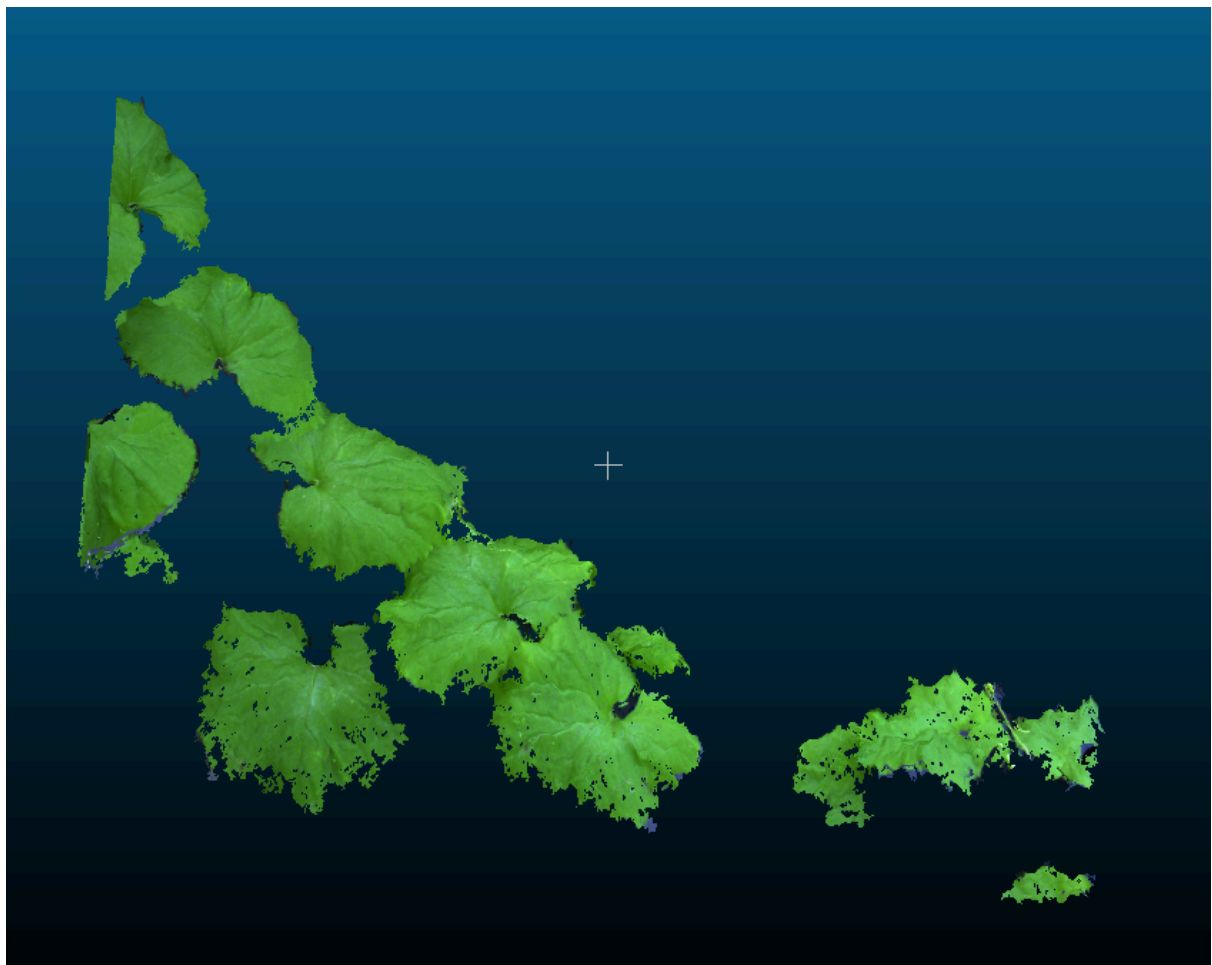


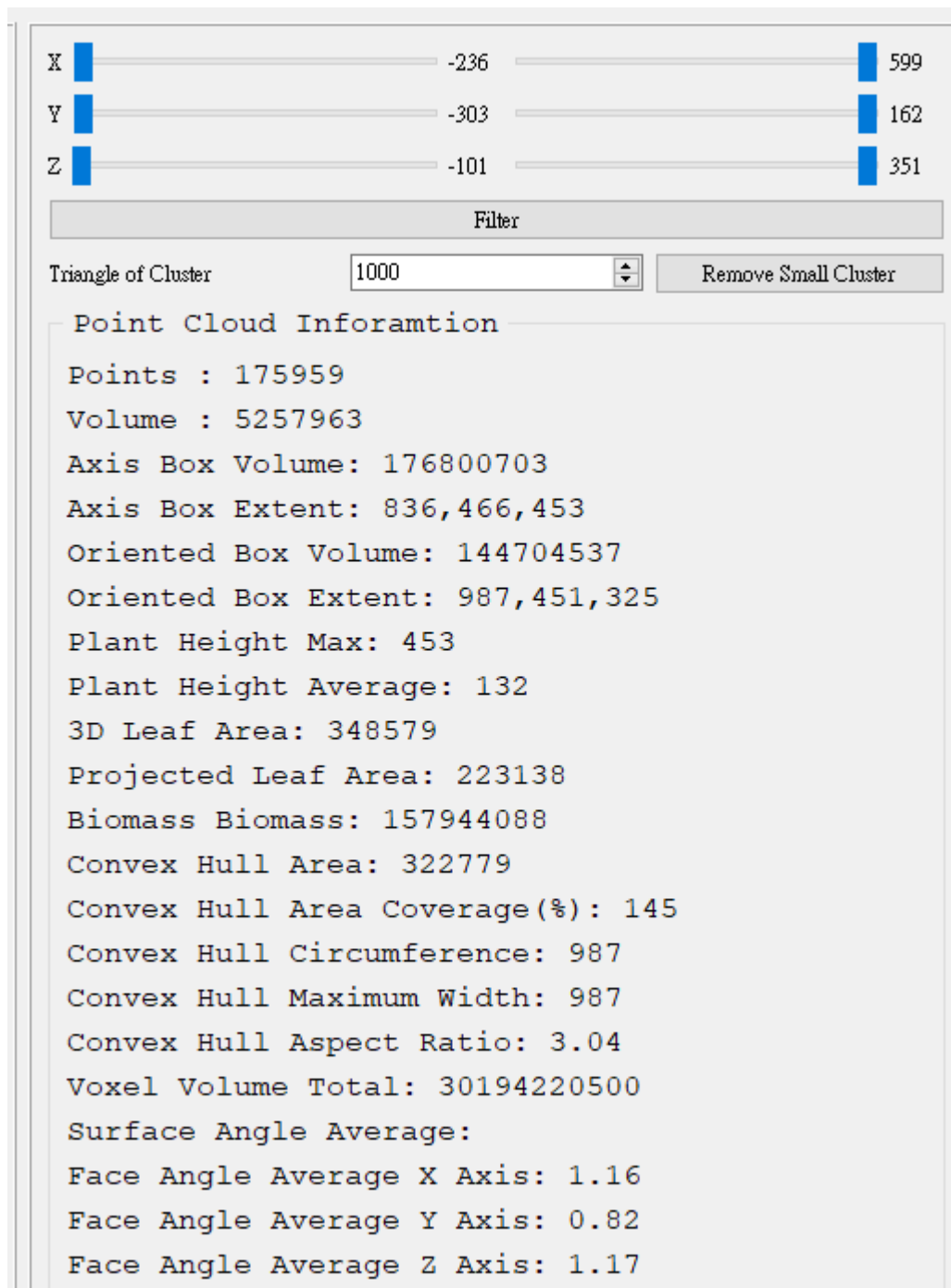
```
ply
format binary_little_endian 1.0
comment Created by Open3D
element vertex 175959
property double x
property double y
property double z
property uchar red
property uchar green
property uchar blue
element face 323465
property list uchar uint vertex_indices
end_header
```

