Computational Fabrication

CS 491 and 591
Professor: Leah Buechley
https://handandmachine.org/classes/computational_fabrication/

Weekly Designer: Neri Oxman

https://www.moma.org/calendar/exhibitions/5090

https://oxman.com/projects

Mediated Matter

Mediated Matter

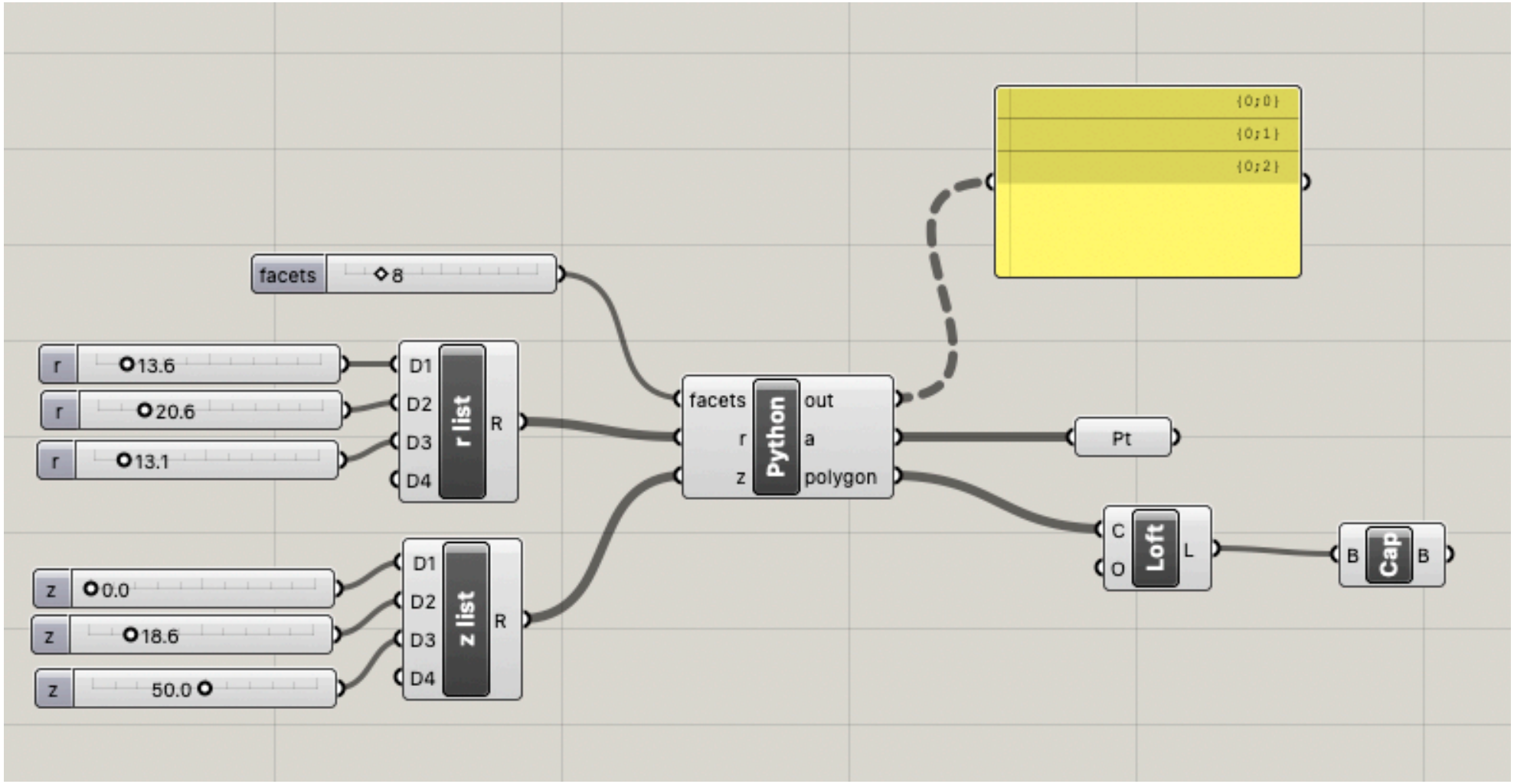
Today
1) Transformations
2) Solid vessels
2) Slicing

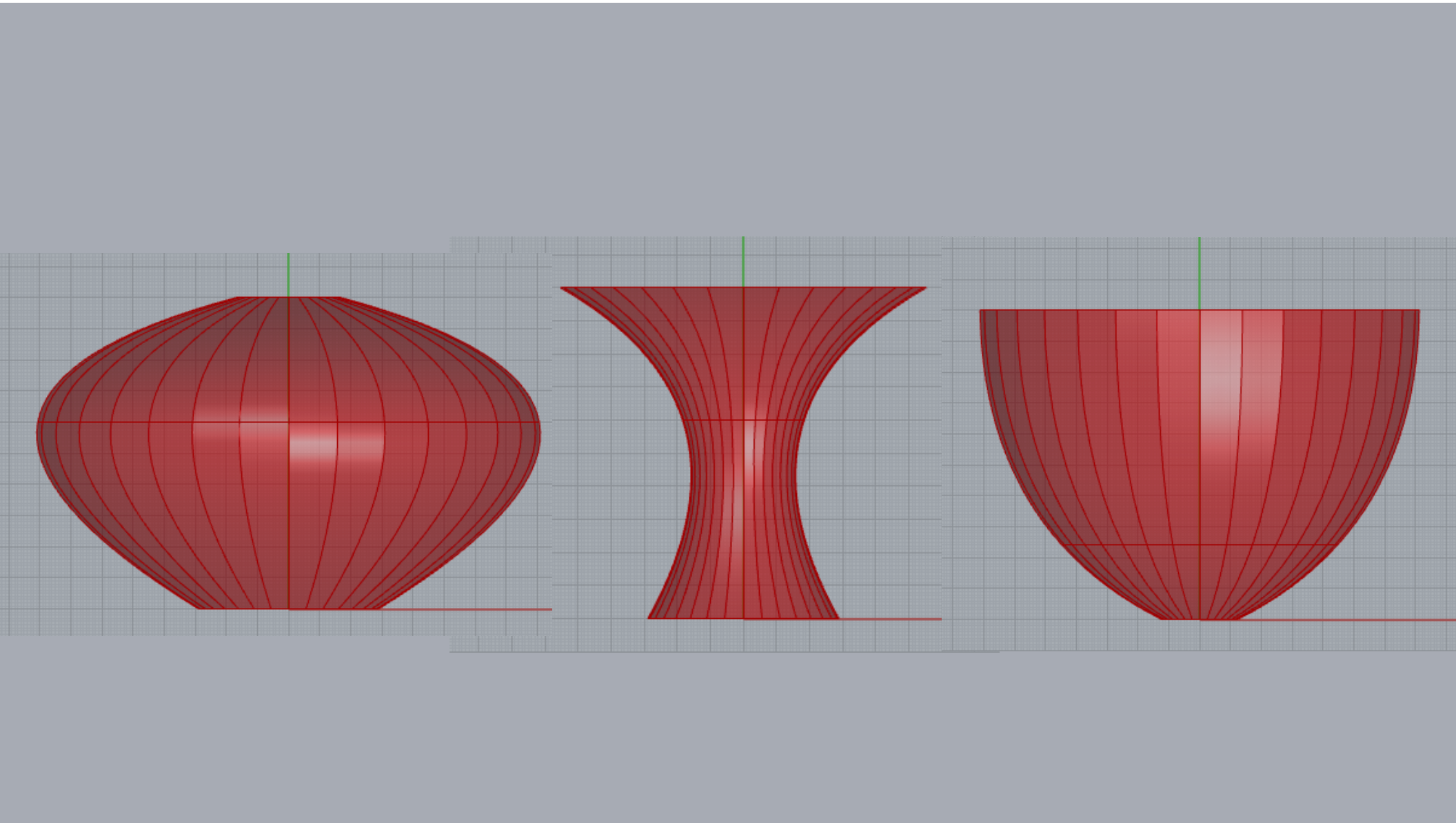
We'll use transformation tools from the Rhino Geometry library:

