COMPUTER PROGRAMMING LABORATORY
Experiment # 7:
Libs

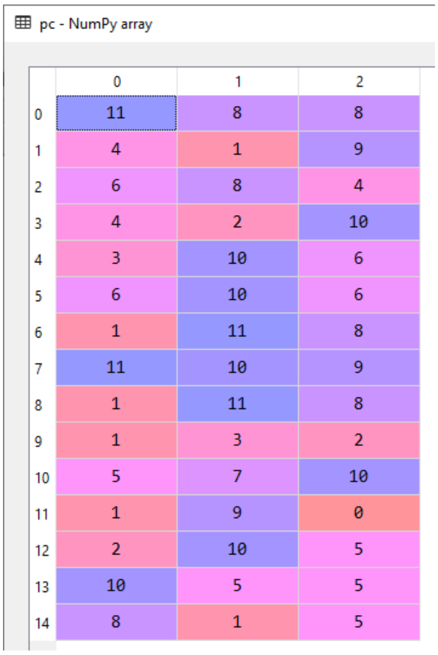
QUESTIONS

In this question, you will write a python program to calculate means of voxels, which describe the point cloud data. The program must include the following steps:

i) The program must include ***getParameters*** function. In the function, prompt the length of cube (i.e l) and step size (i.e ss) and return these values.

ii) The program must include ***generatePointCloud*** function. The function receives the length of cube and returns a **numpy** array. In the function, use **numpy** library to generate 200 points with x, y, and z coordinates, which will be integer values between 0 and the length of cube. An example

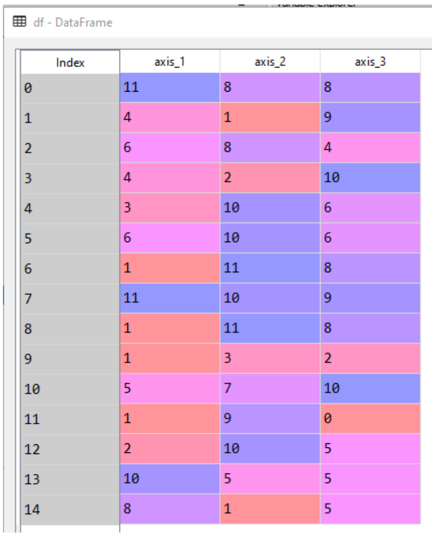
iii) w output for 15 points is given in Figure 1. Assume that the length of cube is 12.



	0	1	2
0	11	8	8
1	4	1	9
2	6	8	4
3	4	2	10
4	3	10	6
5	6	10	6
6	1	11	8
7	11	10	9
8	1	11	8
9	1	3	2
10	5	7	10
11	1	9	0
12	2	10	5
13	10	5	5
14	8	1	5

Fig. 1 An example numpy array for 15 points

iv) The program must include ***writePCToDataFrameAndFile*** function. The function receives the numpy array. In the function, convert the numpy array to a DataFrame (**Hint: You can define Series for each column and add the columns to the DataFrame**). The column headers of the DataFrame must be axis_1, axis_2, and axis_3 for x, y, and z axes. Write the DataFrame to a file with .csv extension. The values in the file must be separated with the slash character (“/”). Also, the file does not include index values. An example output for 15 points is given in Figure 2.



df - DataFrame

Index	axis_1	axis_2	axis_3
0	11	8	8
1	4	1	9
2	6	8	4
3	4	2	10
4	3	10	6
5	6	10	6
6	1	11	8
7	11	10	9
8	1	11	8
9	1	3	2
10	5	7	10
11	1	9	0
12	2	10	5
13	10	5	5
14	8	1	5

Fig. 2 An example DataFrame for 15 points

v) The program must include ***findPointsInAVoxel*** function. The function receives the numpy array, the length of cube and step size. In the function, first define an empty dictionary (i.e voxels). Assume that the length of cube 6 and the step size is 3 (Figure 3(a)). In this case, you will have 2 voxels for each axis. To reach each voxel use 3 nested for statement. Then, find the points in each voxel (Figure 3(b)). Assign these points into dictionary as values and the key of these values must be the lower-right corner of the voxel. An example dictionary is given in Figure 4. Notice that, voxels can contain more than 1 point and the values are in list type. **To implement conditions use & instead of and keyword.** The function must return the dictionary.

