# NPM3D - TP 2 : Iterative Closest Points algorithm for point cloud registration

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A.   CloudCompare ICP

Question 1:

The final RMS for bunny_original and bunny_perturbed is 7.27e-8, and the point clouds are perfectly matched. Between bunny_original and bunny_returned, it is 1.34e-2, and ICP is not able to "return" the returned bunny.
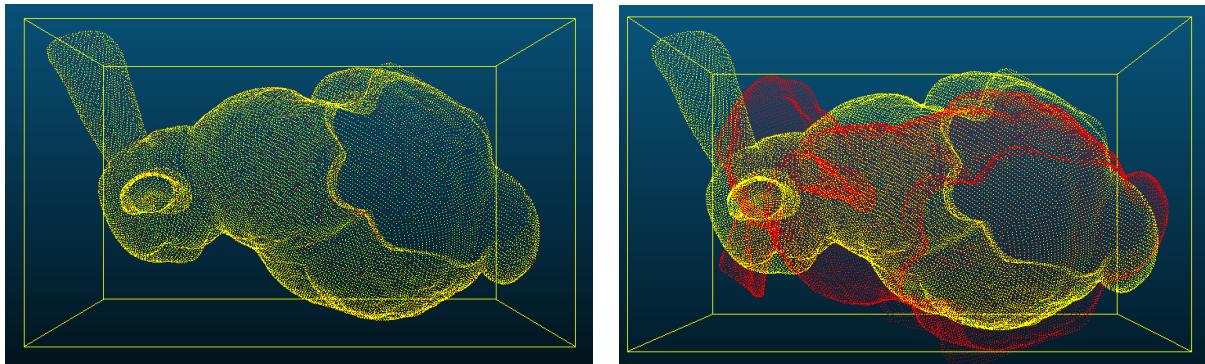
ICP results aligning bunny_perturbed (left) and bunny_returned (right) on bunny_original

Between Notre_Dame_Des_Champs_1 and Notre_Dame_Des_Champs_2, it is 12.94 if the second is taken as reference, and 3.05 if the first is taken as reference. It is the first that should be taken as reference because the second image is a part of the first one, hence many points in the first do not have matching points in the first.
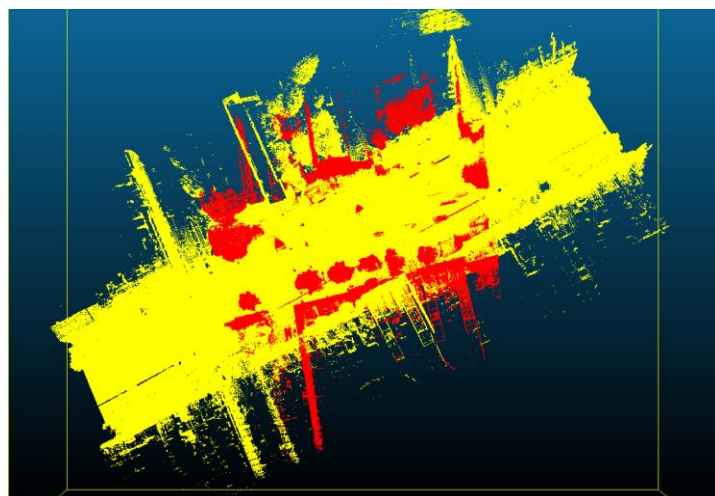

ICP result aligning Notre_Dame_Des_Champs_2 on Notre_Dame_Des_Champs_1

# B. Rigid transformation between matched set of points

Question 2:

