

## Exercise 07

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### Question 1

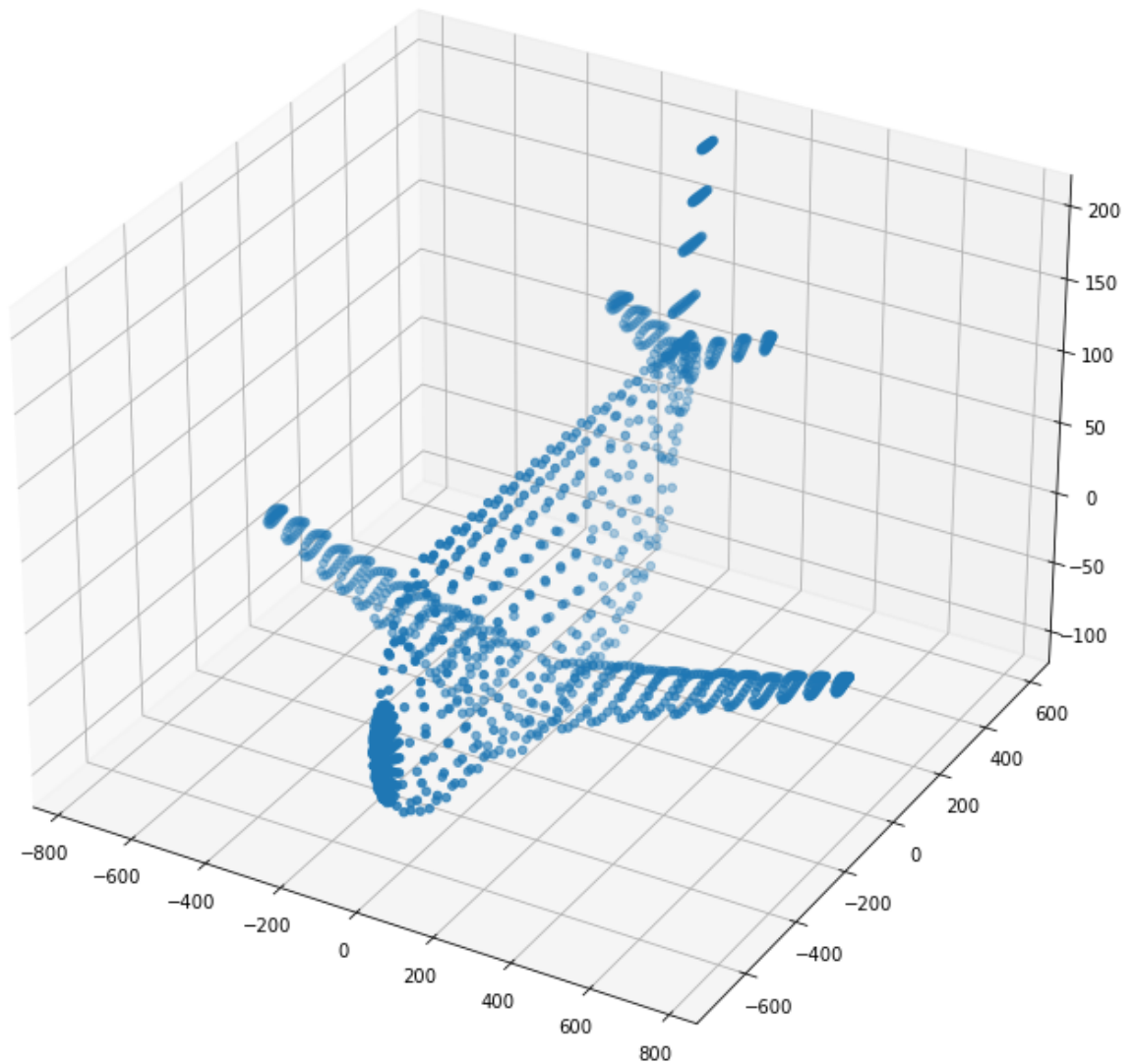
```
In [ ]: import numpy as np
        from plyfile import PlyData, PlyElement
        import matplotlib.pyplot as plt

        pcd = PlyData.read(r"airplane.ply")
        assert pcd is not None

        points = np.concatenate((pcd['vertex']['x'].reshape(1, -1), pcd['vertex']['y'].reshape(1, -1), pcd['vertex']['z'].reshape(1, -1)))
        points = points - np.mean(points, axis=1).reshape(3,1)

        fig = plt.figure(figsize=(12,12))
        ax = fig.add_subplot(111, projection='3d')
        ax.scatter(points[0,:], points[1,:], points[2,:])
```

```
Out[ ]: <mpl_toolkits.mplot3d.art3d.Path3DCollection at 0x1f39177c460>
```



