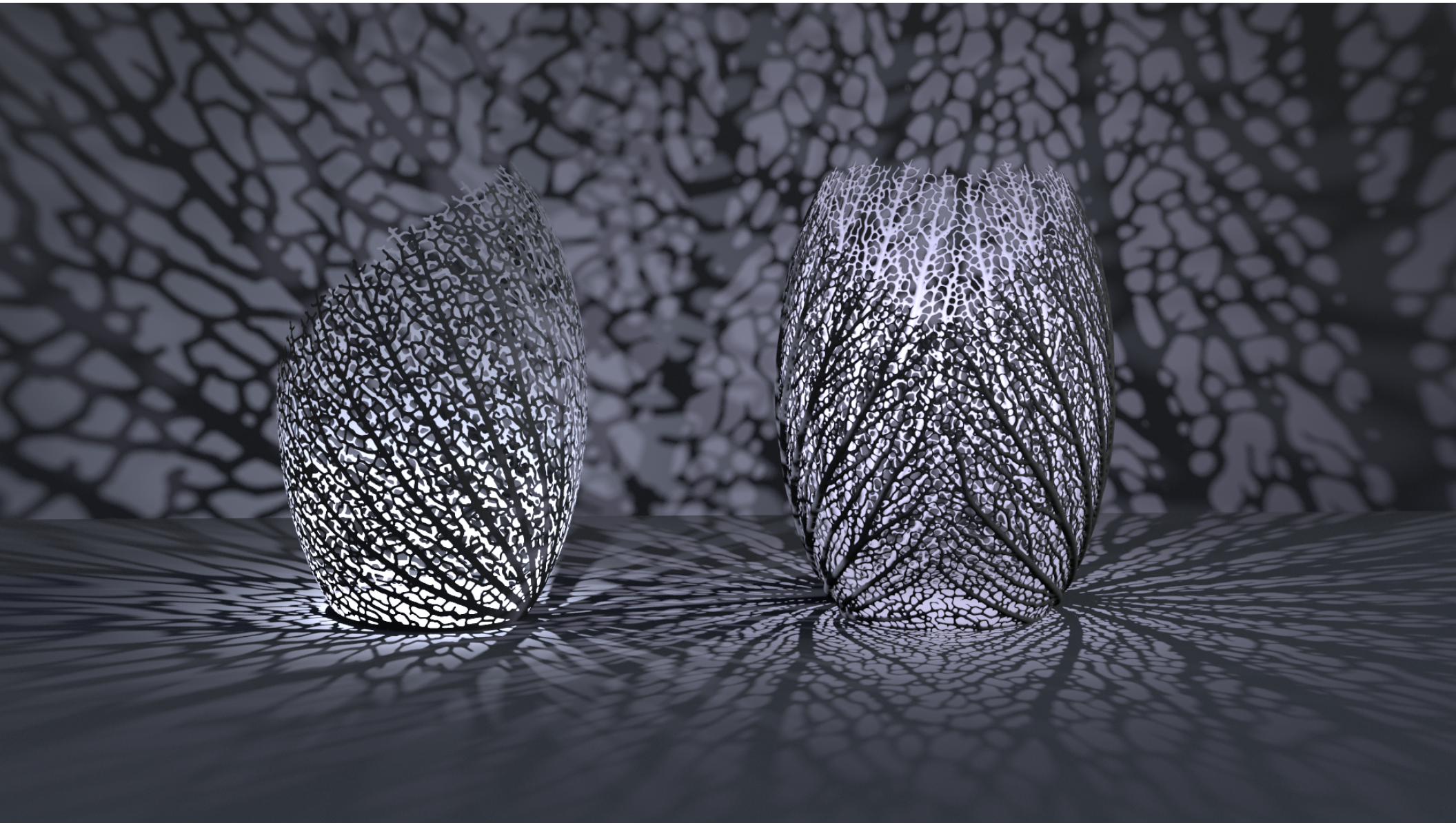
Computational Fabrication

CS 491 and 591
Professor: Leah Buechley
https://handandmachine.cs.unm.edu/classes/Computational_Fabrication_Spring2021/

Weekly Designer: Nervous System

https://n-e-r-v-o-u-s.com/index.php



Nervous System

Assignment 3
Due a week from today

grades by the end of the week

questions?

Data Driven Design cont.

