

# NPM3D: TP1

Pierrick Bournez

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## 1 Question 1

How well does ICP perform on those examples? What is the difference between the aligned cloud and the reference cloud? In the last example (Notre Dame), which cloud should be the reference and why? We show the screenshot of the registered *bunny\_perturbed* with respect to *bunny\_original*. They are perfectly aligned

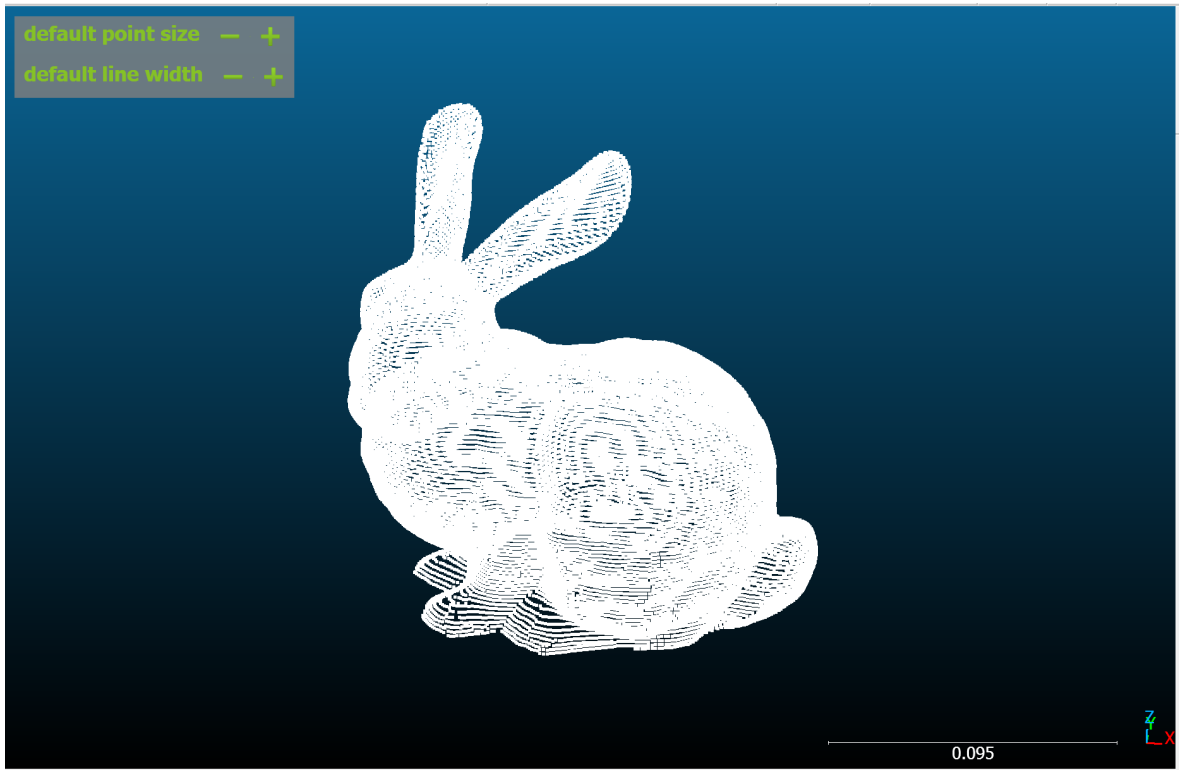


Figure 1: original and perturbed bunnies. they are perfectly aligned

The ICP algorithm did not perform well when comparing the *bunny\_returned/bunny\_original* point clouds. However, its performance was acceptable in the *Notre\_Dame\_Des\_Champs* example when *Champs 1* was used as the reference point cloud.

The aligned point cloud is the one that is translated and rotated to match the reference cloud.

In the final example, *Champs 2* is a subset of *Champs 1*, so *Champs 2* should be aligned to *Champs 1*, which serves as the reference point cloud. This approach is effective in practice, as illustrated in the figure, where swapping the reference and aligned point clouds demonstrates the expected behavior.

