Monday, February 22, 2016 at 10:31 PM
Washington University, Saint Louis, MO, United States · 37°F Mostly Clear

ReadMe

Assignment 2: Shapes

Wenzhen Zhu

Date: 02/22/2016, Monday

> *Late days used this lab: 0*

Structure

Shape (Base class)

- triangle : struct
  - contains 3 points and 1 normal vector to this triangle/face, and a vector of 3 normal vectors corresponding to the 3 vertices
- computeNormal: compute the normal vector (of face) given a triangle.
- drawShapeWireFrame(): do the wire frame
- drawShapeFlat(): do the flat shading
- drawShapeSmooth(): do the smooth shading
- ReverseTriangleVertex(): make the triangle counter-clockwise if they are not
- tessellation is a vector of triangles, I use it to store triangles.

Cube (derived class #1)

- computeTriangle(int n): given 1st parameter n, it generate all correct triangles, and push those triangles to tesselation.
- computeVertexNormal(triangle &tr): given a triangle with p1, p2, p3 it can calculate the face's normal.

Cylinder(derived class #2)

- computeTriangle(int n, int m) : functionality is similar as cube

Cone(derived class #3)

- computeTriangle(int n, int m): functionality is similar as cube

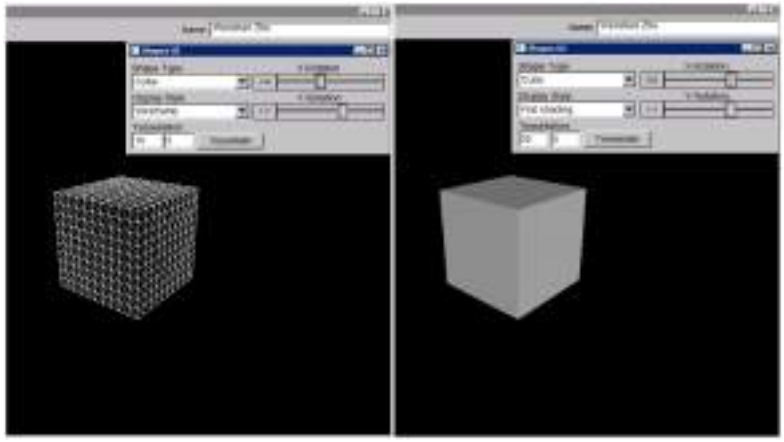
Sphere(derived class #4)

I found this python code on line
https://sites.google.com/site/dlampetest/python/triangulating-a-sphere-recursively
(https://sites.google.com/site/dlampetest/python/triangulating-a-sphere-recursively)

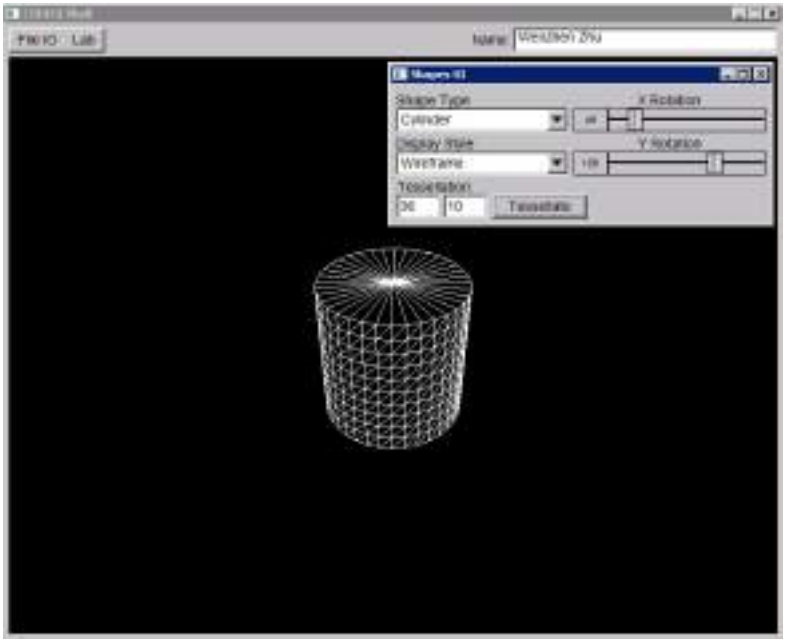
However, after I tried it in python notebook, it doesn't work. I think I understand this recursive midpoint divide process. I did a prototype in Mathematica, which you can find in the appendix.