2D Data: Images & Maps

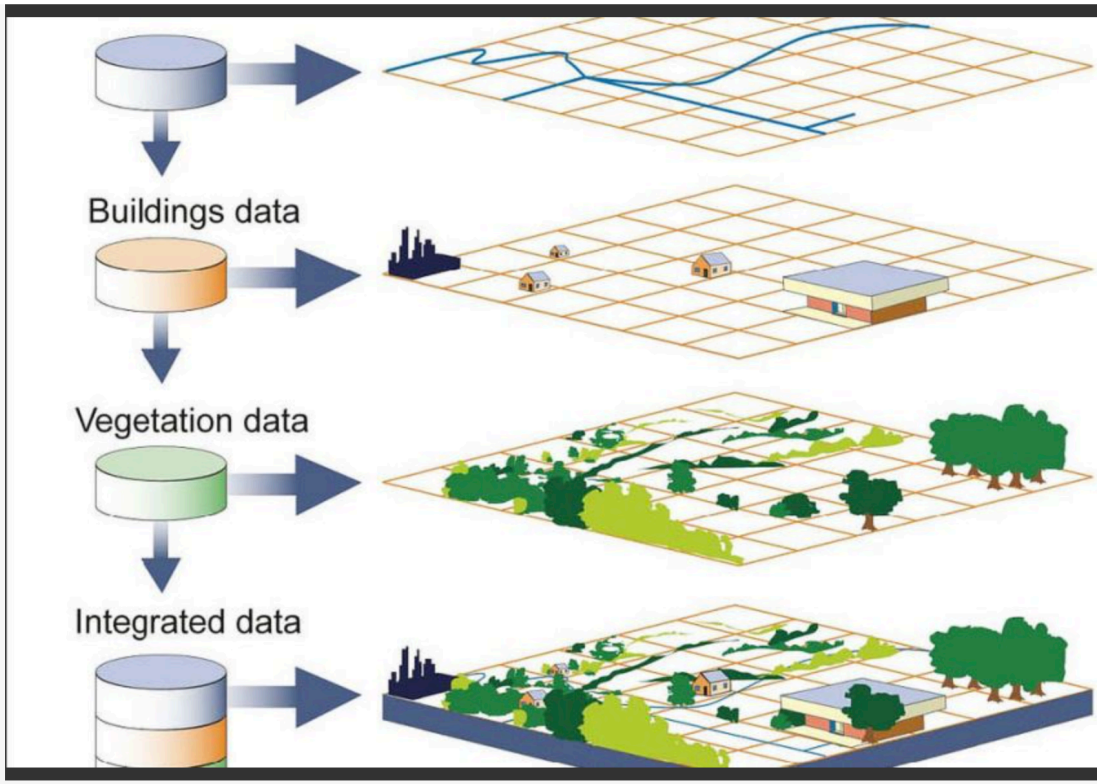
GIS, tip of the iceberg

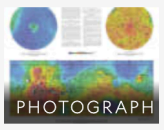
PHOTOGRAPH

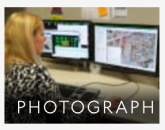
GIS

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can show many different kinds of data on one map, such as streets, buildings, and vegetation. This enables people to more easily see, analyze, and understand patterns and relationships.

