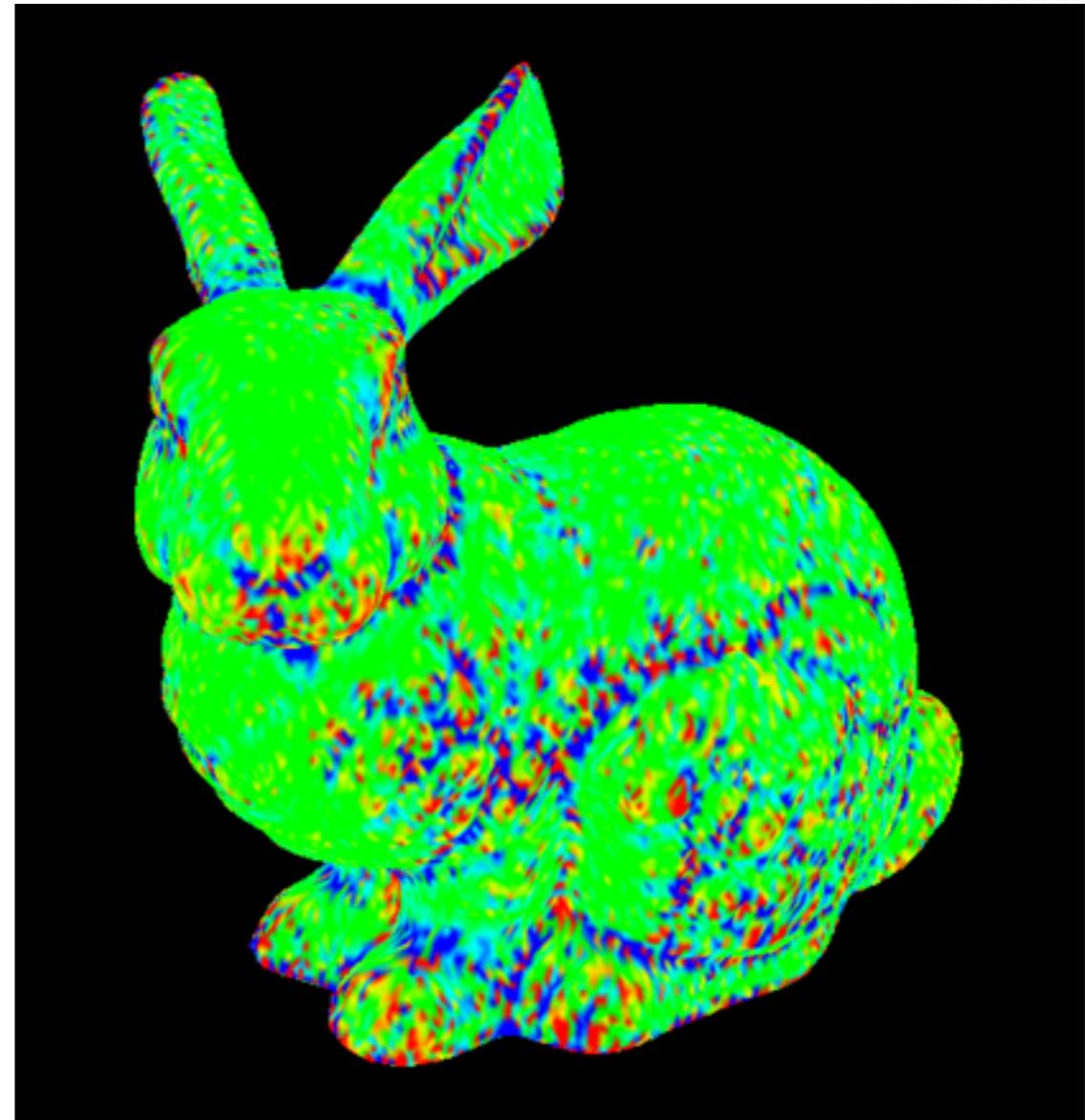
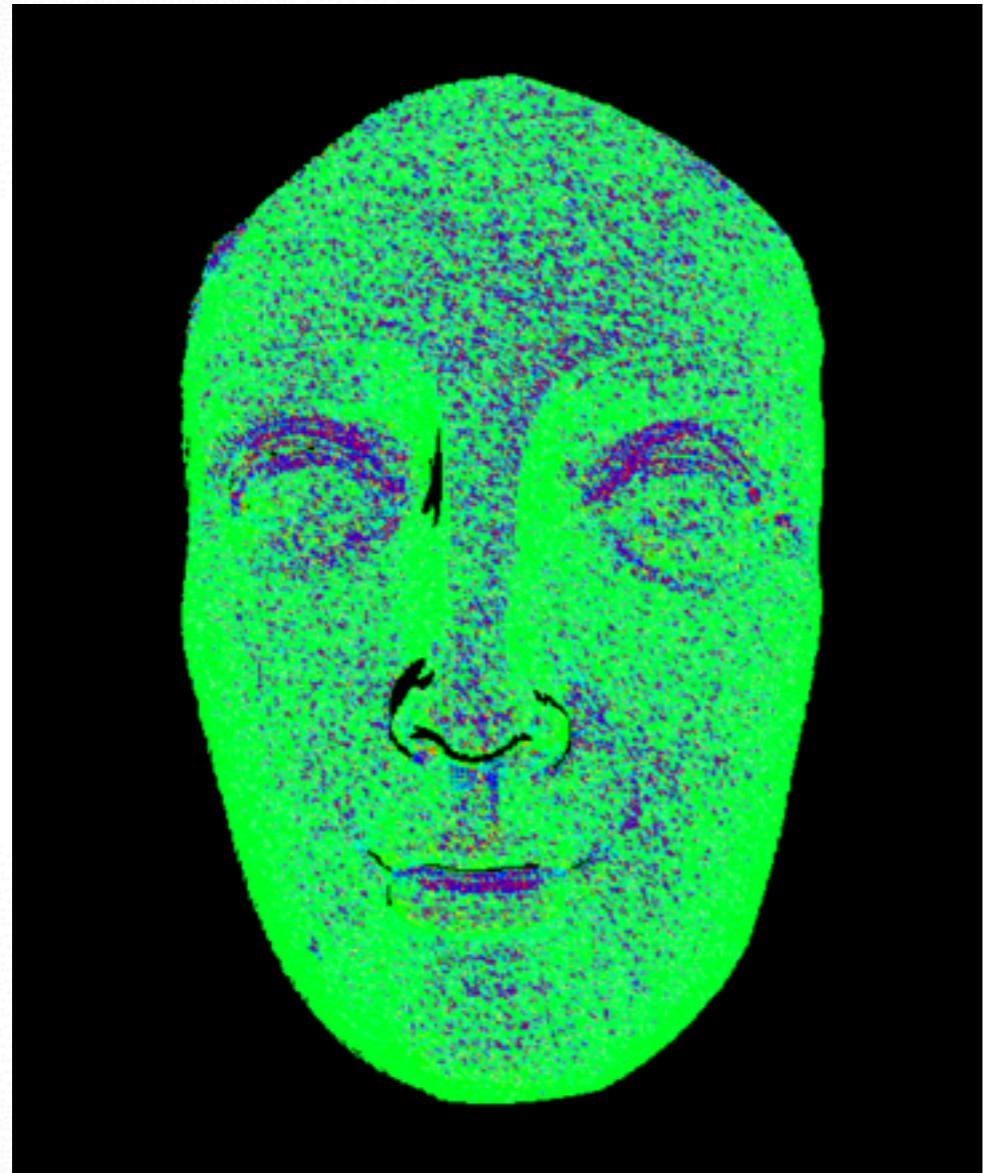


