Surface Normal,Vertex Normal, gmsh, meshio

Physics 129L

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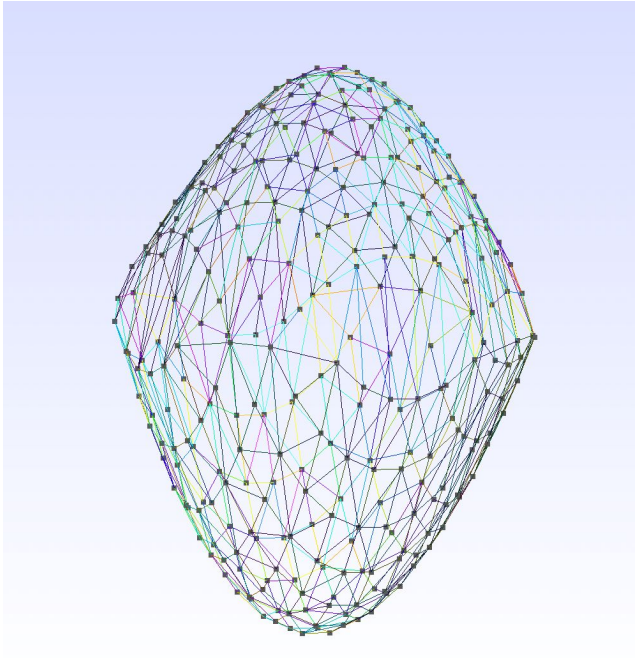
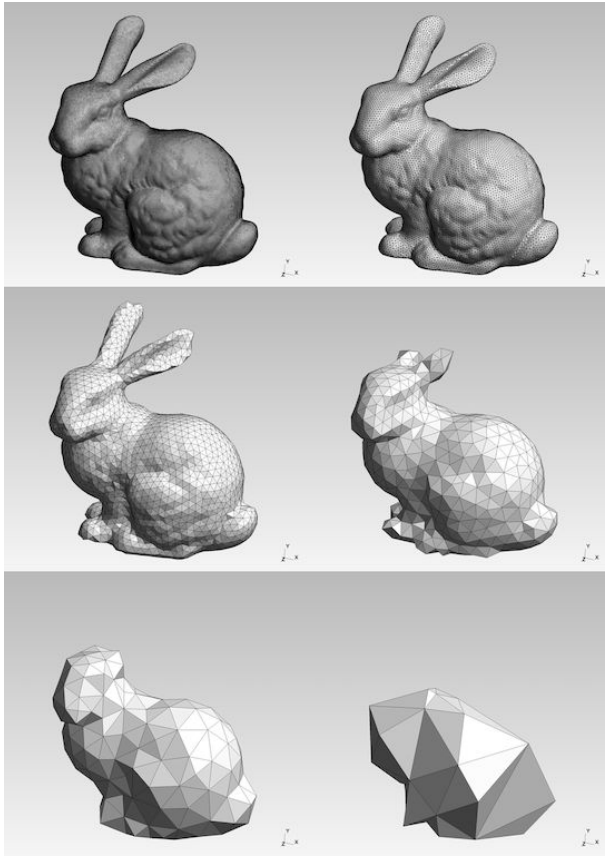
Gmsh

```
import gmsh
```

Gmsh is an open-source 3D finite element mesh generator with a built-in CAD engine





https://gmsh.info/

Gmsh

```
# Compute Delaunay triangulation in 3D
tri = Delaunay(data_array, incremental=True)


surface_ids = []

try:
    # Loop through the simplices (triangles) of the triangulation
    for simplex in tri.simplices:
        # Get the vertices of the triangle
        p1, p2, p3 = points[simplex[0]], points[simplex[1]], points[simplex[2]]


        # Create lines for the triangle
        l1 = gmsh.model.occ.addLine(p1, p2)
        l2 = gmsh.model.occ.addLine(p2, p3)
        l3 = gmsh.model.occ.addLine(p3, p1)

        # Create a curve loop and surface
        cl = gmsh.model.occ.addCurveLoop([l1, l2, l3])
        surf_id = gmsh.model.occ.addPlaneSurface([cl])

        surface_ids.append(surf_id)
```

Gmsh

```
# Synchronize the geometry
gmsh.model.occ.synchronize()

# Create a physical group for the surfaces
surface_group = gmsh.model.addPhysicalGroup(dim, surface_ids, tag=tag)
gmsh.model.setPhysicalName(dim, surface_group, physical_name)

# Generate the mesh
gmsh.model.mesh.generate(dim)

# Save the mesh to a file
gmsh.write(f"{physical_name}_{tag}.msh")

gmsh.finalize()
```

meshio

```
import meshio
```

You can use meshio to import and export meshes in different formats.