ILLUSTRATION COURTESY OF U.S. GOVERNMENT ACCOUNTABILITY OFFICE







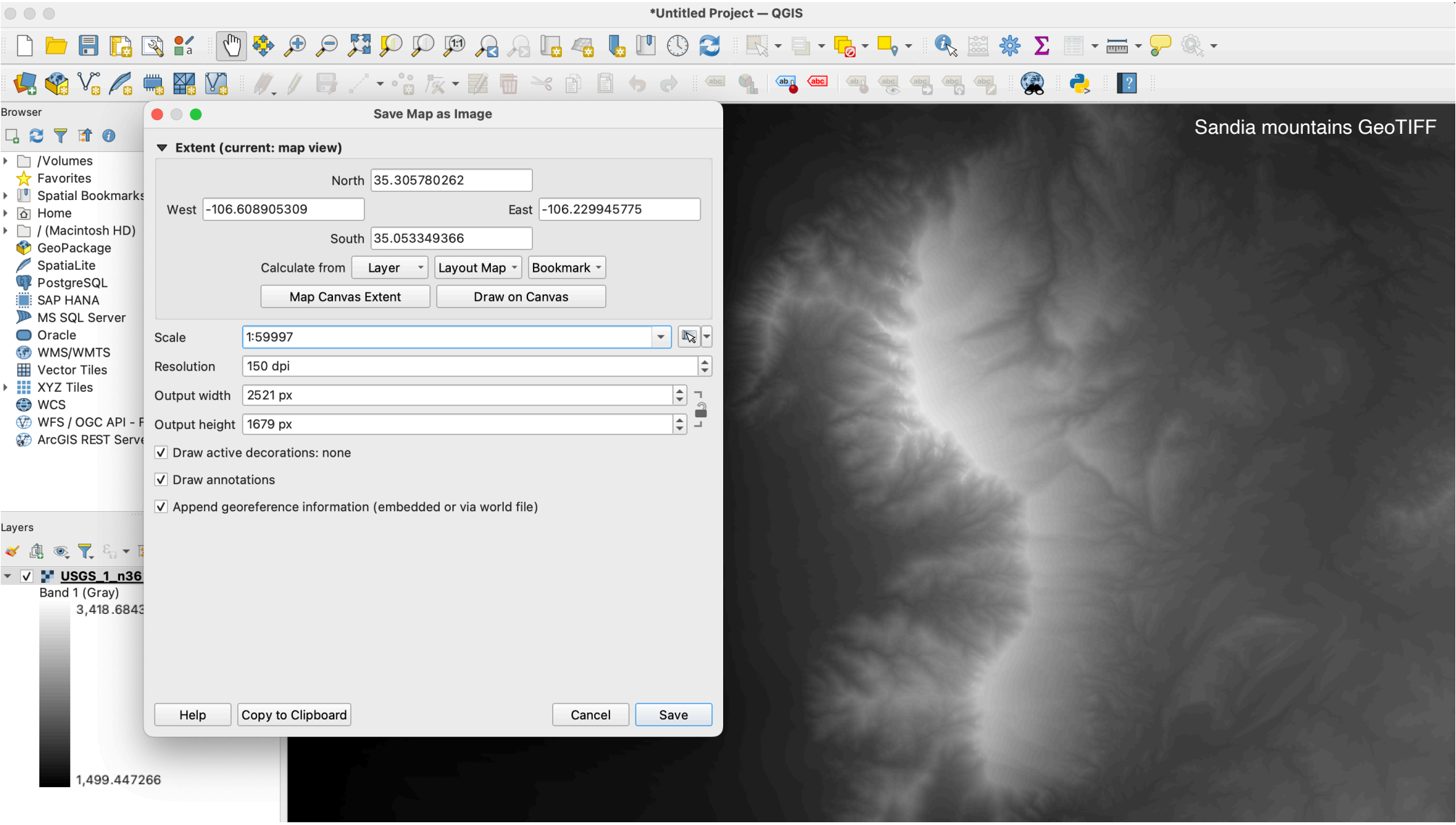
GIS, tip of the iceberg

- GIS = Geographic Information System
  Data may include:
  - GPS locations
  - 3D models of buildings and other structures
  - Environmental data
  - Topographical/elevation data
  - etc.

- Tons of available open data: https://apps.nationalmap.gov/
- Open source GIS software, QGIS: https://www.qgis.org/en/site/

Example Workflow

- Download a GeoTIFF from: https://apps.nationalmap.gov/
- Use QGIS to convert GeoTIFF to an image. Import the GeoTIFF as a new layer in a project. Then go to Project—>Export Map as Image to copy or save the image
- Use Photoshop to convert th3 image to a bitmap (.bmp or .pbm)
- Import bitmap into GH/Rhino to map pixel data to 3D printable geometry