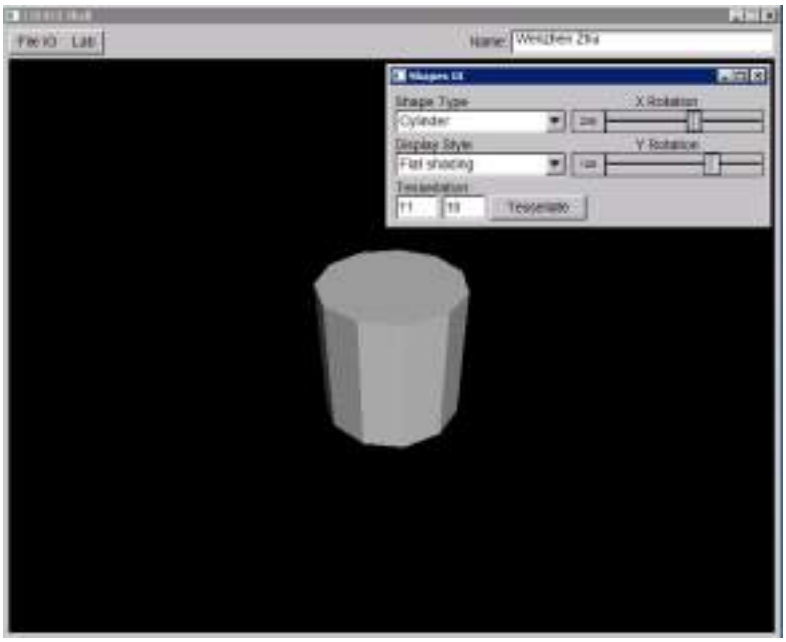
Pictures

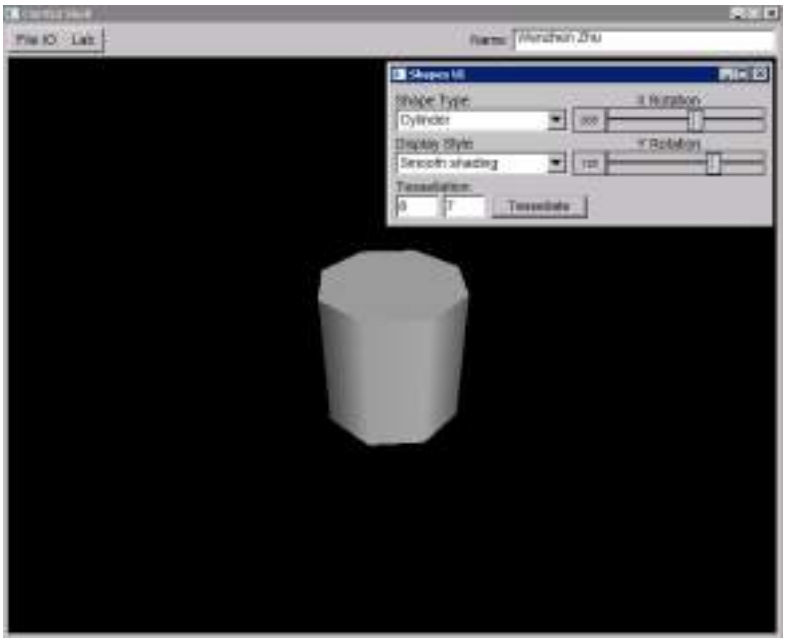
Cube



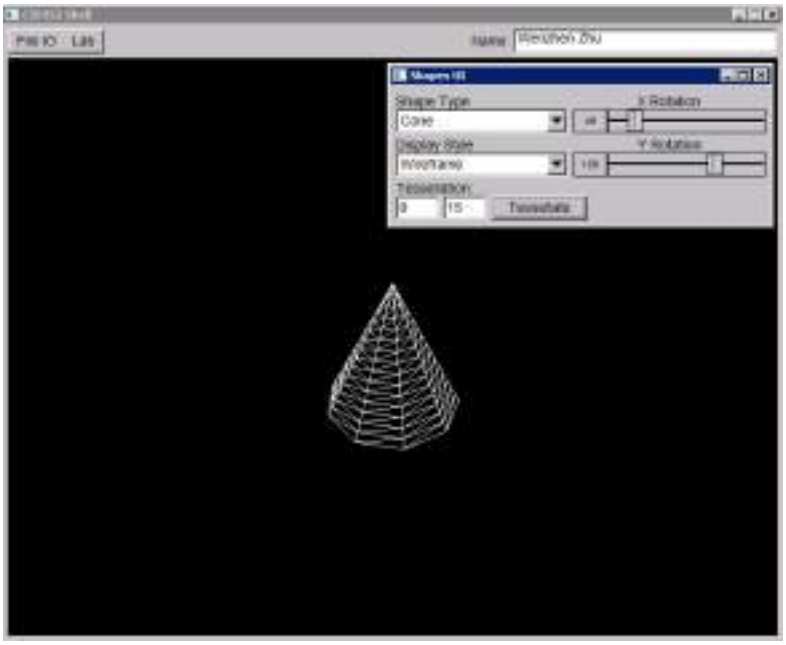
Cylinder

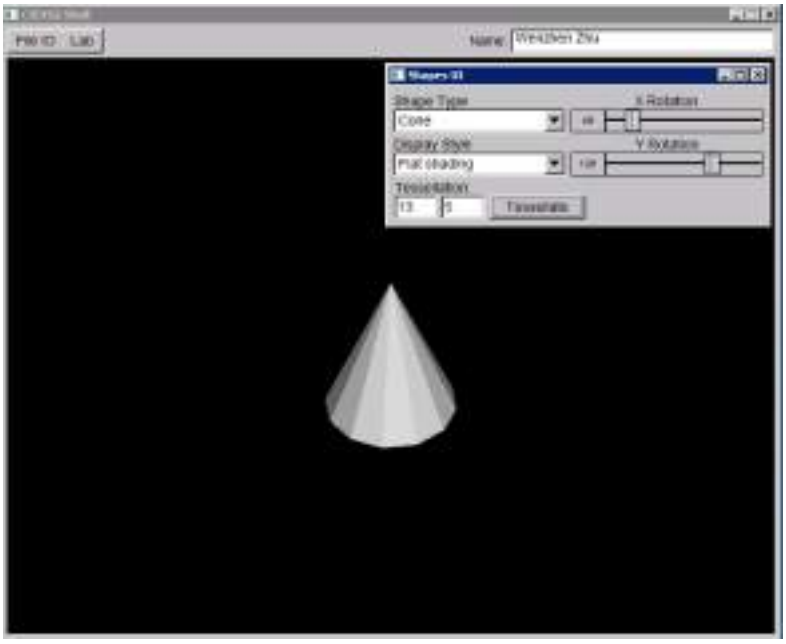


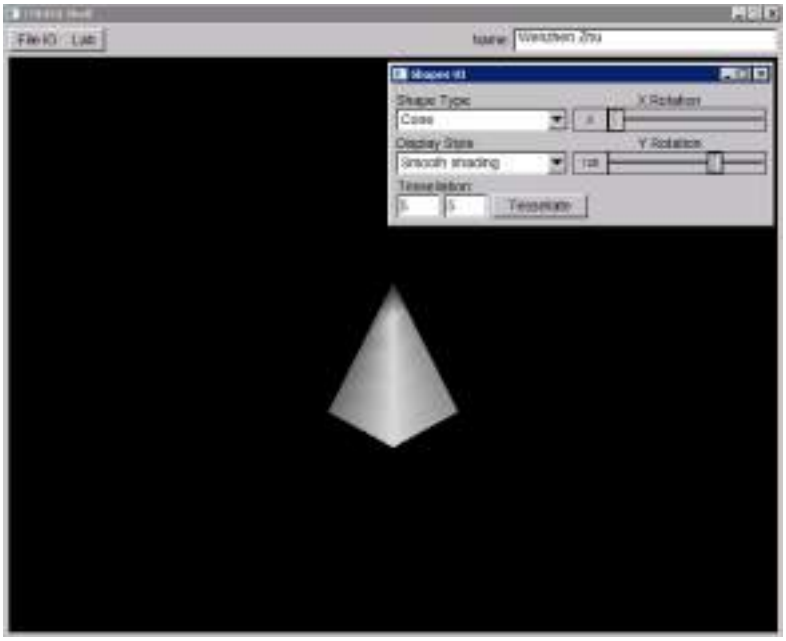



File IO
Lab
Name:
Renzhen Zhu
Shapes III
Shape Type:
Cylinder
X Rotation
Display Style:
Smooth shading
Y Rotation
Tessellation:
Tessellate