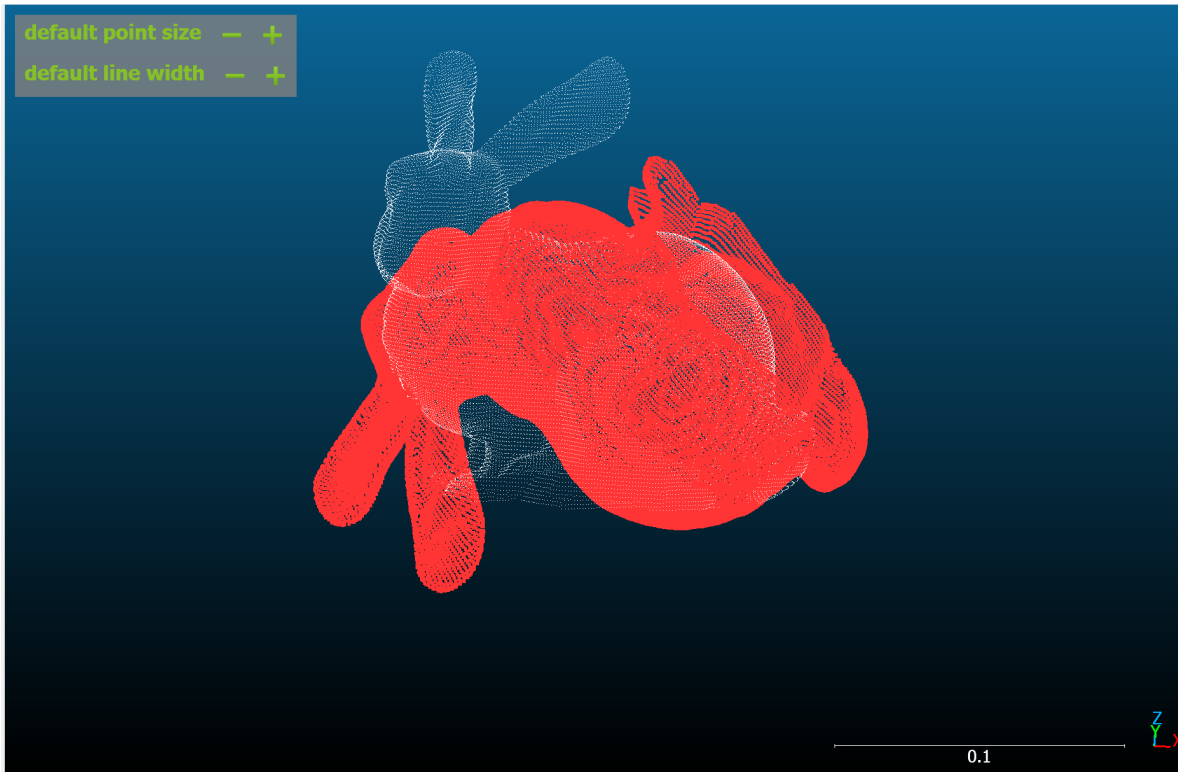


Figure 2: Perturbation of the original and returned bunnies. they are not aligned



Figure 3: Result when we aligned the  $Champs_1$  when the  $champs_2$  was taken as the reference.

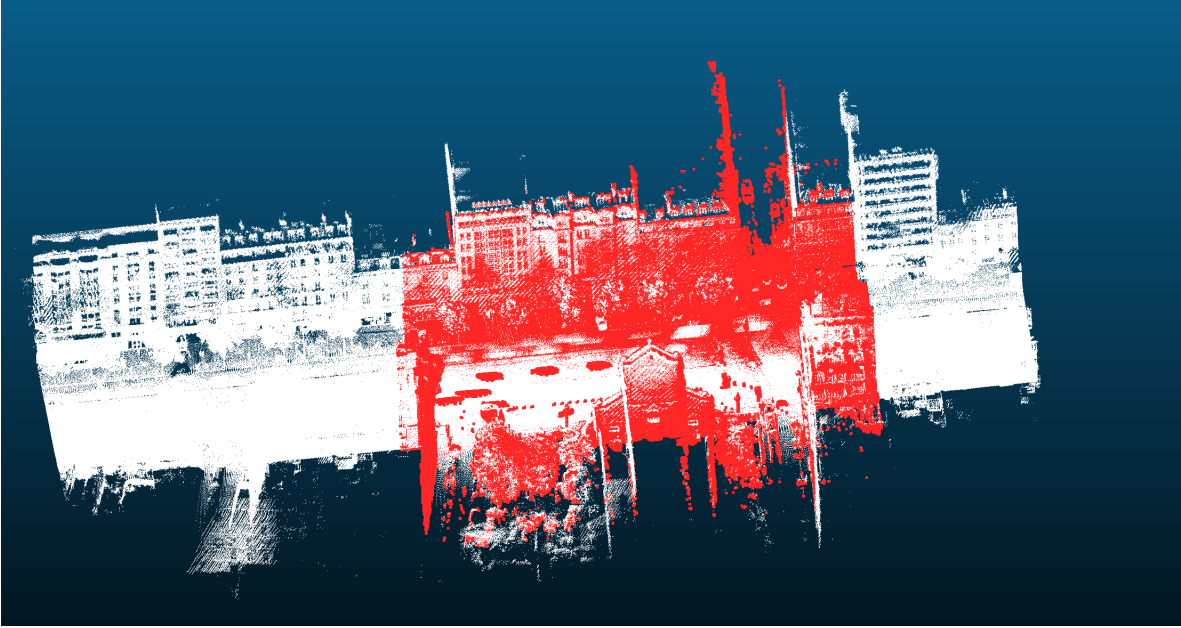


Figure 4: Result when we aligned  $Champs_2$  and  $Champs_1$  was the reference Point Clouds