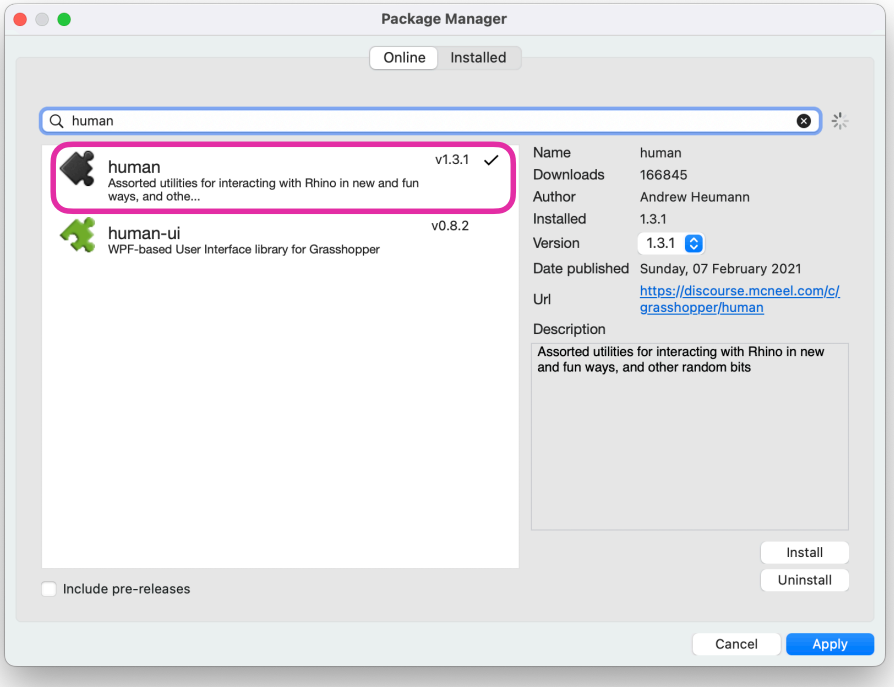

*Untitled Project — QGIS
Browser
/Volumes
Favorites
Spatial Bookmarks
Home
/ (Macintosh HD)
GeoPackage
SpatiaLite
PostgreSQL
SAP HANA
MS SQL Server
Oracle
WMS/WMTS
Vector Tiles
XYZ Tiles
WCS
WFS / OGC API - F
ArcGIS REST Serve
Layers
USGS_1_n36
Band 1 (Gray)
3,418.6843
1,499.447266
Save Map as Image
Extent (current: map view)
North 35.305780262
West -106.608905309
East -106.229945775
South 35.053349366
Calculate from Layer Layout Map Bookmark
Map Canvas Extent
Draw on Canvas
Scale 1:59997
Resolution 150 dpi
Output width 2521 px
Output height 1679 px
Draw active decorations: none
Draw annotations
Append georeference information (embedded or via world file)
Help
Copy to Clipboard
Cancel
Save
Sandia mountains GeoTIFF

Bitmaps in GH and Rhino

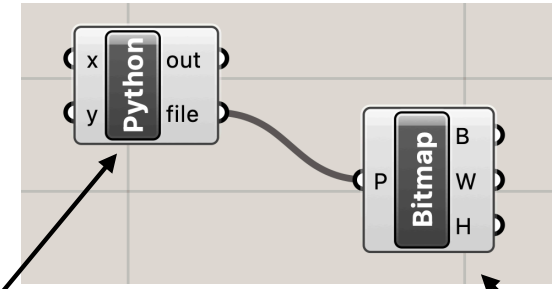
Step 1: what I messed up in class: installing the human GH plugin

Install the human GH plugin

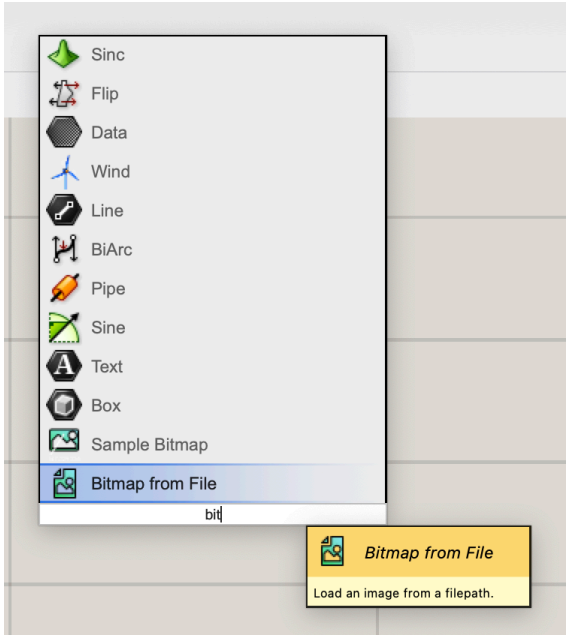
- **IMPORTANT:** must follow these exact steps to install the correct version of the library. Do not install the Food4Rhino version.
- In Rhino, open the PackageManager by typing "Package Manager" in the command line.
- Choose "human" v1.3.1 in the box that pops up and click Apply.
- Quit and restart Rhino.



Open the bitmap in GH



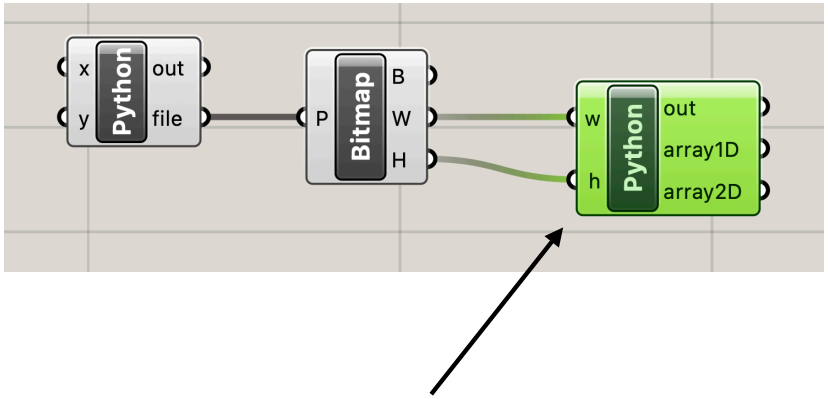
open bitmap block
(requires human plugin)



specify path

```
1 import rhinoscriptsyntax as rs
2
3 filter = "IMG file (*.bmp)|*.pbm|*.png|All Files (*.*)|*.*||"
4 file = rs.OpenFileName("Open Image File", filter)
```

