TP1 Graphic 3D

Mesh Generation

1- Generate a triangle

Reminder: a triangle is an array of 3 vertices, and a vertex is an array of three coordinates.

To represent a triangle in Python we will use a numpy array :

```
import numpy as np
vertices = np.array([
  [0.0,0.0,0.0], #first vertex
  [1.0,0.0,0.0], #second vertex
  [0.0,1.0,0.0], #third vertex
])
```

In this practical work, we will represent meshes with the indexed representation so we need to represent each triangle with an array of three indices pointing toward vertices in the previous array.

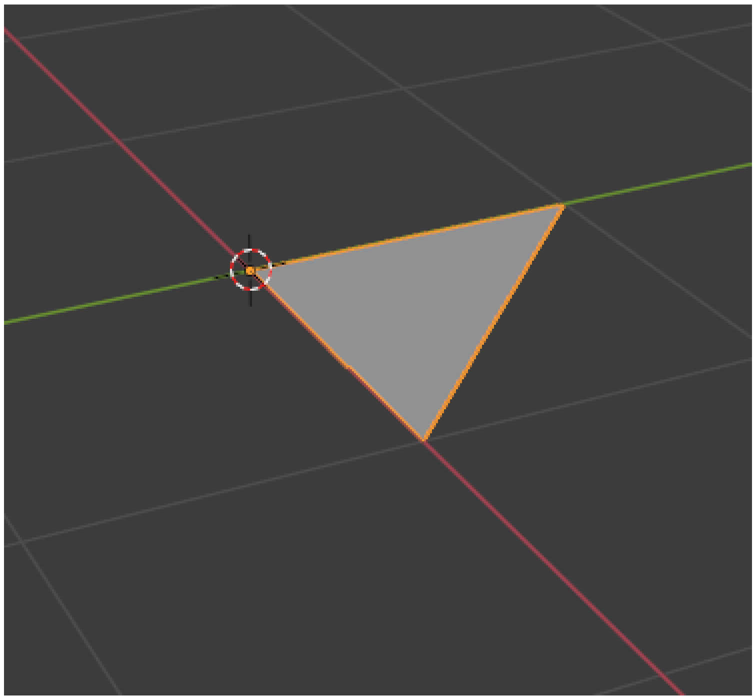
```
triangles = np.array([
  [0,1,2] # create a triangle with the first, second, and third vertices
], dtype=int)
```

Now to visualize our triangle we will export it as a ply file using the following command:

```
from exportToPly import write_ply_file
write_ply_file(vertices,triangles, 'triangle.ply' )
```

Once executed this script will generate a triangle.ply file. Now we can import the file in Blender to visualize it. To do so open Blender, use file > import > Stanford (.ply), and select the file you created.

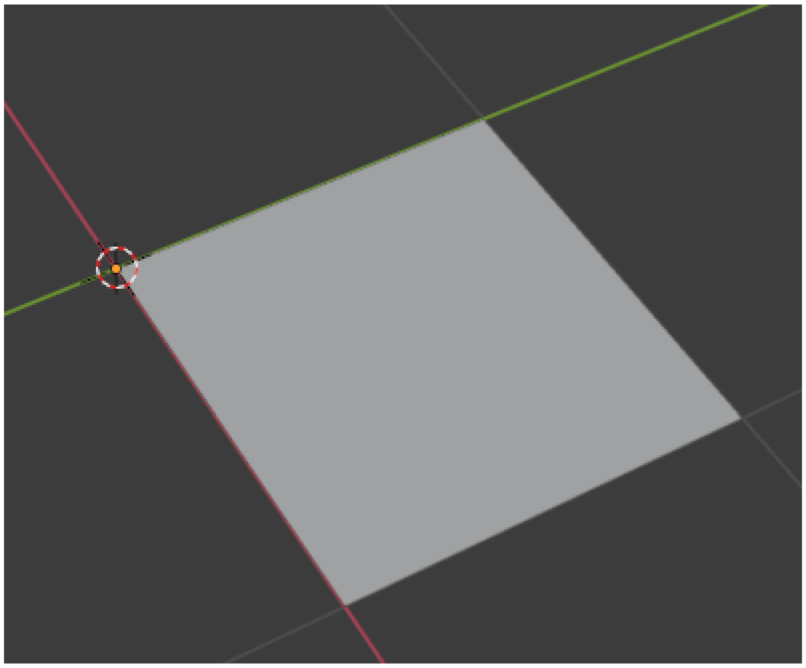
Once imported you should see something like this :



