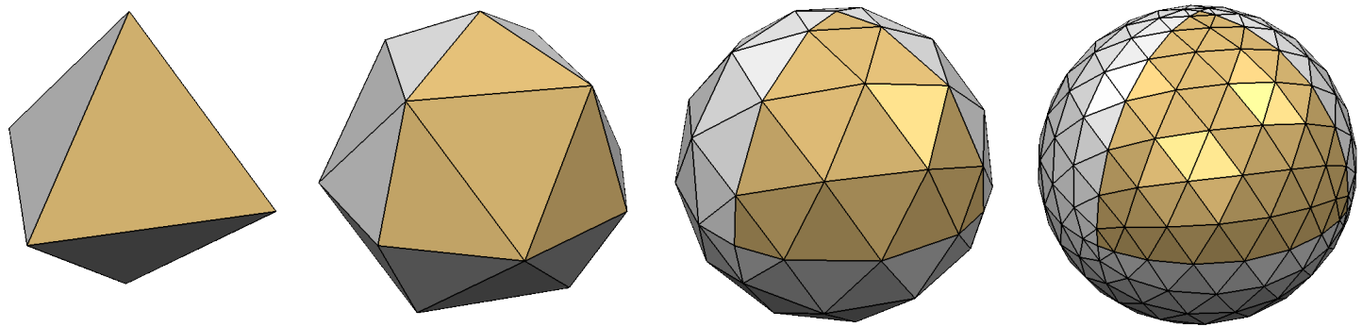
Surface_mesh



Eduard Zell

Computer Graphics & Geometry Processing

Universität Bielefeld

CITEC

Build a Tetrahedron

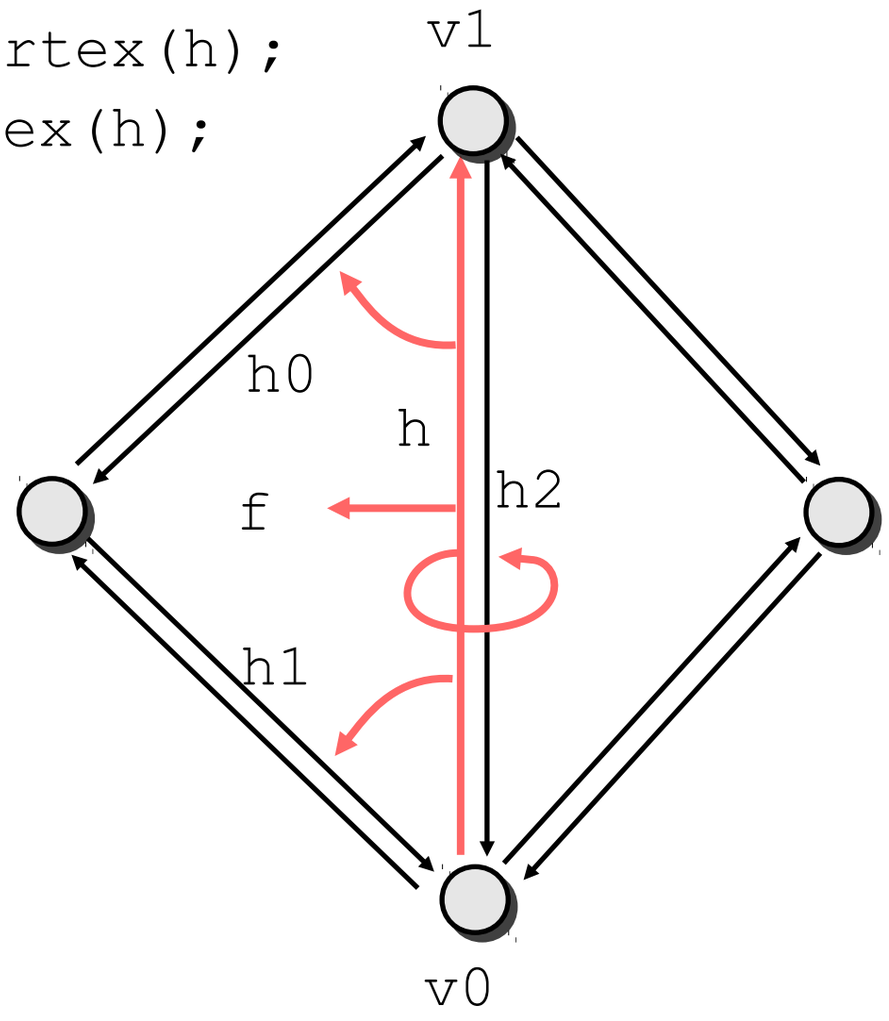
```
#include <surface_mesh/Surface_mesh.h>

int main(void)
{
    // instantiate a Surface_mesh object
    Surface_mesh mesh;

    // instantiate 4 vertex handles
    Surface_mesh::Vertex v0,v1,v2,v3;

    // add 4 vertices
    v0 = mesh.add_vertex(Point(0,0,0));
    v1 = mesh.add_vertex(Point(1,0,0));
    v2 = mesh.add_vertex(Point(0,1,0));
    v3 = mesh.add_vertex(Point(0,0,1));

    // add 4 triangular faces
    mesh.add_triangle(v0,v1,v3);
    mesh.add_triangle(v1,v2,v3);
    mesh.add_triangle(v2,v0,v3);
    mesh.add_triangle(v0,v2,v1);

    std::cout << "vertices: " << mesh.n_vertices() << std::endl;
    std::cout << "edges: "    << mesh.n_edges()    << std::endl;
    std::cout << "faces: "    << mesh.n_faces()    << std::endl;

    return 0;
}
```