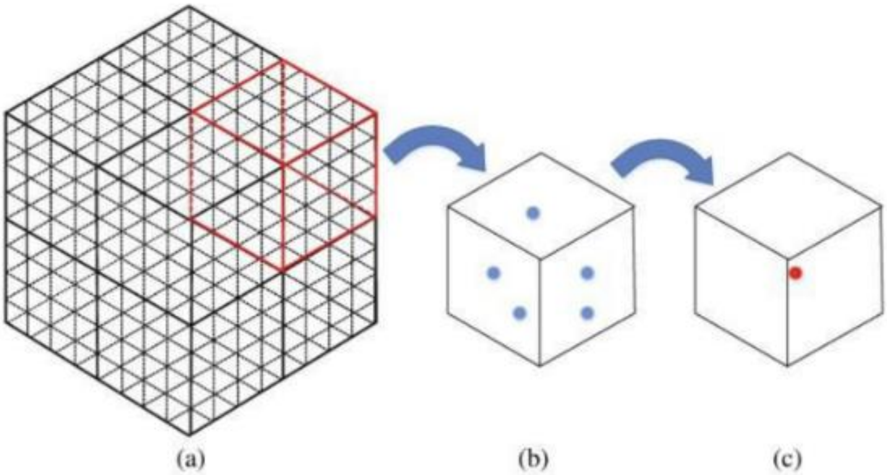
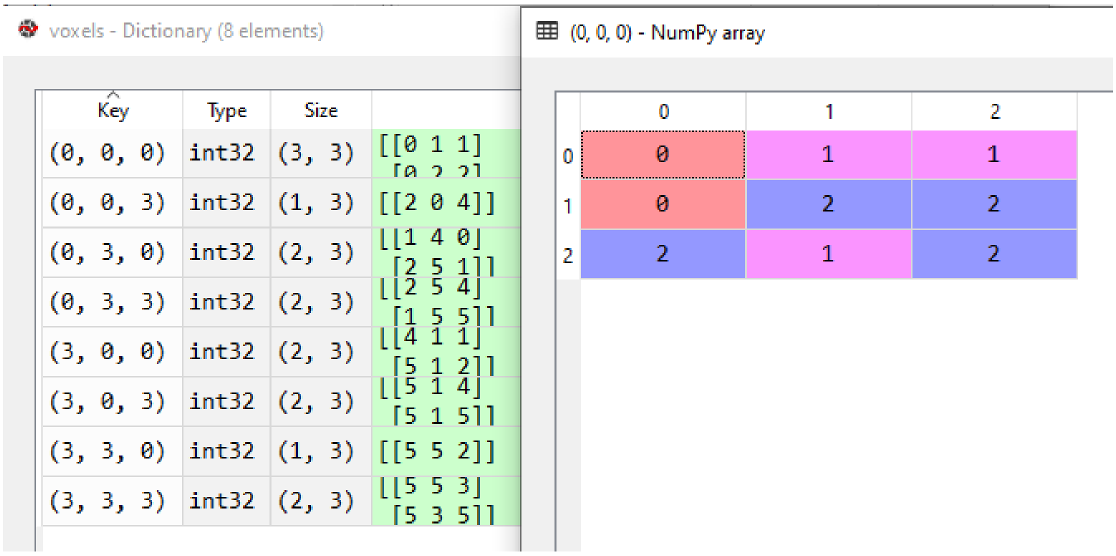


Fig. 3 An example to calculate mean of a voxel [1]



voxels - Dictionary (8 elements)

