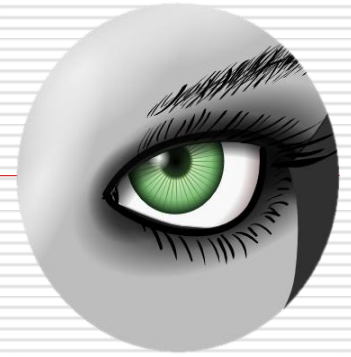




# **Grafica 3D per i beni culturali: MeshLab features**

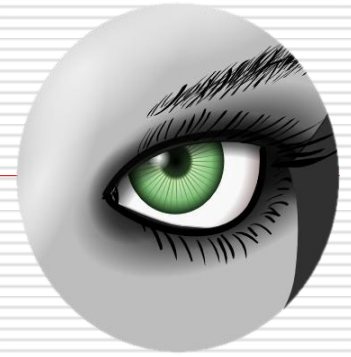
Lezione 7: 22 Marzo 2013



# Cleaning

# Cleaning

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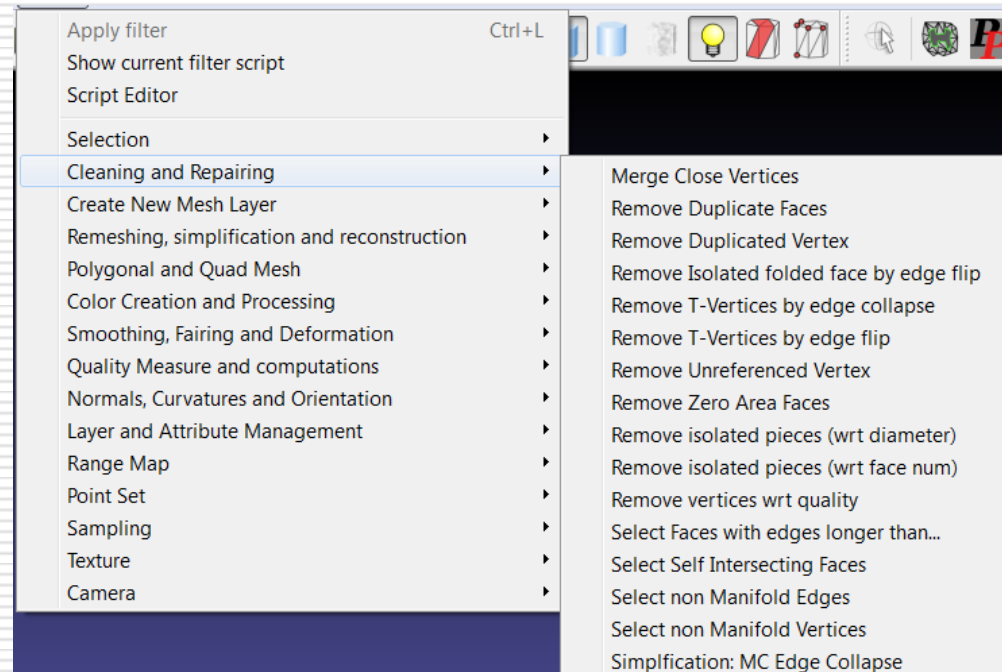
- ❑ Cleaning a mesh is an operation which is often necessary before, during and after the processing of a mesh
  - ❑ There's a number of possible cleaning operations
-

# Cleaning

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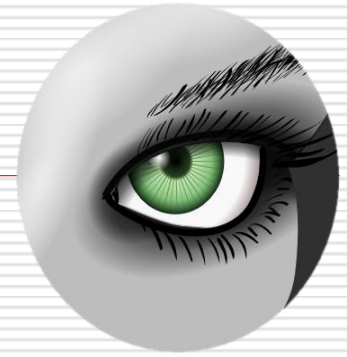


- Most of the cleaning filters is in the Cleaning and repairing sub-menu



# Cleaning: basic filters

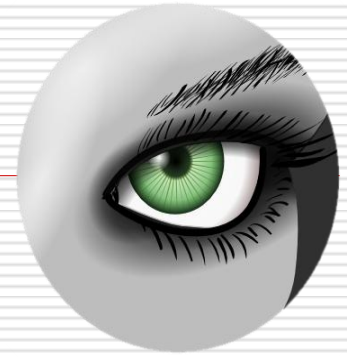
---



- The basic filters are simple to use (no parameter) and usually not “dangerous”
    - Remove duplicated faces
    - Remove duplicated vertex
    - Remove Zero Area faces
    - Select Non Manifold Edges -> Remove
    - Select Non Manifold Vertices -> Remove
    - Remove Unreferenced Vertex
-