Geometry: 3D Vectors

```
Point  x(0,0,0), y(1,2,3);
Scalar length = (x-y).norm();

Point n = cross(x,y);       // cross product
n.normalize();                // n.norm()==1

Scalar dp = dot(x,y);       // dot product
Scalar angle = acos( dp / x.norm() / y.norm() );
```

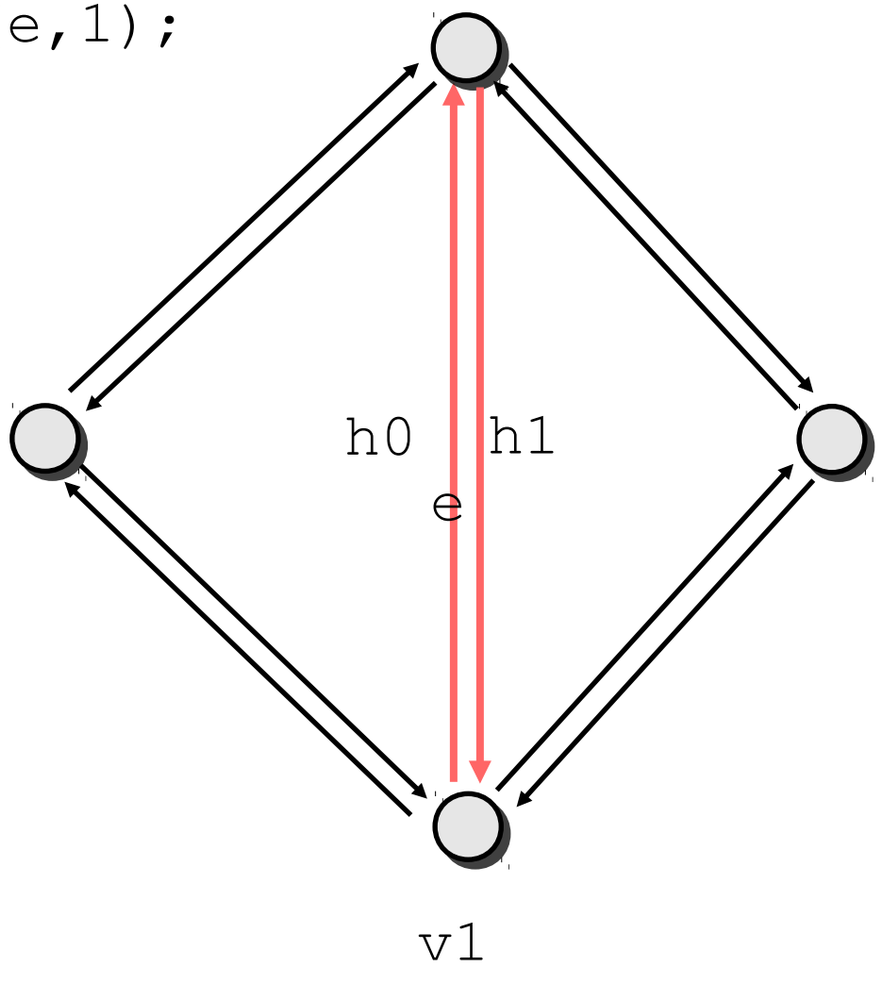
Halfedge Connectivity

```
Surface_mesh::Halfedge  h;
Surface_mesh::Halfedge  h0 = mesh.next_halfedge(h);
Surface_mesh::Halfedge  h1 = mesh.prev_halfedge(h);
Surface_mesh::Halfedge  h2 = mesh.opposite_halfedge(h);
Surface_mesh::Face        f = mesh.face(h);
Surface_mesh::Vertex     v0 = mesh.from_vertex(h);
Surface_mesh::Vertex     v1 = mesh.to_vertex(h);
```