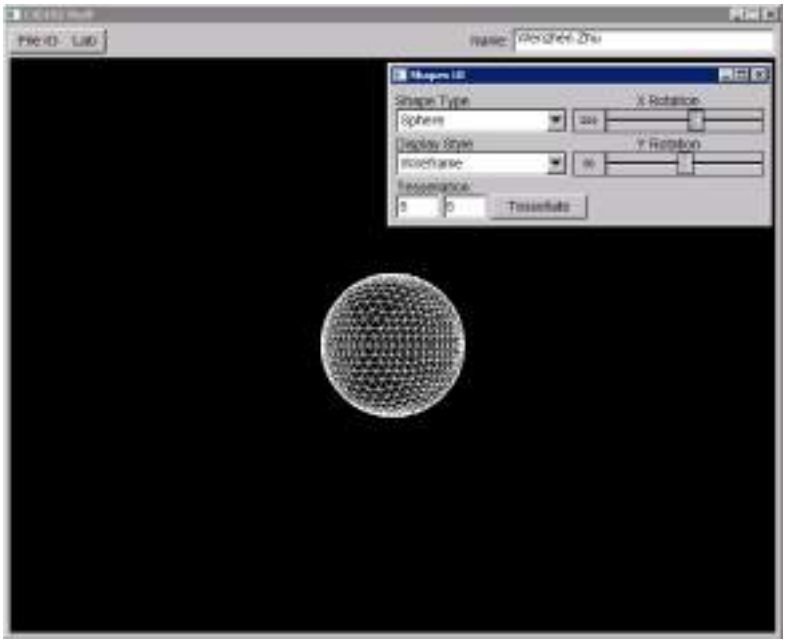
Cone

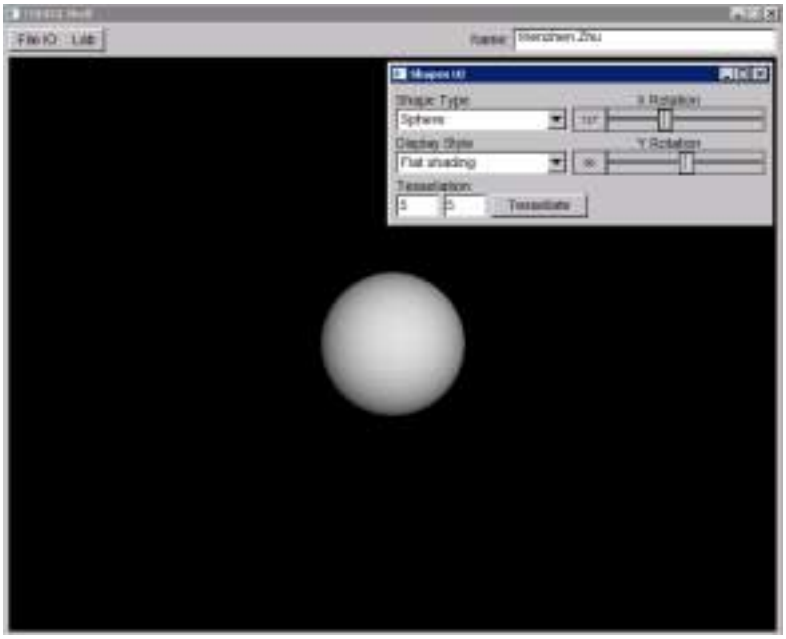

File IO
Lab
Name:
Renzhen Zhu
Shapes III
Shape Type:
Cone
X Rotation
Display Style:
Wireframe
Y Rotation
Tessellation:
Tessellate

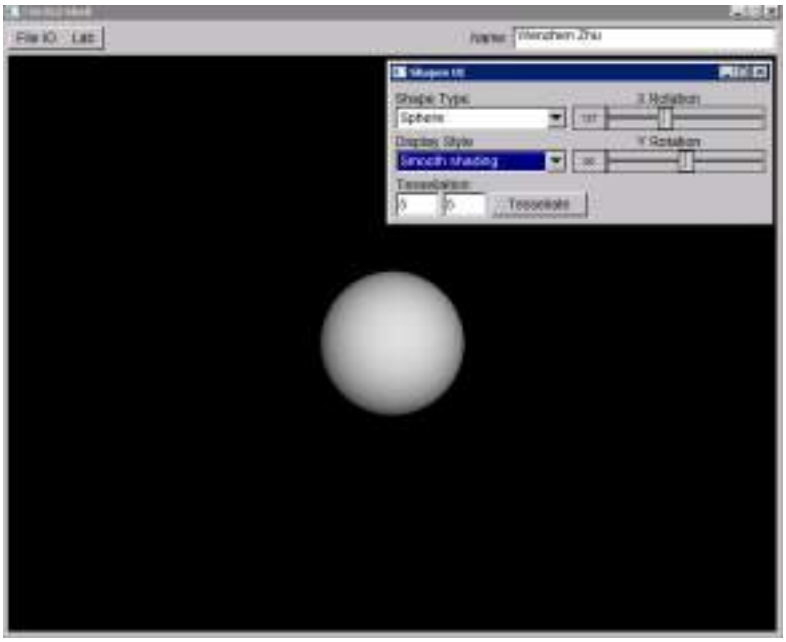

File IO
Lab
Name:
Wenzhen Zhu
Shapes 01
Shape Type
Cone
X Rotation
Display Style
Flat shading
Y Rotation
Tessellation
Tessellate


File IO
Lab
Name:
Wenzhen Zhu
Shapes 01
Shape Type
Cone
X Rotation
Display Style
Smooth shading
Y Rotation
Tessellation
Tessellate

Sphere


Name:
Shape Type
Sphere
Display Style
Wireframe
Tessellation
Tessellate
X Rotation
Y Rotation


Name:
Shape Type
Sphere
Display Style
Flat shading
Tessellation
Tessellate
X Rotation
Y Rotation