https://developer.rhino3d.com/api/rhinocommon/rhino.geometry

Rhino Geometry library
is separate and different from
Rhinoscript library

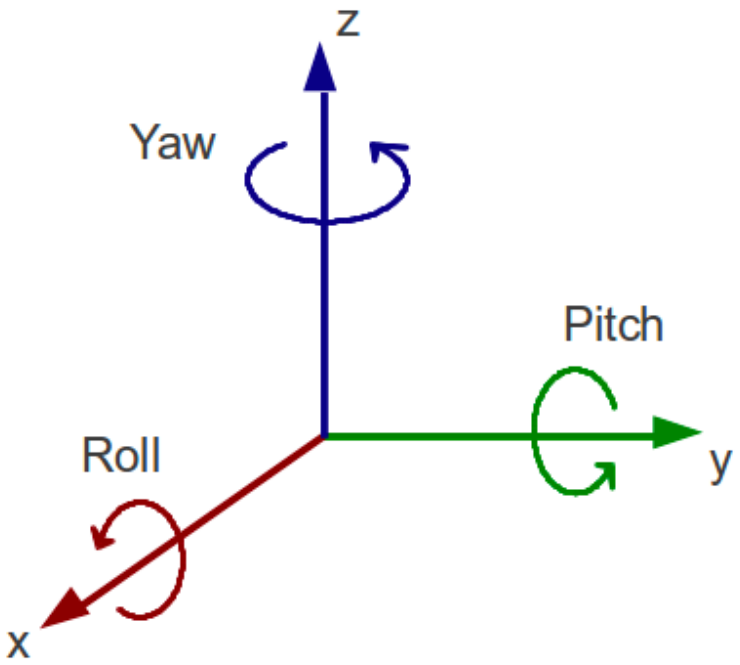
Open up Grasshopper program from last class





We’ll twist/rotate our polygons around the Z-axis

Rotation in 3D



RotationZYX method

Class: Rhino.Geometry.Transform

Description:

Create rotation transformation From Tait-Byran angles (also loosely known as Euler angles).

Syntax:

```
static Transform RotationZYX(
  Double yaw,
  Double pitch,
  Double roll
)
```

Parameters:

yaw

Type: System.Double

Angle, in radians, to rotate about the Z axis.

pitch

Type: System.Double

Angle, in radians, to rotate about the Y axis.

roll

Type: System.Double

Angle, in radians, to rotate about the X axis.

Returns:

Type: Transform

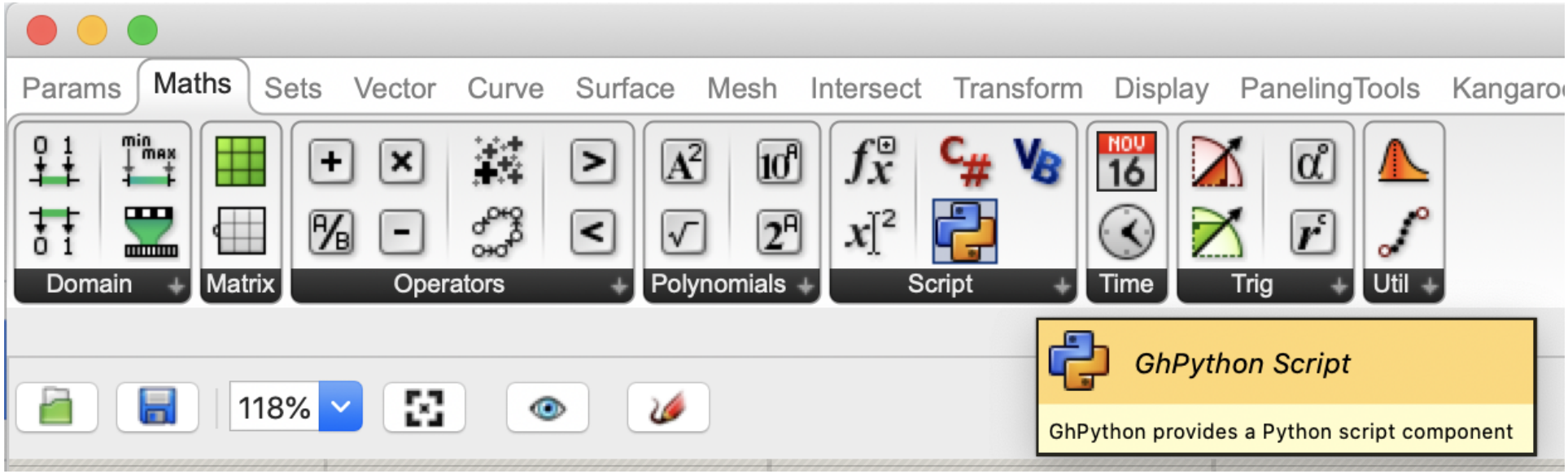
A transform matrix from Tait-Byran angles.

Remarks:

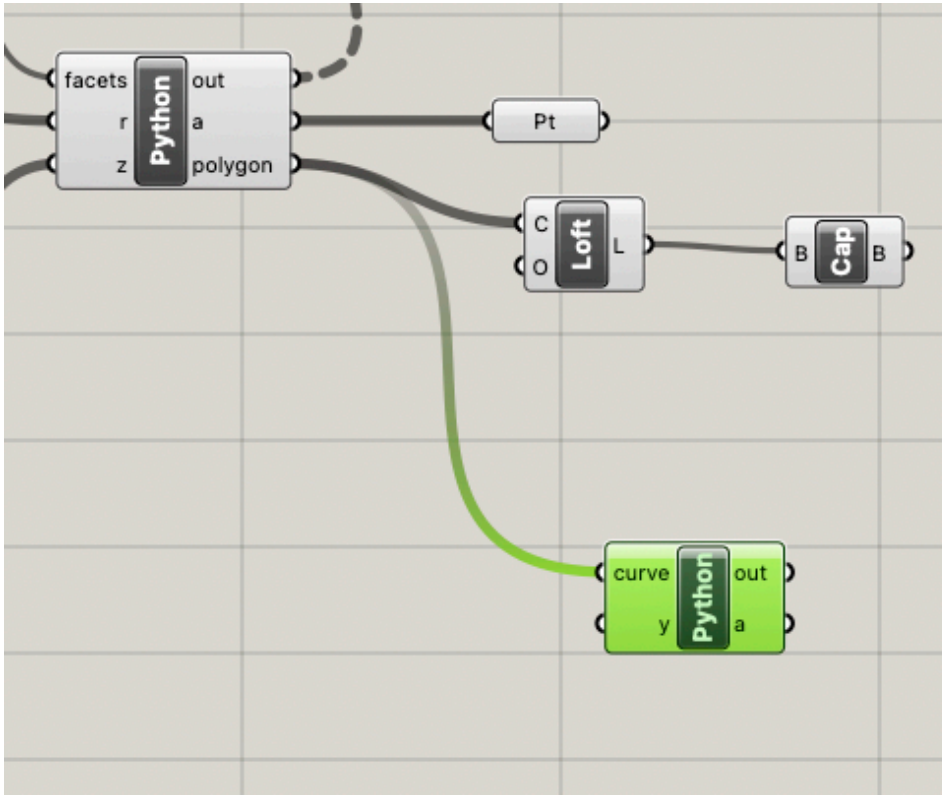
RotationZYX(yaw, pitch, roll) = R_z(yaw) * R_y(pitch) * R_x(roll) where R_*(angle) is rotation of angle radians about the corresponding world coordinate axis.

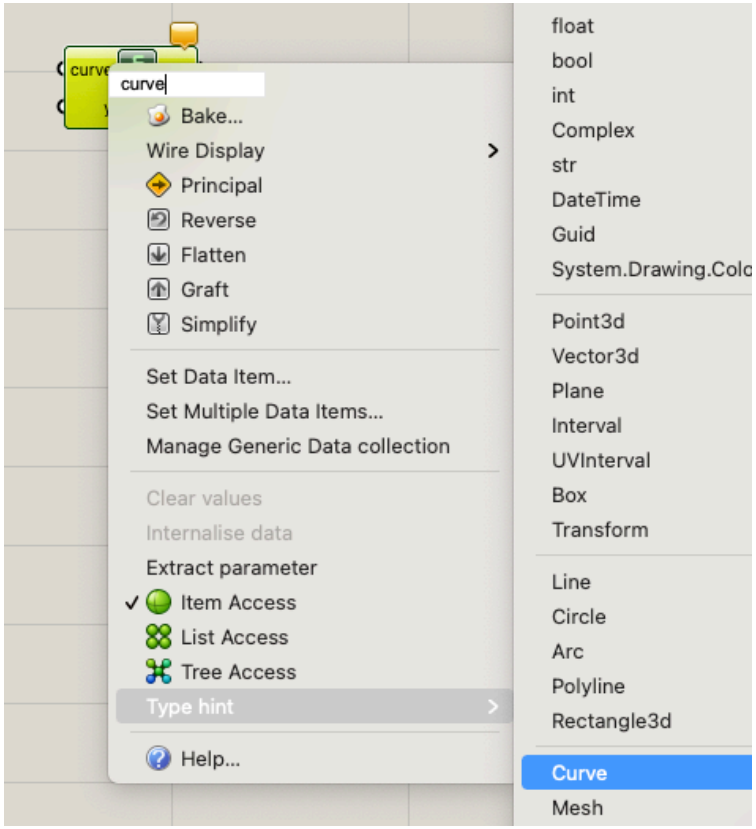
https://developer.rhino3d.com/api/rhinocommon/rhino.geometry.transform/rotationzyx

