MATHÉMATIQUES VISION APPRENTISSAGE

Dauphine UNIVERSITÉ PARIS | PSL

TP1: Basic operations and structures on point clouds

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Exercise B: Point clouds manipulations in Cloud Compare

Question 1:

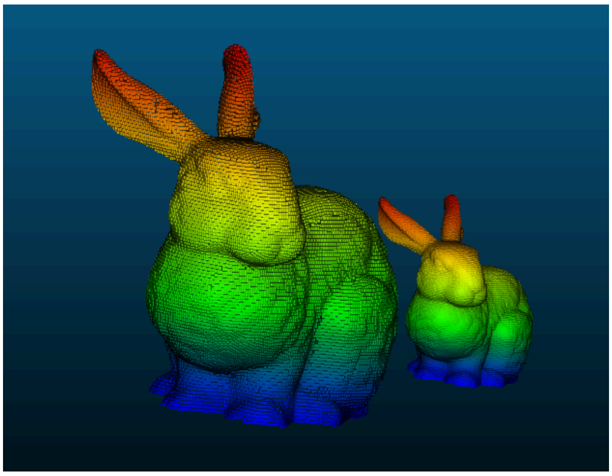

Figure 1: Original bunny alongside the transformed one

Exercise C: Subsampling methods

Question 2:

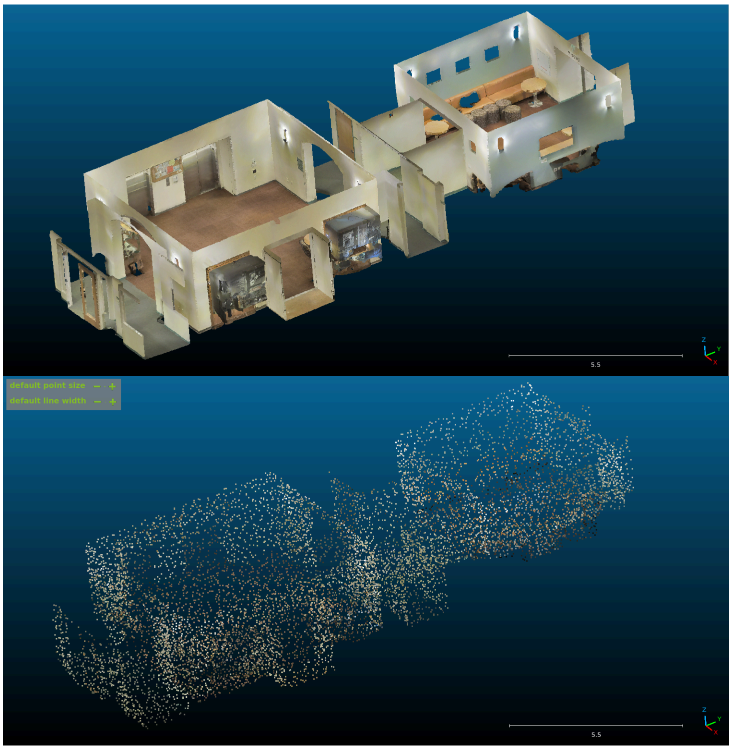

Figure 2: Original indoor scan (top image) and its subsampled version (bottom image)

Exercise D: Structures and neighborhoods

Question 3:

Method	10 iterations	Whole cloud
Spherical neighborhoods	$0.229_{0.001}$ seconds	19 hours
KNN	$1.761_{0.024}$ seconds	149 hours

Table 1: Time spent to apply either Spherical neighborhoods or KNN methods on 10 points. The time on the whole point-cloud is computed from the value obtained with 10 points.

Question 4(a):

A leaf size of around 40 proved to be optimal in our tests, balancing tree traversal costs against direct point comparisons. While a leaf-size of 1 creates the deepest possible tree, the overhead of traversing such a deep structure often exceeds the cost of comparing a few extra points, especially given NumPy's efficient vectorization of point comparisons. Performance metrics for both queries and tree construction are shown in Figure 3 and Figure 4 respectively. (A tree is created once and can be queried multiple times, and creation time is proportional to the size of the tree).