175959 個點

323465 個面（三點為一個面）

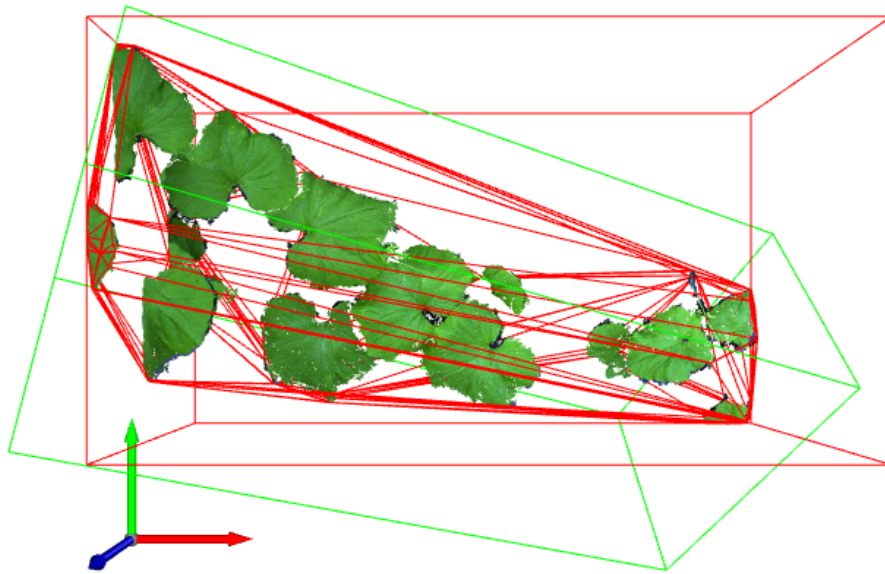
目前的3D函式庫，如果進來有參考face的資訊，可以產生3D Mesh的資訊格式（3D網格）。如果沒有只有參考點的資訊，可產生Point Cloud的資訊格式（點雲圖）





Volume: the total volume of all meshes in this dataset

```
pv_mesh = pv.read('temp.ply')  
pv_mesh.volume
```



Axis Box:

與軸平行的Box

Oriented Box:

與3D物件平行的Box

Plant Height Max:

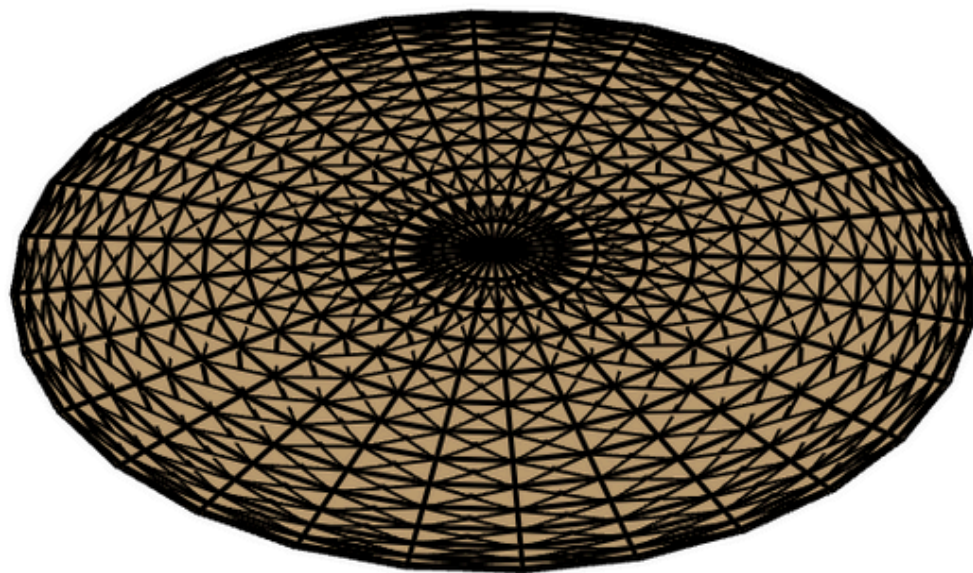
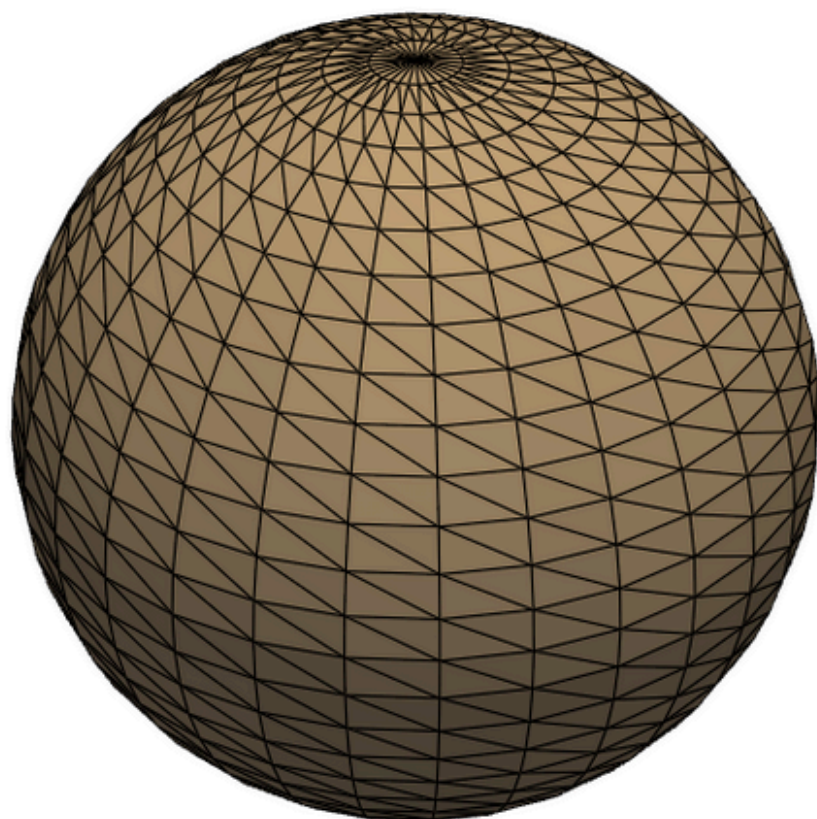
回傳3D物件Z軸的最高點。