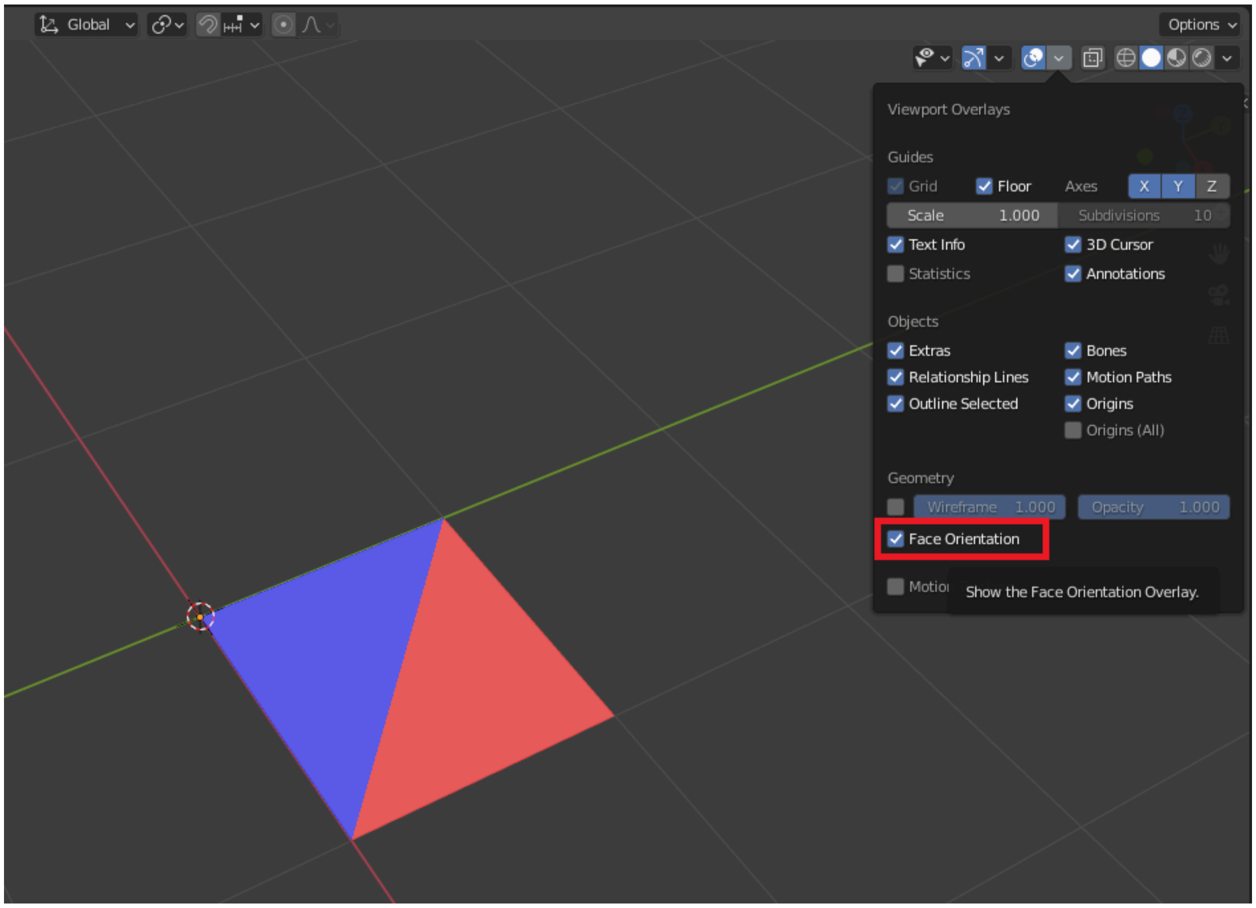
2- Generate a square instead of a triangle

Hint: you need to add one vertex to the vertices array, and one triangle to the triangle array.