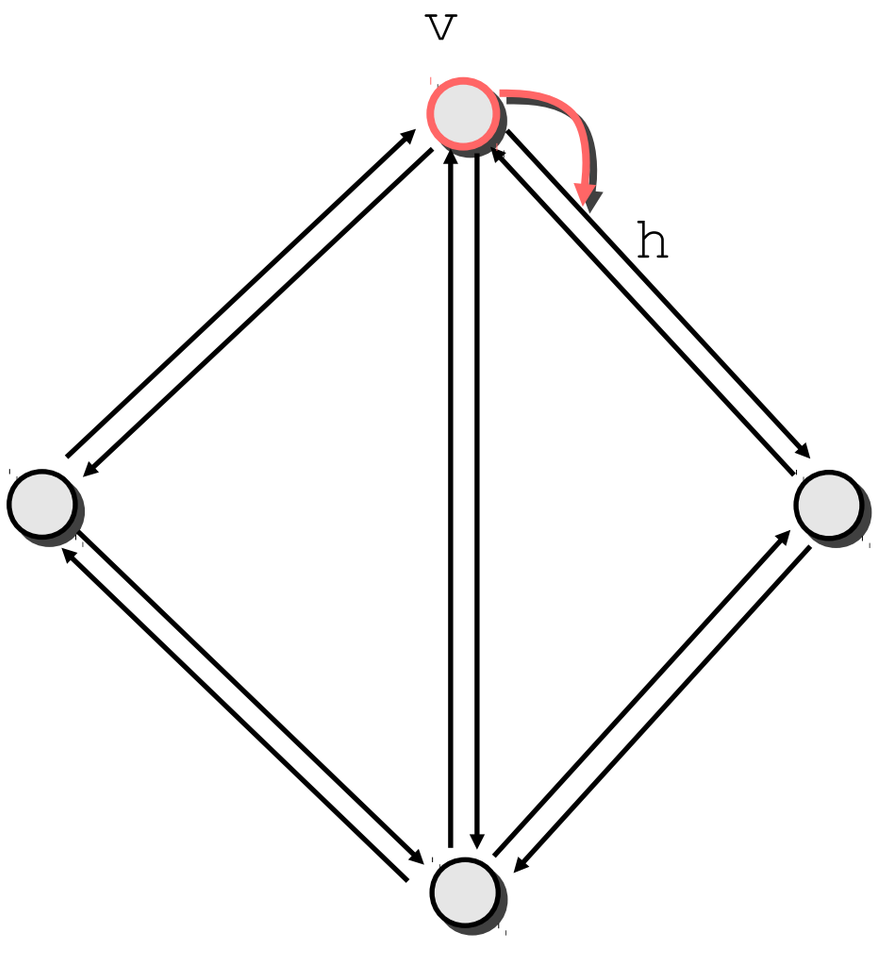
Edge Connectivity

```
Surface_mesh::Edge e;
Surface_mesh::Halfedge h0 = mesh.halfedge(e,0);
Surface_mesh::Halfedge h1 = mesh.halfedge(e,1);
Surface_mesh::Vertex     v0 = mesh.vertex(e,0);
Surface_mesh::Vertex     v1 = mesh.vertex(e,1);
```