# Cleaning: other filters

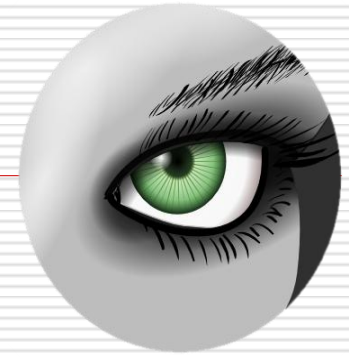
---



- Other useful filters need simple parameters setting
    - Remove isolated pieces  
Parameter: n. of faces
    - Select faces with edges longer than...  
Parameter: edge threshold
    - Select border faces  
Parameter: iteration
    - Close holes: something between remeshing and cleaning, we'll see later
-

# Cleaning: general hints

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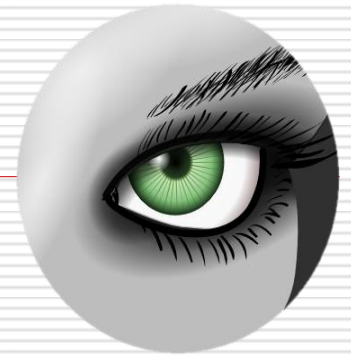


- Some general hints
  - If a filter or external tool crashes, clean the meshes!
  - Save frequently (no undo!)
  - A “nice” mesh is closed, with triangles of the same size, a very clean topology...

- Videotutorial playlist:

[http://www.youtube.com/playlist?list=PLBBF41579E4B65566&feature=view\\_all](http://www.youtube.com/playlist?list=PLBBF41579E4B65566&feature=view_all)

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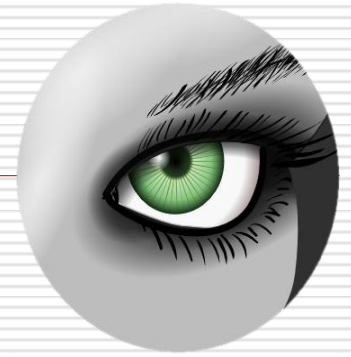


# ReMeshing



# Remeshing

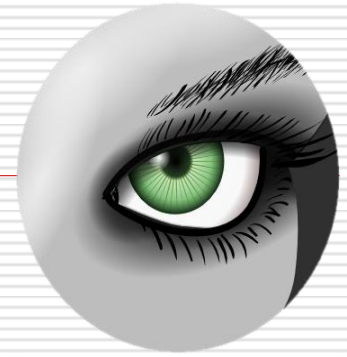
---



- Remeshing operations modify an existing geometry, by completing, removing, adding, changing the triangles.
  - There's a number of possible remeshing operations, and several ways to do each...
-

# Simplification

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- The simplification reduces the number of triangles in a mesh
- Several ways to do that
- Best one:

Remeshing, simplification and reconstruction-  
>Quadric Edge Collapse Simplification

Parameters: Target number of faces, preserve boundary or normal

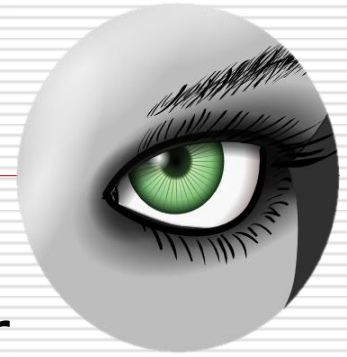
Videotutorial:

<http://www.youtube.com/watch?v=PWM6EGVVNQU>

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# Subdivision

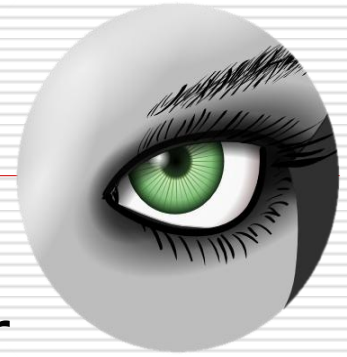
---



- ❑ The subdivision increases the number of triangles in a mesh
  - ❑ Several ways to do that
  - ❑ Reliable one:  
Remeshing, simplification and reconstruction->Subdivision Surfaces:  
MidPoint  
Parameters: Edge Threshold
-