Create point arrays



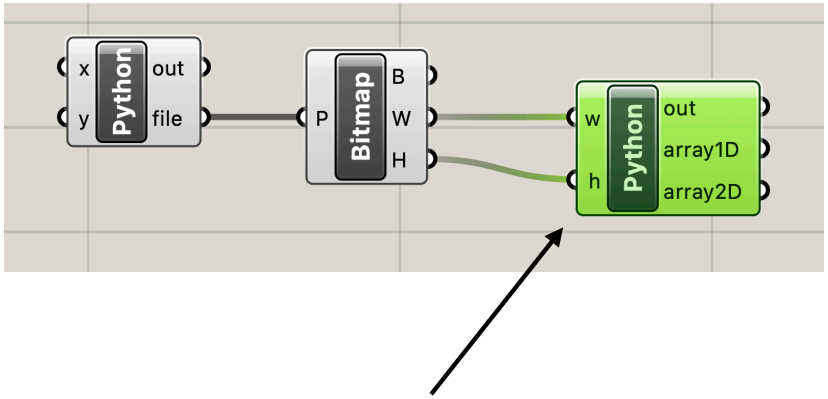

```python
import rhinoscriptsyntax as rs

array2D = []
array1D = []
for i in range (0,w,10):
    row = []
    for j in range (0,h,10):
        row.append(rs.CreatePoint(i,j,0))
        array1D.append(rs.CreatePoint(i/float(w),j/float(h),0))
    array2D.append(row)
```

The 1D array creates a list of points in the range 0-1. This will be used to access pixel information.

The 2D array creates an array of points in that correspond to the size of the bitmap. This will be used to create the final geometry.

Create point arrays

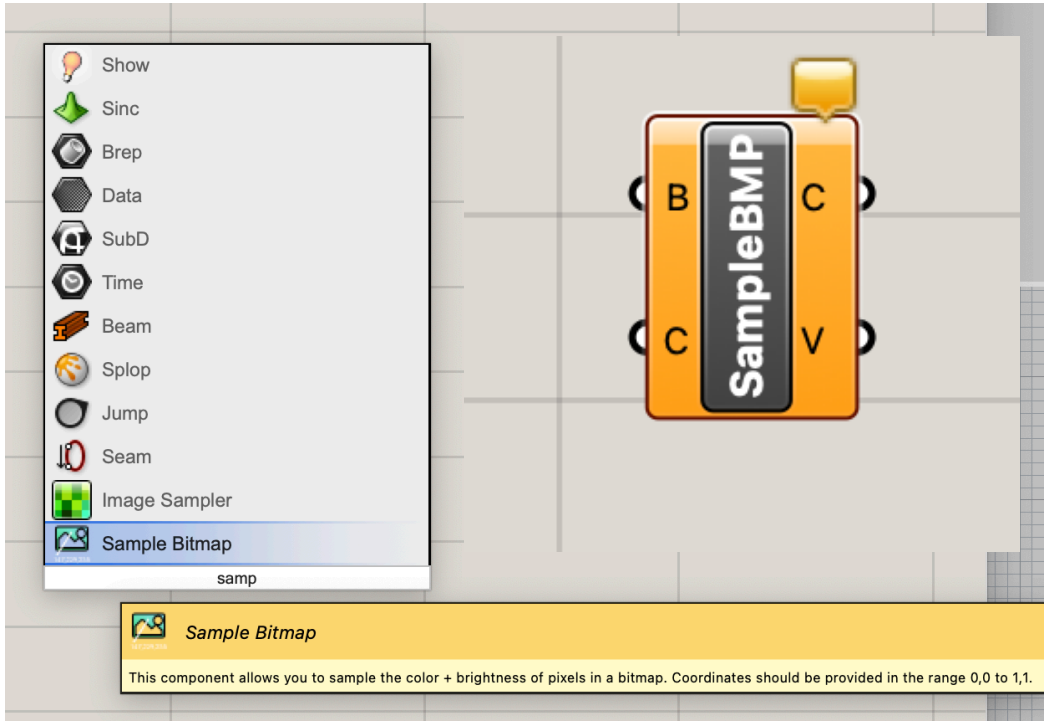



```python
import rhinoscriptsyntax as rs

array2D = []
array1D = []
for i in range (0,w,10):
    row = []
    for j in range (0,h,10):
        row.append(rs.CreatePoint(i,j,0))
        array1D.append(rs.CreatePoint(i/float(w),j/float(h),0))
    array2D.append(row)
```

Important: make sure you are incrementing the i and j variables by 10. Otherwise your program will generate too many points and run very very slowly.