## 2 Question 2

*Report the RMS errors obtained. Why did the alignment worked while CloudCompare ICP could not align those two clouds? Would this function align the 3D scans of “Notre Dame des Champs”? Why?*

When we computed the RMS for *bunny\_original* over *bunny\_returned*, the RMS was initially equal to 0.161. After registration, it decreased to 0.011. Here, we assumed that there was already a good matching of points between the two point clouds, resulting in a more robust algorithm. In the Cloud Compare ICP algorithm, an iterative process is used to approximate the matching, which can lead to sub-optimal results.

In the *Notre Dame des Champs* point clouds, some points exist only in one of the point clouds, while others are exclusive to the other. Therefore, it is not straightforward to compute a matching between all points, and the algorithm is likely to fail under these circumstances.

## 3 Question 3

*Plot the RMS during ICP convergence for those two examples (2D and bunny).*

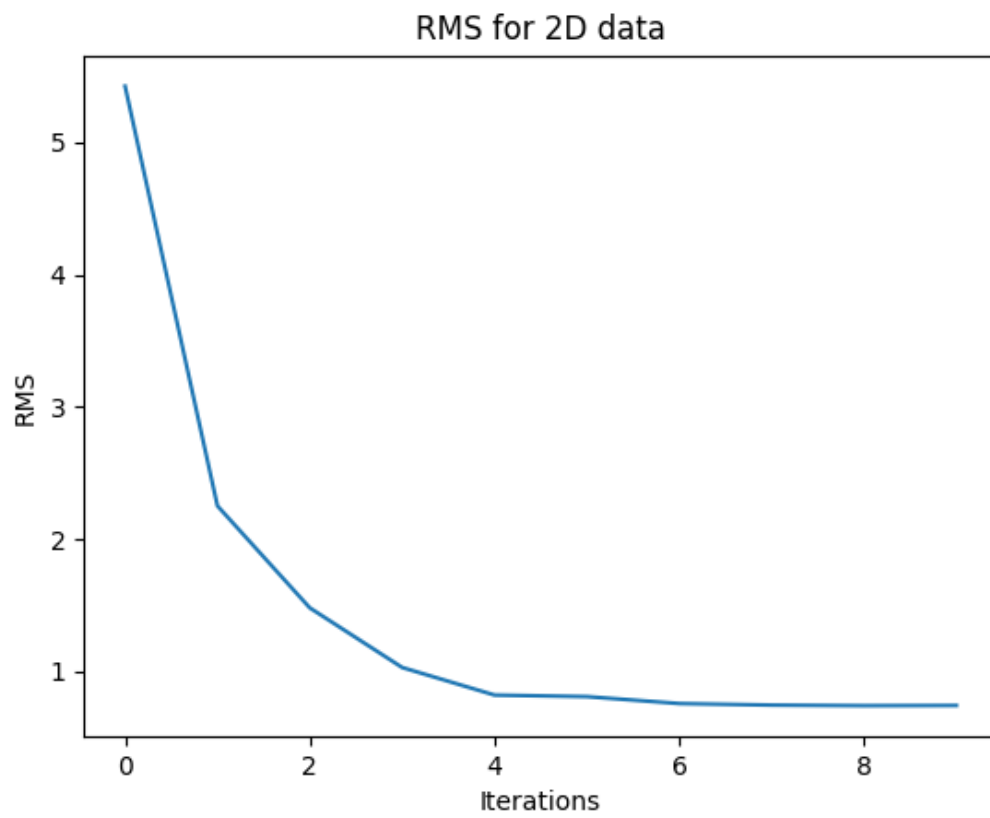


Figure 5: RMS over the 2D Data

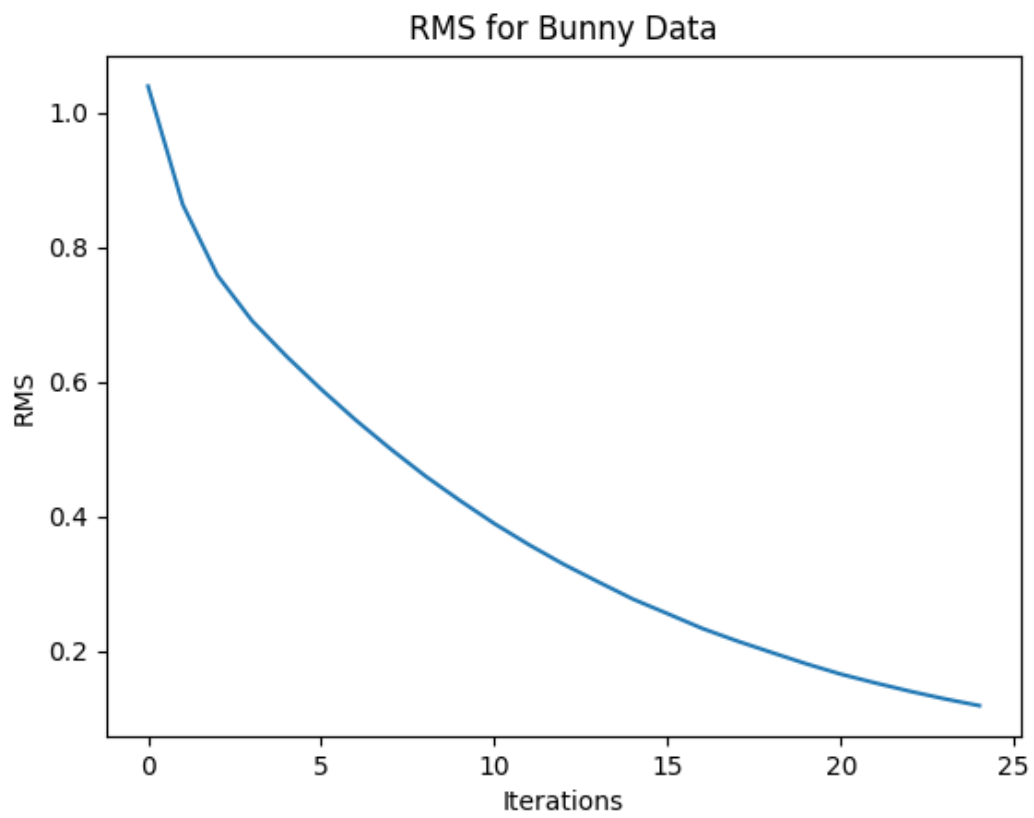


Figure 6: RMS over the bunny data

## 4 Question 4

*Comment on the two previous curves*

The RMS error plots for both datasets exhibit the expected behavior for ICP, with an initial rapid error reduction followed by slower convergence as the algorithm approaches the optimal alignment. Lower final RMS values indicate better alignment. The bunny data demonstrates superior alignment quality. Higher-dimensional datasets like the bunny require more iterations, reflecting the increased computational complexity and iterative refinement needed in 3D ICP.

## 5 Question Bonus

*Question Bonus: Plot the RMS (computed on all points) during ICP convergence for the “Notre Dame Des Champs” clouds with 1000 and 10000 points used at each iteration. What do you think of those curves?* When computing the RMS with a sampling limit of 1000 and 10,000 points, neither algorithm converged, and both were relatively slow. We suspect that the sampling size was either too small to allow the algorithm to efficiently converge or that the number of iterations was insufficient for convergence.