# Subdivision

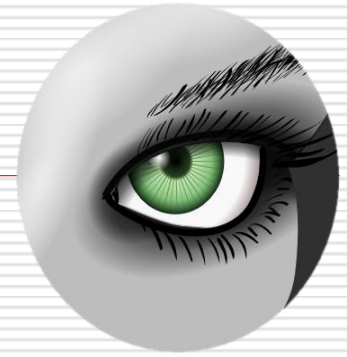
---



- ❑ The subdivision increases the number of triangles in a mesh
  - ❑ Several ways to do that
  - ❑ More complex one:  
Remeshing, simplification and reconstruction->Refine User-Defined  
Parameters: refinement decided by the user (using also color and quality!)
-

# Close Holes

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- ❑ Most of the meshes have holes, but some of the filters need “watertight” models.
  - ❑ Hole filling is not always a trivial operation
  - ❑ Two possible approaches to fill holes in Meshlab
    - 1) Small Holes
      - Remeshing, simplification and reconstruction->Close Holes
      - Parameters: max size to be closed
-

# Close Holes

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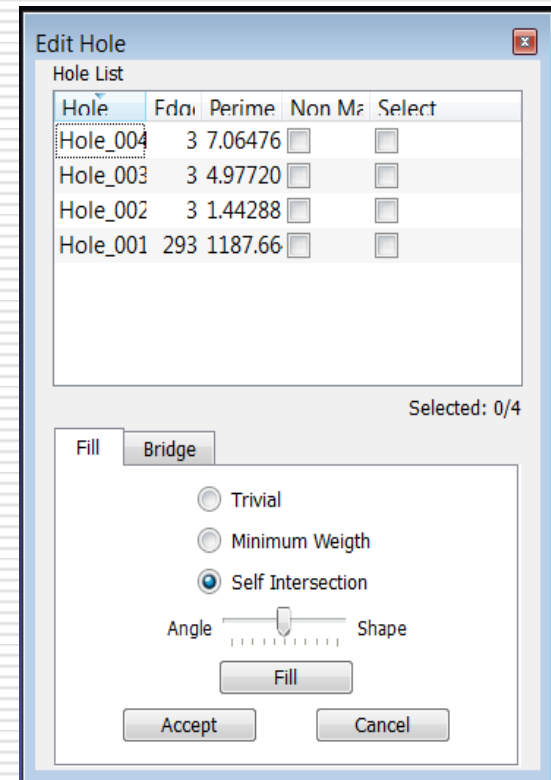


## 2) Bigger holes Holes

Hole filling tool 

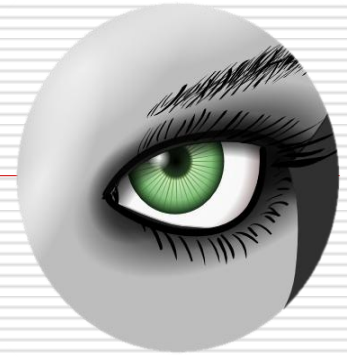
- Select the holes to fill
- Fill and accept
- (Use of bridges to help the filling)

## 3) Use Poisson or other reconstructions!



# Optimization

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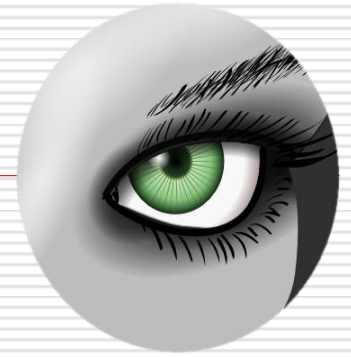


In some cases (i.e. after the hole filling) it is necessary to optimize the triangulation of part of the mesh. This is usually reached via a combination of filters.