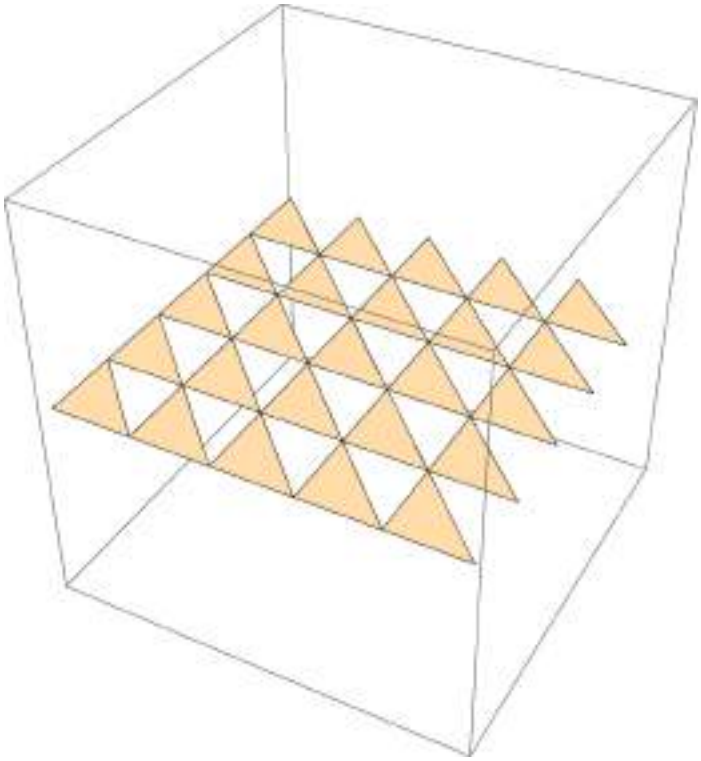
Created with ♥ in Day One

Shapes ReadMe

Cube

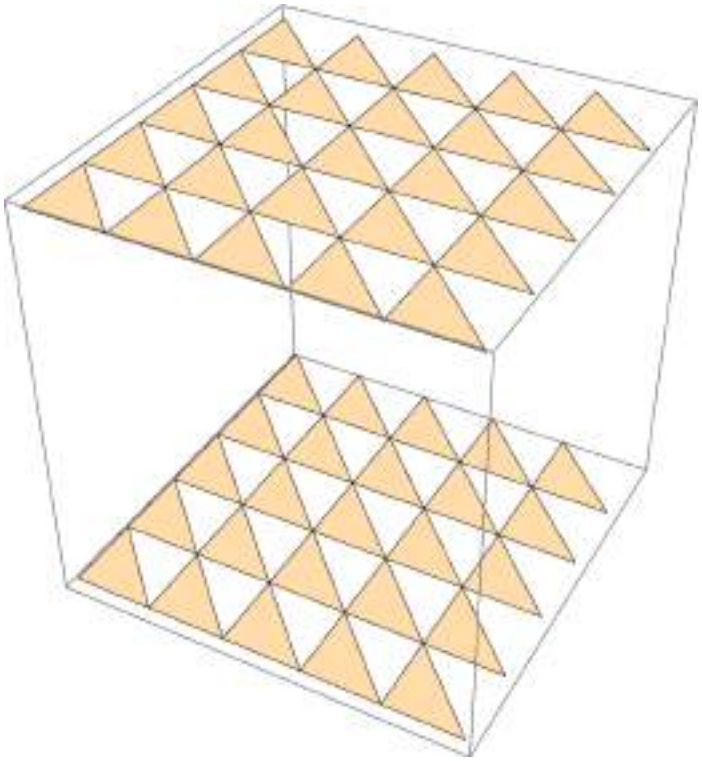
In[340]:=
```
cube1[n_] := Table[Polygon[{{(i - 1)/n - 0.5, (j - 1)/n - 0.5, -0.5},
    {i/n - 0.5, (j - 1)/n - 0.5, -0.5}, {(i - 1)/n - 0.5, j/n - 0.5, -0.5}}], {i, 1, n}, {j, 1, n}]
Graphics3D[
 cube1[
  5]]
```

Out[341]=



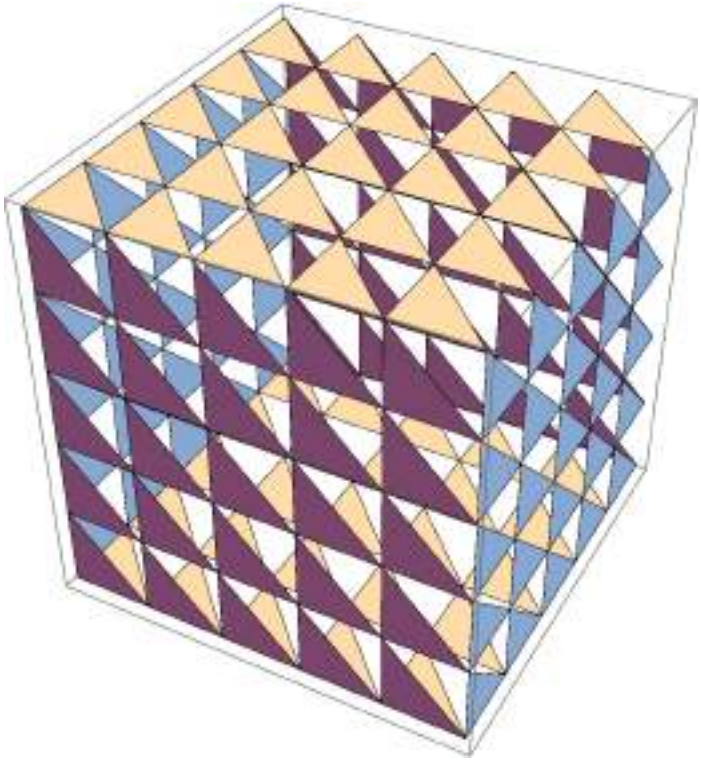
In[342]:=
```
cube2[n_] := Table[Polygon[{{(i - 1)/n - 0.5, (j - 1)/n - 0.5, k}, {i/n - 0.5, (j - 1)/n - 0.5, k},
    {(i - 1)/n - 0.5, j/n - 0.5, k}}], {i, 1, n}, {j, 1, n}, {k, {-0.5, 0.5}}]
Graphics3D[
 cube2[
  5]]
```

Out[343]=



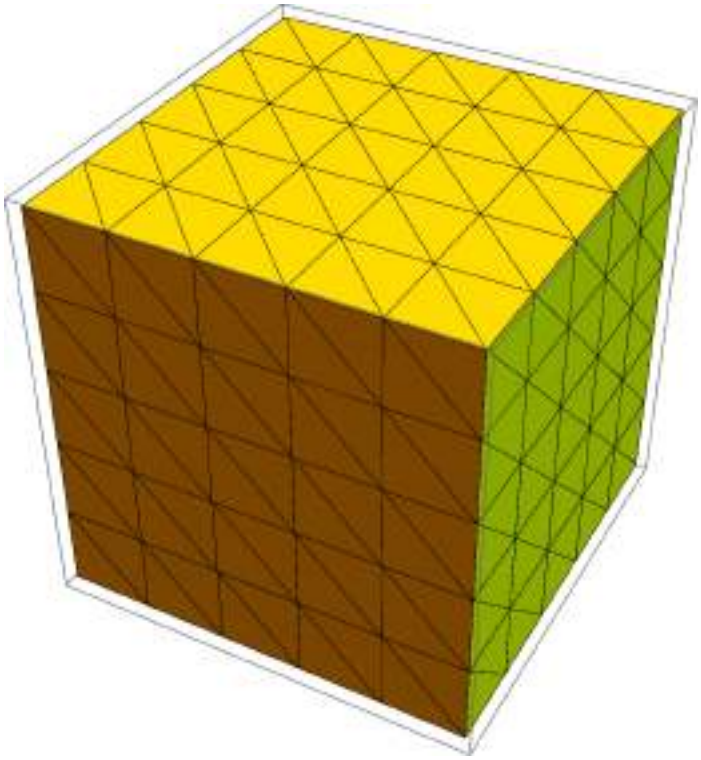
In[344]:=
```
cube3[n_] := Table[Polygon[{RotateLeft[{(i - 1) / n - 0.5, (j - 1) / n - 0.5, k}, m],
     RotateLeft[{i / n - 0.5, (j - 1) / n - 0.5, k}, m],
     RotateLeft[{(i - 1) / n - 0.5, j / n - 0.5, k}, m]}],
  {i, 1, n}, {j, 1, n}, {k, {-0.5, 0.5}}, {m, 0, 2}]
Graphics3D[cube3[5]]
```