Get pixel information using Sample Bitmap

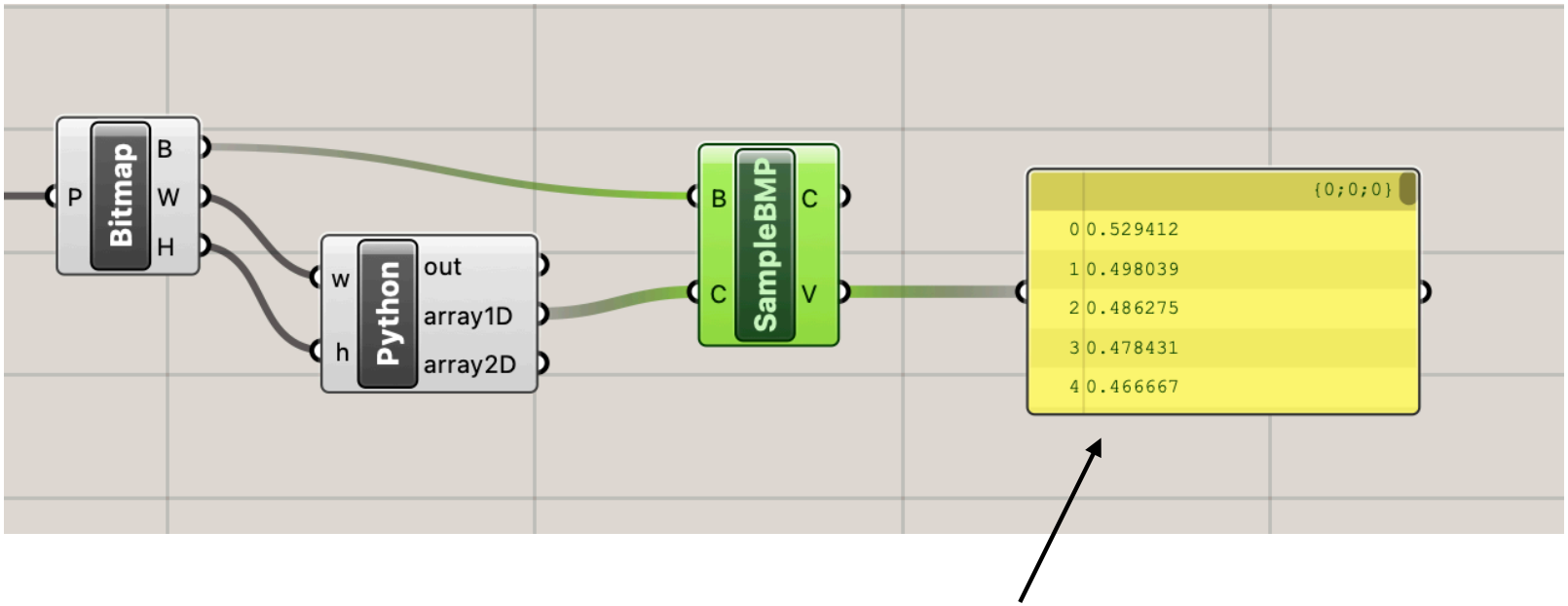


returns pixel color (C) and brightness (V) information

B input = bitmap

C input = point/pixel index (in range of 0-1)

