

**If you can code,
you can CAD!**

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Agenda

- The CAD Landscape
- Parametric Design
- OpenSCAD
- Model to Physical Thing
- Q&A

About me

- I work for Amazon
 - This talk has nothing to do with my work
 - Talk to me at the Amazon booth about Linux
- Coding for a long time
- CAD for slightly less time
- Picked up 3D printing at the start of the pandemic



The CAD Landscape

Popular CAD Software

- Autodesk Fusion360
- Dassault Systèmes SolidWorks
- Trimble SketchUp
- Autodesk TinkerCAD
- FreeCAD / LGPL-2.0-or-later / www.freecadweb.org
- OpenSCAD / GPL-2.0-or-later / openscad.org

Parametric Design

Parametric

of, or relating, to a parameter, mathematical, or statistical variable

Instead of *drawing* you're *specifying*

- Traditional CAD: A combination of clicking, placing, entering values.
- Parametric CAD: A full, or complete reliance, on specifying values and calculating positions.

The buttons are too close together

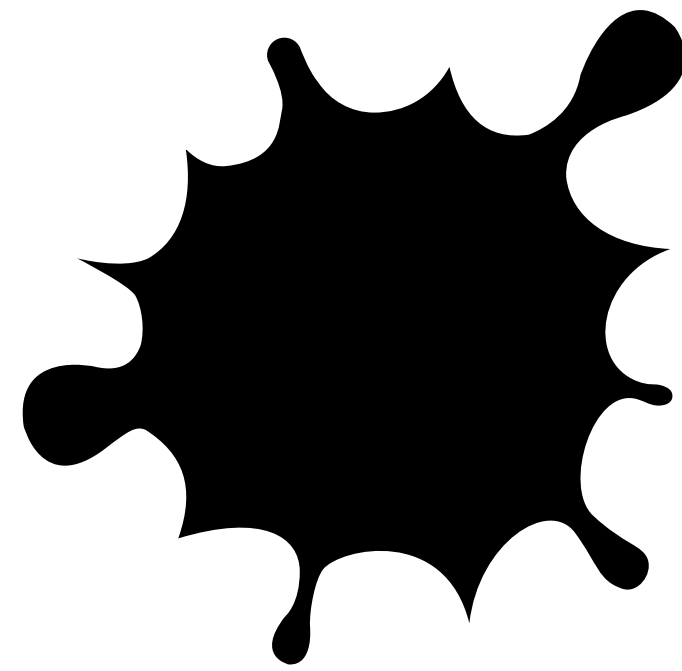
1. Click each button
2. Change the width of the button by dragging
3. Adjust the spacing between each button



1. Change the button spacing variable

Draw this organic shape

1. Use the mouse to set points



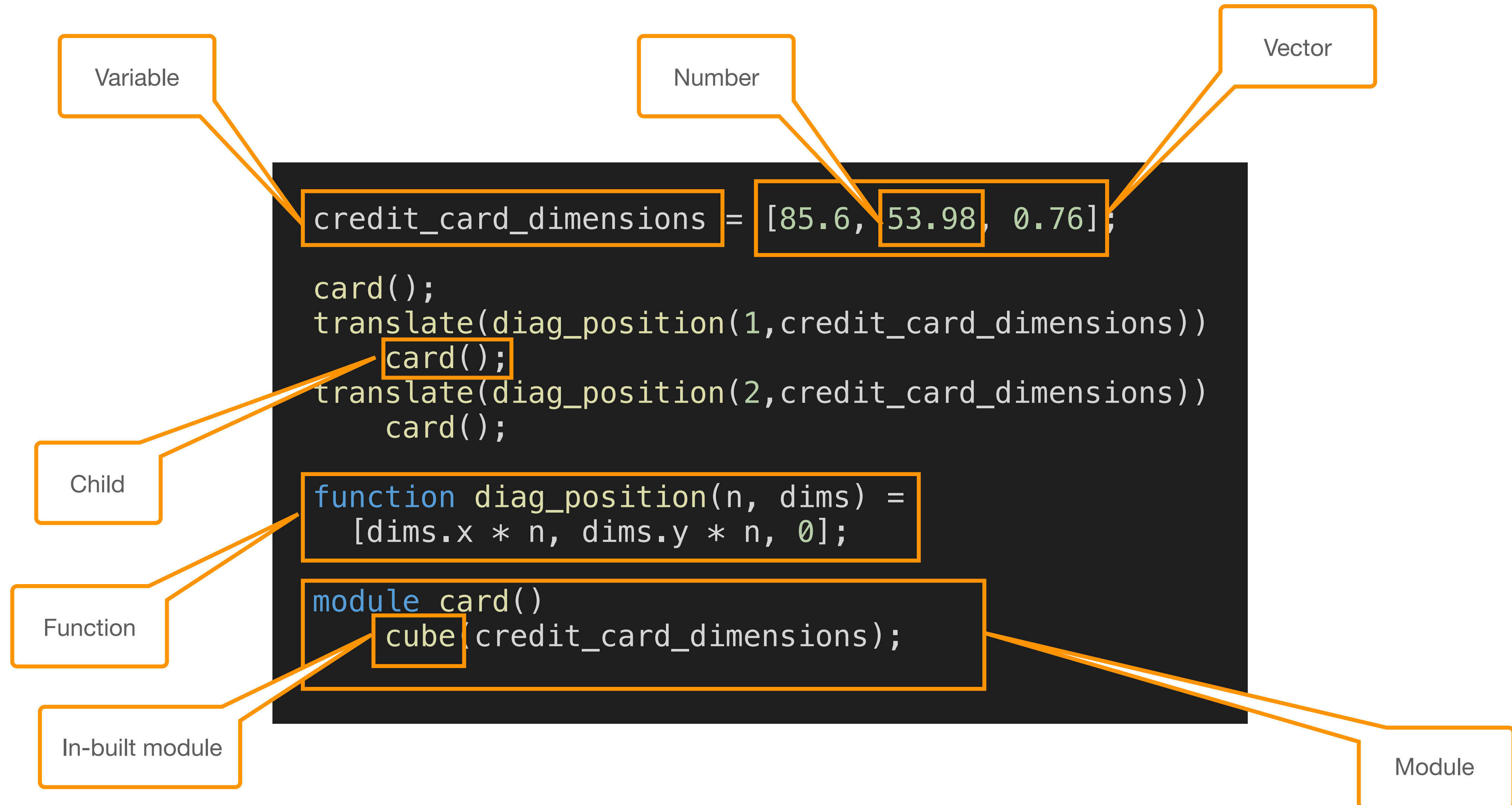
1. Plot hundreds of points
2. Compile
3. Repeat ∞ ***