Out[345]=



In[346]:=
```
cube4[n_] := {FaceForm[Yellow, Transparent],
  Table[Polygon[h If[h (2 k) == -1, {#[[2]], #[[1]], #[[3]]} &, Identity]@
      {RotateLeft[{(i - 1) / n - 0.5, (j - 1) / n - 0.5, k}, m], RotateLeft[{i / n - 0.5,
         (j - 1) / n - 0.5, k}, m], RotateLeft[{(i - 1) / n - 0.5, j / n - 0.5, k}, m]}],
   {i, 1, n}, {j, 1, n}, {k, {-0.5, 0.5}}, {m, 0, 2}, {h, {-1, 1}}]}
Graphics3D[
 cube4[
  5]]
```

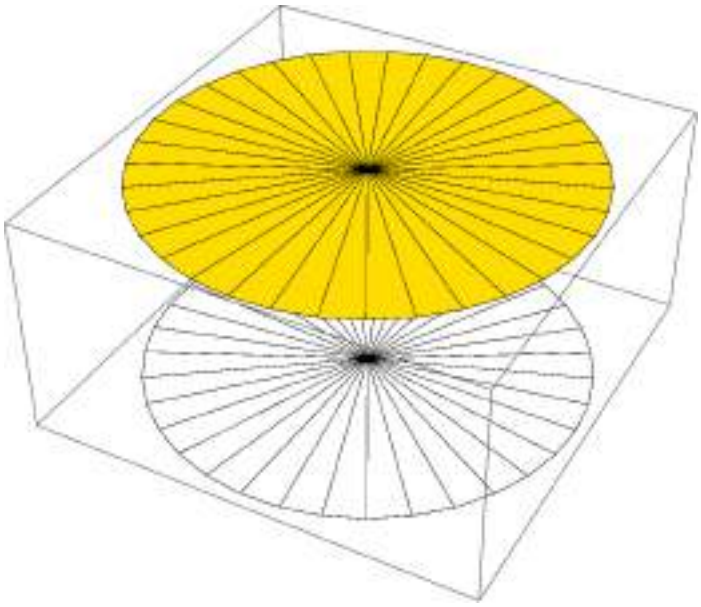
Out[347]=



Cylinder

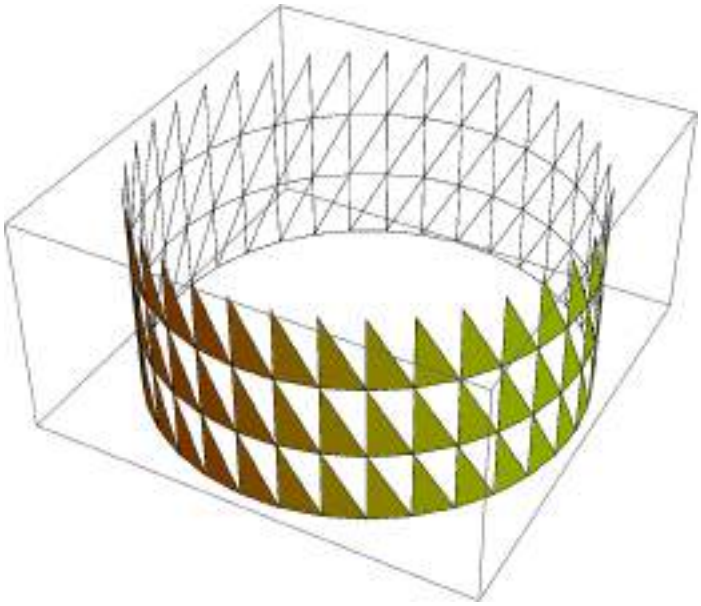
In[370]:=
```
cylinder0[n_, m_] := {FaceForm[Yellow, Transparent], Table[
    Polygon[If[k == -0.5, Reverse, Identity]@{{0, 0, k}, {Cos[i/n 2 π], Sin[i/n 2 π], k},
      {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], k}}], {i, 1, n}, {k, {-0.5, 0.5}}]}
Graphics3D[cylinder0[
  35,
  3]]
```

Out[371]=



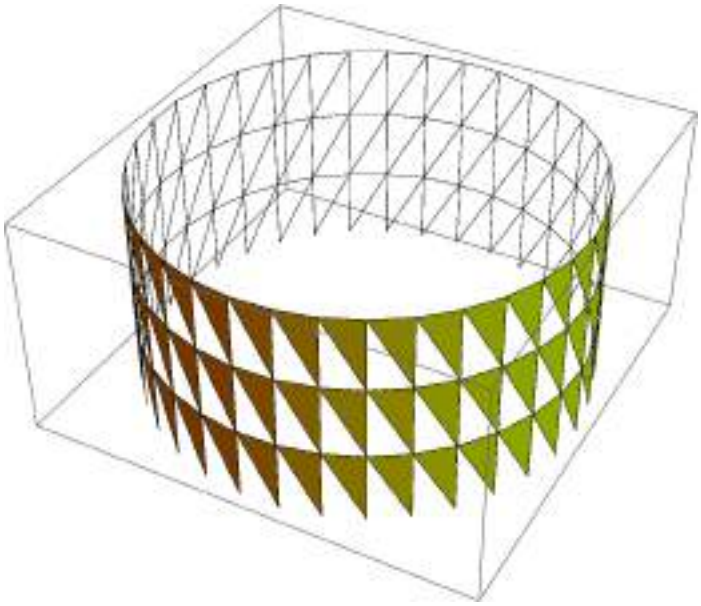
In[372]:=
```
cylinder1[n_, m_] := {FaceForm[Yellow, Transparent], Table[
    Polygon[{{Cos[i/n 2 π], Sin[i/n 2 π], -0.5 + j/m}, {Cos[i/n 2 π], Sin[i/n 2 π], -0.5 + (j - 1)/m},
      {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}]}
Graphics3D[cylinder1[
  35,
  3]]
```

