NPM3D - TP 1 : Basic operations and structures on point clouds

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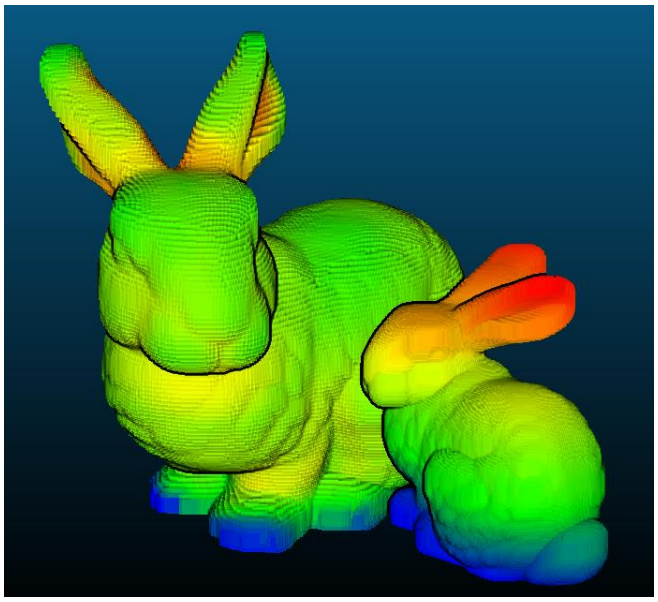
A. Point clouds manipulations

Question 1:

Below is a screenshot of the points cloud together with the transformed points cloud:



B. Structures and neighborhoods

Question 2:

The brute force running times are: 10 spherical neighborhoods computed in 1.425 seconds and 10 KNN computed in 0.313 seconds, for 1000 closest neighbors.

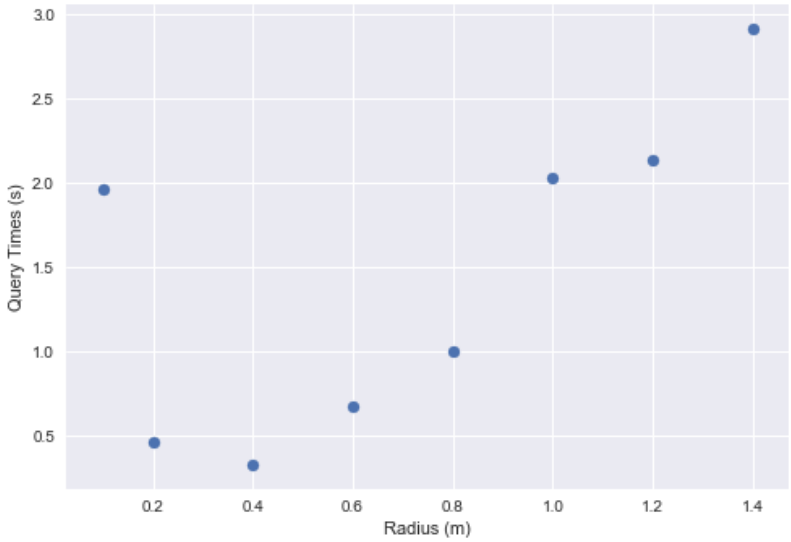
If I query the 3038661 points of the points cloud, using this brute force algorithm (linear complexity with the number of queries), it would therefore take more than 100 hours (433000s) to compute their 1000 closest spherical neighbors, and about 25 hours (95110s) for their 1000 nearest neighbors.

Question 3:

I tried the following values for the leaf size: [1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100]. The spherical search was faster with leaf size 25. The optimal leaf size is not 1 because for such leaf size, it is equivalent to brute force. Generally, the lower the leaf size, the longer the search within the KD Tree cell (which is brute force). The optimal leaf size is not the maximum leaf size either though because the higher the leaf size, the harder the search in the tree.