- Remeshing, simplification and reconstruction-> Subdivision Surfaces: MidPoint
  - Remeshing, simplification and reconstruction-> Planar Flipping Optimization
  - Smoothing, Fairing and Deformation-> Laplacian Smoothing (Surface Preserving)
  - Remeshing, simplification and reconstruction-> Quadric Edge Collapse Decimation
-

# Parameterization

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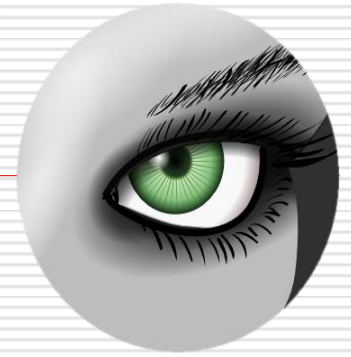


Parameterization is an important, yet critical, problem in mesh processing.

We'll talk about this when dealing with color

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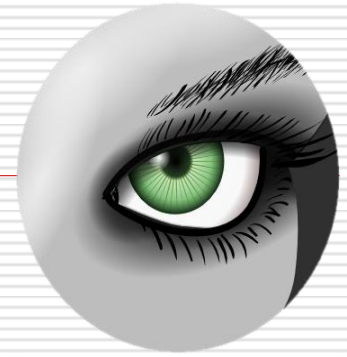




# Measuring

# Measuring

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- ❑ The measurement of a mesh (of the difference between meshes) can be extremely valuable for a practical application of MeshLab
  - ❑ There are different measures that can be extracted from one or more meshes
  - ❑ To see most of the data, use the Layer Dialog!
-

# Single Mesh: simple direct measures

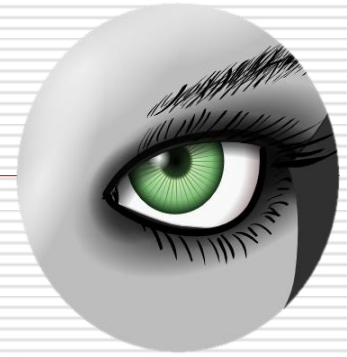
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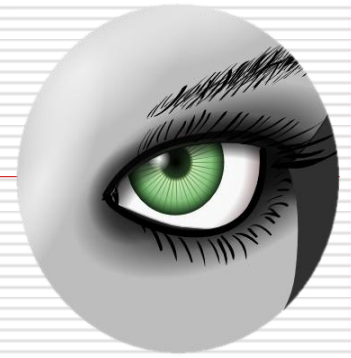
- It is possible to obtain simple measures with a couple of tools
  - Point picking   
The coordinates of the picked triangle can be seen.
  - Measuring   
The Euclidean Distance between two points is given
  - PickPoints   
Veeeeery basic annotation tool..
-

# Multiple Mesh: Hausdorff distance

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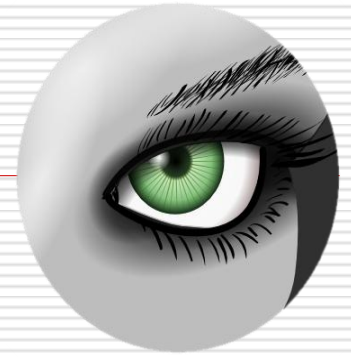
- ❑ Another type of measure is the one obtained between two meshes
  - ❑ It is important that the meshes are perfectly aligned
  - ❑ Filter
    - Sampling -> Hausdorff distance
    - Parameters: N. of samples
-



# Coloring

# Coloring

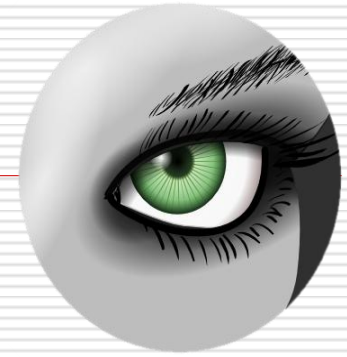
---




- ❑ The color attribute of a mesh can be extremely important both for the realism of visualization, the enhancement of features and lots of other things...
  - ❑ In MeshLab there are already a few features related to color, and others will come in the future.
-