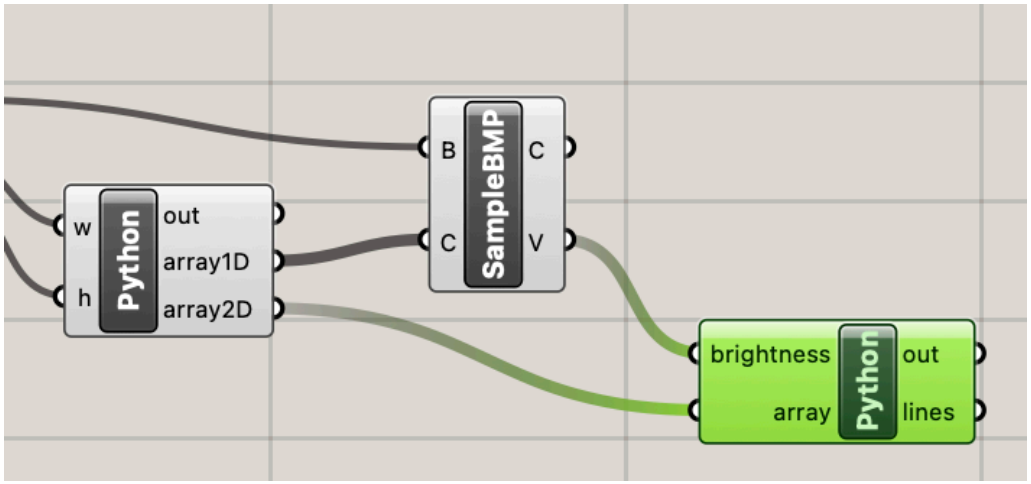
Get pixel information



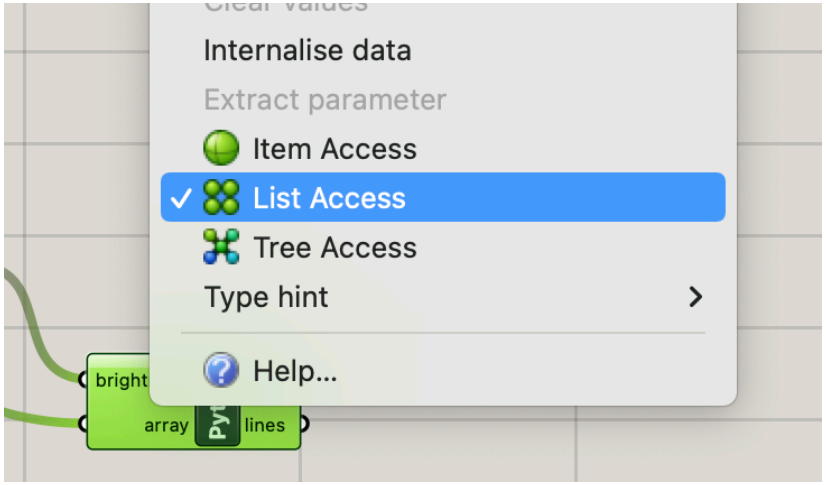
brightness of each pixel
note: just using a yellow Panel text box to look at the data.

Generate geometry from pixel info

Important: List Access vs. Item Access



connect 2D array &
brightness info to
new python block



choose list access for both inputs
also set correct Type hints
brightness: float
array: Point

Brightness = z component of new point

```
1 import rhinoscriptsyntax as rs
2
3 lines = []
4
5 b = 0
6 for i in range (0,len(array)):
7     points = []
8     for j in range (0,len(array[i])):
9         point = rs.CreatePoint(array[i][j].X, array[i][j].Y, brightness[b]*500)
10        points.append(point)
11        b = b+1
12    line = rs.AddCurve(points)
13    lines.append(line)
```

add a multiplier to z component (here 500) to get a more dramatic effect

Array of points for each image row

```
1 import rhinoscriptsyntax as rs
2
3 lines = []
4
5 b = 0
6 for i in range (0,len(array)):
7     points = []
8     for j in range (0,len(array[i])):
9         point = rs.CreatePoint(array[i][j].X, array[i][j].Y, brightness[b]*500)
10        points.append(point)
```

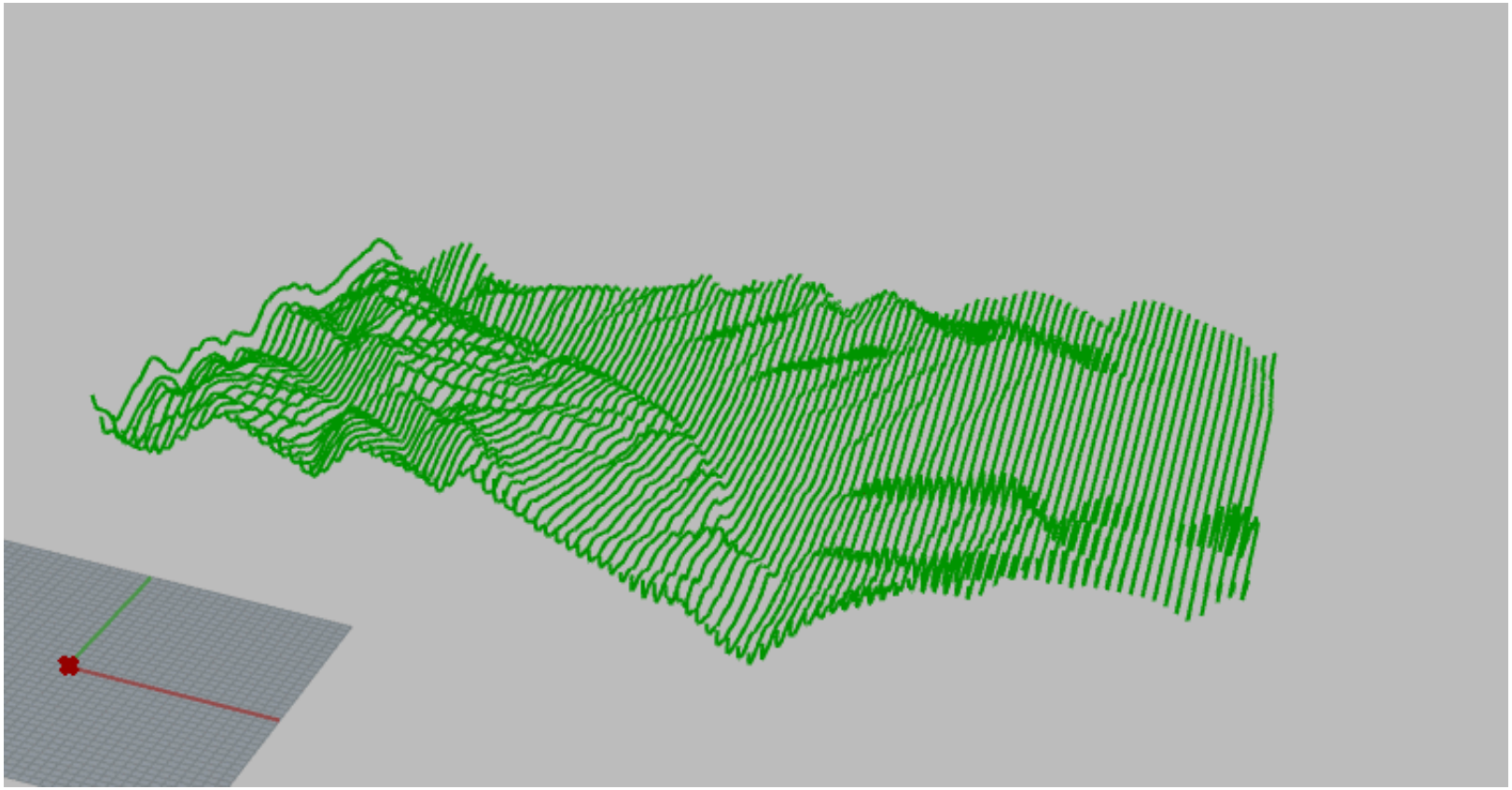
Line for each image row

```
1 import rhinoscriptsyntax as rs
2
3 lines = []
4
5 b = 0
6 for i in range (0,len(array)):
7     points = []
8     for j in range (0,len(array[i])):
9         point = rs.CreatePoint(array[i][j].X, array[i][j].Y, brightness[b]*500)
10        points.append(point)
11        b = b+1
12    line = rs.AddCurve(points)
```