Gaussian Curvature



- Gaussian curvature $G = (2\pi - \sum_j \theta_j) / A$
- `QualityViewer::calc_gauss_curvature()` in `QualityViewer.cc`

Gaussian Curvature



Submission

- Deadline: **Wednesday, March 11, 2015 11:59pm**
- Upload a .zip compressed file named “Exercise4-YourName.zip” to Blackboard, same as before
- Include a “read.txt” file describing how you solve each exercise and the encountered problems

Contact

The screenshot shows the Blackboard Discussion Board interface. On the left, a sidebar menu lists course navigation options: Announcements, Syllabus, Contacts, Content, Assignments, Readings, **Discussion Board** (which is circled in red), Tools, USC Code of Ethics, and Course Home. The main content area is titled "Discussion Board" and contains a sub-header: "Forums are made up of individual discussion threads that can be organized around a particular subject. C". Below this is a "Create Forum" button. A table lists existing forums:

Forum	Description
Exercise 1 Questions	Please post any questions concerning Exercise 1 here.
Exercise 2 Questions	Please post any questions concerning Exercise 2 here.

- email (include “CSCI_599” in title):
olszewski.kyle@gmail.com, peilun.hsieh@usc.edu
- Highly recommended to post your questions on Blackboard

<http://cs599.hao-li.com>

Thanks!