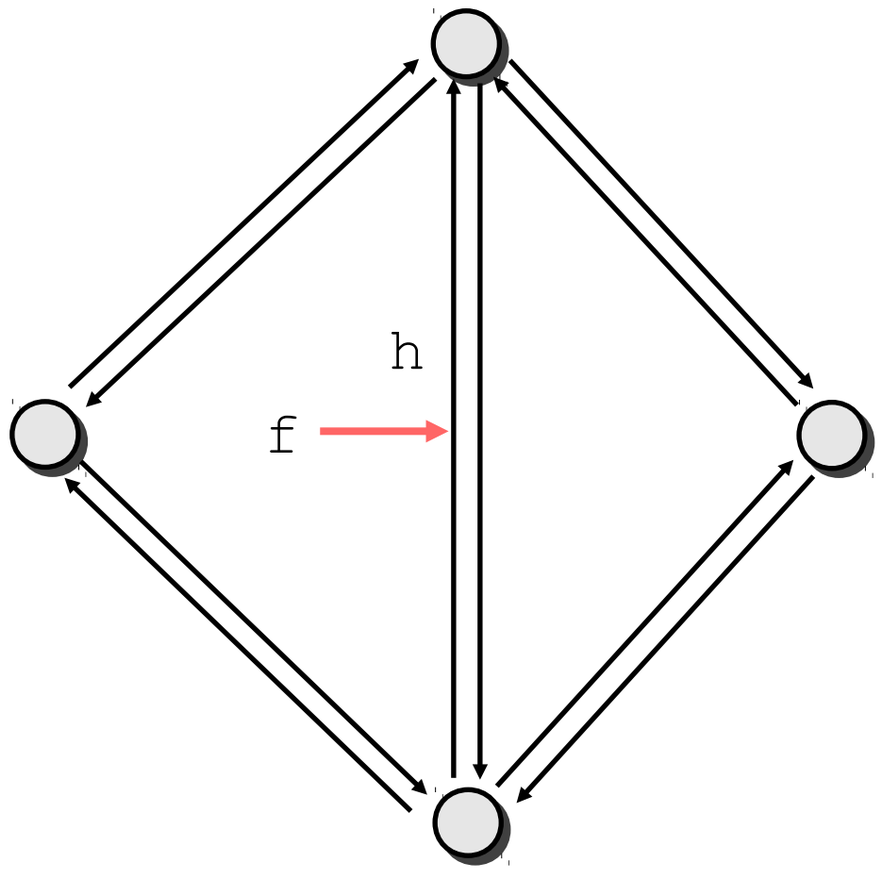
Vertex Connectivity

```
Surface_mesh::Vertex     v;
Surface_mesh::Halfedge h = mesh.halfedge(v);
```



Face Connectivity

```
Surface_mesh::Face     f;
Surface_mesh::Halfedge h = mesh.halfedge(f);
```



File I/O

```
#include <surface_mesh/Surface_mesh.h>

int main(int argc, char** argv)
{
    // instantiate a Surface_mesh object
    Surface_mesh mesh;

    // read a mesh specified as the first command line argument
    mesh.read(argv[1]);

    // ...
    // do fancy stuff with the mesh
    // ...

    // write the mesh to the file specified as second argument
    mesh.write(argv[2]);

    return 0;
}
```

Iterators

- Iterate over all vertices

```
Surface_mesh::Vertex_iterator vit;

for (vit = mesh.vertices_begin();
     vit != mesh.vertices_end();
     ++vit)
{
   ...
}
```

- Analogous for halfedges, edges, faces

Iterators with C++11

- Iterate over all vertices

```
for (auto v: mesh.vertices())
{
    ...
}
```

- Analogous for halfedges, edges, faces

Vertex Circulators

- Enumerate all vertices, halfedges, faces around a center vertex

```
unsigned int valence(Surface_mesh::Vertex v)
{
  unsigned int count(0);

  Surface_mesh::Vertex_around_vertex_circulator vc = mesh.vertices(v), vc_end = vc;
  do
  {
    ++count;
  }
  while (++vc != vc_end);

  return count;
}
```

Vertex Circulators with C++11

- Enumerate all vertices, halfedges, faces around a center vertex

```
unsigned int valence(Surface_mesh::Vertex v)
{
  unsigned int count(0);

  auto vc = mesh.vertices(v), vc_end = vc;
  do
  {
    ++count;
  }
  while (++vc != vc_end);

  return count;
}
```

Face Circulators

- Enumerate all vertices or halfedges in a face

```
unsigned int valence(Surface_mesh::Face f)
{
  unsigned int count(0);

  Surface_mesh::Vertex_around_face_circulator fvit = mesh.vertices(f), fvend = fvit;
  do
  {
    ++count;
  }
  while (++fvit != fvend);

  return count;
}
```

