Classify Ground Points by Multiscale Curvature

LIDAR point clouds may contain point returns from bare ground, vegetation, water, and man-made objects such as buildings, towers, and wires. In order to create a bare-earth terrain surface, a major application of LIDAR surveys, it is necessary to differentiate ground from non-ground returns in the data. The Lidar Classification process in TNTmips (see the Technical Guide entitled *LIDAR: Automatically Classify LAS Point Clouds*) includes several classifiers that you can use to automatically identify likely ground points. The Ground - Multiscale Curvature classification method is designed for use in forested areas with a relatively small proportion of ground returns.

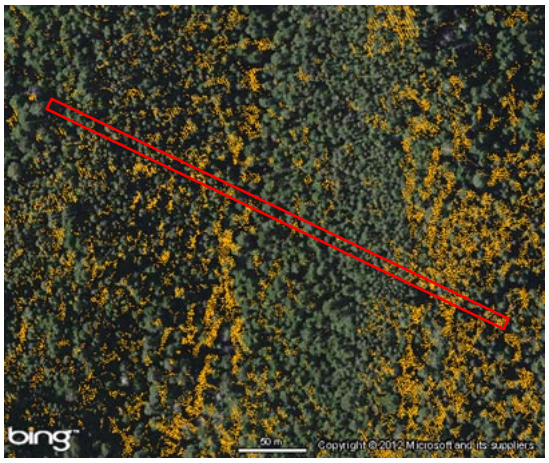
Multiscale Curvature Classification Strategy

The Multiscale Curvature (MSC) classifier uses an iterative, multiscale approach to evaluate local point deviations from a mean surface and progressively eliminate points above this surface from the ground class. The classifier begins by considering only points that are single returns or the last of multiple returns, as earlier returns are almost certainly from vegetation. Some last returns are also rejected as likely vegetation if their elevations are significantly higher than nearby last-of-multiple returns. The remaining points are considered potential ground points.

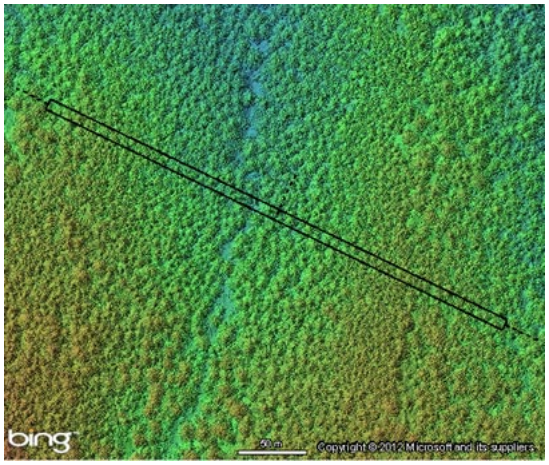
The MSC classifier computes a mean surface from potential ground points by performing thin-plate spline interpolation with tension, then smoothing the temporary terrain surface using a low-pass filter. The cell size of the interpolated surface is controlled by the value of the Nominal Point Spacing (NPS) parameter. Processing is divided into three stages using progressively larger terrain cell sizes: stage 1 uses 0.5 NPS, stage 2 uses NPS, and stage 3 uses 1.5 NPS.

(over)