Add a python scripting block



Rename input and set to our polygons





set Type hint to **Curve**

Write a twist function

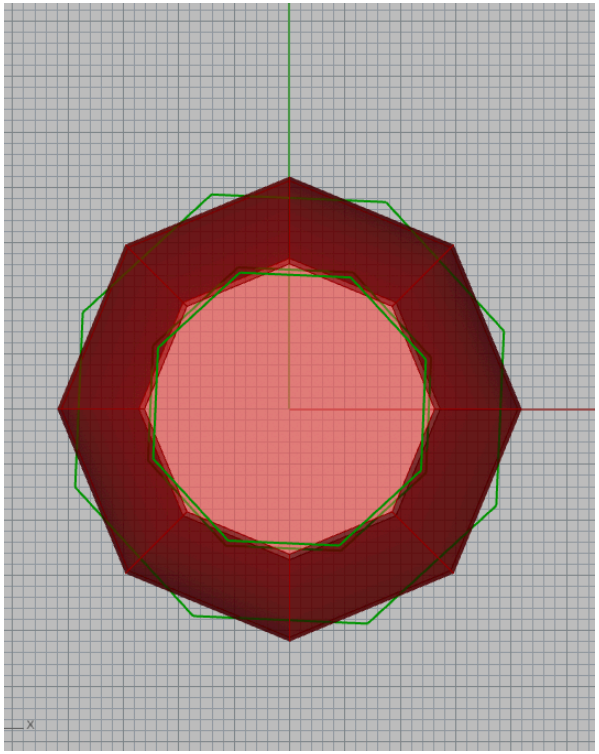
```
1 import rhinoscriptsyntax as rs
2 import Rhino.Geometry as geom
3 import math
4
5 def twist(curve, angle):
6     angle = math.radians(angle)
7     twist = geom.Transform.RotationZYX(angle, 0,0)
8     curve.Transform(twist)
9
```

Transformations, process

- Create a transformation using geom.Transform.RotationZYX() or other method. This returns a transformation matrix.
- Apply the returned matrix to your geometry. ie: curve.Transform(your_transformation)
- We'll create some simple translations, but you can also define your own transformation matrices and use them in the same way
- More info: https://developer.rhino3d.com/api/rhinocommon/rhino.geometry.transform

Apply the twist function to our polygons

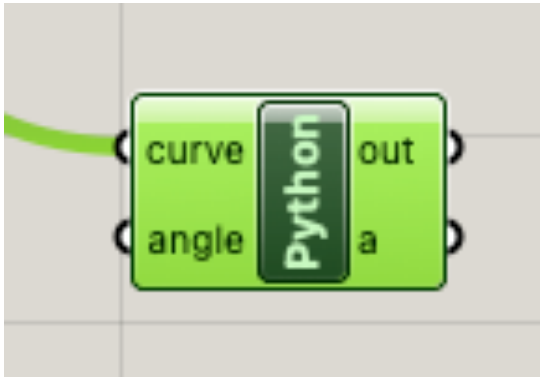
```
1 import rhinoscriptsyntax as rs
2 import Rhino.Geometry as geom
3 import math
4
5 def twist(curve, angle):
6     angle = math.radians(angle)
7     twist = geom.Transform.RotationZYX(angle, 0,0)
8     curve.Transform(twist)
9
10 twist(curve,20) # apply the transformation
11 a = curve   # the output is the (transformed) curve
```



green shows
rotated polygons

questions?

Add angle input variable



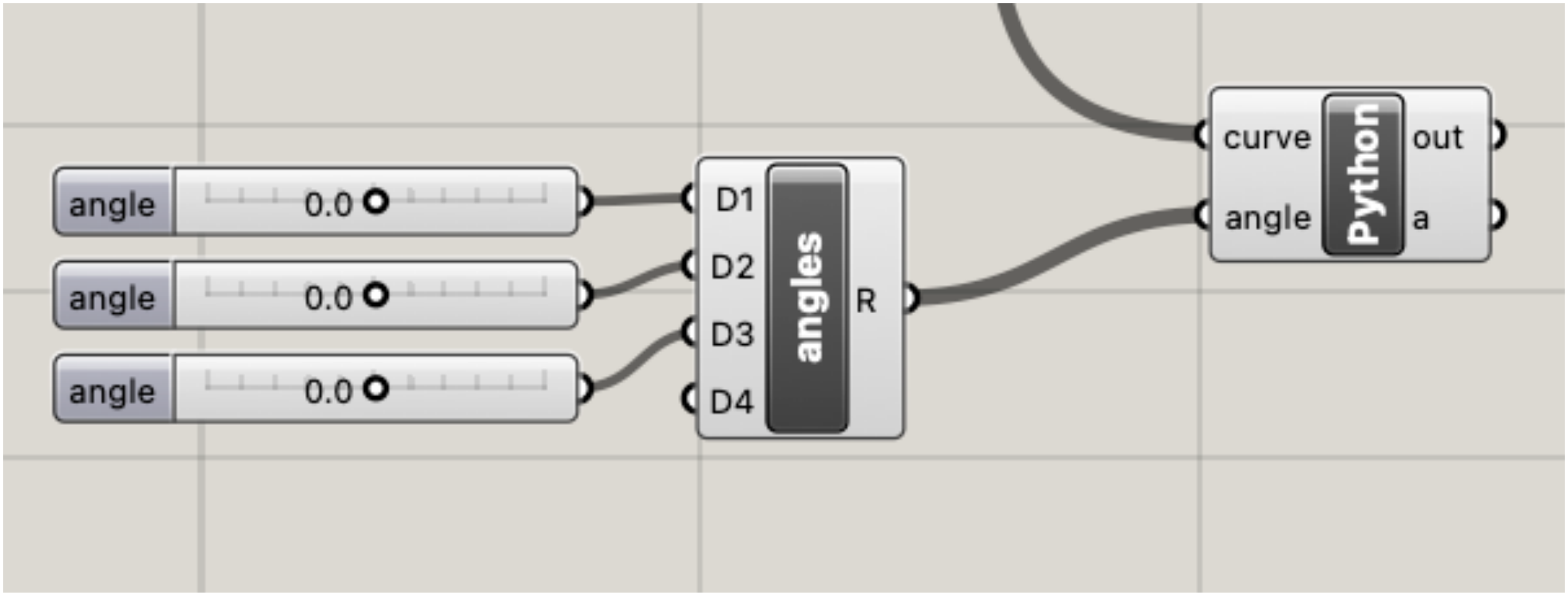

```python
import rhinoscriptsyntax as rs
import Rhino.Geometry as geom
import math

def twist(curve, angle):
    angle = math.radians(angle)
    twist = geom.Transform.RotationZYX(angle, 0,0)
    curve.Transform(twist)

twist(curve,angle) # apply the transformation to the curve
a = curve   # the output is the (transformed) curve
```