Question 4:

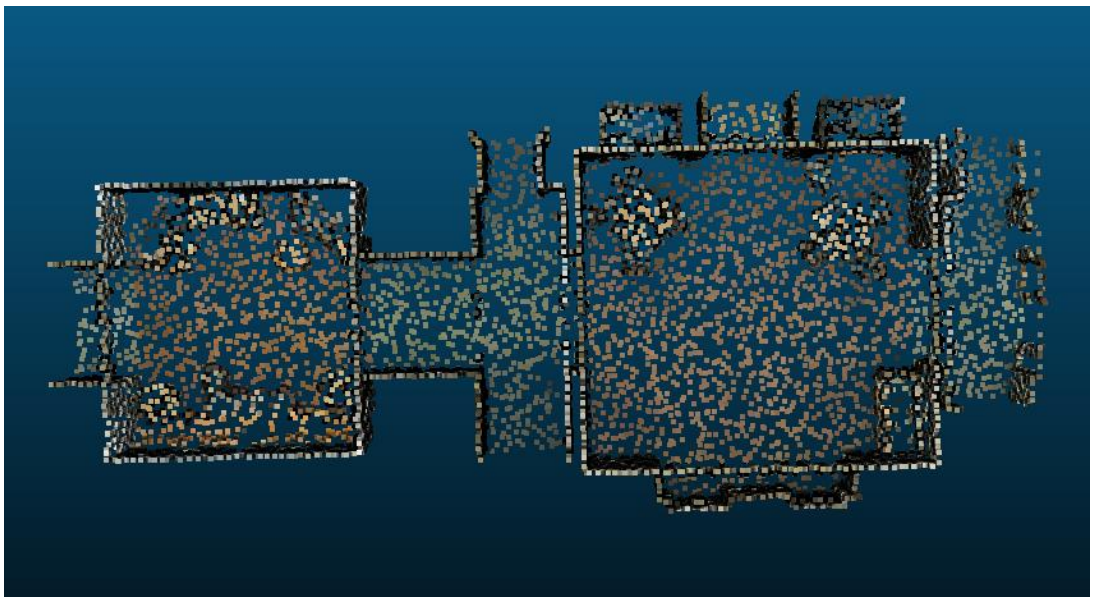
Below is the scatter plot of the query times (for 1000 random points) as a function of the radius for leaf size 25. The querying time seems to increase faster than linearly with the radius. As it takes about 0.5s to compute the spherical neighbors (radius 20cm) for 1000 queries, for the 3038661 points in the cloud, it would take roughly half an hour to compute the neighbors (1519s).