Out[373]=



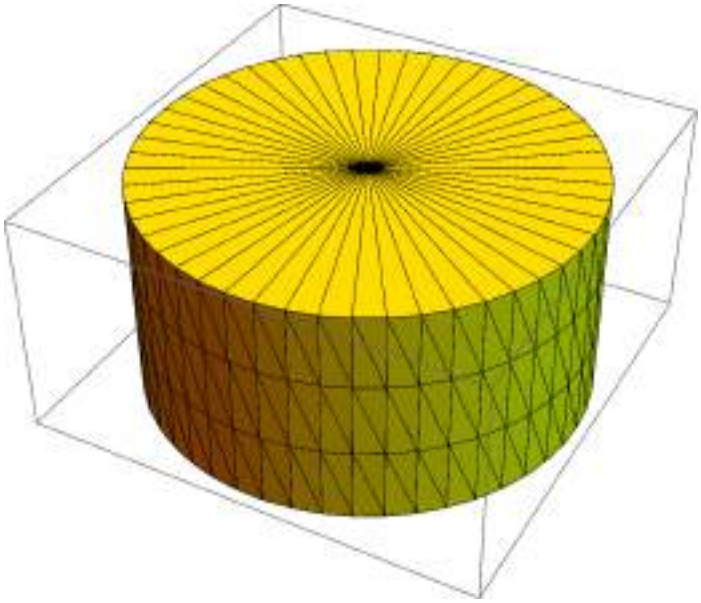
In[374]:=
```
cylinder2[n_, m_] := {FaceForm[Yellow, Transparent],
  Table[Polygon[{{Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5 + j/m}, {Cos[i/n 2 π], Sin[i/n 2 π],
      -0.5 + j/m}, {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}]}
Graphics3D[cylinder2[
  35,
  3]]
```

Out[375]=



In[376]:=
```
cylinder[n_, m_] := {
  {FaceForm[Yellow, Transparent], Table[
    Polygon[If[k == -0.5, Reverse, Identity]@{{0, 0, k}, {Cos[i/n 2 π], Sin[i/n 2 π], k},
      {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], k}}], {i, 1, n}, {k, {-0.5, 0.5}}],
   Table[Polygon[{{Cos[i/n 2 π], Sin[i/n 2 π], -0.5 + j/m}, {Cos[i/n 2 π], Sin[i/n 2 π], -0.5 +
       (j - 1)/m}, {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}],
   Table[Polygon[{{Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5 + j/m}, {Cos[i/n 2 π], Sin[i/n 2 π],
       -0.5 + j/m}, {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}]}
 }
Graphics3D[cylinder[50, 3]]
```

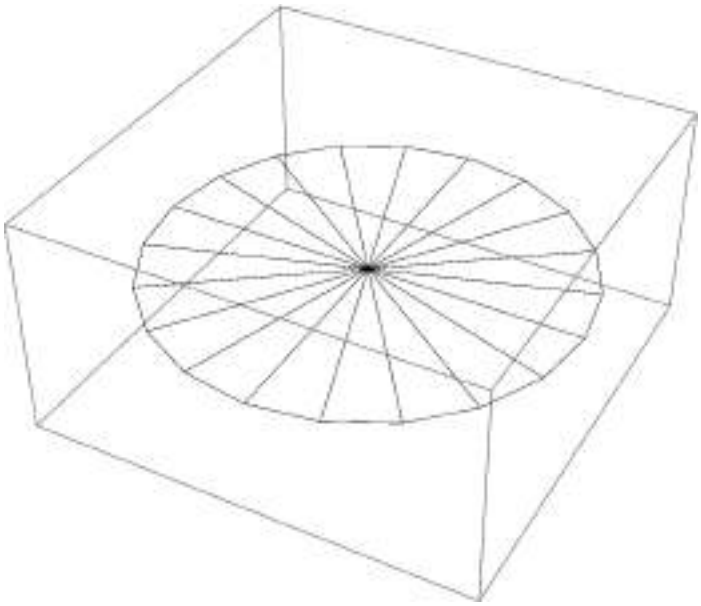
Out[377]=



Cone

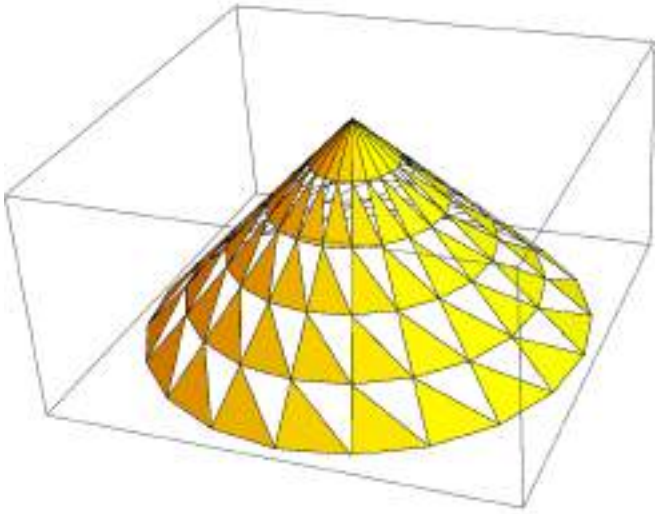
In[381]:=
```
cone0[n_, m_] := {FaceForm[Yellow, Transparent],
  Table[Polygon[{{0, 0, -0.5}, {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5},
     {Cos[i/n 2 π], Sin[i/n 2 π], -0.5}}], {i, 1, n}]}
Graphics3D[
 cone0[
  20,
  3]]
```

Out[382]=



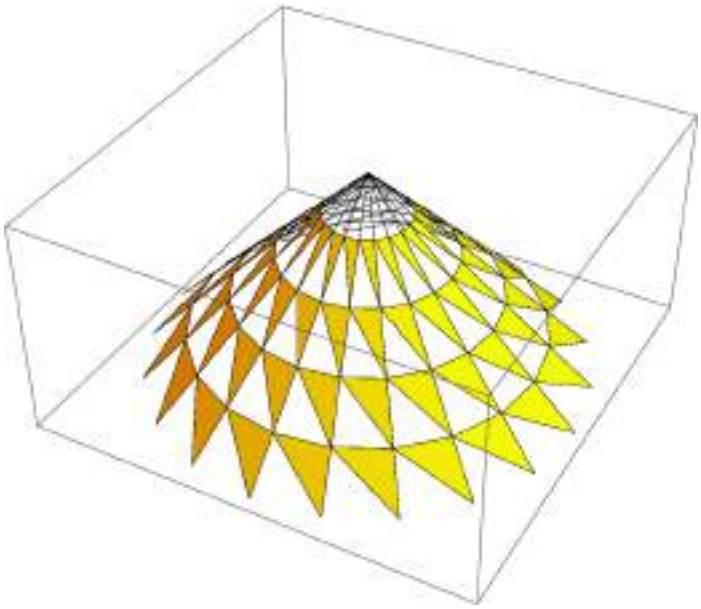
In[393]:=
```
cone1[n_, m_] := {FaceForm[Yellow, Transparent],
  Table[
   Polygon[{{Cos[i/n 2 π] (1 - j/m), Sin[i/n 2 π] (1 - j/m), -0.5 + j/m}, {Cos[i/n 2 π] (1 - (j - 1)/m),
      Sin[i/n 2 π] (1 - (j - 1)/m), -0.5 + (j - 1)/m}, {Cos[(i + 1)/n 2 π] (1 - (j - 1)/m),
      Sin[(i + 1)/n 2 π] (1 - (j - 1)/m), -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}]}
Graphics3D[
 cone1[
  20,
  5]]
```