Once you did the modification to your scrip, import it into Blender, you should see something similar to this:



Now to check if our triangles are correctly oriented, we can use Blender to visualize the orientation of our faces:



Viewport Overlays

Guides

- [✓] Grid
- [✓] Floor
- Axes: X Y Z
- Scale 1.000
- Subdivisions 10
- [✓] Text Info
- [✓] 3D Cursor
- [ ] Statistics
- [✓] Annotations

Objects

- [✓] Extras
- [✓] Bones
- [✓] Relationship Lines
- [✓] Motion Paths
- [✓] Outline Selected
- [✓] Origins
- [ ] Origins (All)

Geometry

- [ ] Wireframe 1.000
- Opacity 1.000
- [✓] Face Orientation
- [ ] Motio

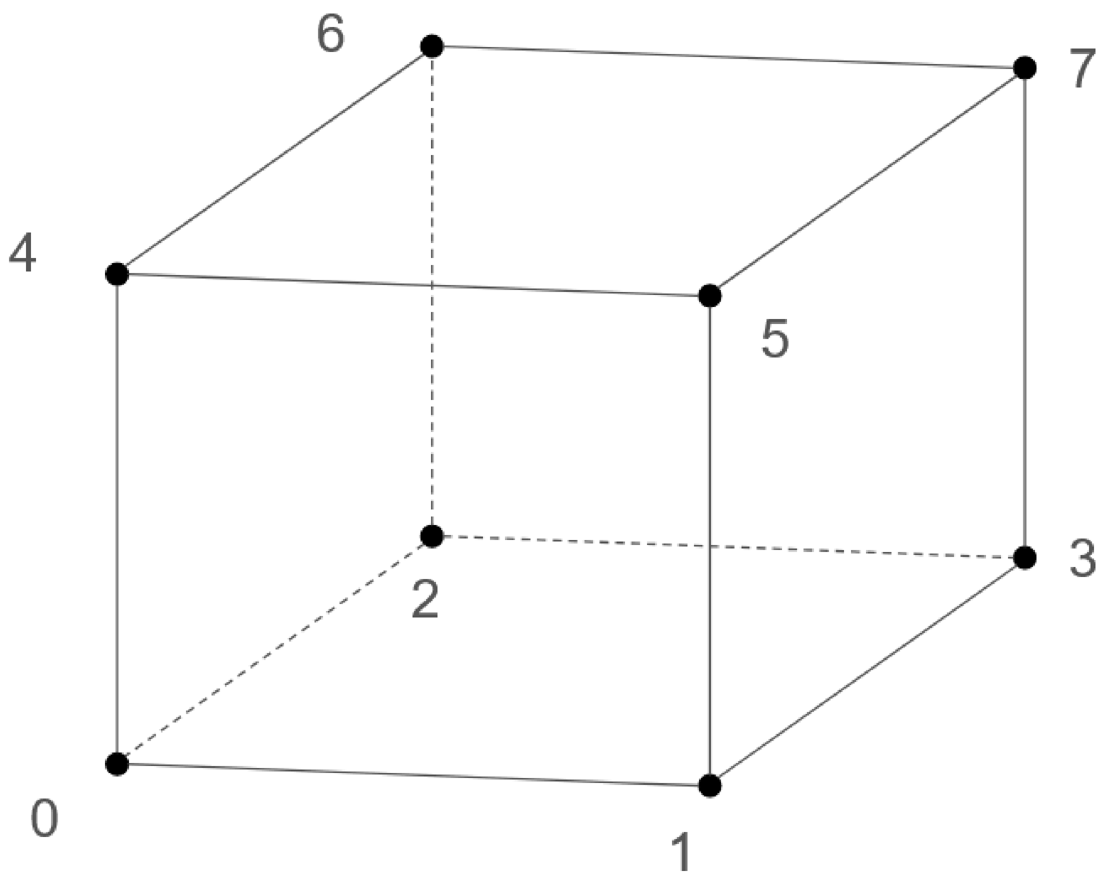
Show the Face Orientation Overlay.