# Painting

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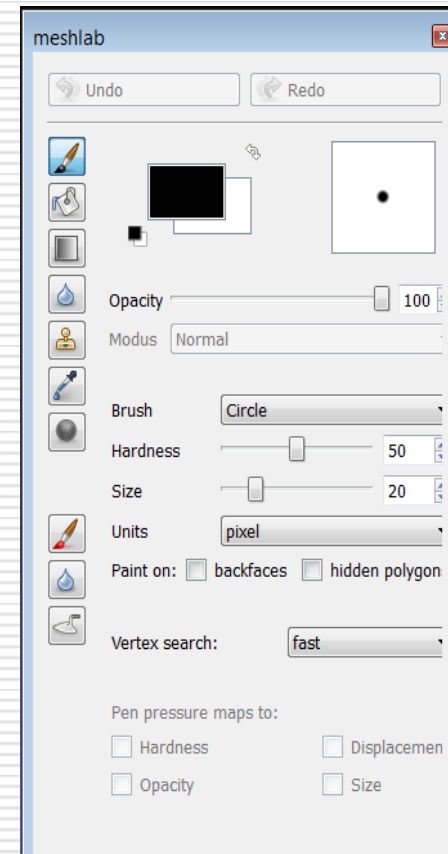


A simple “Photoshop style”  
painting tool is available 

The features are the typical  
ones:

- Pen
- Bucket
- Gradient
- Stamp
- ...

It also has the Undo!!!



# Coloring and Quality mapping

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An alternative way to map measures on a 3D model is to use the color and/or the quality.

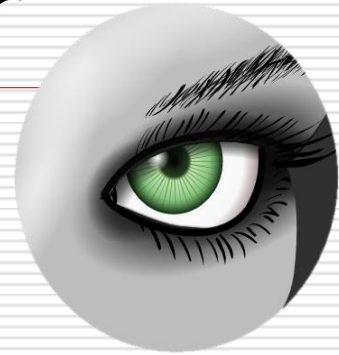
We'll see how to use it in the next presentation...

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# Coloring and Attribute transfer

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- ❑ A very interesting feature is the possibility to transfer the color from a mesh to another mesh.
- ❑ Some filters (especially the remeshing ones) tend to cancel the color.

- ❑ Filter:

Sampling -> Vertex Attribute Transfer

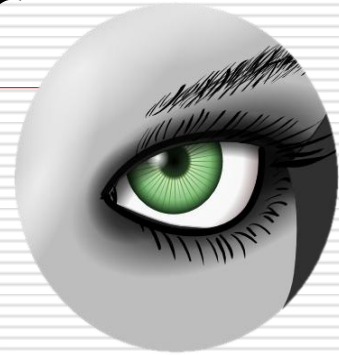
Parameters:

Source and target Mesh, what to transfer

---

# Coloring and Attribute transfer

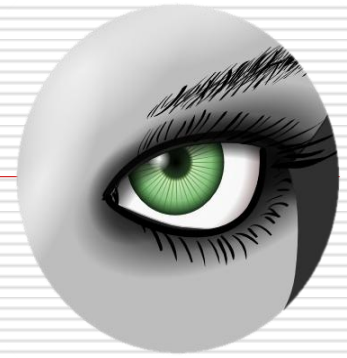
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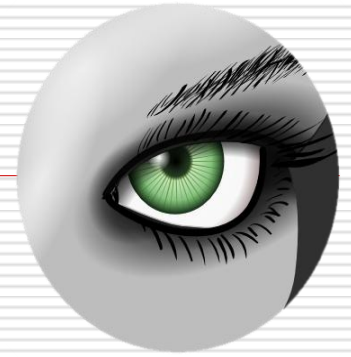
- There are three ways to see color in a mesh: color-per-vertex, color-per-face, texture
  - There are filters to transfer the color from one encoding to the other
  - Filters:  
Color creation and processing -> Vertex to face, Face to vertex and Texture to Vertex Color transfer
-

# Coloring processing

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- If a mesh already has color on it (per-vertex or per-face only) it is possible to modify it using a number of “photoshop style” filters.
  - They are all in the “Color creation and Processing” menu. Some of them are
    - Fill
    - Invert
    - Gamma correction
    - Colourisation
    - Brightness and contrast
    - ...
-