OpenSCAD

Basic Concepts

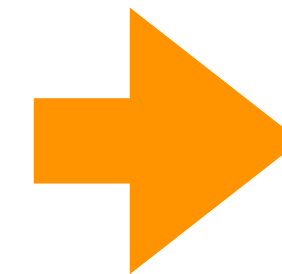
- Variables
 - Numbers, Booleans, Strings, Ranges, Vectors, and undef
- Functions
 - Take in parameters, returns values
- Modules
 - Draws in geometry
 - Has children, but returns nothing

Simple Example



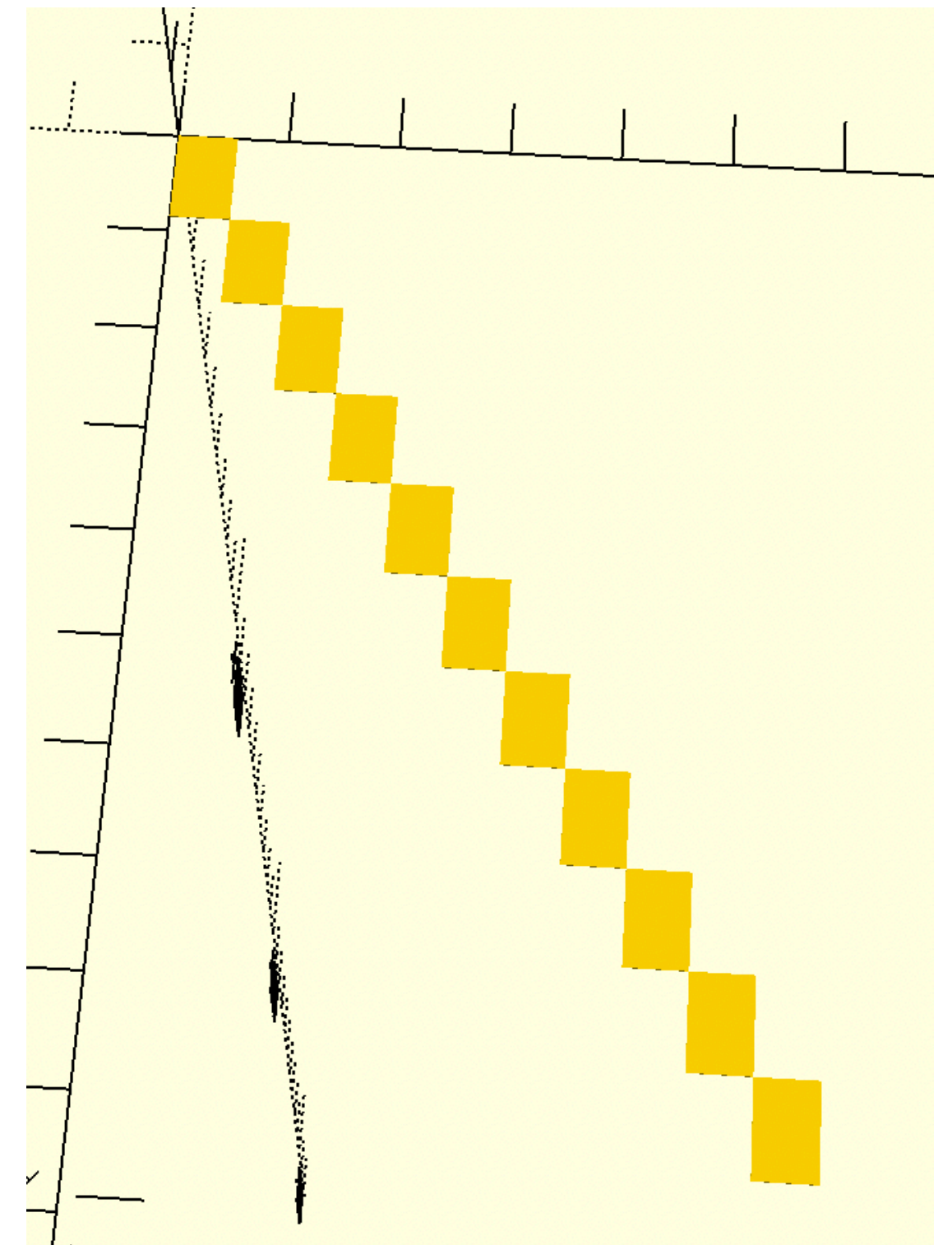
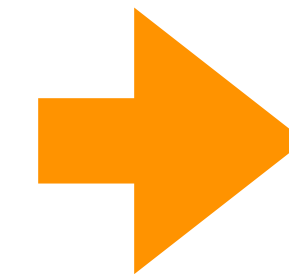
The Result

```
credit_card_dimensions = [85.6, 53.98, 0.76];  
  
card();  
translate(diag_position(1,credit_card_dimensions))  
    card();  
translate(diag_position(2,credit_card_dimensions))  
    card();  
  
function diag_position(n, dims) =  
    [dims.x * n, dims.y * n, 0];  
  
module card()  
    cube(credit_card_dimensions);
```



