Variational Graph Methods
for Efficient Point Cloud Sparsification

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In recent years new application areas have emerged in which one aims to capture the geometry of objects by means of three-dimensional point clouds, e.g., via LiDAR, stereo vision, or depth-by-motion techniques. Often the obtained data consist of a dense sampling of the object's surface, containing many redundant 3D points. These unnecessary data samples lead to high computational effort in subsequent processing steps. Thus, *point cloud sparsification* or *compression* is often applied as a preprocessing step. The two standard methods to compress dense 3D point clouds are random subsampling and approximation schemes based on hierarchical tree structures, e.g., octree representations. However, both approaches give little flexibility for adjusting point cloud compression based on a-priori knowledge on the geometry of the scanned object. Furthermore, these methods lead to suboptimal approximations if the 3D point cloud data is prone to noise.

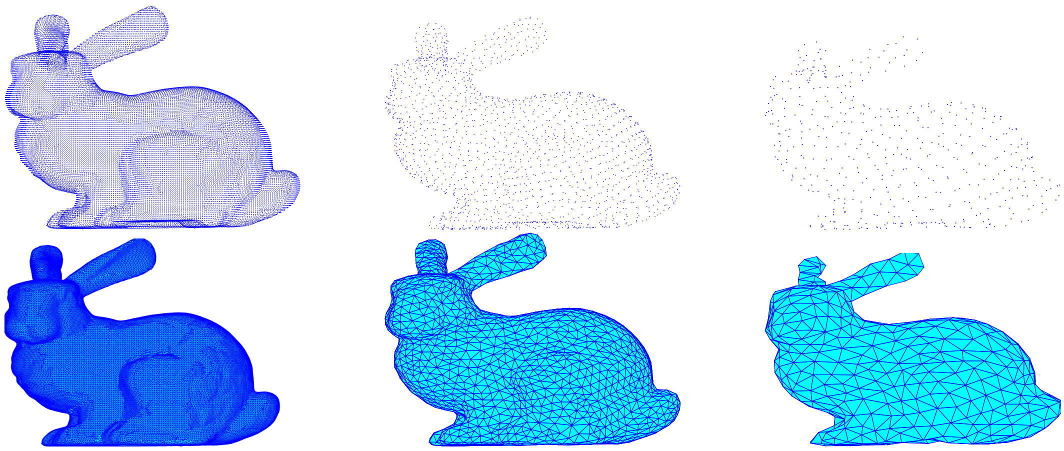

Figure 1: Point cloud sparsification of the 3D Stanford bunny model (top) and resulting triangulations (bottom).

This talk is based on our findings in [3], in which we propose a variational method defined on finite weighted graphs, which allows to sparsify a given 3D point cloud while giving the flexibility to control the appearance of the resulting approximation based on the chosen regularization functional. The main idea of our approach is a novel coarse-to-fine optimization scheme for point cloud sparsification, inspired by the efficiency of the *Cut Pursuit algorithm* for total variation denoising proposed in [1]. This strategy gives a substantial speed up in computing sparse point clouds compared to a direct application on all points as done in previous works, e.g., in the seminal work in [2], and renders variational methods now applicable for this task. We compare different settings for our point cloud sparsification method both on unperturbed as well as noisy 3D point cloud data.

Joint work with: Fjedor Gaede, Martin Burger

References

[1] L. Landrieu, G. Obozinski. Cut Pursuit: Fast Algorithms to Learn Piecewise Constant Functions on General Weighted Graphs. *SIAM Journal on Imaging Sciences 10(4)*, pages 1724–1766, 2017.

[2] F. Lozes, A. Elmoataz, O. Lezoray. Partial Difference Operators on Weighted Graphs for Image Processing on Surfaces and Point Clouds. *EEE Transactions on Image Processing 23(9)*, pages 3896–3909, 2014.

[3] D. Tenbrinck, F. Gaede, M. Burger. Variational Graph Methods for Efficient Point Cloud Sparsification. *arXiv preprint*, arXiv:1903.02858, 2019.