

Mines Paris — PSL

Intelligence Artificielle, Systèmes et Données (IASD)

Nuages de Points et Modélisation 3D

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**Question 1:** Modify the parameters (octree depth, boundary, samples per node, point weight) to get the "best" reconstruction of the surface from PoissonRecon. Take a screenshot of the result. How many triangles does your final mesh have? Give the parameters that allowed you to have that result. Explain what "better" reconstruction means for this object.

Best Parameters	
Octree depth	14
Sample per nodes	3
Point weight	0.5
Boundary	Neuman

Table 1: Best parameters for best reconstruction of the surface from PoissonRecon

After analyzing various parameters, we achieved the best performance, as seen in *Figure 1*, with the values presented in *Table 1*. The final mesh consists of 908,738 triangles and 454,371 vertices.

For this object, better reconstruction corresponds to higher resolution—in other words, a greater octree depth ( $\rightarrow$  more triangles). Precise details, such as the rabbit's nose, eyes, and chin, require an adequate point weight and density, controlled by the sample-per-node setting, to preserve the geometric shape. Conversely, for smooth surfaces, the point weight should not be too high to prevent point cloud noise. In this case, the boundary setting did not significantly affect the reconstruction.

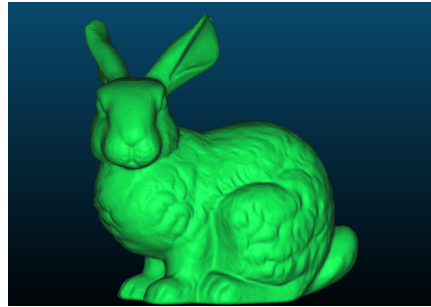
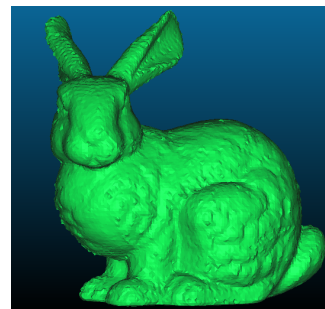


Figure 1: Reconstruction of the bunny with the best parameters seen in *table 1*

**Question 2:** Make a surface reconstruction of the Bunny with the Hoppe function on a  $128 \times 128 \times 128$  voxel grid. Take a screenshot of the final mesh.



(a)



(b)

Figure 2: Reconstruction of the Bunny with the Hoppe function on a (a):  $16 \times 16 \times 16$  voxel grid and on a (b)  $128 \times 128 \times 128$  voxel grid

**Question 3:** Make a comparison between Hoppe and the reconstruction obtained with PoissonRecon in CloudCompare (visual comparisons with side-by-side screenshots, computation time, number of triangles, quality of reconstruction).

We can compare the bunny generated by PoissonRecon in *Figure 3* with the one generated by Hoppe in *Figure 4*. The PoissonRecon model consists of 908,738 triangles, whereas the Hoppe model uses only 82,168, which explains why PoissonRecon's surface appears smoother. Additionally, Hoppe's method is significantly more time-consuming, taking 126 seconds compared to PoissonRecon's 41 seconds.

This difference may be due to the lack of optimization in Hoppe’s algorithm, particularly regarding matrix-based calculations.

Visually, the Hoppe reconstruction introduces more noise since it relies on direct point-based calculations, whereas PoissonRecon benefits from a global implicit function, resulting in smoother surfaces, as seen in the screenshots above. There are also some outlier points in the Hoppe reconstruction, notably near the left ear and at the bottom of the rabbit. Finally, the details in the muzzle of the Hoppe model are less defined than those in PoissonRecon; the separation between the nose and the mouth is not clearly visible.



Figure 3: Bunny generated using PoissonRecon (41 seconds — 908,738 triangles)

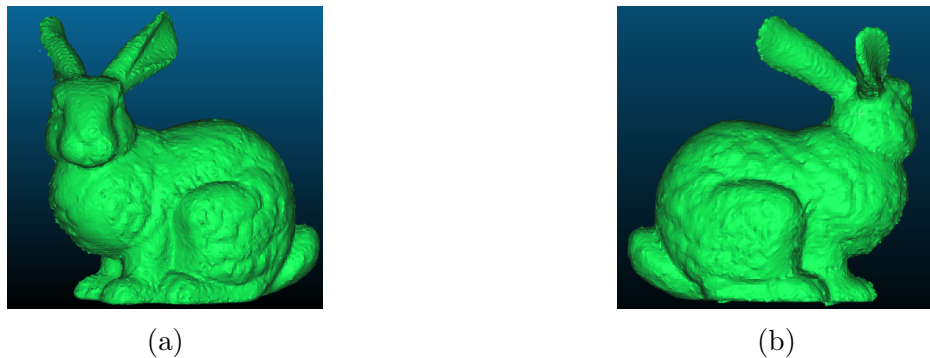
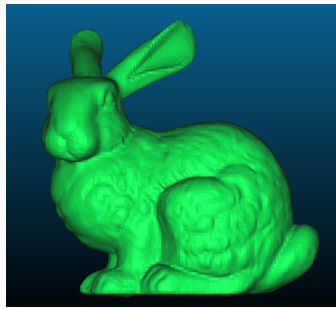


Figure 4: Bunny generated using the Hoppe method (126 seconds — 82,168 triangles)

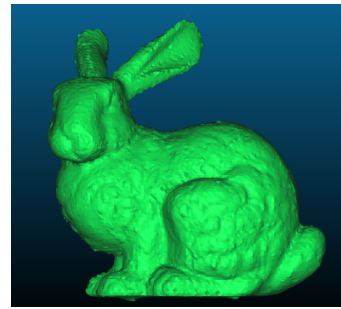
**Question 4:** Make a surface reconstruction of the Bunny with the IMLS function on a  $128 \times 128 \times 128$  voxel grid. Take a screenshot of the final mesh. Make a comparison between Hoppe, IMLS and the reconstruction obtained with PoissonRecon in CloudCompare (visual comparisons with side-by-side screenshots, computation time, number of triangles, quality of reconstruction).

	Triangles	Time	Quality
<b>IMLS</b>	77,164	200s	Good
<b>Hoppe</b>	82,168	126s	Bad
<b>PoissonRecon</b>	908,738	41s	Great

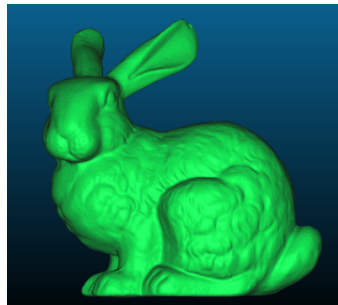
Table 2: Comparison of the different reconstruction methods.



(a)



(b)



(c)

Figure 5: Reconstruction of the bunny using the (a): IMLS method, (b) Hoppe method and (c): PoissonRecon method

We notice that PoissonRecon is the fastest while computing the highest number of triangles. The quality of reconstruction is the best by far. There are more details on the PoissonRecon rabbit's muzzle than with IMLS or Hoppe. The ears also have

smoother surfaces with Poisson Recon and IMLS whereas the Hoppe rabbit's ears have inconsistencies as previously noticed. The outlier triangles below the rabbit also disappear for PoissonRecon (they can be observed when using IMLS and Hoppe). In conclusion, PoissonRecon is the ideal choice on all criterias.