Iteration

```
credit_card_dimensions = [85.6, 53.98, 0.76];  
card();  
  
for (i = [1:1:10])  
    translate(diag_position(i,credit_card_dimensions))  
    card();  
  
function diag_position(n, dims) =  
    [dims.x * n, dims.y * n, 0];  
  
module card()  
    cube(credit_card_dimensions);
```

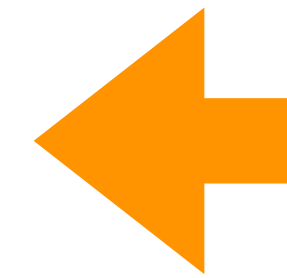
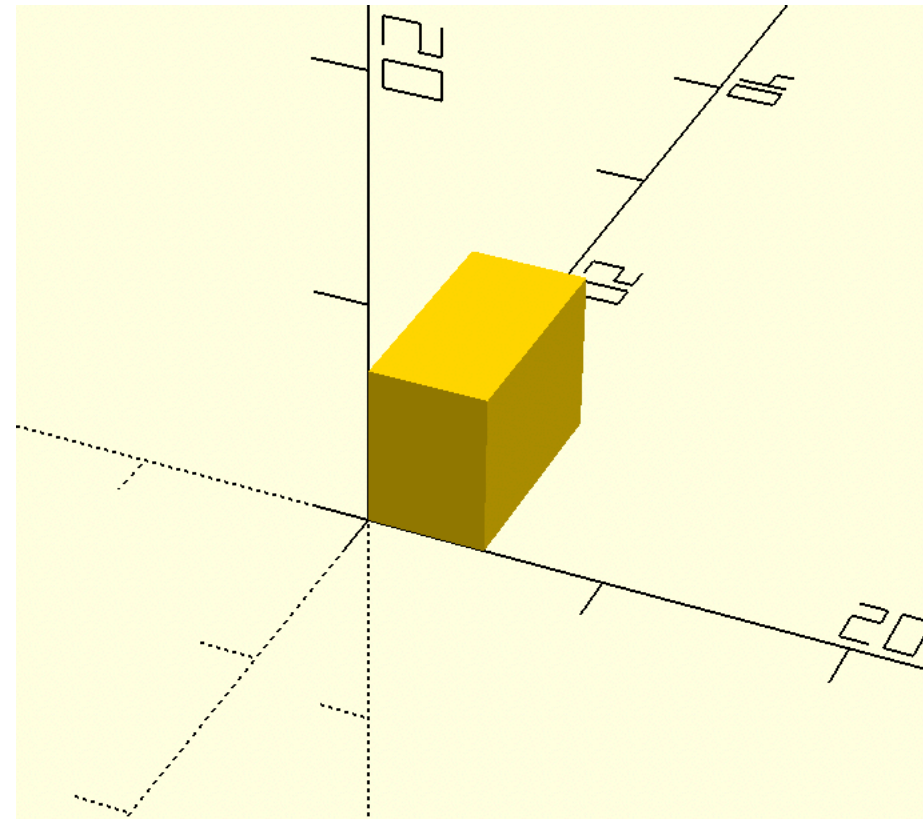
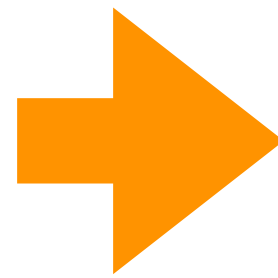


Two Dimensions	Three Dimensions
Circle	Sphere / Cylinder
Square	Cube
Polygon	Polyhedron
Imported Geometry (DXF/SVG for 2D, STL/OFF/AMF/3MF for 3D)	
→	Linear Extrude
→	Rotate Extrude

2D vs 3D

Cube Example

```
dimensions = [5, 10];  
height = 7;  
  
linear_extrude(height)  
  square(dimensions);
```