In [ ]:

```

ones = np.ones((1, points.shape[1]))
X = np.concatenate((points, ones), axis = 0)

R = np.array([[1,0,0],[0,1,0],[0,0,1]])
K = np.array([[1,0,0],[0,1,0],[0,0,1]])

t = np.array([[0],[0],[-4000]])

P1 = K @ np.concatenate((R,t), axis = 1)

R = np.array([[0,1,0],[1,0,0],[0,0,1]])
K = np.array([[1,0,0],[0,1,0],[0,0,1]])

t = np.array([[0],[0],[-4000]])

P2 = K @ np.concatenate((R,t), axis = 1)

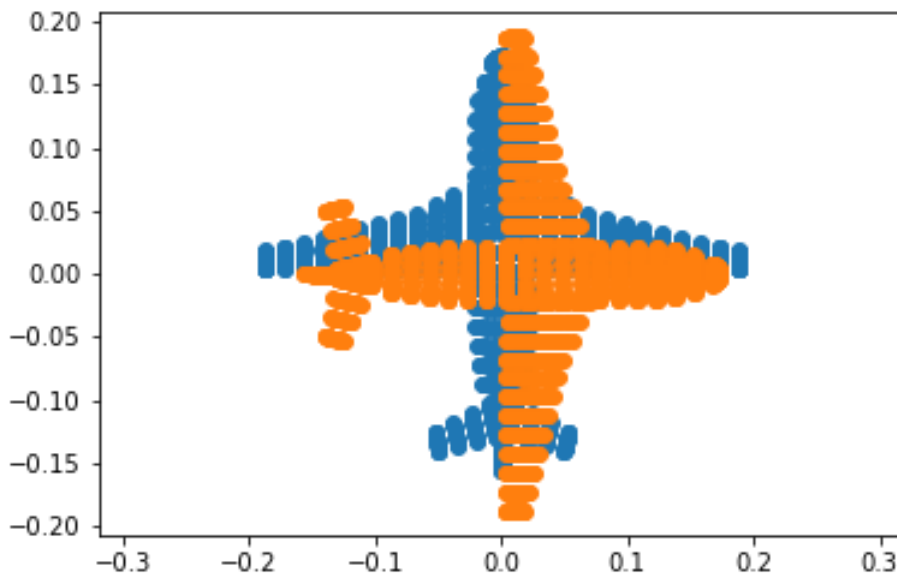
```

```

x1 = P1 @ X
x1 = x1/x1[2,:]
x2 = P2 @ X
x2 = x2/x2[2,:]

fig,ax = plt.subplots(1,1,sharex = True, sharey = True)
ax.scatter(x1[0,:],x1[1,:])
ax.scatter(x2[0,:],x2[1,:])
ax.axis('equal')
plt.show()

```



### Question 3

In [ ]:

```

import cv2 as cv
import numpy as np
im = cv.imread('earrings.jpg',cv.IMREAD_COLOR)
assert im is not None

hsv = cv.cvtColor(im, cv.COLOR_BGR2HSV)
th,bw = cv.threshold(hsv[:, :, 1],0,255, cv.THRESH_BINARY+cv.THRESH_OTSU

w = 5
kernel = np.ones((w,w), np.uint8)
opened = cv.morphologyEx(bw, cv.MORPH_CLOSE, kernel)

retval, labels, stats, centroids = cv.connectedComponentsWithStats(bw)
colormapped = cv.applyColorMap((labels/np.amax(labels)*255).astype('ui

z = 720
f = 8
for i,s in enumerate(stats):
    if i != 0:
        print('Item ', i, ' area in pixels =', s[4])

```

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print('Item ', i, ' area in mm^2 =', s[4]*(2.2e-3)**2*(z*z)/(f

cv.namedWindow('Images')
cv.imshow('Images',im)
cv.waitKey(0)
cv.imshow('Images',hsv[:, :,1])
cv.waitKey(0)
cv.imshow('Images',bw)
cv.waitKey(0)
cv.imshow('Images',opened)
cv.waitKey(0)
cv.imshow('Images',colormapped)
cv.waitKey(0)
cv.destroyAllWindows()

fig,ax = plt.subplots(1,5, figsize=(20, 20))

ax[0].imshow(cv.cvtColor(im, cv.COLOR_BGR2RGB))
ax[0].set_title("Image")

ax[1].imshow(cv.cvtColor(hsv[:, :,1], cv.COLOR_BGR2RGB))
ax[1].set_title("Hue of HSV Image")

ax[2].imshow(cv.cvtColor(bw, cv.COLOR_BGR2RGB))
ax[2].set_title("Thresholding")

ax[3].imshow(cv.cvtColor(opened, cv.COLOR_BGR2RGB))
ax[3].set_title("morphological Operation")

ax[4].imshow(cv.cvtColor(colormapped, cv.COLOR_BGR2RGB))
ax[4].set_title("Color Mapped")

plt.show()

```

```

Item 1 area in pixels = 59165
Item 1 area in mm^2 = 2319.50466
Item 2 area in pixels = 59196
Item 2 area in mm^2 = 2320.7199840000003
Item 3 area in pixels = 1
Item 3 area in mm^2 = 0.039204

```