Out[394]=



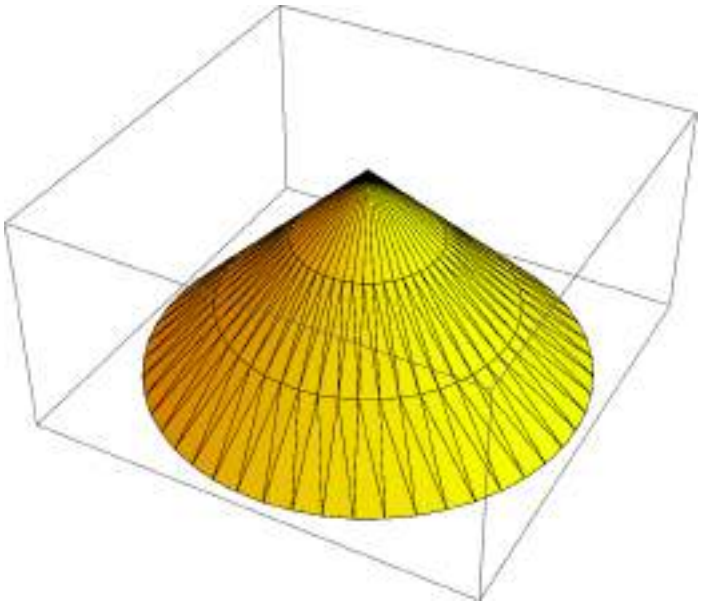
In[395]:=
```
cone2[n_, m_] := {FaceForm[Yellow, Transparent],
  Table[Polygon[{{Cos[(i + 1)/n 2 π] (1 - j/m), Sin[(i + 1)/n 2 π] (1 - j/m), -0.5 + j/m},
     {Cos[i/n 2 π] (1 - j/m), Sin[i/n 2 π] (1 - j/m), -0.5 + j/m}, {Cos[(i + 1)/n 2 π] (1 - (j - 1)/m),
     Sin[(i + 1)/n 2 π] (1 - (j - 1)/m), -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}]}
Graphics3D[
 cone2[
  20,
  5]]
```

Out[396]=



In[447]:=
```
cone[n_, m_] := {FaceForm[Yellow, Transparent],
  Table[Polygon[{{0, 0, -0.5}, {Cos[(i + 1)/n 2 π], Sin[(i + 1)/n 2 π], -0.5},
     {Cos[i/n 2 π], Sin[i/n 2 π], -0.5}}], {i, 1, n}],
  Table[Polygon[{{Cos[i/n 2 π] (1 - j/m), Sin[i/n 2 π] (1 - j/m), -0.5 + j/m},
     {Cos[i/n 2 π] (1 - (j - 1)/m), Sin[i/n 2 π] (1 - (j - 1)/m), -0.5 + (j - 1)/m}, {Cos[(i + 1)/n 2 π]
      (1 - (j - 1)/m), Sin[(i + 1)/n 2 π] (1 - (j - 1)/m), -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}],
  Table[Polygon[{{Cos[(i + 1)/n 2 π] (1 - j/m), Sin[(i + 1)/n 2 π] (1 - j/m), -0.5 + j/m},
     {Cos[i/n 2 π] (1 - j/m), Sin[i/n 2 π] (1 - j/m), -0.5 + j/m}, {Cos[(i + 1)/n 2 π] (1 - (j - 1)/m),
      Sin[(i + 1)/n 2 π] (1 - (j - 1)/m), -0.5 + (j - 1)/m}}], {i, 1, n}, {j, 1, m}]
 }
Graphics3D[cone[50, 3]]
```

Out[448]=



Sphere

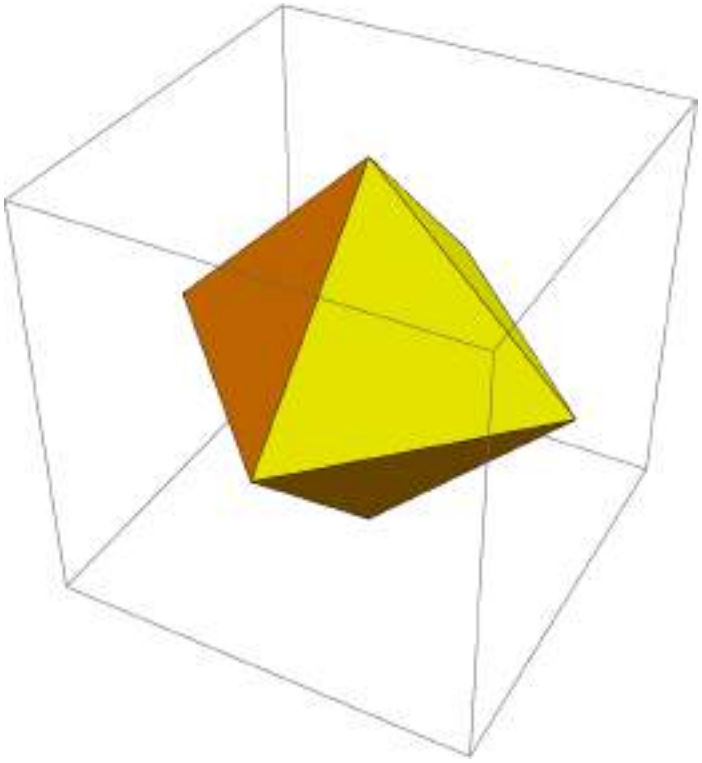
```
octahedronVertices = 1. {
    {1, 0, 0},
    {-1, 0, 0},
    {0, 1, 0},
    {0, -1, 0},
    {0, 0, 1},
    {0, 0, -1}
   };
octahedronTriangles = {
    {0, 4, 2},
    {2, 4, 1},
    {1, 4, 3},
    {3, 4, 0},
    {0, 2, 5},
    {2, 1, 5},
    {1, 3, 5},
    {3, 0, 5}
   } + 1;
divide[points_] := Block[
  {
   a = Mean[{points[[1]], points[[3]]}],
   b = Mean[{points[[1]], points[[2]]}],
   c = Mean[{points[[2]], points[[3]]}]
  },
  {{points[[1]], b, a}, {b, points[[2]], c}, {a, b, c}, {a, c, points[[3]]}}
 ]
```

In[397]:=
```
vertex = Table[octahedronVertices[[tr]], {tr, octahedronTriangles}]
```

Out[397]=
```
{{{1., 0., 0.}, {0., 0., 1.}, {0., 1., 0.}}, {{0., 1., 0.}, {0., 0., 1.}, {-1., 0., 0.}},
 {{-1., 0., 0.}, {0., 0., 1.}, {0., -1., 0.}},
 {{0., -1., 0.}, {0., 0., 1.}, {1., 0., 0.}},
 {{1., 0., 0.}, {0., 1., 0.}, {0., 0., -1.}},
 {{0., 1., 0.}, {-1., 0., 0.}, {0., 0., -1.}},
 {{-1., 0., 0.}, {0., -1., 0.}, {0., 0., -1.}},
 {{0., -1., 0.}, {1., 0., 0.}, {0., 0., -1.}}}
```