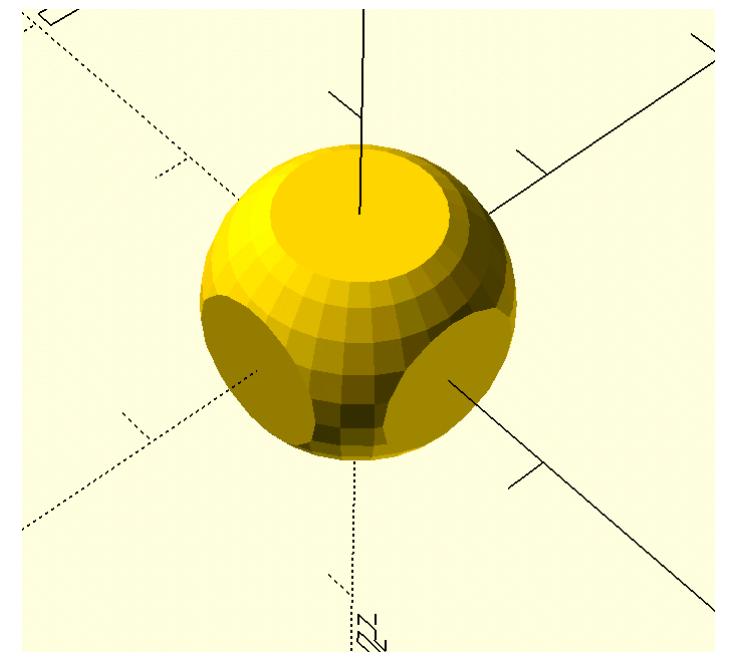


```
dimensions = [5, 10, 7];  
  
cube(dimensions);
```

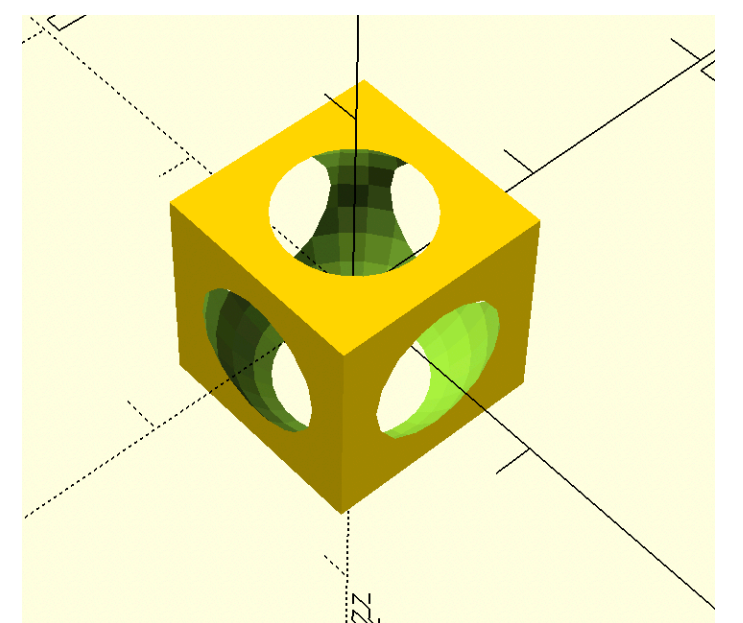
Geometric Booleans

```
$fn = 30;  
dimensions = [10,10,10];  
sphere_diameter_multiple = 1.2;  
  
module my_cube()  
  cube(dimensions, center = true);  
module my_sphere()  
  sphere(d= dimensions.x * 1.2);
```

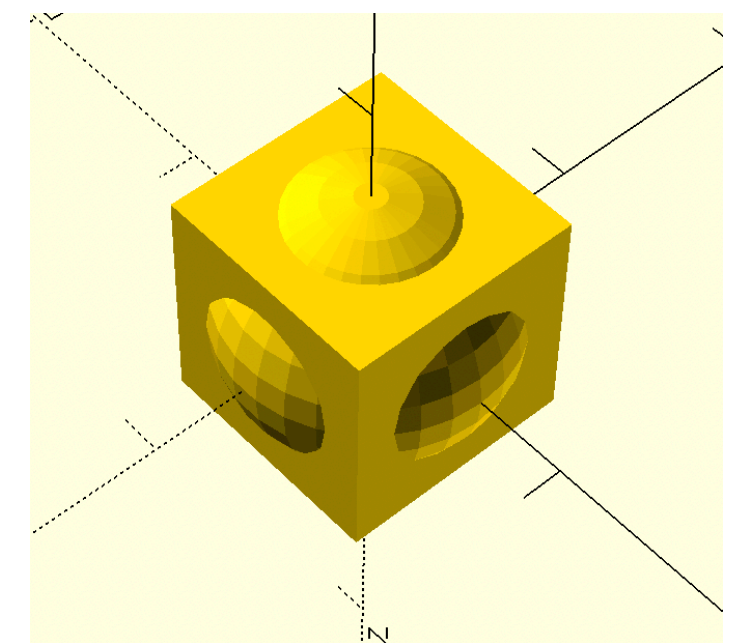
```
intersection() {  
  my_cube();  
  my_sphere();  
}
```



```
difference() {  
  my_cube();  
  my_sphere();  
}
```