(If you don’t have these colors make sure only the object you want to visualize is in the scene)

If the triangles you generated are of different colors it means the orientation of your triangles is not coherent. To change that, you can modify the order of the indices of the triangle you added in your script.
In general, we want to have faces oriented coherently, which will simplify a lot of computation in future practical work.

3- Generate a cube

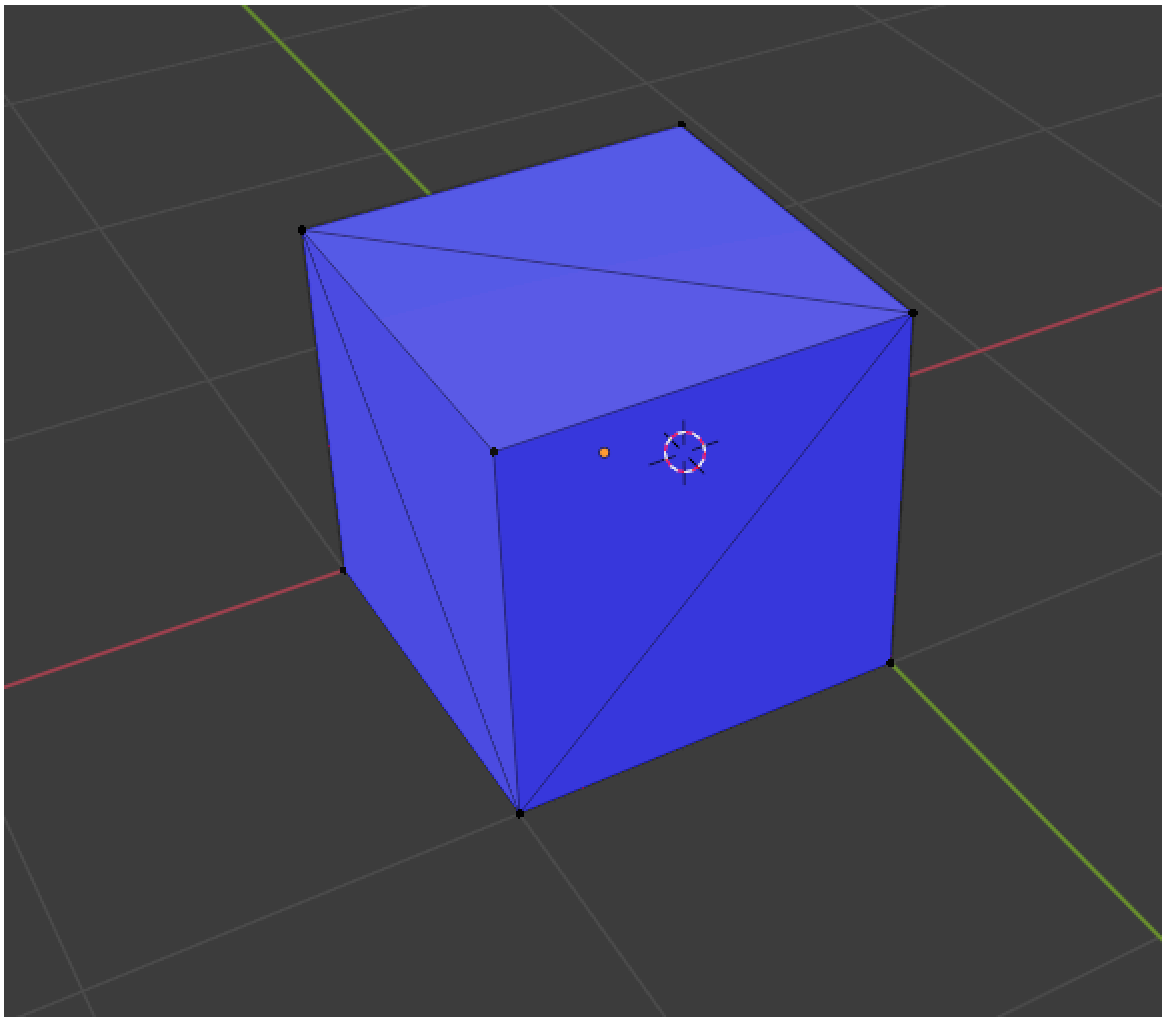
In this exercise, your goal is to generate the following cube :