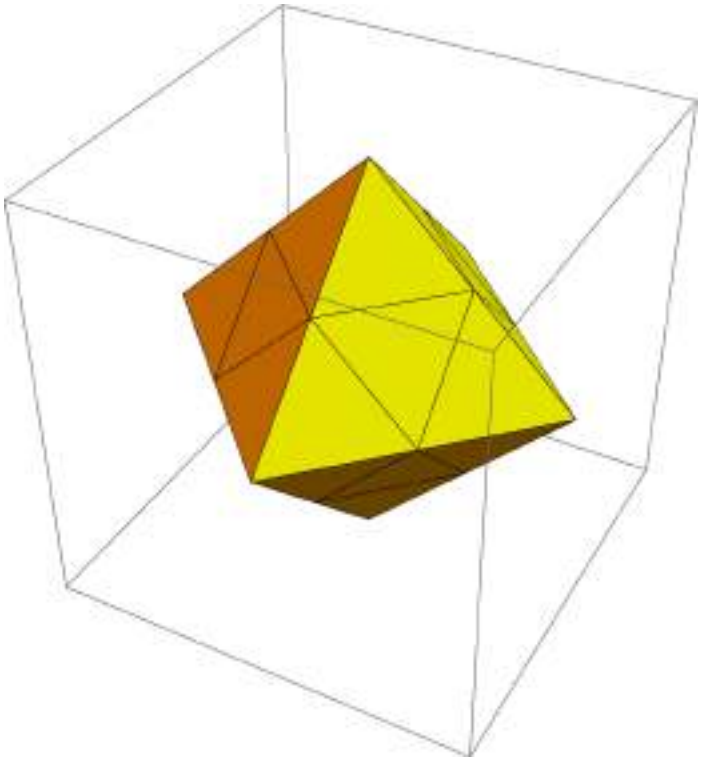
In[398]:=
```
Graphics3D[{FaceForm[Yellow, Blue], Polygon /@ Reverse /@ vertex}]
```

Out[398]=



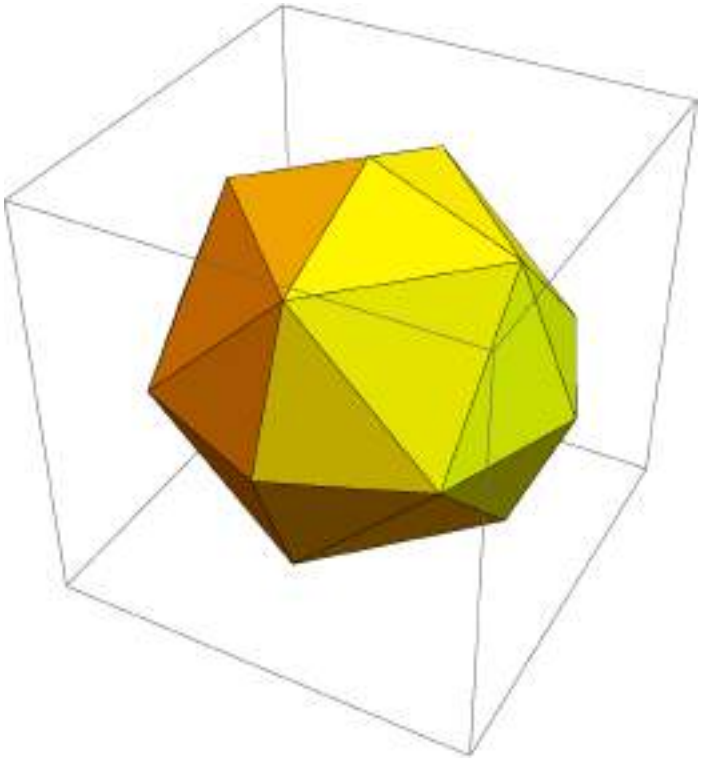
In[408]:=
```
vertex1 = Flatten[divide /@ vertex, 1];
Graphics3D[{FaceForm[Yellow, Transparent], Polygon /@ Reverse /@ vertex1}]
```

Out[409]=



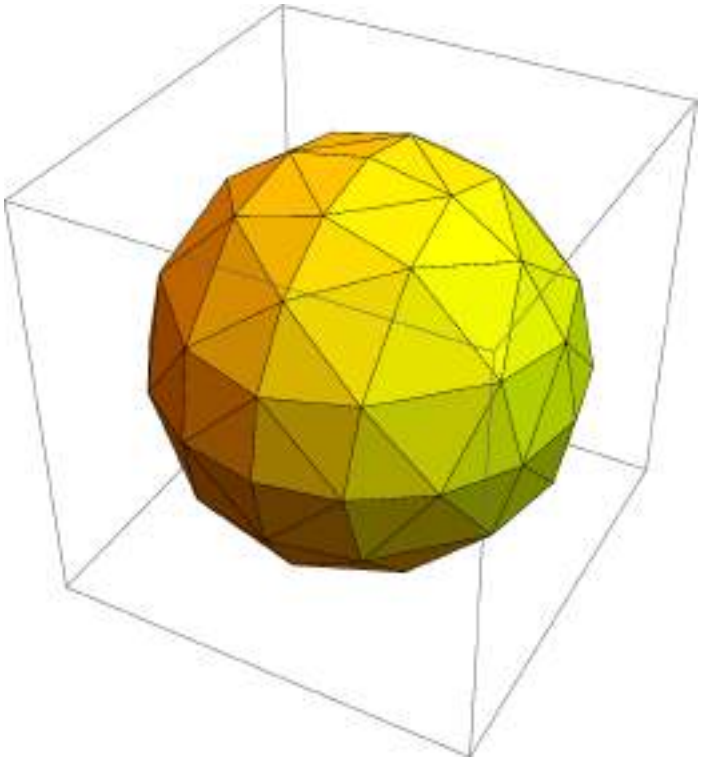
In[412]:=
```
vertex1 = Map[normalize, Flatten[divide /@ vertex, 1], {2}];
Graphics3D[{FaceForm[Yellow, Transparent], Polygon /@ Reverse /@ vertex1}]
```

Out[413]=



In[414]:=
```
vertex2 = Map[normalize, Flatten[divide /@ vertex1, 1], {2}];
Graphics3D[{FaceForm[Yellow, Transparent], Polygon /@ Reverse /@ vertex2}]
```

Out[415]=



```
normalize[v_] := v / Norm[v]
```

In[440]:=
```
sphere[n_] := Polygon /@ Nest[Map[normalize, Flatten[divide /@ #, 1], {2}] &,
   Table[octahedronVertices[[tr]], {tr, octahedronTriangles}], n]
```

In[445]:=
```
Graphics3D[sphere[4]];
Graphics3D[{FaceForm[Blue, Yellow], sphere[4]}]
```

Out[446]=