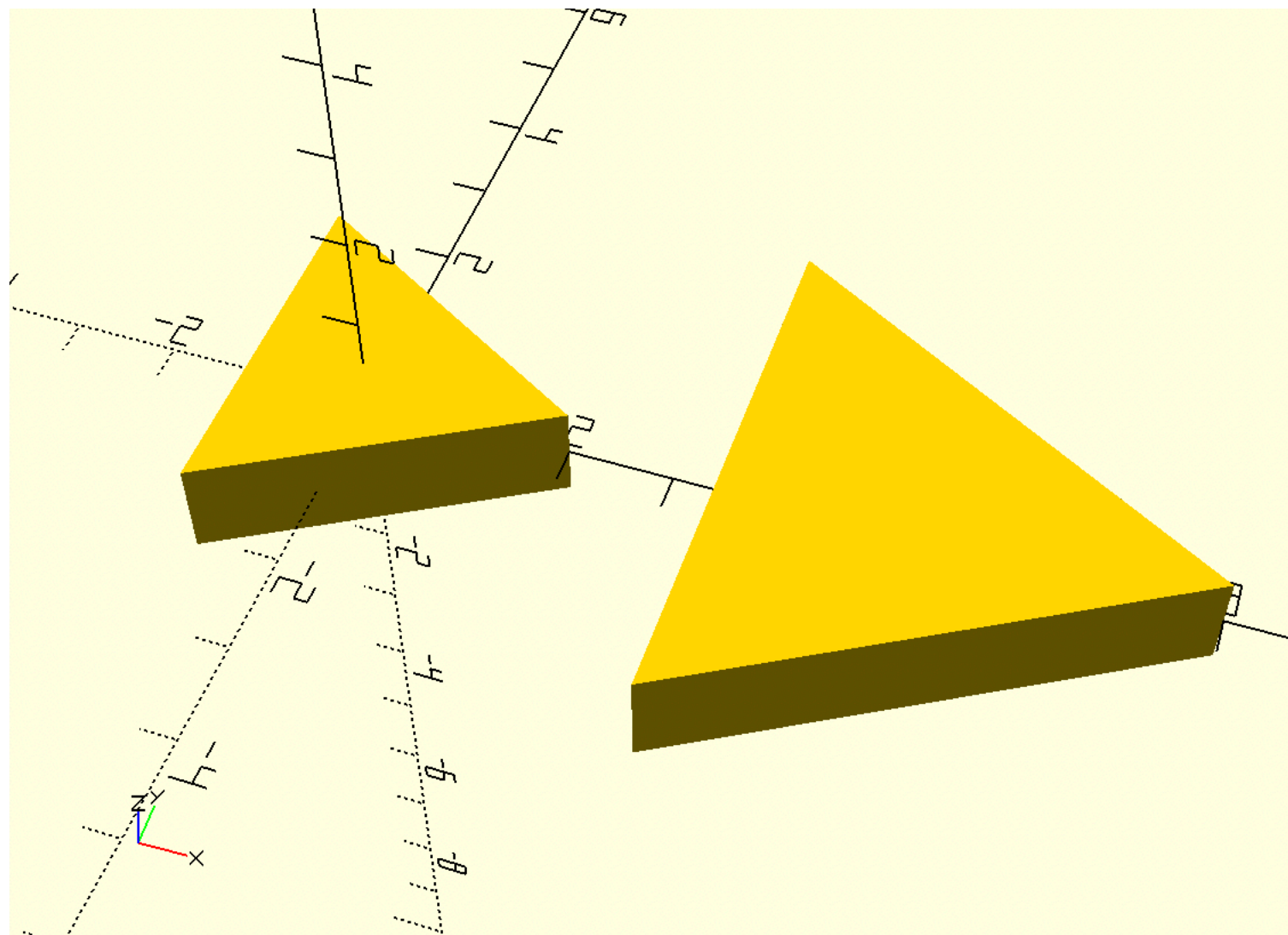
```
union() {  
  my_cube();  
  my_sphere();  
}
```