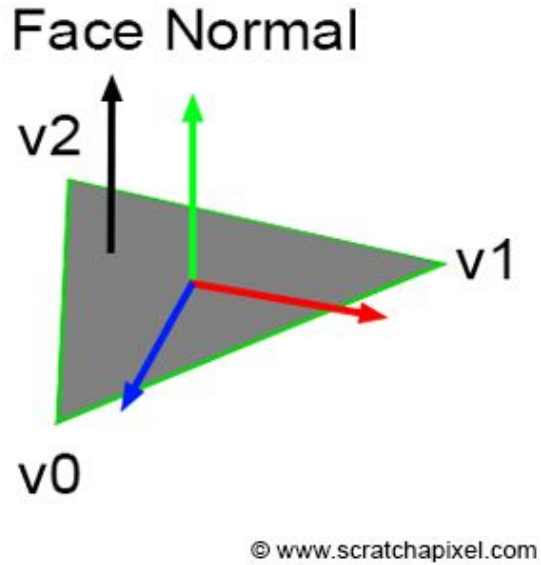
```
mesh = meshio.read(f"{physical_name}_{tag}.msh")

points = mesh.points  # Nx3 array of vertices
triangles_list = mesh.cells_dict.get("triangle")  # Triangle indices
```

Surface normal

A surface (face) normal is a unit vector that is perpendicular to the plane of a triangle in a mesh.

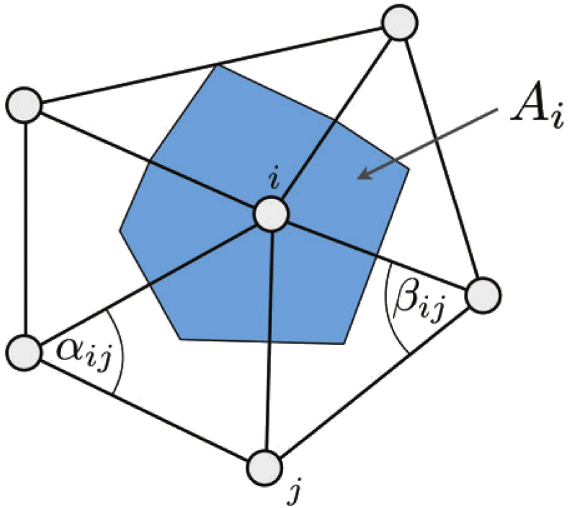
You can define the area and direction by the **cross product**.



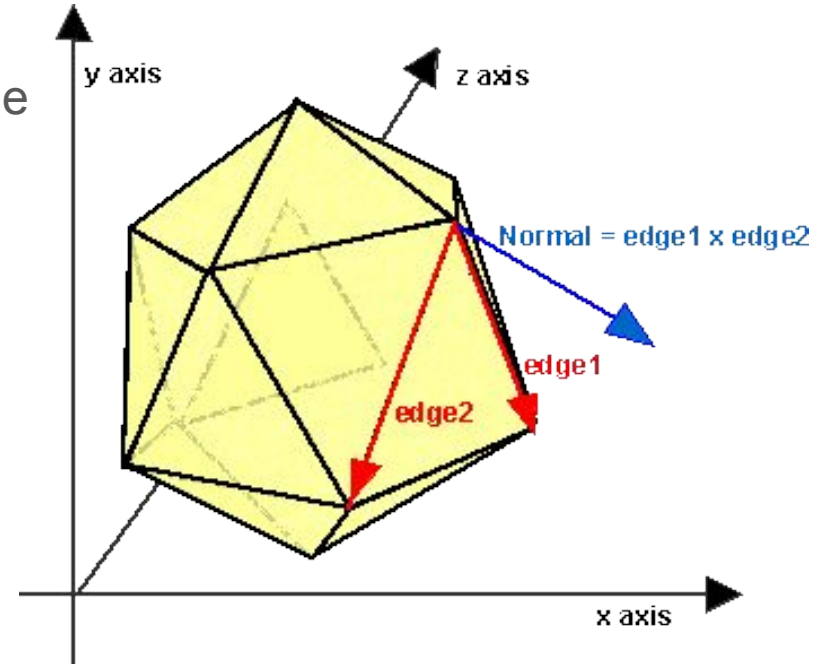
https://www.scratchapixel.com/lessons/3d-basic-rendering/introduction-to-shading/shading-normals.html

Vertex normal

A vertex normal at vertex **V** is a weighted average (**Weighted by the area)** of normal vectors of all triangle surfaces that share the vertex **V.**



https://rodolphe-vaillant.fr/entry/33/curvature-of-a-triangle-mesh-definition-and-computation



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