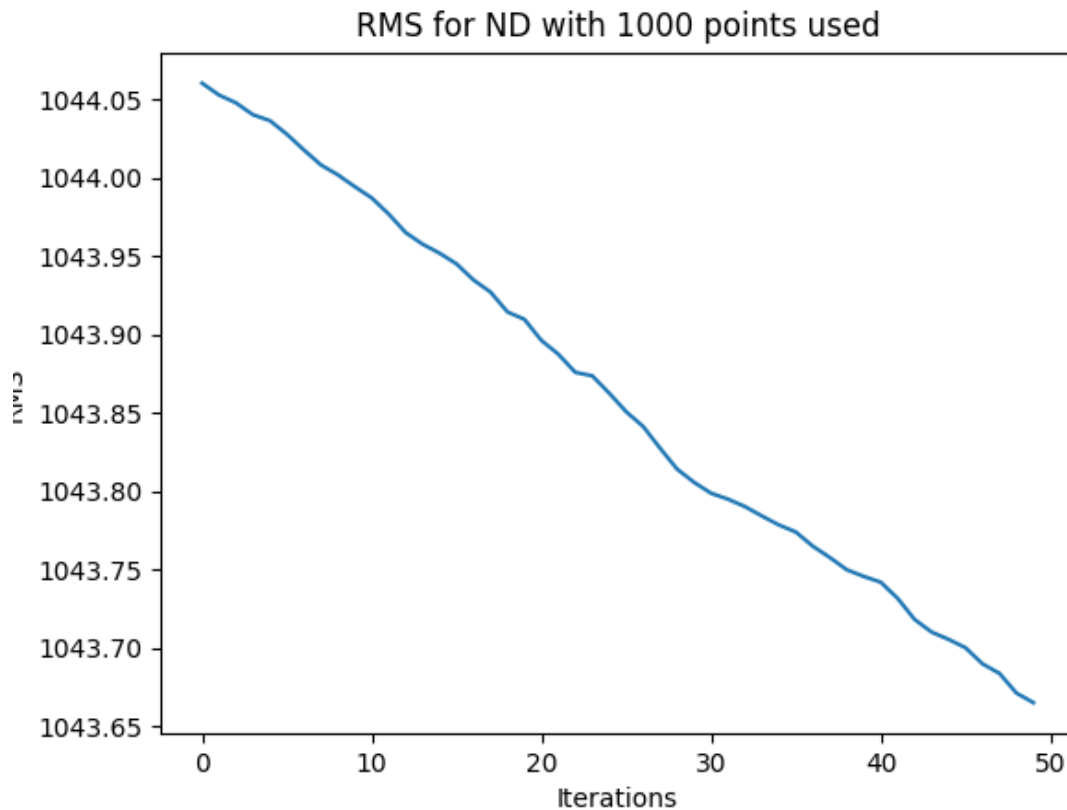


Figure 7: ICP sampling algorithm with 1000 points

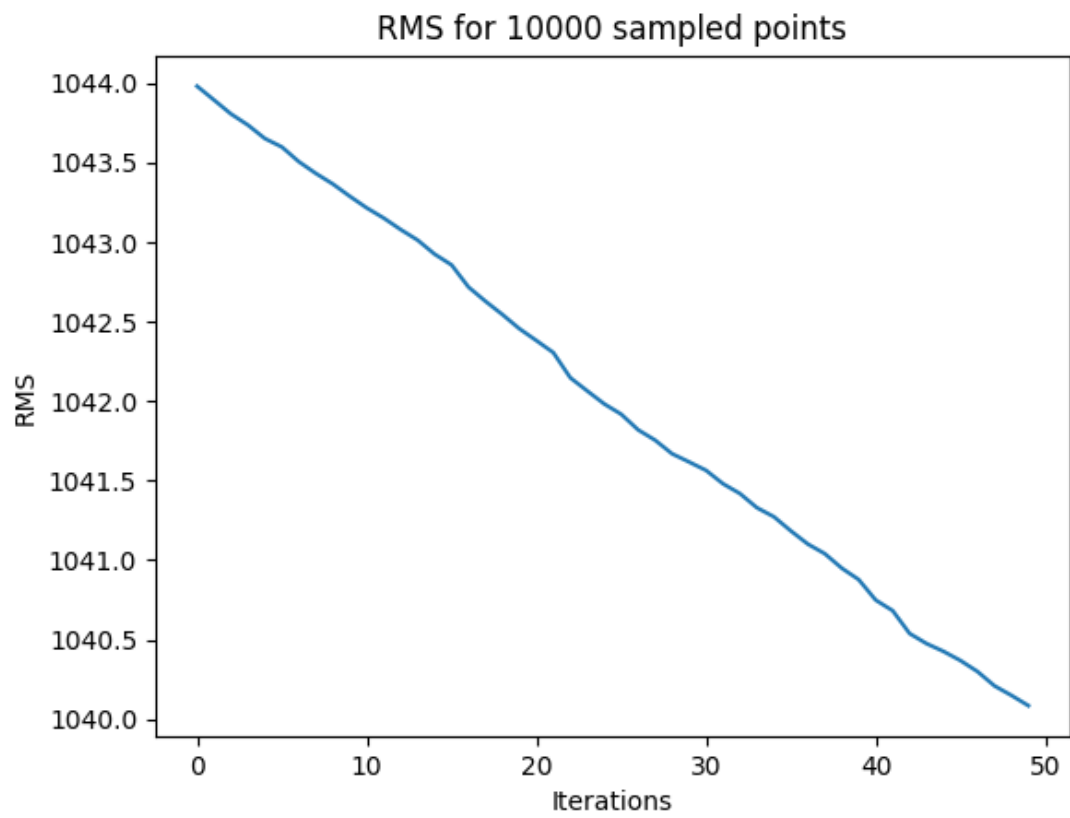


Figure 8: ICP sampling algorithm with 10000 points