Aligning bunny_original on bunny_returned, I obtained a RMS of 0 with the proposed method, and both point clouds are perfectly aligned. The reason why ICP on CloudCompare gave poor results is matching these two images is tricky. The proposed method would not work for the 3D scans of Notre Dame though, as the two points clouds have a different number of points and cannot be matched.
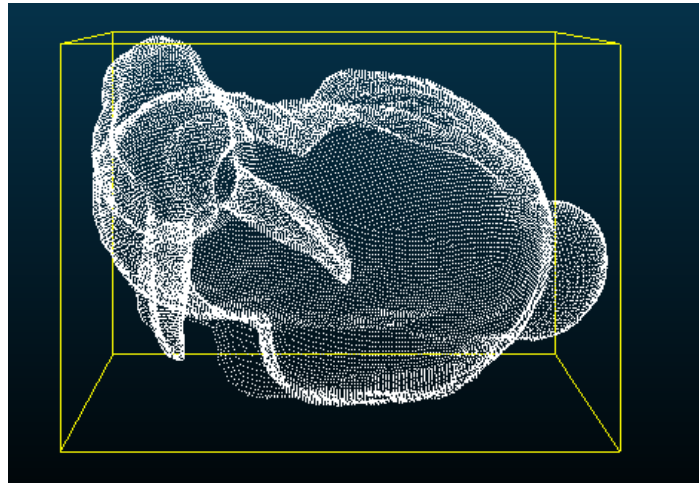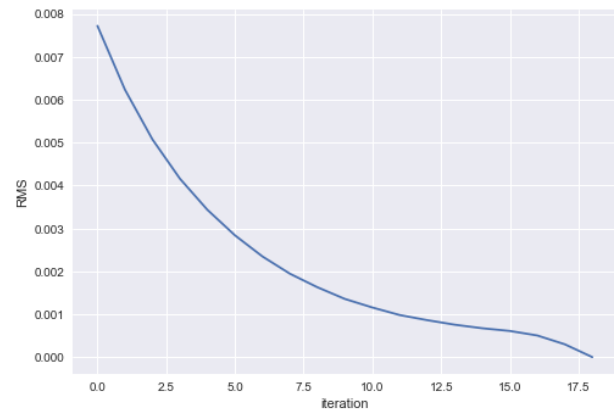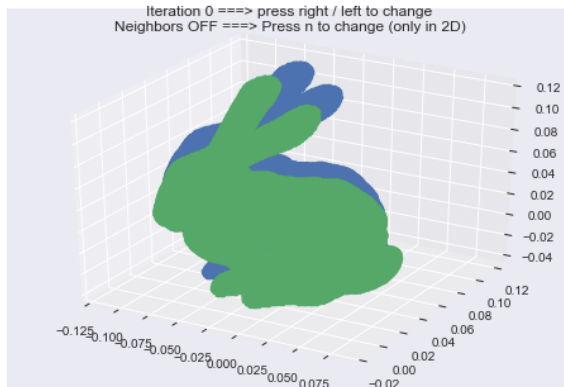

Proposed method to align bunny_original on bunny_returned
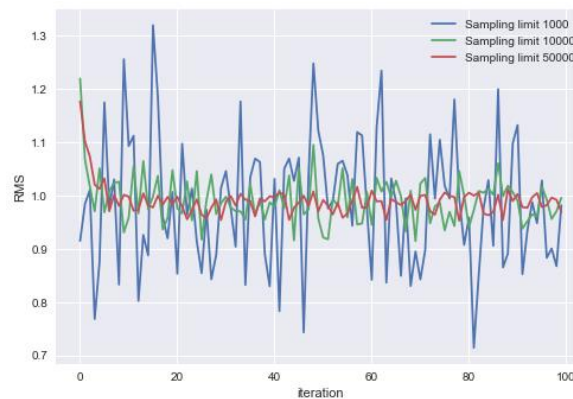
C. Point to point ICP

Question 3:
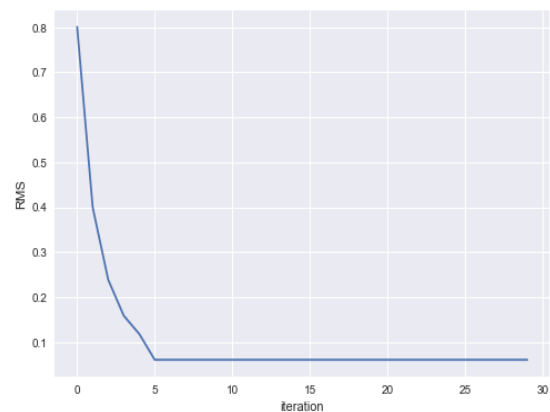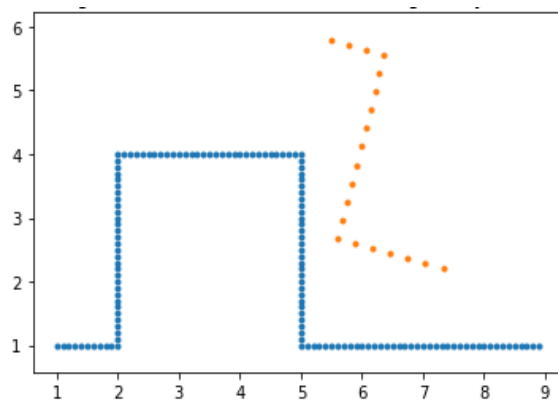
ICP plot (left) and RMS evolution (right) on 2D