Using the following vertices :

```
vertices = np.array([
  [0.0,0.0,0.0], #0
  [1.0,0.0,0.0], #1
  [0.0,1.0,0.0], #2
  [1.0,1.0,0.0], #3
  [0.0,0.0,1.0], #4
  [1.0,0.0,1.0], #5
  [0.0,1.0,1.0], #6
  [1.0,1.0,1.0], #7
])
```

Once the cube is generated it should look like this:

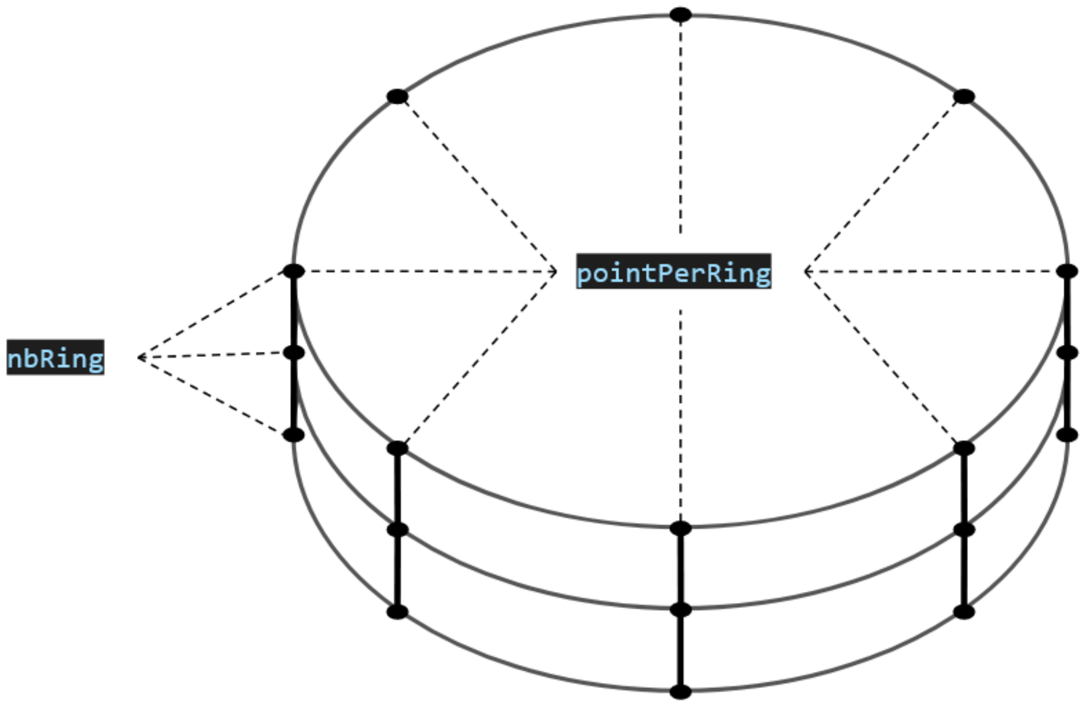


All the triangles of the cube should be blue in Blender.
Hint: each face of the cube should generate 2 triangles.