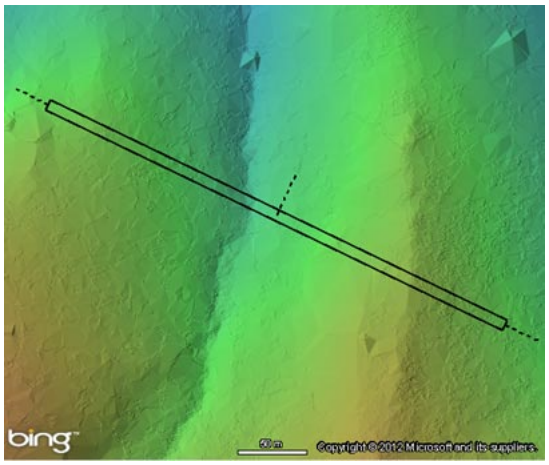
Bing Maps Image of Test Area



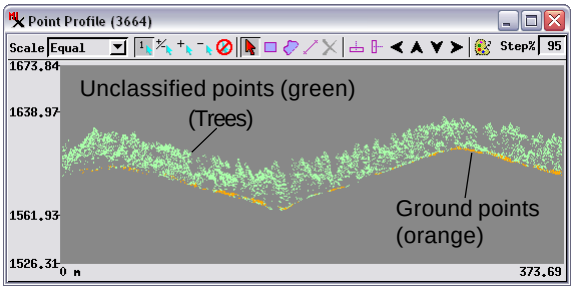
Ground Points from Multiscale Curvature



Virtual Terrain Display from All Points

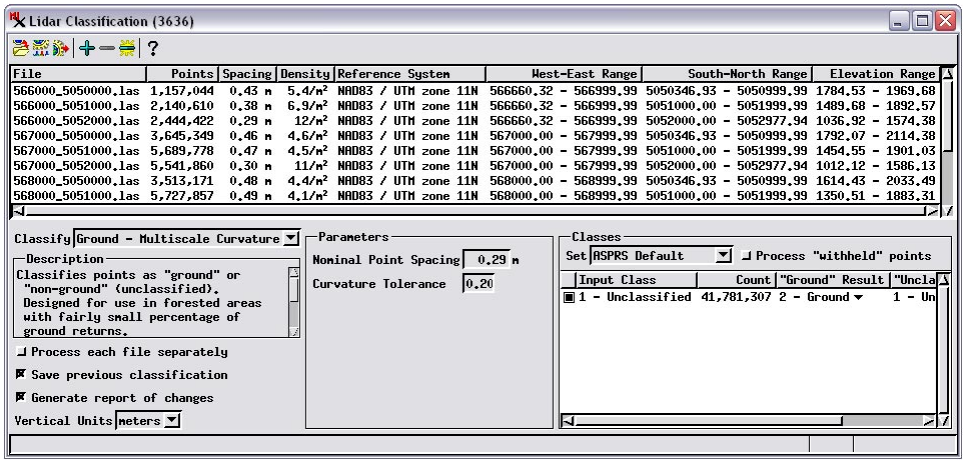


Virtual Terrain Display using Ground Points from Multiscale Curvature method



Result from LIDAR ground point classification by the Multiscale Curvature method for an area of coniferous forest with moderate relief. The Bing Maps image (top left) and other illustrations show only a portion of the classified area; the scale bar length is 50 meters. The illustration top right shows the distribution of ground points (orange) classified (from all input points) by the Multiscale Curvature method in the Lidar Classification process in TNTmips. Over the entire test area, the Multiscale Curvature classification identified 584,138 ground points out of 5,689,788 points (10.3%). The density of ground points varies depending on the spacing of the trees. The illustrations directly above are color shaded-relief virtual terrain displays from the Lidar points. Blue color indicates lower elevations and red the higher elevations; total relief in the test scene is about 130 meters. The virtual terrain on the left uses all point classes, so the surface includes trees. The virtual terrain on the right is based only on the ground points classified by the Multiscale Curvature method. The boxes in the illustrations (red over images, black over terrains) outline the location of the point profile shown to the left. The vertical and horizontal scales in the profile are equal, so true ground slopes are shown. Most trees were excluded from the ground point class by the Multiscale Curvature classifier. However, the ground virtual terrain includes several scattered pyramidal "bumps" (e.g., top center and top right) where some tree returns were misclassified as ground. Such isolated points can be reclassified manually (see the TechGuide entitled *LIDAR: Interactive Editing of Point Classes*).

Each of the three classification stages also includes multiple iterations. In each iteration a mean surface is computed at the current cell size from the remaining potential ground points. Points are then eliminated from the pool of potential ground points if their elevations are higher than the mean surface elevation and their height above it exceeds the value of the Curvature Tolerance parameter. Nonground points are thus eliminated in each iteration as the mean surface is refined, and iterations continue within each classification stage until the number of points eliminated in the last iteration falls below a percentage threshold. When all three stages are complete, the remaining points that have not been rejected are classified as ground.



Multiscale Curvature ground classifier set to process several unclassified LAS files as a group. Classifier settings can be modified in the Parameters panel as described in the text.

The majority of nonground points are rejected in the first classification stage using the highest-resolution model terrain surfaces. Because of the smaller cell size used in this phase, the mean surfaces computed may still be influenced by the presence of above-ground vegetation and man-made structures. Increasing the cell size in the later stages produces smoother mean surfaces that are less influenced by remaining local vegetation points, allowing these points to be progressively eliminated.

Because of its multistage, iterative approach, the MSC classifier requires longer processing times than the Terrain Following ground classifier for comparable input data.

Parameters for Multiscale Curvature

Controls for setting the values of the parameters that guide the Multiscale Curvature classifier are in the Parameters pane of the Lidar Classification window. The Nominal Point Spacing parameter controls the resolution of the interpolated terrain surfaces, as described above. The default value for this parameter is set automatically based on the nominal point spacings of the input LAS files (shown in the Spacing column in the file list). The value you use for this parameter should be no larger than the typical point spacing, and may need to be smaller if the files have highly variable point spacing, which may occur in tiled Lidar data when individual tiles include points from several adjacent flight lines.

The Curvature Tolerance value sets the maximum height allowed above the mean surface for a point to be retained in the pool of potential ground points. You can enter values between 0.1 and 1.0. The value shown is used in the first of the three classification stages. For each subsequent stage, 0.1 is automatically added to allow larger deviations from the smoother mean surfaces. A smaller value for the Curvature Tolerance parameter tends to avoid misclassifying low vegetation points as ground, but may also eliminate valid ground points in areas with complex local topography.