Plant Height Average:

加總3D物件點雲座標的Z軸 / 3D物件的點雲個數

3D Leaf Area:

加總3D物件face的面積。三點成為一個face, 加總每一個face的面積



Projected Leaf Area:

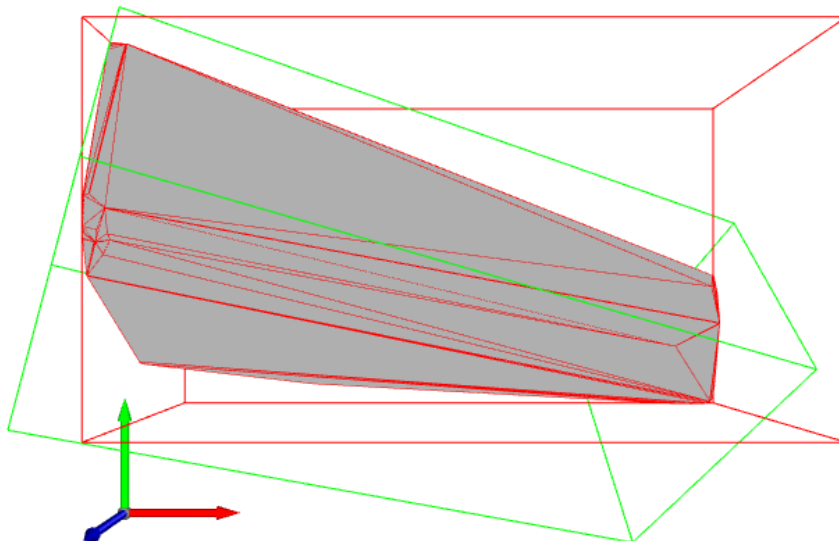
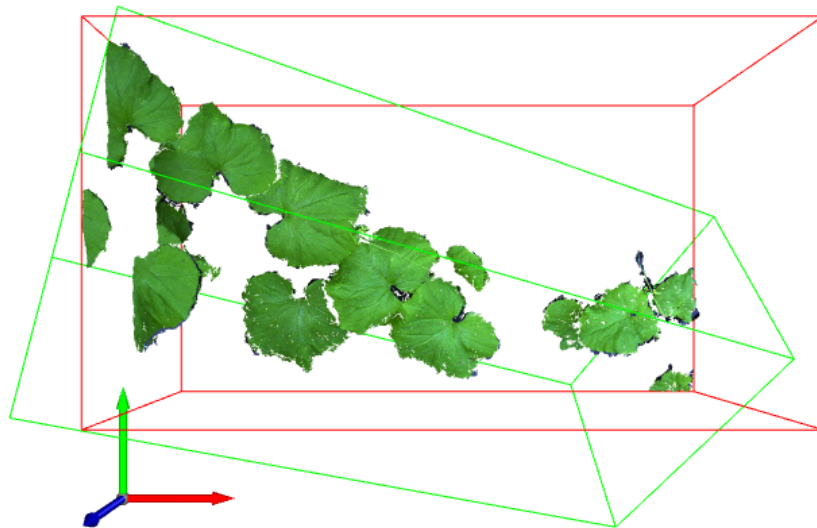
3D網格圖投射到Z軸平面上的面積加總