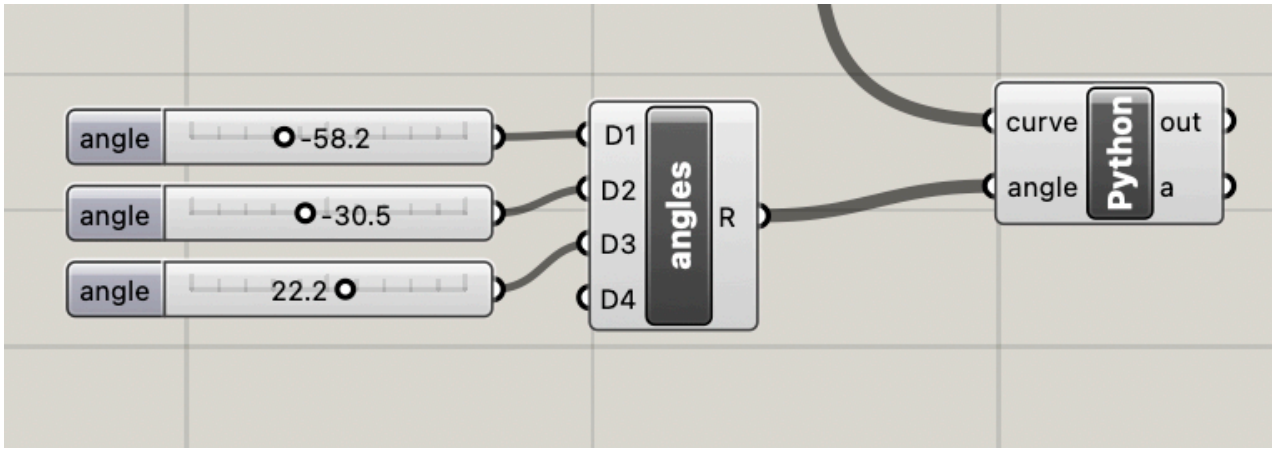
Type Hint: **float**

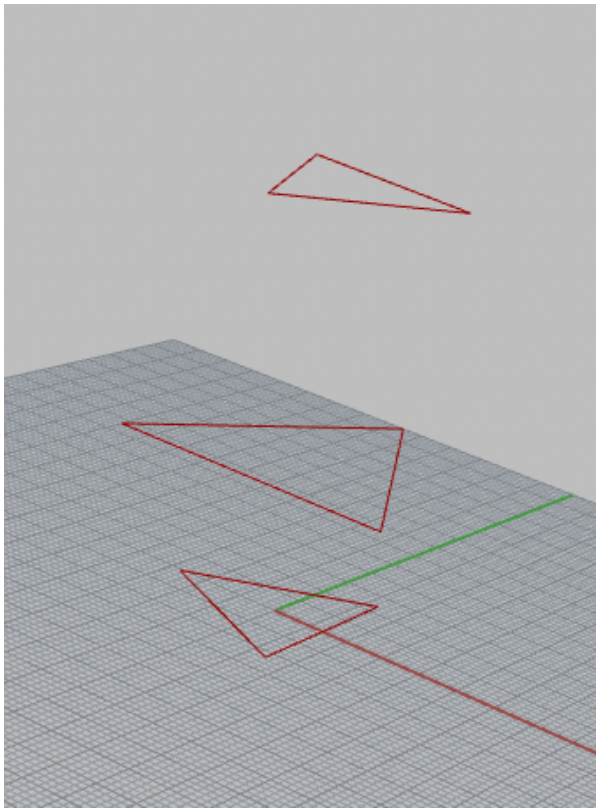
Add number sliders



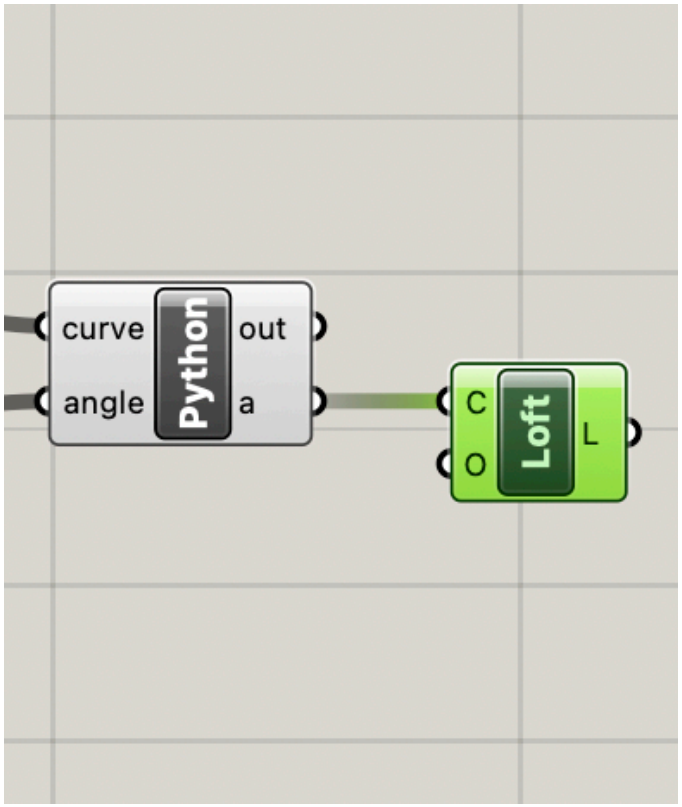
Range: -180 to 180

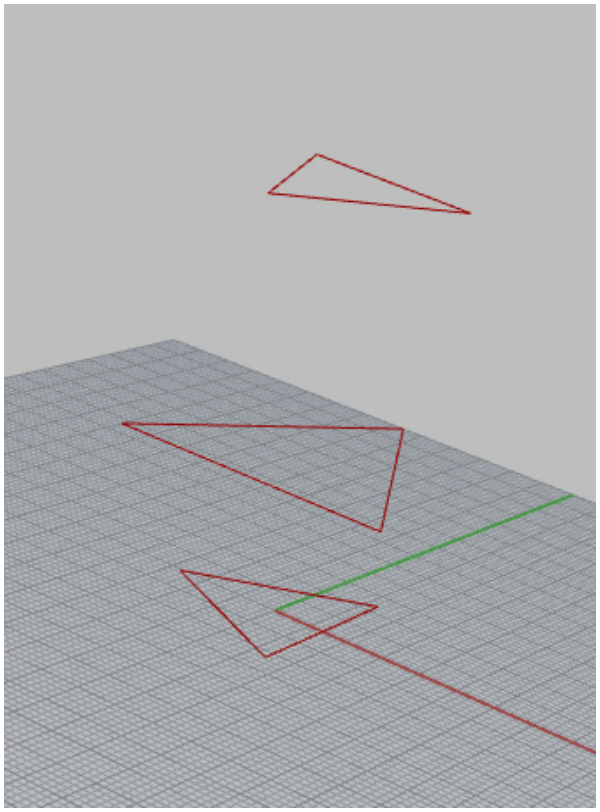
Can control the rotation of each polygon