4-Generate a cylinder

In this part, we will focus on creating a script that can generate the mesh of a cylinder.
First, we will define two variables that will define how we will subdivide the cylinder :

```
pointPerRing = 8
nbRing = 3
```

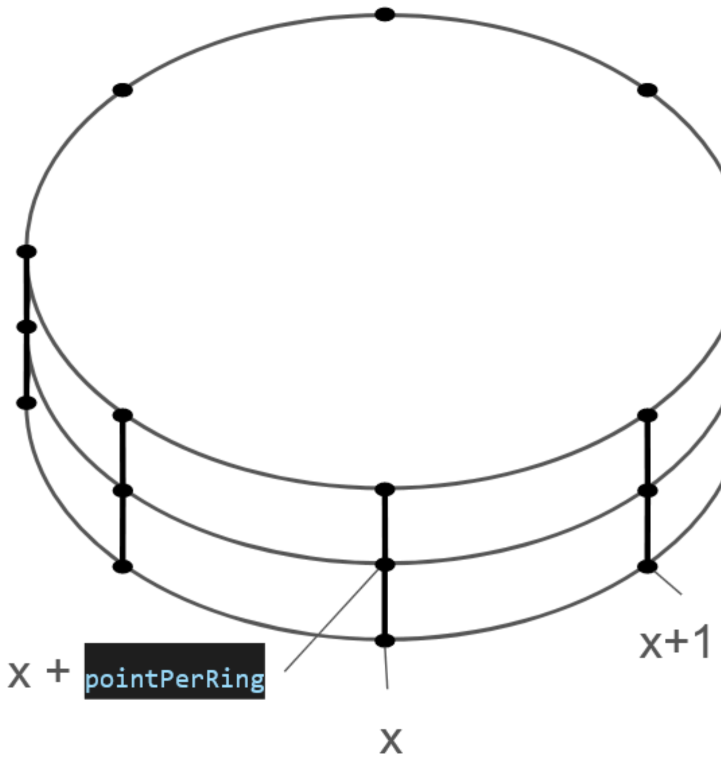


Then we need to define all the vertices we need to

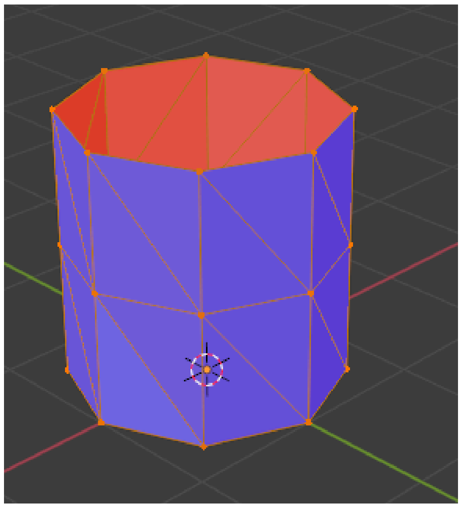
```
vertices = []

for i in range (nbRing) :
  for j in range (pointPerRing) :
      x= #todo
      y= #todo
      z= #todo
      vertices.append([x,y,z])
vertices = np.array(vertices)
```

Hint: Given an angle phi you can find a point on a circle using cos(phi), sin(phi). In mathematics libraries, angles are expressed in radians [0, 2pi].

Finally, we need to define all the triangles. If you followed the instructions above, the vertices should be stored as follows:



Where given a vertices at the index x, its neighbors should be at x±1 and x ± pointPerRing. Using this information generate the triangle that composes the following cylinder.



All triangles should be blue when looked at from the exterior.

Optional: modify the script to close the top and the bottom of the cylinder