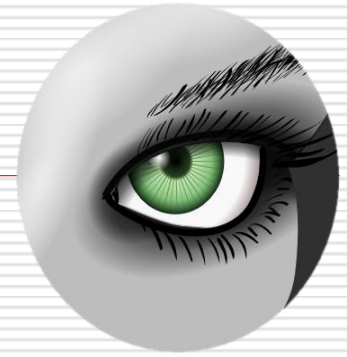


# **Advanced Visualization**

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# Advanced visualization

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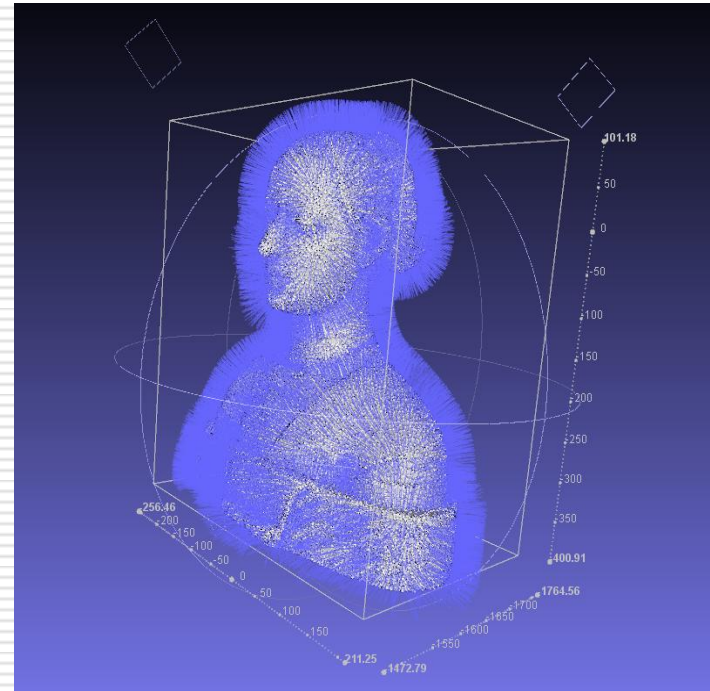
- One of the most important features of MeshLab is the possibility to easily visualize a mesh and create a snapshot.
  - There are a lot of functionalities to enrich visualization, enhance details, add information to the geometry...
-

# Decorations

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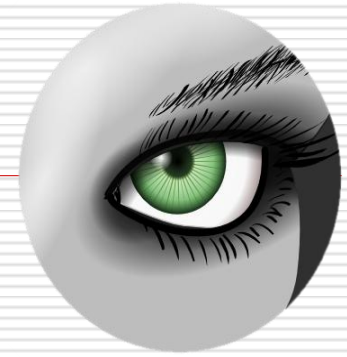


- ❑ A very simple way to add information to a rendering is the use of Decorations
- ❑ Menu:  
Render
- ❑ Useful ones:
  - Axis
  - Quoted Box
  - Principal Curvatures
  - Face/Vertex Normals
  - ...

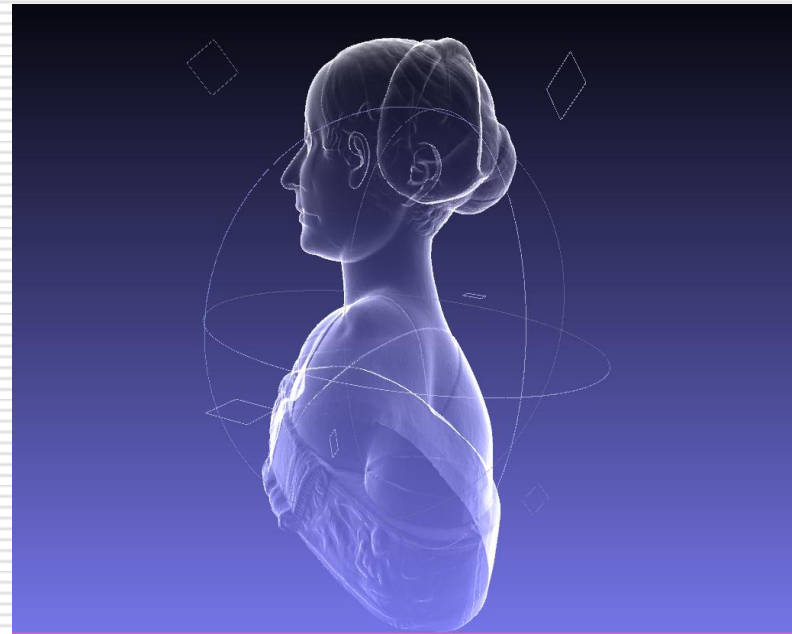


# The Shaders

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- ❑ The shaders use the GPU to make fast computations on geometry.
- ❑ Using simple shaders it's possible to obtain very nice visual results
- ❑ Menu:  
Render-> Shaders
- ❑ Useful ones:
  - Xray
  - Toon
  - Hatch
  - Glass
  - ...