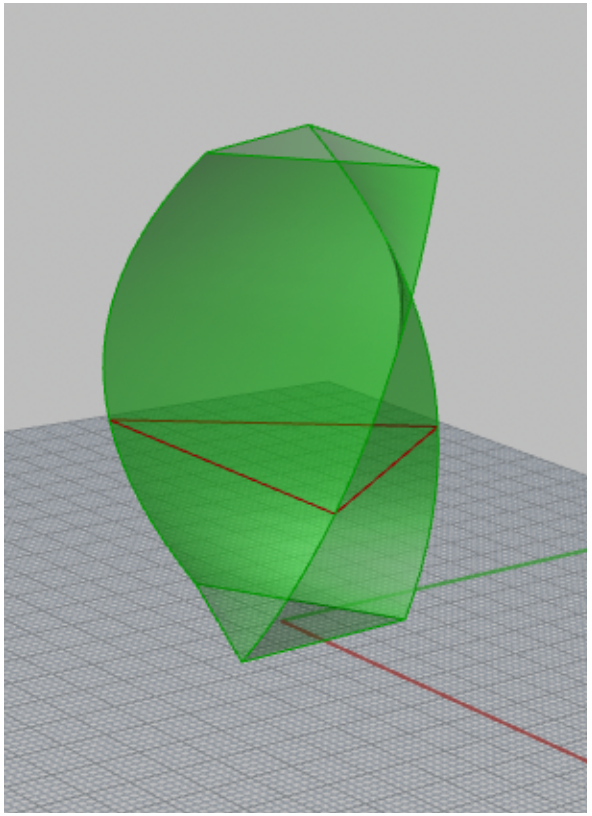




Loft ‘em



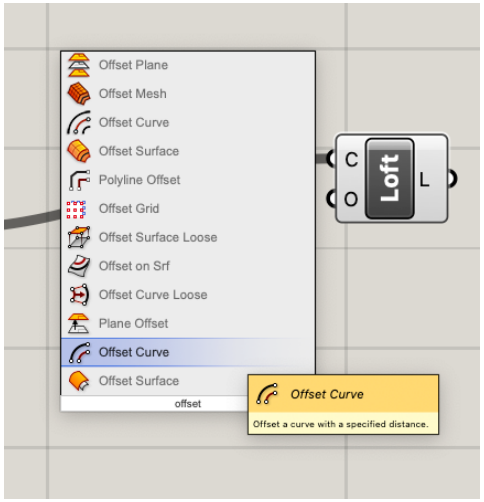




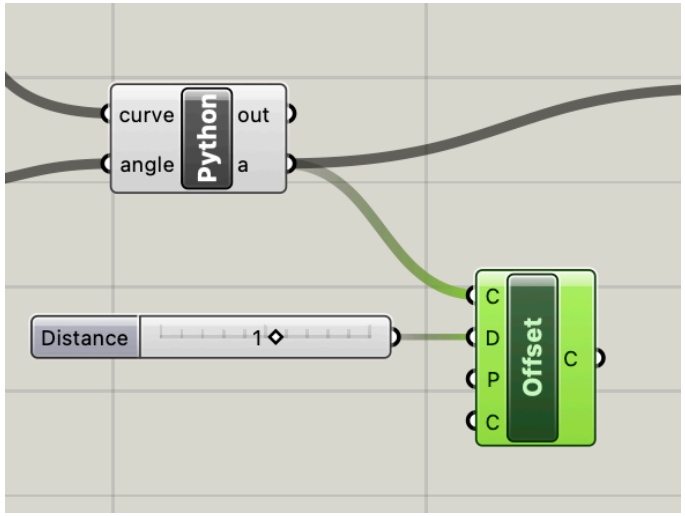
questions?

Making a solid vessel

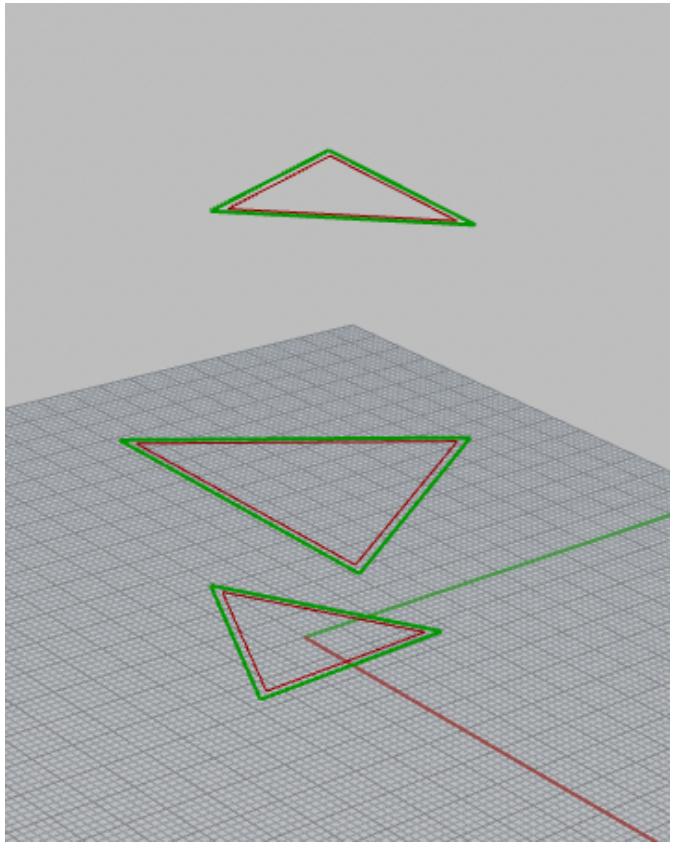
Create a set of **Offset Curves**



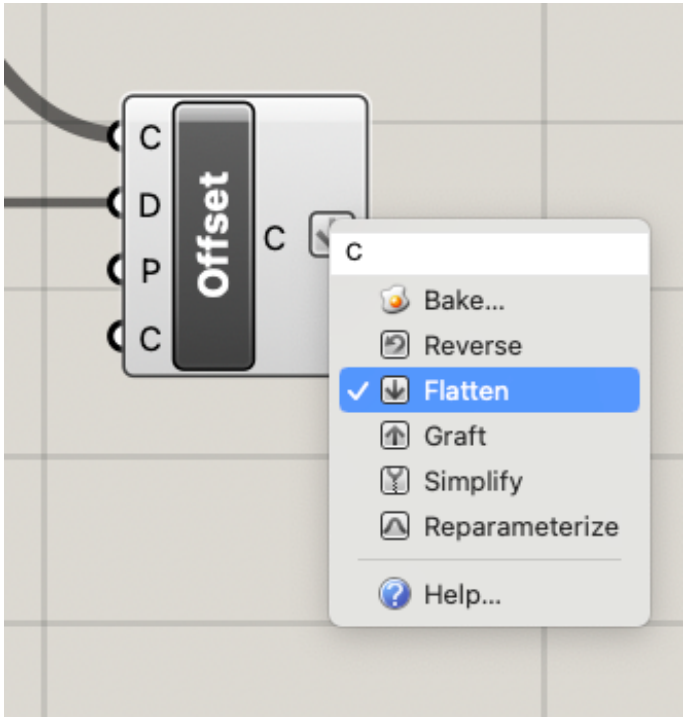
Offset Curve block



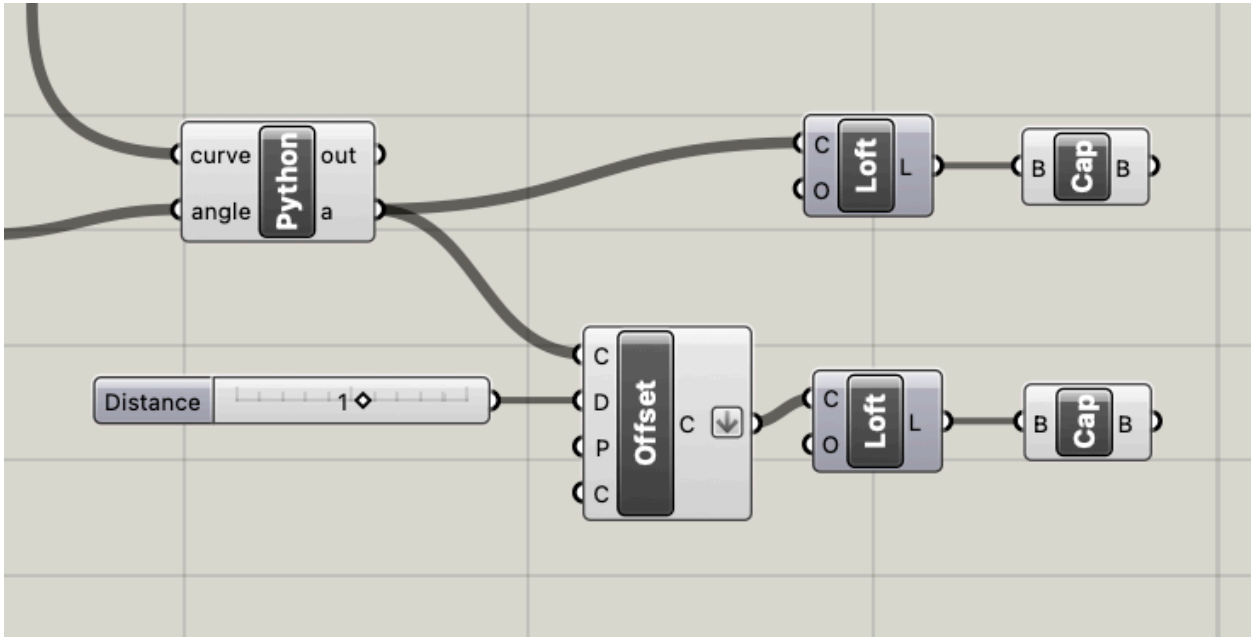
D = offset distance
+1 = 1mm outside
-1 = 1mm inside



