Pyoints: A Python package for point cloud, voxel and raster processing.

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Summary

The evolution of automated systems like autonomous robots and unmanned aerial vehicles leads to manifold chances in science, agriculture and industry. Remote sensing sensors, like laser scanners and multi-spectral cameras can be combined with sensor networks to monitor a research object all-embracingly.

The analysis of such big data is based on techniques of geoinformatics and remote sensing. Next to physically driven approaches, today machine learning techniques are used to extract relevant thematical information the data sets. The analysis requires a fusion of the data sets, which is hardened conceptually and technically by different data dimensions, data structures and various spatial, spectral and temporal resolutions.

Today various software to deal with these different data sources is available. Software like (GDAL/OGR contributors, 2018) and (Bradski, 2000) is intended for image processing. Libraries, like (Rusu & Cousins, 2011), (Zhou, Park, & Koltun, 2018) and (PDAL contributors, 2018) focus on 3D point cloud processing. Each of these software packages provide an API specially designed to solve the problems of their field efficiently. When developing algorithms for automated processing of various types of input data, the differing APIs and programming languages of these software packages become a drawback. To support fast algorithm development and a short familiarization, a unified API would be desirable.

Pyoints is a python package to conveniently process and analyze point cloud data, voxels and raster images. It is intended to be used to support the development of advanced algorithms for geo-data processing.

The fundamental idea of *Pyoints* is to overcome the conceptual distinction between point clouds, voxel spaces and rasters to simplify data analysis and data fusion of variously structured data. Based on the assumption that any geo-object can be represented by a point, a data structure has been designed which provides a unified API for points, voxels and rasters. Each data structure maintains its characteristic features, to allow for an intuitive use, but all data is also considered as a two or three dimensional point cloud, providing spatial indices which are required in many applications to speed up spatial neighborhood queries.

During development great emphasis was put on designing a powerful but simple API while also providing solutions for most common problems. *Pyoints* implements fundamental functions and some advanced algorithms for point cloud, voxel and raster data processing, like coordinate transformation, vector algebra, point filters, or interpolation. *Pyoints* also provides a unified API for loading and saving commonly used geo-data formats.

Pyoints was designed to support research activities and algorithm development in the field of geoinformatis and remote sensing. Early versions of the software have been used for

(Lamprecht, Hill, Stoffels, & Udelhoven, 2017) and some pre-studies at Trier University. *Pyoints* is also used in the (consortium, 2018) project to monitor hazelnut orchards.

The source code for *Pyoints* has been archived to (GitHub, 2008) at (Lamprecht, 2018).

Acknowledgements

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