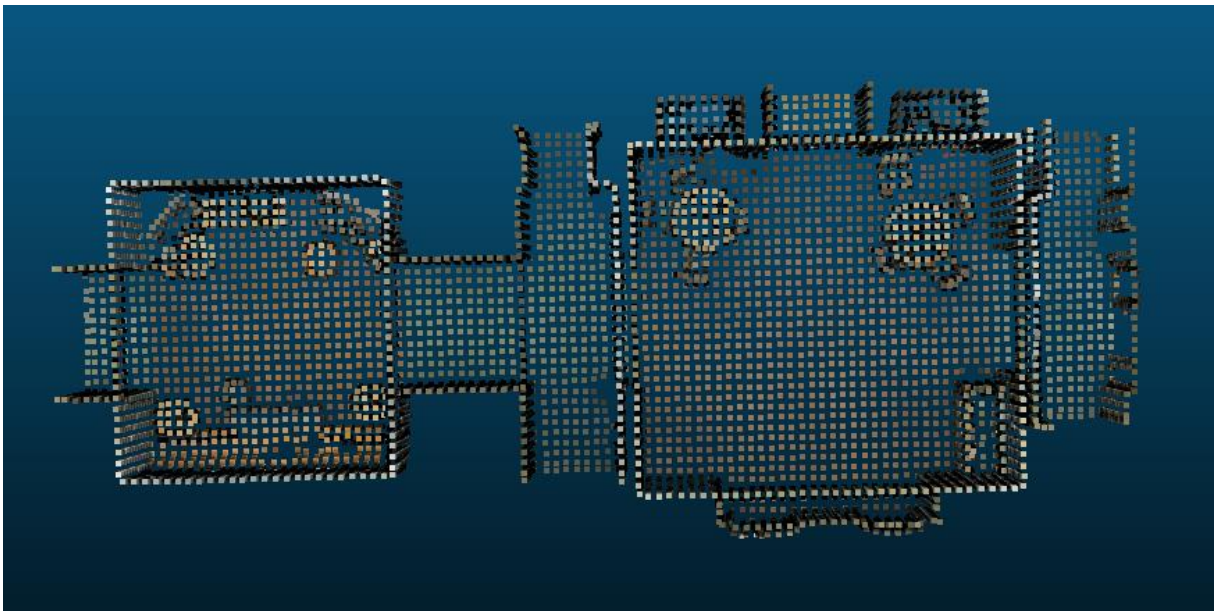
C. Subsampling methods

Question 5:

The main advantage of the decimation is its execution time (0.024s here), whereas subsampling takes a significantly higher execution time (209s), but produces higher quality point cloud, the holes being regular and of small size. Decimated and subsampled point clouds figures are provided below.

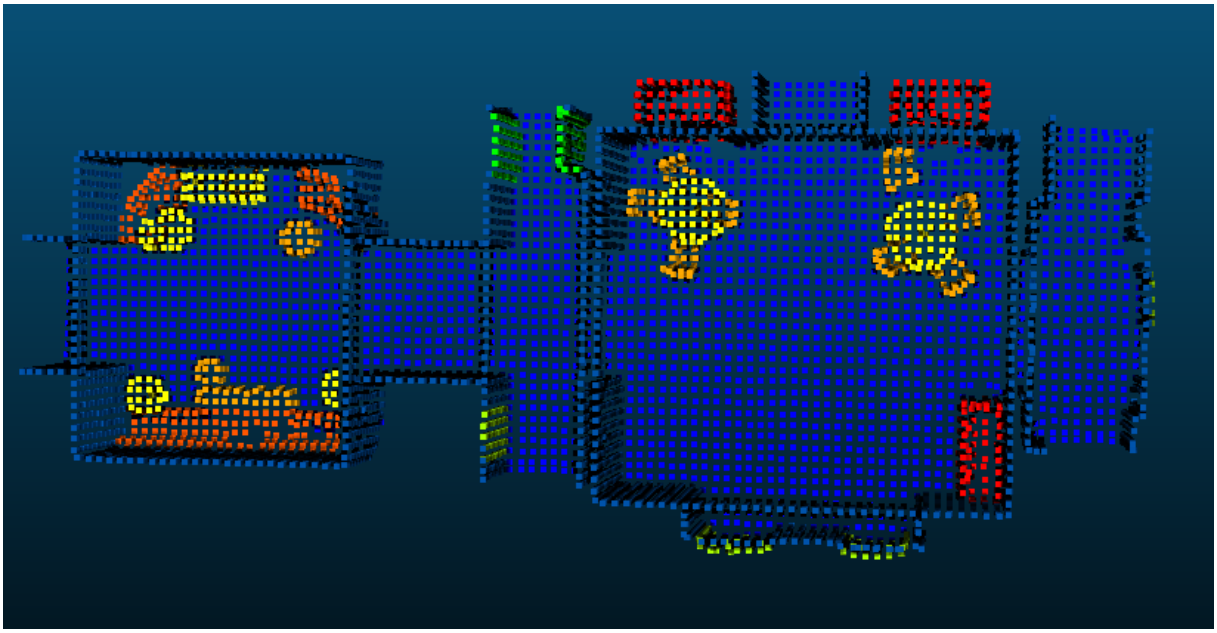


Decimated Point Cloud



Subsampled Point Cloud

Bonus question:



Subsampled Point Cloud with Labels