Digital Biomass:

3D Leaf Area X Plant Height Max

Convex Hull Area:

以下圖為例，灰色3D物件的面積加總



Convex Hull Area Coverage (%):

Convex Hull Area / Projected Leaf Area

Convex Hull Circumference:

```
convex_hull_circumference =  
np.amax(np.array([float(oriented_box_extent[0]),  
float(oriented_box_extent[1]), float(oriented_box_extent[2])]))
```

Convex Hull Maximum Width:

```
if oriented_box_extent[0] > oriented_box_extent[1]:  
    convex_hull_max_width = oriented_box_extent[0]  
else:  
    convex_hull_max_width = oriented_box_extent[1]
```

Convex Hull Aspect Ratio:

```
convex_hull_aspect_ratio = convex_hull_max_width /  
oriented_box_extent[2]
```

Voxel Volume Count:

體素的個數

Voxel Volume Total:

體素的加總

Surface Angle Average:

使用trimesh 函式庫得到每個網格的體素角度 angle at each vertex of a face.

Face Angle Average X Axis: X軸角度加總 / 總數

Face Angle Average Y Axis: Y軸角度加總 / 總數

Face Angle Average Z Axis: Z軸角度加總 / 總數

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老師所提的數據需求

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- Plant Height Max: to find the absolute highest point of the plant in millimeters, and is therefore very accurate.
- Plant Height Average: is focused on stability over accuracy, by minimizing the effect of small movements, as a result of wind, external artifacts or diurnal plant

movements.

- Canopy Light Penetration Depth: We calculate the depth of the laser light penetration through the canopy of the plant. Very dense plants will therefore exhibit a low value.
看圖片說明比較清楚
<https://phenospex.helpdocs.com/plant-parameters-phena-2-0/canopy-light-penetration-depth>
- 3D Leaf Area: 3D leaf area is the sum off all of the calculated triangle areas
<https://phenospex.helpdocs.com/plant-parameters-phena-2-0/3d-leaf-area-phena-2-0>
- Projected Leaf Area: Projected leaf area is defined as an area of the projection of all elementary triangles on X-Y plane.
- Digital Biomass:
- Digital Biomass is calculated as the product of height and 3D leaf area assuming that the plant has a regular body of which the volume can be computed by taking into account height and length.
Digital Biomass has been proven by many studies to be highly correlated with the biomass of the plant.
- Convex Hull Area :
- The convex hull describes a shape that encloses the 2D projection of the plant. The convex hull area represents the area that the convex hull surrounds. It is therefore a measure for the maximum space a plant could occupy in its current state.

It must be noted that convex hull parameters are prone to overlapping. These parameters will work best when there is as little overlap as possible.
- Convex Hull Area Coverage (%):
The convex hull area coverage represents the amount of hull area that is filled up by the plant. In other words, how much of the area is covered by the projected leaf area. It is related to the morphological structure of the plant.
- Convex Hull Circumference :
The convex hull circumference represents the distance around the convex hull. It can be used in combination with the hull area as a morphological shape descriptor.
- Convex Hull Maximum Width:
The maximum width of the convex hull is the largest axis that can be drawn in the convex hull. One use case example could be to follow up the width of the cotyledons in a germination essay.
- Convex Hull Aspect Ratio
The aspect ratio of the convex hull describes the ratio between the convex hull maximum width and its perpendicular axis inside the hull.

- Voxel Volume Total

This is calculated as the total count of the visible voxels multiplied by the voxel volume. Voxels are the 3D equivalent of a pixel and is frequently used for calculations in 3D imaging.

- Surface Angle Average

This parameter calculates the average angle of the triangles with respect to the height axis. The weighted average of all angles of every face in the plant mesh based on their normal.

<https://phenospex.helpdocs.com/plant-parameters-phena-2-0/surface-angle-average-phena-2-0>