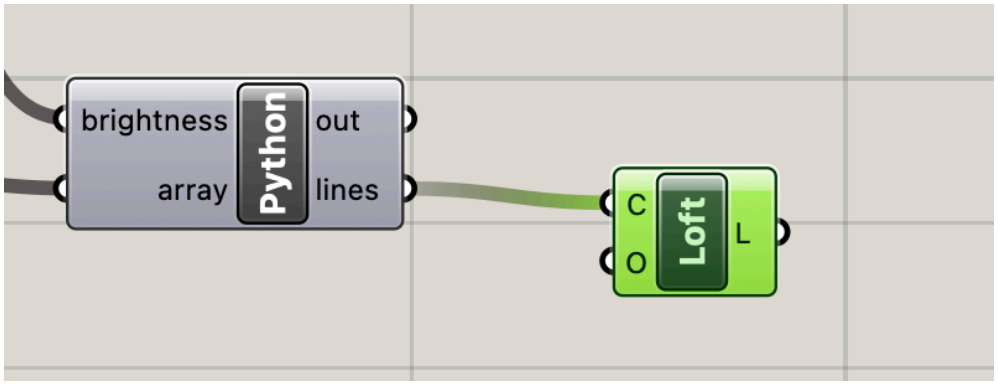
Array of lines is final output

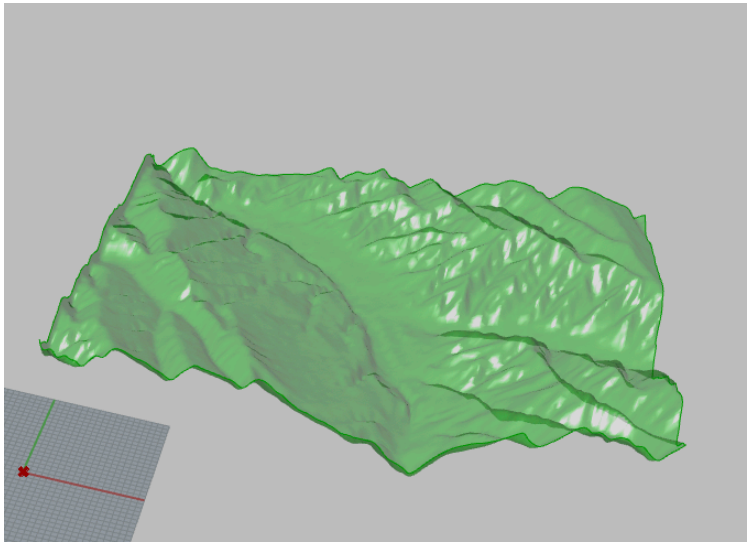
```
1 import rhinoscriptsyntax as rs
2
3 lines = []
4
5 b = 0
6 for i in range (0,len(array)):
7     points = []
8     for j in range (0,len(array[i])):
9         point = rs.CreatePoint(array[i][j].X, array[i][j].Y, brightness[b]*500)
10        points.append(point)
11        b = b+1
12    line = rs.AddCurve(points)
13    lines.append(line)
```

Array of lines is final output



Loft to create surface from lines





questions?

Thank you!

CS 491 and 591
Professor: Leah Buechley
https://handandmachine.cs.unm.edu/classes/Computational_Fabrication_Spring2021/