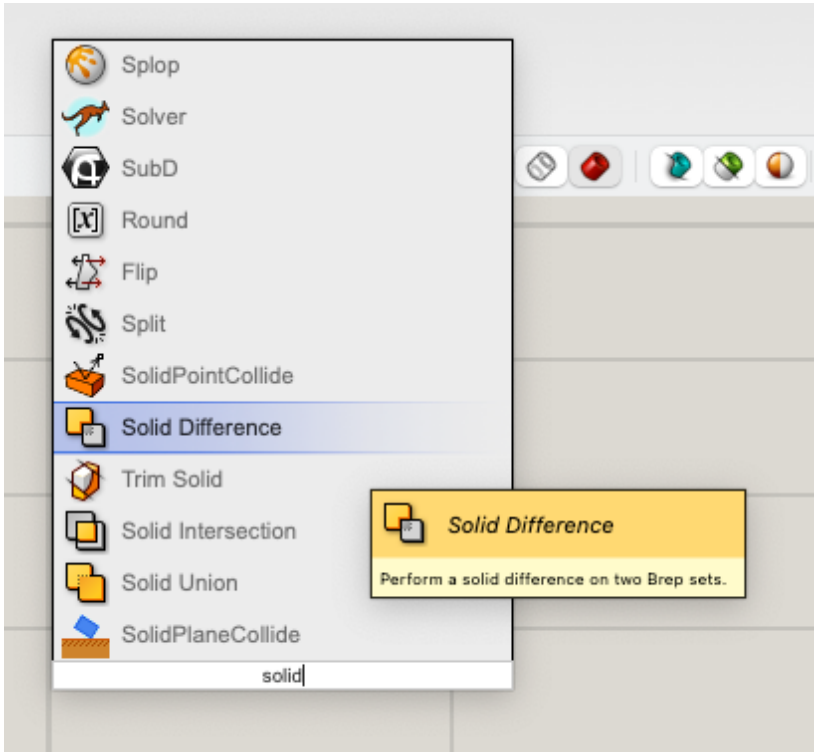
Loft and cap both sets of curves

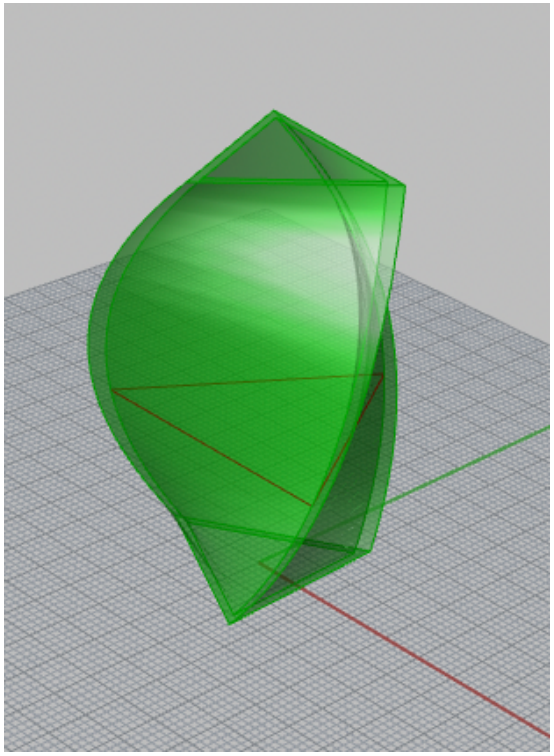


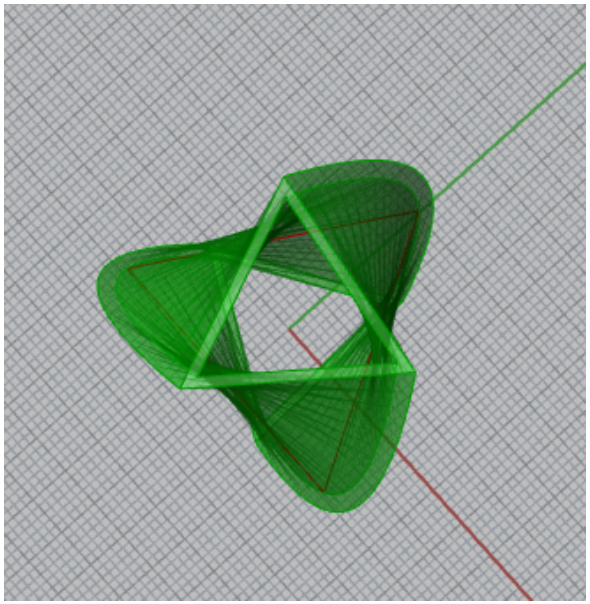
First, Flatten output from Offset Curve



Subtract inside object from outside



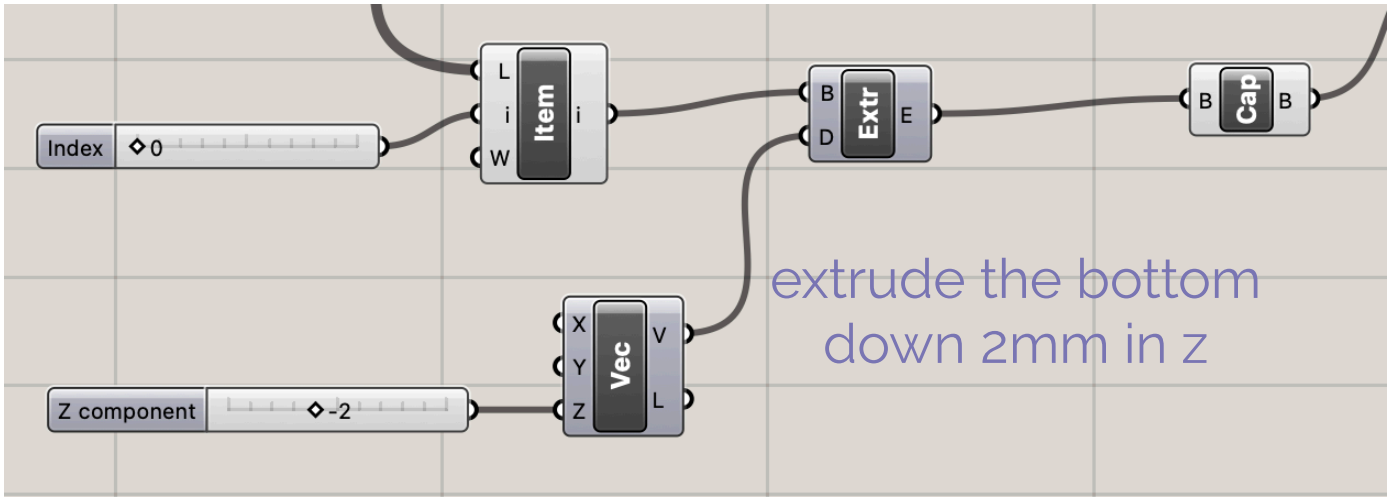




Add a bottom

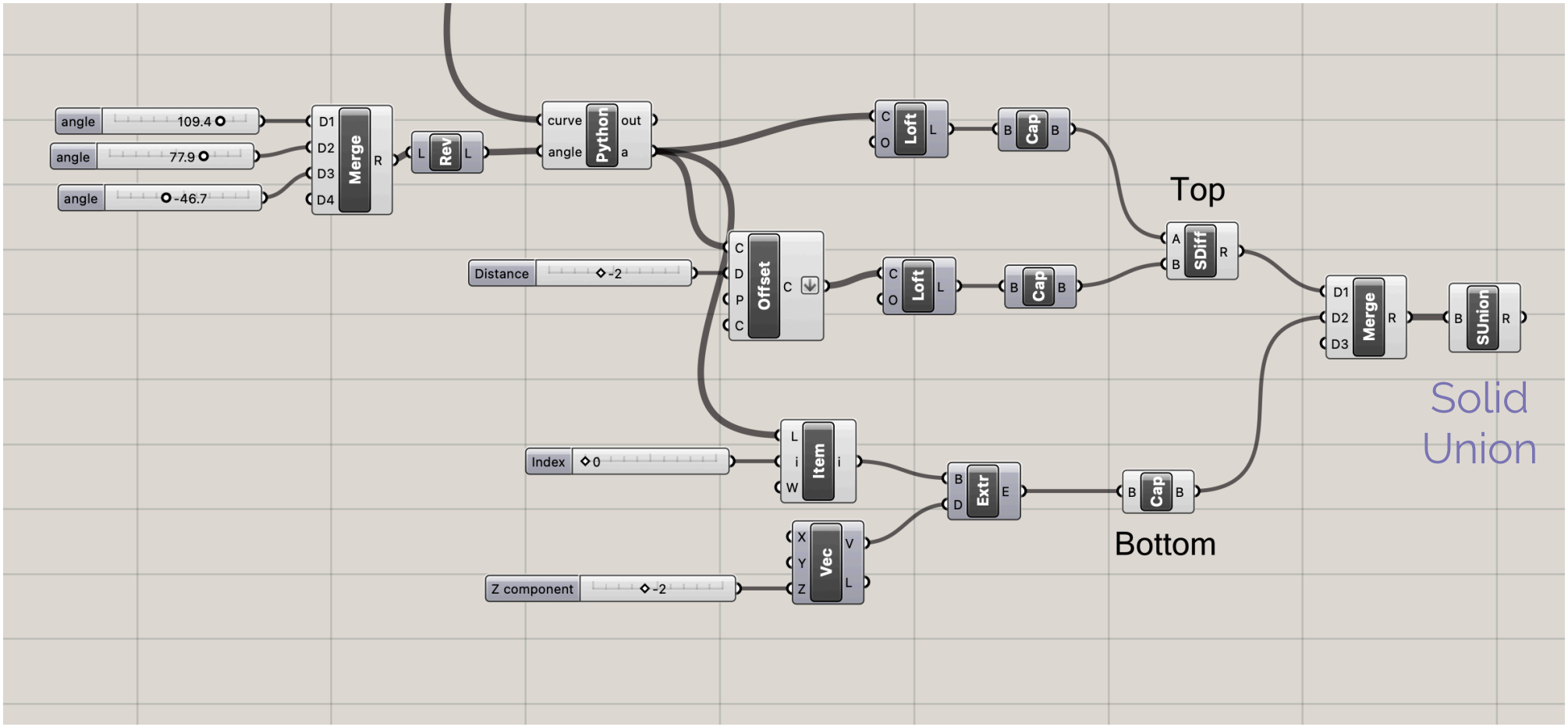
get the bottom polygon from the a output list