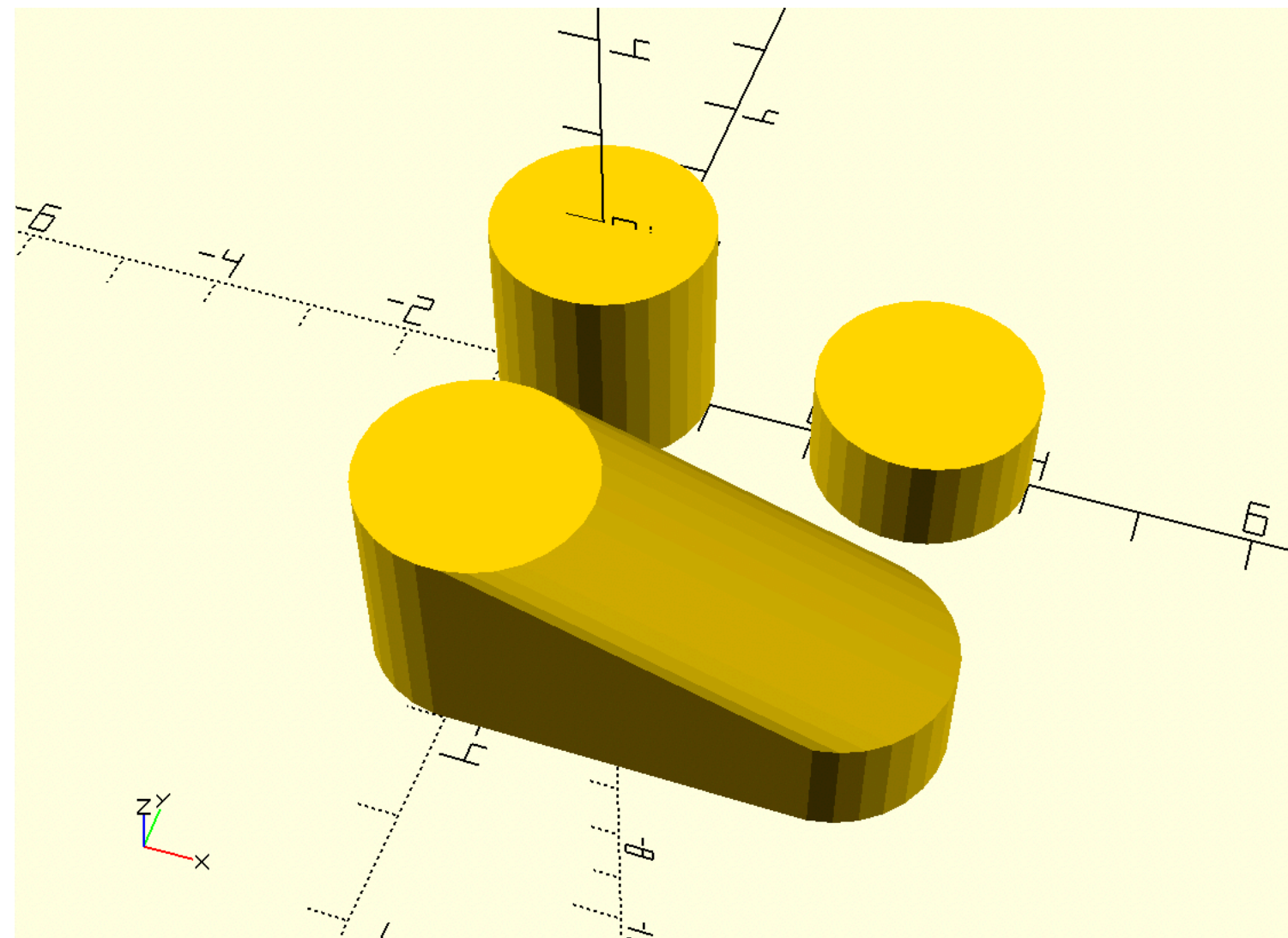
Move and alter

- Translate
- Rotate / Scale / Resize / Mirror / Multitmatrix
- Color

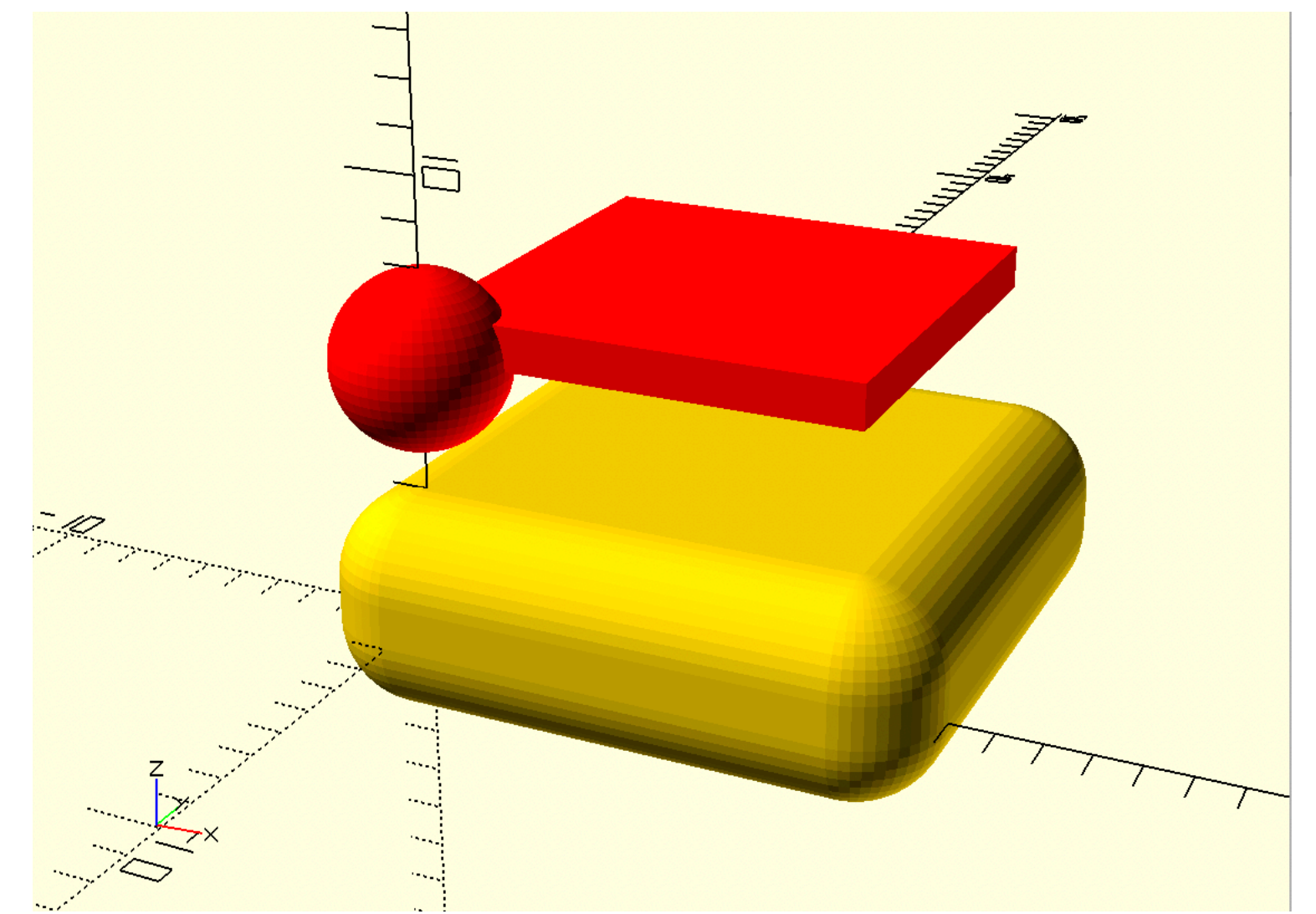
Changing Shapes



Offset



Hull



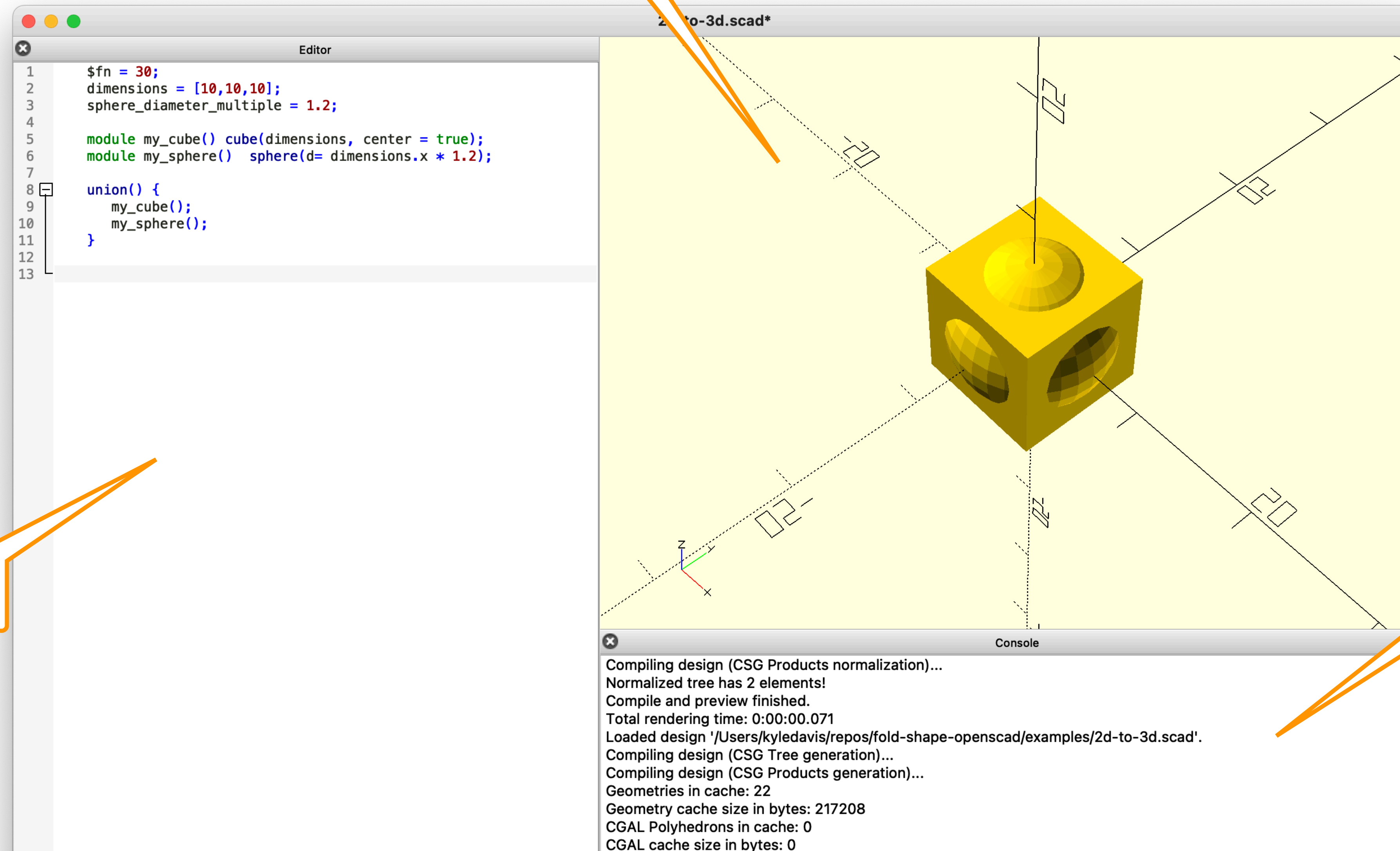
Minkowski

Built-in IDE

Viewer

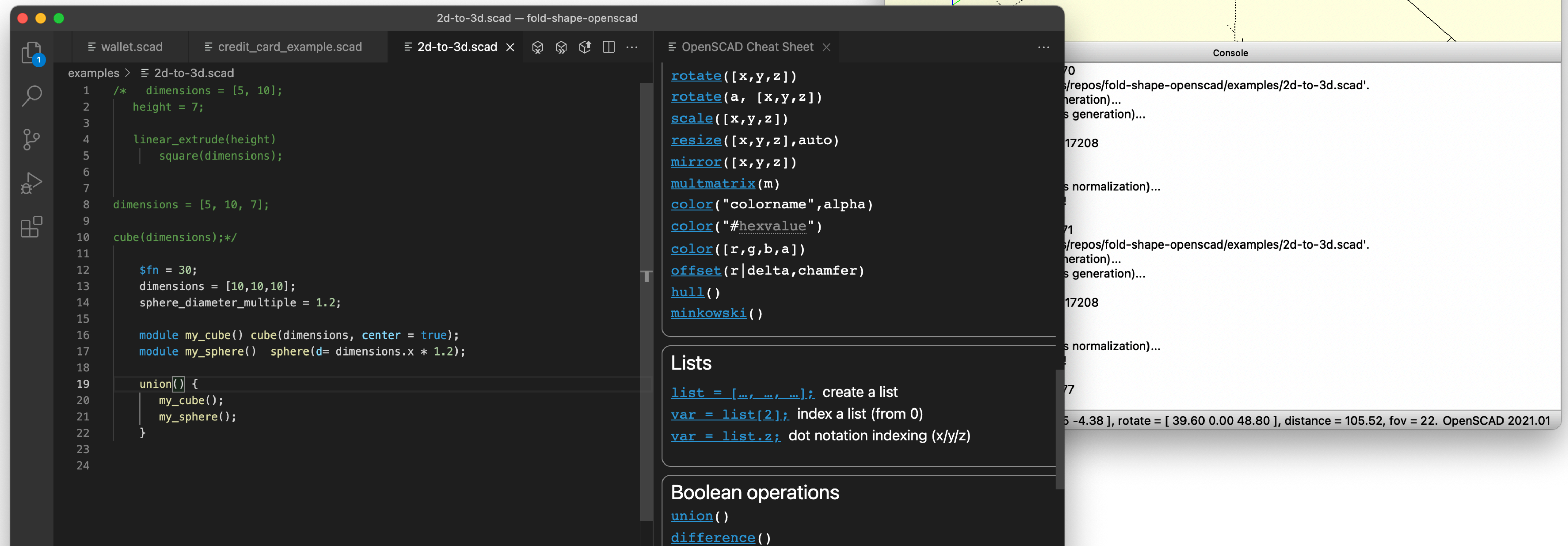
Code Editor

Console



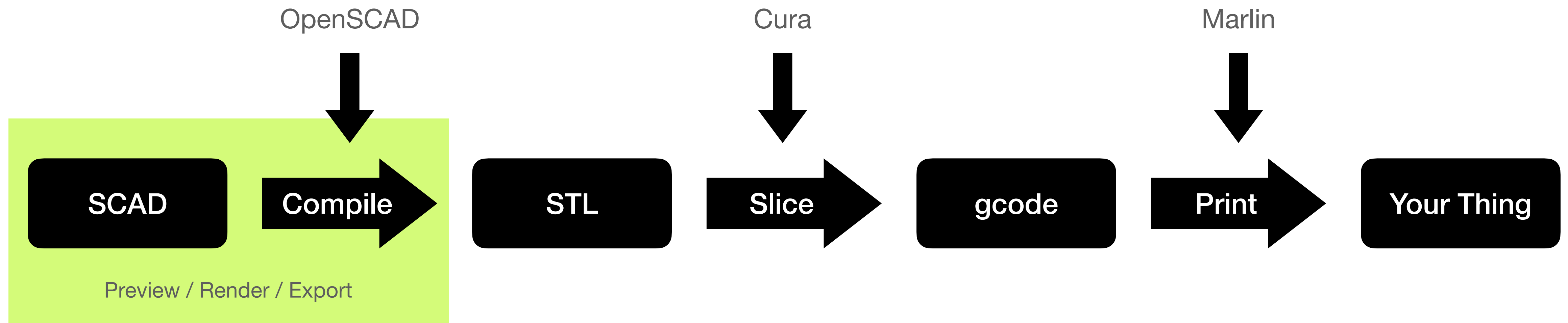
Using VS Code

With OpenSCAD for VS Code Plugin



Model to Physical Thing

Process overview



Slicing

Triangles to motion

- STL
- Object into layers
- Each layer into lines
- Specific to your printer
- Results in gcode (RS-274)
- Tools
 - Cura / LGPLv3 / github.com/Ultimaker/Cura
 - Slic3r & PrusaSlicer / SuperSlicer / AGPL-3.0 / github.com/prusa3d/PrusaSlicer

Gcode to printer

- Save gcode from slicer
- Good: Put gcode on a (micro) SD card and print from LCD
- Better: Use Octoprint (<https://octoprint.org>)
 - Written in Python
 - AGPL-3.0
 - Usually on a Raspberry Pi and connected to print via USB
 - Lots of great plugins - webcam, bed level, etc.

Printing

- Every printer has a “main board”
- Usually: 8 or 32 bit microcontroller
- Converts gcode to movement of motors / fans / accessories
- Firmware:
 - Marlin / GPLv3 / marlinfw.org
 - RepRap / GPLv3 / www.reprapfirmware.org
 - Klipper / GPLv3 / www.klipper3d.org

Q&A

Thank you!

Connect with me:

@stockholmux (Twitter & Github)

On Printables:

printables.com/social/260544-kyle