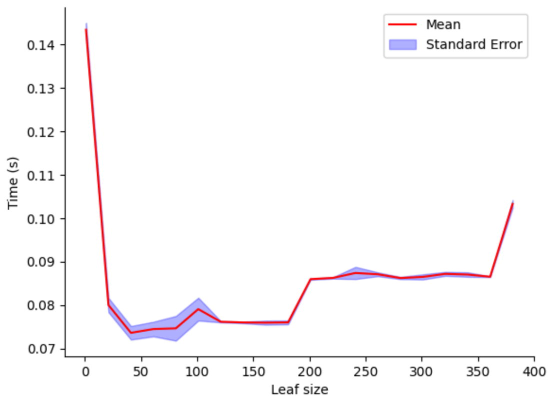

Figure 3: Query time wrt. on leaf size

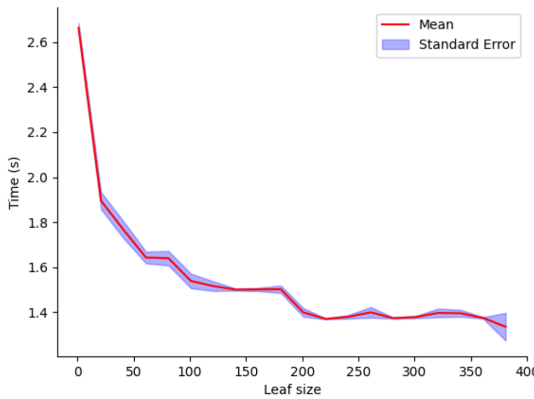

Figure 4: Creation time wrt. leaf size

Question 4(b):

As the radius increases, query time increases roughly linearly (Figure 5) due to the larger number of points being considered. For a radius of 20 cm and 1000 queries, the process lasts 0.05 seconds. Therefore, querying the whole point clouds takes 152 seconds (ceiled).

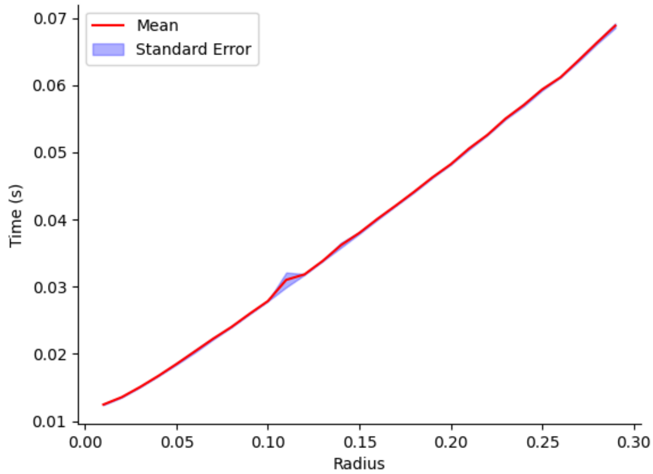

Figure 5: Query time wrt. radius

Exercise E: Grid Subsampling (Bonus)

Bonus Question:

Grid subsampling provides a more structured and uniform down sampling method, which can be preferable for preserving the spatial characteristics of the point cloud, while random subsampling can introduce more randomness in the representation of the data.

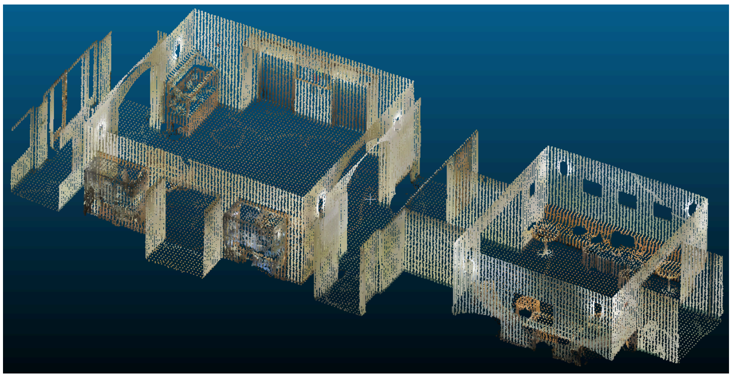

Figure 6: **Results of grid subsampling.** The space is divided across each dimension with $(n_x, n_y, n_z) = (80, 200, 300)$ boxes. These numbers are chosen accordingly to the AABB box of the point-cloud. A non-empty voxel is represented as the barycenter of the points falling inside.