cap the extrusion to generate a solid

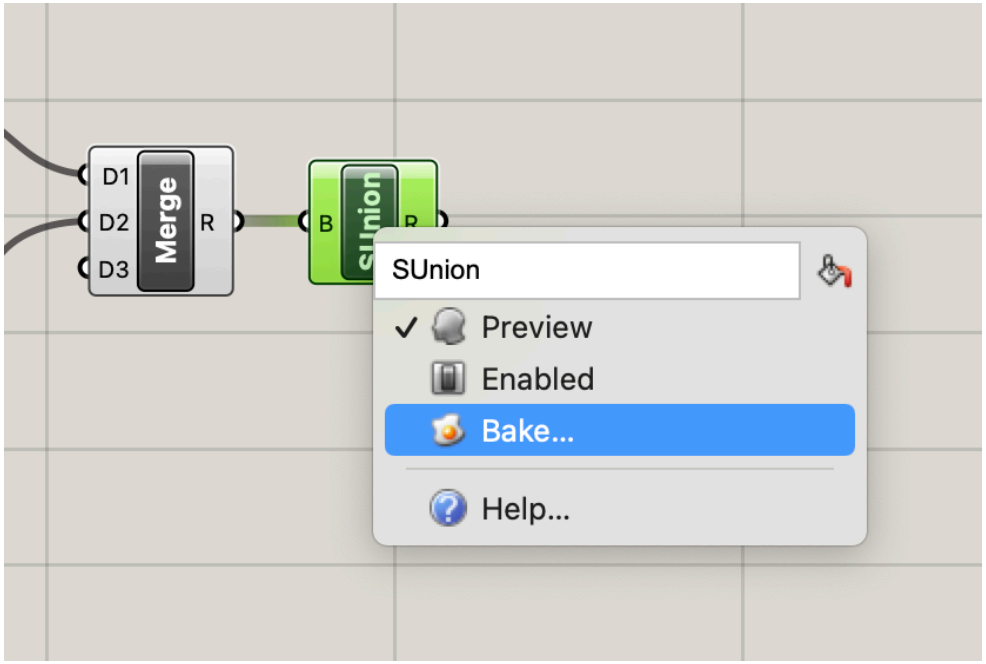


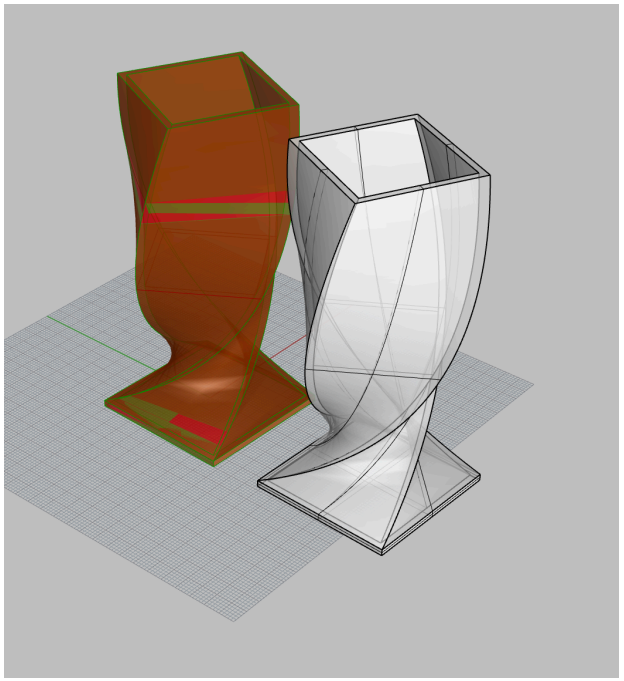
extrude the bottom down 2mm in z

Union the top and bottom



Bake



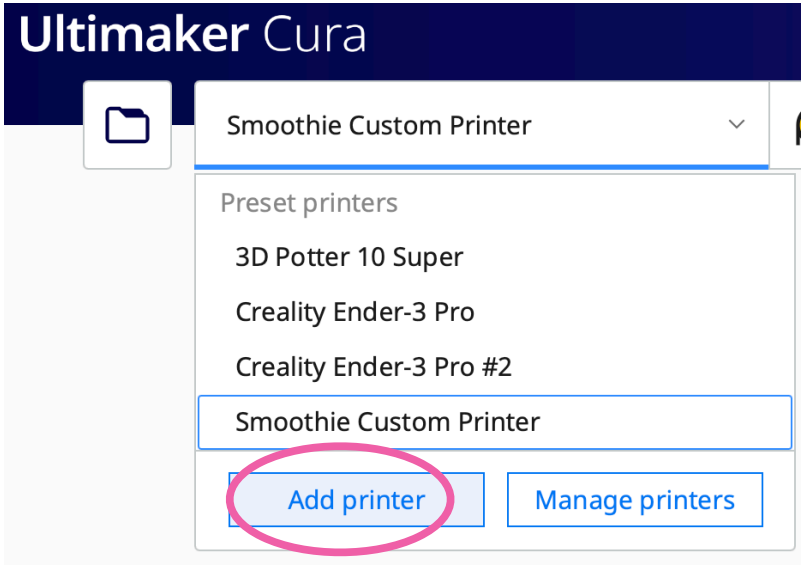


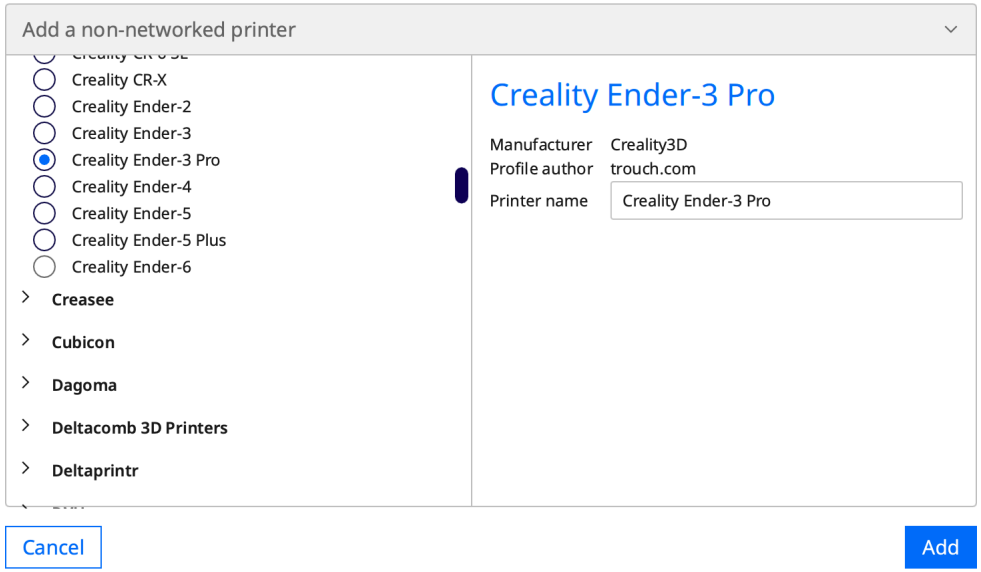
Export a .stl from Rhino

- File —> Export
- Choose .STL (Stereolithography) as the file format
- Choose at least .01 as the resolution for your export
- Make a note of where you saved the file.