# Ambient occlusion

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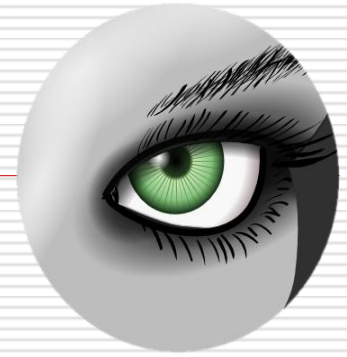


- ❑ If no color is available for a mesh, Ambient occlusion is a very nice way to present the geometry.
  - ❑ Filter:  
Color creation and processing -> Vertex Ambient Occlusion  
Parameters: Use VBO and/or GPU
  - ❑ It is possible to process the color to enhance the features!
  - ❑ Videotutorial:  
<http://www.youtube.com/watch?v=wiNzvISGLAI>
-



# User-defined coloring

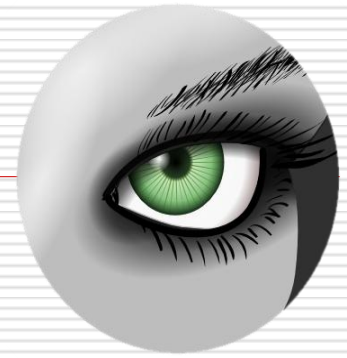
---



- Similar to User-defined refining
  - Filter:  
Color creation and processing -> Per-Vertex Color Function
  - It is possible to process the color to enhance the features!
  - The same thing can be done on the Quality attribute
-

# Discrete curvature

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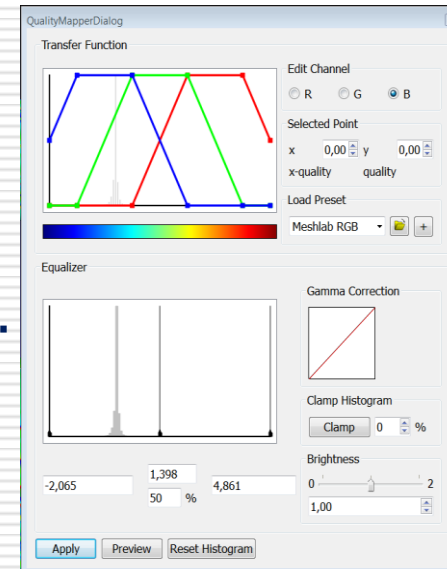
- ❑ An example of a nice coloring is the Discrete Curvature
  - ❑ Filter:  
Color creation and processing -> Discrete Curvatures
  - ❑ This filter stores the curvature in the quality value, and shows it by coloring the mesh.
-

# Quality mapper

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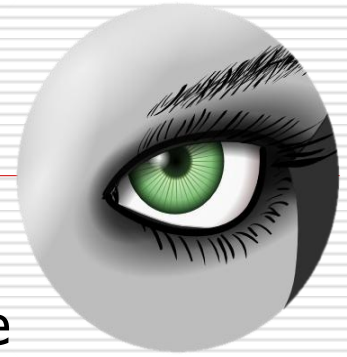


- ❑ Mapping the quality is a very useful way to enhance the important features of a mesh 
- ❑ The Quality Mapper tool is very flexible and extremely valuable
- ❑ Parameters:  
A LOT! Need to “play” with it...



# Advanced visualization

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- The presentation of a mesh is key in most of the cases
- MeshLab gives much more possibilities than what it could seem at a first sight
- If you are able to deal with all these aspects:
  - Light
  - FOV
  - Coloring
  - Position
  - Shaders
  - Background
  - ...

Then you can make really nice stuff. You just need to practice a bit more...

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# Next in line...

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Next lesson:

- PTM and relightable images

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VCG website: <http://vcg.isti.cnr.it>

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