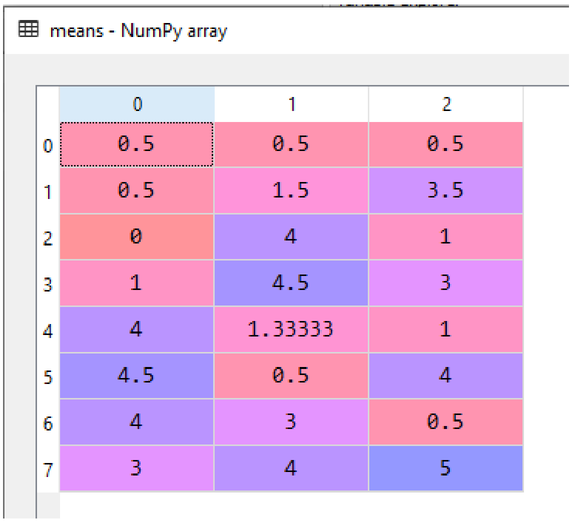
Key	Type	Size	
(0, 0, 0)	int32	(3, 3)	[[0 1 1] [0 2 2]]
(0, 0, 3)	int32	(1, 3)	[[2 0 4]]
(0, 3, 0)	int32	(2, 3)	[[1 4 0] [2 5 1]]
(0, 3, 3)	int32	(2, 3)	[[2 5 4] [1 5 5]]
(3, 0, 0)	int32	(2, 3)	[[4 1 1] [5 1 2]]
(3, 0, 3)	int32	(2, 3)	[[5 1 4] [5 1 5]]
(3, 3, 0)	int32	(1, 3)	[[5 5 2]]
(3, 3, 3)	int32	(2, 3)	[[5 5 3] [5 3 5]]

(0, 0, 0) - NumPy array

	0	1	2
0	0	1	1
1	0	2	2
2	2	1	2

Fig. 4 An example dictionary. The right figure shows the values corresponding to (0,0,0) key

vi) The program must include ***calculateVoxelMeans*** function. The function receives the dictionary, the length of cube, and step size. In the function, first define a numpy array with the size of dictionary and initialize the array with 0. Then, calculate means of the points in each voxel (Figure 3(c)). **In this step, you have to use for statement with the dictionary.** Then, assign the mean points to the numpy array. Write the numpy array to a file with .csv extension. The values in the file must be separated with the comma character (“,”). An example output for the numpy array is given in Figure 5.



means - NumPy array

	0	1	2
0	0.5	0.5	0.5
1	0.5	1.5	3.5
2	0	4	1
3	1	4.5	3
4	4	1.33333	1
5	4.5	0.5	4
6	4	3	0.5
7	3	4	5

Fig. 5 An example output for the numpy array

vii) The program must include ***plotFilteredPoints*** function. The function receives the filenames and plots the point cloud and mean points via matplotlib.pyplot library. In the function, read the point cloud file to a DataFrame and the mean points to a numpy array. Then, add the following statements to your function. Use **scatter** method to plot the points. An example output is given Figure 6. In the figure, point cloud points and mean points are shown with red and green colors, respectively.

```
from mpl_toolkits.mplot3d import Axes3D   // add the lib to your code
fig = plt.figure()                        // add the statement to your code
ax = fig.add_subplot(111, projection='3d')    // add the statement to your code
```

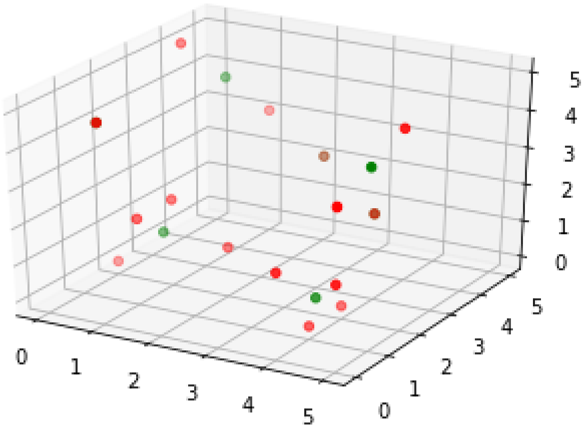


Fig. 6 An example output for plotFilteredPoints function

viii) The program must include ***main*** function. In the function, call the functions ***getParameters, generatePointCloud, writePCToDataFrameAndFile, findPointsInAVoxel, calculateVoxelMeans, plotFilteredPoints***.