Open up Cura

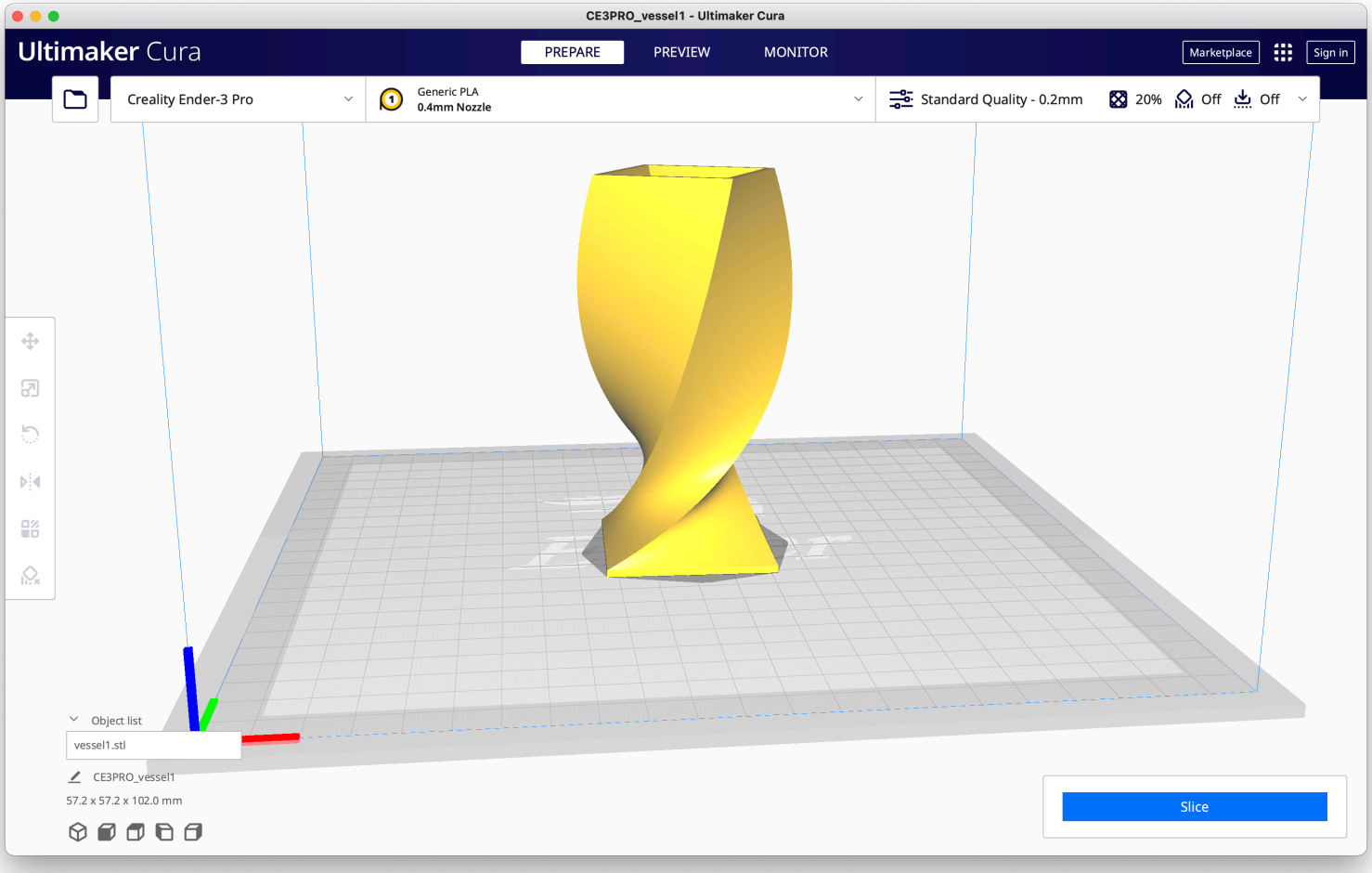
Add Your Printer in Cura





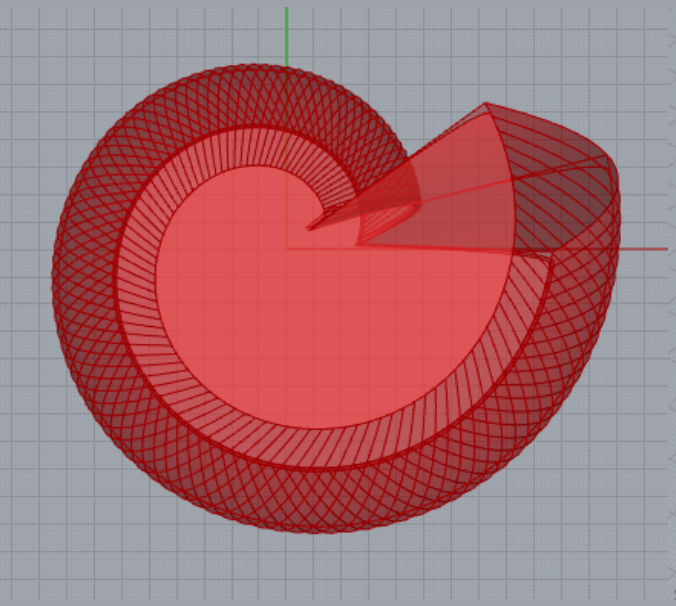
Choose the (default) Ender 3D Pro settings for Generic PLA material

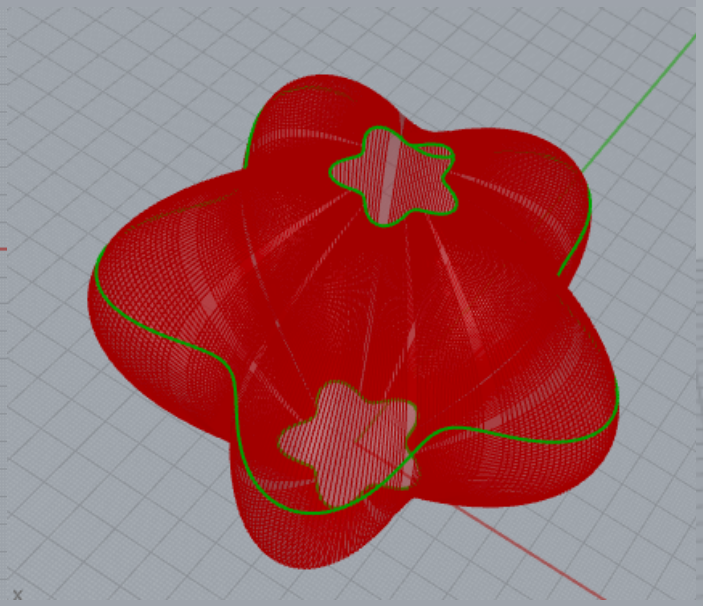
Import .stl into Cura

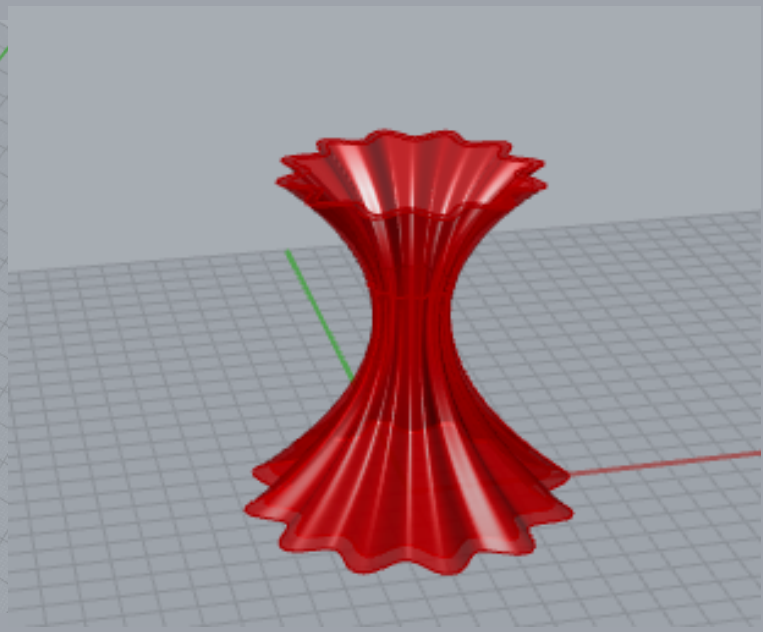


Slice and Print!

Explore more interesting surfaces: r = f(angle)







Thank you!

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