Face Circulators with C++11

- Enumerate all vertices or halfedges in a face

```
unsigned int valence(Surface_mesh::Face f)
{
  unsigned int count(0);

  auto fvit = mesh.vertices(f), fvend = fvit;
  do
  {
    ++count;
  }
  while (++fvit != fvend);

  return count;
}
```

Custom Properties

```
Surface_mesh::Vertex_property<int> val = mesh.add_vertex_property<int>("v:val");

for (v_it=mesh.vertices_begin(); v_it!=mesh.vertices_end(); ++v_it)
  val[*v_it] = compute_valence(v_it);

// do some work...

mesh.remove_vertex_property(val);
```

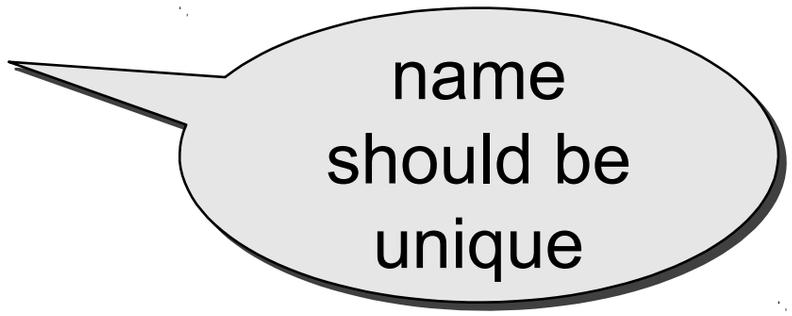
name should be unique

```
Vertex_propertyT<Point>  points  = mesh.vertex_property<Point>("v:point");
Vertex_propertyT<Normal> normals = mesh.vertex_property<Normal>("v:normal");
Vertex_propertyT<bool>   locked  = mesh.vertex_property<bool>("v:locked");

for (v_it=mesh.vertices_begin(); v_it!=mesh.vertices_end(); ++v_it)
  if (!locked[*v_it])
    points[*v_it] += normals[*v_it];
```

“get or add” property

Custom Properties with C++11

```
auto = mesh.add_vertex_property<int>("v:val");

for (auto v: mesh.vertices())
  val[v] = compute_valence(v);

// do some work...

mesh.remove_vertex_property(val);
```




```
auto  points  = mesh.vertex_property<Point>("v:point");
auto  normals = mesh.vertex_property<Normal>("v:normal");
auto  locked  = mesh.vertex_property<bool>("v:locked");

for (auto v: mesh.vertices())
  if (!locked[v])
    points[v] += normals[v];
```

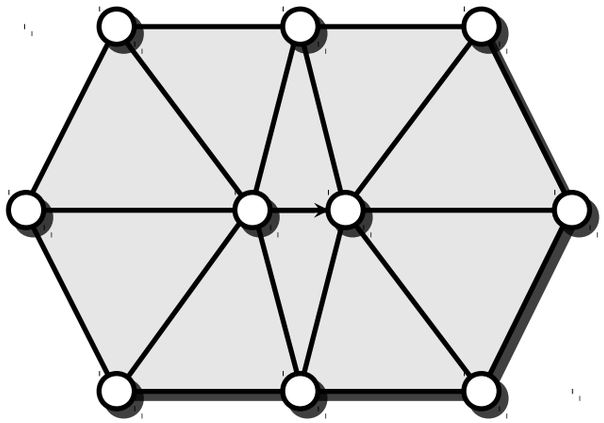
Compute Barycenter

```
Point barycenter(Surface_mesh& mesh)
{
    // get (pre-defined) property storing vertex positions
    Surface_mesh::Vertex_property<Point> points =
    mesh.get_vertex_property<Point>("v:point");

    // vertex iterator
    Surface_mesh::Vertex_iterator vit, vend = mesh.vertices_end();

    Point p(0,0,0);

    for (vit = mesh.vertices_begin(); vit != vend; ++vit)
    {
        // access point property like an array
        p += points[*vit];
    }

    p /= mesh.n_vertices();

    return p;
}
```

