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Gridless, pattern-driven point cloud completion and extension

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While satellites offer Earth observation with a wide coverage, other remote sensing techniques such as terrestrial LiDAR can acquire very high-resolution data on an area that is limited in extension and often discontinuous due to shadow effects. Here we propose a numerical approach to merge these two types of information, thereby reconstructing high-resolution data on a continuous large area. It is based on a pattern matching process that completes the areas where only low-resolution data is available, using bootstrapped high-resolution patterns.

Currently, the most common approach to pattern matching is to interpolate the point data on a grid. While this approach is computationally efficient, it presents major drawbacks for point clouds processing because a significant part of the information is lost in the point-to-grid resampling, and that a prohibitive amount of memory is needed to store large grids. To address these issues, we propose a gridless method that compares point clouds subsets without the need to use a grid. On-the-fly interpolation involves a heavy computational load, which is met by using a GPU high-optimized implementation and a hierarchical pattern searching strategy.

The method is illustrated using data from the Val d'Arolla, Swiss Alps, where high-resolution terrestrial LiDAR data are fused with lower-resolution Landsat and WorldView-3 acquisitions, such that the density of points is homogeneized (data completion) and that it is extend to a larger area (data extension).