ICP plot (left) and RMS evolution (right) on bunnies

I run ICP for 30 iterations or RMS threshold 0.06 for 2D, 1e-4 for bunnies.
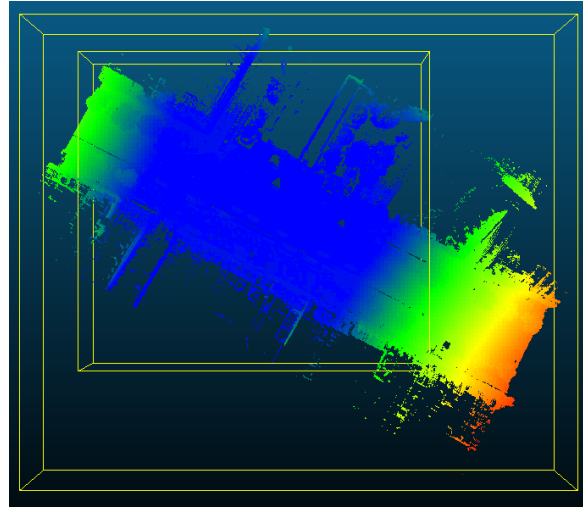
Question 4:

RMS evolution for different sampling limits on the Notre Dame point clouds

I run ICP for 100 iterations or RMS threshold 1e-4, for 3 different sampling limits (1000, 1000, 50000). A higher sampling limit results in a smoother convergence which is logical as theoretically convergence is guaranteed in that case, but it is more computationaly expensive.

D. Going further

Question 5:

The farthest points do not have a corresponding point in the reference cloud, but are still matched with points in the reference cloud, thus they deny convergence of ICP. Computing RMS over the whole data cloud takes into account these points; it would make more sense to consider only the points having a decent matching in the reference cloud.

Cloud to cloud distance on Notre Dame

Question Bonus 1:

I tried 30%, 50%, 70% and 100% final overlaps and 50%, 70%, 90% and 100% RMS overlaps, with sampling limit 10000, for Notre Dame example. The RMS value I have seem constantly significantly below Cloud Compare results.

	Overlap 30%	Overlap 50%	Overlap 70%	Overlap 100%
RMS Overlap 50%	0.047	0.035	0.040	0.098
RMS Overlap 70%	0.056	0.041	0.050	0.14
RMS Overlap 90%	0.066	0.048	0.061	0.22
RMS Overlap 1	0.071	0.052	0.068	1.02
CloudCompare	0.41	0.73	1.31	3.05

Question Bonus 2:
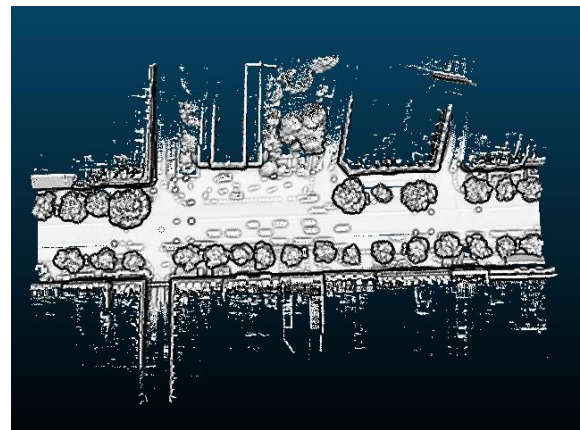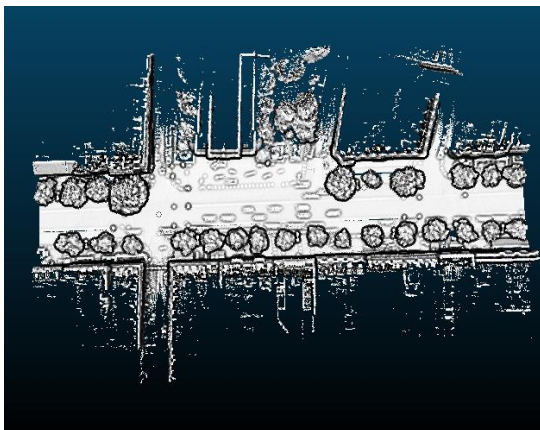
Cloud Compare best result (left) vs my best result (right)

My best result is obtained with final overlap 50%. Visual result is similar to the one of CloudCompare.