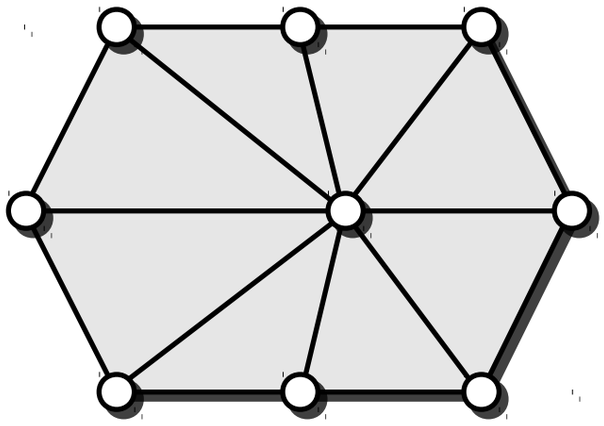
Compute Barycenter with C++11

```
Point barycenter(Surface_mesh& mesh)
{
    // get (pre-defined) property storing vertex positions
    auto points = mesh.get_vertex_property<Point>("v:point");

    Point p(0,0,0);

    for (auto v: mesh.vertices())
    {
        // access point property like an array
        p += points[v];
    }

    p /= mesh.n_vertices();

    return p;
}
```

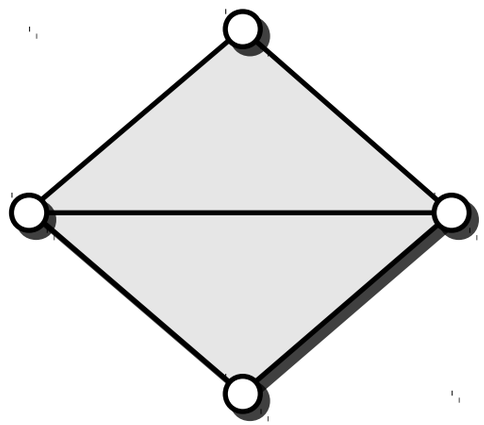
Change Topology



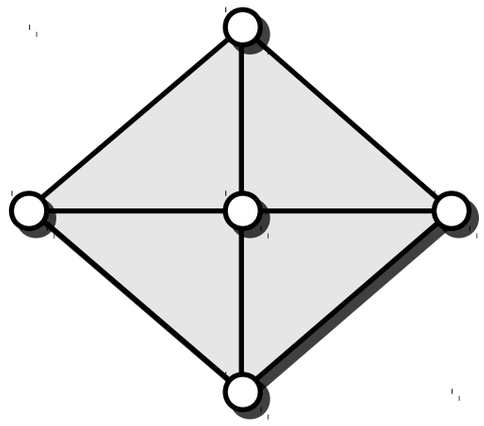
Halfedge Collapse



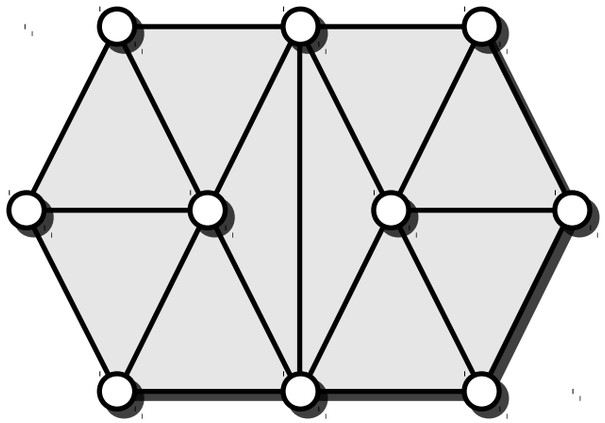
`mesh.collapse(Halfedge)`



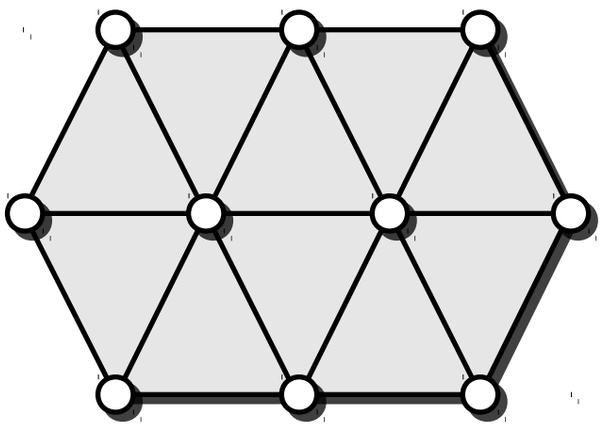
Edge Split



`mesh.split(Edge,Point)`



Edge Flip



`mesh.flip(Edge)`

Documentation